# OUT OF SIGHT, OUT OF MIND

## The Regulation of Canada's Leaking Underground Storage Tanks



John Swaigen

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such a matrix. Virginia Kairys also carried out research into common law remedies in LUST cases as a CIELAP volunteer.

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## METHODOLOGY

Data were collected from a variety of sources, including personal interviews, searches of computer data bases, newspaper clipping files and data bases, court files, trade publications, and access to information requests under various provincial freedom of information statutes, and published reports and studies. Letters were sent to departments of labour, coroners, and emergency response authorities throughout Canada to obtain information on subjects such as injuries and fatalities related to LUST and the frequency and cost of emergency response measures resulting from LUST incidents.

Persons interviewed included government officials, including environmental and fire protection personnel, oil company officials, environmental consultants, tank installers, service station operators, and individuals who have suffered harm as a result of the impacts of LUST incidents.

One thing I have learned in the course of this study is that historical research is difficult to do and "truth" is both relative and evasive. Many people involved in the same transactions have different recollections of what happened and when, and differing versions of how past events are to be interpreted. I found that documentation that would explain, confirm, or contradict what I was being told in interviews was often impossible to obtain. Freedom of Information laws are slow and expensive to use and much information is often held back. In particular, I heard widely differing views as to how effective our regulatory regimes are and how effective is our democratic, free enterprise social system in responding to environmental problems. I would come away from interviews with some oil industry and government officials persuaded that everything that could reasonably have been done to address the growing problem of LUST was done as quickly and efficiently as it could possibly have been made to happen. I came away from other interviews with pollution victims and other government officials with exactly the opposite impression. In the end, therefore, I was forced to draw my own conclusions as objectively as I could given the conflicting information I was given, the lack of access in many cases to "objective" statistical data and to documents prepared contemporaneously with the evolution of awareness of this problem and a regulatory response to it, and my own personal views, which arise from my experience in this field as a government official involved in environmental enforcement and as an environmental activist.

# OUT OF SIGHT, OUT OF MIND

## The Regulation of Canada's Leaking Underground Storage Tanks

In 1986, Environment Canada estimated that there were approximately 200,000 underground storage tanks in Canada containing gasoline, diesel and heating oil, waste oil, aviation fuel, and a variety of other chemicals, and that between 5 and 10 per cent of them were leaking. This meant that there were between 10,000 and 20,000 leaking tanks at that time, if Environment Canada's estimate was accurate. (In fact, according to the official who made these estimates, they were designed to be conservative, to avoid any possibility of criticism by the oil industry, and experience has shown that there are probably considerably more underground tanks, and consequently more leaks, than were estimated.). [1] The following year, in recognition that many of the older tanks were being replaced with new ones that had not yet corroded, Environment Canada reduced the lower end of its estimate to 7,500 leaking tanks. These figures represented only the tanks leaking at those times, and did not take into account leaking tanks that had already been removed from the ground or tanks that later began to leak.

This problem has become known by the acronym LUST, for Leaking Underground Storage Tanks, but in practice, it is frequently impossible to determine whether contamination at facilities having underground tanks came from leaks in the tanks and associated piping, or from spills, for example, from overfilling tanks and vehicles.

Approximately 200 leaks and spills at facilities with underground petroleum fuel tanks are reported to Ontario's Fuels Safety Branch, which administers the regulations covering tanks containing fuels, but not other hazardous substances stored underground. As Ontario has approximately 17% of the gasoline stations across Canada, assuming a proportionate number of leaks and spills in other provinces and Territories, there are almost 1200 leaks and spills a year from gasoline stations and other facilities that have their own underground tanks to fuel their vehicles (often referred to as "private outlets").

[1] Karr interview.

What is the significance of these figures? The significance becomes clear when one understands the potential impact of these leaks on the environment, on public health and safety, on the ability of the public to use and enjoy their property, and on the Canadian economy.

To understand the significance of these leaks and spills, it is important to grasp a few basic facts. First, it takes very little leakage of many substances kept in underground tanks to cause extensive harm. A few litres of gasoline leaking from a tank into a sewer is sufficient to kill a human being exposed to the fumes. Under some circumstances, a few gallons of gasoline migrating through the soil or through the sewers into a building is enough to cause an explosion that will destroy the building. One litre of gasoline leaking from an underground tank into the groundwater can render one million litres of water unfit for use for up to 50 years. (Fact sheet, Beak). A very small leak can, over time, release a lot of hazardous material and cause a great deal of contamination. For example, "A tiny gasoline leak of just one to two drops per second can discharge more than 35 Imperial gallons (132 litres) per month, which can contaminate more than 120 million gallons (454) litres) of groundwater with detectable concentrations of benzene". [2]

There are several communities throughout Canada where people have been drinking gasoline-contaminated water for more than a decade and others where the groundwater has been permanently destroyed as a source of drinking water.

Secondly, it is much easier to discover, contain, and clean up a spill of pollution on the surface of the land than an underground leak. Once pollutants leak into the soil, they are difficult to discover and often almost impossible to contain or remediate.
The rate of migration of pollutants through soil and groundwater is frequently very slow, and the behaviour of pollutants in the soil and groundwater is relatively unpredictable. As a result, the contamination is frequently not discovered until it causes harm, often decades after the release occurred. Thus, the contamination has often become widespread by the time it is discovered, and it is often impossible to determine the source. If the source is discovered, its owner is often bankrupt or insolvent and therefore it is no longer possible to obtain compensation from the

[2] IJC at p. 24

source for the harm caused by the leakage. The results of this delayed discovery of pollution are two-fold. First, the cost of cleanup has escalated, and has often become prohibitively expensive. Secondly, it is impossible to establish legal liability or the source no longer has the means of paying for the cleanup. Therefore, a substantial portion of the costs of remediation of UST leaks is borne by the victims of the pollution or by the public purse.

It is crucial to prevent leaks because it is often impossible or prohibitively expensive to decontaminate the soil and groundwater once they are contaminated. Traditional forms of clean-up have often succeeded in recovering only about 50% of the escaped product. The larger the amount of escaped product, the lower the percentage recovered. (Dames and Moore, Table 3-16, 3-22) Modern methodologies can improve the recovery rate, but are slow, often requiring the operation of equipment for several years, and are often prohibitively expensive. It is particularly difficult and costly to investigate to determine the cause of contamination and carry out remediation activities in urban areas, where most service stations are found. The constraints on effective hydrogeological investigation and a effective containment and clean-up efforts include the inaccessibility of areas occupied by buildings and other fixed structures, restraint on mobility of drilling equipment by the location of buildings and structures, and restraints imposed by overhead and underground utility services on the location of test holes and trenches. In addition the costs of investigation are increased by damage to paved roads, sidewalks, and driveways, damage to lawns, gardens, shrubbery and trees, damage to fences, retaining walls, and other structures, noise, and disruption of traffic patterns. As one commentator has noted, "Only by major disruptions and disturbances of urban areas at a drastically increased cost of the clean-up operation can some of the problems of mobility and accessibility be overcome". [3]

A second reason why prevention is crucial is that most current clean-up methods do not destroy or contain the pollutants, but merely transfer them from one medium to another; for example, transfering them from the groundwater to the soil, surface water, or the air or from the soil to the air.

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[3]JJ Vonhof, "Hydrogeological Investigation of a Gasoline Spill, Flin Flon, Manitoba", circa 1975.

Since the early 1970s, the drinking water supplies of thousands of Canadians in numerous communities have been contaminated by UST leaks; many homes and businesses have been evacuated as a result of explosive levels of fumes in sewers and buildings, for periods ranging from a few hours to several months; there have been several explosions and fires causing injuries, extensive property damage and business losses; extensive soil and groundwater contamination has prevented land development and imposed expensive remediation and disposal costs on property owners; and underground utility cables have been destroyed.

Moreover, the economics of spill clean-up suggest that this is a problem that cannot be ignored. The average cost of a site clean-up following leaks and spills of petroleum products has been estimated at $200,000 a site. [4] Thus, Ontario's oil spills alone will cost approximately $40 million a year to clean up. Projecting these figures across the country, leaks and spills from gas stations and private fuel outlets cost approximately $235,200,000 a year. These are direct clean-up costs only. They do not include many other costs associated with these leaks and spills, such as business losses; emergency response efforts by fire departments, road authorities, police, environmental authorities, and other government departments; litigation expenses; uncompensated losses of third parties; and emotional distress.

Nor do these costs take into account the losses attributable to leaks and spills from underground tanks containing many hazardous substances other than fuels. If the costs related to these sources are added in, the total cost of LUST clean-up each year is far higher.

In light of these facts, the urgency of the need to put in place systems to prevent such leaks would seem to be self-apparent. Yet in this study, I have concluded that despite numerous improvements in the technology available to prevent leakage and improvements in the regulatory regime governing underground tank systems, there remain serious problems in the regulation of underground storage tanks.

[4] Philip

Among the conclusions that raise concerns are the following:

- the agencies responsible for regulating underground storage tanks are understaffed and underfunded. They do not have the resources to put in place the systems required to ensure that underground tank leaks do not occur, or if they do occur, to ensure that they are detected quickly and steps are taken to prevent and rectify harm.

- In most jurisdictions, since the 1970s any new underground tank for gasoline or fuel oil must be protected against corrosion. However, when this requirement was put into place, owners of existing tanks, many of which were 20 or 30 years old, were not required to replace them with the more modern tanks, that were less susceptible to corrosion. Most provinces gave owners of unprotected steel tanks up to 15 years to replace or upgrade their existing tanks.

- Many provinces gave owners of existing tanks the option of upgrading them using either cathodic protection or internal lining. However, there have been many problems with internal lining failure. Despite this, most provinces have not required any special monitoring of tanks upgraded by internal lining to determine if they are leaking.

- The legislation generally contained no requirements that owners of large numbers of tanks set up a tank replacement program to ensure continuous removal of old tanks during the interim period before the final deadlines. Although some large oil companies set up ongoing tank replacement programs, they did not always follow them. As a result, removal of many tanks was left to the eleventh hour. Rather than enforce these time limits, provincial governments further extended them.

- Although the oil industry developed a scientific technique for predicting tank failure, for use in determining priorities for tank replacement, this scientific methodology was not always followed. The speed and priority of tank removal was often governed by economics rather than science.

- One of the strategies used by the major oil companies to avoid removal of deteriorating tanks was to sell them to the operators of service stations for $l. Many of the least profitable service stations were sold to independent operators, who were the least likely to be able to afford to replace tanks when the tank replacement deadline approached, and the least able to afford the cleanup of contaminated soil and groundwater and the compensation of victims of spills.

- With a few exceptions, there are no requirements that the owners and operators of facilities with underground tanks carry any liability insurance or provide any form of security or financial assurance to cover harm from tank leaks.

- In 1993, roughly two decades after the LUST problem became apparent, British Columbia, Alberta, the Yukon, and the Government of Canada still had no specific regulations governing underground tanks.

- Unlike many U.S. states, Canadian provinces and Territories do not provide any financial assistance to small operators to assist them in upgrading their facilities to prevent leaks. Instead, they have reacted to arguments that these owners cannot afford safe equipment by delaying the implementation of laws that would require such upgrading.

- Much of the contaminated soil from petroleum leaks and spills is simply dumped in local landfill sites without any treatment.

- It appears that much of the contaminated soil and groundwater from leaks of gasoline and other petroleum products has been, and continues to be, "treated" largely by releasing the fumes to the air. The release of volatile organic carbons is considered a major contributor to global warming (the "greenhouse effect"). VOCs are also an ozone precursor, contributing to the formation of ground-level ozone. Benzene and other volatile components cause cancer and other diseases.

- Although a substantial proportion of leaks result from improper installation of tanks and associated piping, most provinces have no requirements or minimal requirements for training and certification of installers, and most legislation does not require installers to carry any insurance or post any security or financial assurance to cover clean-up and compensation costs.

- Although injuries and deaths, as well as environmental damage, have occurred as a result of improper procedures in carrying out repairs to tanks and removal of old tanks, there are few requirements that those involved in the business of repairing and removing tanks be trained or certified, or that they carry liability insurance or post financial assurance.

- The laws requiring replacement of corroding tanks often exempt small fuel oil tanks and both large and small tanks at individual residences and farms. These tanks are sometimes underground, but more often are in basements or sitting on the ground or on a stand outside the residence. Such an exemption cannot be justified on environmental grounds. These tanks are frequent sources of spills, sometime cause substantial damage to soil and aquifers, but the damage from leaks and spills is frequently not covered by homeowners' insurance policies, and the public often must pay the cost of clean-up.

- Governments have often not met the standards they have imposed on the private sector. For example, the Ontario Government made a regulation in 1983 requiring that all unprotected steel tanks and lines be removed by January 1, 1991. The Ministry of Government Services, which administers most land owned by the province did not begin to document where its tanks were located and their age until the spring of 1992. As of December 1993, the Ministry had not yet compiled the data it had collected and had not yet undertaken a program of removing and upgrading any tanks shown by the survey to require this. When the data was compiled, it showed that the Ontario government owned many old, unprotected steel tanks which would have been illegal if they were privately owned.

- Similarly, the federal government has no legislation to govern the safety of tanks owned by federal government departments and no up-to-date inventory

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# PART I - THE NATURE AND SCOPE OF THE PROBLEM

## Chapter 1 - THE CAUSES OF LUST

The phenomenon we have been discussing is usually referred to by the acronym LUST, for Leaking Underground Storage Tanks. In fact, however, the most frequent cause of leakage from underground tank systems is not holes in the tanks themselves, but damage to the piping, or lines, connecting the tanks to pumps, boilers, and other associated equipment. In particular, leaking occurs at the joints and elbows to those pipes, either as a result of improper connection, incompatibility between pipes and their fittings, or shifting of the piping after installation. Pump failures, often resulting from worn seals, are a significant source of leakage, and result in a disproportionate degree of loss when the liquid flowing through them is under pressure.

The most dramatic cause of leakage from tanks has been the deterioration of old, unprotected steel tanks. It has been estimated that up to 95% of the old bare steel tank failures resulted from corrosion.[5] In the past, tanks were constructed of bare steel, with no interior coating to prevent corrosion. Often, such tanks were coated with asphalt or coal tar, or with some other exterior coating. However, deficiencies or gaps - referred to in the industry as "holidays" - occur in the best of coatings, and even if the tank is uniformly coated, holidays can occur during installation or after installation through shifting of the tank. Moreover, all coatings are permeable to some extent, however small.

In the past, many tanks were put into the ground without taking proper precautions to prevent damage to them or reduce the possibility of corrosion. Tanks were often placed in the native soil surrounding them without any sand or gravel backfill around them to reduce corrosion. The hole was often backfilled with material containing various kinds of rubble and garbage. The surrounding soil might contain sharp stones or rocks that could puncture them, or metal that would increase the risk of corrosion.

[5]EPA, cause - check.

Tanks were often placed with their bottoms below the water table. Often, they were not anchored. These practices resulted in piercing of the tank or lines, stresses resulting for shifting, or accelerated corrosion.

Corrosion occurs both from within the tank and from the outside. Corrosion from within is often a result of incompatibility of the tank or its internal lining with the material in it. In past, the primary method of leak detection, "dipping" the tank, sometimes punctured the tank from within, as the dipstick repeatedly hit the tank bottom when the liquid level was being measured.

Lack of compatibility between the tank or lines and the product they contain is another source of tank corrosion. Some of the plastic tanks and linings introduced in the late 1970s to replace or upgrade unprotected steel tanks proved to be incompatible with the products they were intended to contain, particularly some tanks for gasoline.

The second generation of tanks which came into common usage in the late 1970s and early 1980s are less likely to leak than the bare steel tanks. These tanks are primarily either Fibreglas Reinforced Plastic (FRP) or cathodically protected steel. The U.S. Environmental Protection Agency has found that these tanks rarely fail as a result of corrosion. [6] Most FRP failures occurred shortly after these tanks first came on the market, and resulted from the use of incompatible products, from damage before or during installation, and from manufacturing defects. Tank failures have since dropped off and have been estimated to be 1 per cent [7] of the tanks sold. With the advent of cathodically protected tanks, which reduce the likelihood of external corrosion, it is believed that the main source of steel tank failure will become internal corrosion. [8]

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[6]EPA, causes.

[7](check epa causes)

[8]epa causes.

Since tanks are much less susceptible to internal corrosion than to external corrosion, this will mean a much lower incidence of tank failure. However, no one knows exactly how much internal and external corrosion respectively contribute to the failure. It has been estimated that 70 to 80 per cent of the corrosion failures result from external corrosion, 6 to 10 per cent from internal corrosion, and 15 to 19 per cent from a combination of the two.[9]

There is now a third generation of tank systems available which are more reliable than either cathodically protected steel or FRP. These are secondary containment (that is, double-walled) sytems with interstitial monitoring. Leaks can be detected either when groundwater enters the external wall or when product enters the interstitial cavity through the internal wall. In addition, there are new methods of leak detection available, including methods of detecting defects in tanks and pipes that may allow leakage and detecting the presence of product in the surrounding soil or groundwater after its escape. However, governments throughout Canada have been reluctant to require the use of such modern technology. In the case of secondary containment tank and piping systems the reason for the reluctance is their cost. In the case of leak detection systems, the reluctance results from a combination of cost and uncertainties about the reliability and effectiveness of some of the technologies.

However, tank and line corrosion is not the most common cause of leaks. The most common cause is improper installation. The most significant sources of UST releases have not been leakage from tanks, but spills and overfilling, and (epa causes of release) leaks from product delivery lines, particularly where they are under pressure. Of the leaks from tanks, most have been due to loose tank fittings and vents or fill pipes on top of the tanks, rather than holes in the tanks themselves.

[9] epa causes 7.

## Chapter 2 LUST IN PERSPECTIVE

This study focusses on LUST because it is a relatively self-contained subject matter, and because its causes, effects, and cures are relatively obvious and inexpensive compared to many other environmental problems. I do not mean to suggest that LUST is the most serious environmental problem that Canadians face or that it is the most significant source of spills, groundwater pollution, or air pollution. However, in light of the amount of harm attributable to LUST and the relative ease with which the problem and its solutions can be identified and corrected compared to many environmental pollution concerns such as acid rain, global warming and ozone-depletion, our failure to deal with LUST more quickly and effectively than we have raises serious questions about the ability of our institutions to respond effectively to environmental problems.

In this chapter, therefore, I attempt to look at LUST in the context of its contribution to other environmental concerns. Leaking underground tanks have not been the most common source of soil and groundwater contamination, nor have the most catastrophic individual pollution incidents generally been caused by LUST. However, LUST is of particular interest because the causes are much easier to isolate and control than many other accidental releases of hazardous substances to the environment. LUST relates specifically to containers - their design, installation, use, monitoring, and abandonment. As such, we are dealing with relatively self-contained systems, which can be regulated and dealt with to prevent harm, if society has the will to do so.

Leaking underground tanks can be isolated as a subject for study and for action because UST systems have common characteristics that facilitate the design of legislation and technology designed specifically to address them, and because they form such a substantial proportion of certain environmental problems that focussing on their regulation will make an important contribution to the overall control of those problems. Moreover, a study of LUST regulation is worthwhile because it sheds light on the features of our political system that place barriers in the way of dealing effectively with other environmental problems.

Within the LUST category, tanks containing petroleum products used as fuel, and within this category, tanks containing gasoline, can be isolated for discussion, both because these categories of tanks and products are regulated separately from other USTs and because they represent a substantial proportion of the escapes of petroleum products. Gasoline has particularly been the focus of attention by researchers and regulators because of its ubiquitousness, its high mobility through air, soil, and groundwater, its high percentage of benzene, a carcinogen, compared to other fuels, and its explosivity.

However, in attempting to determine the causes, effects, sources, and costs of LUST, the researcher faces the difficulty that LUST incidents are frequently reported together with other other environmental issues. Often, data are simply non-existent. As other researchers have noted, baseline data about the environment needed to make environmental protection decisions is often unavailable. In relation to contamination of groundwater, for example, researchers have little or no documentation of sources of wastes, the fate of contaminants in the substrate, lack of detailed inventories of groundwater sources, depths of wells, contaminant sources, and local hydrogeology. [10]

Where information about LUST incidents is available, it is often lumped together with other information. For example, reports of leaks and spills often do not indicate whether a release resulted from a leak or a spill, references to tanks do not differentiate between tanks, pumps, and piping, or between above-ground and below-ground tanks. Indeed, leak and spill statistics are not available at all in some provinces. Reports of spills and leaks of petroleum products often simply refer to them as "oil"; and reports of "gas leaks", may refer to gasoline, or to a material in its gaseous state, such as natural gas or methane. The categories of sources of fires listed in fire loss reports prepared by provincial fire marshals or fire commissioners and local fire departments are seldom fine enough to differentiate between UST leaks and other escapes of chemicals. Nor do the statistics on workers' injuries and fatalities clearly differentiate between UST leaks and other releases of toxic gases or

[10] beak alley.

explosions. Information on the causes of voluntary and legally required evacuations of buildings and communities as a result of actual or anticipated fires, explosions, or fumigations is often even less complete or satisfactory.

Moreover, by far the most common source of LUST is gasoline and other petroleum products, which are so ubiquitous that it is frequently impossible to definitively determine the source of a leak or spill. There are usually so many spills in places where there are tanks that it is impossible to determine whether contamination came from a tank leak, a single spill, or an accumulation of many spills and/or leaks. Moreover, tank testing equipment gives both false positives and false negatives. That is, a tank may fail a pressure test for reasons other than holes in the tank (for example, loose-fitting bungs), or may pass a pressure test even though it contains holes.

As a result, it is difficult to determine the precise degree of seriousness of LUST. However, it is useful to understand that LUST is, in fact, an important component of many other environmental and public safety problems. LUST cuts across many other areas of concern, including groundwater contamination, soil contamination, spills, and air pollution:

**1. Groundwater contamination**

Common sources of groundwater pollution include garbage dumps and landfills, waste storage and holding impoundments (commonly known as "lagoons"), septic systems, spreading of sludges on land, mine wastes, pipelines, seawater intrusion, deicing salts, and agricultural activities, including feedlots, application of pesticides and fertilizers, and irrigation.[11]

As indicated in a later chapter, contamination of groundwater is one of the most significant environmental impacts of leaking underground storage tanks. However, the difficulties of dealing with groundwater impacts from LUST and the failure to

[11] beak.

prevent and remediate UST leaks and spills are merely one manifestation of our difficulties in dealing effectively with preservation of groundwater quality and quantity.

As a resource to be protected, groundwater has been relatively ignored in Canada.[12] This results from many causes, including the relatively sparse population of the country and its relatively low reliance on groundwater as a source of drinking water; the slow movement of contaminants through soil and into groundwater, and through the groundwater itself, so that contamination may not become apparent for many years, and the high cost of "mapping" subsurface systems. It has been suggested that concern about groundwater protection is directly proportional to the extent to which it is needed for drinking water. Thus, concern and steps to protect the resource have been much greater in provinces dependent on it as a drinking water source than in provinces that rely primarily on surface water sources.[13] It has also been suggested that groundwater has largely been ignored because it is needed as a drinking water source primarily in rural communities, while influence on politicians is most concentrated in urban areas.[14]

In addition, water can be contaminated without having a bad taste. As a result, many people throughout Canada routinely drink well water contaminated with bacteria and viruses from septic systems and animal husbandry, pesticides and fertilizers from farming, and low levels of benzene and other chemicals, without knowing that they are being exposed to potential health risks. The lack of expressions of public concern is due in part to the fact that people do not realize they are drinking these contaminants. The lack of ability to measure small quantities of contaminants and inaccessibility of equipment and laboratories has also contributed to a lack of collection and dissemination about groundwater contamination until recently. In addition, the science of hydrogeology is just emerging from its infancy, and the inability to accurately determine direction and speed of groundwater flows and dissemination of contaminants through groundwater

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[12]beak, alley:

[13]BEAK.

[14]BEAK? Coon.

has and the relatively high cost of doing so have discouraged efforts to become more familiar with this resource. One result is that contamination from underground storage tanks that leaked decades ago is only now being discovered, and many such leaks are as yet unknown. [15]

## 2. Contaminated soil

Until recently, soil contamination was also largely ignored, as long as the contaminant did not enter other media, such as air, surface water, or groundwater. However, increasing development pressures, changing land use patterns, and highly publicized incidents such as Love Canal, the construction of the Malvern housing subdivision in Toronto on soil contaminated with radioactive waste, and the costly clean-up of BC Place required before it could be sold, have focussed attention on this source of contamination. In addition, the escalating cost and difficulty of disposing of contaminated soil have focussed the attention of the development industry on a problem previously ignored. In the past, if contaminated soil was discovered and was an impediment to development, it was frequently hauled to the local garbage dump and disposed of. However, capacity problems in urban areas, restrictions imposed by senior levels of government on the disposal of contaminated soil, restrictions imposed by landfill site operators concerned about potential liability in the event of migration of contaminants from their sites, and substantial increases in "tipping" fees where dumping is still permitted, have drastically reduce the ability of landowners and developers to use this inexpensive method of cleaning up contaminated land. This has meant that contaminated soil on a building site has become a serious impediment to land development,(hore, peterborough) and the cost of disposing of or decontaminating the soil may be prohibitively costly. The federal government has earmarked $200 million dollars for clean-up of "orphan" contaminated sites over the next five years, but it is estimated that this will allow the clean-up of only a small fraction of the known abandoned sites. [16] No one knows where the money will come from to clean up the rest, and it has been predicted that many such sites will have to be left in a contaminated condition indefinitely.

[15] BEAK.

[16] notes cited in mitchell paper.

There is no doubt that soil contaminated by leaks and spills from USTs is a major component of the soil contamination problem. The decommissioning of gasoline stations alone is resulting in the need to deal with large quantities of contaminated soil. The closing of one Petro-Canada service station in Preston, Ontario in 1994, for example, is reported to have required the excavation of 10,000 tonnes of soil to get access to 6,000 tonnes of contaminated soil. [17] These amounts are typical of gas station clean-ups. The closing of military bases and factories throughout Canada has also resulted in the discovery of large quantities of contaminated soil, some of it from UST leaks, some from on-site waste disposal, and some from spills.

### 3. Spills

Leaks and spills have traditionally been lumped together under the rubric "spills", and treated differently by the legal system than routine, ongoing "process pollution". One reason for this differential treatment is that the causes of leaks and spills are frequently different from the causes of "process pollution". Process pollution involves the ongoing creation of waste as a result of a production process, and the deliberate use of air, land, or water as a waste disposal site. The creation of this waste is a by-product of the production process, and is often costly and difficult to avoid. Leaks and spills, on the other hand, are usually isolated accidental events which can generally be avoided through vigilance.

Leaks and spills are also treated differently by the legal system because of differences in the availability of insurance. Most third party liability insurance coverage exempts liability for damage from ongoing discharges of contaminants, and covers only "sudden and accidental" events, such as spills. Leaks, which are sometimes ongoing and gradual, may or may not be considered "sudden and accidental". Thus, they fall into a gray area between sudden spills and ongoing process pollution. The fact that insurance coverage is available for spills, but not for ongoing discharges, was the key factor in leading the Ontario Government to impose absolute liability for the clean-up of spills, and to provide a compensation scheme for victims of spills, but not for ongoing pollution.

[17] Bob Burtt, "Bacteria eat up contaminants", K-W Record, p.B3, May 6, 1994.

Between 1978 and 1983, 21,587 spills and leaks were reported to provincial and federal authorities across Canada involving 3,669,460 tonnes of material. The sources of these spills included mines, wells, batteries, storage depots, trucks and other motor vehicles, industrial plants, trains, service stations, refineries, pipelines, marine terminals, and aircraft. Materials that leaked or spilled included natural gas, salt water, pesticides, fertilizers, sewage, petroleum products, and a variety of chemicals. Petroleum products that spilled or leaked included crude oil, No. 2 fuel, No. 4 fuel, No. 5 fuel, No. 6 fuel, gasoline, waste oil, and asphalt, as well as petrochemicals. The petroleum sector and transportation were the most frequent sources of leaks and spills, with the petroleum sector accounting for about half of all spills. [18]

In fact, the number and magnitude of spills during this period was probably far greater than reported. For one thing, the network collecting spill information did not include all agencies that would be informed of spills. Moreover, the laws requiring spill reporting were much less stringent and much less rigorously enforced than they are today. That these numbers underrepresent the actual number of spills and leaks is apparent from later statistical summaries. In Ontario, for example, in 1990 alone, there were 5,686 reported spills and leaks. [19] That is, in one province in one year, there were 25% (check exact no.) of the total spills reported for ten provinces and two Territories over the five year period between 1978 and 1983. Unless the number of spills has been increasing dramatically, a possibility that appears to be remote in light of more stringent penalties and increased civil liability and improvements in spill prevention systems, the explanation is probably that spills in earlier years were far greater in number than reported.

Leaks from underground tanks and piping have consistently been a significant source of these spills. Moreover, as indicated above, contamination from underground tank leaks is often unreported or undiscovered for many years. Thus, it is likely that this is a more frequent source of "spills" than the available statistics indicate. [20]

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[18] everything in this para from Env. Cda Summary of Spill events 74-83.

[19] SAC Summary Report of 1990 Occurences.

[20] BEAK.

Moreover, provincial laws that require the reporting of spills often do not require the reporting of the discovery of soil or groundwater contamination resulting from past spills. Often, the contaminated soil or groundwater is disposed of without its existence ever having been reported to environmental authorities. This is particularly true of contaminated soil, which, as mentioned above, has traditionally simply been carted off to the local garbage dump, a practice which still continues, although to a lesser extent.

As stated above, 200 leaks and spills from gas stations and private outlets alone are reported to Ontario's Fuels Safety Branch each year, a number which, if projected across Canada would represent 1176 LUST incidents per year, since Ontario is believed to have approximately 17% of Canada's tanks. The Ontario Environment Ministry's Spills Action Centre received 343 reports of spills and leaks associated with underground tanks between May 23, 1992 and February 10, 1993. [21] The sources of these LUST incidents included not only gas stations and private fuel outlets, but also septic tanks, furnace oil tanks at residences, businesses and institutions, and industrial establishments, and tanks containing industrial products and raw materials. Although gasoline was by far the most common substance, underground tanks also leaked diesel oil, furnace oil, sewage, ammonium sulfate liquor, acetate, paint thinner, sewage, hydraulic fluid, waste motor oil, and hydrochloric acid.

### 4. Air pollution

The contribution of LUST to air pollution is discussed in the following chapter. LUST incidents involving gasoline, one of the most ubiquitous products in society, and solvents, are of particular concern because some of their components are both volatile and injurious to human health. Leakage to soil and groundwater eventually reaches the air through a variety of paths such as discharge to surface water, entry into sewers and buildings, excavation of contaminated soil, various forms of "treatment" of contaminated soil and groundwater that involve venting emissions to the atmosphere, spreading contaminated soil at landfill sites, dumping contaminated material to fill low areas and wet areas of land, and discharging contaminated water

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[21]. many reports during this period involved the discovery of soil contaminated by past leaks and spills rather than the spills themselves.

to municipal sewers, which empty into water courses. There have been few attempts to determine the extent of air pollution from such occurrences and therefore little is known about the extent to which LUST contributes to air pollution.

## Chapter 3 THE DAMAGE CAUSED BY LUST

LUST incidents have been responsible for a variety of kinds of harm to the environment, to property, and to public resources. As indicated above, the most obvious impacts of LUST incidents have been groundwater and water supply contamination, contaminated soil, build-up of vapours in structures, requiring evacuation or abandonment, and explosions. These effects in turn result in loss of use and enjoyment of property, business interruption and business failure, the need to provide alternative or replacement water supply systems, and inability to develop or redevelop property.

LUST incidents also impact on surface waters. This may occur when groundwater emerges into surface waters as part of the hydrological cycle, by overland flow, or by flow through sewers or other human constructs. One example of leaks reaching surface waters through the normal hydrological cycle occurred throughout the 1980s in British Columbia's lower mainland, particularly in West Vancouver and North Vancouver. While most home heating oil tanks throughout Canada are found in basements or above-ground, parts of Vancouver are an exception. Vancouver's North Shore has a large concentration of underground tanks. A survey carried out by Environment Canada found that 12,595 single-family dwellings were built on the North Shore from 1946 to 1960. Of them, 4,595 were heated by oil or kerosene. By the early 1980s many of these tanks were deteriorating. The area has mountainous geography, with many steep slopes from these residences down to the ocean. The wet climate and creeks in the area are very conducive to tank corrosion. In addition, there are many springs in the area. Leaking fuel would often enter the ground and emerge at the surface through these springs, then flow into the ocean or other surface waters. Environment Canada documented 24 such leaks on the North Shore in 1989, but estimated that many similar leaks occurred that were not documented. [22]

[22] ecological timebomb article, Harrington (?) interview.

LUST incidents occasionally cause other kinds of damage. For example, a gasoline leak at a service station in Red Lake, Ontario resulted in raw sewage entering a lake. The gasoline flowed through the municipal sanitary sewer system into the municipal sewage treatment plant, where it temporarily destroyed the functioning of the plant, resulting in the discharge of untreated sewage to the lake. [23]

Destruction of underground utility cables by leaking gasoline has been documented both in British Columbia and in Alberta. In 1982, for example, British Columbia Telephone Company experienced service failures of its telephones in Kelowna. The failures were traced to loss of circuits in the cables in two buried conduits. The cables were saturated with what appeared to be gasoline. Even after the telephone company replaced the cables, service outages in the same area of conduit continued. In June of 1983, the conduit and cables were again found to be saturated with gasoline. One of the underground conduits had to be abandoned, and a new manhole constructed and the cables replaced in the other. According to one source, this kind of damage was a frequent occurrence in major cities in Alberta in the late 1980s and early 1990s.

Occasionally, human injury has resulted from LUST incidents.

Below, I will discuss some of the impacts that have been observed in Canada and the United States. This information, however, is far from complete. Both the number of incidents and the impacts of LUST resulting from individual incidents are poorly documented in Canada. Most information is found in individual inspectors' files and incident or investigation reports, and is either not compiled in any aggregate form or is found in incident summaries that give minimal information about the causes and effects of the incidents they describe. In many cases, the information is found in "spill reports" that describe the information given to an environmental agency when the spill or its impact is initially discovered, or after the agency's initial response to the report. These reports often list the suspected source of the pollution, but are not followed up with a similar set of reports that reflect the ultimate findings of the investigation. Thus, they may greatly underestimate or overestimate the amount of material released to the environment, the extent of its migration, and the damage

[23] Shell decision and transcript.

caused. The source initially suspected may not be the actual source, or may be only one of several actual or potential sources of the release. The investigation resulting from a spill often reveals additional sources of contamination, which may not be documented in spill reports. Moreover, these summaries often do not distinguish between recent releases and the discovery of accumulations of pollution in the soil or groundwater when land is disturbed for excavation or construction activities. In recent years, as tank removal programs have accelerated, many of these summaries relate to the discovery of contaminated soil at sites that are being decommissioned, or where tanks are being removed.

LUST has been much better documented in the United States. Even there, however, there are substantial gaps in the available information. For example, a study of releases (spills and leaks) from underground storage tanks published by the U.S. Environmental Protection Agency in 1986 revealed 12,444 release incidents - noting, however, that the total number of releases was unknown, that the full impacts may be incomplete, and that the information available represents only the minimum number of impacts associated with releases. [24] Like the Canadian information summaries that are available, most of the summaries upon which the US EPA based its conclusions were short and "many were uninformative". Only half of the reports reviewed by the EPA contained any comments describing the impact of the release. [25]

The EPA found the following documented impacts from UST releases: contamination of private ground water and surface water supplies, municipal ground water and surface water supplies, industrial water supplies, other ground waters, and surface waters; human illness and death; damage to aquatic life, wildlife, and plant life and crop losses; damage to materials from corrosion; damage from fire and explosion; contamination of non-contact and contact recreational waters; and combustible fumes in confined areas. [26]

[24]Summary on releases p. 8-4.

[25]both the last two sentences from Summary, p. 8-5.

[26]US EPA Summary on releases from USTs, table 8-1.

The EPA documented 749 incidents of contamination of private wells, 155 fires and explosions; 100 incidents involving human illness; 103 incidents with impact on aquatic life; 99 incidents causing harm to plant life or crop loss; 34 incidents resulting in corrosion of structures; and 2 incidents causing human death. [27] Many incidents resulted in more than one of these impacts.

In Canada, the same kinds of effects are found. Below, we describe some of the harm from LUST documented in this country.

Groundwater and Well Contamination

Groundwater contamination often does not become a matter of concern to the public or to regulators until it reaches someone's water supply. By this time, it is often extremely difficult to determine the source and to decontaminate the water supply. In cases of petroleum fuel contamination, the sources are ubiquitous. There are frequently several known underground and above tanks in the area. In addition, the soil in the vicinity of service stations, garages, bulk plants, refineries, and other facilities that use petroleum products is frequently contaminated by a few large spills and leaks or many small ones over many years from usage of these products. By the time wells are impacted, the pollutant may have travelled far enough from its source and become dispersed to the extent that it is impossible to isolate the source. In addition, remedial action is often delayed because of the intermittent nature of the contamination. Frequently, there are seasonal fluctuations of contaminant levels in wells. The contamination often rises and falls with the level of the water table, so that contamination found in the spring will "disappear" until the following spring, resulting in a failure to detect the contamination in water sampling programs, and lulling both the well owners and government authorities into a false sense of security.

Efforts to determine the source of well pollution are therefore prolonged and costly. Hydrogeological studies are often inconclusive. Hydrogeological studies and sampling programs have taken from several weeks to several years without successfully determining the source of the pollution. Since under our legal system

[27] p. 8-4.

the owners and users of petroleum and other chemicals are generally not required to contribute to any clean-up or compensation fund, and since no one can be required to clean up a spill or leak until the source is ascertained, and in many provinces not until negligence is established, this means that the investigations and studies needed to determine liability are often carried out at public expense. Moreover, because remediation usually cannot await detection of the source, replacement of water supplies is also often initially carried out at public expense or the costs are borne by the victims of the pollution.

The most commonly reported source of well contamination as a result of LUST is petroleum products, particularly gasoline. There is little or no proof of harm to human health from petroleum-contaminated well water, largely because little is known about the precise levels at which these products cause health effects in low doses, because few epidemiological studies have been carried out, and because the low taste and odour threshold of petroleum products often causes rejection of the water supply before contamination reaches high levels. [28] However, there have been incidents when people have been warned by public health authorities not to drink petroleum-contaminated water, but have not been warned of the danger of taking in these products through the skin or through breathing the fumes. As a result, they have continued to use the water for bathing, washing dishes and clothes, and other household purposes. The adequacy of the health advisory warnings given to the public was an issue raised by some people interviewed during the course of this study. [29]

Of particular concern is gasoline, one of the most ubiquitous products in our environment. Gasoline is not a single substance, but has many different formulations, each containing different proportions of the same components, as well as a variety of additives. Gasoline contains over 225 chemical compounds, some of which are known carcinogens, neurotoxins, and foetotoxins. People affected by short-term exposure to gasoline have complained of itchy eyes, drowsiness,

[28] ecobichon, innis and allan health effects file.

[29] Coon.

headaches, depression, and anxiety.[30] Long-term exposure to gasoline-contaminated water may cause damage to the liver and kidneys, and there is some evidence that gasoline can cause cancer in animals and damage foetuses, and is clastogenic (causes chromosomal damage). Among the toxins in gasoline are the following:

- Benzene - The first cases of chronic benzene toxicity were documented in 1897 [31] Benzene hematoxicity was reported about 80 years ago, and the first reports of leukemia associated with benzene exposure were published in the 1920s and 1930s. Its carcenogicity is well established, although the mechanism is unclear.

- Ethyl benzene - Ethyl benzene has been recognized as a skin irritant since at least 1963.

- Toluene - Toluene has adverse effects on muscle coordination, and has been associated with nausea, aplastic anemia, embrotoxic effects, neurological damage, and narcosis.

- Xylene - Long-term exposure to xylene has been correlated with aplastic anemia. Other health effects associated with xylene exposure include gastrointestinal disturbances, embryotoxic effects, dermal and eye irritation, hepatic and renal disfunction, and some fatal blood dyscracias.

- Ethyl Bromide - A known carcinogen.

- Heptane, pentane, and hexane - Cause irritation and dizziness. N-hexane is a neurotoxin [32]

[30]Pet on tap p. 10.

[31]Santeson and LeNoire.

[32]ecobichon et al.

- Tetra ethyl lead - The neurotoxicity of lead is well documented. There is also evidence of retardation of mental development in children exposed to lead.

- Ethylene dibromide. This chemical, present in leaded gasoline in trace amounts in the tetra ethyl lead added to the gasoline, has been called by the National Cancer Institute the most potent cancer-causing substance ever found in its animal testing program [33]

- Ethylene Dichloride - This substance, an animal carcinogen, is also present in the lead added to gasoline.

- MMT - This manganese compound is being added to gasoline to replace the lead that has been banned in Canada and the United States. Like lead, it accumulates in the body. While less toxic than lead, manganese can cause brain damage and Parkinson's disease-like symptoms.

There have been numerous documented examples of water supplies rendered unfit for use as a result of LUST incidents. These range from the contamination of a few individual wells to the destruction of municipal wells serving all or parts of several communities.

Wells have been contaminated with hydrocarbons from petroleum products, including the carcinogen benzene, at Beaver River and La Crete, in Alberta; at Ashurn and Swan River (check) in Manitoba; at Delaware Township, Delta, Fullarton, Ops Township, Brooklin, Noelville, Killaloe, and Port Loring in Ontario; at Fairvale, Grand Bay, and Hillsborough in New Brunswick; in Nova Scotia, at Tony River in Colchester County affecting a community well that served six families and Sydney Forks in Cape Breton County affecting one domestic well; [34] at Tignish affecting approximately 20 wells, Tyne Valley and Winslow contaminating six wells, Kensington, and North River (15-20 wells polluted) in P.E.I.; [35] In Saskatchewan, at Estevan in 1991

[33] pet on tap p. 15.

[34] Beak 2.84-5.

[35] sources - beak, Delta report 2.89-90, Jardine report on Kensington etc.

leaks in underground storage tanks owned by Saskatchewan Property Management Corporation resulted in the medical health officer issuing a drinking water advisory to warn residents not to drink their water, in 1992, a municipal water distribution line in Marengo which did not supply drinking water was contaminated by abandoned underground service station tanks; in July 1990, gasoline was detected in the municipal drinking water supply of Fulda resulting in a drinking water advisory being issued and replacement and rerouting of part of the water distribution system. [36]

In some of these cases, a substantial amount of groundwater and many wells were affected. For example, 20 wells were contaminated in Tignish and 76 in Killaloe. [37] In Hillsborough, at least 18 wells were contaminated. It has been estimated that 75 per cent of the drinking water supplies in the Hillsborough business district have been tainted by petroleum products [38] At Delta, a leaking underground gasoline tank contaminated an estimated 45 million U.S. gallons of groundwater. [39] In many of these cases, contamination has persisted or recurred for decades. At Port Loring, for example, residents tasted gasoline in their drinking water from 1976 to 1978, when Gulf Canada installed and began to operate a new communal well to replace 17 contaminated private wells. However, this communal well and several private wells were found to be contaminated with gasoline again in November of 1991. When the contamination was discovered in the 1970s, the gasoline in the ground was not removed, because this was considered prohibitively expensive. Gulf's consultant had anticipated that within a decade, the groundwater would purge itself of gasoline by dilution and dispersion. However, this did not occur.[n40]

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[36]Estevan, Fulda, Marengo examples from ltr James Mr. Brandt. Sask Env. to JS Dec 31, 92.

[37]eyeopener p. 23.

[38]Pet on tap p. 25.

[39]An Assessment, Devlin et al.

[40n] Bruce Brown interview.

At Delta, the groundwater contamination came to the government's attention when a resident complained in 1976 that her water had a petroleum taste and odour. The Ministry of the Environment concluded that a local gasoline station was the source of the contamination, and an activated carbon filtration system was installed in the affected residence. However, in 1980, the homeowners living west of the original contaminated well made a similar complaint. A water treatment system was installed at this residence. However, in 1982, a hydrogeological investigation carried out by the Ministry of the Environment revealed a contaminant plume 550 metres long, 350 metres wide, and 60 metres deep. It was estimated that between 7,700 and 34,000 litres of fuel had been lost, and 38 million gallons of groundwater were polluted.[41] Pumping and treating the contaminated groundwater began in January of 1987[42] Gulf Canada Limited, which was paying for this treatment expressed hope in September of 1991 that the groundwater would be decontaminated sufficiently by the Spring of 1992 that it could cease operation of the treatment system[43] However, the decontamination process was still continuing as of November 1992.[44] In Noelville, petroleum was discovered in a well in 1968. There were no additional reports of contamination until the 1980s, when petroleum was discovered in several more wells. The contamination continued into the 1990s. In Killaloe, a foul smell was first noticed in the water in 1978, after blasting operations. Underground gasoline storage tanks and surrounding contaminated soil were removed in 1978, but there were continuing complaints about a gasoline smell in drinking water from residents of other areas in the village core. In 1978, a survey by the Ministry of the Environment showed that the contamination area had spread, but well contamination came and went according to the season. Local wells remained contaminated in 1990[45]

[41]Low cost treatment. Note discrepancy in no. of gallons.

[42]Low Cost.

[43]Ingram.

[44]Ingram.

[45]eyeopener 23.

In addition to contaminant plumes that have been traced to leaking underground tanks, there have been several severe cases of widespread fuel contamination where it has not been positively proven whether the source of the contamination was leaks, or whether it was spills. In many cases, the contamination is believed to have resulted from a combination of spills and leaks from a single source or several sources. In Ashern, Manitoba, two large underground plumes of dissolved contaminants, including petroleum products, solvents, and cleansers, may have come from leaks in several underground tanks as well as spills at bulk plants.[46] Toxic organic pollutants had been identified in many drinking water wells in this village since the mid-1970s and this pollution was still continuing in early 1992[47] Complaints about a gasoline odour and taste in private drinking water wells were registered with municipal authorities on numerous occasions since the early 1970s.[48] In 1991, a sampling program by Manitoba Environment found gasoline in 24 drinking water samples, 19 of which contained benzene. Eight showed benzene above the Canadian Drinking Water Objective of 5 ppb. Further sampling of the local wells also showed that they were contaminated with chemicals other than fuel, including 1,2-Dichloroethane, chloroform, chloromethane, 1,1,2 trichloroethane, and tetrachloroethane. The contaminated water supplies included a motel and its restaurant, a bake shop, the municipal offices, and several homes. Traces of benzene were also found in the water at the hospital and the elementary school. In 1991, the source, or more likely, sources, of the contamination were not yet known. There were, in fact, two clusters of contaminated wells, one on the village's east side, and one on the west. The clustering, together with the diversity of the chemicals found in the water, suggested that there might be more than one source. There were several underground tanks in the area. However, there had been spills at a former Gulf Canada Products Bulk Plant in 1976 and 1978 that may have caused or contributed to the contamination.

[46] Geokwan.

[47] geokwan p. 11.

[48] Important information pamphlet.

In Rogersville, New Brunswick, 20 petroleum contaminated wells were discovered between November 1982 and February 1983, including the well serving the region's high school. According to the principal of the high school, its drinking water had been contaminated since the late 1970s. A new 300 foot deep well was drilled in 1984, but it too was contaminated with petroleum.

The municipal well for the village of Missinipie, Saskatchewan was contaminated by leakage from an independent gas station around Thanksgiving, 1992.

More insidious in some ways than petroleum contamination, is groundwater contamination from septic systems. Because the bacteria and viruses in human sewage cannot be tasted, people are likely to drink sewage-contaminated water without knowing they are harming their health. In addition, nitrates in sewage are the cause of the "blue baby" syndrome. Nitrates can also cause irritation of the mucous membranes of the stomach and the urinary bladder, and diuresis.[49] Between 1945 and 1973, 2000 cases of fatal nitrate poisoning were reported throughout the world. Nutrients such as phosphorous and nitrates from leaking sewage systems leach into surface waters, robbing them of oxygen and causing eutrophication. While the problem of these systems rests more with the clogging and overloading of the tile beds and leaching systems associated with the tanks than with leaks in the tanks themselves, there are similarities with the petroleum LUST problem, both in the fact that many of the older septic tanks and holding tanks, like petroleum tanks, were made out of unprotected steel and have been in the ground for roughly the same length of time as the petroleum tanks that are now leaking, and because these underground systems, being out of sight, also do not receive the recognition they deserve as a widespread and serious source of contamination.

[49]Gibb and Jones intro.

As discussed below in chapter 9, groundwater contamination from malfunctioning septic systems has been well documented for many years. There are an estimated 2 million septic tanks in Canada [50] and in some areas 65 to 75% of them do not meet today's standards for design and construction or are observably malfunctioning. [51] Examples of well contamination from septic systems include fecal bacteria in domestic wells in Selkirk, Manitoba, high nitrate levels in almost all the wells in Woodville, Ontario, domestic wells affected by high nitrate levels in Sault Ste. Marie, Ontario, 36% of the wells in Milton, Nova Scotia and 39% of the wells in Brooklyn, Nova Scotia contaminated with bacteria. [52]

## 2. Evacuations and building abandonments

Petroleum products exhibit different degrees of volatility. It is precisely this volatility that makes them so useful as fuels. Petroleum products do not burn in their liquid state. However, when vapour and air are mixed in certain proportions, a fire or explosion can occur. Gasoline is particularly volatile. In a lean mixture (a little less than 2%) 5 gallons of gasoline will produce 8,000 cubic feet of burnable or mildly explosive gas - enough to fill a room 20 feet long and 40 feet wide, with a ten-foot high ceiling. In 100 parts per volume of air and gasoline, an explosion can take place if there is more than 1.4 parts of gasoline vapour or less than 6 parts. Thus, although the explosive range is narrow, it requires very little gasoline vapour to create an explosion. Moreover, the flash point of gasoline is zero degrees fahrenheit, or lower, so an explosion can occur even in the dead of winter.

Petroleum fumes can build up in any confined space, such as a sewer or basement, and when the concentration is within the explosive range, it takes nothing more than a spark, that may be caused by turning on a light or by a sump pump or furnace "kicking in" to set off an explosion.

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[50] beak, table 3.5.

[51] Cottage Life, cottage country surveys

[52] BEAK.

Moreover, even in the absence of explosive levels of fuel, the odour of fumes in homes and workplaces can cause nausea, headaches, and other symptoms of illness requiring evacuation of the premises. For example, an ambulance station owned by the Municipality of Metropolitan Toronto had be be abandoned permanently after ambulance drivers complained of fuel odours for three years. As is typical of such incidents, the problem was slow to be recognized and dealt with because of its intermittent nature. The odour levels increased in periods of heavy rainfall and decreased when rainfall was light. The problem may occur when the water table is high and disappear when it drops. In addition, during cold months, more gas may be drawn into a building from the soil because the heat in the building creates a "stack effect", forcing air up and out through the building. After considering several alternatives, including venting the soil, which could result in emissions that would bother neighbours, and complete demolition of the building and replacement of the building, its foundation, and the surrounding soil, Metro decided to close the station permanently. [53]

Evacuations of buildings and areas of municipalities since the 1970s as a result of the build-up of fumes to explosive levels have included: removal of two families from their homes in Brandon, Manitoba for several weeks in 175; evacuation of 2000 residents from their homes in St. Eustache, Quebec in April, 1978 after gasoline in the town's sewage system caused an explosion; abandonment of a house in Port Loring, Ontario in 1978 [54] evacuation of three families in the Hillhurst-Sunnyside district of Calgary in January 1980, following leakage of 20,000 to 60,000 gallons of gasoline [55] the evacuation of two families in Hillsburgh, Ontario for over two weeks in December of 1982 [56]; evacuation of about 600 residents from about 200 homes in west-end Halifax in April, 1987 as a result of faulty underground piping at a Chebucto Road gas station, [57] evacuation of one building

[53]Metro Ambulance Station 38 Soil Investigation (MacLaren), Pim memo to Grier.

[54]Beware! This water can start a blaze, Tor Star p. 1, Nov. 25, 1978.

[55]Calgary Herald, Problems from gasoline spill could linger on for years, Jan 7/81, p. B1.

[56]newsp. clip.

[57]gas leak blamed on faulty pipes, HCH Ap 7/87 p.1.

on Bilby Street in Halifax in May 1987 [58]; the evacuation of a one-block area of Woodstock, New Brunswick in 1987, after fumes were discovered in a bank's basement; evacuation of two buildings beside a service station in Caraquet, N.B.[59]; evacuation of several blocks of residences in Halifax in the area of a Chebucto Road service station, evacuation of a home in Esquimalt, B.C. in February 1988 [60] in Timmins, Ontario beginning in November of 1988, the evacuation of one building that served both as a home and business premise for more than one and one half years before the building was demolished because it was beyond repair [61] the evacuation of two buildings for two days in downtown Halifax in 1990; permanent abandonment of a home in Orleans, near Ottawa, Ontario beginning with its evacuation in March of 1993, an elderly couple evacuated from their home in Nelson, B.C. as a result of leaks at a Shell service station [62] evacuation of a two-block area of downtown Charlottetown in March of 1990 for several days [63] Fifty-two residents of East Kildonan, Manitoba were forced from their homes and police cordoned off three blocks of Panet Road in March of 1990. An investigation revealed gasoline in the underground tank bed of a nearby Shell service station. [64]

In 1990, a couple were forced to abandon their home in Lobo Township, near London, Ontario as a result of leakage from a tank at a township works yard. (Aird) In May of 1993, leaking fuel from an underground storage tank at a gas station in the East Kildonan area of Winnipeg caused the evacuation of almost 1,000 schoolchildren and two hundred homes and the closing of several businesses in a seven-block area. [65]

[58]Halifax gas leak traced to Texaco service station, HCH May 14, 87, p. 12.

[59]see evacuations file.

[60]"Explosive fumes fill house", Feb 13, 1988.

[61]Grier letter, Bisson docs.

[62]Dakin interview.

[63]Gas Leak clears area, Charlottetown Telegraph Journal March 21, 1990.

[64]52 flee as gas fills "sewer" WFP, Mar. 14/90, p. 1,4.

[65]Wpg Free Press.

### 3. Explosions and fires causing property damage

Fortunately, the volatile compounds in gasoline, solvents, and other petroleum products are highly aromatic and strongly irritating to the eyes, nose, and throat. As a result, people smell fumes at very low concentrations and take steps to avoid exposure and to instigate investigation of fumes. This reduces the possibility of explosions or exposure to acutely harmful concentrations of fumes. However, there have been a number of explosions in Canada in which LUST was suspected or determined to be the cause that have caused substantial property damage, as well as evacuations.

In Flin Flon, Manitoba, gasoline was noticed in a sump in the basement of a building. and a leak of more than 20 gallons a day was discovered in a gasoline tank at a nearby gas station. Although this tank was removed and replaced, gasoline odours continued to surface in this basement and in nearby sewers and drains. Between October 30 and November 30th, 1970, 1500-2000 gallons of gasoline were removed from a hole dug for this purpose. Despite this, and other efforts to deal with the problem over the next two-and-one half years, on June 10, 1972 an explosion and flash fire occurred in the basement of the building where the gas had originally been found. More leaks were discovered in a tank at the same service station. By January of 1975, clean-up still had not been completed. Although an estimated 1700 gallons of gasoline had been removed from the soil, 1500 to 3000 gallons were still believed to be in the ground. [66]An explosion and resulting fire destroyed a service station in Nequac, New Brunswick, in 1974. A leaking tank had been removed ten years earlier, but 4500 gallons of gasoline left in the soil caused a build-up of vapour in a crawl space under the building. [67] In Bristol, New Brunswick, a house blew up in July 1984. According to a New Brunswick government inter-office memo, the owner of a nearby service station suspected that a 3000 gallon gasoline tank had ruptured, since people had complained the previous week that the gasoline in this tank contained water. [68] In Douglas Harbour, New

[66]Vonhoff Flin Flon paper.

[67]Allain v. Texaco Canada Ltd. (1978), 37 APR 682.

[68]Inter-office memo, to Dave Williams from Andre Chenard, Oct. 10, 1984.

Brunswick, faulty installation of an underground storage facility resulted in leakage of gasoline into a nearby basement, causing an explosion and fire. [69] In Sherwood Park, Alberta, gasoline got into a basement where a sump pump was running and caused an explosion. [70]

The most widely-publicized UST fire and explosions occurred in the early hours of April 19, 1986 in Saint John, New Brunswick. Gasoline fumes migrating through the city's sewers from a leaking underground gas line at a service station in downtown Saint John caused several explosions and fires, which destroyed three buildings, damaged several others, and caused the evacuation of hundreds of residents for three days. Because the explosions took place early on a Saturday morning, no one was in any of the buildings at the time of the explosions.

These incidents continue. In the fall of 1991 or the spring of 1992, in Arbourfield, Saskatchewan, a village of about 500 people, a line leak from an independent gas station sent gasoline into the sewer system, causing an explosion which damaged a home. [71]

### 4. Injuries and Deaths

The provincial agencies responsible for keeping statistics on injuries to workers and the provincial coroners responsible for the investigation of deaths under unusual circumstances often do not keep statistics in a form that allows them to retrieve information as to whether injuries and deaths have resulted from leaks, spills, explosions, or escaped vapours from underground storage tanks. Those agencies that are able to access such information reported that they have no record of injuries or deaths resulting from such incidents. Nevertheless, it is well-established that the escape of fumes from leaking underground tanks and from accumulated spills at facilities using and dispensing petroleum products can cause injuries and fatalities. Moreover, any work done on such tanks requires great care. There have been several

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[69] Petroleum product pollution cases, NB Pet on Tap? p.2.

[70] Environment Alberta, Environment Views, June/July 1981, p. 22.

[71] Scott Robinson Dec.10/92.

deaths resulting from inhalation of fumes or explosions while repairing and removing underground tanks. Federal government statistics show numerous injuries at facilities with underground storage tanks, but do not indicate whether those injuries were related to the tanks themselves, and if so, how they were related to the tanks. The U.S. Petroleum Equipment Institute reports that it receives at least one report a month about a serious accident involving men working in, around, or on top of USTs. [72]

Despite the lack of official documentation of such injuries, it is clear that they are occurring. The explosion at St. Eustache, Quebec that resulted in an evacuation in 1978 also injured four men at a municipal pumping station. [73] Four years earlier, an Ontario Ministry of the Environment employee, Ed Diplock, suffered burns and cuts to his face and hands when a pumping station from which he was vacuuming gasoline fumes was demolished by a similar explosion. [74] In 1988, an elderly woman in Burlington, Ontario required treatment in hospital after she was apparently overcome by gasoline fumes that had entered her home from the sewer system. The source of the gasoline appeared to be a nearby Petro-Canada service station, whose inventory control records and corrosion found in a tank that was removed indicated that the tank had probably been leaking for several weeks.

The most tragic accident resulting from gasoline leaks or spills was the death of Stephen Way on September 30, 1988. While performing maintenance work on an underground pumping station in a municipal sewer, Mr. Way was overcome by gasoline fumes in the sewer system. He collapsed, and nearly drowned in sewage at the bottom of the pumping station, but was rescued by co-workers, and rushed to a hospital. Two days later he died from "respiratory distress syndrome" caused by exposure to the gasoline fumes. Whether the fumes that killed Stephen Way came from leaking tanks or lines at nearby service stations, or from accumulated spills could not be definitively established. Workers had smelled gasoline fumes in this pumping station on earlier occasions. When the tanks at a nearby Suny service

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[72]Tulsa Letter, July 28/92, reprinted in LUSTLine Bulletin Oct 92, p. 16.

[73]St. Eustache fights to keep gasoline out of sewers", Montreal STar, March 20/79 p. A3.

[74]Interview, Ed Diplock, November 1992.

station were pressure tested, they showed no evidence of leaks. However, an accident that occurred when the Ministry of the Environment was attempting to determine the source of the gasoline made it difficult to trace the source. While workers were digging trenches in the area of the underground tanks, the removal of soil around the tanks undermined their support. One tank shifted and broke a union, causing up to 50 litres of gasoline to spill in the area under investigation. Frank Crossley, a hydrogeologist with the Ministry of the Environment, concluded that "a spill or leak in the vicinity of the Suny's pump island is a source of contamination". [75] However, he was not able to pinpoint the source of this spill or leak. Officials of the department that employed Stephen Way were successfully prosecuted for failing to ensure that Mr. Way took proper safety precautions before entering the sewer. But no charges were laid under the Gasoline Handling Act against the person whose gasoline leaked into the sewer, as the Ministry of Consumer and Commercial Relations, which administers that statute, felt it did not have sufficient evidence of the source of the contamination to lay charges.

## 4. Air Pollution

One of the least-discussed concerns related to underground tank leaks is air pollution resulting from treatment and disposal of contaminated soil and groundwater. As discussed above, many of the volatile components of petroleum products and other chemicals flow through soil and groundwater until they find an outlet to the air. When they surface in confined spaces, they form an air pollutant whose effects can range from discomfort and illness to explosions or respiratory failure. Eventually, most groundwater becomes surface water or enters wells, where once again the volatile components will enter the air. Householders who rely on well water for household water supplies often complain of symptoms such as headaches and nausea caused by fumes given off by contaminated water coming from their taps.

[75] crossly p. 15.

In addition, there is evidence that workers involved in tank installation, repair, and removal may be exposed to substantial concentrations of volatile chemicals that are carcinogenic, as well as workers involved in contaminated site cleanup and working at landfill sites where contaminated soil is disposed of, and during the course of construction and demolition activities at contaminated sites, particularly during excavation.

Perhaps most significantly, the most common methods of disposing of and treating contaminated soil and groundwater involve the deliberate release of VOCs to the air. The very techniques used to dispose of petroleum-contaminated soil and to reduce the concentrations of petroleum in such soil to levels at which the soil will be suitable for disposal rely on venting of the volatile components to the open air. Petroleum-contaminated soil has often been used as "cover" at municipal and private landfill sites, where it is dumped and spread, resulting in releases of VOCs to the air and exposure of landfill site workers to these gases. When soil is too contaminated for acceptance as waste or as cover material at landfill sites, the contamination levels are frequently reduced by what is known as "landfarming". Essentially, the material is dumped on the surface of the ground and is spread and periodically tilled until the VOCs "evaporate". Similarly, the traditional method of reducing contaminant levels in ground water has been what is known as "pump and treat". The contaminated water is pumped from the ground and released into surface water courses or municipal sewers after treatment which consists partly of aerating the water to drive off the VOCs into the air.

Methods of treating contaminated soil and groundwater have been developed which involve the capture or destruction of VOCs, rather than their release to the air. However, these methods are very expensive, and probably constitute only a small proportion of disposal and treatment. One method captures these compounds on activated charcoal. However, once contaminated, this charcoal or the contaminants it has captured must be disposed of or treated as hazardous waste, at great expense. Another method of treatment, known as "bioremediation", involves the use of bacteria to break down hydrocarbons. It too is slow and expensive.

As the release of volatile organic compounds from leaks and spills is only one of many, little is known about its overall contribution to this source of air pollution. However, an estimated 34,000 tonnes of benzene are released to the air annually in Canada, approximately 70% of which come from automobile emissions. How much of the remaining 30% is from LUST incidents is unknown. Lead has largely been eliminated from gasoline, so lead emissions have been reduced in Canada. However, ambient air concentrations of manganese, which has replaced lead as an octane-booster in some gasoline blends, have risen by 28% in Ontario between 1981 and 1990. Moreover, newer gasoline formulations often contain higher concentrations of benzene.

In addition, drycleaning businesses in Canada released an estimated 14,000 tonnes of VOCs in 1990, principally perchlorethylene, a toxin and probable carcinogen. As will be discussed below, these drycleaning fluids are among the petrochemicals stored in underground tanks, and leaks and spills from drycleaning plants have been a serious source of groundwater contamination in several communities, including Fairvale, New Brunswick and Manotick, Ontario. [76] As mentioned earlier, a portion of the volatile compounds which enter groundwater are eventually emitted to the air.

VOCs turn from a liquid to a gas without any human intervention. They are of concern because they may cause cancer, because of their contribution to the formation of ground-level ozone. Benzene, toluene, ethyl benzene, and xylene (BTEXs), described above, are amongs the VOCs that are hydrocarbons. However, not all VOCs are hydrocarbons. This category includes other volatile organic chemicals as well. Polyaromatic hydrocarbons (PAHs) are less volatile, but may also be emitted from spilled petroleum products and from petroleum-contaminated soil and water. PAHs are of concern primarily because some of them, such as benzo(a)pyrene, are highly carcinogenic.

In the air, many of these volatile compounds eventually break down into carbon dioxide, which is a "greenhouse" gas that contributes to global warming and to a much lesser extent to atmospheric ozone depletion.

[76] Probe air report.

## 5. Soil Contamination

Even when leaks do not enter the groundwater or structures, as long as the contamination remains in the soil, it is a potential source of harm.
Eventually, the contamination may migrate, or activity at its location will expose people to the risk of harm. In the past, soil contamination was largely ignored. When leaking equipment was replaced, the contaminated soil was left in place rather than spend the relatively small sums required to haul it to the local dump. Therefore, the soil around virtually every gas station, refinery, bulk plant, and marina in Canada is contaminated to some degree.

However, leaving contaminated soil in place is frequently no longer a feasible solution for many reasons. Most significantly, the pace of development and redevelopment has escalated, and sophisticated purchasers insist on soil tests before closing, insurers have learned not to provide coverage at industrial and commercial facilities that might be contaminated without soil testing.

Knowledgeable lenders will no longer provide loans to such facilities unless they have been satisfied that this potential liability does not exist. Where the main security for a loan is property and the solution to default is taking possession, lenders realize that such property has a negative value. Not only is it worthless because there is no market for resale of land that is seriously contaminated, but if they take possession, they may be responsible for conducting the cleanup, the cost of which may greatly exceed the value of their loan. One such example was contamination discovered at an independent service station in Creighton, Saskatchewan in 1992. When the owner applied for a bank loan, the bank insisted on soil testing around October of 1992, which revealed gasoline in the soil around the tanks. Although groundwater was not impacted, it has been estimated that the cost of soil removal will be around $250,000. [77]

[77] Scott Robinson, Dec 10/92.

In addition, the "rationalization" of the retail gasoline business in Canada over the past few years has involved the maintenance and establishment of fewer and larger service stations. It has been estimated that there has been a net loss of 1500 service stations a year for the past four or five years. [78] Before these sites are put to new uses, there are pressures on their owners through non-legally binding provincial and municipal site decommissioning guidelines and soil testing requirements required by municipalities as part of the approvals processes under land use planning legislation. Moreover, the large oil companies have become sufficiently concerned about their potential liability to future owners and tenants of such properties and their liability for harm to neighbours if it cannot be determined whether pollution resulted from their activities or those of their successors that they frequently carry out contaminated soil removal programs before closing a station or selling it to an independent dealer, even though they may not be required by law to do so.

[78] Karr Dec 16/92.

## Chapter 4 THE HIGH COST OF LUST

In this chapter, we will show how much the failure to prevent LUST costs Canadians, and compare the costs of cure to the costs of prevention. These data will suggest that it would be cheaper to remove every substandard tank and piping system in Canada and replace it with a state-of-the-art system designed to detect and prevent leaks than to continue paying the high costs associated with LUST cleanups.

<u>Costs imposed on the Canadian Economy in responding to LUST incidents</u>

Earlier, we estimated the direct cost of detection of leaks and spills from underground petroleum fuel tanks as $235,200,000 a year. This estimate was based on an average cost of $200,000 per clean-up and 1,200 leaks and spills across Canada. The number of leaks and spills was based on the 200 incidents reported each year to Ontario's Ministry of Consumer and Commercial Relations, which administers Ontario's legislation regulating these tanks, and the fact that Ontario has 17% of the petroleum USTs in Canada. This did not include the costs associated with leaks and spills from tanks containing petroleum products other than fuels, other chemicals, or septic systems.

Another way to estimate the cost would be to use the estimate by Environment Canada in 1986 that between 10,000 and 20,000 underground tanks were leaking at that time (an estimate which Environment Canada considered conservative). Applying the estimates by experts in the field that the average clean-up cost for a LUST incident is about $200,000, the cost of clean-up of those leaks alone would have been $2,000,000,000. It is likely that the actual costs are much higher, since such estimates do not include many indirect costs, such as much of the time and money spent by public agencies in investigating, monitoring sites, and carrying out clean-up using internal government resources; many business losses experienced by owners and operators of leaking facilities as a result of shut-downs, product lost to soil and groundwater; and third-party losses that are uncompensated. In addition, it is difficult to place a dollar value on the emotional distress suffered by residents who are afraid to drink their water and entrepreneurs who fear the loss of their business as a result of LUST incidents.

It is impossible to obtain all the data that would be necessary to determine precisely the full economic impact of leaks from underground tanks and lines. The costs associated with investigation of leaks, replacement of tanks and contaminated soil and groundwater, remediation, compensation of victims, and public administration are not generally available to the public. The books of oil companies and private entrepreneurs are not open to researchers. Government agencies have difficulty compiling records of direct expenditures and do not generally account for staff time and the use of internal government resources in a manner which allocates internal costs to specific leaks or even to programs dealing with leaks.

One of the most useful kinds of documents available to the public is the claims made for compensation in lawsuits. However, these claims are nothing more than allegations until they are proven in court or accepted in settlement of the claims. The process by which these costs are verified or disproven is not open to the public. In civil suits, claims are tested through a process of "examination for discovery" at which persons claiming losses can be examined orally and must disclose all documentation supporting their claims. However, these examinations are not open to the public nor can the lawyers for the parties make public the information obtained through this process without the consent of the parties. Following examination for discovery, most cases are settled without a trial. There is no public record of such settlements, and in any event, plaintiffs frequently settle for less than their actual damages to avoid the cost, delay, and uncertainties of a trial. If a trial takes place, the judgment will rarely provide a detailed breakdown of the damages. The cost of obtaining transcripts of trials for research purposes is prohibitive. Moreover, many LUST incidents are before the courts for many years, during which time parties to the litigation are reluctant to make documentation relating to the incidents available or to discuss the incidents with researchers.

Nevertheless, the costs associated with LUST are clearly substantial, and the limited data received during the course of this study confirms the estimates given above. There is little doubt that the cost of prohibiting underground tank leaks over the past two decades has greatly exceeded the costs that would have been incurred by tank owners in installing and operating systems that would have prevented the leaks or detected them before they could cause substantial harm. It is not possible to prove this with the level of certainty required by scientists, as precise data as to the costs incurred in remediation in each incident and the costs that would have been incurred through more thorough monitoring and through replacement and upgrading of tankage and associated facilities, had this been undertaken, is not available in statistically significant numbers.

Nevertheless, a comparison of the typical costs involved in upgrading tank systems and better monitoring with the costs resulting from rectifying problems resulting from LUST suggests strongly that the costs of correction far exceed the costs of prevention.

Assuming that there were 200,000 petroleum USTs in Canada in 1986, the number estimated by Environment Canada, and that every one of them was an unprotected steel tank, the cost of replacing every tank in Canada at that time with a new cathodically protected steel or FRP tank, based on an extremely conservative maximum cost of $10,000 per tank, would have been no more than the cost of cleaning up all the damage from every leak occuring at that time. Had every one of those tanks been replaced by third-generation technology, that is, secondary containment systems at a maximum cost of $20,000 per tank, the cost of replacing every tank in Canada would have been $4,000,000,000. This would have been twice the cost of repairing the harm from the tanks leaking <u>at that time</u>. In both cases, however, this would have been only a fraction of the cost of clean-up if one includes the tanks that had leaked before 1986 or began to leak between 1986 and 1994. Clearly, the cost of upgrading these facilities is less than the aggregrate cost to society of allowing an estimated 1200 leaks and spills across Canada each year.

Why then have government agencies not made and enforced regulations that would ensure prevention, and why have the owners and operators of underground tank systems not taken the steps needed to prevent leakage, rather than incur the costs of clean-up? The answers to these questions will be suggested in other chapters. However, in this chapter, we will compile some of the information available on the cost of cleaning up UST leaks. These costs range from a few thousand dollars to replace the leaking components of the tank system, leaving in place contaminated soil surrounding the tanks or hauling the soil to a local landfill site, to multi-million dollar soil and groundwater remediation programs that last for several years. In some cases, the full cost of leakage is unknown, as contamination remaining in the soil or groundwater will migrate to areas in future where it will cause additional impacts on the environment or the use and enjoyment of property, or will remain in place, but will result in future economic impacts when the contamination must be dealt with to allow redevelopment or redevelopment results in exposure of workers or residents to the contamination, requiring remedial measures. The Port Loring and Winnipeg Remand Centre incidents are examples of such delayed impacts. In the Port Loring case, as mentioned above, petroleum products were left in the groundwater in the expectation that the aquifer would eventually cleanse itself through dilution and dispersion. However, approximately ten years later, the contaminants migrated to new wells and contaminated them. In the case of the Remand Centre, the Manitoba Government had removed leaking tanks at a garage in 1988, but left the contaminated soil surrounding the tanks. When a new provincial remand centre was being being built in 1990, it was necessary to halt construction when workers excavating the basement began to smell gasoline fumes and it was determined that the soil was contaminated. [79]

The costs set out in this chapter are those at the time they were incurred, and have not been adjusted to reflect inflation. Clearly, many of these costs would be much higher today than at the time they were incurred, both because of inflation and because decontamination standards and disposal restrictions are much more stringent, and therefore more costly to comply with, than those in place at the time of many of the incidents described.

Where American examples are given, the sums are in U.S. dollars, and would have to be adjusted using exchange rates at the time the costs were incurred to reflect the cost in Canadian dollars.

The Freshwater Foundation in the United States attempted in 199 to profile both the direct and indirect costs of groundwater contamination to cities and companies in the United States. Although the causes of the 15 groundwater contamination incidents surveyed varied from industrial waste disposal practices and leaking landfills to spills, the kinds of impacts and costs incurred are representative of those to be expected from LUST incidents. The impacts of the groundwater contamination included

[79]Ediger interview, Hansard.

devalued real estate; diminished home sales or commercial real estate sales; relocation of commercial development; loss to the tax base; consulting and legal fees; increased operation and maintenance costs; and increased water rates. These costs were in addition to the cost of new equipment, and treatment of contamination and cleanup costs. "All of these costs", the Foundation concluded, "have a potential to adversely affect local economic development".[80] The Foundation conducted a survey of cities and companies in Minnesota affected by groundwater contamination incidents. In this survey, 21 cities and 18 companies estimated that the groundwater contamination from 24 incidents had resulted in the following costs (in U.S. dollars):

- to 17 Minnesota cities, a total of $24,045,500
- to 18 Minnesota companies, a total of $43,026,500

The costs of these 24 incidents were estimated by the participants at over $67 million. For the cities surveyed, the major cost associated with the groundwater pollution was the loss to the tax base because of commercial and residential real estate devaluations and lack of business development due to the pollution. Other major costs included construction of new water treatment plants or purchase of new equipment for existing water treatment facilities; cleanup and remediation; and consulting and additional staff expenditures.

The companies surveyed reported that 14 cases of groundwater pollution resulted in more substantial costs than those incurred by cities and utilities. These companies spent:

- $21 million on site clean-up and remediation
- $13 million on consulting services and staff time
- $7 million on soil and water testing. (ibid p 11)

Four companies spent a total of more than $12 million on properties contaminated by previous owners, for which they became liable. Fifteen companies collectively spent $4 million on legal fees. Nine companies spent $3.7 million on new equipment and

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[80]Economic Implications of Groundwater Contamination to Cities and Companies, Freshwater Foundation, p. 5.

technology. Eleven companies spent $1.9 million drilling monitoring wells. Four companies spent $1.5 million for increased operating costs. Two companies reported changes in manufacturing costing almost $1 million each.

Two of the case studies dealt with leaks from underground tanks. In one case, a pulp and paper manufacturer acquired land in 1965 which had previously been owned by a wood-preserving company. The land was later sold and in 1980, the new owner discovered a buried tank that had been used by one of the previous owners for wood-treating. There was extensive soil and groundwater contamination. The company surveyed was named along with two other parties as responsible for the clean-up of the site. This company spent over $500,000 on legal fees, over $500,000 on soil and water testing, and over $5 million on clean-up and remediation. Consulting and additional staff time were not estimated, but nearly five years of study, negotiation, and remediation involved company staff. (p 66) The second case involved several underground tanks of solvents at a site owned by a manufacturer and formulator of household insecticides. Leakage contaminated soil and groundwater, resulting in abandonment of a production well and replacement with a municipal water supply. The costs included $l00,000 to $250,000 for installation of monitoring wells; construction of a cooling tower for municipal water, bulk storage of wastes, and disposal charges between $100,000 and $250,000; legal fees up to $100,000; analysis, evaluation and sampling of water under $100,000; retrofitting of piping for the cooling tower and treatment of recycled water under $100,000; and clean-up and remediation consisting of removal of underground tanks and installation of a pump-out system, in addition to the cost of reports, feasibility study and other incidentals between $100,000 and $250,000. Consulting and additional staff time cost approximately $200,000. The extensive investigation required that one staff person be assigned to work almost full time on the project. Several consultants were hired. The company also had to reimburse the cost of state environmental agency staff conducting an investigation.

A study carried out by the U.S. EPA in 1984 found that liability awards and court settlements in underground tank leak cases ranged from under $1,000 to over $10 million, with a median of $136,000. [81] In 198 , the U.S. EPA estimated the

[81] "20,000 leaks under Ohio, p. 6.

average clean-up cost to be between $50,000 and $100,000, and as high as over $1 million in severe cases. Settlements, of course, do not represent the full cost of the clean-up. They represent a compromise arrived at by taking into account the uncertainty and cost of litigation, and discounting these costs. Thus, in reaching a settlement, a plaintiff will discount the value of future dollars and legal and other costs that will not be recoverable from the defendant, and must be deducted from the sum ultimately awarded by the court.

Another EPA estimate put the cost of undertaking clean-up in the event of a leak at around $2,500 for assessing and mitigating an immediate hazard, up to almost $50,000 for removal of leaked product from the soil, and clean-up of groundwater if a spill is not checked in time ranging from about $50,000 to several million dollars. [82]

The Steel Tank Institute in the United States estimated in 1983 that site cleanup costs alone of an underground tank averaged $100 per gallon of gasoline leaked. [83]

A 1988 case study in the U.S. determined the cost of removing 550 gallons of gasoline from groundwater as a result of one small spill using soil venting to be $144,000. The soil was "tight", consisting of medium to fine sand and silt, the plume had travelled only 70 feet downgradient from the spill site, and the water table was 4 to 6 feet below the surface. The soil venting system drew air through the soil to evaporate gasoline, then passed the contaminated air through activated carbon beds to adsorb the volatile organics. The cost of removing the first 150 gallons of gasoline was $71,000 and the cost of removing the next 400 gallons was $73,000. These costs included installation and operation of the equipment, but did not include consultant fees to devise the clean-up plan and obtain approval, soil and groundwater testing, and installation of groundater and soil monitoring wells. By

[82] J.Winston Porter, EPA Assistant Administrator for Solid Waste and Emergency Response, quoted in Environment Canada; LUST Newsletter, Juner 1987.

[83] both above figures from 20,000 leaks, p. 6.

comparison, it was estimated that landfilling the contaminated soil would have cost about $560,000 for removing and disposing of 2,500 cubic yards of soil at $225 per cubic yard. [84]

Major expenditures have been documented in the United States. In one case in Ohio, the water supply of residents of Martinsburg in Knox County had to abandon the use of a shallow aquifer for drinking water and the village had to develop a communal well system in a deeper aquifer. It is reported that "a large portion" of a $2.1 million community development grant from the federal government was used for this new water system. [85]

Costs of LUST clean-ups range from a few thousand dollars to millions of dollars. The Manitoba Department of the Environment stated in 1989 that the cost of clean-up for LUST incidents began at $30,000 for the least serious incident. The upper end of the range was not given. [86] One Ontario government official advised that in December, 1992, removal of leaking tanks and lines and remediation of contaminated soil and groundwater was likely to cost between $5000 and several million dollars. [87]

Various cost estimates have been provided for LUST incidents in Canada. The CCREM task force which produced a model environmental code of practice for underground storage tanks has stated that a small leak "which may not create a significant fire threat, could contaminate a water supply that could cost millions of

[84] Connor, R.J. "Case Study of Soil Venting:, Pollution Engineering, v. 20, no 7 p. 74-78, 1988.

[85] 20,000 leaks, p. 9.

[86] "Gasoline leaks contaminate water", WFP Dec 9/89, quoting Maurice Mazerolle.

[87] Gill Dec 4.

dollars to replace or clean up. In some areas, an alternative water supply may be essentially unavailable." [88] According to an insurance adjuster retained by Gulf Canada, that company has spent over $500,000 on each of several clean-ups resulting from LUST. [89]

The costs associated with leakage in Canada have been as high as $35 million for cleanup of a leak in the Cornwall area and $15 million for an incident in the Peterborough area. [90]

In Grand Bay, N.B., in 198 , the provincial Environment Department estimated the cost of a recovery well recommended to pump gasoline-contaminated groundwater at $40,000 (No cleanuup planned , telegraph-journal - check whether a lust incident). Estimates obtained by the village of Rogersville, N.B. in 1983 for the cost of installing a municipal water system to replace contaminated private wells was $200,000. In addition, residents who formerly obtained water from their private wells would be charged a user fee of about $110.00 per year per household, and the municipality expected to have to raise municipal tax between sixteen cents and 20 cents per $100 assessment. [91] In the case of Glenn and Patricia Hermiston of Orrville, Ontario, they paid about $9000 to test tanks at their service station and to remove contaminated soil, after discovering petroleum in their drinking water. It is not known whether the source was leaks or simply the spills that inevitably occur at service stations. They also suffered business losses for which no estimate is available, and incurred some legal fees. In 1992, however, the Ministry of the Environment issued a clean-up order to the Hermistons as well as to the previous owners of the property. Both families retained lawyers and appealed this cleanup

[88]SSGM supplement Feb 90.

[89]Ingram Dec 18/91.

[90]both figures given in a telephone communication by Brenton Gill, Dec 4/92. Gill quoted in Feb 90 SGGM suppl. as $12 mill for the one that is now $15 million.

[91]Letter, Willie Robichaud, Mayor, Rogersville, to Hon. Bill Harmer, Minister of the Environment; March 3, 1983.

order to the provincial Environmental Appeal Board. Thus, at the time of writing, both appellants were expected to incur substantial legal costs in addition to any further remediation that might be required under the order. [92]

An official of the Fuels Safety Branch of the Ontario Ministry of Consumer and Commercial Relations stated in 1990 that in one case in which leaks had necessitated the replacement of a municipal water supply, the cost of cleanup had reached $12 million "and still counting". [93] A 1975 leak from a service station in Brandon, Manitoba has been estimated to have cost a major oil company that supplied fuel to a service station approximately $750,000. A contractor involved in the investigation and clean-up estimated that the same clean-up today would cost "a couple of million dollars". [94] The costs to the oil company included putting up 8 to 10 families at hotels for several weeks, excavating the soil around the perimeter of homes into which gasoline vapours were seeping, excavating basement floors, digging trenches l0' to l5' deep to intercept groundwater containing gasoline, and pumping gasoline-contaminated groundwater from these trenches for disposal. Bracing was constructed to prevent the trench sides from collapsing. A company with trucks used to pump out septic systems was retained, and a heated building was constructed to house these trucks, which were on 24-hour standby. Gasoline-contaminated water continued to flow into the trenches and was pumped out daily for several weeks.

Over a two-week period in 1989, the Regional Municipality of Hamilton-Wentworth spent $20,000 dealing with the removal of gasoline found 20 feet (6 metres) below the surface of the intersection of King Street East and Gage Avenue in Hamilton [95] The Noelville leak described in a previous chapter was estimated in April of 1991 to have cost the Ontario Ministry of the Environment $250,000, and the Ministry was

[92]Ltr Grier to Bradley, May 18/90.

[93]SGGM supplement Feb 90.

[94]Vic Robinson interview Jan 6/92.

[95]Gas leak cost hits $20,000, Ham Spec May 31, 1989.

continuing to incur investigation costs. [96] The Ministry had budgetted $271,000 to deal with this problem, and as of December 31, 1991, had spent $48,100 in fiscal year 1991/92 on well studies. (stats provided by MOE to author)

The Port Loring contamination involved two separate phases, the discovery of well contamination and drilling of replacement wells in 1978 and the migration of polluted groundwater to these new wells in 199 . Some of the costs to Gulf Canada in 1978 were: (see ingram tape). Costs of the 1991 incident as of December 1991 had included approximately $900 to $1000 a week for delivery of 50 bottles of water to approximately 25 families. In addition, Gulf had provided families with coolers for this water. Gulf had also paid for provision of water treated by reverse osmosis to some people with special needs. Gulf was considering drilling a new well up-gradient of the area of groundwater contamination and had retained a consultant to determine the cause of the re-contamination and develop a remediation plan. [97]

By November of 1992, Gulf was still supplying bottled water. Gulf had drilled a new well, but had been unable to negotiate purchase of an easement over private properties for the piping required to carry the water from the well to affected residences. Therefore, the well was not in use. The cost of studies to determine the location of this new well, the cost of well construction, anticipated costs of purchasing easements and of operating the well have not been made available. Other costs resulting from this situation have included the design and implementation of a water sampling and analysis program, remuneration of the hydrogeological consultant and an insurance adjuster retained by Gulf, dissemination of information to the public, holding public meetings, and media relations, as the situation became a matter of concern to the community and attracted some media coverage. These costs were not available to me.

In Arnstein, Ontario, just south of Port Loring, four of the five dwellings in this small community lost their water supply in 1990 for about a year, and were supplied with bottled water by the Ministry of the Environment at public expense. The Ministry spent approximately $5000 to provide charcoal filtration units for two water supplies

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[96] Rick Bradley moe to Tzabiris Ap 25/91.

[97] Ingram interview December 1991.

and "$1,000 or more" to supply bottled water. As the Ministry's own staff were unable to conclusively determine the source of the contamination, thought to be from UST leaks or service station spills, $60,000 was allocated to hire a consultant to determine the source. [98]

A clean-up of an estimated 20,000 to 60,000 litres of gasoline from a PetroCanada service station at Renfrew and 22nd in Vancouver, discovered in January of 1985 was expected to cost PetroCanada between $50,000 and $100,000. [99]

The Delta, Ontario incident, described in the previous chapter had cost Gulf Canada over $700,000 in soil and groundwater remediation costs by December of 1991. Because of the difficulty of remediating this site and because of the provincial interest in developing effective remediation techniques, the Ontario Ministry of the Environment had contributed $l5,000 to the development of the remediation program by a consulting company. Gulf had expected to cease treatment of the groundwater by the spring or summer of 1992, but as of November 1992, the quality of the groundwater was still unsatisfactory to the Ministry of the Environment, and the treatment program was continuing.

Costs of remediation of the hydrocarbon leak in Ops Township, near Lindsay, Ontario referred to in the previous chapter were estimated at $5 million in 1986, and the clean-up was still continuing [100] The leak, suspected to have come from an UST which had a 1/8" hole in its bottom when excavated, contaminated wells drilled into an aquifer in the limestone bedrock. Work carried out included hydrogeological studies involving measurement of water levels and water quality in drinking water wells, containment of the contaminant plume by several continuous-pumping interceptor wells, and installation of a pipeline to provide water to local residents whose wells were affected.

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[98] Personal communication, Gord Johnson, Dec 17/91.

[99] "Gas station's tank seepage not considered a hazard", Van. Sun, Feb 14/85, p. A16.

[100] Beak p. 2.52.

One estimate has given the clean-up and well replacement costs at Fairvale, New Brunswick as $500,000. [101] Another report states that the cost of the alternative water supply was $400,000 and management of the contaminant plume cost an additional $400,000. [102] However, this does not represent all the costs associated with this incident. Several families whose wells were contaminated by petroleum sued Irving Oil, the owner of a local service station. The case was not settled for several years, so there were legal costs involved in pursuing and defending this action. In addition, the Village of Fairvale froze all development in part of the municipality because the groundwater remained contaminated, either as a result of the petroleum leak or as a result of leakage or spillage of drycleaning fluid. Although some homes had been supplied with water through a pipeline from the water system of a nearby town, no water supply was available to any new homes. The refusal of the municipality to approve a new housing subdivision resulted in an unsuccessful lawsuit against the municipality by the owners of this land. This suit would also have resulted in legal costs.

The costs of rectifying a well contamination problem at Ben Lomond Estates in N.B. was around $250,000, including $50,000 to drill two replacement wells. [103]
The municipal government of Oakville, Ontario spent approximately $50,000 in an unsuccessful attempt to determine the source of a leak discovered in October 1986 in the area of the Third Line and Speers Road, in which gasoline entered the sewer system and vapours built up in 23 homes. [104] The investigative and abatement actions carried out for this sum included installing well points and pumping of contaminated water and gasoline products. [105] As a result of the Region's lack of success in determining the source, the Ontario Ministry of the Environment retained a consultant to carry out further investigations at a further cost of $20,300.

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[101] beak -- summary table.

[102] Petroleum Contamination of Drinking Water in New Brunswick 1984.

[103] Petroleum contamination of drinking water in NB) (check whether a LUST incident).

[104] Ham Spec Jan 13/87, Monenco Report on Contamination in Oakville) (In November 1986, G and M reported that expenditures as $20,000 without the source having been determined. The report did not indicate who paid this amount or the work undertaken "Stiffer U.S. Laws aid maker of containers for storage in ground" G & M Nov 8/86, B5.

[105] Monenco.

A leak at West End Auto Sales in the vicinity of Talbotville, Ontario may have cost in the $5 million range [106] An incident in Orangeville, Ontario is in the $200,000 range [107] In Lobo Township, near London, Ontario, the cost to the Township of moving a house, excavating contaminated soil, reconstructing the basement, and placing the house back on its foundations in 199 was reported to be around $700,000. [108]

In November 1988, gasoline began to seep into the basement of the home of Aurel and Madeleine Bisson Timmins, Ontario. The Bissons lived in the rear of the main floor of the building. The front portion of the main floor was leased to the operators of a hairdressing salon and the second floor was leased to three roomers. As a result of gasoline-contaminated soil, the house became uninhabitable, in the opinion of the Fire Marshal, who ordered the occupants to leave it and not to return. The Bissons sued the owner of a gasoline station next-door and several other parties. They also applied to the Environmental Compensation Corporation, set up by the Ontario Government to provide compensation to victims of spills, for compensation. Although the case was still before the courts as of October 1993, the ECC assessed the Bissons'losses at $275,972.46. This sum included $200,000 for the replacement cost of their home, $26,500 for damage to the contents; $4,500 for clean-up. In addition, the Ministry of the Environment spent $56,000 between 1988 and 1993 on studies and unsuccessful attempts to remove the contamination. [109]

Even where the only damage from a leaking tank is contaminated soil, and the risk of harm to people is minimal, the cost of soil removal alone may be several hundred thousand dollars. For example, the Ontario Goverment discovered soil contamination from a tank leak in 1991, at a property it owned in its Pickering Land Division. According to a government official, there were few residences in the area and the risk of harm was minimal. Nevertheless, a consultant hired to recommend clean-up

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[106] Gill hearsay estimate Dec 4/92.

[107] Gill Dec 4 hearsay estimate: J & P Service, Orangeville.

[108] Aird.

[109] Security account multi-year expenditures, p. 1.

procedures advised that the cost of soil removal would be $400,000. In 1992, the Ministry of Government Services did not have the money, and was investigating alternative methods of decontaminating the property, such as vapour stripping. [110]

It was reported in 1992 that "a substantial deposit of fuel from old tanks under a bus garage owned by the Toronto Transit Commission had leaked into adjacent property. The Commission had budgeted $2.2 million for clean-up of this site as well as investigations of soil, groundwater, and air vapours at other bus garages where leaks and spills of fuel may have occurred. An engineer on the TTC staff said at the time, "I suspect we'll be coming back and asking (Metropolitan Toronto council) for substantially more than that". [111]

A soil and groundwater clean-up and replacement of tanks at a PetroCanada service station on Harvester Road in Burlington in the summer of 1988 was expected by a Petro-Canada spokesman to approach $100,000. After gasoline was found in a sewer and a woman was overcome by fumes in her home, PetroCanada examined the tanks at its service station and found that one of them was corroded enough to have been leaking. [112]

Leaking tanks and lines also result in substantial business losses, both to the owners and operators of the facilities that are the source of the pollution and to their neighbours.

An idea of the kinds of economic harm that result from such incidents can be obtained from statements attributed to local businessmen in the Brandon Sun after approximately two months of business interruption during the 1974-75 Brandon, Manitoba clean-up.

[110] Geo Crowe, Dec 14/92.

[111] Lawsuits feared over TTC leaks, Toronto Sun, June 12, 1992, p. 59.

[112] "Mike Pettapiece, "gas station leak no threat: MOE", Ham Spec Aug 16, 1988.

> "My business is down at least 30 per cent over last year," John Gaudet owner of Advance TV said in an interview Tuesday.
>
> "And it's all because of that damn gas leak. People are scared to come around here. Every second day they are digging something and the whole building starts to shake.
>
> Where can my customers park? Everything is blocked off. All the lots are dug up. ..."
>
> Bill Peters, who runs Peter's agencies in the same block, said he has also suffered some loss of business.
> "I figure I've lost $400 in the past month on the post office I run here.
>
> "As far as my Autopac business goes - I won't know until the end of the month. I will probably lose quite substantially there too". [113]

Although typical business losses may be comparatively small compared to the costs of replacing water supplies, decontaminating soil, and other costs associated with LUST, they are of concern because even relatively small business losses may be sufficient to cause small businesses to fail.

For example, Larry Morris, a small real estate developer in the London, Ontario area, lost his entire business as a result of a leak at a gas bar in a small plaza his company, Lamor Ltd., owned in Strathroy, Ontario. After purchasing the plaza, Morris rented what had formerly been a Sunoco gas station to Silcorp Ltd., the owners of the Mac's Milk variety store chain. Mac's opened a combination convenience store and self-serve gas bar. The existing gasoline tanks, which were then approximately 20 years old, were tested for leaks, but not replaced, when the gas bar was put into operation. Soon after, a leak from one of the tanks contaminated the groundwater, threatening Strathroy's municipal water supply. Initially, Morris's company paid a consultant to remove the tanks and excavate and haul away contaminated soil and groundwater. However, Morris ran out of money to pay for the cleanup long before

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[113] Gregg Shilliday, "Gas spill - some questions being answered", Brandon, Sun, Feb 19/75.

the gasoline was all removed from the groundwater. His contractor abandoned the work because he was not being paid. Morris tried to negotiate a three-way division of the cost of remediation with Mac's and Suncor, which had formerly owned the service station and continued to supply gasoline to the new gas bar. Officials in both companies agreed to recommend this cost-sharing arrangement, but a more senior official in Suncor decided that Suncor would not contribute to the clean-up cost. The property was left for months with a large hole in front of the other stores in the plaza which prevented access to their customers. They began to refuse to pay rent to Lamor.

Morris felt that had the three-way division of costs been carried out, he could have salvaged his business by refinancing other properties. However, without the participation of Suncor, Morris's company faced economic ruin.

In the early 1980s, a Squamish, B.C. service station owner lost his business as a result of a leaking union in piping installed in 1977 between two tanks. Over a four-year period 100,000 litres of gasoline disappeared into the ground, and business was disrupted during periods when the causes of the losses were being investigated and underground lines were being repaired. A court found an oil company that supplied gasoline and had installed the piping responsible for the service station owner's losses, which the court assessed as $25,000 for lost gasoline and business disruption. The court found that this leak was the cause of the failure of the operator's business.[114]

The operator of a service station, restaurant, and motel near Britt in Ontario has estimated that he suffered a loss of 50% of his business over a two-month period as a result of the property being dug up while PetroCanada removed tanks and piping and contaminated soil. PetroCanada had decided to close the station, which was leased to this person, as part of a major down-sizing. However, the operator estimated that removal of the tanks, lines and pumps would have taken one week, with business disruption during this period, except for the extensive soil removal operation and the difficulty in finding a place to dispose of the soil, which extended it to two months. Although the operator could not determine a precise loss, or

[114]Ellis Case.

determine how much of the reduction in business was due to the recession and how much due to the physical disruption of the property, he felt that the additional losses attributable to the disruption on top of the effects of the recession might make the difference between survival and business failure. [115]

One of the most unpredictable components of the cost of clean-up is the cost of disposal of contaminated soil. The costs range from the transportation costs alone to take soil to landfill sites that will accept it for free because they are in need of cover material, to long and costly decontamination processes in cases where landfill sites will not accept contaminated soil at all. In urban areas, where volatile gases cannot be vented to the open air because odours will affect nearby residents, costs of capturing VOCs and disposing of them must be included. Nor are there generally any province-wide standards for levels of soil contamination that landfills will accept. Each landfill has different standards and different tipping fees. In the area of Pembroke, Ontario, for example, the township landfill site operated by the township itself was charging $50 a tonne in 1992, while in the next township, where the landfill is operated by a private company, the charge was $l00 a tonne. [116]

### The Cost of Prevention

To put the costs of clean-up into perspective, one may compare them with the cost of prevention of leaks. The minimum form of leak protection now required in most provinces is cathodically protected tanks and lines or FRP tanks and lines. Additional protection can be obtained from installation of monitoring wells around the tanks. Further protection can be obtained by secondary containment. Even greater protection can be achieved by interstitial monitoring. Only the latter method reliably detects leaks before they leave the tank, rather than after they are in the environment.

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[115]rogers Dec 4/92.

[116]Darryl Tubman, Dec 16/92.

In a July 1976 memo, an MOE official wrote to his superior that "the most obvious solution to (the problem of groundwater pollution by unprotected tanks) is to remove all of the buried underground tanks which do not meet current standards and replace them with cathodically protected or fibreglass tanks...". Based on discussions with Barry Hardcastle, a BP Canada official, the MOE official estimated that the removal of all tanks at a service station and their replacement with cathodically protected or fibreglass tanks would cost an average of $10,000 per service station. A new protected tank was estimated to cost approximately $2000, compared to $600 for an unprotected tank. Assuming 12,500 service stations in Ontario, the official estimated the total cost of replacement of substandard tanks with protected tanks to be $125,000,000. [117]

In March of 1977, an official of B.P Canada was quoted in a government memo as stating that there were 200,000 USTs in Canada, and their replacement would cost in the order of $1 billion [118]

A 1989 U.S. estimate of the cost of removing the underground tanks at a gas station with three 6,000 gallon product tanks and one 500 gallon waste oil tank was a range from $14,800 to $17,300. This included removing product from the tanks, permits, labour, equipment, materials, repavement, tank transport, tank disposal, lab analysis, preparation of a final report, and miscellaneous expenses. If these tank systems were to be replaced with third generation systems and with leak detection systems, of course, the cost would be greater. In Ontario, for example, the Canadian Petroleum Products Institute stated in September of 1990 that the cost of double-walled tanks was twice that of second-generation single-walled tanks. [119]

A single aspect of the tank removal process, the emptying of residual gasoline and sludge from a tank and the disposal of the tank itself, was the subject of one study commissioned by the U.S. EPA. This February 1988 study looked at the cost of various ways of disposing of tanks, from recycling to disposal in a landfill licenced to

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[117]Hughes to Hore, July 6/76.

[118]Hughes to file Mar 16/77.

[119]Ltr to G. Mills from Wayne Wright, Sep 21/90.

accept hazardous waste. The study considered a tank system which the authors considered typical of the systems being taken out of service because of their advanced age at the time of the study. This system consisted of a single 5000 gallon steel tank buried under 6 inches of concrete and 30 inches of compacted fill, containing 50 gallons of leaded gasoline and 50 gallons of sludge, with the tank and backfill both completely above the water table. The study assumed a "best case" scenario; that is, no contamination around the tank and free access to the site. Estimates for removing the tank and recycling it ranged from $2,200 to $9,000. Estimates for removal and landfill in a hazardous waste site were $5,000 and $6,915. The costs of removing gasoline and sludge, inerting the tank, and abandoning it in place ranged from $2,800 to $5,250. [120]

The cost of new fiberglass tanks in the United States in 1983 was reported to be about $20,000 each. [121] In 1989, the U.S. EPA estimated that leak detection systems for a service station with three 5,000 gallon tanks would cost between $3,000 and $8,000. The cost for retrofitting cathodic protection for steel tanks ranged from $10,000 to $48,000 for the three tanks. The cost for installing three new 10,000 gallon tanks could range from $76,000 to $100,000 depending on the level of detection used. [122] Upgrading a service station by installing a lining in the pit containing three single-walled fiberglass tanks cost one U.S. oil company about $42,000. The site work, which included excavation for the tanks and line holes was about $5,000. The three 10,000 gallon single-walled tanks cost a total of $13,000. Underground fiberglass piping at $2.50 per running foot cost almost $5000. Lining the pit and backfilling cost $8,000, including the tank hole, piping trenches and gravel backfill. Equipment, including submerged pumps, overfill boxes, in-tank gauges, leak detector street boxes, monitoring well with hydrocarbon sensor, cathodic protection, monitoring wells, labour, electrical and other miscellaneous materials cost $8,000. A concrete slab to cover the tanks cost $2,500. [123]

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[120] Robinson, Scott, Knocke, and Conn, "Underground Storage Tank Disposal: Alternatives, Economics, and Environmental Costs", Bulletin 160, Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University, Feb 88.

[121] Fuel leaks called threat to water", New York Times, Nov. 30/83.

[122] National Petroleum News Feb 89, p40

[123] Nat Pet News Feb 89, p47

While many estimates of costs are available, the most reliable cost information I was able to obtain on costs actually incurred in Canada was a list of service station upgrading expenditures provided by Chevron in British Columbia. The actual cost of a service station upgrading program undertaken by Chevron in British Columbia between 1982 and 1988 was $5,536,500 for 109 locations, or an average of approximately $50,800 per location. Assuming an average of three tanks at each service station, allocating these costs on a per tank basis would give a cost of approximately $17,000 associated with the replacement of each tank. [124] These expenditures, did not isolate costs relating directly to better protection against leakage from other costs incurred in modernizing facilities. The actual cost of tank replacement would be far lower, as the upgrading program included not only the replacement of unprotected tanks with protected ones, but remodelling of stations, new signage, and other features designed to attract customers and provide better service, as well as safety features.

An official of a company carrying out installations for large oil companies in British Columbia estimated the cost of replacing the tanks at a typical service station in British Columbia in 1991 as about $80,000. [125] This estimate was echoed by a B.C. hydrogeology consultant, who estimated the cost of replacing a tank at about $2 per gallon. Thus, at a typical B.C. service station with four 10,000 gallon tanks, the cost would be $80,000, or $60,000 if the station had three tanks. [126]

In Ontario in 1992, one service station owner reported that it cost him approximately $25,000 to install two 5000 gallon tanks and one 2000 gallon tank and associated piping. The pumps, etc (check tape) were to be installed by the gasoline distributor whose signage the station would carry at an estimated additional $30,000. Paving the station to prevent spills from entering the soil would be needed as well. [127]

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[124] "Retail Underground Tank Replacement Program, October 1989, provided by D. Riekin, Dec. 5/90.

[125] Ray Porcina, VP Sales, P.D. McLaren Ltd.

[126] from interview of student with Allan Dakin.

[127] James Rogers, interview Dec. 4/92.

In May, 1993, the Saskatchewan government released estimates of the costs that service station owners would incur in complying with upgrading requirements for tank testing and monitoring and equipment improvements. The government estimated that the total cost of an upgrading program consisting of a system tightness test, a separate line tightness test, monitoring wells, and analysis of soil to confirm the level of contamination in the tank bed, together with drip collection trays, vertical check valve, overfill bucket, overfill preventer, and cathodic protection would be a minimum of about $7,000 for one tank, plus some installation costs. The cost for a service station with three tanks would not be three times as high, because "some items may not be required to be repeated in direct relationship to the number of tanks". [128]

When Ontario introduced new regulations in September of 1993 that would require new tanks to have spill prevention devices, spill containment devices under the gas pumps and at tank fills, perimeter monitoring devices around existing substandard tanks, and secondary containment and alarm systems for all new tanks and piping, the Canadian Petroleum Products Institute, which represents the major Canadian oil companies, estimated that "a site could require an investment of between $5,000 and $l0,000 for new underground equipment to meet the new standards". On a per-tank basis, assuming an average of three tanks per service station, this would mean a cost of between $1,667 and $3,333, a cost which the Director of Ontario's Fuel Safety Branch said could be met by raising the price of gasoline "a fraction of a cent per litre". [129] However, some service station owners have disputed these figures. One independent owner claims to have spent $140,000 on "upgrades" in late 1992. [130] Another newspaper article quoted Chatham area service station owners as stating that "the cost may work its way up to $100,000 in some locations". [131] Although no explanations are given for the disparity between the CPPI estimates, which concur with those provided by the Fuels Safety Branch, and the owners' estimates, it appears likely that the difference does not lie in the cost of replacing old

[128]ltr. Treleaven to Swaigen, Jan. 24/94.

[129]News Release, "Industry praises Ontario's new gasoline handling code" Sept 28/93.

[130]Ruryk, "War's on to stop gas leaks", Tor Sun, Sept 29/93, p18.

[131]"Our Opinion: Consumers will apy", Chatham Daily News, Oct 3\4/93 p4.

equipment with equipment that meets current standards, but in the amount of contaminated soil and groundwater that may be discovered during the course of replacement. The cost of disposing of contaminated soil and remediating such soil and groundwater is a cost that would have to be borne eventually in any event, and in many cases this cost will only increase if the contamination is not dealt with.

It is difficult to reconcile these various cost estimates. For example, why should the cost of installing third generation technology in Ontario be less than the cost of upgrading to second generation technology (cathodic protection) in Saskatchewan, when the third generation technology is often estimated as having twice the capital cost of second generation technology?

The wide range of cost estimates given above probably reflects the fact that they are related to different time periods and different regulatory requirements. Some would include costs related to clean-up of existing contamination, while some do not.

Regardless of these variations, however, it is clear from the information provided above that the overall potential economic impacts of LUST greatly exceed the potential costs of prevention. In many cases, the actual costs resulting from leaks have greatly exceeded the cost that would have been incurred in replacing unprotected steel tanks and lines with protected ones and installing monitoring devices for early detection of leaks.

Why then, have the necessary steps not been taken to replace these bare tanks and lines and to install leak detectors? There are many factors that have mitigated against operators taking such steps. However, one significant factor is how the costs of prevention and of clean-up and compensation are allocated.

In the absence of any program of financial assistance to operators to replace unprotected tanks and lines, the costs of replacement would be borne solely by the owners and operators of these facilities. By delaying upgrading of facilities, these operators can defer these costs for many years.

A substantial portion of the costs associated with investigation and remediation of leaks, on the other hand, are not borne by the owners and operators of USTs and by those whose negligence caused leaks, but by the public and by the victims of this pollution.

In the following chapter, we will discuss how the costs of harm done by these leaks are allocated.

## Chapter 5 WHO PAYS FOR LUST?

As of November, 1992, there were still a substantial number of unprotected steel tanks and associated piping in the ground, in many cases with no monitoring but manual dipping of tanks and inventory reconciliation. The most effective system, double containment and interstitial monitoring, was frequently not required by the governing legislation or installed voluntarily. Moreover, although the problem of aging tanks and piping had been apparent since the 1960s in Europe and had manifested in numerous leaks in the early to mid-1970s in Canada, many of the unprotected tanks and piping systems had been left in the ground for another decade or more, with a rush to remove them in large numbers as legislated deadlines for removal or upgrading loomed or passed towards the end of the 1980s and the beginning of this decade.

Why weren't these systems upgraded or replaced earlier? And when they have been replaced, why weren't the most effective systems installed? There are several answers to this question, including lack of understanding of the potential consequences of leaks from these systems in the 1960s and 1970s, technological limitations, weak laws and ineffective law enforcement, and economic considerations.

In this chapter, we will consider one of these factors: the economic barriers to environmental protection. In particular, it is important to realize that while the cost of taking preventive measures was substantial, and would be borne entirely by the owners and operators of facilities where tanks were located, the costs of <u>not</u> taking preventive measures could often be passed on to others. Economists refer to this as "externalizing" costs. Externalization of costs is the opposite of the "polluter pays" policy espoused by Canada and other members of the Organization for Economic Cooperation and Development (OECD), which states that companies should be required to pay the costs of environmental damage associated with their activities; that is, "internalize" these costs. When a good or service is free, more of it will be used than if it must be paid for. The more the good or service costs, the less of it will be used, the actual amount being affected both by the cost and by the elasticity of demand for that good or service.

Thus, looking at the environment as a commodity, more of it will be used for waste disposal if this is free or inexpensive than if a higher cost is attached to this use. In other words, if there is no cost to tank owners from using the soil or groundwater as the receptacle for leakage, that is, if the cost of leaks is externalized, there will be more leaks and less action taken to prevent them or clean them up.

There is no doubt that in Canada, the owners and operators of USTs have been able to externalize many of the costs of leaks, passing them on to the tax paying public and to third parties.

I have found it impossible to determine how much money public agencies are spending in Canada to investigate and remediate private-sector UST leaks. However, there is no doubt that the cost is substantial. Government agencies often must carry out the investigation needed to determine the source of a leak and the extent of the risk at public expense. Where the source cannot be determined to a level of proof that would satisfy a court, or the owner of the known or suspected source cannot afford the investigation and clean-up, the costs are often borne by the taxpayers.

Some estimates in the United States are helpful in approximating the extent to which the costs associated with LUST are borne by the taxpayers.

In the United States, it has been estimated that only two-thirds of approximately $1 trillion spent on environmental clean-up between 1970 and 1990 had been paid directly by private industry. A "large number" of U.S. states represented at a meeting on LUST remediation estimated that collectively they would spend $550 million on UST-related corrective actions in 1992. [132] In January of 1994, it was reported that, "State funds alone are contributing approximately $1 billion annually to the cost of remediating petroleum releases." [133] The report did not state how much of this was public funds and how much came from surcharges on petroleum products collected for clean-up purposes.

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[132] Lisa Larsen, "Kansas Trust Fund Program Moves Toward More Effective Cleanup Scenario", LUSTline Bulletin 17, Oct 92 p.6.

[133] L.U.S.T.Line Bulletin 19, January 1994, p.2.

There is no doubt that in Canada many of the costs of environmental clean-up are also passed on to the public sector. Between 1985 and 1993, the Ontario Ministry of the Environment spent $119,951,999.59 from its Environmental Security Account for clean-up of environmental contamination at sites where it was impossible to recover the cost from the owner or operator of the facility.[134] Of note are several high-profile clean-up efforts. As of April 1991, for example, Ontario had spent approximately $25 million to excavate and treat PCB contaminated soil and sludge and groundwater at a PCB storage site at Smithville. In April of 1991, a further $2.4 million was committed to this project through a joint federal-provincial program to clean up high-risk orphan waste sites, and a total cost of up to $134 million was projected by consultants.[135] Between $8 and $9 million was expended by the Ontario Government for fire fighting, containment of pollutants, and clean-up of soil and groundwater pollution as a result of the Hagersville tire fire between February 1990 and March 1991[136] and the total cost was projected as up to $40 million.[137] and the costs associated with closure of the TransCanada Highway, digging up the highway, and repaving it, as a result of the PCB spill near Kenora in 1985. Efforts to obtain reimbursement of the costs of the latter two incidents through the courts have been unsuccessful to date. The Regional Municipality of Waterloo, the Ontario Government, and Uniroyal Chemicals Limited have shared the costs of cleaning up contaminated soil and groundwater in Elmira, Ontario, monitoring the quality of surface water and groundwater, and constructing a new water supply system to replace the contaminated wells supplying the village of Elmira. In November of 1991, the Region had budgeted $19 million for this purpose, which included a grant of over $29,000 from the Environment Ministry.[138]

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[134] Ont. MOE, "Security Account Multi-Year Expenditures".

[135] Emilia Casella, "Minister admits $91m won't clean dumps"; Ham Spect Apr 4/91.

[136] EAB decision.

[137] Minister admits...

[138] Elmira Independent, Nov 4/91.

Government agencies interviewed for this study generally stressed that most clean-up expenses associated with LUST are paid for by the person at fault or the owner or operator of the facility, and that government funds are expended only when the source cannot be determined or the person responsible has insufficient resources. However, there is evidence that this is a frequent occurrence. As indicated in an earlier chapter, it is extremely difficult to conclusively isolate the source of a leak for many reasons, including the numerous potential sources of leaks and spills in most areas, the difficulty in determining the pathway followed by contaminants through soil and groundwater, and the delayed discovery of many leaks. It is also difficult to isolate the impact on health of such leaks because of the frequent occurrence of other forms of pollution such as bacteria and nitrates from septic systems, road salt, oil from road oiling, and pesticides and fertilizers in wells contaminated with petroleum products.

Therefore, the costs of investigation and clean-up fall initially, and in a substantial number of cases, ultimately, to the public and to third parties. Direct costs often result from the need to retain consultants to determine the source of the pollution when staff efforts are unsuccessful. For, often the agency cannot successfully apply pressure to the private sector to undertake remediation until it has obtained sufficiently conclusive evidence of the source. In Ontario, for example, extensive hydrogeological studies by Ministry of the Environment staff which have not succeeded in isolating the source have led to the Ministry retaining outside consultants both to investigate the source and to develop a clean-up plan.

As of October 1991, the Ministry of the Environment had budgeted $4,454,900.00 from its Security Account to deal with 27 leaks and spills known or suspected to be associated with USTs. These were all incidents for which the Ministry accepted financial responsibility because owners were not known or readily available, the source of the contamination was not known, or owners were not in a position to carry out the clean-up.[139] Thus, the Ministry had budgetted an average of almost

[139]RC Hore to JS March 3/92.

$165,000 for each of these incidents. These expenditures were allocated to investigation, remedial action, supplying residents with bottled water, water treatment systems, and in one case, expenses for legal defence. In one of these cases, the Ministry expected to be reimbursed for its expenditures. Of the money budgetted, $403,700 was actually spent in fiscal year 1991/92. [140]

Information as precise as the information above is rarely available from government agencies. Indeed, the information presented above was not readily available, but was compiled in response to my request, a process which took five months, because of the pressure of other workload. However, a list of costs which the City of Saint John, New Brunswick claimed to have incurred in responding to the April 19, 1986 King Square explosion gives some insight into the kinds of direct and indirect expenditures that may be incurred by public authorities. In a lawsuit against Irving Oil, the City claimed $153,608.06. The City eventually settled for $75,000.

The expenditures included $l0,000 paid to engineering consultants, $2,100 to replace foam used in fighting the fire; meals, transportation and hotel bills for evacuees of about $19,000; $700 for film and processing; over $3,300 for rental of equipment including lighting plants and a generator, telephones, a vaccuum truck, and portable toilets; over $1,000 for miscellaneous supplies and equipment such as flashlights and batteries, hose, and replacement of a lost meter; over $50,000 in payroll for municipal employees, including firefighters, police, works department employees, and others; and an additional $13,000 paid to salaried city employees under the terms of an emergency measures by-law. There were also business losses to the public sector. The Aquatic Commission claimed over $11,000 in business losses. Costs associated with the law suit itself included almost $12,000 for expert witnesses and nearly $17,000 in legal fees. [141]

While the Saint John incident represents one of the largest, if not the single largest, economic losses associated with LUST, it does not represent the "worst case". Because the explosions and fires happened early on a Saturday morning and occurred

[140] ibid.

[141] "The City of Saint John, Explosion of April 19, 1986, Costs" obtained from Daryl Wilson, City Manager, date.

in a commercial area rather than a residential area or an area containing institutions such as hospitals and convalescent homes, there were no personal injuries and the evacuation was on a much smaller scale than had the fires and explosions occurred in the same location at a different time or in a different part of Saint John.

The Saint John incident is one of the few instances in which the public costs associated with evacuations are available - particularly the indirect costs such as the value of staff time -- are available. Such information is not routinely compiled by agencies involved in emergency response or emergency response coordinating agencies.

While not a LUST incident, the Mississauga derailment provides an example of the kinds of costs that can be expected as a result of evacuations that occur in LUST cases. These costs have been documented in a study of the evacuation of the City of Mississauga resulting from a derailment of a train carrying chlorine on November 10, 1979. The costs included those incurred by householders forced to leave their homes and find shelter elsewhere, businesses, and public agencies. The total estimated cost was about $70 million for costs incurred within the evacuation area. However, the authors of the report were unable to obtain precise amounts and note that $70 million "should be viewed as a tentative and incomplete measure of the overall economic costs of the evacuation". [142]

Some glimpses into the kinds and extent of indirect losses to the public sector from LUST were provided by some of the persons interviewed for this study. A Saskatchewan Department of the Environment inspector responsible for investigation of spills and leaks throughout the province indicated that he frequently carries out at public expense investigations typical of those a consultant would undertake to determine the source of leaks and spills, the contaminant pathway, and the remediation required. He estimated that a consultant would typically charge about $5000 for the same work that he does in attending the site with a drill truck; installing four or five piezometers to determine the stratigraphy and groundwater gradient; and taking some soil and groundwater samples for analysis. He estimated some of the costs involved in his investigations as $1500 in laboratory analysis fees

[142] Ian Burton et al., The Mississauga Evacuation: Final Report, Ministry of the Solicitor General, November 1981, 7-67.

for a "large" spill or leak and approximately $600 for analysis of four groundwater samples at $150 each for a typical gas station leak with limited impact; use of government equipment that would normally be charged out at about $100 an hour if leased; and his salary at about $25-30 an hour. [143] During the previous summer two students had been hired to assist in spill investigations, and he frequently took a student with him to assist in the field.

Another indirect cost that is difficult to quantify is the increased risk of harm resulting from the deflection of staff time from preventive inspections to response to leaks and spills. One fire official, for example, identified the costs incurred in investigating leaks and trying to determine the sources as additional employees' expenses, travel and accommodation, and delay in carrying out regular scheduled fire inspections. [144]

The Ontario Ministry of the Environment is not responsible for regulation or inspection of USTs. However, it becomes involved once a spill or leak threatens to migrate beyond the property line and affect third parties or the environment outside the property. An Ontario Ministry of the Environment official indicated in 1991 that in his experience, the Ministry was expending in the order of 5 person-days per LUST incident for those incidents presenting a significant environmental issue. He estimated that such incidents may represent 20% of the total incidents reported to the Ministry. For the remainder, which were usually "minor sites involving the removal of tanks where contamination is encountered or spill incidence", [145] he estimated staff time at one to two person-days per incident. This official estimated that based on 158 leaking underground storage tanks per year in the province, 20% of which are significant ones involving 5 person-days of Ministry time and the remaining 80% requiring 2 person-days, the Ministry was using 412 person-days a year to deal with LUST. In addition, he estimated Ministry resources used under the Security Account, mentioned above, as "in the order of 15 days per year", for a total of 427 person-days per year. This estimate, however, did not include any resources

[143]Ashley Olesen interview Jan 9/92.

[144]Peter Fitzpatrick, Oct 15/91.

145Memo, Higg to Hore, below. I suspect that the author incant "incidents" rather than "incidence".

of the Investigations and Enforcement Branch, who deal with difficult investigations leading up to consideration of formal administrative orders or prosecution. It also is not clear whether the estimate was intended to include time spent by the Ministry's legal branch, which drafts administrative orders arising out of such incidents and represents the Ministry in appeals from such orders, conducts prosecutions, and assists in the preparation of civil suits for recovery of Ministry costs associated with LUST investigations. However, from the context, of the official's letter it would appear that these resources were not considered. [146]

In addition to costs to regulatory agencies, the costs of LUST are often borne by those whose property, drinking water, and business activities are affected. Lawyers describe LUST cases as among the most difficult to prove, for the reasons given earlier. In the service station business, which has been a fertile source of LUST, complicated contractual arrangements create additional difficulty in determining liability. In one LUST case, for example, between 1984 and 1992, under a system of head- and cross-leases, the service station was owned by one of its operators and leased to Shell, which provided the petroleum products to that operator and to up to five different operators at different times. [147] Such contractual arrangements are often designed to minimize the liability of the oil suppliers and shift it to the operators of the stations, who often do not have the assets or insurance to pay for clean-ups and compensation. Litigation is often costly and protracted. Ultimately, it is often impossible to prove the source of the contaminant or to recover money from an impecunious tank owner.

One reason costs of LUST are borne by the public and third parties rather than by those whose fault caused the leakage or who own the facilities is the lack of insurance coverage. Because of the high cost of pollution insurance, large oil companies are generally self-insured; that is, they have set aside a fund to cover third-party claims.

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[146] Memorandum from Darryl Hogg to Ron Hore, November 25, 1991.

[147] Shell Canada Products Ltd. v. Director, Waste management and Sage Brush Services Ltd., B.C. EAB, appeal no. 93/10, April 14, 1994, p.6.

However, self-insurance is not practical for small operators. Insurance is either not available to smaller operators, or is available only at prohibitive cost. In the 1970s, most insurers, recognizing the extent of their potential liability in pollution cases, restricted their coverage to "sudden and accidental" pollution incidents; that is, they refused to provide coverage for harm caused by any ongoing discharges or emissions of pollutants or waste disposal activities.

"Sudden and accidental" pollution, commonly called "spills", often excluded gradual leaks. As the effects of LUST are often discovered many years after the initial leakage, it is very difficult for an insured person to prove that the cause of the contamination was "sudden". This has led to extensive litigation by insured persons against their insurers to compel them to pay claims, with mixed results. Therefore,, in the mid-1980's insurers rewrote their policies to exclude coverage of all pollution. In addition, insurers changed the basis of their coverage from "claims-made" to "occurence" type policies. The difference is that a claims-made policy covers damage for which a claim is made during the term of cover, the policy, while and occurred policy covers only damage that occurs during the term of the policy (usually one year). As a result, leaks, which are often undiscovered for many years, are not covered.

Apart from the restriction to sudden and accidental pollution, however, insurers in recent years have simply refused to provide any insurance coverage for pollution, whether sudden and accidental or not, to any facility that they suspect to have unprotected steel tanks and lines.

Environmental Impairment Liability insurance and other specialized pollution insurance policies later came on the market, but this coverage was available only after insurers had carried out an environmental audit of each facility applying for coverage to determine the extent of their potential liability, and some forms of pollution insurance explicitly excluded USTs. This insurance had many exceptions and was too expensive for small operators.

The Insurance Bureau of Canada has also taken the position that, "Pollution which is inherent to certain economic activities cannot be considered accidental and is therefore generally uninsurable". [148]

Another factor that contributes to the lack of ability of service stations in particular to pay for clean-up and the reluctance of both service station operators and large oil companies to pay for proper monitoring and state-of-the-art leak prevention systems is the low profit margins on the sale of gasoline. As the oil industry frequently points out, the price of gasoline has remained relatively low in relation to the rate of inflation and a substantial percentage of the increases in cost over the past two decades have been taxes included in the price of gasoline. Both the large refiners such as Imperial Oil and regional refiner-marketers such as Irving and Husky have claimed that they either break even or lose money on sales of gasoline to service stations. [149] Service station owners say this is true of them as well. Many service station owners and operators combine gasoline sales with an accompanying business such as a grocery store, variety store or restaurant. It is often suggested that a gas bar in most small communities is no longer a viable business except in combination with such other businesses. According to the federal Department of Energy, Mines and Resources, out of an average Toronto retail gasoline price of 57.5 cents per litre in June of 1991, the crude cost was 13.5 cents, federal tax was 12.3 cents, provincial tax was 13 cents, profit on refining and marketing was 14.6 cents, and the retailer's gross profit margin was 4.1 cents. [150] Some cut-rate gasoline chains such as Olco operate on a profit margin of about 2 cents a litre. [151] Average gross profit margins for retailers have generally remained in the 2 to 5 cents per litre range

[148]Jack Lyndon, Canadian Insurance/Agent & Broker, April 1991, p.8.

[149]Drew Fagan, "Gas stations don't bring home bacon", Globe and Mail Aug 28/91, p. B1, B5.

[150]Globe article.

[151]Globe.

throughout the second half of the 1980s and the early 1990s. [152] Despite these low profit margins, retailers have been reluctant to charge more for gasoline, both because of competition within Canada and competition from retailers in the United States, where the price of gasoline is even lower than in Canada.

The result of this combination of a lack of insurance coverage and low profit margins is that small operators do not voluntarily upgrade their equipment and those who have substantial leakage cannot afford to pay the costs of clean-up and compensate victims. These costs therefore are often borne by the public or the victims. In the case of service stations that are identified by signage as stations of the major oil company that supplies the fuel and other products sold there, the oil company will often pay all or part of the clean-up costs even if it does not own the station. There appear to be a variety of reasons for this largesse, including public relations, difficulty in determining liability as a result of complex ownership, leasing and cross-leasing practices in the retail gasoline business, reluctance to lose a dealer to bankruptcy or to a competing distributor, and a belief, whether correct or not, that the oil company will be held legally responsible for its dealers' leaks.

The divestiture practices of the major oil companies during the 1960s and 1970s have also contributed to a shifting of the costs of LUST to the public purse and third parties. Today, some major oil companies that want to divest themselves of less profitable service stations will not sell them to the stations' operators or to others without first removing all tanks, pumps, piping and contaminated soil. However, this was not always the case.

In the 1960s and 1970s, the majors in Canada divested themselves of many of their least profitable stations, largely in rural areas. These stations were often sold to their operators. The underground tanks were often sold separately for $l; oil company officials interviewed for this study acknowledged that the reason was "to get rid of the liability". Thus, the least profitable stations which often had old tanks and piping have been put into the hands of persons unlikely to be able to obtain insurance against LUST damage and unlikely to be able to pay for costly clean-ups.

[152] SSGM Sept 90, Mar 1984, p.16.

Another factor that results in costs of clean-up and compensation being absorbed by innocent third parties is the doctrine of caveat emptor or "buyer beware". In the absence of deliberate concealment of risks by the vendor, the purchaser of property is usually responsible for remediating any contamination on the property. Sophisticated purchasers will take steps to protect themselves against this liability. However, unsophisticated purchasers, who are generally the least able to absorb the costs of clean-up and compensation, have frequently purchased property with leaky underground tanks on it or with contaminated soil or groundwater resulting from past leakage. The Hermistons, mentioned earlier, are a classic example of such unsophisticated purchasers. Glenn Hermiston was a long-distance truck driver when he purchased a service station in Orrville, Ontario. He and his family had no experience in running a gasoline station, but they were relieved that Mr. Hermiston could stay home with his family. However, they soon discovered that even though their tanks were not leaking, their well water and soil were contaminated, possibly as a result of past practices at the property. The Ontario government ultimately ordered both the Hermistons and the previous property owners to remove all the contaminated soil and groundwater, but it later revoked the order against the previous owners, leaving the Hermistons and the taxpayers of Ontario to share this cost.

Even a sophisticated purchaser can become responsible for past contamination. The Municipality of Metropolitan Toronto, for example, which has extensive involvement in land dealings, purchased the site of a former gasoline station as an ambulance station. The property later had to be abandoned because fumes from contaminated soil beneath the site permealed the building, but the legal department of the municipality advised the municipality that it would be unsuccessful in recovering damages from the vendor, as the existence of underground tanks was disclosed to Metro before it purchased the property.

In addition, some laws favour the transfer of such liabilities to innocent purchasers, despite the obvious unfairness of such a situation. For example, until it was amended in 1990, Ontario's Environmental Protection Act required the current owners of land where waste had been illegally deposited to remove the waste at their own expense.

There was no provision allowing the Ministry of the Environment to order the previous owner of the land, or the person who deposited the waste on the land to remove it.

A final factor which encourages the externalization of these costs is the lack of enforcement of laws regulating USTs and low fines imposed for violating those laws. Companies will have an incentive to obey laws intended to prevent LUST incidents when they believe that the cost of non-compliance will exceed the cost of compliance. As long as they have reason to believe that there will be no cost associated with non-compliance, they will be tempted to ignore the laws. As discussed in a later chapter, enforcement activity in Canada has not been vigorous.

## Chapter 6 A BRIEF HISTORY OF LUST

In the following chapters, we will begin to describe and evaluate the laws regulating underground storage tanks. For the reader to form his or her own conclusions about the adequacy of the process of developing the laws now in place, it may be useful to discuss how long LUST has been a problem, and has been known to government authorities to be a problem.

In many ways, the current LUST problem arises from regulators' efforts to solve another problem. As long ago as the 1930s, fire officials began to press for burial of tanks containing gasoline and other petroleum products used to fuel vehicles, as a way of reducing the problem of fires and explosions resulting from leaks and spills. One of the earliest steps taken to reduce the fire hazard from gasoline sales was to remove gasoline pumps from the curbside, where vehicles could collide with them. Later, pumps with windows which showed the gasoline moving through the pump were banned, presumably because these windows provided an exit for gasoline if they were broken. These laws were accompanied by restrictions on indoor petroleum tanks. Tanks were gradually forced both out of doors and under the ground.

Gasoline and other petroleum products were, in fact, among the prime causes of fires, and burial of tanks and lines was successful, in the short run, in reducing this risk. In correspondence with his British counterpart in 1939, the Ontario Fire Marshal advised, "We feel here that one of our biggest (fire) hazards is gasoline and storage generally of petroleum products". [153] In 1945, for example, the U.S. Department of Agriculture, in a booklet for farmers on the safe use and storage of gasoline and kerosene on the farm stated: "Gasoline, kerosene and other petroleum products are among the principal causes of loss of life by fire on farms and ranks sixth among the causes of property loss in farm fires. It is estimated that more than 500 lives are lost annually in farm fires caused by the careless use and storage of

[153] Ont. Archives file.

gasoline and kerosene and other petroleum products; that more than 1,000 men, women and children suffer serious burns from this cause; and that more than $5,000,000 worth of farm property is destroyed." The same publication advised that, "The best method of storing gasoline is in an underground tank...".

By the late 1930s, British regulations required that all gasoline storage tanks with a capacity of 10,000 gallons or more had to be underground unless a permit was obtained to place them above ground. By the 1940s, Ontario regulations required all petroleum products to be outside buildings in either underground or aboveground storage tanks, except for service stations, where all flammable storage products had to be stored in underground tanks. [154]

In response to a question about the best way to store gasoline at a cottage, the Ontario Fire Marshal wrote in 1946, "For larger storage tanks, aboveground tanks present a considerable hazard, particularly from accidental damage, from grass fires, or from an accident occurring from discharging. Therefore, an underground storage tank discharged by means of a hand pump is recommended." [155]

Putting storage tanks underground reduced a fire hazard but made punctures, breaks, loose fittings and corrosion invisible. It meant that when such tanks and lines eventually corroded or began to leak for other reasons, this leakage might not be discovered until a build-up of fumes in structures created a risk of explosions or until extensive, and largely irreversible, soil or groundwater contamination had occurred.

The decision to bury tanks was not made as a result of ignorance of the possibility that such leaks would occur, but more likely as a result of a lack of concern about the soil and groundwater contamination that would result. That the possibility of leakage was well-known to authorities is demonstrated, for example, from an excerpt from a code of practice for fire and safety in aviation adopted by the U.S. National Fire Prevention Association in 1931:

[154] Ontario Gasoline Regulations, s.25, 34(1).

[155] WJS Fire Marshal to Keith McElroy, M.D. Jan 7/46.

## B. Filling from Underground Tanks by Hose

> 12. Check for water in gasoline. Constant precautions should be taken against water getting into gasoline delivered to airplanes. This means daily checking of underground tanks to be sure they are in good order. The presence of water can be determined by testing with water testing paper or paint soluble in water.

Of course, as indicated by this passage, water entering a tank is as much an indication of a leak as gasoline leaving the tank. Whether the gasoline escapes depends on the level of the water table and hydrostatic pressure, which fluctuate seasonally and with precipitation and snow melt. The concern expressed by the fire officials who prepared this Code, however, was with the safety of the airplane taking on fuel with water in it, not with any impact of leakage on the environment. [156]

By the 1950s, the general problem of leaks and spills from storage tanks, pipelines, waste lagoons, mine drainage, transportation spills, and other sources was well-known and well-documented. In its 1958 annual report, the New York State Department of Health described contamination of groundwater supplies by waste waters discharged into a percolating lagoon at a starch company and barium and strontium contamination of wells from waste waters at a Westinghouse Electric Company plant.

In January 1959, attendees at a symposium held in Germany by the European Federation of Water Protection and Special Risks were regaled with tales of oil pollution from long distance pipelines and surface and underground storage facilities. In the same year, 27 cubic meters of heating oil leached from an underground container at Saarbrucken, only 1200 meters from the nearest well of the municipal water supply system. Although the oil was recovered before it reached the water supply, the success of the clean-up was attributed in part to "luck". The case illustrated the difficulty of recovering oil once it enters soil and groundwater. Even after extensive removal of soil from the level of the tank down to the groundwater and pumping of the groundwater surface, only one-third of the oil was initially recovered, requiring removal of additional soil.

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[156] Recommended Good Practice Requirements for Fire and Life Safety in Aviation, prepared by Aviation Committee, Adopted by National Fire Protection Association, 1931.

At a 1961 symposium on groundwater contamination held in Cincinnati, Ohio, various papers described incidents involving contamination of groundwater with inorganic chemicals, which are relatively "indestructible, causing persistent pollution which is difficult and costly to abate"; contamination of groundwater in Michigan with hexavalent chromium, caused by percolation from ponds of infiltration pits receiving electroplating waste waters, from spills, and from the use of chromium-treated salts to melt snow; pollution of wells at a plant producing pyridine compounds where the waste had been discharged to a lagoon constructed on porous gravel soil; and contamination of a rural well by leakage from a fuel oil tank. Symposia held in Basel and Berlin also dealt with groundwater pollution from leakage of oil from household storage tanks, storage of oil, domestic sewage, waste disposal, agriculture, and industry, and with the movement of oils through groundwaters. A similar symposium held in 1962 heard tales of pollution of an industrial well in 1951 by tarry wastes from a gasworks that had been closed down for at least 120 years; pollution of a water supply in Lincolnshire, England by spilled aviation fuel consisting of a petroleum/kerosene mixture; and groundwater contamination in various places in Queensland, Australia by nitrate and nitrogen compounds, iron and iron bacteria, turbidity, and fluorides. One of the most serious groundwater contamination episodes involved an extensive outbreak of illness in parts of Torreon City in Mexico. An investigation showed that this resulted from chronic arsenic poisoning from drinking well water contaminated by leaky storage tanks.

By the early 1960s the LUST problem had been recognized as widespread and serious in Europe, and legislation was being passed to control it. Indeed, as early as 1960, a paper was published in Belgium describing cases of groundwater and surface pollution in Germany, Sweden and the USA, and warning that pollution of water by hydrocarbons had become a serious problem. The author recommended the creation of protective zones, where the construction of underground fuel storage tanks would be prohibited and the routine inspection of all equipment used in the transport and storage of fuel. As we will see in later chapters, more than 30 years later, similar recommendations continue to be made in this country with few results.

Marcel Moreau, a US expert on LUST, wrote in 1985 that, "While the threat posed to our ground water resources by leaking underground petroleum storage tanks has only recently been recognized in this country, several European countries recognized the problem over 20 years ago, and have developed considerable practical experience in effectively preventing underground storage tank leaks." [157] Specific programs to protect groundwater from UST leaks began in the late 1960s in West Germany and in the early 1970s in Sweden, Denmark, and several other west European countries. [158] Germany, for example, began a program requiring upgrading of unprotected steel tanks in the late 1960s, and this program was almost complete by 1987. All new tanks were to have double walls with interstitial leak detection. [159] Individual German states had their own upgrading program for existing unprotected tanks. A typical requirement was a regulation passed by the state of North-Rhine Westfalia. Put in place in April of 1968, the regulation required that all tanks containing fuel oil in operation before 1959 or situated in an area designated as a groundwater protection area had to be upgraded immediately, and all other fuel oil tanks had to be upgraded before September 30, 1968. All non-fuel-oil tanks had to be upgraded by September 30, 1968 if they were in a groundwater protection area. If they were not in a groundwater protection area, the deadlines for upgrading were September 1971 for tanks more than 12 years old, September 1972 for tanks more than 6 years old, September 1973 for tanks more than 3 years old, and September 1974 for tanks less than 3 years old. [160] To put these dates in perspective, in 1989 Saskatchewan gave its tank owners until 1994 to upgrade their unprotected tanks, and extended the deadline until 1995 when tank owners complained they could not afford to meet it.

German upgrading programs generally allowed retrofitting of unprotected steel tanks with either internal coating or cathodic protection and required either a periodic inspection of the tank every five years including a physical inspection inside the tank,

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[157] Marcel Moreau, Some European Perspectives on Prevention of Leaks From Underground Oil Storage Systems (undated) p 1.

[158] Dames and More 1-3.

[159] Dames and Moore 2-18.

[160] Dames and Moore 2-19, 2-20.

or an internal membrane liner and interstitial leak detection. Alternatively, the tank could be replaced with a double-walled steel tank with interstitial leak detection, in which case the leak detection system must be inspected every 5 years. [161] Other regulations developed in Europe in response to the LUST problems of the 1960s include examination and certification of tank installers; requirements for double walls for pressurized pumping systems or a complete ban on pressurized piping; periodic tank inspection by a government-approved association; automatic overfill protection devices; and manholes in tanks large enough to permit entry for inspection. [162]

It is difficult to understand how Canada and the United States, in which some of the same major oil companies operate as in Europe, did not foresee the same problems in these countries as were occurring in Europe in the 1960s. It is difficult to determine how widespread LUST was in the 1970s and early 1980s, since most provinces did not systematically keep statistics on leaks and spills during this time, and oil company records are not readily available. Nevertheless, it was apparent by the early 1970s that many of the tanks installed after the Second World War were beginning to leak, and other problems relating to leaks and spills had become obvious by that time.

The extent of the problem became apparent earlier in some provinces than others, depending largely on the degree of dependence of the province on groundwater for drinking water supplies and the corrosivity of the soil in areas where tanks were located. However, by the mid-1970s, there were certainly enough warning signs to allow government and industry to recognize the potential, and in some cases the actual, extent of the problem.

The major Canadian oil companies were certainly aware of LUST by the mid-1970s. In 1971, sixteen oil companies formed the Petroleum Association for the Canadian Environment (PACE, renamed the Canadian Petroleum Products Institute in 1990).

[161] Dames and Moore 2-18, 2-19.

[162] Dames and Moore.

Around 1973 or 1974, PACE formed a Product Storage and Handling Committee to study the problem, as "that's when problems started to arise". [163]

In 1977, one of the members of PACE monitored the condition of tanks being removed from the ground and confirmed that a substantial number of them were corroded. However, the problem had been apparent before this. In a letter to the office of the Minister of Health thanking the Minister's staff for sending a 1985 report on petroleum contamination of groundwater, the New Brunswick Environment minister called petroleum contamination "the problem we have been grappling with ever since the spill of a quarter of a million gallons of gasoline in Chatham in the early seventies". [164] An opposition party member stated in New Brunswick's Legislature in that same year that "between 1965 and 1980, it has been discovered that over 1.6 million gallons of gasoline have been contaminating the soil of New Brunswick, leading to some extremely serious hazards, both to well water and in terms of human life and safety". [165]

By 1974, the problem of leaks and spills had become sufficiently serious in Manitoba that the provincial Clean Environment Commission held an investigation into pollution of underground water by refined petroleum products. The Commission stated, "Pollution of groundwater by refined petroleum products is not a new problem in Manitoba. Several cases, some attributed to spills and others to leaking tanks, have been investigated in the last twenty to thirty years by provincial public health inspectors. In recent years, however, the number of reported cases appears to have increased considerably. (emphasis added). [166] The Commission found that leakage of storage tanks and piping systems was a major source of contamination; [167] that because the movement of contaminants through aquifers is very slow, contamination may show up long after the leak, and that the reported cases of

[163]Matilla interview.

[164]R.C. Jackson to Nancy Clark Tweed, April 3/86.

[165]Oral Questions, page 1, tape 1423(1) June 10, 1986.

[166]Province of Manitoba, The Clean Environment Commission, Report on the Investigation of the Pollution of Underground Water by Refined Petroleum Products, December 1975, p, 1.

[167]Ibid, p. 8.

pollution formed "only the visible tip of the iceberg";[168] that many of the underground tanks had been in the ground for a long time, and "considering what they are made of, one must expect leaking tanks to be a rather common occurrence";[169] and that the clean-up of an aquifer was frequently impossible,[170] so the best way to deal with the problem is prevention.[171] The Commission also found that leaking lines generally resulted from poor installation rather than corrosion, yet there was no legislation in the province dealing with the installation of piping.[172]

Among the Commission's recommendations were the following: that underground tanks be made of fibreglass or cathodically protected, recognizing that cathodic protection would not prevent internal corrosion and the efficacy of internal coatings was still controversial; that all piping drain towards the tank and all pumps be of the suction type; the need for proper design of piping systems and their proper installation; inspection and testing of all new installations, including leaving open all excavations in which the tank and piping are installed until an inspector has had an opportunity to check and approve the installation; and standardization of inventory control procedures.

The Commission found that "all existing tanks must be considered substandard in the light of generally accepted standards of corrosion protection".[173] Because of this, and because no method of leak detection available at that time was capable of detecting a leak before an amount of petroleum escapes that would contaminate a water supply in sensitive areas, i.e., those that depended on groundwater for such water supplies, the Commission recommended that an immediate program of replacement of these tanks in sensitive areas was needed. The Commission felt that

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[168] ibid p. 10.

[169] ibid, p. 10

[170] ibid p 11

[171] ibid p 12.

[172] ibid p 8

[173] Ibid p 23.

there would be no difficulty in identifying the most sensitive areas on the basis of geologic information available at that time.[174] Specifically, the Commission recommended legislation to authorize a program aimed at replacing substandard tanks, (which it found to be almost all tanks in the province) in sensitive areas; to ensure that proper inventory control is practised; to ensure that tanks are tested, and if necessary taken out of service, as soon as there is an indication of leakage; to ensure that all new tanks are manufactured and installed in accordance with the latest Underwriters' Laboratories of Canada standards; and to ensure that all new installations are properly tested and inspected.

The Commission recognized technological barriers to additional legal requirements. In particular, the Commission noted that none of the leak detection methods available were sufficiently sensitive or reliable to ensure detection of leaks in environmentally sensitive areas before an amount of petroleum would escape that would seriously contaminate the water supply; and the lack of proven effectiveness of tank coatings available at that time in preventing corrosion from within.

Technological barriers alone, however, do not appear to fully explain the delays in acting on this problem. For example, one of the problems recognized early in the consideration of this situation within government was the fact that unprotected steel tanks were rusting out. Yet in most cases, owners were given up to a decade to replace them with less vulnerable tanks. Operators were allowed to continue to purchase unprotected tanks even though a method of reducing corrosion had been known to the industry for decades and tanks of a better design were available. Cathodic protection had been recognized as a feasible method of protecting steel pipelines since the 1940s, when a series of oil pipeline failures in the United States

[174]ibid p. 23.

led to consideration of requirements to cathodically protect them. Some above ground tanks had also been constructed with cathodic protection since the 1940s.[175] Cathodically protected underground tanks for petroleum products were available from the late 1960s. The first pre-engineered cathodically protected UST of a design still being sold was installed in Indianapolis in 1969.[176]

Similarly, although tanks with secondary containment and interstitial monitoring have been on the market for several years, with the exception of Ontario, which will require tanks installed after 1996 to have secondary containment, legislation throughout Canada still allows the installation of less effective cathodically protected steel and fibreglass tanks.

In Ontario, the problem had also become apparent by the mid-1970s. An Ontario official provided the Manitoba hearings in 1974 with statistics collected in Ontario over a four-year period showing that leaking tank and fuel lines were responsible for about two-thirds of the pollution problems in that province.[177] The seriousness of the damage that LUST could cause must have also been apparent to Ontario government officials as a result of incidents such as the destruction of a public building in Huntsville, Ontario and the injury to a government employee in 1974. [178]

Although there was little public discussion of the problem, Ontario officials were privately acknowledging that it existed and would only get worse. In a 1976 memorandum, the Ontario Environment Ministry's supervisor of hydrology and monitoring told the Chief of the Ground Water Protection Unit that, "In early 1975, the MOE Regional offices requested that the Ground Water Protection Unit look into possible solutions to their continuing problems with ground-water contamination

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[175]Donald H. Bond, "Cathodic Protection of Oil Storage Tank Bottoms", The Petroleum Engineer, March 1940; J.R. James et al., "Cathodic Protection of Steel Tank Bottoms by the use of Magnesium Anodes, American Institute of Mining and Metallurgical Engineers Publication No. 2202, May 1947.

[176]Tank Talk, Aug 89, p 1.

[177] ibid, p 8.

[178]Huntsville incident referred to above.

from the leakage of petroleum products from underground storage facilities, in particular those facilities at retail service station outlets. There are approximately 12,500 ... retail service stations in Ontario. The Regions have expressed concern that as the tanks at these service stations grow older, leaks will develop at an accelerating rate and ground-water contamination cases will increase in frequency. There seems to be general agreement in the (Ministry's Regional offices) that the solution to this problem <u>is not in regulations requiring clean-up but in the prevention or early detection of the leaks</u>... ."

This official went on to comment on the fact that although a 1974 regulation required all new tanks to be cathodically protected or made of fibreglass, the regulation contained no provision to require removal of existing unprotected tanks or regular inspection or monitoring of these tanks. In a memo dated June 6, 1975, G.R. Smith of the Ministry of Consumer and Commercial Relations, which was responsible for the regulation of these underground tanks, stated that "on average an expected life span for such a tank in most areas of Ontario is 8-10 years". The MOE official concluded that if Smith's estimate was correct, "some urgency can be justified" in dealing with the problem of unprotected steel tanks. It took approximately one-and-one half years for the concerns being raised with "urgency" at the staff level to filter their way up to the senior management in the Ministry of the Environment and to be raised formally with the Ministry responsible for regulation of underground tanks. In January of 1977, the Director of MOE's Water Resources Branch reiterated precisely the same concerns in a draft memo to the Ministry's Assistant Deputy Minister. In the bureaucratic language in which government officials usually couch any sense of urgency, the Director concluded, "It is felt that Senior Management of this Ministry may wish to convey to the Ministry of Consumer and Commercial Relations, our Ministry's concerns over the potential for environmental damage, especially through groundwater contamination, through any delays in promptly addressing the problem of control of these older (pre-1974) storage facilities".

On March 4, 1977, the MOE Deputy Minister, Everett Biggs, wrote to the Deputy Minister at MCCR, relaying these concerns, particularly in relation to MCCR's failure to monitor or remove the unprotected steel tanks. That Deputy Minister replied, advising that a meeting would be convened in April to discuss revisions to the

Gasoline Handling Act, "at which time it is planned to table a draft amendment dealing with pre-May 1974 tanks". Such an amendment was made in 1982, but it gave tank owners until 1991 to remove or upgrade these unprotected tanks and did not require any steps in the interim to monitor the condition of these tanks or detect leakage from them.[179]

That the problem had reached substantial proportions in Ontario by the early 1980s was also indicated by a report to his superiors by an Ontario Ministry of the Environment hydrogeologist. In a report on an investigation of a furnace oil spill at an Aylmer mushroom farm, Saul Essop wrote: "It is recommended that a government agency educate the industry and advise the public about the hazard of hydrocarbon leaks and spills to the groundwater and the importance of proper location and installation of storage tanks". [180]

If there was still any doubt about the seriousness of the problem, it was dispelled in the early 1980s, when the large numbers of tank failures predicted by the Manitoba Clean Environment Commission in 1975 began to manifest themselves in much larger numbers of reported leaks throughout Canada. By 1983, for example, Robert Gunn of the New Brunswick Department of the Environment was reporting in a memo to his superiors that, "Communities who utilize private well supplies for a source of drinking water run the risk of having significant if not severe contamination problems. Sources of contamination include petroleum storage facilities, road salt storage sites, and septic tank effluent".[181] Moreover, Mr. Gunn reported, replacement water supplies also were subject to the same contamination: "Often the construction of deeper wells results in (1) a time lag in regard to the new water supplies becoming contaminated; and (2) a deeper water-bearing zone may become contaminated and possibly adversely affect other deep nearby wells".

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[179] GHC, s.7 (50).

[180] Saul Essop, "Investigation of Hydrocarbon Contamination of Water Well at Little Aylmer Mushroom Farm", June 1981, p.9.

[181] Memorandum, R.N. Gunn to R.G. Lutes, Re: Severe Drinking Water Contamination in Communities which Utilize Private Wells", ca 1983.

Gunn reported that four New Brunswick communities had significant water quality problems, requiring the installation of a municipal water supply system for each of them. In Rogersville, although many of the shallow wells had been replaced, the contamination was continuing to spread and there was a danger that wells drilled into the lower water-bearing zones would draw down contaminated water from the more shallow aquifer. Contaminated drinking water supplies in Hillsborough included the wells at a restaurant, dental clinic, medical clinic, senior citizens home, and individual residences. The contamination there was continuing to spread.

The following year, Mr. Gunn and Dr. D.J. Ecobichon of the provincial health department co-authored a report on petroleum contamination of drinking water in New Brunswick. In this report, they stated that preliminary studies in New Brunswick had identified 350 abandoned storage tanks at 161 sites, 30% of which still contained "quantities of material". They warned that "An ever increasing number of petroleum contamination problems are being reported to the Department of the Environment each year. At present, the water supplies of three New Brunswick communities (Ben Lomond Estates, Fairvale, Hartland) have been contaminated by gasoline or fuel oil. Recently, the only municipal well supplying the community of Drummond has been threatened by the spillage of furnace oil from a delivery truck. <u>It is evident that these problems will continue to occur with alarming regularity, are difficult and costly to rectify and immediate steps should be taken to curb and prevent such occurrences.</u>" (Emphasis added).

Ecobichon and Gunn also warned that although the long-term toxicity associated with the daily consumption of petroleum-contaminated water was unknown, it was well-established that one of its components, benzene, was a potent carcinogen in humans.

Gunn and Ecobichon stated that some 200 underground storage tanks were probably already leaking at service stations in New Brunswick. "The remaining 2600 tanks", they said, "are time bombs, which if left unchecked, will cause serious problems in the near future".

Certainly, the news coming out of the United States at this time left little doubt as to the seriousness of LUST. On December 18, 1983, the popular CBS television program "60 Minutes" featured an interview with a U.S. EPA spokesman who stated that leakage from underground tanks would be the number one environmental problem of the 1980s. A November 1983 article in The Groundwater Newsletter reported that the US EPA, would launch a one million dollar study aimed at defining the scope and severity of the underground storage tank problem.. Jack Ravan, assistant administrator for water in the EPA stated in the article that gasoline tank leaks "may be one of the most common causes of groundwater pollution in many parts of the country". The article reported that between 75,000 and 100,000 storage tanks were leaking in the United States.

By the time Gunn and Ecobichon prepared their report, there was mounting evidence of the LUST problem in the United States. They stated that the Florida Department of Environmental Regulation had reported that a significant number of drinking water supplies were becoming contaminated by aging gasoline storage tanks and action was needed immediately to curb the problem. A California study of underground storage tanks containing solvents for industry had shown an 80% leakage rate at 52 sites surveyed. An abandoned tank survey in Maine had shown that there were I.25 abandoned underground tanks per mile of secondary road.

In 1985, Dr. Ecobichon issued a further report, in which he alleged an exponential increase in the number of well water contamination incidents between 1975 and 1985, and predicted that the number of incidents would continue to rise exponentially. Of 558 well water samples collected in 1985, 229 were contaminated with total hydrocarbons or benzene above the health advisory levels. 133 of the contaminated samples contained gasoline, and 90 contained fuel oil. Most of the contamination came from service station UST leaks. "Tank age was a principal factor contributing," Dr. Ecobichon stated, "many of the tanks having been installed in the 1960s without any subsequent maintenance or upkeep".

By the mid-1980s, large numbers of LUST incidents were occurring throughout Canada. Many government officials and oil industry officials interviewed for this study stated that it was when these leaks were discovered in the early-to-mid 1970s that they first became aware of the problem and the need to take corrective action.

Many such persons also identified the early 1980s as the period when they first started a program of upgrading and removing the old bare steel tanks and lines. However, as the Manitoba Clean Environment Commission report and the European experience indicate, it was certainly possible for informed scientists, regulators, and industry officials to predict the problem many years earlier.

As I will discuss in chapters 8 and 9, the history of the regulation of leakage of chemicals other than petroleum fuels from underground septic systems has generally followed a similar pattern to petroleum USTs. That is, the problems have been apparent to regulators for several decades, and effective regulation and enforcement has lagged far behind regulators' recognition of the problem.

In following chapters, we will discuss the existing laws to regulate and prevent leakage from underground storage tanks. However, this historical overview should provide the reader with a backdrop against which to draw his or her own conclusions as to the adequacy of the industry and government response to date.

## PART II - THE LAWS OF LUST

## Chapter 7 THE REGULATION OF PETROLEUM PRODUCTS

### Introduction: The Lack of Uniformity of LUST laws

One of the most striking things about the regulation of underground storage tanks in Canada is the almost complete absence of uniformity, despite the fact that most of these laws are dealing with essentially the same containers and products in circumstances that have substantially the same risk of damage caused in the same manner. Even where the regulations impose essentially the same standards or practices it is difficult to ascertain this because of the use of different terminology to describe the same thing.

This is obviously undesirable and unnecessarily confusing. The Canadian Council of Ministers of the Environment has attempted to address this problem by drafting a Uniform Code for use by the provinces and territories in drafting or amending their regulations. This Code will prove very useful in providing a model for those provinces and territories, such as Alberta and the Yukon, which currently have only skeletal legislation. It will also be useful to other provinces in providing a checklist of issues to be addressed in regulations and language to consider when amending or expanding existing regulations. Unfortunately, the Code has been developed far too late to achieve the desirable goal of uniformity, in light of existing detailed regulations in provinces such as Ontario, New Brunswick, and Prince Edward Island.

In relation to this study, the lack of uniformity of approach and language has made it impracticable to attempt to prepare a detailed systematic comparison of the laws from province to province. A matrix that would show in detail how each province and Territory treats each aspect of the regulatory regime proved to be impossible to produce. Accordingly, the discussion below will take place at a greater level of generality than I had initially hoped. The precise rules in each province are not discussed. Rather the issues are discussed in a more general way. For a more precise explanation of how a particular province treats a particular issue, for example, the age at which a tank of a specific design and size holding a specific petroleum product must be removed or upgraded and the methods of upgrading permitted under those circumstances, the reader must look specifically at the applicable provincial or territorial regulation.

Moreover, it is often necessary to look at more than one statute or regulation to determine this. "Safety" aspects of regulation (ie., prevention of fires and explosions) are often addressed in a Fire Code administered by one department, while "environmental" aspects are often addressed in one or more different codes, depending on the use of the product in the tank. For example, in Ontario, tanks that contain petroleum used to fuel vehicles are largely regulated by the Gasoline Handling Act, which does not only cover gasoline, but also diesel fuel and some other products, while tanks that contain fuel to heat buildings as well as petroleum products flowing through pipelines are regulated by the Energy Code under the Energy Act.

Saskatchewan is the only province that has attempted to integrate the rules for storage of all hazardous materials in a single set of regulations administered by one department.

**Overview**

The laws that affect the conduct of underground tank owners and operators and provide a degree of environmental protection consist of both general and specific legislation, or direct and indirect regulation. The general or indirect laws that can be used to encourage high standards of conduct include general pollution control and land use planning laws as well as common law rights and remedies. The specific or direct regulations consist of codes of design and practice governing specific kinds of facilities and containers.

There are many studies discussing the adequacy of general laws as mechanisms for protection of the environment. In this study, we will discuss these general laws only briefly. We will focus on the regulations specifically designed to regulate underground storage tanks.

## Laws of General Application

### Pollution control legislation

All provinces have laws that make it an offence to pollute, authorize authorities to issue preventive or remedial orders where pollution is anticipated or has occurred, and authorize authorities to regulate potential sources of pollution by requiring owners and operators to conduct some form of assessment of potential environmental impacts and obtain approval before constructing or expanding facilities that may pollute. The remedial aspects of these laws, such as prosecution and clean-up orders, generally apply to pollution after it has occurred. However, this is an after-the-fact approach to environmental protection, rather than a preventive one. The various assessment and approvals processes under these general laws, which form the anticipatory and preventive aspects of the law, generally deal with these facilities on a piecemeal and ad hoc basis; that is, a particular facility may or may not be subject to an assessment or approval process, depending on many factors, including the work load of government officials. A systematic approach to regulation of such facilities is generally taken only where there are specific regulations governing the design and operation of such facilities.

### Land use planning legislation

Land use planning laws generally create zones where different kinds of activities can take place. These zones are designed to ensure that appropriate infrastructure for the intended use of the area is in place, and to prevent land use conflicts. Thus, for example, commercial facilities, industrial facilities, residences, and institutions such as schools and hospitals, may be separated from each other to minimize land use conflicts. This is a frequent use of land use planning laws. Less frequent, however, is the use of these laws to ensure siting of hazardous facilities where they will create the least harm to the natural environment. This can be accomplished, for example, by prohibiting the construction of aboveground and underground tanks near surface waters, and above vulnerable aquifers. Underground tanks could also be prohibited in areas of aggressive soil. Occasionally, one sees this kind of application of land use planning laws. For example, in 1993, the Ontario Municipal Board refused to approve a rezoning of land in an environmentally sensitive area to allow contruction of a service station. The Board agreed with a consultant to the owner of the land that leaks and spills could be prevented through a variety of design, operating, and monitoring requirements. But since none of these measures were required by Ontario's Gasoline Handling Act, the Board felt that it would be impossible to ensure that they were implemented if this use of the land was approved. [182] However, this kind of use of land use planning laws is still the exception rather than the rule.

All provinces have such legislation that allows municipal governments to control the location of land uses and minimize land use conflicts. Such legislation can be used, for example, to prohibit facilities with underground storage tanks from being located in areas where they pose a particular hazard, for examples in environmentally sensitive areas such as the headwaters of important watercourses and over aquifers used as municipal water supplies. Again, the use of these laws in relation to USTs tends to be hit-and-miss. Moreover, the lack of integration between such land use planning laws and environmental laws and the failure of these land use planning laws to take into account environmental considerations has been extensively documented.

**Common law rights and remedies**

In addition to public laws administered by government agencies, there is an extensive body of "private law" allowing persons harmed by the activities of others to sue for compensation, or in some cases for an injunction to prevent the continuation of the offending activity under certain circumstances. Such relief is available primarily where the plaintiff can prove that the harmful activity was unreasonable or was carried out in a manner that fell below the appropriate standard of care. In cases involving certain particularly hazardous activities or substances - including gasoline - a plaintiff may sometimes succeed in obtaining compensation or an injunction even without proving that the activity was unreasonable or was carried out negligently. Again, the limitations of the availability and usefulness of these remedies have been widely documented.

[182] In the Matter of an appeal by Nicholas Boothman et al. against Town of Newcastle zoning by-law 89-103, T. Yao, member, March 17, 1993. OMB file R. 900538.

## Contract law

Finally, private parties may regulate their business transactions through binding agreements, or "contracts". Contract law, combined with successful use of common law tort remedies, has perhaps been as great an incentive to owners and operators of USTs to improve their standards of operation as formal regulations. In particular, the practice of sophisticated purchasers to put clauses in their contracts preventing vendors from selling them property containing underground tanks or contaminated soil or groundwater, as well as some successful law suits by purchasers against vendors who have sold them such properties, have put pressure on the owners and operators of USTs to prevent or clean up leaks and spills.

## Specific Regulations

The main components of most provincial regulations specifically governing USTs are:

- design standards for equipment such as tanks, lines, and pumps
- approved installation methods
- permits and licences for installing tanks and other equipment and/or operating the facility containing the equipment
- location requirements - for example, setbacks of tanks and other equipment from foundation walls, street lines, and water tables.
- monitoring and leak detection
- clean-up requirements relating to containment and recovery of escaped liquids
- replacement or upgrading of existing unprotected steel tanks
- notification of authorities of actual or suspected leaks and spills
- steps to be taken when tanks are temporarily taken out of use
- emptying, stabilizing, and removing tanks that have been abandoned
- inspection powers
- powers to issue preventive and remedial orders
- provisions making it an offence to do anything contrary to the regulations or to fail to do anything required by the regulations.

In addition, some provinces have additional requirements that are not commonly found throughout Canada, such as

- requirements for licensing of tank installers, operators of leak detection equipment, persons engaged in repairs or maintenance of equipment, and/or persons removing tanks and other equipment
- requirements that some of the above persons receive training and/or pass examinations designed to ensure competence
- provisions for designation of specific areas as environmentally sensitive and stricter requirements regarding location of underground tanks and associated equipment in these areas
- requirements to carry third party liability insurance.

**Institutional Arrangements for the Administration of Petroleum LUST Regulations**

Optimizing the location of administration of any subject matter is always a problem. One approach to locating the administration of a regulatory regime is to create a "one window" approach that allows the consumer of all government services in relation to that subject matter to deal with a single agency. This approach is difficult to implement because the expertise relating to different aspects of this subject is often found in different agencies.

Taken to its extreme, the "one window"approach would lead to a single government agency to deal with everything, since everything is ultimately connected in some way to everything else. The challenge, therefore, is not to continue to create new agencies, transfer responsibilities from one agency to another, or consolidate agencies each time a problem is discovered with the way existing agencies administer a subject matter, but to allocate functions in the most effective and efficient manner and to coordinate these functions, given that there will always be some degree of overlap and duplication among agencies responsible for different aspects of the same subject matter.

Some institutional arrangements work better to protect the environment than others. The allocation of responsibilities for administration of UST regulations relating to petroleum products has caused problems since its earliest days. As early as 1943, the Ontario Fire Marshal and the Deputy Minister of Highways were both complaining about inability to adequately inspect petroleum storage facilities as a result of too few resources. Inspection of gasoline stations was to be funded from a $1 licence fee payable to the Highways Department. Under the regulations, enforcement could be carried out by either the Highways Department or the Fire Marshal's Office. However, according to internal memoranda prepared by the Fire Marshal of the day, this fee was insufficient for the Highways Department to carry out adequate enforcement. But, the Fire Marshal was also reluctant to carry out expensive investigations, since his department received none of these funds,. In response to a suggestion that he send inspectors to New Liskeard to investigate gasoline fumes entering a basement, the Fire Marshal stated, "...I do not see how we can accept any major responsibility with reference to gasoline fumes when we neither licence nor get any revenue from gasoline storage plants, in comparison with both the municipality and the Department of Highways, both of whom licence and gain revenue from this storage". [183] The following year the Fire Marshal similarly placed the blame for difficulties in prosecuting offences on these administrative arrangements: "...I think most of the difficulties regarding prosecutions arise out of the fact that in the original enactment the Department of Highways insisted on having all fines paid solely to the Department of Highways. Municipal Fire Chiefs and Municipal Solicitors hesitate to go to the expense of prosecutions when the fine goes only to the Department of Highways. Similarly, where there is an infraction of the regulations, but no fire has occurred, I can find no authority under the Fire Marshals Act to expend the funds of this office to institute prosecutions". [184]

Until recent years, the regulations governing USTs in most provinces were, in fact, administered by authorities responsible for fire protection, rather than environmental concerns. This explains the successful pressure to place tanks underground, where the fire and explosion risk was reduced, but the risk that leaks would not be detected before they reached groundwater was increased. It also helps to explain the lack of consideration of environmental issues such as groundwater contamination in inspection and monitoring procedures.

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[183] Nov. 18/43 memo.

[184] Sept 28/44 memo.

In recent years, responsibility for UST regulations in many provinces has been transferred from fire authorities to Environment Departments. Ontario, however, remains a curious exception, which appears to be particularly ill-suited to effective environmental protection. In Ontario, the Ministry of Consumer and Commercial Relations, a department responsible for consumer protection and public safety, administers the regulations intended to prevent leaks. However, if this department's inspections fail to detect leaks before the fuel migrates through soil or groundwater to surrounding properties, the Ministry of Environment and Energy is responsible for the clean-up. Thus, the costs of failure to enforce the regulations is not borne by the Ministry responsible for enforcement, but by a sister Ministry. Among the costs that fall to the Environment Ministry as a result of the failure of the Consumer Ministry to prevent or detect leaks at an early stage are the costs of monitoring and investigation by regional hydrogeologists, which come out of the budgets of the Environment Ministry's Regional offices, the cost of clean-up where the source of pollution cannot be determined or the person responsible has insufficient funds, which comes from the Environment Ministry's Security Account; and the cost of compensating victims of pollution and municipal authorities that assist in the clean-up, which are paid by the Environmental Compensation Corporation, an agency of the Environment Ministry. This division of responsibilities is hardly conducive to vigorous enforcement by the Consumer Ministry.

Moreover, historically, the two Ministries have had difficulty coordinating their efforts and cooperating with each other. For example, both the Environmental Protection Act and the Gasoline Handling Act contain provisions prohibiting officials of the two Ministries from disclosing information to each other. Information collected by Fuels Safety Branch officials can be used only for the purposes of administration of that Act. Therefore, although the Environment Ministry is responsible for issuing clean-up orders once a spill or leak has left the regulated property, on occasion Fuels Safety Branch inspectors would refuse to provide the Environment Ministry with the information needed to draft and enforce such orders.

This lack of coordination was compounded by inadequate resources. According to MOEE documents, for example, even though the Environment Ministry has the duty to investigate and clean-up off-site pollution, MCCR was reluctant to advise MOE of all leaking tanks. According to a 1980 memo, the Chief Inspector for the MCCR

Fuels Safety Branch "noted that in the last week there had been four cases of suspected leakers reported to him and that he felt that notifying the MOE of each case would create a resource problem". [185]

Problems of coordination of the enforcement activities of the two agencies have been reduced in recent years, by a protocol agreed upon by both Ministries which divides investigation activities between them. Under the protocol, the Fuels Safety Branch is primarily responsible for on-site tests and investigations and the Environment Ministry has primary responsibility for off-site investigations. Nevertheless, the secrecy provisions of both statutes, which theoretically prevent the agencies from sharing information with each other, remain in force, and the costs of rectifying the results of inadequate enforcement continue to fall to the Environment Ministry rather than to the Ministry responsible for administration of the regulations.

## SIZE AND OWNERSHIP EXEMPTIONS

The regulations of many provinces exempt tanks below a certain size from their requirements whether they are aboveground or underground. Many of the requirements of the New Brunswick and Nova Scotia regulations, for example, apply only to tanks having a capacity of 2000 litres or more.

Other regulations, such as Saskatchewan, have exempted tanks used for domestic purposes or at farms, regardless of size. In effect, these exemptions are similar to size-based exemptions since these tanks usually hold 2000 litres or less.

These exemptions appear to be based primarily on political and economic considerations rather than environmental ones. Many of the tanks at residences and farms are small aboveground tanks rather than underground tanks. These tanks on the whole are less harmful to the environment, both because they are small, and because they are above the ground, where leaks can spills are often discovered quickly. However, from time-to-time, there have been serious problems from these aboveground tanks. When these tanks are below ground, there appears to be no positive correlation between tank size and degree of risk to the environment.

[185]Memo to file from G. Hughes 1980 09 11.

Although larger tanks have the potential to release a greater quantity of oil, in light of small quantity of oil that can cause a fire or explosion or result in extensive and relatively irreversible groundwater contamination, size does not appear to be a significant factor in terms of environmental risk. Moreover, while larger quantities of liquid can potentially escape from a larger tank, smaller tanks may pose a greater risk of escape because they have thinner walls. In fact, one study found that because of their thin walls, tanks with less than 4,000 gallon capacity had more perforations than large tanks, accounting for 95.8% of all perforated tanks.[186] In aggregate, these small tanks may pose as great a threat to the environment as large tanks because there may be far more of them.

Because they are largely unregistered and unregulated, it is difficult to ascertain how many such tanks exist, their age, and their condition. However, some available information suggests that these small tanks greatly outnumber the large ones. For example, it has been estimated that of about 60,000 underground storage tanks in British Columbia, only about 5,000 to 6,000 contain gasoline, while approximately 50,000 contain home heating oil. While not all of these tanks would be small tanks that are largely exempt from regulation, it is likely that a large percentage of them fall into that category. [187]

Many of these small tanks are found on farms and at homes and small businesses. In 1990, it was estimated that there were between 500 and 2,000 abandoned residential storage tanks in British Columbia which had the potential to leak heating oil. [188]

There are many examples of extensive harm arising from leaks in small tanks. In Fredericton, New Brunswick, a gradual leak from a small home heating oil tank threatened the aquifer supplying water to that city. In West Vancouver approximately 4,500 underground oil tanks, ranging from 250 to 1000 gallons were installed between 1945 and 1990 to provide oil to furnaces of single family homes.

[186]J.H. Pim and J.M. Searing, "Tanks Corrusion Study", Suffolk County Department of Health Services, November 1988.

[187]BC Engineers, Paul Ross, Envt Canada in news clipping, Suzie Christianson.

[188]BC Debates, June 18/90, p. 10403, Christianson material.

According to the West Vancouver Fire Department, the majority of these tanks were no longer in use at the end of 1990, but had been abandoned with many of them still containing oil. According to the Assistant Fire Chief, "Many of these tanks have now rusted and are leaking". A 1988 investigation of such residential underground tanks on Vancouver's North Shore found that 60 per cent of 126 abandoned tanks that were located had not been drained of oil. Environment Canada concluded that "the cumulative threat posed by (these) broken fuel tanks to local creeks, ground water and soil is substantial".[189] Out of 343 leaks and spills from underground tanks reported to Ontario's Spills Action Centre between January of 1991 and February of 1993, 88 were described as "furnace oil", "fuel oil", or "heating oil". Of these, 17 or x per cent were described as "private" or "residence", suggesting that they may have been small residential tanks.

When persons interviewed were asked why these small residential tanks, both underground and above ground, were exempt from regulatory regimes in their jurisdictions, they generally gave as reasons either that these tanks were less likely to cause substantial harm or they acknowledged that these tanks are a significant source of harm but that legislators are generally unwilling to impose substantial replacement costs on homeowners and farmers because of the likelihood of public resistence to such measures. In the case of aboveground tanks, they often added that although many of these tanks are rusting or resting on unstable foundations, little harm is likely to be caused by a leak or spill because it will be observed by the farmer or home owner.

One interviewee described the situation in his province in the following words:

> Our regulations have traditionally exempted farmers or private homeowners. There are 66,000 farms in the province and every one of them has at least 500 to 1000 or 2000 gallons of fuel (in tanks) on stands. They are thin-walled, cheaply produced tanks that were built to no standards. Or they're old heating oil tanks that the guy has been able to buy at an auction. He bought it for 5 or 10 bucks, he built a stand. They are starting to wear out and rust and the stands are falling

[189] North Shore News, Jan 18/90 "Site clearing causes VW oil spill.

> over. But we have elected not to regulate those. It's more out of practicality - it hasn't caused a lot of problems in the past and we, there's two of us in this program, we can't even deal with the big ones we should be taking care of. So we've just ignored those. (Scott Robinson, but don't cite)

## NEW TANK AND PIPING STANDARDS: Single Walls versus Double Containment

To date, there have been three generations of underground tank systems for petroleum products. The first generation tanks and lines consisted of unprotected, relatively thin, steel, sometimes protected by a layer of asphalt on the outside. The second generation consisted of cathodically protected steel tanks and piping and fibreglass reinforced plastic tanks and pipes. There is now a third generation of tank and piping that is proven to be far more effective in preventing leakage than the second generation systems: tanks and piping having secondary containment with interstitial monitoring.

Considering the extent of the LUST problem in Canada, it would seem reasonable to mandate that all new tanks and piping installed in Canada must be third generation design. Similarly, it would appear reasonable to place time limits on how long second generation tanks and piping may remain in the ground before they must be replaced by third generation equipment, just as time limits were put on first generation equipment when cathodic protection and FRP tanks became available. However, with the exception of Ontario, no province or territory has put either of these requirements in its regulations.

Most provinces have prohibited any new installations of unprotected steel tanks for several years. Some provinces (Ont. NS, NB) require that any tanks installed after a specific date must meet second generation standards. Generally, new tanks must either be fibreglass or steel cathodically protected in accordance with ULC standard 603.1. In Ontario, the date after which unprotected steel tanks could not be installed was 1974. In Saskatchewan, however, facilities could continue to install unprotected steel tanks until 1989 [190] Thus, some provinces continued to allow the installation of new tanks of outmoded and dangerous design for a decade or more after the problems with such tanks were known.

Generally, the laws prohibiting installation of unprotected steel tanks did not prohibit the sale of those tanks. Thus, they theoretically remained available to purchasers, even though it was illegal to use them for underground storage of gasoline and other petroleum fuels. I did not find evidence of any widespread practice of continuing to install unprotected tanks illegally after the final date. However, this may have occurred from time to time. Records provided by the Ontario Government, for example, appear to show that it installed unprotected tanks after they were outlawed for the private sector in 1974.

Are the new tank and piping standards found in current regulations adequate, however, to protect the environment and public health and safety? Since these provisions were passed, a new generation of tanks and piping has become available. These tanks and piping systems have double walls with interstitial monitoring (a leak detection device between the two walls). Double walls are one form of what is known as "secondary containment"; that is, a second barrier to contaminants entering the environment if the wall of the tank is breached. Other forms of secondary containment include putting the tanks within a vault and the lines within a trench, both of which have walls or sides made of a relatively impermeable material such as treated concrete and lining the excavations for the tank and piping with an impermeable membrane, or a tank having a flexible liner or "bladder" within a rigid outer shell.

These double walled containers and piping systems appear to be the most reliable system of secondary containment, and the least susceptible to installation-related problems.

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[190] Haz. Subst. regs. s. 18

The U.S. EPA has stated that a double walled tank with a monitor between the walls is the most effective means of preventing leaks from contaminating the environment surrounding a tank. [191]

There is strong evidence that double-walled tanks and piping is less likely to leak than single-walled systems. The preliminary results of a study in Suffolk County New York that was underway in 1990 indicated that of the 2,428 "non-corrodable" single-walled tanks in the County, 20 had failed. If compared to the total number of single-walled fibreglass tanks in the county (2,428), this was a failure rate of 0.86%. Of these 20 failures, the cause of failure of six was unknown, two cracked due to settlement and one split, probably as a result of settlement; two failed from overpressurization; two cracked from the force of a manway riser improperly resting on top of the tank; one from a pinhole leak which was probably an undetected manufacturing fault; one from a puncture by a rock in the bottom of the excavation; one from undiscovered impact damage during installation; one from a puncture caused by a pipe dropped in the bottom of the tank; one from the pressure of a concrete footing poured on the end of the tank; one from a puncture caused by an interior ladder pressed through the bottom by settlement; and one from dipstick damage. One fibreglass tank was considered a failure because although it was designed to contain caustic solution, spillage onto the soil outside the tank was destroying the main body of the tank.

In addition to these failures, 23 cases of damage due to improper installation, manufacturing flaws, and damage inflicted during transport were discovered in both single walled and double walled tanks and were remedied before final installation. Had this damage not been discovered or had it been ignored, it could have led to leaks. [192]

By contrast, none of the double-walled fibreglass tanks installed in Suffolk County had failed.

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[191] Federal Register, vol. 53, no 185, p 37128.

[192] Pim, Tank Talk, June 90.

There is also evidence that double-walled fibreglass tanks are less susceptible to "deflection" than single-walled tanks. The integrity of fibreglass tanks depends, among other factors, on the stability of the backfill surrounding the tank. If the backfill is not sufficiently stable, it will settle or shift. The tank can then spread or flatten as a result of the weight and pressure of its contents and of the overburden. Preliminary results of the Suffolk County study suggest that single-walled fibreglass tanks exceed safe deflection limits more than three times as often as double-walled fibreglass tanks.

One expert has stated: "There is no advantage in single-walled systems over double-walled, except cost. In every other way, the double-walled system is superior". Pim listed the following "significant advantages", which provide "improved environmental protection":

- Double walled tanks provide a means of monitoring far superior to any of the monitoring systems available for single-walled tanks since monnitoring between the walls allows detection <u>before</u> the escape of product into the environment. (emphasis added)

- If only manual monitoring or if the automatic monitoring system is not functional, the escaped product will be held idefinitely until detected with no environmental release.

- The outer shell acts as a shield against physical damage to the inner shell. Likewise, the inner serves the same function for the outer against internal damage.

- By filling the space between the shells with fluid, any fault in the inner tank can be located and repaired, tested, and the tank returned to service.

- double-walled tanks are much stronger, more rigid and, therefore, less easily deformed and cracked.

- Though not designed as pressure vessels, because of their extra strength and added wall thickness, double walled tanks are more capable of withstanding inadvertent overpressurization.

In light of the obvious environmental advantages of double-walled systems, therefore, the question that must be answered is whether the financial savings to tank owners of installing single-walled systems balances or outweighs the costs to the public from the additional undetected leaks that will occur using single-walled systems.

No definitive answer exists, because, as indicated earlier in this study, no one is systematically keeping track of the costs to society of LUST, and estimates of the range of costs and average costs of leakage vary greatly, as do estimates of the costs associated with prevention of leakage. Nevertheless, the information that is presented in earlier chapters strongly suggests that the costs to society resulting from the use of single-walled systems rather than double-walled systems in the long-run will greatly exceed the costs of prevention. If tank owners are required to internalize these costs rather than pass them on to others, the data presented suggests strongly that in the long run the costs to owners of using single-walled systems will also greatly exceed the costs of prevention of leaks.

The EPA's regulatory impact analysis of its UST regulations indicated that the savings in remedial action costs and the avoidance of costs resulting from harm to human health and the environment are far greater than the cost of most double-walled systems with interstitial monitoring. The costs of this preventive approach appear to exceed the costs of single-walled systems only if the sole cost considered is the capital outlay, and these other costs are ignored. [193]

Estimates of the difference in cost between single walled and double walled systems vary greatly. The Ontario branch of the Canadian Petroleum Products Institute, the trade association for most of the largest gasoline suppliers, has told the Ontario Government that double-walled tanks will cost twice as much as single-walled tanks. The Director of Ontario's Fuel Safety Branch has estimated that double-walled

[193] "An Environmentalist's Tank Standards", Tank Talk, Aug 89, p.5.

systems, including both tanks and piping, with interstitial monitoring of both tanks and piping would add between 50,000 and 70,000 to the cost of equipping a typical service station. [194]

However, a U.S. environmental administrator has estimated that the difference in cost between three 10,000 gallon single-walled and double-walled tanks, installed, is only $9,000. If monitoring wells are required surrounding the single-walled tanks, these wells are unnecessary if double-walled systems are installed. Subtracting the cost of these monitoring wells means that the net difference in cost between a single-walled and double-walled system is $6,000. (Installation costs of both systems are comparable).

Assuming a failure rate of 0.86% with single-walled tanks (the failure rate found in a preliminary study in Suffolk County) and an average cost of $200,000 per incident, this regulator estimated that single-walled tanks would result in 550 additional leaks in the State of Florida at a clean-up cost in 1990 of $110,000,000. He pointed out that this cost would probably be greater when leaks actually occurred as clean-up costs were "steadily rising" and inflation would add to the cost. He pointed out that this figure would only result in partial clean-up as clean-up methods do not successfully recover a large proportion of product once it enters groundwater.

Based on these projections, Pim concluded that "(I)t is worth this extra expense to minimize or eliminate the leak risk".

Some U.S. states require secondary containment in areas considered environnmentally sensitive. Florida, for example, has approved legislation that requires secondary containment for any USTs within 100 feet of a well or any environmentally sensitive area. California, Massachusetts, Virginia, New Hampshire, Vermont, New York, and Texas have laws defining areas in which secondary containment is mandatory for all USTs. [195]

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[194] Philip Dec 21/92.

[195] Tank Talk, Aug 89, p 2 - dont cite.

However, most Canadian provinces do not require new tanks to have secondary containment. Only a few provinces, such as New Brunswick, provide for a discretionary power to require operators to exceed the minimum standards. New Brunswick's Construction Standards for Installation and Removal of Petroleum Systems, for example, provide that on "sensitive sites", tanks and piping must have double walls, and tanks must have continuous monitoring of the interstitial space. (s 1.2) Alternatively, the secondary containment may consist of a flexible liner system that completely encloses both tanks and piping. In that case, "sniffer tubes" must be installed both within and outside the liner.

Prince Edward Island mandates a form of secondary containment, but only as a voluntary alternative to cathodic protection. Steel tanks are required either to have cathodic protection or to be contained within a precast concrete vault.

The requirement to utilize secondary containment in certain areas designated as environmentally sensitive is better than having no secondary containment requirements. However, this approach suffers from several shortcomings. The first problem lies in defining the circumstances under which secondary containment will be required. Criteria must be developed for determining which sites or areas require secondary containment. Once criteria have been developed, they must be applied either on a case-by-case basis or by pre-designating areas in which secondary containment will be required. Either process will be costly and time-consuming. Adequate information to determine the boundaries of sensitive area is often not available. In addition, the process of surveying and mapping areas can be slow and costly. If such designations are carried out on a case-by-case basis, the process may require costly environmental studies, or alternatively may require that government officials spend considerable time monitoring applications for tank approval and may delegate to these officials a great deal of discretion, which they may have inadequate training to exercise appropriately.

There is, however, a more fundamental objection to this selective approach. It is short-sighted. All systems other than secondary containment with interstitial monitoring rely upon detecting and containing contamination after it has been released to the environment. They therefore entail a much greater risk of harm than secondary containment systems, and are much more subject to human error and wilful blindness. Moreover, in a rapidly changing society, designation of areas as "sensitive" or "non-sensitive" deals with the risk only at the time of the designation, and does not take into account the possibility that any given area may change from "non-sensitive" to sensitive at any time, as development occurs and land use patterns change. Therefore, allowing single-walled systems in an area either becomes a significant restraint on the future development of that area, or involves a higher future risk as the area develops.

The indicators of "sensitivity" for the purpose of UST location and design are generally the proximity of the tank to public and private drinking water supplies and to above-ground and underground structures that may be impacted by a leak. However, areas where there are no current sensitive uses must be "frozen" by land use controls preventing future development if they are not to become sensitive areas in future. Indeed, there are significant examples of areas that were not considered sensitive, which have become sensitive as a result of development. One possible example is Port Loring, described in an earlier chapter, in which the development of new wells may have caused the migration of contaminants that otherwise were having no impact on drinking water.

Of Canada's provinces, only Ontario has imposed a universal requirement of secondary containment regardless of site sensitivity. The petroleum industry opposed to such a requirement for tanks, arguing that there was insufficient risk of leakage from cathodically protected steel tanks or fibreglass tanks to justify the additional expense to tank owners. It did not oppose secondary containment for piping, which it felt was more susceptible to leaks. Nevertheless, in September 1993, a regulation was made requiring that all new tanks and piping installed after 1996 anywhere in the province must have secondary containment.

## 1. TANK AND LINE REMOVAL AND UPGRADING PROGRAMS

The requirement that all new tanks and lines be of a higher quality than the existing ones did not deal with the question of what to do with the aging stock of existing unprotected steel tanks. Although they would eventually have to be upgraded or replaced, both steps were costly. Replacement, however, was often more costly than upgrading. The question, therefore, was whether to permit upgrading or require replacement, which was clearly the environmentally superior solution, and if tanks must be replaced, by what date. These questions became the focus of a great deal of study and lobbying over many years.

Based on the information it heard during public hearings in 1974, the Manitoba Clean Environment Commission concluded in its report, released in December of 1975, that leakage of storage tanks and piping systems was a major source of contamination. It found that statistics collected in Ontario over a four-year period showed that leaking tank and fuel lines were responsible for about two thirds of the pollution problems reported. The size of petroleum losses from LUST and other causes of spills and leaks varied from 150 gallons to 11,000 gallons, and sixty per cent of the reported cases involved gasoline as opposed to diesel fuel. The Commission also cited statistics from the American Petroleum Institute showing that 61% of the UST leaks came from the underground piping and 21.6% came from the tanks themselves.[196]

However, this figure may underestimate the importance of corroding tanks, as the amount of material lost from leaking tanks tends to be much greater than the amount lost from leaking lines.

The Commission found that most leakage from piping resulted from poor installation practice, rather than corrosion, and focused its recommendations in relation to piping on improvements to installation practices. As noted in an earlier chapter, the Commission recommended replacement of all the unprotected steel tanks with cathodically protected or fibreglass tanks or upgrading of these tanks.

Eventually, all Canadian provinces adopted a regulation requiring that unprotected steel tanks and piping either be upgraded by internal lining or adding cathodic protection or replaced with the new generation of cathodically protected or fibreglass tanks. What is interesting, however, is the timeframe in which this was allowed, in light of the evidence of the risk involved in leaving them in the ground, how the governments arrived at this timeframe; and whether there has been compliance with the time frames.

[196] p.8.

It is impossible to set out in simple terms the time frames and methods of upgrading tanks chosen by the provinces, as each province started at a different time, chose a different formula for determining which tanks had to be removed or upgraded by which dates, a different date by which tanks had to be removed or upgraded, and permitted different methods of upgrading, or similar methods described in different language.

In addition, each province applied its legislation to a different tank population. For example, some provinces required removal or upgrading of all tanks above one size, while others chose a different size. Some regulations applied only to tanks at service stations, while others applied to some tanks at "private outlets". Indeed, one of the most striking features of provincial legislation in this area is the lack of uniformity.

**Timing for Upgrading or Removal**

Several provinces have no timetable for removing or upgrading unprotected steel tanks. Most of these provinces provide for replacement of a tank only when testing has shown that it is leaking. These provinces have adopted a provision of the 1985 version of the National Fire Code of Canada that applies to both aboveground and underground tanks containing flammable or combustible liquids. This section provides that where a leak is detected in an underground tank using an approved leakage test, the tank must be replaced. This is the case, for example, in Alberta. As of December, 1993, Alberta had no legislated tank upgrading or replacement program. Unprotected steel tanks need be upgraded or replaced only after they start to leak. British Columbia and the Yukon also have no timetable for replacing the old tanks. In B.C., however, the Fire Code provision has been modified to provide that if a leak is discovered, the tank must be replaced <u>or repaired by an acceptable method.</u> [197] The Yukon has a similar rule. [198] The result of this lack of regulation is that,

[197] reg 14/87, sched 2.

[198] Gas Handling Regulations, s. 9(34)(e).

in the Yukon, for example, in 1993 there were tanks in the ground that were more than 50 years old. Only 35 of 526 steel USTs identified in a survey had any form of corrosion protection. 51% of the tanks were believed to have exceeded their lifespans. [199]

Some provinces have required the upgrading or replacement of unprotected tanks not only when they leak, but also within a fixed timeframe in specific areas designated as "critical" or "sensitive". In Newfoundland, as of October 1982 tanks in areas designated as critical or sensitive must be tested and upgraded immediately if they show a leak. If the testing did not reveal a leak, the tanks have to be upgraded in any event within one year afater testing once an area has been designated as critical. This applies only to areas where the groundwater was already contaminated by hydrocarbons. [200] Tanks also had to be upgraded if they were in an area designated as sensitive, but no deadline was given. Unprotected tanks in any other area could remain in the ground until a leak was discovered. A similar approach is found in the Manitoba regulations. However, these regulations give no hint of what makes an area "critical" or "sensitive". They simply provide that these areas are ones that are so designated by the Minister. Moreover, the starting point for upgrading or removal was February of 1988, approximately five-and-one half years later than in Newfoundland.

Among those provinces that mandate a removal or upgrading program for all unprotected tanks, the timeframes also vary greatly. Ontario, for example, made a regulation in 1982 requiring that all unprotected steel tanks and piping be removed or upgraded by January 1, 1991. [201] The regulation also required that owners of these systems to establish a program of upgrading or removal that would take into account such factors as the age of the tanks, soil conditions, the location of the tanks in relation to potable water sources, and the owner's contractual obligations. [202] The upgrading and removal program was to give priority to service stations. [203]

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[199] Yukon Territorial Govt, Fuel Storage Tank System Inventory, 1993, 1993, p 7.

[200] s. 6.

[201] GHC, s. 7(50).

[202] 7(56).

Each owner of unprotected tanks was to submit a report to the Director of the Energy Branch (now the Fuels Safety Branch before April 1 of each year until 1991, showing how many unprotected tanks were still in use. [204] Presumably the purpose of this graduated approach was to discourage tank owners from waiting until the 1991 deadline before removing most of their tanks and to encourage them to determine which tanks posed the greatest risk and give priority to removing them. Notwithstanding the requirement to remove or upgrade these tanks by 1991, the owners could continue to use them indefinitely without protection after 1991 by by submitting an engineer's report stating that the tanks are in benign soil [205]

Despite the government's efforts to achieve a graduated and timely response on a voluntary basis, many tank owners still did not meet the 1991 deadline, even though they had 9 years' notice of it. When January 1991 arrived, the Ministry granted an extension of one year to anyone who requested it. Saskatchewan had a similar experience. It passed a regulation in 1988 that gave notice that an upgrading or removal program would have to be completed by 1994, but when that deadline came, Saskatchewan extended it for an additional year, subject to certain monitoring requirements, when faced with arguments that tank owners could not afford to comply.

Some provinces, like New Brunswick, have more detailed removal schedules. New Brunswick allows only disposal, not upgrading, of unprotected steel tanks. Moreover, cathodically protected tanks that are not performing according to the specifications set out in the regulation must also be disposed of. The oldest tanks, those manufactured in 1960 or before, or whose date of manufacture cannot be established, were to be removed by June 30, 1989; those manufactured between 1961 and 1965, by June 30, 1990; from 1966-1970, by June 30, 1991; from 1971-1975, by June 30, 1992; and those manufactured after 1975, by June 30, 1993. [206] This regulation was filed in July of 1987 and came into force in August

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[203] 7(57).

[204] 7(59).

[205] s. 7(58).

[206] Sched. B.

of 1987, giving the owners of unprotected tanks a minimum of two, and up to six years, lead time to remove their tanks. Nova Scotia's regulation requiring removal of unprotected tanks was made in August of 1988. It requires that (i) all owners of steel tanks 25 years old or older that are not cathodically protected must remove them at an evenly-spaced rate over a five year period or at a rate acceptable to the Minister if they are at retail or bulk petroleum sales outlets, and within three years or at a date acceptable to the Minister if they are not at a retail or bulk sales outlet. If the tanks were less than 25 years old in 1988, within 3 years the owner was required to evaluate the tank condition by a method acceptable to the Minister or remove them. The acceptable methods of evaluating life expectancy were set out in Schedule A to the regulation. Both the PACE and Warren Rogers methods of tank life expectancy analysis were approved. Depending on the life expectancy or probability of a leak occurring shown by the evaluation, the tank could be left in the ground without upgrading, as long as a leak detection test was performed annually, or had to be removed within one year of the life expectancy analysis having been performed. Once a tank had only five years of life expectancy using the PACE method or the probability of a leak would reach 25% within five years, upgrading of a tank would no longer be an option. The only available option would be removal. Prince Edward Island's regulations came into force in March of 1990. They required removal of any unprotected tank more than 25 years old within thirty days. For tanks less than 25 years old, the tank could be removed before reaching an age of 15 years or by a date approved by the Minister, or a tank life expectancy test could be performed within 30 days and the tank could be upgraded. Thus, owners were given a choice of leaving tanks in the ground without a life expectancy test until they reached the age of 15, or carrying out an immediate life expectancy test, which would give them an option of keeping the tanks for more than 15 years by upgrading them. Owners of tanks at a retail outlet or bulk sales outlet were given until September 1991, or any later date approved by the Minister, to comply with the section.[207]

[207] s.15.

Thus, it is apparent that there has been a wide range of responses by government to the information available in the mid-1970s that large numbers of unprotected steel tanks were susceptible to leakage, and indeed, were beginning to leak. Some provinces still do not require the removal or upgrading of these tanks. Other provinces, such as Ontario, gave the tank owners many years to remove or replace these tanks, only to find that when deadlines came, many of the tanks were still in the ground. The Director of Ontario's Fuel Safety Branch, for example, was unwilling to release the number of tanks still unprotected and unremoved as of January 1, 1991. But he did volunteer that of an approximate 6000 tanks in Ontario, "hundreds" were not in compliance when the deadline was reached. [208] Other provinces gave much less lead time to the industry. In some of those provinces, with no interim deadlines to require upgrading or removal at an evenly-paced rate, many tank owners left their upgrading programs to the eleventh hour. As a result, insufficient contractors were available to handle the workload, and deadlines were often not met. This was the case, for example, in New Brunswick.

Nor did there seem to be any scientific rationale for the decision to allow tanks of up to 25 years in age to remain unprotected. Both industry and government agree that tank age is only one determinant of whether a tank is likely to leak. When asked how the 25-year limit was arrived at, government officials often answered that this was determined by a study to be the age at which tanks are likely to leak. One official suggested that the study had been done by the U.S. EPA, another, that it was carried out by the Atlantic Petroleum Association. I was unable to find any such study. In fact, experienced installers in different parts of the country have given widely divergent views, based on their experience, as to the age at which tanks are likely to leak. One contractor in southwestern Ontario told the author that in his experience any tank over 10 years old is suspect. Many estimates of tank life expectancy have been given, most of which suggest a much shorter life span. [209] Studies based on observations of the condition of tank populations as they were removed from the ground have also shown significant numbers of corroded tanks at a much earlier age.

[208] Mike Philip Dec 22/92.

[209] cite Fact Sheet, Karr and his reliance on Maine.

In addition, the likelihood of leakage, however ascertained, is only one component of a scientifically sound risk assessment. Another component is the likelihood of harm should leakage occur. Assessment of this component requires analysis of significant receptors in the tank area, such as underground water supplies, aboveground structures, and underground structures such as utility corridors, subway lines, and sewers.

In reaction to suggestions by regulatory agencies that they would require tank upgrading or removal based on age alone, the oil companies themselves, through PACE, developed a predictive model to use in designing tank upgrading and replacement programs, which took into account additional factors such as soil aggressivity, conductivity, and location in relation to groundwater and sensitive land uses. However, only a few provinces required tank owners to design and carry out their upgrading programs in accordance with this scientific approach. In preparing this report, I was unable to obtain any reliable information on the extent that these provinces enforced these requirements.

In provinces where a scientific approach was not required by law, it would appear that some oil companies followed such an approach, and others did not. Moreover, those companies that did follow such an approach did not always appear to follow it rigorously. The speed and priorities of tank upgrading programs were often dictated as much or more by economic factors as by scientific rigour. That is, oil companies often decided whether and when to upgrade or remove tanks not on the basis of a scientific study such as the ones developed by PACE and Warren Rogers, but on the basis of plans to renovate or shut down existing stations. In several cases, including one of Canada's largest oil companies, Imperial Oil, the companies did not keep to the timetables they established for upgrading and removing unprotected steel tanks.

Moreover, tank owners were reluctant to follow the scientific programs designed by their own trade association because of the cost of carrying out the required studies and because these programs did not predict perfectly whether leakage would be found. In fact, both the PACE and Warren Rogers methodologies were conservative; that is, they erred in favour of removing sound tanks rather than leaving them in the ground longer than was safe. Tank owners were upset when they removed a tank based on these predictive methodologies, only to find that it appeared to be in good condition.

In the course of this study, it proved impossible to obtain accurate information about the extent to which oil companies followed a phased, scientifically-based removal and upgrading program throughout the 1980s, and the extent to which tanks have been upgraded or removed by the deadlines imposed under legislation. PACE, which designed a scientific program, did not monitor the extent to which its members followed this methodology. [210] Nor did its members provide this information voluntarily to their association. Government agencies generally were either unable or unwilling to provide statistical information. However, there was strong evidence to indicate that:

(a) despite the knowledge or the availability of information to indicate the seriousness of the problem of unprotected steel tanks as early as the mid-1970s, provincial governments often have not required the removal of these tanks, or gave tank owners periods of fifteen to 20 years from the mid-1970s to do so;

(b) there were often no interim deadlines or requirements to follow scientifically defensible procedures for priorizing tank removal programs;

(c) tank owners often left their tank upgrading programs to the eleventh hour and did not utilize the methodologies for the probability of leakage developed by the experts in this field;

(d) statutory and internally-imposed deadlines were often exceeded;

(e) provincial governments were reluctant to order the installation of monitoring devices to give early warning if these tanks failed, allowing tank owners to continue to rely on unreliable manual "dipping" as the sole source of leak detection;

[210] Mattilla interview.

(f) during this period there continued to be thousands of leaks, resulting in hundreds of millions of dollars in property damage, business losses, personal injuries, and many other negative environmental and economic impacts, including soil and groundwater contamination is often technically or economically impossible to remediate for all practical purposes.

and

(g) in 1993, there were still tanks in the ground in Canada that were over 50 years old.

**Upgrading v. Removal**

Provincial statutes generally allow either the upgrading or the removal of old tanks, although New Brunswick allows only removal. [211] As mentioned above, some provinces, such as Nova Scotia, require removal if the tank is 25 years of age or older, but allow upgrading of newer tanks, although there appears to be no scientific basis for this cut-off point. Where upgrading is permitted, each province's regulation has a different description of the upgrading methods that are acceptable. The regulations often leave it up to the Minister's discretion to determine what upgrading procedures will be accepted, making it difficult to determine the actual situation in each province. However, despite the differences in language and the open-ended discretion given to Ministers, the upgrading systems allowed generally are the following:

- cathodic protection of steel tanks. Generally, two methods of cathodic protection are permitted: sacrificial anode and impressed current.
- by lining the inside of the tank with approved substances such as a fibreglass coating.

[211] 239(2)

Where tanks have been upgraded, they are often allowed to remain in the ground indefinitely, no matter how old they were at the time they were upgraded or where they are located, as long as a prescribed periodic precision-testing or monitoring program is carried out to detect leakage.

It is unlikely that upgrading old tanks will give as much protection to the environment as installing new tanks constructed to current standards. However, the numbers of leaks from upgraded old tanks have been relatively small, and governments have decided that the economic advantages to tank owners justify the additional risks inherent in allowing upgrading of old tanks rather than their replacement. In fact, many major oil companies currently prefer not to incur this risk and primarily replace the older generation of tanks rather than upgrade them. However, smaller operators, who are often those least able to pay the costs of leakage should it occur, may find the option of upgrading attractive.

Generally, provincial regulations require either cathodic protection or internal lining of steel tanks, but not both. Cathodic protection alone, of course, deals only with external corrosion and does not address the risk of internal corrosion. In general, there is no doubt that such systems have greatly extended the life expectancy of tanks on which they were installed. Nevertheless, there have been failures. Cathodic protection is not infallible. It must be monitored periodically to determine whether it is still operating, but as noted elsewhere in this study, regulatory agencies do not have sufficient resources to carry out inspections to ensure that operators are doing this monitoring or to determine the condition of the system. A 1986 study carried out by Suffolk County, N.Y. found that out of eight cathodically protected steel tanks removed from the ground, four showed some corrosion, indicating that the cathodic protection was not working well and there was severe corrosion in one of the tanks. [212] In Ontario, there was evidence in 1987 that some of the tanks that had been cathodically protected may not have a suitable level of cathodic protection. [213]

[212]Pim, Tank Talk, June 90 p 1.

[213]Hore to OPA, Sept 17/87.

interior linings have failed, either because products incompatible with the linings were put in the tank or because of "holidays" in the lining.

Moreover, internal coating and external cathodic protection are not alternatives to each other as governments have treated them, but complementary systems. The effectiveness of internal coating or lining depends on the integrity of the wall of the tank. If the tank is not protected from external corrosion, it will continue to rust from the outside in, leaving nothing to hold the lining in place. The difficulty of relying on internal coatings is that, "No one knows for certain to what degree or how quickly tanks corrode internally. ... Concerned interest groups ... generally disagree on the impact of internal corrosion and how to mitigate it."[214]

Government Agencies

Laws passed by the federal and provincial governments do not bind the government that passed them unless they expressly say so, or it is a necessary implication of a law that it binds the government. Moreover, it is questionable whether laws passed by a provincial government can bind the federal government under any circumstances.

Thus, even though provincial regulations require the removal or upgrading of unprotected steel tanks, these laws do not require the governments to institute such upgrading programs for their own facilities unless the regulations state that they cover the government itself. These laws often do not cover government-owned tankage.

Ontario's Gasoline Handling Act, for example, does not bind the Crown. Although the private sector has been required by this Act to remove or upgrade its unprotected steel tanks, Ontario government departments and agencies are not required to do the same. In Ontario, most property owned by the provincial government is managed by the Ministry of Government Services. When contacted in December of 1992, that Ministry had no inventory of tanks on its property, their age or condition, or any

[214]"Internal Tank Corrosion", Underground Tank Technology Update, Feb 1989, p 2.

formal tank upgrading program. At least one of its tanks had leaked, causing extensive soil contamination. As a result of an access request under the Freedom of Information Act, the Ministry compiled an inventory. This inventory showed that the Ministry owned approximately 1100 USTs. Of those tanks, approximately 100 were unprotected steel tanks, dating back as far as 1957, even though the Ontario law required all privately-owned unprotected tanks to be removed or upgraded by lining or cathodic protection by 1991. Also, the records indicated that many of those unprotected tanks had been installed after 1974 - some as recently as 1990 - even though the law forbade private owners from installing unprotected tanks after 1974. In addition, the Government owned over 500 tanks for which the year of installation and/or the material out of which the tank was constructed were unknown.

## Certification

### 1. Certification of Installers

As indicated in an earlier chapter, improper installation of tanks and piping is one of the most significant causes of system failure. A 1986 U.S. EPA study found 8% of UST releases to be directly caused by improper installation. An additional 46% of releases resulted from structural failure, which included several factors that could be attributable to poor installation.[215] In addition, tank installers themselves have estimated that tank piping is damaged between the time of installation and completion of paving on 10% of all installations.[216]

Moreover, this is a problem that will not be eliminated by the removal or upgrading of unprotected tanks and lines or by more stringent design standards for modern equipment.

This suggests that one of the most important steps that can be taken to prevent future leaks is to ensure that all tank system installers are not only licensed, but adequately trained and certified. Nevertheless, few Canadian provinces require that

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[215] Versar, Inc., Summary of State Reports on Releases from Underground Storage Tanks, Prepared for U.S. EPA, 1986.

[216] Federal Register, vol 53, no 185, Sept 23/88, 40 CFR part 280. p. 37089.

tank installers demonstrate their competence. Some provinces do not even require that tank installers be licensed. Other provinces, like Ontario, that require that tank installation be carried out only be licensed installers, have no criteria for obtaining a licence other than the payment of a small licence fee.

In the United States, Maine has led the way in developing a certification program for tank installers. Legislation was passed in June of 1985 that required that persons providing UST installation services be certified as competent. A Board composed of seven citizens was established to administer the certification program. The Legislature required that as of May 1, 1986, only certified installers could install USTs.

In Maine, certification as an UST installer requires an applicant to provide references, to pass a written or oral examination dealing with knowledge of the applicable legislation and tank manufacturers' specifications, and to pass an on-site inspection consisting of carrying out an actual installation under the observation of a respresentative of the Department of Environmental Protection. Initially, the Board issued only a single class of oil tank installer certificate; however, in 1989 this was divided into three separate classes of certificate. In addition, a period of apprenticeship was recognized as part of the training required for certification.

The Board that certifies installers is also responsible for taking discplinary action against installers who violate Department rules and ethical business practices. The Board has the power to investigate complaints against installers and to suspend or revoke their licences.

In addition, the U.S. EPA has promulgated regulations requiring UST owners to certify the proper installation of tank systems. In practice, this means that either the installer must be in a position to certify the installation, or it must be independently certified by a professional engineer or by a State regulatory agency. Therefore, if the owner wishes to avoid retaining a second expert to certify the installation, the owner must find an installer capable of certifying his or her own installation. Under the EPA rules, the only installers entitled to do so are those who have been certified by the tank and piping manufacturers or by the State regulatory agency. [217]

In practice, large oil companies and other large tankage owners, tank and piping manufacturers, and insurers will often require that only installers trained and/or certified by the equipment manufacturers be employed in tank installation. However, the market is very competitive, and the small business person - who can least afford to pay the costs of remedial action - may be most tempted to hire unqualified installers, who are most likely to quote the lowest prices for installation.

In Canada, only Prince Edward Island has instituted an installer training and testing program. The PEI regulations do not require that an installer demonstrate his or her competence, but require only that an installer successfully complete a training and examination program if one is instituted by the Minister. [218] In fact, the PEI government did institute a training course. By March 1987, two courses had been held to educate installers on proper installation standards. Approximately 100 people had attended each course, after which an exam was given. This resulted in 106 individuals passing the test and being registered to install tanks in PEI. These individuals represented 39 companies from PEI, New Brunswick, and Nova Scotia. [219]

In the fall of 1992, the Ontario Government was considering a new regulation governing petroleum storage. Although the Director of the government's Fuel Safety Branch, which is responsible for administering these regulations identified training of installers as one of the most important gaps in the regulations, a draft of the regulations circulated in December of 1991 had contained no provision for installer training. The reason given for this omission was a lack of legislative authority to

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[217] Federal Register, vol 53, no 185, Sept 23/88, 40 CFR Part 280, Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks, p. 37198.

[218] Petroleum Storage Tanks Regulations, No EC187/90.

[219] Underground Storage Tank Pilot Project - Progress Report, March, 1987 Water Resources Section, Department of Community and Cultural Affairs, Govt of PEI.

make such a regulation. Officials have stated that the Ministry is unable to get "House time" to introduce amendments to the Gasoline Handling Act that would give the necessary legislative authority for such a regulation. The new regulation was made in September 1993, but as of July 1994, no amendments to the Act had been introduced to enable the government to require installer training or certification.

Alberta announced its intention in 1988 to establish a tank contractor training and certification program; however, as of May 1993, this had not happened. [220]

## 2 Certification of persons for tank testing and tank Removal

Frequently, the same people who carry out tank installation also provide a service of tank testing and tank removal. However, each of these functions requires a different set of skills and knowledge. Competence to carry out any one of these functions does not imply competence to carry out the others.

The few legislative requirements for training and certification have focussed primarily on ensuring the competence of tank installers, rather than tank testers or removers. Tank testers have primarily been trained by the equipment manufacturers themselves, who sometimes attempt to ensure that their equipment is used only by those whom they have trained. Tank removal, on the other hand, has often been carried out by completely unqualified and inexperienced personnel, sometimes resulting in the death or injury of those involved in the activity and illegal disposal of the tanks.[221]

Certification of tank testers and removers is almost as important as certification of tank installers.

[220] May 93 Alta ELC 2.3.

[221] For example, thirty or more tanks were disposed of in the mid-1980s in a property in what is now part of the City of Fredericton. This caused concerns about explosion because children were playing around them: Ken Harris, Oct. 23/91.

Improper tank testing has been identified as a cause of leaks. For example, the U.S. EPA has identified excessive air pressure during tank tightness tests as causing a tank rupture. [222] Moreover, inadequate tank testing can fail to identify leaks, resulting in continuing releases to the environment. Proper operation of testing equipment has been identified by the EPA as the most significant variable in the precision of equipment and the accuracy of measurements. All tank testing methods are highly subject to human error, and measurements are subject to interpretation. It has been suggested that experience plays a substantial role in interpreting the results of a test. One experienced tank installer interviewed for this study said, for example, "I knew a lot more after testing 100 tanks than after 50". [223] Moreover, it has been suggested that tank tests themselves can be inconclusive, and are only one of many factors that should be considered in deciding whether to take the costly step of removing a tank from the ground. [224]

Tank removal involves primarily three areas of hazard. The first is that improper removal of tanks and piping can result in releases that contaminate the environment. For example, the EPA found releases resulting from tanks rupturing due to careless excavation. [225] The second hazard involves occupational health and safety. There have been a sufficient number of deaths and injuries from explosions, fires, and inhalation of fumes during removal of underground tanks and efforts to repair them to demonstrate the need to protect workers from their own incompetence or inexperience. For example, a man was killed in Central Saanich, B.C., when a gasoline tank exploded while he was cutting it open with a torch. The man was employed by a business involving buying old tanks and cutting them up for scrap. [226] In Portland, Maine, a fatal accident occurred as a result of attempts to comply with regulations requiring the removal of all gasoline from tanks before removing tanks from the ground. The venting was carried out by a vacuum truck which was

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[222] Versar Inc., supra.

[223] Vic Robinson.

[224] Vic Robinson.

[225] Versar, Inc. supra.

[226] "Metal-cutter killed in gas tank explosion", undated newspaper clipping.

removing gasoline from the tanks as well as moving air through the tanks to vent them of fumes. The air exhausted from the truck contained sufficient fumes to reach the explosive level. A spark from the vehicle ignited them and fire travelled into the tank, which exploded. [227]

The third area of concern is the improper disposal of tanks and their residual liquids and sludges and surrounding contaminated soil or groundwater. The persons contracted to remove tanks are also often required to dispose of the tanks and their contents as well as any surrounding contaminated soil or groundwater. (In some provinces, a separate licence as a waste hauler is required for these functions.)

The lack of standardized procedures for cleansing and disposing of tanks, piping, and sludges and the lack of available disposal options have been identified as problems throughout Canada. [228]

Certification of tank removers can ensure that they have knowledge of the proper methods of transporting and disposing of hazardous wastes, and can provide an important incentive to them to report any surrounding contamination to the relevant authorities where this is required, and a disincentive to illegal or dangerouse disposal of surrounding contaminated soil or resale or improper disposal of excavated tanks. The resale of leaky tanks by tank removers has been documented as a problem in some cases, and as a suspected problem in others.

One potential problem area is that each of these three areas of concern is often dealt with by different regulatory regimes, administered by different agencies. The timing of removal and conditions under which tanks must be removed and steps to prevent leakage into the soil may be covered by petroleum storage regulations; clean-up and containment of any contaminants released to the air, soil or water may be covered by general environmental protection laws; transportation and disposal of tanks and piping and their contents and contaminated soil and groundwater may be covered by a variety of laws governing transportation of dangerous goods and wastes and waste

[227]"Maine Tank Removal Accident Prompts Words of Precaution", Tank Talk? App B in PEI report.

[228]D.A. Johnston and D.E. Jardine, (Investigation into Methods and Costs for Disposal of Removed Underground Petroleum Storage Tanks and Associated Contents, June 26, 1989, PEI Dept of the Environment.

disposal. Fire hazards may be covered by the regulations governing petroleum storage or by a separate fire code; and finally, safety of workers involved may be covered by occupational health and safety legislation. Fire officials, environmental officials, transportation departments, labour departments, and any other department given specific authority over the storage of petroleum products, may be involved.

Critics of such regimes often complain of "fragmentation" of responsibilities and recommend that a subject matter that is subject to separate regulatory regimes be administered by a single agency. This is not always a desirable or practical option. Problems have different aspects, each of which requires different expertise. To amalgamate all the required expertise in one department is not always a practical option. However, the fact that the removal of tank systems and their associated waste products and contamination has so many aspects underlines the importance of ensuring that those involved in this activity are properly trained in all these aspects and are accountable through licensing procedures.

## Inspection of Tank Installation and Removal

One of the recommendations of the 1974 Manitoba Clean Environment Commission Report was that tank installers be inspected. However, provincial regulations often do not require such an inspection and regulatory agencies have inadequate resources to carry out these inspections. The combination of a lack of certification of installers and removers and a lack of any inspection of installation and removal operations enhances the likelihood of the problems described above. Without one or the other, the possibility of inexperienced, incompetent, or unscrupulous installers or tank removers causing environmental and public safety problems is substantial. However, both certification and inspection are necessary for an effective regulatory regime.

The certification of installers and removals is often viewed as a substitute for inspection of individual operations, and a way to save money. For example, this was the rationale for Maine's certification program. It was seen by the government as an alternative to a detailed permitting and inspection program. Such a program would have required ten additional staff to review detailed permit applications and drawings and to inspect individual installations. This option was rejected "based on the determination that the Maine Legislature would most likely not fund such an expensive program".[229]

However, the value of certification lies partly in the possibility of revocation of the certification if work is substandard. But unless the work is inspected, authorities are unlikely to find out about substandard work in a timely fashion. Because of the delay in leaks manifesting themselves, problems may not be discovered until years after the installation. By this time, it is often impossible to prove the cause of the leak.

## Financial Assurance and Financial Assistance

The solution to replacing substandard tank systems with ones less likely to leak lies in a comination of requiring those who can do so to carry adequate insurance or provide other forms of financial assurance, and assisting those who cannot afford to do so.

Those who carry on inherently hazardous activities are often required by legislation to provide some form of financial assurance to be used to repair damage caused by their activities or to compensate victims of those activities for their losses. The financial assurance required is often in the form of mandatory third party liability insurance (motor vehicle owners, pesticide sprayers, nuclear facility operators), a bond or letter of credit, (waste disposal site operators, mines) or requirements to pay into a fund (rehabilitation of pits and quarries in Ontario, workers' compensation, oil pollution from shipping activities, deep well disposal of wastes in Ontario).

Although the underground storage of petroleum products is such an inherently hazardous activity, Canadian laws regulating this activity generally do not require owners and operators of these facilities to provide any form of financial assurance. If the taxpayers and the victims are to absorb less of the cost of LUST damage, it will be necessary for government to require such financial assurance, since insurance

[229] Woodward and Curran Inc., Summary and Assessment of Maine's Underground Storage Tank Installer Certification Program, Jan 1989, p 3.

companies will not provide coverage to UST owners and operators to cleanup contamination on their own land or to compensate third parties. They consider the risk too great.

In the United States, UST owners are required by federal law to provide financial assurance. In 1986, Congress passed legislation requiring them to carry insurance or use other methods to demonstrate financial responsibility, such as letters of credit or self-insurance. These requirements were premised on the assumption that by creating a potentially large market, the legislation would encourage insurers to provide coverage at affordable rates. But because of concerns about whether this would happen, the Congress also amended the Superfund legislation to require the General Accounting Office to ascertain whether insurance was available and investigate the availability of other financial assurance methods. The legislation authorized the Administrator of the EPA to suspend the requirement to obtain insurance or other financial guarantees in cases where owners and operators demonstrate that this protection is not available. To obtain a suspension, the owners and operators must show that they are banding together to provide insurance for themselves or the the State in which they are located is creating a clean-up fund that would cover LUST incidents.

Among the provinces, New Brunswick is one of the few that requires UST owners and operators to carry third party liability insurance, and like the U.S. EPA, it has not vigorously enforced these requirements because the government has found that affordable insurance is not readily available.

The Congress also established an Underground Storage Tank Trust Fund to provide up to $500 million in clean-up assistance over 5 years where there is no solvent owner or operator or the owners and operators refuse to cooperate in clean-up. The fund is financed by an excise tax of 1/10 of a cent on motor fuels (including gasoline, diesel and aviation fuel). The law also encouraged states to develop their own Trust Funds as a supplement to or replacement for tank leak insurance. These funds would serve as cheaper insurance for companies who could not obtain insurance from the private sector. In some cases, they also could be used as a clean-up fund or to reimburse victims of pollution for their expenses.

In April 1987, the U..S. EPA published proposed regulations requiring all petroleum tank owners and operators to maintain evidence of financial responsibility of between $1 million and $6 million, depending on how many tanks they own. The EPA expected to bring those requirements into effect in mid-1988.

However, a GAO study released in January 1988 concluded that UST insurance was not generally available despite the increasing demand for it and "when available it has become increasingly more expensive. [230]) The GAO study found that only 14% of tank owners in the U.S. had insurance. It reported that EPA had estimated that approximately 65% of the tank owners who would be subject to regulation would be unable to comply with the proposed financial assurance requirements if they were imposed in mid to late 1988 [231] In fact, the tanks most likely to leak - old tanks owned by small retailers, particularly those who do not monitor for leaks on a regular basis - were those least likely to be sold insurance. [232] The GAO also found that other methods of demonstrating financial responsibility acceptable to the EPA were largely unavailable or too expensive for small businesses. Accordingly, the GAO recommended that EPA postpone the implementation of financial responsibility regulations and phase them in over a more "realistic" timetable. [233]

As a result of the GAO report, the EPA phased in its financial assurance requirements, giving those which it considered to have the least resources, which included small petroleum marketing firms and local governments, until October 1990 to comply.

The GAO updated its report in February of 1990. It reported that one of the largest suppliers of tank insurance had announced that it would no longer provide this insurance and another was reducing its area of operations. In addition, most states either had not established trust funds to help owners meet financial responsibility requirements or had created funds that only partially satisfied the regulations'

[230] Gao, Jan 88 p. 19.

[231] P.30.

[232] p 30.

[233] p. 57.

coverage requirements. As a result, the GAO reported that small businesses would not be able to meet the extended deadlines, and "(t)herefore, whether EPA should delay its financial responsibility requirements or suspend enforcement has again become a pressing issue".[234] By February of 1990, 34 states had created trust funds to pay for tank clean-ups and/or to compensate victims of leaks. EPA had given conditional or final approval to 23 of those funds.[235] Some states established clean-up funds, others created insurance schemes, while others gave loans to tank owners to upgrade their facilities.[236] However, according to the GAO, some of the tanks still in the ground were "in such poor condition that they will not qualify for coverage under state funds."[237] Moreover, it has been reported that where the funds have created "mini-insurance companies", the amounts being collected through premiums or taxes frequently fall far short of what might be needed to pay claims.[238] Because of the inability of small businesses to meet the requirements, the EPA had given "a low priority" to enforcement, even where owners could afford to comply.[239]

Obtaining private insurance at a reasonable cost in the United States has continued to be a problem for the smallest businesses - which also tend to be the ones that, because of old tanks and lax monitoring practices - tend to be the highest risks. However, large companies have met EPA requirements by self-insuring, some companies have grouped together to form insurance pools, and state funds have assisted other companies to insure themselves or provide loans, loan guarantees or grants to upgrade equipment. Companies with modern tanks and leak detection systems have found it somewhat easier to obtain private insurance.

[234] GAO, Statement of Peter F. Guerro, before the subcommittee on Environmental Protection, Committee on Environment and Public Works, United Senate, Feb. 20/90 p. 2.

[235] Guerrera p. 7.

[236] See Tank Talk, Sept/Oct/92, pp 4,5.

[237] Guerrera, p. 7.

[238] Michael Bradford, "Captives can reinsure underground tanks", Business Insurance, March 18, 1991, p1 and 2 at p. 2.

[239] Guerrera, pp 10, 11.

Unlike the United States, Canadian governments generally provide no assistance to tank owners who cannot afford to upgrade their substandard and tank systems. In Canada, there are a few funds that have been established to provide cleanup costs, largely where owners and operators are insolvent. However, these funds generally do not come from contributions by the industry that has created the problem, but from general tax revenues, or, in the case of Nova Scotia, from a provincial lottery. They are too small to cover more than a small proportion of the anticipated clean-up costs, and they are not available to upgrade outmoded and defective tank and piping systems.

In 1993, faced with complaints that businesses could not afford to comply with its UST upgrading requirements, the Saskatchewan government discussed the possibility of imposing a surcharge on petroleum products to help subsidize tank upgrading programs. However, in light of criticism that this would subsidize polluters and raise the price of gasoline to consumers, the government instead announced a relaxation of its rules. The deadline for upgrading facilities, which was already the longest in Canada, was extended an additional year for all USTs and longer for those that met certain monitoring and safety requirements. [240]

Thus, in Canada, rather than protect the environment by financially assisting tank owners who cannot afford to upgrade their facilities, Canadian jurisdictions have instead delayed passing laws that require upgrading or failed to enforce such laws. While government assistance violates the "polluter pays" principle by subsidizing polluters with public funds, in light of the fact that the public will often have to pay for remediation when these tanks fail and the cost of clean-up will often greatly exceed the cost of subsidizing prevention, the economic wisdom of this do-nothing approach is questionable.

[240] News release, "Weins announces action plan", Government of Saskatchewan Information Services, May 20, 1993.

## Enforcement

The weak link in most regulatory chains is enforcement. Government agencies responsible for administration of regulatory regimes designed to protect public health and safety rarely have sufficient staff to systematically inspect facilities and to issue administrative orders or prosecute offenders.

The exceptions tend to be areas of regulation where the failure to enforce the law has led to such serious consequences or such widespread adverse publicity or embarassment to the government that resources are increased. Examples that come to mind are aviation safety and inspection of meat-packing plants. As mentioned earlier, however, LUST has received relatively little public attention in Canada, and the human resources devoted to enforcement reflect this.

The lack of enforcement of UST regulations is not for want of widespread non-compliance. For example, regulations requiring daily dipping and inventory control came into effect in Manitoba in July of 1976. It has been estimated that in 1976 and 1977, only 10% of the operators were complying with these requirements. [241] Two or three years after the provincial government sent out inventory books in which these records were to be kept, inspectors were finding them empty. By November of 1985, compliance had risen only to 50% on the first inspection. Even after a re-inspection, 20% of the facilities were still not in compliance. [242] The situation in other provinces is similar. For example, a survey of 247 retail service stations in Prince Edward Island in the summer of 1985 showed that 63.4% kept no inventory records. 18.5% kept records that did not meet the requirements of the regulation. Only 18.1% were keeping acceptable inventory control records. [243]

[241] 1985 conference, ediger.

[242] ibid at 14.

[243] 1985 conference, Jardine paper.

Among the barriers to effective enforcement reported during the course of interviews conducted for this study were: the belief of government officials that they could not match the lawyers that large corporations would use to defend prosecutions; the refusal of superiors to support the recommendations of inspectors that prosecutions be launched; and the unavailability of a "ticketting system" to prosecute minor violations using the simple, inexpensive, and effective system used routinely throughout Canada for minor highway traffic offences.

The lack of enforcement of LUST laws has been documented throughout Canada since the 1970s. For example, a major recommendation made by government and industry representatives who participated in a Canada-Wide workshop on leaking underground storage tanks in November, 1985, was "ENFORCE EXISTING INVENTORY CONTROL REGULATIONS" (capitalization is in the original). [244] In 1988, the provincial Department of the Environment told a Manitoba Court that the province had only two inspectors to enforce its gasoline storage regulations. The court was told that many facilities were "rarely, if ever inspected".

Despite the knowledge that enforcement is inadequate, provincial governments have generally done little to expand their enforcement capacity. For example, by 1991, as a result of a reorganization, four staff members of the Manitoba Environment Department were each spending a portion of their time on such inspections, but it was questionable whether this actually represented any more time devoted to inspection in actual person-years than in 1988, when this problem was acknowledged in the courtroom.

In 1993, Ontario had approximately 30 inspectors to cover the entire province and one relatively junior lawyer responsible for all prosecutions. Offenders are rarely prosecuted, even in the case of transgressions that appear to be blatant violations of the law. The Fuels Safety Branch of the Ministry of Consumer and Commercial Relations refused repeated requests for prosecution statistics. However, a review of five files obtained under the Freedom of Information Act revealed the following: Three of the five appeared to involve flagrant violations of the law having serious consequences, yet no prosecution was recommended or undertaken:

[244] Canadian Workshop on Leaking Underground Storage Tanks, Summary and Recommendations, Environment Canada, March 1986.

1. In 1991, in Gloucester, near Ottawa, un unknown person removed the fuel oil cap from an underground disused storage tank, causing groundwater to flow into the tank and displace oil in the tank. This caused soil damage that required a $3,000 clean-up. The tank had been out-of-use for eight years. Thus, for five years its owner or previous owner had been in violation of a regulation requiring the removal of such tanks. No legal action was recommended or taken.

2. In 1976, a sewage treatment plant operator in Huntsville, Ontario was hospitalized after being blown out of an exploding building as a result of a build-up of fumes. As described earlier in this report, the problem of leaking gas at this location had been public knowledge for several weeks, yet nothing had been done to prevent the continued migration of fumes. According to an accident report prepared by the Ministry, one Ministry official concluded that "no useful purpose would be served by prosecuting", while one of the Ministry's lawyers "felt that we should not undertake to prosecute on 8(34g) due to a possible ambiguity in the wording".

In September 1990, a house in Lobo Township, near London, had to be evacuated by the local fire chief due to "heavy gasoline odour" in the home. According to the inspector, when three underground tanks at the Township of Lobo garage were removed, "all...had numerous corrosion holes in the bottom, sides and top". When the inspector asked to see the dip records used to monitor for leakage, he was told the no such records were being kept by the operators or owners of the tanks. Despite an apparently flagrant violation of the law, no prosecution was recommended or undertaken.

This widespread lack of enforcement encourages a lack of compliance. As Donald Jardine, one of the first government representatives to become actively involved in this problem, has noted, To ensure that adequate inventory records are maintained by all stations it is up to our department to enforce the regulations and penalize those not adhering to the codes. This will require periodic checks of all stations. If we neglect to visit stations the quality of the records kept will suffer. If our department doesn't see the importance of revisiting all stations on a regular basis then that attitude will reflect on station owners/operators and the maintaining of records will be neglected. (emphasis added) [245]

[245] 1985 conference.

# Chapter 8 OTHER HAZARDOUS MATERIALS

Throughout the world it has been common to store hazardous materials in the ground, either in pits or in various kinds of containers. In some developing countries, for example, experts have suggested burying pesticide containers and residues in pits as a less hazardous alternative to dumping them on the ground or into watercourses. When India's first nuclear fuel reprocessing plant was partialy decommissioned in 1974, the liquid waste generated during the decontamination of the interiors of various processing equipment was transferred to underground storage tanks. Most of the contaminated solid wastes, such as cotton mops, cotton rags, polythene (sic) and rubber items, and metallic scrap were disposed of in "leak-proof" underground concrete trenches. [246] In particular, it has been common practice to store wastes in pits or "lagoons". Until recent years, many such pits were dug in porous sand or gravel or fractured rock, which were particularly susceptible to mobility of contaminants through the soil. In fact, until recent years there was a widespread belief, even among industrial personnel with scientific training, that wastes would degrade or break down in the soil into harmless components. In some cases, high permeability of such pits was considered an asset rather than a liability. At a waste disposal site in Stouffville, Ontario, for example, liquid industrial wastes were dumped into several natural depressions or "kettles" throughout the 1960s. One such depression was particularly valued by the operators of the site because of their ability to continually refill it with waste. Known as "the leaky lagoon", this depression could be filled with waste in the evening and it was empty the following morning.

As indicated in an earlier chapter, even as long ago as the 1950s there were incidents involving widespread groundwater contamination as a result of storing hazardous materials in pits in porous soil. Later, the practice of lining such pits with materials such as asphalt, concrete, dense clay or plastic liners became more common. However, this also has not entirely prevented releases of toxic materials into soil and groundwater.

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[246] P. Kotappa et al., "radiation Protection Aspects in Decommissioning of a Fuel Reprocessing Plant", Radiation Protection, vol 1, p 27-30; M.K. Rao, "Decommissioning Aspects of a Nuclear Chemical Plant", 1978, paper presented at the International Symposium on the Decommissioning of Nuclear Facilities (Vienna) 1980-1982: Summaries of reports of two epidemiological studies.

Other methods of underground storage include the use of mine shafts, injection wells, and caverns. In Germany, for example, barrels containing toxic chemical wastes are stored in caverns cleared by potash mining. [247]

Leakage from underground storage tanks

A wide variety of materials are stored in underground tanks throughout the world, as noted above, including radioactive wastes, other wastes, and solvents. Putting such materials into underground containers is a step above putting them into a hole in the ground, whether lined or unlined. However, although the most notable problem of corrosion and other failures of underground tanks has been in relation to gasoline and other fuels, there have been notable examples throughout the world of leakage of other materials from underground storage tanks and piping. At the Hanford nuclear reservation near Richland, Washington, the U.S. Atomic Energy Commission disposed of radioactive wastes in the 1950s by a combination of injection deep into the ground, dumping in open trenches or ponds that were then filled in by bulldozers, and storage in underground tanks. [248] There has been extensive leakage from high-level radioactive waste tanks at this facility. Over 50 of 149 single-walled USTs at this location have leaked or are suspected of leaking high-level radioactive waste into the soil and groundwater. Some of these leaks were detected in the 1960s. [249] Despite this, the International Atomic Energy Agency endorsed the use of underground storage tanks for liquid radioactive wastes in a technical report in 1972. The report suggested that for underground tanks "where no secondary containment is provided, measurement of the liquid level in the tank and waste inventory control will indicate leakages". No warning was provided that this method of leak detection

[247] International Water Report, vol 5, no 5, Sept/Oct 82.

[248] "radioactive waste dumped into ground - Degree of danger unknown, EPA says", G & M, March 28/91.

[249] U.S. Government, General Accounting Office, Environmental Problems in the Nuclear Weapons Complex, April 1989, p.3.

is highly subject to human error and is often incapable of detecting small, gradual leaks before they result in extensive releases. [250] Radioactive material stored underground at a facility in India has also leaked into the groundwater [251]

Another highly publicized situation in the United States involved the storage of solvents used in the microelectronics industry in California's Silicon Valley. The State government has confirmed at least 100 solvent leaks from USTs, resulting in more than 60 public and private wells being shut down because of water contamination. [252] In one incident, an estimated 250,000 litres of chemicals, including trichloroethane, a suspected carcinogen, escaped from the storage tanks of a semi-conductor manufacturer, contaminating drinking water. [253] An excess of miscarriages and birth defects led to concerns about a causal link between the leakage and the health problems, and a law suit against the tank owner, although a government investigation found that the evidence was inconclusive. [254]

Underground storage of hazardous substances in Canada

Many hazardous substances other than fuels are also stored in underground tanks and piping systems in Canada. These include: paints, paint sludges, solvents, dry-cleaning fluid, wood preservatives, coal tar, brine, radioactive wastes, acids, isopropyl alcohol, glycol, transmission fluid, and various wastes.

The storage of wastes in underground tanks is especially common, and is of particular concern because wastes are often not uniform in composition. They often consist of a mixture of materials, making it difficult and expensive to analyze their

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[250] International Atomic Energy Agency, Storage Tanks for Liquid Radioactive Wastes: Their Design and Use, Technical Reports Series No. 135, Vienna, 1972.

[251] 60 Minutes, February 13, 1994.

[252] National Wildlife Magazine, Feb 85.

[253] "High tech hazards", Alternatives, Spring/Summer 85.

[254] California Department of Health Services, Pregnancy outcomes in Santa Clara county, 1980-1982 - Summaries of reports of two epidemiolic studies.

contents and determine the degree of hazard or compatibility with the design of the tank system, and the chemical composition of the waste, and consequently its hazardousness, may vary greatly from load to load.

It is not uncommon for industries to bury disused tanker trucks in the ground, to be used to store wastes and other materials, often unknown to regulatory agencies. This was the case, for example, at Varnicolour Chemical Ltd., an Ontario solvent reclaiming company whose president was eventually jailed for environmental infractions. When a local environmental group claimed there were tanks buried on the company's property, the Ministry of the Environment initially denied this. However, subsequently both a buried tanker and concrete tank with lines leading to a municipal sewer were found. There were lines leading from the floor drain of a building to the concrete tank, although they were not hooked up. Although this facility was licensed by the Ministry of the Environment, and therefore, plans and specifications showing all potential sources of contamination should have been provided to the Ministry, there was no record of the existence of these tanks.

Underground tanks provide an ideal method of carrying out illegal waste disposal activities and other illegal activities involving hazardous contaminants, precisely because they are out of sight. For example, A-1 Sanitation, a waste hauling company, used underground tanks at a farm in southern Ontario to store liquid industrial waste from local industries, including latex and "fibreglass material". This activity was discovered by the Ministry of the Environment, which regulates waste haulers and waste disposal, only after a disgruntled employee "blew the whistle". Another waste hauler, Mac's Liquid Disposal (1982) Limited, assisted this illegal activity by falsifying the way-bills that track every shipment of liquid industrial waste to delete any reference to this location. According to the transcript of an interview with manager of the second company, the illegal storage went on for about six years before it was discovered by the Ministry.

A potential future problem area involves the increasing use of heat pumps as a method of heating water and heating and cooling buildings. The closed-loop geothermal heat pump is designed to remove natural heat from the earth to provide space and water heating. In the summer, the system can be reversed to provide air-conditioning. However, these systems often rely on an extensive circuit of underground piping containing heat transfer fluids. These fluids may be methanol, methyl hydrate, potassium carbonate, potassium chloride, or potassium acetate. In 1991, there were approximately 22,000 heat pumps installed in Canada. [255] The system currently approved by the Canadian Standards Association utilizes methyl hydrate anti-freeze, which has been described as "highly toxic to humans, aquatic life and the environment generally". [256] Such systems may involve several thousand gallons of fluid.

There are far fewer leaks of chemicals from underground storage tanks than gasoline and other fuel leaks, simply because there are far fewer chemical tanks than fuel tanks. As a result, regulators have paid less attention to these potential sources of contamination.

However, however, it is questionable whether this relative lack of regulatory concern is justified. There is no evidence that the number of chemical leaks or the amounts of chemicals that escape as a result of leaks is any smaller than petroleum fuel leaks in proportion to the number and size of these tanks. Moreover, the potential consequences of chemical leaks are no less serious than fuel leaks. A federal government review of the possibility of a Bhopal-type accident in Canada shows that

- of the 150 most frequently spilled substances in Canada, many are chemicals that may be stored in underground tanks,
- of the chemicals in Canada with a high probability of release based on historical spill data, many are chemicals that may be stored in underground tanks,
- of the chemicals most likely to cause a Bhopal-type accident, that is, chemicals that form toxic gases or toxic liquids under pressure that will easily evaporate or form aerosols and possess good dispersive qualities, that are flammable or explosive liquids or gases, or substances which, on burning or

[255] Leeds & Grenville Board of Education v. Gerrard, (1991), 8 CELR (NS) 266.

[256] Leeds, supra.

reacting with other substances, produce toxic substances or a serious fire or explosion, many may be found in underground tanks. [257]

Many of these chemicals are just as hazardous as petroleum fuels, or even more so. Many of them are as volatile as gasoline and migrate through soil and groundwater just as quickly. Nor is there any evidence that the tanks containing these chemicals are newer, better designed, less likely to leak, or more closely monitored than tanks containing petroleum fuels. A 1985 survey of its Ontario member companies by the Canadian Chemical Producers' Association, for example, revealed that 23 chemical companies had 5,230,360 litres of chemicals other than petroleum fuels stored in underground tanks in Ontario. Ten of the 23 companies reported having had leaks from those tanks in the previous 10 years. Only 14 of the 23 companies had policies on underground storage tanks, and of those 14, only four described their policy in terms of specific design, installation, testing or maintenance standards. The other ten dealt with the USTs only in a "general corporate environmental policy".

In fact, Canada has had its share of chemical leaks over the past two decades. One incident involved leakage of chlorophenol through the bottom of a concrete dip tank at a lumber company in Penticton, B.C. around 1978. Chlorophenol, which consists of a mixture of sodium tetrachlorophenol and sodium pentachlorophenol, with sodium tetra borate as a buffer, is a fungicide, used to prevent the growth of moulds and fungi on wood. The concrete used to construct the tank was porous, and as a result, an estimated 16,000 litres of chlorophenol over one weekend shortly after the tank was installed. According to a hydrogeologist who investigated the incident, the chlorophenol "went straight down through the unsaturated zone until it hit the water table, and from there it started flowing towards the Okanagan River" . This river is about 150 metres away from the leaking tank, and some downstream communities obtain their drinking water from it. [258]

Although remedial action prevented contamination of these drinking water supplies, extensive remedial activities and litigation ensued. Following a hydrogeological

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[257]Environment Canada, Bhopal Aftermath Review: An Assessment of the Canadian Situation, March 1986.

[258]Leibsher, Dec. 5/90.

investigation to determine the groundwater chemistry and flow, used to identify the location of the contaminant plume, relief wells were installed and pumped for two or three months before the groundwater was purged of most of the contaminants. The contaminated groundwater recovered by pumping had to be treated. This was done by discharging the groundwater to a bay at the Penticton sewage treatment plant, where the organics were stripped from the water using charcoal, before discharging the water to the river.

In addition to the staff of Environment Canada, 60 staff members from other government agencies became involved in responding to the incident itself, as well as time spent by other government staff conducting litigation between the federal government and the owner of the facility.

In another incident, a leak in a line to an underground storage tank at a paint products company in Winnipeg in 1990 resulted in a report to the Manitoba Environment Department that 330 kg of xylene had been lost, resulting in 110 tonnes of contaminated sand. The company initially reported that the contamination had all been contained in the sand fill surrounding its underground tanks, but the Environment Department was not satisfied, and requested that the company hire an independent consultant to do soil testing. The consultant reported that "the site is highly contaminated", and that the contamination extended outward from the sand fill.[259] The facility contained six underground solvent storage tanks, containing mineral spirits, varnish makers and naptha, toluol, xylol, hi-flash naptha, and xylene. (Hardy report, supra).

In June of 1989, an explosion at a solvent reclaiming plant in Winnipeg sent a fire ball 150 feet wide 350 feet into the air. The total destruction of the building housing the reclamation facilities prevented the determination of the source of the fire, but one of the possible causes identified by the Manitoba Fire Commissioner was spillage from a waste disposal tank, one of eight 16,000 litre underground tanks.[260] As of June 1990, it appeared that the owners of the property would not be able to pay

[259]Hardy BBT Ltd., "Soil Contamination Assessment, Phillips Paint Products", February 1991.

[260]Manitoba Labour, Investigation Report - Explosion and Fire, Solvit Resources Inc., December 18, 1989.

for the cleanup of the site. The Manitoba government estimated that it would have to pay $20,000 to 30,000 to remove each of the underground tanks, as well as between $50,000 and $150,000 to remove 71 drums of solid waste and to pump the waste solvents out of the tanks.

Summaries of reports of underground tank leaks made to Ontario's Spills Action Centre give some indication of the variety of chemicals that leak from underground storage in Canada, their sources, the range of quantities lost, and the environments impacted. Summaries of incidents from January 1988 to November of 1990 show the following spills of chemicals other than petroleum fumes: April 1988, a leak of wastewater to the ground at Iroquois Chemicals in Cornwall; 140,740 litres of acid solution at Stelco in Hamilton on May 30, 1988; up to 8900 litres of perchlorethylene lost when an excavator dug into two tanks in Timmins, June 20, 1988; 10 litres of mineral oil containing PCB from a transformer at Ajax Hydro, August 1988; 2250 litres of an unidentified substance leaking from a tank at a Brewers Retail store in Kingston; 41,500 litres of waste printing ink at Maclean Hunter in Toronto; 20 to 40 litres of an oil and perchlorethylene mixture at a Petrocanada facility in Ottawa in June of 1990; an unknown quantity of paint or paint-related substances in Brampton in July of 1989; a leak of isopropyl alcohol in Markham in August 1989; a loss of 1000 litres of a paint and xylene mixture to the ground and the plant pond at a Ford Motor Company facility in St. Thomas in February of 1990; chromic acid leaking into the soil at NEO Industries in Hamilton in March of 1990; 800 litres of glycol and transmission fluid lost when a tank split at Navistar in Chatham in April 1990; an unknown quantity of solvent lost to the ground at a steel company in Scarborough in April 1990; solvent lost to the ground and to a sewer from a tank vent leak in Mississauga in April 1990; approximately 1300 litres of a water-varsol mixture lost in Sudbury in June 1990; and roughly 2,000 litres of mineral spirits lost to the ground and the storm sewer from Colour Your World in Etobicoke in July 1990.

Further SAC statistics covering the period January 1991 to February 1993 show leaks or spills from underground tank systems of the following substances: paint thinners, filter backwash water,hydrochloric acid, phosphoric acid, turpentine, 6,480,000 litres of "dirty recirculating water" from a steel production complex, acidic pulp mill effluent, untreated sewage, ammonium sulfate, solvent of unknown character, and acetate.

In addition, brine has been alleged in a pending law suit to have leaked from underground tanks owned by Toronto Hydro, interfering with the ability of a developer to construct a building nearby.

## The regulatory regime

In light of the information presented above, one would think that there is a sufficient risk from chemicals other than petroleum fuels to justify regulations for underground tanks containing these chemicals similar to those governing gasoline and other fuels. In fact, with the exception of Saskatchewan, Canada's provincial governments do not have laws requiring the registration of such tanks, removal or upgrading of unprotected steel tanks, monitoring, leak detection, or removal of out-of-service tanks. With the exception of standards for tanks containing flammable liquids, designed to prevent fires, and pressure vessels, which are generally above-ground, there are generally no legislated design and construction standards for such tanks which the owners are required to comply with.

Provincial governments often have no idea where such tanks are located, what they are made of, or what is in them. According to the Chair of a federal-provincial task force drafting a model law to regulate such tanks, after Bhopal the committee made efforts to obtain such information from industry, but met with no success. [261]

Unlike petroleum fuels, which are regulated by a detailed, if inadequate code governing installation, design, construction, monitoring, leak detection, leak and spill reporting, and tank removal, chemical storage systems, whether below ground or

[261] Kallungel.

above ground, are subject only to general environmental laws, land use planning laws, and where the chemicals are flammable or combustible, by provincial fire codes.

The use and effectiveness of land use planning laws for prevent LUST has been discussed in a previous chapter. Therefore, in this chapter I will discuss the applicability of environmental laws of general application and fire codes.

Environmental laws generally require owners and operators of facilities that have the potential to cause pollution to obtain government approval for the facilities, processes, and waste management practices; require reporting of spills and leaks; give the government the authority to issue preventive and remedial orders where problems come to their attention. Less frequently, they provide for compensation of victims of leaks, for mandatory cleanup and remedial action without a formal order having been issued or proof of negligence; and a discretionary power to require operators to provide insurance or other forms of financial assurance to cover damage they may cause.

The requirement to obtain prior approval, however, is a hit-and-miss approach to ensuring proper design and operation of underground storage facilities. Whether an operator will apply for approval depends on whether it is aware of the requirements of the law and chooses to comply with them. If not, ensuring that approval is obtained may depend on whether the operation comes to the regulatory agency's attention through routine inspections or complaints from the public or from the operator's competitors.

Even then, there is no guarantee that the approval process will include a review of the facility sufficient to identify underground storage and to make approval conditional on the tank owner meeting appropriate design, construction, installation, monitoring, and operational requirements. As the Manitoba Fire Marshal summed up the current state of the law in the report on the Solvit fire:

> To date the approach to control of hazardous materials and products (including hazardous wastes) has focused on hazards that are intrinsic to the material. Similar attention has not occurred with respect to hazards intrinsic to the

industrial systems which process dangerous materials. There is no mandatory overall examination of the process as a functional system by either the collective group of persons involved in the design, construction and operation of the system or by the regulatory inspection agencies. This situation is not unique to Manitoba but is also found in other Canadian jurisdictions. [262]

An Ontario Government lawyer summed up the deficiencies in these general environmental laws in a paper presented in 1984. Although her comments referred to the Ontario legislation, they are largely applicable to the laws of other provinces, which tend to follow a similar pattern. According to Linda McCaffrey,

> (W)hile the Ministry (of the Environment) has a legal framework which does allow it to address the prevention and consequences of leaks from underground storage facilities, the existing framework is not designed to provide a comprehensive system of standards for the designe, installation, operation, maintenance and monitoring of underground storage facilities. Administratively, no comprehensive inventory of abandoned or existing facilities is in existence, no program for inspection, monitoring and remediation is in effect and no guidelines for approval of new facilities exist. The Ministry responds to reported spillls or leaks that come to its attention as a result of the creation of perceived pollution. While the legislative and administrative response to actual pollution resulting from leaking underground storage tanks may be adequate, the Ministry has not planned and implemented a province-wide comprehensive prevention and early detection program for underground system failures. Legislation is necessary, as well as the recognition administratively of the need for such a program.

This was reiterated two years later in a briefing note prepared for the Minister by staff in response to an investigation by the Fifth Estate. The briefing note told the Minister that,

[262] Solvit Report, p. 21.

> While Ontario has laws regulating refined hydrocarbons and flammable substances stored underground, it has few if any regulations covering other toxic substances stored underground. [263]

Provincial Fire Codes are based on the National Fire Code prepared by the National Research Council. Most provinces have such a Code, often administered by a different agency than the one responsible for underground tanks containing petroleum fuels. Lack of coordination between the two agencies can be a problem. Fire Codes often do contain fairly detailed design standards, monitoring requirements, and other provisions similar to those governing codes for petroleum USTs. However, these Codes apply only to flammable and combustible materials, and not to materials that may be hazardous for other reasons, such as corrosivity, carçinogenicity, mutagenicity, or reactivity. In addition, because these Codes are designed to prevent explosions and fires, they are not necessarily adequate to address soil and groundwater pollution.

Thus, there are both a large number of chemicals that are not subject either to petroleum product codes or to fire codes, and others that are subject to fire codes, but not adequately regulated through these codes in relation to dangers to soil and groundwater.

The Canadian Council of Ministers of the Environment has attempted to address these gaps in relation to certain petroleum products by drafting a model code for "allied petroleum products" that can be adopted by provincial, territorial, and municipal governments throughout Canada. This Code is an attempt to harmonize the provincial fire codes with the provincial codes for underground fuels, by creating a single code dealing with both fuels and other petroleum products which are flammable or combustible. If adopted by provincial and territorial governments, this Code will be of great importance because it will apply many of the current regulatory requirements for fuel USTs to USTs containing other flammable and combustible petroleum products such as solvents and thinners. Of particular importance are requirements to register these tanks so that the government will know where they are, how old they are, and what they are made of, and requirements to remove or

[263]Issues report: CBC's Fifth Estate Preparing story on underground storage tanks, June 3, 1986.

upgrade existing unprotected steel tanks in the same manner that has been required for petroleum fuel USTs. <u>However, there continues to be no similar code for USTs containing many other hazardous materials.</u>

## Chapter 9 SEPTIC SYSTEMS

In most rural areas of Canada, as well as many urban areas that are not yet served by sewers connected to sewage treatment plants, the main method of disposing of sewage is the septic system, consisting of a tank (usually buried) and a disposal field.

Basically, the system consists of a tank into which sewage is discharged from toilets, sinks, bathtubs, showers, and washing machines and a disposal field. Solids are separated from liquid in the tank. The heavier solids sink to the bottom and the lighter ones, such as fat and grease rise to the surface, forming a layer of scum. Much of the sludge and scum is liquified in the tank through decomposition. The remaining solids must be removed from the tank periodically.

The liquid flows out of the tank into the underground disposal field. The disposal field consists of rows of tiles laid in gravel-lined trenches. The effluent flows through the tiles into the trenches and surrounding soil where it is further digested by bacteria in the ground, is taken up by the roots of plants or evaporates into the air. The tile field must be large enough to allow this process of absorption and digestion to occur at a rate that does not overload the capacity of the surrounding soil to fulfil these functions. The tile bed must also be a sufficient distance from wells and watercourses to prevent them from being contaminated. They must be constructed in soil with a permeability low enough to absorb the effluent and prevent surface breakout and ponding of sewage, but high enough to prevent effluent from migrating through the soil more quickly than it is treated. For this purpose, the tile bed must also be constructed sufficient distance above the watertable and bedrock.

The septic tank itself can fail through corrosion or cracking that causes leakage into the soil or through mechanical failure that may prevent effluent from entering the disposal field, resulting in overflowing or backup of effluent into the plumbing system.

Once the effluent enters the disposal field, effluent may fail to be absorbed by the soil or digested for a variety of reasons, including soil permeability that is too low or too high, an excessively high water table, blockages in the tile due to damage to the tiles or build-up of sludge, or too small a tile bed.

All septic systems have a limited life span. The tile bed will eventually clog up and cease to fulfill its function. Estimates of the expected life of a septic system vary from an upper limit of 15 years to a maximum of 30 years, depending on the expert consulted and the nature of the soils and other conditions in a particular area. Many systems in Canada are reaching or have surpassed their life expectancy, resulting in frequent complaints of pollution from these systems.

The results of septic system failure can be exposure to bacteria, and possibly to viruses, that can cause severe stomach and digestive tract illnesses, as well as other diseases. Moreover, even a properly functioning septic system will not adequately treat nitrates, phosphorus, and other materials found in effluent, such as some pesticides, solvents, cleansers, and degreasers, paint, oil, unwanted medicines and drugs.

Nitrate is of particular concern because it is thought to be a cause of cyanosis or "blue baby" syndrome, a disease caused by oxygen deficiencies in the blood. Nitrates will accumulate in the soil at a faster rate than they break down, and will eventually migrate through the soil to surface or ground waters.

The United States Environmental Protection Agency has stated that effluent from septic tanks is the most frequently reported cause of groundwater contamination in the United States. [264] It has been suggested that groundwater contamination from this source is the most frequently reported cause of water-borne disease outbreaks associated with the consumption of untreated groundwater. [265]

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[264] US EPA, "The Report to Congress - Waste Disposal Practices and Their Effects on Ground Water", 1977.

[265] M.V. Yates and S.R. Yates, "Septic Tank Setback Distances: A Way to Minimize Virus Contamination of Drinking Water", vol. 27, No. 2, March-April 89, p 202.

In December of 1991, the Commission on Planning and Development Reform in Ontario issued a newsletter calling the issue of septic system pollution "a sleeping giant". [266] The Commission quoted the official in the Ontario Ministry of the Environment responsible for coordination of the Ministry's septic system approvals program as saying, "...it's hard to get people to realize the sleeping giant that this issue is".

The Commission noted that "the problem is now coming to light". It stated that "evidence is mounting about harmful effects" of installing septic systems in urban-style subdivisions. "Every jurisdiction got caught with its pants down", according to a Ministry of the Environment official quoted in the Commission's newsletter.

The belated discovery of the problem of septic system pollution by the Commission and by regulators raises the question why government authorities have been "caught with their pants down". In fact, the problem is neither new nor novel. Widespread pollution from septic systems has been a problem for decades, and some government officials have been warning for almost 30 years that the problems would materialize that we are now facing.

It has been apparent since at least the 1960s that the increasing density of developments relying on septic systems was leading to widespread pollution problems. For example, by the mid-1970s, nitrate pollution of groundwater to which septic systems were contributing had been documented in Nova Scotia, Delaware, Minneapolis, California, Illinois, and Ontario. In fact, high nitrate values had been documented in California as early as 1947. [267] Nitrate levels in the Great Lakes have also been steadily rising. Nitrate-nitrogen levels in Lake Ontario more than doubled between 1968 and 1987. [268]

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[266] New Planning News, vol. 1, no. 3, Dec. 91.

[267] All examples cited in Gibb and Jones,Pollution Hazard to Groundwater in Nova Scotia", N.S. Dept of Environment, 1974.

[268] International Joint Commission, Groundwater Contamination in the Great Lakes Basin, 1993, p 20.

John F. Jones, the former Chief of the Groundwater Section of the Nova Scotia government warned of the problem of increasing nitrate values in groundwater in 1965. [269] By 1974, Gibb and Jones reported that "nitrate values in some (Nova Scotia) wells, reached alarming proportions" [270] They stated that it is likely that excessive concentrations of nitrate in groundwater had probably existed in the past and were only being discovered in the mid-1970s as a result of increased frequency of water monitoring. They attributed these excessive concentrations to the increased use of nitrate fertilizers and "the increasing density of individual sewage disposal system development". [271] They concluded that "...the magnitude of septic tank pollution and/or contamination increases with the density of development. Therefore, even if the problem is not current in Nova Scotia, <u>it very probably would happen in areas of concentrated septic tank development in the future</u>. (Emphasis added) [272]

Similarly, outbreaks of water-borne diseases attributable to septic systems have been occurring for decades, and have frequently occurred in areas of high septic system density. [273] For example, a high incidence of infectious hepatitis in the Halifax area was attributed to contamination of wells by septic tank effluent in the early 1960s. [274] Outbreaks of hepatitis, typhoid occurred in such areas in Washington, Colorado, Florida, Arkansas, Michigan, and other areas of the United States throughout the 1960s and 1970s and were documented in published studies. [275]

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[269] Jones, above.

[270] Gibb and Jones, 1974, p 5.

[271] Gibb and Jones, p. 38.

[272] Gibb and Jones, p. 49.

[273] Yates, "Septic Tank Density and Ground-Water Contamination", vol. 23, 1985.

[274] J.F. Jones "Groundwater Pollution, paper presented to the Nova Scotia Institute of Agrologists, Truro, NS, 1965.

[275] See reports cited in Yates.

Some of the potential problems were recognized in British Columbia as early as 1974. A government task force report on sewage disposal policies in unorganized areas of that province recognized that land development in those areas was characterized by a lack of long-term planning.[276]The report commented on the fact that effects of future planning and sewage disposal were not considered in the regulations governing on-site sewage systems, limited, imprecise and inaccurate use of percolation tests in determining whether soil was suitable for such systems; the absence of any requirement for periodic maintenance of disposal systems; and lack of consideration of the cumulative impacts of additional development. A 1979 report on septic tanks in the Okanagan Basin "implied that provincial regulations are not strict enough".[277]A 1987 government report on rural sewage disposal problems identified 73 areas in the prove with significant sewage disposal problems. It estimated the cost of correction at $47 million. The sources of the problem were described as small lot sizes, cumulative effects of development of an area, weakness of the percolation test, and drainage from uphill areas.[278] Most recently, the British Columbia Ombudsman conducted an investigation of the process of issuing permits for septic systems, as a result of continuing complaints which led him to conclude that, "To many of those affected, the rules regarding the creation of a septic field seem unclear, ever changing and inconsistently applied".[279]

Despite several amendments to regulations and changes in institutional arrangements and methods of funding development infrastructure, the Ombudsman concluded that serious problems had not been addressed:

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[276] Sewage Disposal Task Group, Review of Sewage Disposal Policies in Unorganized Areas of B.C., Interim Report No. 1, 1974.

[277] The Task Force on Septic Tank Regulations, "Septic Tank Sewage Disposal Recommendations for the Okanagan Basin", Okanagan Basin Water Board, October, 1979.

[278] Cited in The On-Site Septic System Permit Process, Office of the Ombudsman, British Columbia, July, 1989.

[279] Ombudsman, above, at p. 3.

> There remains little dispute that on-site sewage problems continue to cause many government officials, elected politicians, land developers, and home owners enormous grief and frustration. The Charlie Lake subdivision near Fort St. John (correction costs $2 million), the Black Mountain Subdivision near Kelowna (correction costs $6 million), the Pritchard Subdivision near Kamloops (correction costs $1 million) and the Barnhardtvale subdivision also near Kamloops (correction costs $20 million) serve as reminders of the high cost of fixing malfunctioning systems. There is general agreement that we have seen only the beginning of the emergence of such problem sites. Old standards and practices used in approving systems 15 years ago for the most part continue to be used today. As these systems continue to fail, the cost of correction will increas significantly. It would appear that strictly from an economic perspective, recommendations contained in government task force reports of 1987 and 1974 can no longer be ignored.[280]

By 1977 - more than 15 years ago - the U.S. EPA had concluded that septic systems were the most frequently reported cause of groundwater contamination in the United States. There was ample evidence to support similar conclusions in Canada. According to one report, domestic wells have been contaminated by bacteria or nitrates in East Selkirk in Manitoba; in Sault Ste. Marie and Woodville, in Ontario; and in Milton and Brooklyn in Nova Scotia. [281] Many other examples are found in other reports and in newspaper clippings. Despite the evidence of a widespread and serious septic system pollution problem in Canada, a 1986 report prepared for Environment Canada concluded that, "Of all the major sources of contamination, septic systems receive the least attention, probably because they are mundane and so ubiquitous that it is not realized that they should be an environmental concern". [282]

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[280] Ombudsman, pp.25-6.

[281] Beak, 1986.

[282] Beak, 1986, p3.10.

If public authorities are just now "discovering" the septic system problem, the reason does not appear to be lack of information. In fact, the reason for the "discovery" of the problem appears to be similar to the reasons for delay in dealing with the problem of leaking underground petroleum product tank systems. First, large numbers of systems installed decades ago are now beginning to malfunction, and secondly, increased population density means that these failures are much more likely to cause adverse impacts on water used by neighbours for drinking or aquatic recreation than in the past. This has now made it more difficult for governments to continue to ignore a problem that they have known for decades was likely to occur.

However, As a result of not taking action earlier, governments will now be forced into a reactive mode in which correction is generally much more costly and difficult than prevention would have been, had action been taken earlier.

## The Economics of Leaking Septic Systems

The research into the economic implications of inadequate regulation carried out for this part of this study was much less extensive than the research into the economic impacts of leaks from underground petroleum tanks. Nevertheless, there is evidence to suggest the same pattern that emerges in relation to petroleum USTs, namely, substantial costs resulting from the failure to take steps to prevent leaks and frequent displacement of those costs from the person at fault to third parties, including shifts in the cost of correction from vendors and installers responsible for construction of buildings with deficient systems to purchasers of these homes and businesses and displacement of costs from the builders, vendors and owners of deficient properties to government agencies.

Under Ontario's regulations, for example, the officials responsible for administration of the regulations are generally empowered to order the owner of a defective sewage system to correct malfunctions rather than the vendor of the land or system or the installer. Purchasers are often left to their own devices to prove negligent design or installation. Installation of a septic system for a single family residence in Ontario generally costs between $3,000 and $6,000. However, system failure may result in remedial costs may be as high as $25,000 per home. [283] Although such systems are generally expected to last 15 to 30 years, in fact, one study found that 16% of the systems installed in Ontario between 1985 and 1991 malfunctioned within the first seven years. [284] The potential liability to consumers for the failure of these sewage systems was estimated to be $75 million. [285] At the time of writing, one outstanding law suit claimed damages of $ 1 million as a result of the alleged failure of 15 septic systems and the anticipated failure of another 16 systems installed between 1989 and 1993 in a housing subdivision in Ajax, Ontario. The developer was suing the consultant who prepared a report on the soil conditions, the designer of the systems, the installer, and the government agency that approved the systems.[286]

Another economic consequence of septic system pollution is the need to replace private wells with municipal piped water supplies. Septic system contamination has had this result, for example, in some municipalities in Nova Scotia [287] and Ontario. One former New Brunswick government official estimated that in the 1980s it typically cost $2 to 43 million dollars, or an average of $18,000 to 20,000 per house, to replace failed septic systems in rural subdivisions with sewer system and central sewage treatment plants.Examples of this in New Brunswick included a subdivision of about 50 homes outside Grand Falls and the village of Barrett, near Edmundston, where "25 to 30 per cent of the wells were contaminated with fecal material from their own septic tanks". The largest portion of these replacement costs was borne by the New Brunswick government.[288] Replacement of private water supplies by municipal services imposes additional costs on the landowner as well as on public authorities. Such costs would likely be similar in the case of sewage

[283]ONHW p. 28.

[284]OHWP p. 28.

[285]ONHWP p. 28.

[286] Cougs Investments Ltd. v. Todd Brothers Contracting Limited, Claim issued July 27, 1993, Ontario Court (General Division), Action no. 53329/92.

[287]Minister's Taskforce on Clean Water, "Clean water for Nova Scotia, N.S. Dept of the Envt, June 1991.

[288] Robert Lutes, October 22, 1991

contamination to those indicated for petroleum contamination in chapter , and are frequently in the millions of dollars. For example, several rural areas annexed by the City of Windsor, Ontario in 1977 had septic systems so primitive that septic tanks discharged directly into municipal ditches and sewers. Many of the lots were too small to contain a disposal bed. As a result, sewer systems and sewage treatment plants had to be built to service new subdivisions and to replace deficient septic systems in these areas. The cost has largely been borne by the federal government through the Central Mortgage and Housing Corporation and through grants from the Ontario government and funds from the City of Windsor. Between 1987 and 1982, $39.5 million in provincial and municipal tax dollars were spent on this. [289]

Residents of a housing subdivision in London, known as South Winds Village, also had to abandon their septic systems and connect to a newly-constructed municipal sewer system only 6 years after they purchased their homes. These septic systems were installed around 1988, and effluent was ponding on the ground above the leaching beds within a few months. In at least one case, the cost of carrying out an order to convert the septic tank to a holding tank and pump it out every week or two was borne by the Ministry of the Environment rather than the developer of the subdivision or the contractor who installed the septic system.

Residents of such areas are also often required to contribute to the cost of such replacement programs through "local improvement" levies. For example, in the McNabb subdivision in the Muskoka area of Ontario, a residential area plagued by drinking water problems to which leaking septic systems contributed, residents were to be connected to the town's water supply if they approved a local improvement project. The cost to the 87 owners of 93 affected properties would be $506,000, an average of $5,216 per lot. [290]

Like the petroleum leak situation, those who create the problem are not always required to internalize the costs of prevention or correction. As indicated above, in some cases, homeowners who have purchased properties with defective systems are required by government agencies to replace them, rather than the vendor of the

[289] Tom Murray, Director of Sewers Engineering, City of Windsor, Dec. 15/93.

[290] "Town water proposed for McNabb subdivision, The Herald-Gazette, July 14, 1993.

property or the installer of the system. In other cases, rather than requiring owners of old systems to bear the cost of replacement, government subsidies are being offered.

## The Legislative Framework for Regulating Septic Systems

The legislative framework for regulating septic systems generally includes two primary sources of regulation:

- land use planning legislation, generally administered by municipalities with some oversight from provincial departments which have responsibility to plan urban growth and development and provision of housing;
- specifications for septic system design and installation and licensing requirements for septic system installers, generally administered by provincial or municipal departments responsible for protection of public health or the environment.

Commentators generally agree that the problems in this area stem largely from the failure to integrate environmental considerations into the land use process. Many of the problems experienced with leaking septic systems result from lack of coordination between these two systems of regulation or from authorities giving the development process priority over the environmental protection process. The mandates of the two regulatory systems and their administrators often conflict. Development is seen as a source of jobs, wealth creation, and increased municipal and provincial tax revenue, while environmental protection places constraints on this development and is perceived as imposing costs on developers and purchasers without commensurate financial benefits.

The results have been that land use planning approvals have frequently been granted to sever, subdivide or develop lands which are not suitable for the use for which they have been zoned because they cannot support a septic system and the area is not serviced by municipal sewers. These lots are generally too small to hold a septic system adequate to meet current standards for the size and location of such systems.

In other cases, however, the size and location standards themselves are inadequate to prevent pollution. For example, Ontario's regulations provide that septic system disposal fields must be a minimum of 50 feet from a dug well and 100 feet from a drilled well or watercourse. The tiles must generally be at least 3 feet above groundwater. However, these setbacks may often be inadequate, as there is evidence that pathogenic bacteria and viruses may migrate and remain viable through greater distances. [291] While legislation often states that these setbacks are minimum distances, which can be increased where local conditions warrant greater setbacks, they are often applied mechanically, as regulators often have insufficient knowledge of soil conditions and other variables and of the relevant scientific considerations to justify imposing greater setbacks.

It has been suggested that the most important factor influencing ground water contamination by septic tanks is the density of systems in an area. The densities allowed under most current Canadian regulations are far greater than those considered appropriate. The U.S. Environmental Protection Agency has designated areas with septic system densities of greater than 40 systems per square mile ( 1 system per 16 acres) as regions of potential groundwater contamination. [292] However, in the past the generally recognized legal minimum lot size for septic systems in the United States has been about 0.47 acres. [293] This is similar to the minimum size lot that would be allowed, for example, under Ontario's current regulations.

It follows therefore, that one of the simplest ways of dealing with the problem in future septic system approvals would be to increase the minimum size of lot that would be approved for any use that would require a septic system. A more complex but more scientific method of achieving the same goal would be to require more systematic study of the characteristics of each individual site, including soil porosity

[291] See Yates and Yates, "Septic Tank Setback Distances, and studies cited therein.

[292] U.S. EPA report to congress - 1977.

[293] Reneau, "Changes in concentrations of selected chemical pollutants in wet, tile-drained soil systems as influenced by disposal of septic tank effluents", J. Envir. Qual. v. 8, p. 189, 1979.

and depth, groundwater fluctuations and rate and direction of flow, etc., rather than the more-or-less mechanical application of legislated formulae to each site, regardless of potential environmental differences.

The problem of existing substandard tanks has largely not been addressed by Canadian regulations. Unlike the laws regulating underground gasoline tanks, regulations governing septic systems generally contain no requirements to upgrade or replace the systems unless and until they actually malfunction or a major change is made in the use of a parcel of land that will impose additional loadings on the existing system.

As mentioned earlier, many of the existing systems have reached or are rapidly reaching the end of their expected life. Moreover, many of these systems are currently handling much larger loadings of sewage than they were designed for as a result of lifestyle changes that have increased water usage, such as larger houses, automatic washers, jacuzzis, and more fixtures per person than in past. Many cottages built for seasonal use with sewage systems designed to handle seasonal loadings have been converted to year-round use, with the result that loadings have increased beyond their capacity.

Moreover, like petroleum tanks, many of the older septic tanks are made of unprotected steel, which will eventually corrode, just as the petroleum tanks did. Yet there are generally no requirements to provide cathodic protection to such tanks or any limit on how much longer they may remain in the ground.

There is another similarity to most petroleum tank regulations. Although septic system installers must be licensed in most provinces, there are often no requirements that installers meet specific standards of competence to obtain a licence. This is particularly important since it has been estimated that approximately 31% of leaching bed failures result from poor design, poor construction, and inaccurate soils information, all of which could be improved by ensuring competence of installers. [294] One study of septic systems in Ontario recommended that only qualified engineers be permitted to design, inspect and certify private sewage systems within plans of subdivision. [295]

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[294] Ontario New Home Warranty Program.

[295] ONHW, p.v.

## Chapter 10 OTHER AREAS OF CONCERN

During the course of this study, some issues came to my attention that were not initially intended to be part of this study. The following are some areas of concern that might be further addressed by organizations interested in environmental and public health issues.

### 1. Above-ground tanks

Although this study has focussed on underground tanks, the regulation of above-ground tanks (ASTs) appears to be an area equally in need of reform. Several commentators have noted that USTs appear to have received much greater attention from regulators than ASTs. Regulatory attention has focussed on USTs rather than ASTs both in Canada and in the United States.

Governments have been aware for many years that action is needed. Ontario is still using set of Guidelines for environmental protection measures at chemical storage facilities adopted in 1978, which covers aboveground tanks. It has planned to update this document for many years. In May of 1988, an Ontario official wrote that, "Based on our work plans for 1988, this has been identified as a low priority. A tentative timeframe to begin this work is about one year from now". [296] As of May 1994, the revision had not been completed.

Similarly, in October of 1986, the Canadian Council of Resource and Environment Ministers voted unanimously to establish and industry-government task force to draft an environmental code of practice for aboveground tanks containing petroleum products. In December of 1993, this Task Force had completed a draft of the code. The code would be approved by the Task force, then sent to the Council for approval before being released to the public. It would then serve as a model for provincial and territorial regulations. [297] As of May 1994, this code had not been released, although an Ontario official said that "It is releasable. Apparently there's some problem with getting the money to release it".

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[296] Memo, Bartkiw to Hore, May 10/88.

[297] Karr, telephone Dec. 14/93.

This attention is warranted, since regulatory requirements to upgrade underground tank systems have created a trend in both Canada and the United States towards replacing USTs with ASTs, increasing the risk of fire and explosion that the burial of tanks was intended to reduce.

ASTs range from small tanks outdoors and in basements to heat buildings and outdoors or in barns at farms to fuel machinery to large tanks at facilities such as refineries and bulk plants. As in the case of USTs, AST regulations often contain "small tank exemptions", leaving residential and farm ASTs largely unregulated, even though, as in the case of USTs, leaks and spills from small tanks can cause extensive harm.

In the United States, it has been estimated that there are 800,000 to 900,000 ASTs containing petroleum products and 200,000 in which other hazardous products are stored [298] The Environmental Defense Fund estimates that 200,000- to 275,000 (20-25%) of these tanks are leaking [299] In 1992, there were 69 releases from American ASTs involving a loss of over 6 million gallons of petroleum. [300]

The U.S. EPA has stated that if the owners of facilities with ASTs were required to remediate their releases to groundwater, this would cost them approximately $790 million a year, exclusive of costs that would fall to third parties, such as property devaluation, victim compensation, and relocation costs. [301] Over a 20-year period

[298] Aboveground Storage Tank Survey, prepared by Entropy Limited for the American Petroleum Institute (Washington, D.C.) Technical Report RN-623, April, 1989, p. 1.

[299] EDF study, p. 3.

[300] EDF study, p. 5.

[301] "The OPA Liner Study (Draft)" prepared by ABB Environmental Services for U.S. EPA, Jan. 1992, p. 57.

(the approximate life of a liner which would prevent underground releases) the accumulated clean-up costs would therefore be \$6.7 billion. However, the Environmental Defense fund has stated that this figure is probably "extremely low", since the data base used in the EPA study to determine the likelihood of releases missed many of the known past releases. [302].

To my knowledge, no similar studies have been done in Canada, so the scope of the problem is largely undocumented here. However, there are many ASTs in Canada as well, and we also have a history of leaks and spills from these facilities. In fact, there may be for more ASTs than USTs. A 1993 survey carried out in the Yukon found that there were almost twice as many ASTs as USTs. [303] Athough no attempt was made to obtain statistics on leaks and spills from ASTs for this study, several documented cases and some statistical information have come to my attention.

Documented AST leaks and spills in Canada include the following: 4,000 litres of gasoline leaking from an AST at a service station on Walpole Island, Ontario in July of 1993.[304]; contamination of private water wells in Pierceland, Saskatchewan in March, 1990 resulting from leaks or spills at an Imperial Oil bulk plant. [305]

In the 1989-90 fiscal year, 54 of 273 reported spills were overflows from aboveground tanks. These overflows released 189,883 litres of material into the environment.

The causes of AST leaks and spills are generally similar to the causes of UST leaks, including improper installation, cracking of welds and seams, and corrosion of the tank bottoms and piping. The thickness of the floors of many ASTs is as little as ¼", and the existing tank population is aging. According to one Canadian expert, "The age of the vast majority of (aboveground) storage tanks is greater than ten years,

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[302]EDF study p. 8.

[303]Yukon Terr. Govt. Fuel Storage Tank Inventory, 1993.

[304]Gas Leak contained, London Free Press, July 8/93, p. B1.

[305]Brandt ltr to JS.

with a high proportion greater than 25 years". This expert told a conference in February 1994 that "Even very modest rates such as 10 mils per year is a serious corrosion rate on a 0.251" thick tank bottom approaching 25 years of service. While sudden escapes from the visible portions of ASTs are more readily ascertainable than UST leaks, slow leaks through the bottom of such tanks, like leaks from USTs, often remain undiscovered for long periods and with similar results: extreme difficulty in source detection and remediation, extensive groundwater contamination, risk of fires and explosions, etc.

In addition, there may be a greater risk of substantial spills during filling of ASTs, since liquids must be pumped under pressure rather than using gravity flow. Overfill standards for containment devices may also be inadequate. According to one representative of tank manufacturers, "Overfill containment devices required around the AST overfill port by most regulatory agencies only contain overfills of 15 to 25 litres. Should the overfill exceed this amount, most AST systems ... result in the excess fuel contaminating the ground surface. [306]

Moreover, leak detection methods and equipment have the same limitations as leak detection for underground tank systems, making it imperative to prevent leaks, rather than try to discover and correct them after they occur. [307] The EDF states, "Contrary to the claims of some leak detection companies, the only way to ensure that an existing aboveground tank whose base is on the ground is not leaking is to take the tank out of operation and inspect it internally". [308]

One of the most obvious and long-standing problems in relation to ASTs is lack of spill containment structures surrounding tank systems. Legislation frequently does not require dyking or requires it only in limited circumstances. This problem was noted as long ago as 1954 by the Ontario Fire Marshal, who decried a proposal to remove dyking requirements from Ontario legislation governing ASTs. In a letter to the Deputy Minister of the Department of Highways, which had primary responsibility

[306] Elson G. Fernandes, "A Practical Guidt to Aboveground Fuel Storage Systems", in Proceedings, Underground and Aboveground Storage systems.

[307] See Rorty and McLearn for a description of limitations of various leak detection methods for ASTs.

[308] EDF p 11.

for what were then called the Gasoline Regulation, the Fire Marshal described the need for dyking and the consequences of an amendment that would remove the requirement to construct dikes:

> "Almost no fire department in Ontario is equipped to extinguish fires in large-size gasoline storages. There are special fixed installations for fire-fighting which can be used by the oil company staff or the fire department, but these are much more expensive than dikes and have never been required under Ontario law. In the existing situation, most fire departments are able only to try to control the fire resulting from any rupture of the tank or leakage of gasoline etc. and to lessen the spread of this to other tanks and storages. Mainly they are able to do this due to the diking. Without dikes fires in any storages will undoubtedly spread and will will inevitably have losses of many millions of dollars." [309]

Dykes not only control the spread of fires, but also prevent flow of pollutants into bodies of water.

Despite this, regulations in Canada often do not require dykes or require them, as in Ontario, only where the tank is in close proximity to a body of water. Even then, there is evidence that enforcement of dyking requirements is inadequate. Canadian governments often do not have basic information about the location, age, and condition of ASTs and whether they are protected by dykes. For example, in response to a question from a member of the Liberal opposition in 1992, as to how many aboveground tanks there are in Ontario, where they are located, their age, and whether they are dyked, the Fuels Safety Branch, which is responsible for regulating ASTs containing petroleum products, answered: "We do not have this information. Branch emphasis has been on addressing underground tanks and equipment first". [310] The available evidence suggests that many ASTs are not dyked. For example, in the Yukon, dykes were installed around only 27% of the ASTs identified in a 1993 survey. [311]

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[309]Ltr WJS to MA Elson, July 55/54.

[310]MCCR Estimates Committee, Technical Standards Division, Fuels Safety Branch, undated.

[311]Inventory referred to on note.

Moreover, although many tank farms throughout Canada do have dykes, there are often openings in these dykes designed to allow the escape of rainwater or melting snow or for other reasons, which also allow the escape of material that has spilled or leaked. For example, following a spill at a pulp and paper mill in Marathon, Ontario in

1981, an estimated 1,100 gallons of Bunker C oil entered Lake Superior through an open valve in a dyke. [312]Regulations which do require dykes often do not contain a provision that requires them to be designed to eliminate or control such escape routes.

## Conclusions and Recommendations

The solutions, as well as the problems, are similar to the ones needed to prevent and detect UST leaks and to remediate their damage. These solutions include secondary containment, groundwater monitoring around tanks, and leak reporting requirements. Fencing adequate to deter vandals is also needed.

In addition, the EDF has recommended that AST legislation should contain provisions covering:

- installation and design, including tank designs that protect firefighters;
- corrosion protection for metal in contact with soil
- spill and overfill protection and containment
- testing and inspection before use of tanks, including rebuilt tanks and associated piping,
- secondary containment of piping or movement of piping aboveground,
- clean-up and financial responsibility, including petroleum recovery and reuse;
- clear legislative authority to force owners to address aboveground tank releases threatening human health and the environment
- minimum inspection and testing frequencies, and
- closure requirements, including any necessary clean-up activities. [313]

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[312]R. v. American Can (Canada) Ltd., D.G. Pahl, J.P., June 25, 1992, unreported.

[313]EDF p. 12.

Other legislative provisions that are often found or recommended in relation to UST, which appear equally applicable to ASTs, include:

- requirements for training and certification of installers, repairers and removers of AST systems,

- training and certification of operators of leak detection equipment,
- financial assurance requirements for such persons,

- creation of an inventory of existing tanks, including their location, design and construction, age, and local soil conditions, proximity to groundwater, surface water, and sensitive aboveground and underground structures and land uses, and extent of dyking surrounding the tank system, and record keeping.

It has been suggested that records that should be kept by an owner or operator of a facility containing ASTs should include: purchase and installation records, maintenance and repair documents, registration, licences and permits, master calibration records, inspection reports, results of tank testing, manufacturer's instructions, operating records, cathodic protection installation and testing documents, and as-built drawings. [314]

Occupational Health and Safety

The safety issues related to workers' exposures to fumes while repairing or removing underground tanks are generally well-known as a result of several deaths that have resulted from asphyxiation or from explosions of tanks. What is less well-known is the long term implications to human health of exposure to fumes, particularly gasoline fumes, while decommissioning tank systems and during disposal of contaminated soil at landfill sites.

In the United States, there have been studies of exposure of workers and inspectors while decommissioning sites. However, less attention has been paid to exposure of landfill site workers. As mentioned earlier in this study, much of the contaminated

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[314] Rorty and McLearn, "testing, Monitoring, and Maintenance of Aboveground Storage Tanks", 1991, pp. 13,14.

soil removed from storage facilities is disposed of at ordinary landfill sites. To reduce the levels of contamination to those acceptable to the operator of the landfill site, the soil is often "stirred" repeatedly to release the volatile components to the air either at the landfill site itself or before transporting it to the landfill site. In the case of gasoline in particular, these volatile components are a high percentage of the material and include some of the most hazardous components. Government officials, oil company officials and consultants interviewed for this study had little or no knowledge of the extent to which workers breathe hazardous substances in the course of disposal of contaminated soil. They generally expressed little concern or suggested this was not of concern. One government official dismissed the topic with the suggestion that waste disposal site workers are routinely exposed to "a lot worse things". To some extent, this reaction may have been due to the fact that the interview subjects from government agencies were generally those involved in fire fighting or environmental issues, and not those responsible for protection of occupational health. Nevertheless, a very preliminary review of Canadian regulations dealing with occupational health suggests that Canadian regulations are much less comprehensive in dealing with this kind of problem.

Landfill sites do, in fact, emit various gases even when disposal operations are not being carried out. The main gases produced are methane and carbon dioxide. The former is creates a risk of fire. Both are greenhouse gases which contribute to global warming. Of greater concern, however, in relation to this study is the fact that non-methane organic compounds (NMOCs) including several found in petroleum-contaminated soil have been measured being emitted from landfills in trace amounts, even when the waste has been covered with soil. [315] The NMOCs found in the air at landfills include ethane, toluene, propane, benzene, pentane, perchloroethene, hexane and many brominated and chlorinated species. Some, such as benzene, toluene, are found in gasoline and other fuels. Some, such as perchloroethene, are frequently stored in underground tanks, and may also reach landfill sites through soil clean-ups. Emissions are of concern since many of these substances are carcinogens or otherwise impair human health.

[315] US EPA, Air Emissions from Municipal Solid Waste Landfill - Background Information for Proposed Standards and Guidelines, EPA-450/3-90-011A, March 1991.

Occupational safety and health regulations throughout Canada do not usually deal specifically with underground tanks. Instead, they deal more generically with "confirmed spaces". These laws are relatively specific as to safety precautions that must be taken before entering confined spaces such as ASTs, USTs, Ships' holds, sewers, tunnels, pipelines, and silos. They are much less specific, however, when dealing with workers who may be exposed to fumes in the open air or partiall enclosed spaces, such as pits from which tanks are being removed and landfill sites.

## Chapter 11 LESSONS FROM LUST

What lessons can be learned from how Canada has handled the problem of leaking underground storage tanks? The information needed to predict a LUST problem has been available since the 1960s or earlier. The magnitude of the problem has been obvious to government and industry since at least the mid-1970s. Since then, there have been continuing attempts to deal with the problem of petroleum fuels, particularly at gas stations. Numerous task forces have been formed, the effectiveness of existing technologies has been studied, new technologies have been developed, tested, approved, and sometimes made mandatory. Information has been disseminated by government and fuel suppliers to owners and operators of tanks.

The result has been considerable progress in removing unprotected steel tanks and lines from the ground and replacing them with second generation tanks and lines or upgrading them by internal lining or cathodic protection. In some cases, third generation tanks and lines are now being used. Nevertheless, it has taken approximately twenty years from the time the Manitoba Clean Environment Commission first publicly sounded the alarm to remove or upgrade most, but not all, of the unprotected steel tanks containing petroleum fuels at gas stations and institutions, and to implement tank registration and installer training programs. The unprotected steel tanks that were upgraded or replaced in the mid-1970s, when this was first required, are now approaching 20 years of service. How much longer will they last before the problem begins to recur? In most cases, there is no legal requirement to monitor these tanks for leaks, other than the imprecise and largely unenforced requirement to "dip" the tanks daily.

The technology required for tanks installed after the mid-1970s is now obsolete. Third generation systems are less likely to leak, but more expensive. Most provinces do not require their use, except in particularly sensitive environments.

Moreover, the refinements in the laws governing underground fuel tanks have generally not been made for USTs containing other chemicals or for septic systems.

Why has it taken so long to do so little? LUST illustrates many features of our regulatory system that work against faster and more effective action.

1. The lack of a multi-media approach to environmental regulation. Our regulators and industries often do not take a holistic approach or apply an ecological perspective to development of regulations and industry practices. Instead of viewing the environment as a integrated system, the regulators focus only on air, water, or, more recently, soil. Their attempts to solve a problem in one environmental medium often move the problem to another medium. The problem of soil and groundwater contamination was created by the decision to bury tanks to reduce the problem of fires and explosions. The regulators looked at this problem in isolation and solved it by creating a new set of problems.

2. The lack of an anticipatory and preventive approach to environmental regulation. Our environmental laws have largely been directed to cleaning up pollution after it occurs rather than anticipating and preventing it. Once the LUST problem became widespread, industry and government began extensive consultations, studies, etc. to determine how to solve it. This took time. In interviews, industry and government officials often justified the time it has taken to get where we are today on the basis of the lack of knowledge of the extent of the problem, its causes, and its solutions, when the problem became obvious in the mid-1970s. When looked at in this light, the rate of progress may appear acceptable.

However, from a different perspective, the rate of progress may appear less acceptable. The only reasonable approach to the LUST problem is prevention, since clean-up after the fact is prohibitively costly at best and impossible at worst. However, the system was not designed to anticipate and prevent a widespread LUST problem, but only to react to it after it was already underway. Steel rusts. It does not take a sophisticated knowledge of science to know that if you place unprotected steel tanks and lines underground, they will eventually corrode. In fact, as indicated in an earlier chapter, it was well known since the 1940s that underground pipelines and tanks were subject to such corrosion, and cathodic protection was recommended for such pipelines in the late 1940s. What was lacking was not knowledge of the potential problems and their solutions, but the will to act on them.

Although action has been taken to ensure that unprotected petroleum fuel tanks are removed and many provincial regulatory codes dealing with these UST have been updated, as earlier chapters show, the same attention has not been given to other USTs and ASTs which may create similar problems, even though these potential problems are well-known to industry and government. Examples of delays cited throughout this study underline the inability or unwillingness of the system to prevent pollution rather than apply costly after-the-fact solutions.

3. Human and financial resources. Government departments responsible for environmental protection are generally understaffed and undermanned. From time to time, estimates are made of the amount of money needed to address an environmental problem. Frequently, it is much more than is available. I know of no studies that have attempted to determine the number of inspectors, scientists, and other staff members needed regulate in an effective manner. Nor was I able to obtain from government departments any estimates of the staff needed to adequately implement and enforce UST regulations. Nevertheless, the data obtained, some of which is referred to earlier in this study, appears to confirm that government agencies do not have the financial or human resources needed to do their jobs effectively. Nor are governments generally willing to further raise taxes or impose fees or levies on industry to raise the money needed to address these problems at an earlier stage.

4. Assessing the risk. Ultimately, democratically elected governments must represent <u>all</u> their constituents using their best judgement of what is reasonable and attempting to balance competing interests. How they do this, however, raises serious questions. First, it is apparent in the case of LUST that governments often made these decisions on the basis of limited information. As indicated in earlier chapters, governments have made only limited efforts to ascertain the relevant information, such as how many tanks are in the ground, where they are located, what they are made of, how they were installed, their age, and their contents. Few efforts have been made to compile statistics on the scope of the harm being caused by LUST and the associated costs and who absorbs these costs. It is very difficult to justify stringent environmental laws when an affected industry effectively documents the costs to its members of implementing such legislation and lobbies

against the imposition of such costs, while the regulators have almost no information about the costs to society of <u>not</u> implementing these regulations.

A second shortcoming of this process of assessing risks and benefits of alternative courses of action is that it has been carried out largely in the absence of meaningful public discussion. As the Canadian Institute for Environmental Law and Policy has pointed out, "Risk assessment deals principally with questions of science and fact. It means the evaluation of the threats posed to environmental quality and human health and safety by particular events, activities or situations. The question of social and political acceptability of risk is a different matter. It is one which is fundamentally moral and political in nature. It involves a transition from questions of what is or what might be, to questions of what ought to be".

The decision as to how to balance the known risks and benefits from alternative courses of action, according to CIELAP, is not just one of risk-benefit analysis, but of development of public policy using what has been learned from such risk assessments. Often, however, both the risk assessments and the public policy decisions based on them are made by government in consultation with affected industries, but without any consultation with the general public or with those who suffer direct harm from the polluting activities or groups that represent them.

LUST is no exception. There have been few government efforts to inform the public of the LUST problem or involve the general public or public interest groups in the formulation of public policy. This contrasts markedly with the approach taken in the United States. There, materials have been prepared by State governments to educate school children about groundwater protection, including descriptions of the contribution of LUST to groundwater pollution; the US Environmental Protection Agency has produced posters, funded newsletters, made its studies public, and taken other steps to educate the public about this problem. In Canada, almost all government communications about LUST have been directed to the oil industry rather than to the general public or to environmental or consumer groups. To my knowledge, the only efforts ever made by government or industry in Canada to inform the public of this problem were Environment Canada's publication of a fact sheet in 1986 and its 1987 revision, Environment Canada's funding in 1985 of a legal review by the Alberta Environmental Law Centre and funding of subsequent editions of this legal review by the Canadian Petroleum Products Institute, a waste reduction company and an environmental consulting firm, and a contribution by PACE, the predecessor of CPPI to the cost of producing "Petroleum on Tap", the Conservation Council of New Brunswick's 1986 report on leaking underground petroleum tanks.

Other than the examples given above, none of the government and industry representative interviewed for this study could give any examples of efforts to inform or educate the public about this problem.

One of the recommendations of the Conservation Council's report was that the New Brunswick government should embark on a public information campaign to increase public awareness about the threat posed to drinking water supplies by leaking underground storage tanks. This proposal was never implemented, nor was a similar recommendation made by an Ontario government hydrogeologist to his Ministry.

5. The role of public interest groups. The silence of environmental groups in Canada Canada has also been a factor in the pace at which progress has been made. The Conservation Council of New Brunswick is the only environmental group in Canada, to my knowledge, that has made any substantial effort to educate the public or lobby government for stronger UST regulations. The Council was unaware of this problem until it discovered a disproportionate number of LUST incidents during a study of groundwater contamination in New Brunswick. To its credit, the Council recognized the significance of this phenomenon and began to prepare a publication on the subject, Petroleum on Tap. This study had much greater impact on public policy than it might otherwise have had as a result of the fact that the study was released four days after a series of LUST explosions destroyed three buildings and damaged several others in downtown Saint John, causing the evacuation of about 2,000 people. I am not aware of any other environmental group that has made an effort to alert the public to this problem. By contrast, several environmental organizations in the United States have published books, pamphlets and other material designed to alert the general public to this problem.

6. The role of the media

The Canadian media also largely ignored this problem until the 1990s. By contrast, in the United States, the prestigious public affairs program 60 Minutes reported that this was a major environmental problem in 1985.

The Canadian media have often reported on individual LUST incidents. However, the reports generally treat each incident as an isolated event, and not as part of a pattern of conduct or an example of a widespread problem. Rarely has a Canadian newspaper reporting a LUST incident indicated that it is suspected that up to 10,000 such leaks are occurring throughout Canada, or reported the number of similar incidents in the area over the previous year.

As a general rule, only incidents resulting in death or other dramatic outcomes receive this kind of contextual analysis in the Canadian media. Reporters tend to provide some context in which to view individual incidents only in such cases. For example, when a young black purse-snatching suspect was shot by Toronto police in December of 1991, a newspaper reported that this was "the third unarmed, young black suspect who's been shot by a Metro police officer since September". This kind of analysis was provided because the earlier shootings had resulted in an outcry from the Black community that Toronto police were racist. [316] Similarly, following the Westray mine disaster in May of 1992, the media reported on various aspects of the political process that had led to approval of the mine in which 26 workers died during a methane explosion and the history of events that might have provided a warning of the possibility of such an accident.

Rarely do the media report similar details of the history of a LUST incident. In part, this results from the failure of government and environmental groups to provide the media with the information needed to provide such a context, and in part it results from a failure of the media to ask the appropriate questions. An interview with a reporter who broke a front-page story about a dramatic LUST incident provides a telling example of the failure of the Canadian media to appreciate the significance of the LUST phenomenon. In 1978, the Toronto Star ran the story of the LUST situation

[316] Glenn Cooly, "Gunshock - Latest shooting rekindles fears that officers hit the pavement armed with guns instead of strategy", NOW, Dec. 12-18, 1991, p. 12.

in Port Loring, which has been described earlier in this study, under the headline, "Beware! This water can start a blaze". The story began: "It's been two years now and the water that comes out of Audrey Davis' taps is still polluted with gasoline. It can catch fire. It's undrinkable. It stinks".

In light of the newsworthiness of this story, I asked Mr. Howard in 1992 why he had never pursued the issue of LUST after this initial story. When I told him about the scope of the problem, he expressed surprise. He did not know there was a LUST problem. He had assumed that Port Loring was an isolated event.

## 7. Disinformation and Misinformation

Freedom of information laws have made available to the public documents that would have been impossible to obtain a few years ago. For example, much of the information about the severity of the LUST problem in New Brunswick and the warnings by civil servants to their superiors which contributed to the creation of a political climate conducive to reforms in that province came to light through an information access request made by the opposition Liberal Party under New Brunswick's freedom of information legislation. (New Brunswick was the first province to pass such legislation). However, these laws have done little to change the attitudes of government officials towards the disclosure of information. The reluctance to release information has been documented, for example, by Canada's first Commissioner under the federal Freedom of Information Act, who released a report on this subject in 1990. [317] The extent to which government officials voluntarily release information without requiring a requester to use the costly and time-consuming formal FOI procedures dependings largely on who the requester is and why he or she wants the information. Frequently, the first questions a civil servant will ask someone requesting information about a problem such as LUST are, "Who are you representing?" and "Why do you want it?". A representative of another government agency will often have little difficulty obtaining information that will be witheld from a member of the general public or a representative of an environmental group.

[317] See p. 73 EOT.

Moreover, misinformation will often be provided. Here are a few examples during the research conducted for this study:

- A representative of a nuclear facility in Manitoba, from whom information about storage of radioactive wastes in underground tanks was requested, told me "You must be mistaken. There are no radioactive wastes in underground tanks in Canada". When confronted with the fact that the Atomic Energy Control Board, which regulates such facilities, had confirmed that there were such tanks at her facility, the official acknowledged the existence of tanks of low-level atomic waste and explained that she thought I meant high level radioactive waste, which is not found at the facility.

- In response to a researcher's letter to Her Majesty's Inspectorate of Pollution in England asking about the scope of the problem of leaking underground tanks in that country, the following response was received: "I am afraid I cannot help on this matter as there are no leaking underground storage tanks in the UK". When I wrote to ask how the UK has been so fortunate as to avoid or eliminate a problem found throughout North America, I received response from another official explaining that the first official had assumed that I was referring to leaking tanks of radioactive waste. However, there was nothing in the researcher's initial letter or in the initial response that could account for such a misunderstanding.

Moreover, government officials frequently "downplay" the significance of environmental problems in dealing with the media and the public, even though they may admit the seriousness of such problems among themselves. Many of the letters received in response to requests for information contained numerous reassurances that the problems addressed were minimal or listed numerous steps being taken to address them. For example, letters received in response to requests for information about how much public money is being spent on addressing LUST incidents stressed that the persons who caused the problems pay for most of the cleanup costs, and the expenditure of public funds is an exceptional situation. The letter received from authorities in England when they eventually admitted that tank leaks do exist in that country, provides the flavour of such reassurances:

"Petroleum licensing authorities take very seriously the problem of leaks from underground tanks, primarily because of the risks of explosion or fire, but also because of the environmental implications. The requirements for tank testing are designed to ensure that if a leak exists it is found quickly but, increasingly, the emphasis is placed on prevention by means controlling the life of tanks. With the introduction of glass-fibre reinforced plastics and more sophisticated means of testing there is reason to hope that leaks from tanks will become a thing of the past."

A similar example of such reassuring language is found in a memo by an Ontario Ministry of the Environment hydrogeologist to his superior, describing his contact with a producer from the CBC's Fifth Estate. The producer had asked him if he felt that there was an adequate program implemented to protect the public from future leakages. He described his response as follows:

> It was indicated that the Petroleum Industry in co-operation with the Ministry of Consumers (sic) and Commercial Relations has implemented a storage tank replacement program to reduce future leakage problems. Inspection in response to leakages by government agencies appear to be satisfactory to handle the problem. [318]

The approach of minimizing the scope of a problem and stressing the positive actions being taken may be a very useful exercise in self-justification, but it does nothing to create public support for programs to improve the situation further.

These lessons are not new. Environmental activists and academics have made the same points numerous times over the past two decades. The LUST situation, however, suggests that many of these concerns are just as relevant today as they were twenty years ago. There have been many changes in society that promote a faster and more effective response to environmental problems, including increasing public awareness of environmental concerns and support for political and economic responses to them and the growth of an environmental industries sector in the Canadian economy, whose research and development capacities can be mobilized to create new technologies, measuring techniques, and other advances needed to

[318] Mellary to Caplice 26 05 86.

address emerging problems. However, this study suggests that many of the impediments to rapid and effective response have not been addressed. If a problem like LUST is developing today, it is questionable whether it will be recognized and addressed any more quickly than LUST was.