# Chapter 19

# Local Environmental Issues: Recycling, Solid Waste Management, and Land Use

In Canada, local governments are responsible for many important activities that improve environmental quality. Table 19-1 shows the level of expenditures from 1990–91 to 2000-2003 for federal, provincial, and local governments.[1] It illustrates the dominant role played by local governments in solid waste management and sewage treatment. Total expenditures have gradually increased over time for the federal government, but remain low relative to other levels; declined at the provincial level due to a large decrease in expenditures on water purification; and increased by over 40 percent at the local level for all categories. There is a growing problem for municipal governments—aging infrastructure. Municipal governments have found themselves faced with the need to replace and upgrade much of their environmental infrastructure. Although federal and provincial governments have begun again to commit funds to environmental programs, municipalities are still faced with limited budgets. Municipalities are increasingly interested in using economic instruments such as user charges to help in this plight. However, they are still at an early stage in this process.

[1.] These are current dollars, unadjusted for inflation. Deflated values would show a much more modest increase in expenditures, or even a decline in some years.

This chapter examines the issues of solid waste disposal and the potential to reduce it through economic incentives involving recycling, reducing, reusing, and more efficient pricing of waste services. Land-use issues and how to protect natural capital are briefly considered.

## Municipal Solid Waste

The disposal of solid wastes has emerged as a leading problem in many cities and towns across the country, especially in localities with large populations and/or constrained landfill space. The problem is of less immediate concern in areas with the opposite characteristics. Landfilling, for a long time the preferred disposal method for urban solid waste, has come up against a scarcity of sites willing to take wastes in many parts of the country. Some localities have had to ship their solid wastes long distances for disposal, while others are moving into incineration. The public policy problem would simply be one of governments trying to minimize the costs of providing a public service, except for the presence of two externalities:

**Table 19-1:** Government Expenditures on Environmental Improvements, 1990–2003, selected years

**Comment [NO1]:** Note, I have simplified the table by reporting every three years. I have a call into StatCan to see if there is data beyond 2003. None of the more recent volumes in the source series have this table.

| | (Millions of current dollars) | | | | |
|---|---|---|---|---|---|
| | **1990–91** | **1993–94** | **1996–97** | **1999–00** | **2002-03** |
| **Federal** | | | | | |
| Sewage collection & disposal | 0 | 229.4 | 300.7 | 309.3 | 321.1 |
| Waste collection & disposal | 0 | 0 | 0 | 0 | |
| Other pollution control activities | 117.9 | 11.2 | 5.7 | 155.5 | 427.4 |
| Other environmental services | 620.2 | 728.7 | 635.6 | 579.6 | 642.8 |
| Water purification & supply | 7.1 | 235.1 | 328.9 | 318.1 | 334.9 |
| Total | 745.2 | 1204.5 | 1270.9 | 1362.59 | 1726.2 |
| **Provincial/Territorial** | | | | | |
| Sewage collection & disposal | 75.3 | 90.6 | 186.8 | 91.3[r] | 200.0 |
| Waste collection & disposal | 132.4 | 121.5 | 30.5 | 69.9 | 84.5 |
| Other pollution control activities | 327.3 | 309.9 | 187.4 | 295.9 | 390.1 |
| Other environmental services | 443.4 | 516.7 | 531 | 439.1 | 509.4 |
| Water purification & supply | 1130.6 | 872.3 | 987.1 | 784.5 | 502.0 |
| Total | 2109 | 1911 | 1922.9 | 1400.8 | 1686.0 |
| **Local** | | | | | |
| Sewage collection & | 2002 | 1950.5 | 2313.6 | 2162.6 | 2543.4 |

| | | | | | |
|---|---|---|---|---|---|
| disposal[b] | | | | | |
| Waste collection & disposal | 1125.9 | 1253.4 | 1331.8 | 1583.3 | 1888.8 |
| Other pollution control activities & environmental services | 82.3 | 126.8 | 129.4 | 114.8 | 182.8 |
| Water purification & supply | 2078.2 | 2296.8 | 2524.9 | 2527.4 | 2898.9 |
| Total | 5288.5 | 5677.5 | 6299.7 | 6797.0 | 7513.9 |

***Source:*** *Statistics Canada, Human Activity and the Environment, Annual Statistics, 2006. November 2006. Catalogue No. 16-201-XPE, Table 4.7.*

- Producers pay for input costs for their products, but not for the ultimate waste disposal done by the consumers of the products. Consumers typically do not pay for the unit costs of disposal, but rather pay a flat charge through their property taxes. This is a market failure.
- Neither producers (who do pay the unit costs for their own waste disposal) nor consumers pay for the environmental damages released from waste-disposal sites (landfills, incinerators, etc.). These environmental costs include possible groundwater contamination (from landfills) and air pollutants and carbon dioxide (from incineration), and release tonnes of methane – a highly potent greenhouse gas (landfills). There are also social costs from illegal dumping of wastes and littering.

  Thus, the rationale for minimizing the waste stems from both the shortage of land and the environmental externalities created.

Policy issues and options to reduce waste flows and address the externalities from solid waste disposal are the key topics of the next sections.

## The Nature of the Problem

The municipal solid waste (MSW) stream is actually a trickle at the end of a long and very large flow of materials used in the Canadian economy. Household waste is composed of a very diverse set of materials—everything from lawn clippings to mouldy bread to household chemicals to used refrigerators to construction debris. The solid-waste problem is not equally acute everywhere.

### *Technical Options for Reducing MSW*

Define the following terms:

TM is total materials used, by a firm or industry or economy, in a period of time;

VM is virgin materials used; and

RM is recycled materials used.

Then the following identity must holdfor any time period:

$$TM = VM + RM$$

Recall from Chapter 2 that all materials inputs taken into an economic system must eventually end up back in the environment in some fashion. The form may change, as when solid materials are burned to yield energy and waste products. The time span can differ; some materials do not lend themselves to reuse and so are discarded almost immediately, while others can be recycled, perhaps many times. But recycling can never be perfect, because of conversion losses, wastage in consumption, and so on. This means we should focus on the quantity of virgin materials used. Rearranging the above expression gives

$$VM = TM – RM, \text{ or}$$

$$VM = TM (1 – r)$$

where $r$ is the rate of reuse, or RM/TM. There are essentially two ways to reduce the use of virgin materials: reduce the overall quantity of materials (TM), and/or increase the reuse rate, $r$; in other words, waste reduction and recycling.

Total materials use can be reduced in two ways:

**1.** By reducing the rate of economic activity, or

**2.** By reducing the materials intensity of that activity. By “materials intensity” we mean the quantity of materials used per unit of production or consumption.

Materials intensity can be lowered by:

**1.** Rearranging the composition of output and consumption away from products that use relatively large amounts of materials and toward those that use less; for example, a shift away from tangible goods toward services, or by

**2.** Decreasing the materials intensity of particular products; for example, reducing the amount of packaging material in consumer electronics or food products.

*Recycling* means reaching into the waste stream to extract materials that may be reused. Some may be reused directly, as when consumers reuse old boxes. But most require some reprocessing. Of course, the separation, transportation, and reprocessing technologies that are available critically affect the costs of recycled materials, and thus their ability to displace virgin materials. Recycling also has another cost—any pollution released in processing recycled items (for example, air pollution and sludge from recycling aluminum cans). The economics of recycling are now examined in more detail.

# The Economics of Recycling

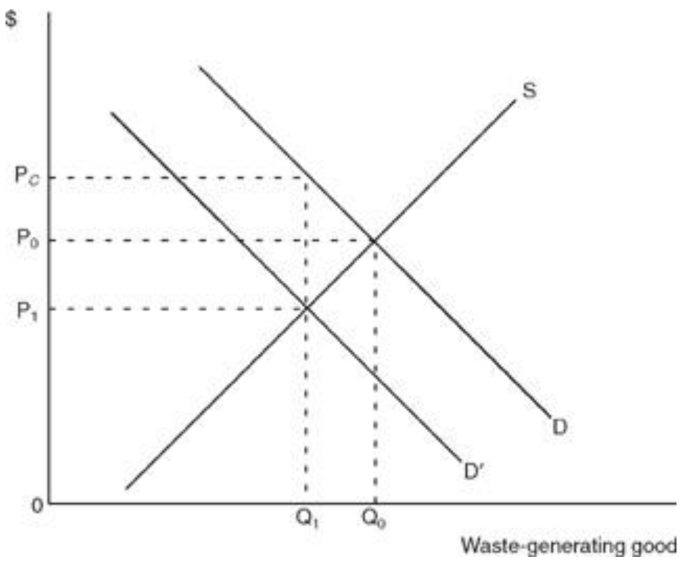
In the recycling process two types of exchanges are of interest: that of material from producers to consumers; and that of recycled material from consumers to producers. In the first flow, producers are the suppliers of material and consumers are the demanders. With recycling their positions are reversed. How much material can be recycled depends on decisions made by both producers and consumers. Produers determine the component parts of a product; do these parts contain materials that lend themselves to recycling. For example, do they use paper packaging instead of non-recyclable plastic blister packs? The decisions of consumers will also affect the extent of recycling – how easy is it for them to recycle products?

Solid waste is a problem because of defects in the pricing systems that govern these transactions. Most Canadian municipalities do not charge households a fee per unit waste discarded. There are volume restrictions that have implicit weight limits, but there is no financial incentive to reduce one’s garbage below the volume limit, as nothing is gained but moral satisfaction. Thus, there is no incentive for consumers to be very concerned about the amounts of solid waste they discard, nor is there any reason for them to be concerned about the amount of “excess” materials or the form of packaging, that accompany their purchases.

Figure 19-1 illustrates inefficient versus efficient disposal of household waste. Demand for goods is shown by curve D. Implicit in the price of the goods people buy is a subsidy when they are not paying the full social cost of waste disposal. Consumption of goods is too high at $Q_0$ and the price too low at $P_0$ to have social efficiency. Now suppose a fee per bag of trash disposed is introduced. The consumers’ demand curve shifts down, reflecting the fee. Because goods now include a waste-disposal charge, the quantity of goods demanded declines and therefore so does waste produced. Consumers pay $P_C$, which is the market price $P_1$ plus the fee per bag. Of course, in practice the situation will be more complicated than this simple diagram illustrates. Goods will have different amounts of waste associated with them. A reallocation of spending away from waste-intensive toward less waste-intensive goods in response to the efficient pricing of waste disposal is one expected result. More recycling of wastes should also occur when disposal is efficiently priced.

Producers also have to make decisions about waste disposal and recycling. When environmental costs of input use and waste disposal are not reflected in the prices paid by producers, producers will usea higher proportion of virgin materials in production rather thanrecycled inputs because firms typically do not pay for any environmental costs of harvesting virgin materials. This makes the prices of virgin materials too low from the standpoint of social efficiency and output of goods too high. Recycled inputs may thus typically cost more than virgin inputs.

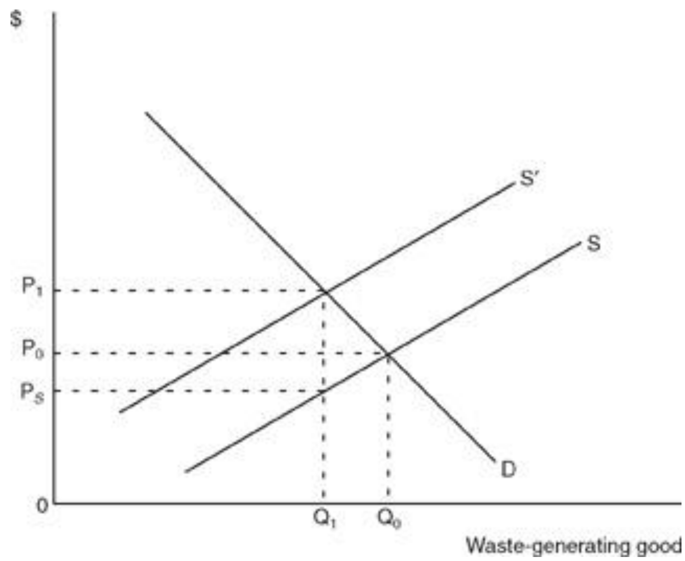
**Figure 19-1:** Waste Disposal Fees and Household Consumption




Socially inefficient consumption of waste-producing goods (all goods!) occurs when people are not paying the full social cost of waste disposal on demand curve D. Because of the implicit subsidy, consumption at $Q_0$ is too high, and the price at $P_0$ is too low to be socially efficient. A waste-disposal charge will shift demand to D′, reducing consumption to $Q_1$, with consumers paying a price of $P_C$.

Figure 19-2 shows the effect on producers of having their costs of production fully reflect environmental costs. Full social-cost pricing of inputs will shift producers' supply curves from S to S′. Quantity produced will fall, prices will rise. If the social-cost pricing were accomplished by imposing a tax on production (equal to $P_1 – P_S$), consumers would pay $P_1$ and producers would receive $P_S$ per unit sold. With less output produced, input use will decline as well. Figures 19-1 and 19-2 can be combined to see the effect in the goods markets of efficient pricing of waste generation. Figure 19-3 illustrates a possible result. All that is known for certain is that efficient waste pricing will reduce the quantity of goods produced and consumed, holding constant the waste generation per good. Because the demand curve shifts down and the supply curve shifts up, we cannot predict what will happen to market prices. However, it is clear that consumers will pay more for their garbage relative to the case without efficient pricing ($P_C$ exceeds $P_0$), and producers will receive less per unit good sold ($P_0$ exceeds $P_S$). In the next two sections the producer and consumer sides of solid waste generation and recycling are examined using a more complicated model.

**Figure 19-2:** Efficient Input Pricing and Production

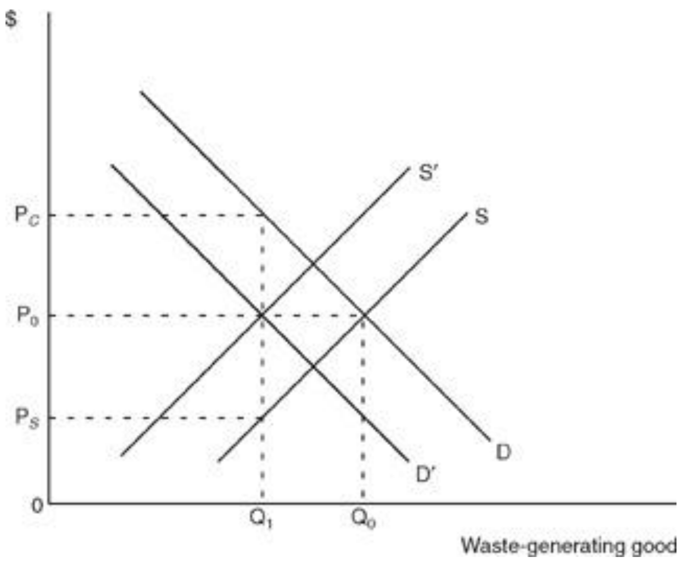



Full social cost pricing of inputs will shift producers' supply curve from S to S′. The quantity of waste-generating good produced falls from $Q_0$ to $Q_1$, and prices rise from $P_0$ to $P_1$. If the social-cost pricing were imposed with a tax on production, the net price per unit received by producers is $P_S$.

## Producer Use of Recycled Material

Figure 19-4 is an analysis of the producer side. The demand curve shown applies to a firm or industry; it shows the quantity demanded of a particular type of material in a given period, for example a year. There are two sources of this material, virgin and recycled. Assume that this firm or industry is small relative to the total use of this material; thus, it can obtain virgin material feedstocks in whatever quantity it wishes at a constant price. This price is marked $p_v$, and is shown as a horizontal line intersecting the demand curve at a quantity level $q_0$. But this material may also be obtained from recycled sources. The procurement cost picture is now more complicated. Reaching into the waste stream for recycled materials involves a number of special costs—of collection, separation, transportation, reprocessing, and so on. Assume that these costs increase with the amount of recycled material used. The supply curve of recycled material to this firm or industry is therefore an increasing function, like $S_1$ or $S_2$. These two supply curves refer to situations with different recycling technology. For $S_1$, costs go up relatively rapidly; $S_2$ increases much less rapidly. Consider for the moment the recycled-material supply curve labelled $S_1$. If this is the one faced by this firm or industry, it will end up using $q_1$ of recycled materials. In other words, the producer will use recycled materials up to the point where its cost is equal to the price of virgin materials. Since the total materials used is $q_0$, the difference $(q_0 – q_1)$ consists of virgin materials.

**Figure 19-3:** Efficient Consumption and Production with Wastes




A possible equilibrium in the market for a waste-producing good after social-cost pricing of the good occurs will lead to an unambiguous decrease in the quantity sold from $Q_0$ to $Q_1$. Consumers pay $P_C$, producers receive $P_S$, given the policies to charge them for waste generated. The underlying equilibrium price may stay constant, rise, or fall relative to the initial price depending on the magnitude of the shifts in the supply and demand curves.

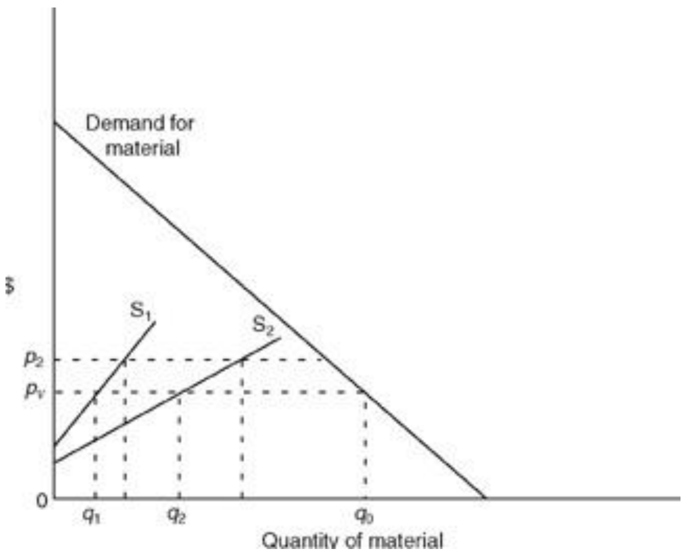
The reuse ratio, the proportion of total materials coming from recycled feedstock, is $q_1/q_0$. If analysis of the socially efficient amount of waste generations leads to the conclusion that the reuse ratio is too low, there are a variety of ways to change the relative price of recycled to virgin materials to provide incentives to producers to change the ratio.

The reuse ratio can be changed in three ways:

- Increase $q_1$ while holding $q_0$ constant,
- Decrease $q_0$ while holding $q_1$ constant, or
- Change both $q_0$ and $q_1$.

Most community efforts at recycling are aimed at the first of these. For example, public curbside sorting and collection programs are ultimately aimed at making the supply of recycled material more abundant and, hence, less costly to producers. In terms of the model of Figure 19-4, these programs have aimed at shifting the recycled supply curve downward; say, from $S_1$ to $S_2$. If this is done, recycled materials use increases to $q_2$ and the recycling rate increases to $q_2/q_0$.

**Figure 19-4:** Use of Recycled Materials in Production




A producer's decision to use recycled materials is modelled. If the producer faces a constant price of $p_V$ for virgin materials and a supply curve for recycled materials of $S_1$, it will use $(q_0 - q_1)$ of virgin materials and $q_1$ recycled materials. With a more abundant supply of recycled materials, as shown by supply curve $S_2$, recycled-material use will increase to $q_2$.

Another way of increasing the recycling ratio is to reduce the demand for materials in general, while holding constant the use of recycled materials. Diagrammatically, this means shifting the whole materials demand curve back. This might be done, for example, by finding ways of producing output using fewer materials. It also might simply happen as consumers shift away from materials-intensive products to products that are less so. Finally, there is one way of simultaneously reducing total materials used and increasing recycled materials: Increase the price of virgin materials. If on Figure 19-4 the price of virgin materials increases to $p_2$ through a tax, this will lead both to a move up the recycling supply curve and up the materials demand curve. This means an increase in the quantity of recycled materials and a decrease in the quantity demanded of materials in total. Raising the price on virgin materials with a tax thus has a double effect on the reuse ratio, since it works at both ends of the problem.

This simple model can be used to examine recent proposals for recycled-content standards in materials-using industries. Early enthusiasm for community recycling efforts led to situations in which the amounts of collected material outstripped technical ability to turn it into useful raw material, and in the absence of demand large quantities of sorted and collected material actually ends up in landfills. This has generated quite a bit of controversy about the "success" of recycling programs. It may be the case that public policies have subsidized recycling activities more than the level required to achieve social efficiency. Alternatively, it could be that externalities associated with waste generation still haven't been fully internalized; for example, if waste-disposal fees are too low to achieve social efficiency.

To deal with these problems in the United States, recent policy efforts have turned toward trying to increase the strength of demand for the recycled material. A number of states have thought to try this by introducing minimum content standards for materials-using production processes. ***Minimum content standards*** require that all materials-using products manufactured or sold within a given state contain some specified percentage of recycled material. Some Canadian jurisdictions are also contemplating standards such as these.

The *cost-ineffectiveness of uniform standards* in the face of heterogeneous MAC curves has been discussed throughout the text. In the case of uniform content standards for materials the same principle applies, but here the important factor is heterogeneity across materials-using firms in terms of the costs of obtaining and using recycled materials. For a truly cost-effective approach to the problem, equality across industries and materials in terms of *marginal recycling costs* is the goal. What this implies is having higher rates of recycled materials used by industries whose recycling costs are relatively low, and lower rates for industries with relatively high recycling costs. One way to achieve this is to apply a tax on virgin materials. As mentioned above, a tax of, say, $p_2 - p_v$ per unit of virgin materials charged to all firms would lead each to increase its recycling ratio in a way that satisfied the equimarginal principle. Another way would be to initiate a tradeable permit system in the recycling market. A regulatory agency or statute would set an overall recycling objective for an industry, expressed in terms of the socially efficient recycling rate. Each individual firm would then have three options from which to choose:

1. Increase its own recycling rate to the industry standard;
2. Increase to a rate higher than the standard, and sell "excess" recycling permits; or
3. Increase to less than the industry standard, buying however many permits are necessary to make up the difference.

In the real world, of course, things are a lot more complicated than they appear in this simple model. For example, one underlying assumption built into Figure 19-4 is that recycled material and virgin material are physically interchangeable. This is hardly ever true in practice. Although newspaper can be produced largely from recycled newspaper, some virgin newsprint is usually necessary to achieve minimum quality levels. The same is true of many recycled metals. It is also true that the recycling market, like any economic market, is very dynamic, whereas the model displayed in Figure 19-4 is essentially static; that is, it is limited to events happening in a single time period. But producers normally look well into the future when making decisions. For example, even though current virgin materials prices are low, producers may nevertheless invest today in recycling and reprocessing works, if they *anticipate* that prices will increase in the future. But the simple model offers insight into basic recycling economics.

## Consumer Recycling Decisions

Consumers' choices of how much recycling they are going to do actually begins before they dispose of waste products. What goods do they buy, and in what quantity?[5] These decisions critically affect the total quantity of the solid-waste stream and its composition. Figure 19-1, discussed above, illustrated efficient versus inefficient consumption of waste-generating goods. Subsequent recycling decisions determine how much of that waste stream ends up in the landfill.

5. Consumers may also wish to buy more goods that have recycled components as a way of reducing their demand for virgin inputs. A policy problem with green goods is how to ensure "truth in advertising." What do labels that say, "made from recycled products" actually mean? Requirements to list the percentage of material recycled would provide more information.

To examine these choices consider some illustrative benefit and cost numbers pertaining to two goods. Assume there are two similar products, but perhaps with different packaging, like bulk cereal and cereal in boxes, or drinks in plastic and drinks in glass containers. The data are in Table 19-2, and they apply to the situation of a single consumer. Products A and B each sell for the same price, but one, because of handling convenience, has a higher value to this consumer. Of course, for other consumers the numbers pertaining to "value to consumer" could be different. For this consumer the net value before disposal of these two goods is in favour of product B.

**Table 19-2:** Individual and Community Benefits and Costs in Product Choice and Recycling(numbers are assumed to be in cents)

| | Product A | Product B |
|---|---|---|
| Purchase price | 100 | 100 |
| Value to consumer | 140 | 160 |
| Net value | 40 | 60 |
| Conventional (landfill) disposal alternative | | |
| Disposal costs | | |
| Private | 10 | 10 |
| Social | 10 | 40 |
| Net benefits | | |
| Private | 30 | 50 |
| Social | 20 | 10 |
| Recycling alternative | | |
| Disposal costs | | |
| Private | 10 | 40 |
| Community transport | (cannot be recycled) | 10 |
| Environment damage | 10 | 0 |
| Value of recovered material | 0 | 20 |
| Net benefits | | |
| Private | 30 | 20 |
| Social | 20 | 30 |

- ***Disposal costs.*** Suppose the consumer faces disposal costs. Disposal costs are in two parts, private and social. The private costs refer to the consumer's costs of handling and discarding the materials, while the social costs refer to the environmental damages caused by the material when disposed of in the community's landfill. The private disposal costs of the two containers are the same—the time it takes to bag up the trash and set it on the curb is the same no matter which product the consumer is dealing with.[6] But the environmental costs for product B are substantially above those of product A, for example because of the quantity or composition of the packaging material. The consumer maximizes net benefits by looking only at private costs and benefits. The community is assumed to maximize net social benefits. The consumer chooses product B; society would choose product A. This is a classic externality problem.

[6.] The private disposal costs might be a bit lower for the good without the packaging as the consumer will not have to wrestle with bulking materials and try to squeeze them into the trash bin. This complexity is ignored; assume private costs are identical.

- ***Recycling.*** Now introduce recycling. Assume that product A cannot be recycled for technical reasons, but product B may be recycled, and the costs of doing so rest partly on consumers and partly on the community. There are private costs coming from the need to separate trash and handle the recycled goods in the home. The community also faces a transport cost, but offsetting this is the fact that the recycled material has a market value. (These costs are shown in Table 19-2.) Recompute net benefits. The net benefit of product A stays the same, since it cannot be recycled. The social net benefit of product B is now substantially higher than it was before the recycling program, primarily because of the avoided environmental damage and the market value of the recycled material.
- ***The consumer's choice.*** The consumer now has three alternatives: (a) Buy product A, disposing of it in the community landfill; (b) buy product B, recycling the associated material; and (c) buy product B, but disposing of it in the landfill. The net benefits to individual and community are tabulated as follows:

| | Net benefits | |
|---|---|---|
| Option | Individual | Community |
| (a) Buy A | 30 | 20 |
| (b) Buy B, recycle | 20 | 30 |
| (c) Buy B, landfill | 50 | 10 |

The individual's preferred choice is product B without recycling, but the community only wants product B if it is recycled. The fundamental question is—what incentives can be provided to encourage the individual consumer to adopt the recycling alternative?

### *Recycling Policy Optionss*

**1.** ***Mandatory recycling.*** A local regulation makes it illegal not to recycle the material from product B. If enforced, what this does is take away option (c) from the consumer. The next best alternative for the consumer is to buy product A. The important point is that the recycling process starts back at the choice of purchase made by the consumer. The impacts of recycling ordinances on this purchase decision, as well as on recycling decisions themselves, have to be examined. In the present case the mandatory recycling law has the effect of causing the consumer to shift purchasing away from recyclable products to non-recyclable ones, thus substantially undermining the intent of the law.[7]

[7.] However, note for this example that purchasing Good A is socially superior to purchasing Good B and *not* recycling it. The law thus has some positive incentive effects in this case. Of course, this need always be so.

**2.** ***Disposal charges.*** A disposal charge is essentially an emissions tax. A completely efficient set of disposal charges would involve a charge on each item at a level equal to the social costs of disposal. Each unit of product A produces damages of 10¢ per unit, so its tax would be that much. The tax on a non-recycled unit of product B would be 40¢. For a recycled unit of B the tax is a little more complicated. If B is recycled, there is no environmental cost, but there is a community transportation cost of 10¢. But this cost is more than offset by the fact that the item has a 20¢ market value. Thus, the net tax is actually 10¢ – 20¢, or –10¢. The tax is actually a 10¢ subsidy to the consumer. If we levy these taxes on these products at the point of disposal, the net benefits of the various options to the individual consumer would now become: (a) 20¢, (b) 30¢, (c) 10¢, which are the same as the social net benefits of the previous tabulation. Now the consumer will choose (b), the recycling option. In effect, *these taxes have changed the pattern of private net benefits so that they are the same as community net benefits*.

When this is done a consumer will have the incentive to (1) choose the product and (2) make the recycling decision in ways that are efficient from the standpoint of the community. A charge based on the social costs of disposal for each item is not going to be feasible in the real world; it would be unmanageably complex to establish tax rates and administer. What many communities are doing, rather, is establishing a single charge per bag or can of undifferentiated waste and collecting separated and recyclable materials for free. In this case the charge on non-separated trash ought to be some average of the disposal costs of the various items in the waste stream. In our example, the social costs (in terms of environmental damages) of a unit of A are 10¢; a unit of B, if not recycled, 40¢. If the authorities took an intermediate value, setting a charge of 25¢ per container thrown away, the private net benefits of the different alternatives would be (a) 5¢, (b) 30¢, (c) 25¢. So in this case the tax would be sufficient to lead the consumer to buy B and recycle. A tax much lower than this, however, would lead the consumer to buy B and dispose of it in the landfill, owing to the relatively high private costs of recycling.

**3.** ***A deposit–refund program.*** Suppose a 40¢ deposit were put on item B, reflecting the damages done if it were thrown away rather than recycled. The array of net benefits for the individual would now be (a) 30¢, (b) 20¢, (c) 10¢. The consumer refrains from throwing out the recyclable item, but also shifts back to buying A, the non-recyclable good. This is the same effect as with mandatory recycling. One way around this is to have a deposit on *all* materials, equal to their disposal costs. For product A, the non-recyclable item, this essentially acts as a tax and gives a result similar to the "perfect" tax discussed above.

These results are illustrative, but of course do not represent all possible cases. In practice, private disposal costs will depend on the individual's own subjective valuation of the burdens of handling different types of products. These could differ among consumers and this could obviously lead to differences in response to various solid-waste policies. It is also quite true that many people obtain a certain amount of civic satisfaction from engaging in behaviour that is efficient from the community's standpoint. But to get as much benefit as we can from recycling decisions made by consumers, we have to consider the benefits and costs of these decisions through their eyes.

## Recycling and Waste-Disposal Issues in Canada

The present policy picture across Canada is very complicated, as one would expect from the nature of the physical problem, the large number of materials involved, and the thousands of municipalities, small and large, searching for solutions. Table 19-3 lists some of the measures that are being pursued in various provinces. For the most part, these focus on some facet of recycling. All provinces have one or more packaging-waste-reduction programs, and all except Ontario and Manitoba have deposit–refund systems for beverage containers. When solid waste first became an issue, it was regarded primarily as a disposal issue—people were taking to the landfill materials and products that could be recycled. Thus, the initial response of most communities was to think about the recovery and recycling of materials.

Voluntary recycling programs began in many municipalities during the 1980s and have expanded to cover most of the country. Statistics Canada's survey of households (see Table 19-4 for the source of this data) finds that 95 percent of households report they had access to one or more recycling projects in 2007, compared to 74 percent in 1994. Private contractors generally handle collection and preparation for sale of recyclable materials.

**Table 19-3:** Solid Waste Reduction and Recycling Activities Undertaken in Provinces and Municipalities

| |
|---|
| Returnable disposal fees: returnable deposits on beverage containers |
| Taxes on tires, beverage containers, high-energy consuming motor vehicles, car batteries |
| Mandatory bottle deposits |
| Consumer fees on municipal solid waste |
| Prohibitions on landfilling certain products, e.g., tires |
| Voluntary material separation and curbside recycling |
| Recycled or recyclable labels on products |
| Technical assistance for recycling programs |
| Grants and loans to municipalities for recycling programs |
| Public construction of waste separation and reprocessing plants |
| Public construction of waste-to-energy plants |
| Tax credits and exemptions for waste-control investment by private businesses |

**Table 19-4: Recycling in Canada, by Material, 1991, 1994, 2007**

| | 1991 | 1994 | 2007 |
|---|---|---|---|
| | percent | | |
| **Access to recycling [1]** | | | |
| Paper | 53 | 70 | 92 |
| Metal cans | 49 | 67 | 89 |
| Glass bottles | 50 | 67 | 89 |
| Plastic | 42 | 63 | 91 |
| **Use of recycling [2]** | | | |
| Paper | 86 | 86 | 96 |
| Metal cans | 86 | 86 | 92 |
| Glass bottles | 86 | 86 | 94 |
| Plastic | 85 | 85 | 96 |
| **Use for households overall [1]** | | | |
| Paper | 45 | 58 | 88 |
| Metal cans | 42 | 56 | 82 |
| Glass bottles | 43 | 56 | 84 |
| Plastic | 36 | 51 | 87 |

Notes: 1. As a percentage of all households.

2. As a percentage of households with access to recycling.

Sources: Statistics Canada, Households and the Environment Surveys, 1991, 1994, 2007 (survey no. 3881) as presented in Table 11, Recycling in Canada, by Material, in A. Munro, *Recycling by Canadian Households, 2007*, Statistics Canada, Environmental Accounts and Statistics Analytical and Technical Paper Series, July 2010. Cat. No. 16-001-M, no. 13.

Table 19-4 shows for 1991, 1994, and 2007 the percentage of households in each province that recycled the common products – paper, metal cans, glass bottles and plastics in total, and for those who had access to a municipal recycling program. The increase in the proportion of households who recycle has close to doubled since 1991, to the point where recycling is now a part of most households management of their waste streams. Over 90 percent of households in all provinces except Newfoundland and Labrador now have access to recycling programs.[New Footnote #1] :.People generally receive no financial reward for their efforts; recycling has become part of Canadian culture. However, even though per capita amount of waste that has been diverted from landfills or incineration to recycled products has risen, aggregate waste is a function of total production and consumption. More economic instruments to reduce materials use are warranted.

[New Footnote #1] Seventy-one percent of households in Newfoundland and Labrador reported access to a recycling program in 2007. See *Recycling by Canadian Households, 2007 as cited in Table 19-4*

**City of Toronto Solid Waste Resources Diversion Task Force 2010: www.city.toronto.on.ca/taskforce 2010/index.htm**

## Example: Toronto's garbage woes

**Comment [NO2]:** This case is dated, but I cannot find as good an example. I would like to leave it in as it illustrates a number of points, and none of the referees commented that it should be removed. OK?

Toronto has been engaged in a lively debate over where to send its garbage because of rising costs for disposal to landfills.[8] Costs of collecting garbage from households range from $32 to $169 per tonne over the metropolitan area.[9] Landfill disposal charges range from about $60 per tonne in fees to nearby landfills (e.g., in Keele Valley) to $90 and more for alternative sites (e.g., shipping waste to Michigan or to abandoned mines in Canada). The rising costs of disposal fees create a big incentive to look for ways to reduce waste flows. What sort of policies should Toronto adopt?[10] There are a number of alternatives, including

[8.] See the City of Toronto's Web page on solid-waste management for a chronology of the landfill debate and links to other related documents: www.city.toronto.on.ca/involved/#solidwaste.

[9.] The $32 per tonne was for Etobicoke, which had contracted out garbage collection to a private-sector company.

[10.] See Donald N. Dewees and Michael J. Hare, "Economic Analysis of Packaging Waste Reduction," *Canadian Public Policy*, Vol XXIV No. 4, December 1998, pp. 453–470 for an in-depth discussion of these policy options. This paper is the source of much of the material in this example.

- increase curbside recycling
- decrease curbside recycling because it is too expensive
- introduce more regulatory programs such as mandatory packaging regulations, mandatory deposit–refund programs
- implement greater use of user fees for waste collection

One study looked at two payment vehicles: user fees and maintaining the standard practice of funding waste collection through property taxes.[11] Studies for the United States and elsewhere repeatedly find that user fees provide a strong incentive to reduce waste. If Toronto continues to use the current system of collection and disposal, a study estimated that it would cost $141 per single-family household per year and 26 percent of the waste stream will be diverted through recycling and composting. An expanded "blue box" recycling program combined with user fees would double diversion rates to 54 percent and lower the cost of collection to $120 per household per year. While these numbers are certainly subject to more scrutiny, they suggest that pricing waste disposal through user fees combined with providing recycling opportunities (for free) might be very cost-effective.

[11.] See Resource Integration Systems, *Preliminary Metro 3Rs Strategy*, Draft report, 1997.

A second study examined curbside recycling costs for rural and urban municipalities in Ontario.[12] The study found that recycling aluminum yields for municipalities net revenues that can be substantial (from $450 to over $2,000 per tonne). In other words, municipalities make money by collecting recyclable aluminum. For rural municipalities, recycling other items leads to a net cost per tonne. Recycling paper, glass, and high-value plastics yields net revenues in urban areas. Overall, recycling yields positive net revenues in urban areas, and negative revenues in rural areas. This study does not consider any of the environmental benefits from reducing total waste flows by recycling. The net return to the municipality is the total costs of collection minus credits for savings in disposal costs and revenue from the sale of recycled materials. The net benefits of recycling will be higher the greater the disposal fees, as the credits for waste diverted will be larger.

[12.] First Consulting Group, "Activity-Based Costing: Implications for Curbside Recycling Systems," Final Report to the Paper and Paperboard Packaging Environmental Council, Toronto, 1995, as cited in Dewees and Hare (1998).

What about *mandatory deposit–refund systems* on beverage and other containers? The costs of these programs are generally higher, about 2 cents per container, than for curbside recycling.[13] There are some environmental benefits of reusable containers—less litter and materials use. The question is, then, are these environmental benefits high enough to offset the additional costs of the deposit–refund system relative to curbside recycling?

[13.] Dewees and Hare (1998).

Another option is to reduce the materials intensity of production. This is also called ***source reduction***. Source reduction can be substantial. For example, the weight of packaging materials sent for disposal per litre of soft drinks consumed in Ontario fell from 218 grams in 1972 to 19 grams in 1995.[14] This is a 91-percent reduction, and 88 percent of this was due to source reduction (the rest to recycling). No regulations imposed this reduction: it was done because it was profitable to producers. Dewees and Hare find that source reduction has decreased the quantity of beverage-container waste by more than has recycling (over 55 percent compared to 11 to 30 percent).

[14.] Dewees and Hare (1998).

What should Toronto do? Think about the options given above (and others) and decide what sort of policy advice you would offer the city of Toronto (or your own municipality, which may be facing similar problems). Remember that any calculations of the costs and benefits of a policy should also take into account the environmental costs of disposal in landfills. And it is *net benefits* that should be computed, not just total costs of abatement.

Many municipalities in Canada have established targets to significantly reduce the amount of waste going into landfills. A number of initiatives, called ***diversion policies***, are being used.[15] For example, many cities (e.g., Halifax,Ottawa, and Guelph) have enhanced their recycling programs to recycle and recover a greater share of "dry" recyclables (paper products, plastics, textiles, light bulbs) and "wet" garbage (food waste, organic material, diapers, soiled paper). Wet garbage is converted to compost and biogas. These systems apply to residential garbage. Guelph's "wet/dry" program, started in 1995, now diverts approximately 45 percent of total solid waste. Guelph hopes this diversion rate will climb to 55 percent with the operation of its organic waste processing facility. Halifax's "three-stream" system, which began in 1999, has a diversion rate of 60 percent. Edmonton also has an enhanced recycling and composting system. The list of municipalities with diversion rates of over 50 percent is growing and includes smaller cities as well (e.g., Nanaimo at 64 percent, Charlottetown – 60%). These diversion rates result in substantially less waste going into landfills. A key policy question is the relative costs of disposal versus diversion. Diversion requires new infrastructure in the form of waste-processing facilities with associated operating costs (labour, energy) and perhaps more garbage trucks. It also requires a change in behaviour on the part of consumers, who must now spend more time sorting their garbage. Whether these costs are lower than landfill disposal fees will vary by municipality.

15. For an overview of these programs see the City of Toronto staff report "A 3Rs Implementation Plan for the City of Toronto," at www.city.toronto.on.ca/legdocs/2000/agendas/committees/wks/wks000913/it009.pdf.

Other policies to reduce the flow of solid wastes to landfills include "fee for bags" and limitations on the amount of solid waste that households can put out for collection.[16] For example, most municipalities in B.C. now restrict weekly trash pickups to two standard-size garbage bags or a bin of particular volume. If a household wants to dispose of more garbage, it must buy stickers (approximate price is $2 to $3 per bag). Potential problems with these programs include non-compliance in the form of illegal dumping. In most urban areas, compliance with these policies does appear to be high (probably because the opportunity for illegal dumping is low). But there is another problem, colourfully called the "Seattle stomp": when the city of Seattle first introduced a fee-for-bags program, the number of bags of garbage fell, but the mass per bag increased by 42 percent.[17]

16. There are many of these policies in place. Check out the Web site for your municipality to see what it is doing about solid-waste disposal.

17. Thanks to a reviewer for pointing out this term and supplying the information.

***Quiz: What is the most recycled object in the United States (and probably Canada as well)? If you guess newspapers or aluminum cans, you are wrong! Asphalt pavement is the winner. According to a report in the United States,***[18] ***80 percent of asphalt removed each year is recycled right back into new pavement, roadbeds, and so on. By contrast, annual recycling of aluminum cans is 60 percent, newsprint is 56 percent, and glass beverage bottles is 31 percent.***

18. "A Surprise Recyclable," *Environment*, Vol. 42, No. 6, July/August 2000, p. 6.

## Land-Use Control Policies

Land-use issues, and the public control over land-use decisions, are also matters that historically have been left to the provinces and individual communities in Canada. There are a variety of land-use initiatives—for example, wetlands preservation and management, and the creation of "action plans" for the Fraser River Basin, the St. Lawrence River, and the Atlantic Coast. While these projects involve all levels of government, it is felt by many that land use is primarily a local issue and therefore requires local policy responses.

Land-use policies involve fundamental decisions about how society decides the human and non-human uses of particular pieces of land. Since almost all environmental externalities have a spatial dimension, it might be tempting to think of all pollution as essentially a land-use issue. But while many of the large cases of air and water pollution are indeed spatial, they do not lend themselves to solutions through altered land-use patterns. The acid rain problem is not a land-use problem, for example. Certain local cases of environmental externalities, however, may be more closely related to decisions on land use. Local air-pollution problems is typically related to how cities have grown and developed their transportation network. Is there sprawl with people dependent on their motor vehicles or more compact cities where public transit is available? Noise pollution is a local issue as well.

But many contemporary land-use issues are not pollution-related; rather, they are about the human use of land that substantially reduces or destroys its environmental value. Recall the discussion of natural capital from Chapter 2. Canada's natural capital is threatened by land use changes that destroy or degrade the goods and services (ecosystem goods and services) it provides. At risk are:

- Wetlands, which provide important environments for plants and animals, water purification, flood and silt control, and are linked into other components of the ground- and surface-water system.
- Coastal lands, where scenic and recreational qualities are important, as well as provision of habitat for many species.
- Critical habitats, such as wildlife corridors, where land-use patterns (e.g., roads, towns, agricultural and forestry practices) affect the health or survival of plant and animal species.
- Scenic and open land, where people may find vistas and experiences that have spiritual significance and recreational value.

To examine the economic logic of public and private land-use decisions, the following example focuses on one particular piece of land. All land parcels are essentially unique and will have varying values in different uses, but illustrative numbers can be used to demonstrate the essence of the problem. Assume the parcel is currently a natural area, with all environmental values intact. A single individual owns the land. Suppose there are three mutually exclusive options for the parcel:

(a) Develop without public restraints

(b) Preserve in its current state

(c) Develop with certain restrictions set by the local environmental agency

The illustrative numbers in Table 19-6 show the returns and costs of these different courses of action. When land-use decisions of this type are made, there is actually a stream of returns and costs off into the future, so the numbers in Table 19-6 in effect represent the *present* values of these streams of returns and costs.

**Table 19-5:** Returns and Costs of Various Land-Use Options

| | Land Use | | |
|---|---|---|---|
| | Develop (a) | Preserve (b) | Develop with restrictions (c) |
| Returns | | | |
| Private | 100 | — | 90 |
| Public | — | 50 | — |
| Total | 100 | 50 | 90 |
| Costs | | | |
| Private | 80 | 20 | 80 |
| Public | 50 | — | 10 |
| Total | 130 | 20 | 90 |
| Net return | | | |
| Private | 20 | –20 | 10 |
| Public | –30 | 30 | 0 |

First, consider options (a) and (b). If the owner were to develop the land, he or she would realize a gross return of 100 and have construction costs of 80. But developing the land would have serious environmental costs; namely, the destruction of its ecological value, which is set at 50. Assume that this lost ecological value is a loss to society but the individual does not care about ecological values. Could private bargaining lead to a socially efficient outcome? Perhaps the landowner and those people interested in ecological values could attempt to bargain over the use of the land if transactions costs are low and no other market imperfections exist. The party with the highest value for the land will bid the most for it, and a socially efficient use results. However, for many land-use decisions, transactions costs will be very high and this private bargaining approach to land use will not work. For example, those interested in ecological values may be dispersed across the country and not aware of each other's existence. It is hard to imagine that information about all such land-use decisions will be available to the ecologically concerned public. If private transactions are impossible, the owner of the land will be unable to realize the ecological value of the land. The owner's decisions about using the land then will be predicated on its private development value. The private net return is 20, while the full social return of developing the land is –30. In the absence of any public land-use policy the land would presumably be developed, even though it represents a net loss to society.

It is instructive to look at it from the reverse perspective, the returns and costs of option (b): preservation. In this case private returns are nil, but public returns from the preserved ecological values of the land are 50. The cost in this case is the forgone net return from developing the land, or 20. Thus, the net social returns from preservation are 50 – 20 = 30. Market failure prevents the attainment of this socially efficient equilibrium.

## Policy Options to Incorporate Ecological Values into Land Use

### *Prohibition of Specific Land Uses*

Outright prohibition of certain land uses that are thought to have low or negative social returns, even though they may have positive private returns, is a commonly used policy. This is done through the exercise of the *police power*, which is a power that communities have of prohibiting private activities that are detrimental to the wider public. The most common technique is ***zoning***, in which communities rule out certain types of land uses where they would be destructive to the surrounding land values; for example, factories in residential areas. Environmental restrictions on development also come under this heading, since these contribute to the health and welfare of the community. Thus, a police power approach to the problem would be simply to develop a zoning law or environmental preservation law that rules out option (a).

A major problem with a police power approach like this is that, although it may legally prohibit certain land uses, like option (a), it does not change any of the numbers in the table, so it does not change any of the underlying incentives of the situation. An owner whose land has been subject to a development restriction by public authorities has much to gain by getting the authorities to relax the restraint. In fact, it would make sense for the landowner in Table 19-6 to spend some portion of the expected net returns to try to get the authorities to reverse themselves.

### *Development Controls*

Instead of outright prohibition, the police power may be used to place conditions on development. For example, a developer might be required to leave a certain amount of open space, to avoid certain ecologically sensitive areas, or to install a public sewer system. The landowner is allowed to develop but certain constraints are placed on this process, which have the effect of avoiding some of the ecological costs. Since the restrictions lower the developed value, the private net return is now only 90 – 80 = 10. The social net return is now 90 – 90 = 0, because all but 10 of the ecological costs have been avoided by the development restrictions.

### *Economic Incentives*

The federal government provides an incentive for landowners to incorporate ecological values into their decision making through the tax system. In 1996, the federal *Income Tax Act* established ecological gifts as a new type of charitable donation. This is a modest beginning; the total amount of land donated as an ecological gift is quite small.. Governments could also stop subsidizing agricultural practices that destroy ecological values (e.g., conversion of wetlands to crops). Removal of a subsidy will, however, bring with it demands for compensation. Alternatively, governments could provide positive incentives by offering landowners tax credits for conservation activities, or offer to purchase what is known as a conservation easement that dictates the uses on some or all of one's land. Some countries (Australia and the United States) have introduced markets for the ecosystem goods and services that require no net loss in natural capital in the region. These are but a few of the potential innovative incentive-based policies.

## The "Taking" Issue

One of the most contested issues in using local land-use controls for environmental protection purposes is the "taking" problem.[20] In Canada, an individual's property rights are protected in the Constitution, but governments can appropriate one's land under certain conditions. Generally, the government has to show that the appropriation or taking is reasonable, clearly enhances public welfare, and is not arbitrary or discriminatory. The problem is in knowing when these conditions are met. In the example of Table 19-6, a local restriction that ruled out option (a) but permitted option (c) would lower the net private return from 20 to 10, thus lowering the private value of the land by that amount. Is this a valid taking? A major difficulty with cases like the one the table illustrates is that, although private revenues and costs of land-use restrictions are usually known with accuracy, the same cannot be said about environmental values. In the example of Table 19-6 a precise value was given for the environmental attributes, but usually this is not the case. There is a need to try to balance known private values with unknown public environmental values. From the standpoint of public health, there may be little difficulty barring development in sensitive wetlands, on the grounds that these are linked into the hydrological systems on which many people depend for water supply.

[20.] A good discussion of the taking issue in Canada is R. Schwindt and S. Globerman, "Takings of Private Rights to Public Natural Resources: A Policy Analysis," *Canadian Public Policy*, Volume XXII Number 3, September 1996, pp. 205–224.

But when public health is not so directly involved, things can be much less clear. Suppose that there is a particular piece of land in a community that is privately owned and that over time the people of the community have come to value the scenic qualities of this land. Clearly the land has environmental (scenic) value, but should the town pass a regulation saying that the landowner must preserve the land and cannot develop it? In doing this, the town is essentially putting the entire burden of preserving scenic values on the private landowner.

One way around the taking issue is *compensation to the landowner*. A straightforward way of doing this is for a public agency or a private environmental group to purchase outright the land in question. In the case of Table 19-6, a purchase price of 20 would just compensate the landowner for the lost development opportunities. The land is then taken out of the private market and its environmental values are preserved. If this sort of market transaction is possible, then no further regulation may be needed. These transactions may require that the community or some private group have substantial financial resources. The Nature Conservancy, for example, is a private group, funded largely through contributions, that preserves sensitive land by outright purchase. Ducks Unlimited, an organization of hunters, helps governments buy wetlands to protect waterfowl habitat. It may be difficult, however, to get people to contribute to land purchases because of free-rider problems, inefficient capital markets (will banks loan an individual money to preserve ecological values if that person doesn't have title to the land?), and other types of market imperfections. Thus, takings with compensation may be necessary to reach the socially efficient land use. Governments, too, face budget constraints, so compromises might be necessary. For example, governments may purchase certain partial rights in the land, not the land in its entirety. In the case of Table 19-6, for example, the community might buy from the landowner just the right to undertake option (a), but not the right to pursue option (c). The value of this one right would be 10, the difference in net returns between the two options. This purchase of just the development right would preserve some, though not all, of the land's environmental values. Social efficiency may be difficult to obtain.

In Canada, compensation for a taking is not established in the Constitution. Compensation is thus becoming an increasingly important public policy issue because of the growing public pressures for preservation of environmentally important regions of the country. While many of the areas in question are Crown lands, the rights to extract resources from these lands had frequently already been granted to private individuals or corporations by provincial governments. This is where much of the conflict lies. As yet, there is virtually no official policy established by any level of government.[21]

[21.] The taking issue is also an important component of Canadian deliberations on endangered species legislation.

## SUMMARY

Local governments deal with important aspects of environmental quality—providing clean drinking water, sewage treatment, solid-waste management, and protection of their natural capital on lands in the region. . Community efforts at recycling are a major part of the effort to address solid-waste issues. We saw how recycling decisions depend on incentives faced by consumers in their buying and disposal decisions and producers facing the relative prices of recycled materials versus virgin inputs. Municipalities in Canada have greatly increased recycling programs over the past two decades, with most Canadians having access to recycling programs and participating in these programs.

## KEY TERMS

Diversion policies, 386

Source reduction, 386

Takings,

## ANALYTICAL PROBLEMS

**1.** Suppose the demand for a product is P = 100 – $^1/2$Q and the supply of virgin inputs is 20 units. The marginal cost curve for recycled inputs is $r$ = Q/4. Compute the socially efficient output level, the use of recycled inputs, and the efficient recycling ratio. Recompute all these under the following changes (take them one at a time) and compare them to the original case.

(a) Demand falls to 80 – $^1/2$Q;

(b) The MC curve for recycling inputs becomes $r$ = Q/6;

(c) The supply curve for virgin inputs increases to 30.

**2.** Another way of increasing the use of recycled material by industry is to subsidize its purchase of materials taken from the waste stream. How would you analyze this in terms of Figure 19-5?

**3.** Many communities have been successful in collecting recyclable material, but have been unable to find buyers for the recovered materials. Analyze this situation graphically using the model of recycling covered in this chapter.

## DISCUSSION QUESTIONS

**1.** If the reuse ratio is lower than is socially efficient, what economic incentives could be used to encourage the recovery and recycling of a substantially larger proportion of the solid-waste stream?

**2.** Suppose there is a wetlands that can be used for ecological values or drained and houses built on it. How could the socially efficient use of the wetlands be reached?

**3.** Many communities are instituting a "pay as you throw" system for solid waste. Discuss the equity implications of this type of system.

**4.** In trying to incorporate ecological values into land-use decisions, what sort of economic incentives might be used?