CHAPTER 12

Dealing with Waste

Whatever is naturally here is all we have. Whatever humans make does not go "away."
— William McDonough and Michael Braungart

From take-make-waste to eco-cycling principles

While recycling rates are improving in some parts of North America, U.S. citizens "waste or cause to be wasted nearly one million pounds of materials per person per year ... the total annual flow of waste, including wastewater, is 250 trillion pounds." This waste includes materials such as carpets, Styrofoam, discarded food, carbon from carbon dioxide, and manufacturing waste. "Less than two percent of the total waste stream is actually recycled — primarily paper, glass, plastic, aluminum, and steel. Over the course of a decade, 500 trillion pounds of American resources will have been transformed into nonproductive solids and gases," according to Paul Hawken, Amory Lovins, and Hunter Lovins in Natural Capitalism.

Added to these considerations are the increasing burdens for local governments in dealing with waste: rising costs and problems of waste disposal, closing of landfills, stricter incineration regulations, and managing disposal of hazardous substances.

What should communities do in the face of all this? Adopt mandatory recycling programs? Maybe. But recycling, in and of itself, is not enough to solve these problems. Indeed, as some point out, recycling may be "an aspirin, alleviating a rather large collective hangover ... overconsumption."

The observation that only one percent of North American materials ends up
in products that are still being used six months after their sale underscores this point. Ultimately, sustainable solutions lie more in the direction of designing products that are not, as Bill McDonough says, “less bad,” but 100 percent good. This means, among other things, designing products that are fully biodegradable or whose components can be easily broken down for reuse in industrial production.

Dealing with waste also means changing patterns of consumption. Two Canadian scientists have developed a measure called an ecological footprint, the estimated amount of land associated with a particular pattern of resource consumption and waste generation. According to these scientists, the ecological footprint of the average U.S. citizen is about 24 acres, the highest of any country in the world. The average world citizen's ecological footprint is 5.6 acres.

Even if tomorrow we were to begin designing "100 percent good" products and cut our consumption habits in half, society already has created massive amounts of waste materials, much of which is hazardous and toxic, already present in the ecosphere. Then there are the products and materials currently in use that will eventually become waste. Landfills are closing. Incineration is problematic. What are we to do with the accumulating masses of nonbiodegradable materials in society? Once again, it helps to think in terms of cycles, continually reusing product materials already present before extracting and consuming virgin materials.

This chapter presents examples of how some Swedish eco-municipalities are applying eco-cycling principles to dealing with waste in different contexts and situations. In northern Sweden, the Rönnskär Smelter is recovering metals from electronic scrap and discarded computers for reuse in society. A small village in northern Sweden, Lovika, is recycling over 90 percent of its solid waste. The town of Eksjö in southern Sweden is helping eco-teams of citizens to reduce household waste in a fun and social way. Eskilstuna and Eksjö are harnessing nature’s cyclic processes by using constructed wetlands that treat city sewage.

VULCAN IS HARD AT WORK IN THE RÖNNSKÄR SMELTER

The Rönnskär (Reunn'-shehr) Smelter is located in Gallivare (Yell'-ih-vah-reh) in the Boliden (Boo'-lee-dehn) region of northern Sweden. It is Sweden’s only smelting plant and one of the world’s largest facilities for extracting and recycling metals, such as copper, lead, gold, and silver. Recycling precious metals is not a new practice in the Boliden region. Here, thousands of years ago, Vikings recycled gold and silver, extracting these metals from secondary raw materials.
Today, recycled materials are the source of 20 percent of Rönnskär’s smelted copper, 40 percent of smelted gold, and 80 percent of smelted zinc. Thirty percent of all the scrap metal traded in the world comes to this smelter, according to company estimates. Scrap metal arrives by train, trucks, and boats, then loaded onto conveyors that bring the material directly into the plant. When there is not enough scrap metal and recycled material to process, Rönnskär uses copper concentrate and other metals extracted from nearby mines and purchased in the world market. The plant also extracts zinc clinker from recycled steel mill dust. As a smelting by-product, the plant produces “iron sand,” or granulated slag. The good insulating and drainage properties of iron sand make it useful for road construction and house foundations and cut down on excavation of natural gravel, a diminishing natural resource in Sweden.

Copper and zinc ash from casting shops and the brass and bronze industries provide much of the secondary raw materials — industrial by-products to be recycled — for the plant. Rönnskär also processes telecommunications scrap, such as wire or cable, and scrap from discarded computers, monitors, and electronic gadgets. Extracted metals, once returned to their pure base state, are sold to customers throughout Europe. Rönnskär’s gold, silver, copper, and lead easily meet the high-grade standards of the London Metal Exchange.

**Profitability is Key**

For Rönnskär to sustain its operations, profitability is key. The smelter has been operating in the black since 1985. In 2000, the facility’s income exceeded its costs by 30 percent. At 34 percent of total operating costs, payroll is
Rönnskär’s biggest budget line item. Materials comprise 18 percent of costs. To stay profitable, Rönnskär has had to mechanize some operations and reduce its labor force. In 1986, 2,000 employees smelted 100,000 tons of copper. In 2000, 850 employees processed 230,000 tons of copper. During 1998 to 2000, the Boliden Company, Rönnskär’s owner, invested a quarter of US$ 1 billion dollars in modernizing and refurbishing the plant. As a result, Rönnskär almost doubled its copper production capacity. Thirty percent of Boliden’s investment went toward improving the plant’s environmental performance.

REDUCING IMPACTS

The Rönnskär Smelter also has been working to reduce its energy consumption and its emissions. Heat recovery units recapture heat from the smelting process, and a condenser turbine recaptures electricity. During 1985 to 2000, Rönnskär reduced its energy consumption by 20 percent, while its metal production increased by 11 percent. Thirty years ago, the plant emitted more than 250,000 tons of sulfur dioxide into the air per year. By 2000, annual sulfur dioxide emissions were less than 5,000 tons.

Both Rönnskär and public regulatory agencies closely scrutinize the plant’s environmental performance. A state-of-the-art computer system continuously monitors emissions at the plant stacks. Air samples taken one or two miles from the site are measured for particulate matter. Sweden’s national food regulatory agency analyzes samples of vegetables grown throughout the region. Sea mollusks and fish in the waters near the smelter are continually monitored and show improvement from past polluting times. Rönnskär melts 25,000 tons of electronic scrap per year without significant emissions of dioxins. These levels are well below the allowed European Union thresholds. The smelting process almost completely destroys hazardous halogen flame retardants. Over the past 20 years, Rönnskär has reduced its total emissions by 90 percent.

CONTINUING CHALLENGES

Rönnskär and the recycling industry as a whole face several challenges, according to a Rönnskär plant manager. First, he says, in many places it is still cheaper to dump solid waste at the landfill than to sort and recycle it. Swedish regulations for electronic waste still dictate that if treatment and recycling facilities are not available in the region, haulers and municipalities can obtain exemptions to dump this electronic waste at landfills. Rönnskär has the capacity to process electronic waste but does not receive sufficient volume to make this a profitable enterprise.
Second, the recycling market is unstable, says the plant manager. In 1997, Rönnskär studied the possibility of expanding its recycling operations. The facility analyzed the primary market, mining, and the secondary market, scrap metal and electronic materials. Plant analysts found that, at that time, the primary market in the developing world was considerably more stable and cost-effective than the secondary world market of recycled electronic goods. Technical problems such as energy input per output ratios that are not cost-effective present another challenge for the recycling industry that must devote time and resources to finding cost-effective solutions. Then, local authorities often dictate particular recycling methods, for example, requiring that certain products or materials must be manually dismantled. All these present considerable challenges for the recycling industry, says Rönnskär’s plant manager.

PROVING IT CAN WORK
Despite these challenges, Rönnskär is demonstrating that it is feasible to recover and reuse existing metals before mining and introducing additional accumulations of virgin metals into society. To eventually be able to make products in the first place that are “100 percent good,” society will need a facility like Rönnskär to extract base metals from fabricated products and purify them for return and reuse in industry. Sustainable extraction and use of metals involves efficient use of resources, profitable production, and minimal environmental impact, according to the plant manager. Rönnskär makes this possible through low costs, high metal recovery rates, recycling, and first-rate environmental care, says the Boliden Company. Vulcan, the mythological blacksmith god of fire and metalworking, is indeed hard at work in the Rönnskär smelter.10

Lovicka Village: Outstanding mittens, outstanding recycling
The village of Lovikka (Loo'-vick-ah), inhabited by about 120 people in the town of Pajala, has a particular distinction — it may have created the world’s largest mitten. Among other accomplishments, Lovikka has been producing mittens for the Swedish military for the past 100 years. Pajala and its village of Kangos were discussed in Chapter 9.

Lovikka has another distinction. It recycles an astonishing 91 percent of its community’s solid waste. The village began its own system for handling trash disposal and recycling in 1995. Through this self-designed system, Lovikka was able to reduce its total solid waste volume by 80 percent. Some estimates put the average Swedish recycling rate at 50 percent.
While Sweden’s laws for producer responsibility of certain solid waste have bolstered recycling throughout the country, the system better supports urban, rather than rural, recycling efforts. Since recycling companies realize higher revenue from the greater volume of materials recycled in urban areas and less revenue from lower recycling volumes in rural areas, the companies often will not collect recyclables in small villages. To address this, villages, such as Lovikka and Kangos, and rural towns, such as Pajala, have developed strategies to combine recycled materials from several villages to make it worth the recycling companies’ effort to collect.

Recycling Competition
In the mid-1990s, the municipality of Pajala ran a competition among its 54 villages to see which village could achieve the highest recycling rate. Pajala supported the contest by providing increased recycling collection to the villages. Lovikka won this competition, achieving the highest number of product types recycled in the country — 23 different material types separated and recycled. Since then, 52 of Pajala’s 54 villages have boosted their recycling rates.

Two strategies were essential in achieving Lovikka’s 91 percent recycling rate, according to a village official. First, the village engaged all village households in first understanding the importance and relationship of recycling to global trends, then how each household could do a better job of reducing and recycling their own waste materials. Understanding how local actions such as recycling can help reduce encroachment upon nature gave added meaning and incentive to changing and improving individual actions. The village also set up a central location for collection of recyclables, next to the centrally located general store, making it easy and convenient for householders to drop them off. Next, villagers set a goal for each household to reduce the creation of household waste in the first place, then to recycle between 90 to 95 percent of the waste they did create.

In addition, Pajala and Lovikka are working on innovative approaches to manage human waste. Pajala has announced a close-the-loop contest among its 54 villages — this time to come up with eco-cyclic approaches to treating sewage.
Eco-teams: Reducing household waste, and having fun doing it

The town of Eksjö (Eh’k-sheu), with 17,000 inhabitants, is one of several eco-municipalities that have helped organize citizen eco-team projects in their communities. Eco-teams are groups of about eight or ten households who band together to explore ways of living more ecologically. The idea for eco-teams comes from an international non-profit organization called Global Action Plan that works with municipalities around the world to reduce waste at the household level.

Eksjö’s eco-team project idea blossomed from a well-attended community event called Lifestyle of the Future, organized as part of the town’s sustainable development planning process. At that event, attendees learning about the eco-team idea helped to get this project started in Eksjö. Following that event, over 80 households got involved, meeting and working together in ten teams of eight households. Eco-teams receive information, education, and support from the municipal government.

WHAT ECO-TEAMS DO

In eco-teams, households learn ways to reduce household waste and support each other in putting these methods into practice. Buying less to begin with, choosing products with little or no packaging, composting food waste, and careful sorting and recycling of materials have made it possible for eco-team households to drastically reduce the amount of solid waste they create and discard. For example, some Eksjö eco-team members reduced their household solid waste disposal to about 44 pounds for the year. In contrast, in 2000, each U.S. citizen disposed of an average 1,642 pounds.\textsuperscript{12}

Reducing household waste is not the only focus of eco-teams. Eco-team members learn how to shop strategically for products that are ecologically prepared and biodegradable, looking for eco-labels such as The Swan, Good Environmental Choice, and KRAV.\textsuperscript{13} Buying more environmentally friendly products increases the market for these products, hence stimulating their production and eventually lowering their cost to the consumer. Another benefit: many companies that produce eco-certified products have also reduced unnecessary product packaging.

Eco-team members monitor their own household’s energy use and help other team members find ways to reduce theirs. They advise one another, for example, about where to buy energy-efficient lamps, light bulbs, and appliances to reduce energy consumption in their homes. Eco-team members also help each other find ways to move around their communities without using gas-powered cars. Since Eksjö’s downtown center is compact, it
was not difficult for members to ride bikes and walk more often to do errands and shopping, instead of driving their cars.

Eksjö eco-team members encouraged each other to have more nature in their lives, for example either by growing butterfly-attracting flowers on their balconies, planting flowers and vegetables in a garden, or visiting and appreciating the lovely nature areas in their community. Eco-team members learned why local food production is important. People enjoyed, many for the first time, growing, cooking, and eating their own chemical-free fresh food.

**Municipal Support for Eco-Teams**

Eksjö's municipal government supports the ecological efforts of its eco-teams and citizens through a broad public outreach about how households can live in more sustainable ways and reduce stress on nature. For several years, Eksjö has used TV, radio, advertisements, and the worldwide web to spread this message. Recently, Eksjö placed a guide to sustainable actions in the local telephone book. In this guide, citizens can read about Eksjö's vision for a sustainable future, the four system conditions of the Natural Step, eco-team opportunities, and waste reduction and recycling tips. Householders can also learn from this guide how to use biomass fuel in adapted home furnaces, reduce energy costs in their household, look for eco-labeling in consumer products, and flush only appropriate materials.¹⁴

There is more information about Eksjö and its sustainability initiatives later in this chapter and in Chapter 16.

**Sewage Treatment: Plants do it better at the Ekeby Wetland**

In the city of Eskilstuna, a constructed wetland is cleaning 12 million gallons of sewage a day, serving about 90 percent of Eskilstuna's 89,000 inhabitants. The Ekeby (Eh'-keh-bih) wetland, developed by Eskilstuna's municipal energy and environment department, is the largest constructed wetland in Sweden. The city's objective: to reduce discharges of nitrogen and phosphorus to the Eskilstuna River, Lake Mälaren, and the Baltic Sea.

In the early 1990s, Eskilstuna developed objectives for the quality of its rivers and water bodies as part of its overall sustainable development program. In 1993, a ten-year initiative began that eventually cut in half the levels of nitrogen and phosphorus in the Eskilstuna River. An additional city objective was to reduce fine particles in the city's drinking water, drawn from local rivers. Municipal regulations to limit agricultural runoff and industrial discharges had helped to reduce these levels, but nonpoint source pollution
still remained. This type of diffuse pollution from undetermined sources was found to be the primary source of nutrients in river water. After studying various approaches, Eskilstuna officials decided upon the wetland construction method as the most suitable and effective means of sewage treatment.

**HOW THE WETLAND WORKS**

Nitrogen and phosphorus, elements that do not break down further, are critical and essential players and nutrients in natural systems. However, when their concentrations become too high, system overload can occur. This nutrient buildup and system overload is called eutrophication.15

The wetland, covering almost 100 acres of city-owned land, acts as a polishing system for the sewage effluent, since wetlands process nutrients and pollutants naturally and cyclically. Wetland bacteria transform dissolved nitrogen into airborne nitrogen. The natural sedimentation process reduces particles that become suspended in water. During the growing season, wetland plants absorb nutrients and sediments in the water for their own nourishment.

In the Ekeby wetland, an inlet channel carries the effluent through a series of three basins, then on to another series of three basins through a system of weirs and dams. The effluent takes one week to pass through the entire wetland system.

In one year, the wetland removes 70 tons of nitrogen from the water, also filtering out phosphorus and taking up bacteria. Water treated by the wetland has ten times less phosphorus and bacteria than that dictated by prevailing water quality standards. After passing through the wetland, the water meets swimming water standards.

Sludge is funneled to sedimentation tanks, where speeded-up biological processes digest nutrients. Other processes remove heavy metals. The digested sludge becomes a composting product called bio-mull that can be used as a fertilizer. The plant is investigating ideas for recapturing and reusing more phosphorus from the sludge. The plant uses a heat pump and recovery system to recapture warmth from the sewage water. In the winter, the wetland rests.

Figure 12.4: The Ekeby wetland in Eskilstuna treats 12 million gallons of sewage effluent a day. It has also become a stopover for migrating birds.
Eskilstuna learned about the constructed wetland technology from another community where, ironically, land acquisition and permitting for construction of its wetland system have been delayed. Later, in 1995, Eskilstuna officials attended an international symposium on this technology to learn more about this innovative sewage technique.

The 100-acre Ekeby wetland has become a popular migratory bird stopover, where birders have sighted over 200 species of birds. The public prefers this type of sewage treatment solution because of its natural beauty and attractiveness for wildlife, say the Ekeby plant operators. A wetland system is also three times less expensive to operate than a conventional treatment system, they add. Building upon Ekeby’s success, Eskilstuna is developing a second constructed wetland to reduce levels of phosphorus, nitrogen, and particles in the Tandla River, a tributary of the Eskilstuna River that is another city drinking water source. Besides the Ekeby wetland, Eskilstuna Energi and Environment also runs the city’s district heating and cooling system, its combined heat and power (CHP) plant, electricity distribution, recycling, and telecommunications. For more information about Eskilstuna and its biomass-fueled CHP plant, see Chapter 5.

Communities learn from each other: Wetland treatment and sustainable development

In the town of Eksjö, a visitor can climb a bird-watching tower, look at and listen to many birds, and observe lots of nature activity throughout 22 acres of wetland. That visitor might not even realize that she is looking at a municipal sewage treatment area, the Wetland Nisarpsmaden (Nisarps-mah'-dehn), constructed by Eksjö’s municipal government to reduce phosphorus, nitrogen, organic material, bacteria, and metals in sewage effluent. The Wetland Nisarpsmaden, a couple of miles from the center of Eksjö, is purifying water that flows from the Eksjö River through a lake into an estuary and then out to the Baltic Sea.

Another of Eksjö’s wetland design objectives was to support biological diversity among wetland plants and animals. The visitor, if she is observant, will be able to identify many species of flowers, birds, insects, and water creatures. She might also encounter classes of school children visiting the wetland to observe and study these creatures, or local birdwatchers wielding binoculars and telescopes.

HIGHLAND COMMUNITIES COLLABORATE

The visitor would not realize, unless she was told, that this wetland is one
outcome of *Höglandskommerna* (Heug'lahnds-komm-eu'-neh-rah), an unusual collaboration of six communities in the Highland region of Sweden. Three of these communities, including Eksjö, are members of SeKom, the national association of Swedish eco-municipalities. For several years, these communities have been working together to brainstorm ideas and implement a range of sustainable development projects. These Highland communities meet periodically and also join with other municipalities at SeKom gatherings to discuss particular implementation problems in sustainable development and share experiences and possible solutions. These communities discovered that they all were seeking better solutions for small-scale sewage treatment. They realized they could all benefit in saving time, effort, and money through exploring different treatment possibilities together rather than separately.

**COLLABORATION ACROSS BOUNDARIES**

Eksjö's collaborative sewage treatment efforts did not stop here. Through a 1994 twinning project sponsored by the national association of Swedish local authorities, Eksjö and seven other southern Swedish communities met with eight municipalities in northern Poland to explore how to make sustainable development happen at a local level. At this gathering, all 16 Swedish and Polish municipalities discovered they shared similar problems in public sector issues such as sewage treatment, landfills, district heating systems, and preservation of natural areas. Eksjö developed an ongoing collaborative relationship with its twin Polish community, Barlinek. Together they organized a 1997 conference in Barlinek to inform county officials in both countries about innovative small-scale sewage treatment methods. When the word spread in Poland about the coming conference, a huge public response occurred. People from all over the country wanted to attend this event. The conference received national TV, radio, and newspaper coverage. Poland's vice-minister of agriculture came to speak.

Eksjö's collaboration with Barlinek has deepened and continues to this day. Among other efforts, Eksjö has helped Barlinek obtain US$125,000 in public funding to reduce phosphorus levels in its sewage treatment works. Barlinek has developed a local sustainable development plan that has become a model for other Polish municipalities. Eksjö officials are impressed by Barlinek's commitment to a sustainable future. One conclusion of town officials in both countries: the problems are very much alike, whether you live in Poland or Sweden.¹⁷ For more about Eksjö and its sustainable development practices, see Chapter 16.
National waste disposal: A Swedish snapshot

Both the Swedish national government and the European Union have passed solid waste disposal and recycling laws governing municipalities and authorities. Since 1993, Swedish law has required that producers of certain products, such as packaging, newspapers, cars, car tires, and batteries, be responsible for recycling of those materials. Since January 2000, regulations have prohibited dumping of combustible waste in local landfills, and as of January 2005, a national law will prohibit dumping of organic waste in landfills.

To ease the burden of these restrictions on households and communities, increasing national and international producer restrictions are emerging to help reduce waste in the first place. The Swedish government is reviewing expanded producer responsibility for waste, for example, possibly requiring electric and electronic product manufacturers to reduce toxicity in their goods. To make disposal alternatives, such as recycling, more economically attractive, the national government has taxed the amount of waste dumped at landfills since January 2000. The European Union is considering directives regulating disposal of scrapped cars, batteries, PVC, product packaging, and construction and demolition waste. The EU also is examining producer responsibility requirements.18

North American examples

Household recycling

The Global Action Plan (GAP) is working with municipalities in North America and beyond to organize and assist household eco-teams to find ways to use less, throw away less, and recycle more. Portland, Oregon; Seattle and Issaquah, Washington; Chattanooga, Tennessee; San Jose, California; and Kansas City, Missouri, are among the dozen U.S. cities that have worked with GAP in an effort that has changed the consumer behavior of over 30,000 citizens. Cities in 15 other countries have worked with GAP to start neighborhood eco-teams, involving over 120,000 consumers. Eco-team households send up to 50 percent less trash into the waste stream, reduce water use by 30 percent, energy use by 17 percent, and transportation fuel by 20 percent, and as a result realize household savings of up to US$400 per year.19

Industrial ecology

In creative approaches to sustainable practices, businesses are choosing to locate in areas where they are able to use each other’s waste products as raw
materials in their own operations. In a process that has come to be known as *industrial ecology*, based upon a remarkable web of by-product exchanges among facilities and businesses in Kalundborg, Denmark, eco-industrial parks have formed in Londonderry, New Hampshire; Devens, Massachusetts; and Fort Charles, Virginia. There, companies and power plants can reduce costs for raw materials and energy through using by-products and waste energy from others nearby, who in turn reduce their solid waste disposal costs for those by-products. In Canada, eco-industrial networks have sprung up in Tiverton, Ontario; Calgary, Alberta; and Dartmouth, Nova Scotia, among other localities. A national association called the Canadian Eco-Industrial Network supports these eco-industrial parks.  

*Alternative sewage systems*

Plant-based sewage treatment systems both for residential and industrial sewage are operating in Nevada, Texas, New York, New Hampshire and Massachusetts. “Living machines” or “solar aquatic systems” use plants grown hydroponically that consume nutrients and absorb many toxic substances in human and industrial sewage, resulting in an effluent that usually meets the U.S. Environmental Protection Agency’s drinking water standards. These facilities, operating in the U.S. and seven other countries, are processing between 300 and 750,000 gallons per day of sewage for single-family homes to commercial institutions, such as the Ethel M. Chocolate Factory in Henderson, Nevada, and The Body Shop in Toronto, Ontario. For other examples of dealing with waste, see Chapter 5 for a description of Umeå’s Dåva power plant that creates heat and electricity from the city’s own solid waste. Chapter 9 describes how 18 small villages pooled efforts to recycle.