July 5, 2006

Carlos Perera, Technical Director
Apdo: 10003-1000
San José - Costa Rica

Dear Sr. Perera:

Enclosed is our report entitled Waste Disposal Practices in the Automotive Industry: Costa Rica's Canton of Moravia. It was written at El Centro Nacional de Producción Más Limpia in San José from May 13th through July 5th, 2006. Preliminary research was completed in Worcester, Massachusetts prior to our arrival in San José. A copy of this report is being submitted simultaneously to Professor David DiBiasio for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you have devoted to us.

Sincerely,

Whitney Rock

Tiffany Lufkin

Nick Kohlstrom

Waste Disposal Practices in the Automotive Industry: Costa Rica's Canton of Moravia

A Project Report for

An Interactive Qualifying Project
To be submitted to the faculty of
Worcester Polytechnic Institute
In partial fulfillment of the requirements for the
Degree of Bachelor of Science

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AUTHORSHIP PAGE

All writing and research for this report was equally completed by Tiffany Lufkin, Whitney Rock and Nicholas Kohlstrom. Each member of this team contributed to the introduction, background, methodology, results, analysis, and conclusions and recommendations.

ABSTRACT

El Centro Nacional de Producción Más Limpia (CNP+L) is concerned with illegal waste dumping and waste disposal practices. To assist with the promotion of cleaner production we collected data on business location, investigated current waste disposal practices, and investigated proper methods of waste disposal. This project has generated a database on the location of automotive businesses in the Canton of Moravia, a brochure directed at these businesses and a procedure to expand the project to other areas and industries.

ACKNOWLEDGEMENTS

We would like to thank our sponsors at CNP+L and everyone there that helped us in the making of this project, particularly Carlos Perera, Karla Salas, and Akira Hidalgo. We would also like to thank Carlos Rosas from La Compañía Nacional de Fuerza y Luz and Augusto Otarola Guerrero from the Municipality of Moravia for their invaluable information, time, and assistance. In addition, we would like to show our gratitude to our advisors Professor David DiBiasio, Professor Natalie Mello, and Professor Guillermo Salazar for their all their help and advice. We would also like to acknowledge all the people we interviewed for taking time out of their days to welcome us and contribute to our project. Muchas gracias.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

Proper waste management is essential in all communities for environmental, health, and economic reasons. Residential, industrial, and commercial wastes are an increasing problem in Costa Rica as it develops and its economy grows. In Costa Rica, the waste management system is not widely and consistently employed, which in turn leads to problems with illegal dumping. Discarded waste accumulates in public areas in urban environments, in parks and open places, and in waterways. When solid waste accumulates in the rivers and travels downstream it can result in problems for residents, businesses, and industry. The hydropower industry, which uses the rivers to make energy, is particularly concerned with this trend.

Hydroelectricity accounts for 80 percent of the energy production in Costa Rica. The industry is well established and is only expected to grow in the future; however the increasing debris and waste in the waterways is raising production costs. The consumer feels these effects through increased electric costs and an overall degradation of the environment.

Much of the waste that accumulates along rivers and tributaries is illegally discarded. There are many proposed solutions to this problem, as well as current efforts and regulations to discourage it. These solutions vary from waste collection services, to educational programs, and national recognitions for exemplary behaviors.

Several groups are interested in promoting more sustainable behavior among the businesses and population residing along the waterways of the Virilla River Basin. The Centro Nacional de Producción Más Limpia (CNP+L) has supported our project as we have studied the problems surrounding illegal waste dumping in the Canton of Moravia.

The overall goal of our project was to identify possible ways to reduce illegal dumping in the Canton of Moravia's waterways, with a particular emphasis on the automotive repair and painting industries. This industry was chosen for two main reasons. The first is because of the large number of these shops in the canton. Businesses associated with automotive repair and painting compromise 20 percent of

the businesses in the area. The second reason is because of the high number of environmentally hazardous wastes produced in the industry. These range from used oil and coolant to tires and metal parts.

We accomplished our project goal by developing a database of information on the location and general information of automotive industries in the Canton of Moravia. Next we investigated current health and safety and waste management practices in the automotive repair and paint shops. We used this information to create a brochure of 'good practices' which outlined waste disposal options and good health and safety practices. Finally we developed a protocol for CNP+L to use to expand the scope of the project and apply it to other areas and industries.

To collect information on the location of automotive businesses in the Canton of Moravia we first obtained a list of businesses from La Compañía Nacional de Fuerza y Luz (CNFL) and a property map of the Canton of Moravia from the municipality. These were used to locate specific businesses and assist in the survey of the area. We visited the study area, where we located, identified and marked the businesses with a GPS unit. The businesses were also photographed and their services and general information recorded.

We interviewed six businesses to investigate current practices in automotive repair and painting shops in the Canton of Moravia. During each interview we took visual stock of the business and questioned the management on their waste disposal practices, safety practices, equipment, concerns, and their views on waste problems. Using this information we produced an educational pamphlet for the automotive industry and returned to the businesses we interviewed to deliver site specific recommendations and collect feedback on the publication. While interviewing businesses we found that although they all had previously established methods of disposing of their waste, they were greatly interested in improving their system and making it more environmentally responsible. They were often happy with one or more of their disposal options, but very receptive to alternative methods and destinations for their waste.

We compiled our work into a protocol for the CNP+L to follow to expand the project to other areas and industries. Armed with this protocol CNP+L can now continue studying the presence of illegal dumping in Costa Rica. They can use this information to support their programs on cleaner production and sustainable business practices. We have supplied them with a set of recommendations outlining a procedure to follow to continue our work, as well as a methodology to expand the scope of the project. This includes a suggestion on how to identify point sources of debris accumulation and to classify waste and debris at accumulation sites.

Through our research and experiences in Costa Rica, we obtained data regarding the status of waste management in the country and the effects that these practices have on businesses and the environment. This was supported by the information we collected during interviews in the Canton of Moravia. This allowed us to gain an understanding of the interest of the automotive industry in waste disposal alternatives. To promote cleaner production as a feasible goal for these businesses, we developed a set of recommendations. These included identifying businesses in an area, identifying illegal or poor waste management practices, promoting their improvement, and gaining knowledge of the options available in this field to those businesses.

If followed, these recommendations can be used to improve waste management practices. With this information CNP+L is one step closer to their vision of clean production in Costa Rica.

Chapter 1: INTRODUCTION

Proper waste management is essential in all communities for environmental, health, and economic reasons. Residential, industrial, and commercial wastes are an increasing problem in Costa Rica as it develops and its economy grows. Unfortunately, the waste management system in Costa Rica is still ineffectively developed. From 1995 to 2005, “47 percent of municipalities disposed of their refuse in sanitary landfills, and the remaining 53 percent used open dumps (see Glossary)" (Pan American Health Organization, 2005). Almost all of these dumps are illegal, and many are located along major waterways.

Despite efforts to clean waterways in Costa Rica improper disposal of pollutants and debris such as furniture, industrial waste, and plastics continues. These pollutants travel downstream and cause problems for businesses and industries. The clogging of hydroelectric dams, which can reduce installed capacity (see Glossary) by as much as fifty percent, is of great concern to La Compañía Nacional de Fuerza y Luz (CNFL) (Loaiza, 2005b). The effects of improper solid waste disposal are especially problematic in Costa Rica because hydroelectric dams account for 80 percent of the nation’s production of electricity (Energy Information Administration, 2005).

To address the waste problem, both CNFL and the Centro Nacional de Producción Más Limpia (CNP+L) wanted to know more about the origin and composition of the waste accumulation in the waterway. They sought to identify the major dumping sites and develop effective ways to discourage illegal dumping along rivers. CNP+L formed our project team to study the debris that is clogging hydroelectric dams and polluting the watershed. A specific area of concern was the automotive repair and painting industries, which comprises of about 25 percent of the industries in the Canton of Moravia (see Glossary), the area this project focused on (Hidalgo, 2001).

Our project goal was to provide possible ways to identify and reduce illegal dumping in the Canton of Moravia, with a particular focus on the waste management practices of the automotive businesses located there. The project had four primary objectives:

1. Develop a database of information on the location of current automotive businesses.
2. Investigate current waste management and business practices in the automotive repair/painting shops in the area.
3. Provide educational information to the automotive community based on our results.
4. Create a protocol for CNP+L to use to expand the scope of the project and apply it to other areas and industries.

Armed with the information, materials, and protocol created by this project, it is now possible for CNP+L to focus its efforts on reducing sources of solid waste (see Glossary). This will assist in alleviating urban impact on the environment and benefit the community and its industries.

Chapter 2: BACKGROUND

Hydroelectricity is a major source of energy in Costa Rica. It accounts for approximately 80 percent of the country's electrical production. The health of this industry is therefore of great concern to the whole country. This background chapter will discuss many different aspects of hydroelectric dams, as well as the effects that illegal dumping has on them. These topics will include information on how water's mechanical energy is turned into electricity through hydroelectric plants and the use of dams in this process. This chapter will also discuss how waste and debris causes problems for the dams that can negatively affect the environment, increase electricity generating costs, and reduce its production.

Some methods for waste disposal are illegal and cause contamination of the rivers and clogging of the dams. There are many proposed solutions for the dumping problem, as well as laws and regulations to discourage this. CNP+L has investigated the use of software to map the locations of businesses in the Canton of Moravia, to identify key sources of waste, and to assist in the development of more effective waste management programs.

Good business policies and health and safety practices in the automotive repair and painting businesses are also presented in this chapter, as one of the results of the project is a brochure on these topics for this industry. Adequate knowledge on the topic will assist in the understanding behind the brochure's creation.

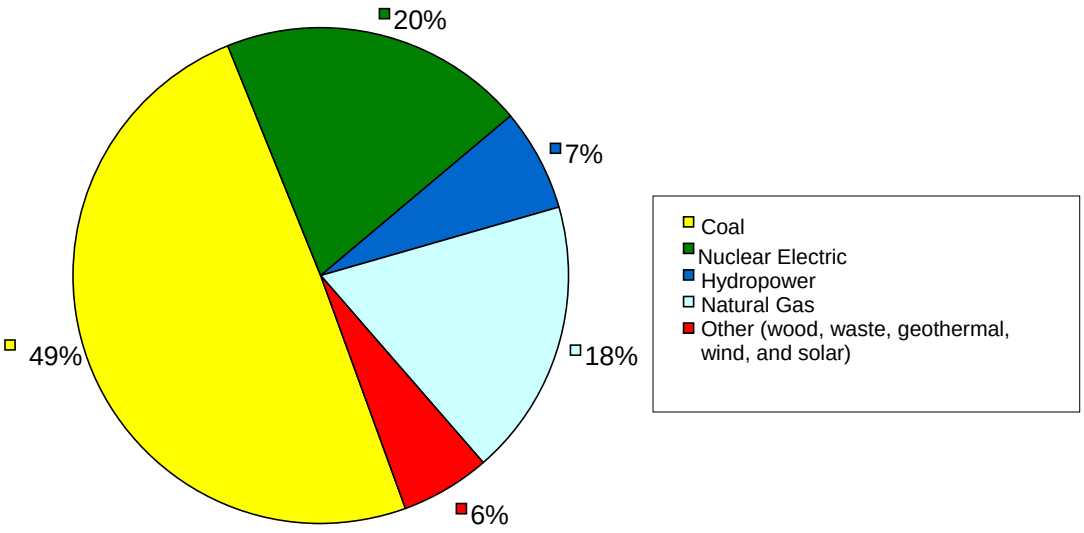
2.1 HYDROELECTRIC POWER

The world's water supply is constantly moves in a vast global cycle, evaporating from oceans and lakes, forming clouds, precipitating as snow or rain, and then flowing back down to the oceans and lakes. This process is driven by the sun and is known as the hydrological cycle (see Glossary). Hydroelectric dams harness power from this cycle by converting the kinetic energy of flowing water into electricity. Because the water cycle is endless, and hydroelectric plants do not reduce the water they use, hydroelectric power is a renewable source of energy.

2.1.1 Worldwide Use

Worldwide hydroelectric plants produce about seven percent of the world's electricity and supply more than one billion people (Figure 2.1). In 2003, hydroelectric plants produced 2,645.8 billion kilowatt-hours of electricity worldwide (Table 2.1). In North America, hydroelectric plants produced about 16 percent of the demand for electricity in 2003 (Figure 2.3) (Energy Information Administration, 2005).

Figure 2.1: Electricity Production by Source 2004- World



Source 1:(Energy Information Administration, 2005)

Table 2.1: World Net Generation of Electricity by Type, 1980, 1990, and 2003

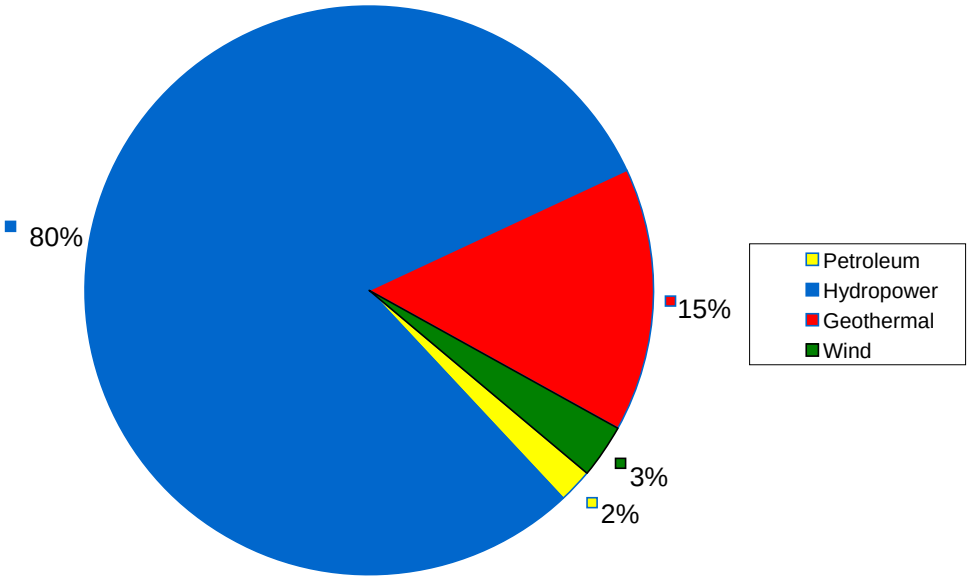
Region and Country	Fossil Fuels			Nuclear Electric Power			Hydroelectric Power [1]			Total [2]		
	1980	1990	2003 P	1980	1990	2003 P	1980	1990	2003 P	1980	1990	2003 P
North America	**1,880.1**	**2,292.0**	**3,087.4**	**287.0**	**648.9**	**844.5**	**546.9**	**606.5**	**619.4**	**2,721.6**	**3,623.9**	**4,659.6**
Canada	79.8	101.9	154.5	35.9	69.2	70.8	251.0	293.9	332.5	367.9	468.6	566.3
Mexico	46.0	85.7	173.3	0.0	2.8	10.0	16.7	23.2	19.7	63.6	116.6	209.2
United States	1,753.8	2,103.8	2,758.6	251.1	576.9	763.7	279.2	289.4	267.3	2,289.6	3,038.0	3,883.2
Other	0.5	0.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.7	0.9
Central and South America	**99.8**	**114.8**	**221.1**	**2.2**	**9.0**	**20.4**	**201.5**	**R 365.1**	**561.4**	**308.2**	**R 497.2**	**828.7**
Argentina	22.2	20.9	40.3	2.2	7.0	7.0	17.3	20.2	33.4	41.8	48.3	83.3
Brazil	7.5	8.1	26.7	0.0	1.9	13.4	128.4	204.6	302.9	138.3	219.6	359.2
Paraguay	R (s)	(s)	(s)	0.0	0.0	0.0	0.7	R 27.2	51.2	0.8	R 27.2	51.3
Venezuela	17.6	21.0	27.9	0.0	0.0	0.0	14.4	36.6	59.6	32.0	57.6	87.4
Other	52.4	64.8	126.3	0.0	0.0	0.0	40.6	R 76.4	114.3	95.3	R 144.4	247.4
Western Europe	**1,180.1**	**R1,171.8**	**1,496.6**	**219.2**	**R 711.3**	**883.0**	**431.7**	**453.4**	**483.7**	**1,844.5**	**R 2,355.9**	**2,973.7**
Belgium	38.3	25.0	31.9	11.9	40.6	45.0	0.3	0.3	0.2	50.8	66.5	78.8
Finland	22.0	22.8	38.6	6.6	18.3	21.6	10.1	10.8	9.3	38.7	51.8	79.6
France	118.0	44.3	55.2	63.4	298.4	419.0	68.3	52.8	58.6	250.8	397.6	536.9
Germany	390.3	358.9	349.0	55.6	145.1	157.0	18.8	17.2	20.8	469.9	526.0	558.1
Italy	125.5	167.5	222.4	2.1	0.0	0.0	45.0	31.3	36.3	176.4	202.1	270.1
Netherlands	58.0	63.2	82.0	3.9	3.3	3.8	0.0	0.1	0.1	62.9	R 67.7	91.0
Norway	0.1	0.2	0.5	0.0	0.0	0.0	82.7	119.9	104.4	82.9	120.4	105.6
Spain	74.5	66.5	131.7	5.2	51.6	58.8	29.2	25.2	40.6	109.2	143.9	247.3
Sweden	10.1	3.2	6.7	25.3	64.8	62.2	58.1	71.6	52.5	94.3	141.5	127.9
Switzerland	0.9	0.6	1.1	12.9	22.4	26.1	32.5	29.5	34.4	46.4	53.0	63.4
Turkey	12.0	32.3	98.5	0.0	0.0	0.0	11.2	22.9	35.0	23.3	55.2	133.6
United Kingdom	228.9	230.0	273.7	32.3	R 62.5	84.5	3.9	5.1	4.5	265.1	R 299.0	369.9
Other	101.4	R 157.2	203.5	0.0	4.4	5.0	71.7	66.6	87.0	173.8	R 231.1	311.5
Eastern Europe and Former U.S.S.R.	**1,309.3**	**1,471.5**	**1,090.7**	**83.2**	**251.3**	**305.0**	**R 210.4**	**R 251.7**	**267.8**	**R1,603.2**	**R 1,974.8**	**1,668.2**
Czech Republic	—	—	51.6	—	—	24.5	—	—	1.4	—	—	78.2
Kazakhstan	—	—	50.9	—	—	0.0	—	—	9.5	—	—	60.3
Poland	111.1	125.0	138.6	0.0	0.0	0.0	R 2.3	R 1.4	1.7	R 113.8	R 126.7	141.2
Romania	51.4	49.7	31.3	0.0	0.0	4.5	12.5	10.9	15.9	63.9	60.6	51.7
Russia	—	—	571.5	—	—	138.4	—	—	170.6	—	—	883.3
Ukraine	—	—	82.9	—	—	76.7	—	—	10.3	—	—	169.9
Other	1,146.8	1,296.7	164.0	83.2	251.3	60.8	195.5	239.4	58.6	1,425.6	1,787.5	283.5
Middle East	**82.8**	**R 217.3**	**483.6**	**0.0**	**0.0**	**0.0**	**9.6**	**12.5**	**22.5**	**92.4**	**R 229.9**	**506.2**
Iran	15.7	49.8	132.3	0.0	0.0	0.0	5.6	6.0	10.0	21.3	55.9	142.3
Saudi Arabia	20.5	64.9	145.1	0.0	0.0	0.0	0.0	0.0	0.0	20.5	64.9	145.1
Other	46.6	R 102.6	206.2	0.0	0.0	0.0	4.1	6.5	12.5	50.7	R 109.1	218.7
Africa	**129.1**	**R 243.7**	**372.4**	**0.0**	**8.4**	**12.7**	**60.1**	**R 54.8**	**85.0**	**189.2**	**R 307.4**	**471.1**
Egypt	8.6	31.5	71.4	0.0	0.0	0.0	9.7	9.9	12.6	18.3	41.4	84.3
South Africa	92.1	146.6	202.2	0.0	8.4	12.7	1.0	1.0	0.8	93.1	156.0	215.9
Other	28.4	65.6	98.8	0.0	0.0	0.0	49.4	R 43.9	71.6	77.8	R 110.0	170.9
Asia and Oceania	**907.7**	**1,626.8**	**3,613.0**	**92.7**	**279.9**	**457.6**	**R 262.7**	**R 404.1**	**606.0**	**R1,268.0**	**R 2,337.6**	**4,736.6**
Australia	74.5	131.6	197.1	0.0	0.0	0.0	12.8	14.0	15.9	87.7	146.4	215.8
China	227.9	465.2	1,484.2	0.0	0.0	41.7	57.6	125.1	278.5	285.5	590.3	1,806.8
India	69.7	196.9	467.7	3.0	5.6	16.4	46.5	70.9	68.5	119.3	275.5	556.8
Indonesia	10.6	35.3	94.8	0.0	0.0	0.0	R 2.2	R 6.7	8.4	R 12.9	R 43.0	109.5
Japan	381.6	524.0	648.3	78.6	192.2	237.2	87.8	88.4	104.1	549.1	R 821.8	1,017.5
South Korea	29.8	45.5	197.4	3.3	50.2	123.2	1.5	4.6	4.8	34.6	100.4	326.2
Taiwan	31.3	43.6	121.8	7.8	31.6	37.4	2.9	8.2	6.8	42.0	83.3	166.0
Thailand	12.3	38.7	105.0	0.0	0.0	0.0	1.3	4.9	7.2	13.6	43.7	114.7
Other	70.1	143.8	296.7	(s)	0.4	1.8	R 50.0	R 81.2	111.6	R 123.5	R 233.2	423.4
World	**5,588.8**	**R7,138.0**	**10,364.8**	**684.4**	**R1,908.8**	**2,523.1**	**R1,722.8**	**R2,148.2**	**2,645.8**	**R8,027.1**	**R11,326.6**	**15,843.9**

[1] Excludes pumped storage, except for the United States.
[2] Wood, waste, geothermal, solar, wind, batteries, chemicals, hydrogen, pitch, purchased steam, sulfur, and miscellaneous technologies are included in total.
R=Revised. P=Preliminary. — = Not applicable. (s)=Less than 0.05 billion kilowatthours.

Note: • Totals may not equal sum of components due to independent rounding.
Web Page: For related information, see http://www.eia.doe.gov/international.
Sources: United States: Table 8.2a. All Other Data: Energy Information Administration, "International Energy Annual 2003" (May-July 2005), Tables 2.6, 2.7, 6.1, and 6.3.

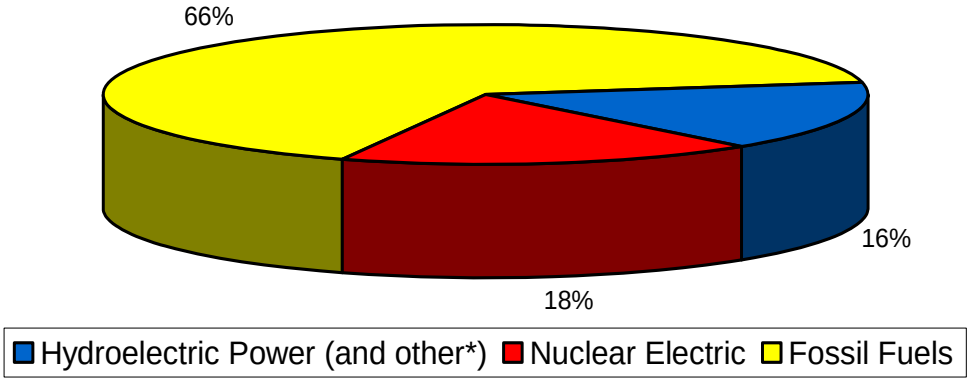
Source 2: (Energy Information Administration, 2005)

Figure 2.2: Electricity Production by Source 2002- Costa Rica



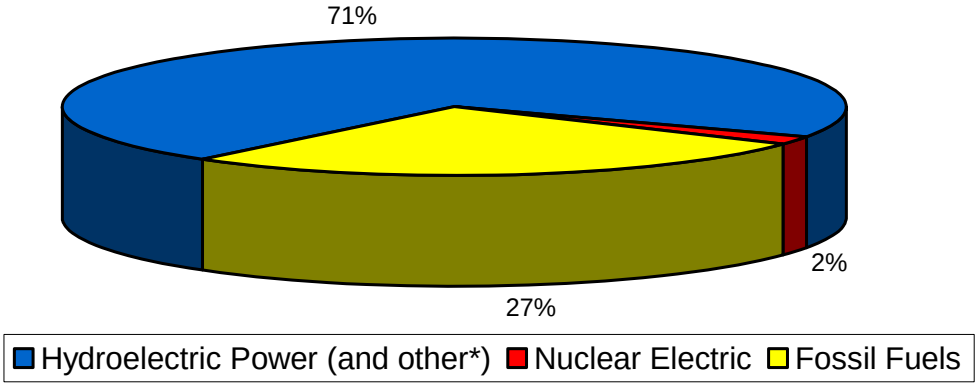
Source 3: (Energy Information Administration, 2005)

Figure 2.3: Net Generation of Electricity 2003- North America



Source 4: (Energy Information Administration, 2005)

Figure 2.4: Generation of Electricity 2003- Central and South America



Source 5: (Energy Information Administration, 2005)

2.1.2 Use in Costa Rica

In an average year Costa Rica's hydroelectric plants produce about 80 percent of its domestic energy (Figure 2.2). This statistic is high compared to the average world consumption of hydroelectricity (seven percent) and is even greater than the 71 percent of the total energy that is consumed in all of Central and South America (Figure 2.4).

In Costa Rica, energy production, telephone and internet service are all controlled by the government. The politically-managed Instituto Costarricense de Electricidad (ICE) generates most electricity used in Costa Rica. For example, in 2002 ICE generated 5,710 GWh (80 percent) out of the 7,128 GWh of the total domestic power produced (Power Plants Around the World, 2005).

2.1.3 Types of Hydroelectric Plants

There are three different types of hydroelectric plants that can be used to produce electricity: impoundment, diversion, and pumped storage. Impoundment hydroelectric plants are the most common type of plant and are typically large. These plants use a dam to form reservoirs from which water can be released to meet electricity needs or to maintain other water needs. A diversion plant channels a fraction of the river through a canal into the electric turbines and does not require a dam. Pump storage plants use electricity when the demand is low to pump water from a lower reservoir to a higher reservoir. When there is a high demand for power, water is released to generate electricity. These plants are constructed in many sizes. Large plants can be used to produce more than 30 megawatts of electricity for public distribution, while micro plants only produce up to 100 kilowatts and are best used to power a home, farm, or small village (U.S. Department of Energy, 2005).

There are two varieties of turbines (see Glossary) used to produce electricity; impulse and reaction turbines. The turbine used at a particular hydroelectric plant is based on several factors, including the head (see Glossary), flow, placement, efficiency and cost. An impulse turbine normally uses the velocity of the water to move the runner, the rotating part of the turbine that converts the energy of falling water into

mechanical energy, and releases the water at atmospheric pressure. An impulse turbine is usually used for plants with high head and low flow. A reaction turbine uses both pressure and the flow of moving water to turn the runner. Reaction turbines are generally used in plants with lower head and higher flow available (U. S. Deparment of Energy, 2005).

2.2 DAMS AND WASTE DISPOSAL

2.2.1 Gravity Dams

Hydroelectric plants commonly generate their energy from falling water. To provide this drop in the water height, dams are used to create an increase in elevation for the water to fall over.

Gravity dams are designed by taking into account many variables relating to the use of the dam, its location, and the general plan for the project. The overall size of the dam, whether it is to be considered low (100 feet or shorter), medium-high (100-300 feet) or high (300 feet or taller) is chosen based on the intended function and the location of the project (U. S. Department of the Interior, 1976, pg. 1). The forces on the dam are calculated in maximum expected conditions (see Glossary) and a factor of safety is constructed into the design.

When the water holds contaminants such as dirt, woody debris, and some not so natural pollutants (items like plastic bottles, shoes, and tires) it applies greater forces to the structure and slows the water speed. While dams have traditionally been constructed on rivers surrounded by undeveloped land, it is convenient to have them located near the consumer. Having the structure close to established roads and developed areas cuts construction costs and makes it easier to maintain and continue the production of electricity.

While natural debris can collect above the dam, the proximity to urban areas comes with additional problems and conflicts. There is the problem of increased amounts of man-made debris as dams and their reservoirs are built in more developed and urbanized areas. When solid waste accumulates upstream of the dam the efficiency of the structure decreases dramatically.

2.2.2 Solid Waste

From the five dams that La Compañía Nacional de Fuerza y Luz (CNFL) operates in the Virilla River Basin, 4,500 metric tons of solid waste must be cleaned out annually (Loaiza, 2005b). Solid waste is defined as any unwanted solid substance or material. "According to the EPA regulations, solid waste [is] any garbage, or … other discarded material … resulting from industrial, commercial, mining, and agricultural operations, and from community activities." (Cheremisinoff, 2003, pg. 25)

Until recently, waste disposal was not considered an important issue and was viewed as a low priority in Public Health and Safety offices (Pichtel, 2005, pg. 1). Now the disposal of solid waste "is one of the more serious and controversial issues facing local governments in the United States and indeed most technologically developed nations" (Cheremisinoff, 2003, pg. 25). More attention was brought to solid waste over the last decade because the amount of waste has dramatically increased during this time. The average US citizen generates about 4.46 pounds of solid waste each day (Cheremisinoff).

Solid waste commonly has negative economic value, which means that it is cheaper for the disposer to discard it than to use it (Pichtel, 2005, pg. 5). Since trash disposal can at times be costly, especially for businesses, people often resort to other ways of waste disposal. Open dumping, which occurs in many places ranging from the side of the road to the river, is most commonly used. In Costa Rica, "47 percent of municipalities disposed of their refuse in sanitary landfills, and the remaining 53 percent used open dumps" (Pan American Health Organization, 2005).

2.2.3 Waste Disposal

When solid waste and debris get into rivers and streams many problems arise. The waste travels down the river and causes problems for businesses and industries, especially impacting hydroelectric dams by clogging them, causing overflowing and decreasing production. The waterways must be cleared several times a year, and in some cases daily, so that the turbines can function closer to their installed capacity. Dredging, one way of cleaning the river, is costly to both businesses and the

environment (The Institution of Civil Engineers, 1968, pg. 1). Dredging uses machines equipped with scooping and suction devices to remove the debris.

Another method and one employed at CNFL's Brasil Plant uses a crane with an enormous basket and another machine, called the "clam", to scoop up waste materials. The waste is then loaded on to trucks and transported to landfills (Loaiza, 2005b). Up to 200 tons of waste per day must be removed. This requires about 120 truckloads to transport the waste to the landfill.

The amount of waste collected increases every year. This process is expensive to execute, and CNFL only budgets $180,000 per year towards waste disposal. The plant also loses an enormous amount of productivity during the process. This cost, in addition to the impact that the debris has on production prior to cleaning, is a great concern to hydroelectric companies. Currently CNFL is searching for ways of recycling the waste that it removes from the dam. The options that they have currently found are too costly to implement at this time.

Because a feasible option for using the waste after it is removed has not been discovered at this time, CNFL is striving to reduce the amount of waste that reaches its facility. Gerald Aguilar, the head of the Brasil plant commented that one of the disadvantages of the Virilla River Basin (which is about 142 square kilometers) is that it is inhabited by thousands of families with little environmental awareness (Loaiza, 2005b).

2.3 ENVIRONMENTAL AND HEALTH IMPACTS OF WASTE

The effect of solid waste debris and other pollutants on the environment is a controversial topic. Those not participating in clean waste practices can have a significant, harmful, and widespread impact on their location.

Waste buildup in the dam can cause overflow, leading to flooding in the reservoir and the area upstream of the dam, and can eventually lead to the collapse of the dam if left unattended. This is of concern to homes and businesses in the area (Amenazas Naturales Canton de Moravia, nd). In 1999 Honduras' concerns regarding the flooding of the El Cajon hydroelectric dam caused the government to evacuate

100,000 people (Energy Information Administration, 2005b). Waste removal is an important to prevent flooding.

When waste is removed using the methods mentioned, water quality and its ability to support life is significantly reduced. Often in order for the waste to be removed in a timely fashion the water must first be released from the dam, which causes the remaining portion to become much more concentrated with debris. The shallowness of the water causes the current to run faster and the silt (see Glossary), sediment, and waste on the riverbed to get swirled up along with all of the debris. Dredging also causes the portion of waste that has already settled to get stirred up. During this process the water becomes extremely turbid, and the amount of suspended matter (see Glossary) in the water increases dramatically (Loaiza, 2005a). Due to this polluted environment fish and other aquatic life can not breathe and consequently suffocate; a situation that is not acceptable to the authorities. After an incident in October of 2003 during which excess sediments held behind the dam were let into the Peñas River, ICE was asked to pay the Administrative Environmental Court for damages and death it caused to the fish and wildlife of the Peñas River - in San Ramon, Alajuela (Loaiza, 2005a).

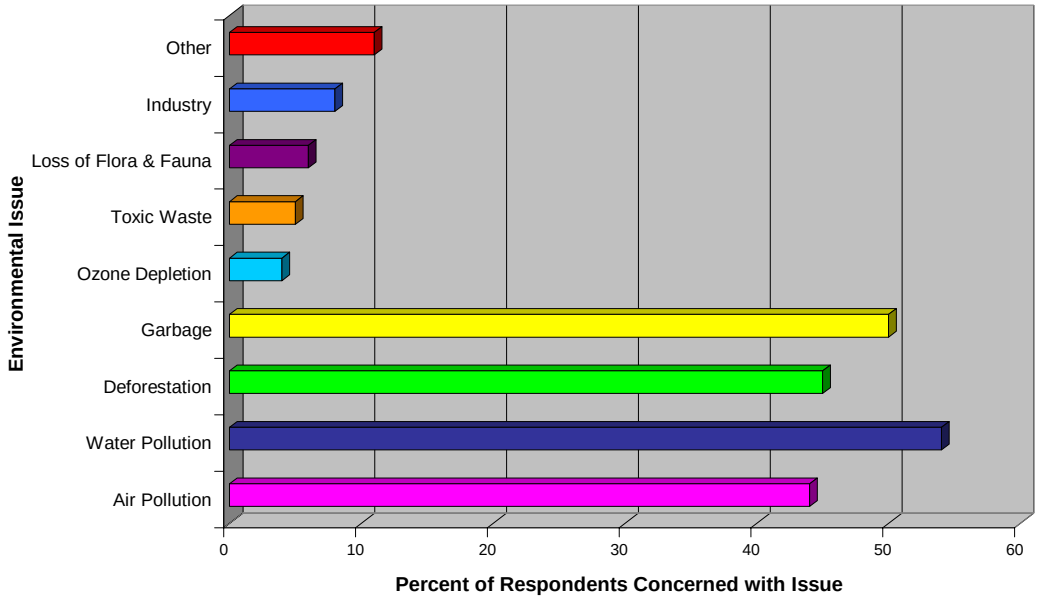
Rivers containing debris are also prime contributors to the spread of disease. One health problem of concern is the occurrence of Dengue Fever (see Glossary). Dengue is contracted by the bite of an infected mosquito. Some symptoms of common Dengue are high fever (up to 105 degrees Fahrenheit), sever headache, severe muscle and joint pain, nausea and vomiting, and a rash (National Institute of Allergy and Infectious Diseases, 2005). The mosquitoes find perfect breeding grounds in discarded items that commonly make their way to the waterway. The amount of waste discarded in Costa Rica has reached a point where it is significantly contributing to the spread of Dengue Fever (Inside Costa Rica, 2005).

2.4 WASTE MANAGEMENT PRACTICES

In order for a community to promote better waste management, it must first take into account the generation, collection, and disposal of waste. In a study done by Holl, Daily and Ehrlich (1995) in Costa Rica it was found that many Costa Rican citizens

believe that air and water pollution, deforestation and garbage are environmental issues of concern, however illegal solid waste dumping still occurs frequently in the San José region (Figure 2.5).

Figure 2.5: Costa Rican Perceptions of Environmental Issues



Source 6: (Holl, Daily, Ehrlich, 2005)

2.4.1 Waste Generation

One way to reduce the amount of generated waste is to set up a comprehensive recycling program in the community. To have a successful program, communities can implement an educational program that will give easy access to information on recycling, promote community involvement programs, and develop community legislation. It is very important to make a recycling program easy and convenient for the public to use (Everett & Pierce, 1997).

2.4.2 Waste Collection

The collection of waste has three main components: location of collection, frequency of collection and the type of transportation used to move waste. Waste

collection should be designed for specific community needs and in agreement with its available resources. Two types of waste collection are house to house collection and site collection. House to house collection usually consists of a vehicle collecting waste from homes and transporting it to another site. This is normally used in urban areas where the population density is high and homes are close together. Using the site collection method residents bring their waste to a designated collection site. The waste is then transferred to another location to be disposed of and/or processed (Korfmacher, 1997).

2.4.3 Waste Disposal

There are various ways to dispose of waste. Some examples include landfills, incineration, and composting.

The most widely used waste disposal system is the landfill, in which waste is buried underground. The problem with landfills is that they cannot be located in or near an environmental sensitive zone; they need large areas of land which limits their use in crowded urban areas, and they can fill up quickly depending on the communities' waste habits.

The incineration of waste reduces the volume of waste and can be used to generate energy. The reduction of waste volume is helpful because it then takes up less space in landfills allowing the landfills to last longer. The heat that is produced during the combustion of waste can be used to produce electricity. There are a few problems with the incineration of waste, and these include air pollution and the inability of some wastes to be used (Lu, 1996).

Composting is a waste disposal process used for organic materials. During composting the waste is broken down through natural processes, this is the most environmentally friendly way of disposing of organic waste because it puts safe materials back into the ecosystem. One problem with composting is contamination by non-organic matter or hazardous materials into those which are safe for the environment. Additional problems also arise when the length of time needed to properly compost is added to the problem of storage. While composting is a basic method for disposing of waste, it needs an additional infrastructure to support its

continued use (McKenzie-Mohr, 1999).

2.4.4 Waste Management Practices in Costa Rica

In accordance with Costa Rica's Ministry of Health Law, municipalities are responsible for managing waste for residential, commercial, institutional and open area sources. Due to Act 74 of the Municipal Code, it is possible for municipalities to charge rates that are fixed according to the real cost, including a 10 percent increase in price for the development of services.

In the San Jose Metropolitan Area (AMSJ), 1,400 tons of waste are generated daily, of this 30 to 40 percent never reaches a landfill. The three main sanitary facilities for solid waste are the Rio Azul, La Carpio, and Los Mangos. Most Costa Rican citizens do not properly handle wastes; for example they do not separate their waste materials by types. This could be caused by the lack of an available infrastructure for handling waste (Guide for Economic Sustainability and Quality Life of San José, 2003).

2.4.5 Current Recycling Efforts in Costa Rica

While environmental awareness in the general population is still undeveloped, there are several programs in place already in the San José area for the recycling or reusing of materials. An example can be found in one waste material commonly generated in the automotive repair and painting industry.

Riteve, a vehicular inspection company, and the Caja del Seguaro Social (CCSS) are working together in an effort to cut the number of Dengue Fever occurrences by reducing the number of tires that become breeding grounds for these dangerous disease carriers. Riteve will accept old tires free of charge to get them out of the environment, where they can contribute to the spread of Dengue (Inside Costa Rica, 2005). The current program is setting up collection campaigns in communities, telling local residents where to take their tires (Inside Costa Rica). This effort to slow pollution before it occurs is having an impact. Studies show that the number of Dengue occurrences so far this year is comparatively lower than last year (Inside Costa Rica).

This example shows that initiatives are being taken to reverse the negative effects of the solid waste pollution on the environment and the people. Industries are

working to improve their relations with the environment and the surrounding community.

2.5 AUTOMOTIVE WASTE AND PRACTICES

In the Canton of Moravia in Costa Rica, approximately 21 percent of workers have jobs in the commercial repair industry, while approximately 17 percent have jobs in the manufacturing industry (Hidalgo, 2001). Since this is a large percentage of all workers in the canton, attention must be paid to its waste management and best business practices.

Automotive repair and paint shops have the potential to release pollutants into the environment and adversely effect workplace health and safety. Some typical wastes generated by these shops are used oils and containers, batteries, brakes and brake fluids, paint and paint cans, tires, glass and metal parts (Montana State University Extension Service, 2000). These items are common to almost every automotive repair and paint shop in the world, and if they are not disposed of properly, can lead to large amounts of solid waste.

2.5.1 Waste Management Practices

Since a large amounts of waste is produced by automotive repair shops, waste management practices must be implemented so that waste can be reduced and disposed of properly. Some basic practices include keeping storage areas and work areas clean and well organized. This reduces the chance of accidents, which can be costly and a waste of materials. It also increases efficiency because time is not wasted searching for materials and tools. This can help save on labor, materials, lower waste disposal costs, and reduce the potential for environmental violations and fines.

Recycling is the most important key in developing ways to execute sustainable practices. Some of the most common recycled automotive materials include metal parts, papers, aluminum cans, and plastics. Depending upon the area, it may be possible to even be reimbursed by the pound for recyclables brought in. Tires can also be recycled or legally disposed of, as outlined in the previous section.

Another way to reduce waste is to have a rigid inventory control system. "An auto body shop can reduce expenses…by simply monitoring its inventory." (WMRC, 1998) This can reduce waste because when a strict inventory is kept, the amount of product used is known. The business can then keep an inventory of how much of each product it needs and excess material or overstocking will not be a problem. This not only reduces waste, but reduces costs and makes the overall business more efficient.

Packaging waste (often overlooked) can be greatly reduced by buying in bulk. Some things such as oil and antifreeze can be purchased in drums rather than in individual containers. These drums can often be recycled or reused while smaller containers would have to be thrown out (Iowa Waste Reduction Center, 1995).

Finally, incentive programs can be part of the solution to minimizing wastes in automotive and paint shops. Employees can be encouraged to conserve and dispose of materials properly by offering incentives such as bonuses or by splitting up the savings between employees who significantly contribute to the reduction and proper disposal of waste. The amount of savings will be substantial enough to cover the cost of these incentives (California Environmental Protection Agency, 2005).

2.5.2 Hazardous Automotive Waste

Oil, batteries, antifreeze, and other automobile fluids removed before repairing cars are generally hazardous wastes and must be managed accordingly. The draining of vehicle fluids and the removal of batteries should be in a designated area away from storm drains. These should be put into hazardous waste containers and labeled with "Hazardous Waste", the date, and the contents. The containers should be kept closed and in a specific location until they are sent offsite to a hazardous waste facility.

2.6 SUSTAINABLE BEHAVIOR

To promote sustainable behavior, barriers and benefits must be identified. Both internal barriers, such as lack of knowledge and external barriers, such as structural changes, must be known. The cost of changing these behaviors is also a common concern among businesses. In order for companies to be willing to change their practices, the incentives for doing so must be clearly outlined and understood.

2.6.1 Communication

There are many ways to present information to the public to foster sustainable behavior. Most importantly, the information should catch the attention of the audience. Pamphlets that are dull or inconspicuous receive little notice. The information should also be presented vividly. Instead of just saying "In the Brasil Dam, 200 tons of waste are removed per day", also add a detailed fact such as, "about the same weight as 200 cars." Vivid information is more effective because it is more likely to stand out and be remembered later (McKenzie-Mohr, 1999, pg 84-85).

Each individual's views, beliefs, attitudes and behaviors should be taken into account. Finding a perfect balance for the scope of the message is vital; as the information should not be too general or too complicated for the viewer. Also the message should not be too controversial or extreme. An audience may not be as interested in these views.

We found that messages that are negative and entail a loss are followed more often than a message that offers a gain. Hence it is better to say "when you don't recycle, you lose your money," than "recycling will lower the amount of money you spend on waste removal." Even though they mean the same thing, people are more likely to respond to the fact that someone or something is taking away what they have. The message, however, should not only be negative. It should also empower the audience so they feel that they can make a difference (McKenzie-Mohr, 1999, pg 90).

The message content can be presented as a one-sided or two-sided argument, depending on the audience. When the audience is unknowledgeable about the subject it is usually better to use only one side of the point. When the audience is familiar with both sides of the point, it is better to present both sides of the argument, with a counter argument provided for the opposing view. This is advantageous since providing counterarguments to the viewpoint can prevent the audience from taking alternate views. A message should also be easy to remember; regardless if it is one or two-sided. It should provide comprehensive and easily accessible information on what to do, and how and when to do it.

Setting goals is an important way to get the audience involved with the material, a vital objective when creating materials. It has been shown that personal, business or community goals are more likely to be accomplished then without any set goal. For example, media is a good way to get point across, but it was found that more people will follow the advice if it has some personal contact. If one person or group starts to follow the advice it is more likely that others will follow their example. If this group is publicized, it gives other the opportunity to know who to approach to discuss topics of interest.

Finally, providing follow up information to the audience about the difference that was made will increase the chances that they will continue with the advised behavior.

2.7 LAWS AND REGULATIONS

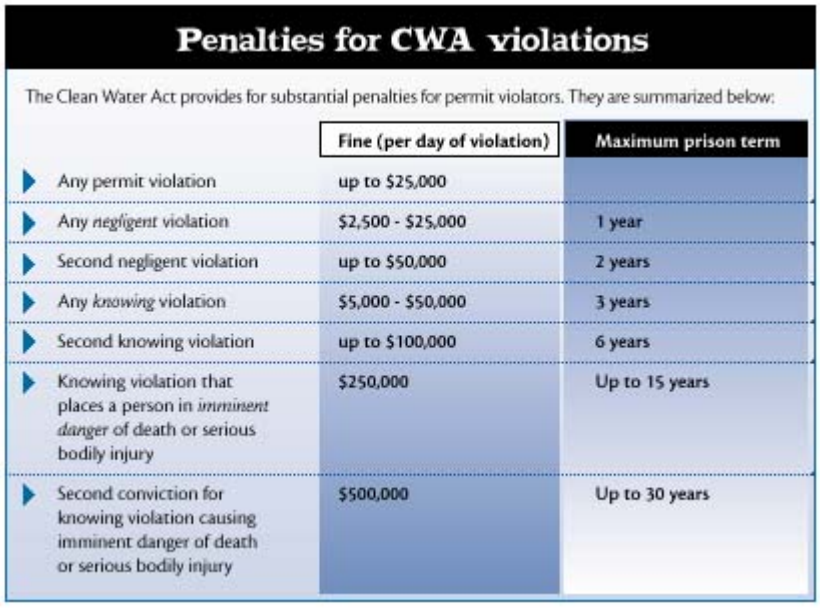
The Costa Rican standards for environmental behavior and the laws and regulations that they have developed to protect their country's environment differ from those that were enacted in other countries around the world. The laws and regulations in the Canton of Moravia include the general health and environmental protection laws of Costa Rica as well as some specific to the area and the industries and businesses in operation there. We relied on a brief picture of the US laws and regulations to strengthen our understanding of general environmental policies in Costa Rica, how they compare to those in other parts of the world, and to understand the differences that occur between our culture and that of the Canton of Moravia.

2.7.1 United States

In 1972 U.S. Congress adopted the Clean Water Act. This law was made to restore and maintain the chemical, physical, and biological integrity of the United States' waters. The Clean Water Act made it mandatory for point sources of pollution to meet certain waste matter limitations. If an entity is seeking to discharge pollutants into the waters, they must obtain a National Pollutant Discharge Elimination System (NPDES) permit.

A NPDES permit allows certain amounts of specific pollutants to be discharged by municipal sewage plants, industrial facilities, and other places that produce waste. Failure to follow these rules can result in fines and/or a prison sentence (Table 2.2) (River Network, 2006).

Table 2.2: Penalties for CWA Violations



Penalties for CWA violations

The Clean Water Act provides for substantial penalties for permit violators. They are summarized below:

	Fine (per day of violation)	Maximum prison term
Any permit violation	up to $25,000	
Any *negligent* violation	$2,500 - $25,000	1 year
Second negligent violation	up to $50,000	2 years
Any *knowing* violation	$5,000 - $50,000	3 years
Second knowing violation	up to $100,000	6 years
Knowing violation that places a person in *imminent danger* of death or serious bodily injury	$250,000	Up to 15 years
Second conviction for knowing violation causing imminent danger of death or serious bodily injury	$500,000	Up to 30 years

Source 7: (River Network, 2006)

2.7.2 Costa Rica

In Costa Rica, the Ministry of Energy and Environment (MINAE) is the governing body for all laws pertaining to energy and environmental matters. The present water laws in Costa Rica have changed little from the 1949 Sanitary Code. These laws do not take into account the current needs and requirements of the population. Nor do these laws set up a working system for waste management. There is great difficulty in changing the current water laws and regulations, due to the lax water laws in neighboring countries. It is feared that if stricter water laws were put into place, businesses will move to neighboring countries in search of cheap or free waste dumping privileges (International Water Management Institute, 2006).

Some laws currently place are Law No. 5395 (General Health Law), Law No. 5412 (Organic Law), Law No. 6043 (Shoreline Area Law), and Law No. 7788

(Biodiversity Law) (Muñoz, 1995). The General Health law defines the relationships among the government, individuals, and businesses. It sets up mandatory guidelines concerning individual and community health and pushes for the best possible health care conditions. The General Health Law made the Ministry of Health responsible for defining policies for planning, coordinating, and controlling health-related activities that are both public and private. The National Health Plan that was created strengthened programs for environmental sanitation, clean drinking water, immunizations, and nutrition. The Organic Law restructured the Ministry of Health and also set up advisory bodies such as the National Health Council and the Sectoral Planning Unit. Shoreline Area Law establishes a restricted coastal zone where housing and business can not be built. The Biodiversity Law seeks the conservation and use of the components of biodiversity in the development of socio-cultural, economic and environmental policies (Costa Rica Legislative Assembly, 1998). These laws apply to all of Costa Rica.

2.8 MAPPING

It is an essential part of understanding an area to have the location of relevant buildings and landmarks. Two technologies that greatly assist in this understanding are the Global Positioning System (GPS) and Geographical Information System (GIS). Through the use of these technologies it is possible to map an area and link information on location characteristics to the actual geographic point.

2.8.1 Global Positioning Units

The first step in developing a database of locations is to determine where points of interest are geographically. This can be done through the use of a GPS unit. GPS is an acronym standing for Global Positioning System. A GPS unit makes use of "a network of satellites that continuously transmit coded information, which makes it possible to precisely identify locations on Earth by measuring the distance from the satellites" (Garmin, 2000, p 1).

GPS units were first developed by the United States military to aid navigation, troop deployment, and artillery fire (Garmin, 2000). The importance of this technology led to the development and implementation by the US military of a sophisticated

network of satellites, which now orbit the earth. Since the creation of the system the use of the satellites is open to any consumer who has a GPS receiver to obtain the radio signals conveyed by the satellites (Garmin, 2000). For an example of a consumer GPS unit see Figure 2.6.

Figure 2.6: Example of GPS Unit- the Garmin eTrex Vista

The different uses of GPS units by the average person have expanded considerably to include a large variety of activities. Some of the most frequent uses for the technology are for leisurely activities such as boating and hiking, as well as navigating road systems and mapping areas.

Different GPS units have varying levels of mapping capabilities. Some are sophisticated enough to download maps with details of buildings, parks and waterways, while others are so basic as to only provide the user's location. When data obtained through a GPS unit is combined with other software it is possible to create detailed mapping systems.

2.8.2 Geographical Information Systems

Geographical Information Systems (GIS) "is a computer technology that uses a geographical information system for managing and integrating data; solving a problem;

or understanding a past, present, or future situation" (The Guide to Geographic Information Systems, 2006).

To use GIS, data must first be put into the system, which is called data capturing. This "involves identifying the objects on the map, their absolute location on the Earth's surface, and their spatial relationships" (U. S. Department of the Interior, 2005). In the past few years, software that takes features from satellite images helps speed up the process.

After putting the data into the system, the process of analyzing the data begins. "Themes" are the layers used in GIS to overlay different types of information. They allow the user to link information to location data so you can view how the layers work together (Meuser, 2006). By linking the information to its location, GIS helps to relate information that would be difficult to connect otherwise.

2.8.3 GIS and Waste Management

GIS can be a helpful tool in waste and pollution management. By using models we can better understand or explain what is happening and under some conditions make predictions (Woolhiser and Brakensiek, 1982, pg 3-16). Since GIS has the ability to integrate many different levels of information into one system, it has allowed detailed analysis of different factors of proper waste management (Maloney, 2001). GPS can be used not only to prevent waste from being dumped but also to help educate the public on the importance of improving waste management around communities and specifically rivers and streams.

Chapter 3: METHODOLOGY

Our project goal was to provide possible ways to identify and reduce illegal dumping in the Canton of Moravia, with a particular focus on the waste management practices of the automotive businesses located there. The project had four primary objectives:

1. Develop a database of information on the location of current automotive businesses.
2. Investigate current waste management and business practices in the automotive repair/painting shops in the area.
3. Provide educational information to the automotive community based on our results.
4. Create a protocol for CNP+L to use to expand the scope of the project and apply it to other areas and industries.

These objectives were accomplished according to the timeline located in Appendix C.

3.1 DATABASE CREATION

The creation of a database of information for CNP+L, CNFL, and the Municipality of Moravia was an important outcome of our project. This database provides information on the GPS location, name, and basic observable information (including photograph) of the automotive industries in the Canton.

3.1.1 General Survey

The first step in identifying the location of automotive repair and painting shops in the Canton of Moravia was a survey of the area under investigation. We did this by driving and walking through the southern part of the Canton. Receiving a general idea for how the urban area of the Canton was structured was vital to the development of the recommendations made to CNP+L on methods for the identification of point sources. To get a more detailed idea of the layout of the Canton we spoke with representatives in

the municipal office about the location of business districts, where waterways crossed the Canton, and urban areas that contain the shops and businesses we were studying.

3.1.2 Business Database

We located automotive businesses in the Canton, first beginning with areas having access to waterways, including small creeks and the Virilla River itself. This was done with the assistance of the business database already in possession of CNFL. We recorded the GPS coordinates of the repair and painting shops by driving (and in some cases, walking) past them. We took photographs of the location and recorded any information available to the passerby, commonly including information about the name of the business, the services offered, and the telephone number. In cases where the business abutted the water, or was in close proximity to it, a note was included in the information recorded. All information was gathered quickly at each location; no business representatives were approached or spoken to during this information gathering process.

3.1.3 Information Distribution

The information gathered concerning business location was then given to CNFL and the Municipality of Moravia for their record purposes. It was also given to CNP+L to serve a basis for further data collection and educational endeavors in the Canton.

3.2 BEST PRACTICES: AUTOMOTIVE INDUSTRY

We consulted with representatives from the automotive repair and painting businesses in the Canton of Moravia to develop a means of conveying information to those involved with the industry. We wanted to inform these businesses on ways that they can support cleaner production and waste management practices in their industry. CNP+L requested that we work closely with two businesses each in the painting and repair sectors of the automotive industry. We were actually able to interview three from each sector. By speaking with and gathering information directly from these people, we can convey the importance of our recommendations effectively and gather the most

helpful information possible, therefore having a significant influence on future business practices.

We spoke with each of the businesses on two separate occasions. The first was an interview focusing on the waste management and disposal options they were currently aware of and employ. This information was essential to our understanding and identification of common areas for improvement in business practices. It also allowed us to begin identifying waste removal options available in the area. The questions asked during the first visit to the businesses can be found in Appendix D.

On the second visit to each company we spoke with them specifically about the publication that we were creating. This included gathering feedback on how information should be presented, what should be included, and their reaction and interest in participation with the disposal options presented.

3.2.1 Business Identification

The research that we have collected on business practices enabled us to have an understanding of the ideal state for an automotive company to conduct its business. We used this knowledge in the selection of businesses to speak with concerning their views of current practices and behaviors, and in the identification of the businesses that we visited. We made personal, specific recommendations on a few areas for improvement to each of these businesses.

We chose businesses based on our inventory of business locations, services, and the advice of our sponsor Carlos Perera at CNP+L and our contact at the municipality, Augusto Otarola Guerrero. He is an official in the environmental office of the Canton of Moravia, and was indispensable in this process. Our own contribution to this decision was based on the initial survey of the canton. We selected businesses that modeled characteristics common to the area. Some specific properties that we looked at included size of the company, suspected current safety practices, associations with other companies (sponsored by an oil distributor), and equipment. We looked for commonalities with local competitors to ensure that the material created was applicable

to the majority of the automotive companies. It was assumed that the repair shops and the painting locations display different concerns, practices, and safety procedures.

3.2.2 Business Interviews

An important part of our protocol is the way in which we approached business representatives. Since our project is to serve as a model for expansion, we wanted to insure that accurate information was conveyed to us. Part of our goal was to develop an effective way to talk to Costa Rican automotive representatives.

When interviewing representatives in the area about their current and ideal views of waste management, production, and safety practices, it was very important to convey that we were not there to cause trouble or to report information to authorities. We were concerned that the businesses that we wished to interview would be suspicious of our intentions and unwilling to answer questions regarding their waste management and health and safety practices.

In speaking with several of the automotive representatives we set up interview appointments. This was done by gathering the contact number from the exterior of the building, and then telephoning to see if they were willing to participate. Our liaison, Carlos Perera put us in contact with businesses. He is a former resident of the Canton and is an acquaintance of a few representatives of the industry that we studied. We made sure that it was made it clear to those businesses that we spoke with that we are students, that our project is sponsored by CNP+L, and that it is focused on investigating methods of waste disposal in businesses.

As incentive for those businesses to speak with us, we also made return visits to each establishment. On these visits we intended to provide each location with one or two specific suggestions for implementation of cleaner practices. By using this method to approach businesses and gather information, we assumed that they would provide us with correct and complete information, because what they contributed to the project would be used to directly benefit them and their business. Each business was also assured that any information they provided us with on areas where they are not in compliance with current laws and regulations would not be used against them.

3.2.3 Disposal Alternatives

To promote cleaner production and proper waste disposal methods within the automotive industry, we researched alternative and feasible methods for the businesses to dispose of their most common wastes. These include used oil, old tires, scrap metal, and hazardous liquid wastes.

Preliminary information on sustainable and legal methods of waste disposal was provided to us by Carlos Perera at CNP+L. In addition to this we conducted research on options available to businesses in the San José region of Costa Rica. We learned of a plant that reuses tires in an alternative way, a cement plant that has permits to burn oil for fuel, and about the laws that pertain to the disposal of automotive waste. We also visited CNFL's Brasil Hydroelectric Plant and associated dam, to gain further understanding of the waste accumulation problems they experience and to obtain general knowledge of debris composition.

To further our study on these businesses, we visited with representatives from each. We prepared for each visit by writing questions to be asked while on tour.

3.3 EDUCATIONAL MATERIALS

The main deliverable of our project is the educational material for the automotive industry on waste disposal options and health and safety practices. We used the information collected from our interviews with representatives in the industry to develop a brochure and a way to present recommendations tailored to specific locations.

3.3.1 Brochure Development

To present the information we have collected and the conclusions we have made, we designed an informational brochure to be distributed by CNP+L to the automotive and painting industries in the community. This brochure will be used as an educational tool to highlight current practices and feasible improvements, which when implemented, can help both the businesses and the environment.

The content of the brochure is dependent on the information collected from the businesses we interviewed. We interviewed both businesses with ideal practices and

businesses with improper practices to determine the difference between them. The brochure consists of reasonable changes that can be implemented based on the information that we gathered. Our hope is that this brochure will help businesses to improve on their current practices.

To present this information in the most effective manner, we evaluated current materials used in the area. We compared our findings to what has already been published. When we found the same information in the businesses' current materials, and there were still signs of improper procedures, we assumed that this strategy did not work, and we applied a different and hopefully more effective way to improve that area of concern.

3.3.2 Brochure Design

When designing the brochure for the automotive industry we used several key sources to assist us. The first were written materials on the topics of promoting sustainable behavior and methods on communicating the importance of environmental behavior. The second key source used was the knowledge and advice of Mike Sherman, a professional graphic artist with over 20 years of experience.

After selecting information from our research and interview process, we designed the brochure for distribution to the automotive industry. It is currently planned to be printed by CNFL for distribution to the automotive industry by CNP+L.

3.3.3 Educational Program Development and Design

The design of the brochure was completed along with the development of an educational program to be delivered to the four automotive businesses that we previously interviewed. The program was designed to make a few (1 or 2) simple suggestions to these businesses. These suggestions were limited to this number to emphasis the importance of these suggestions. During our research we found that often programs for sustainable behavior or cleaner production try and accomplish too much all at once, resulting in the target audience not following any of the suggestions, even though individually these tasks are commonly simple and easy to complete. By placing

emphasis on a couple specific areas of improvement, we expected to see immediate and prolonged improvement in the good practices of the businesses.

We presented our suggestions to the businesses in person on a return visit to the original interview locations. These were conveyed through the distribution of our preliminary version of the brochure and providing each business to the information they needed to take direct action to improve their production and reduce the amount of resulting waste.

3.4 PROTOCOL DEVELOPMENT

One of our main objectives was to provide a living template of our work to CNP+L. This protocol includes all of the documentation on how our project was conducted, as well as specific suggestions for debris sampling methods, identification of illegal dumping sites, conducting interviews, and developing printed materials. Particular focus was placed on how to expand the project to a wider range of industries and larger locations.

3.4.1 Detailed Description

For replication purposes, we recorded our methods of collecting information and conducting interviews vigilantly, and showed which procedures and techniques provided the best results. A logbook was written, detailing our trial and error period which consisted of notes and the information that we found useful. We then made conclusions about which methods were most effective based on our research process, and which should be followed for expansion. These included detailed documentation on problems encountered, how they were overcome, and perceived modifications for translating the procedure to other industries and locations.

We placed emphasis on how to communicate with business representatives in an effective manner. For instances where open communication and important information was obtained, the procedure leading to these results is recommended for future conversations. This includes what questions were asked and how the people were approached.

The results of our findings were edited and presented in an informational worksheet/workbook to aid in the expansion of the process. A digital worksheet was provided for future research to be entered into a database of information. This allows information to be updated, changed, and added as needed.

3.4.2 Proposed Methodology

We have also prepared a methodology for collecting data on the locations of point sources of illegal waste dumping. This methodology was developed in part, off location, and has been modified to fit the Canton of Moravia's specific urban and geographic environment. We developed this process through research of the area, visits to the Canton and the Brasil hydroelectric plant, as well as consultations with representatives in the municipality of Moravia, CNP+L, and Rolando Castro, an environmental lawyer in San José.

The proposed methods have several alternatives for different levels of waste accumulation, physical features of the land and waterways, and time availability for the project. A protocol for choosing the best course of research was developed and is included with these resulting materials.

Chapter 4: RESULTS AND ANALYSIS

This chapter discusses information which we have learned through research meetings and visits. Also included is the database that was developed as well as our individual interviews with automotive businesses in the Canton of Moravia. A brochure was made using the information discovered in these interviews and is being used to educate automotive businesses. Last, we will discuss the findings of our new methodology and protocol.

4.1 CANTON OF MORAVIA

It was important while in Costa Rica to gain an understanding of the country and culture on several levels. We gathered information on how waste is commonly viewed by citizens and businesses and the laws and regulations pertaining to waste disposal. Information on the Canton of Moravia, their municipal department, and their focus on decreasing the waste in the community was also used to form the basis for our project objectives and assist us in fulfilling these.

The Canton of Moravia is located in the northeastern part of San Jose. It is 16 kilometers long and has a combination of both rural and urban areas. Most of the businesses are located in the urban or southern part of the canton. We learned that 90 percent of the businesses in the canton are small and medium sized, and that close to 20 percent of the businesses located in the area are in the automotive industry.

4.1.1 Municipality

We spoke with the Municipal Department of the Canton of Moravia about the possible benefits of our project. They expressed interest in a protocol that they can use to expand the project focus to other areas and industries, such as the leather industry in the Canton. The zoning plan of Moravia was also discussed as well as the accessibility of satellite and aerial photos. It was important to the municipality to have an accurate database of the business locations in the area, as they are currently elaborating and developing the urban plan for the canton. Currently they use AutoCAD as a mapping

program. This contains information on the street layout of the canton, as well as the property lines (with numbers) and land use zones.

A very important goal of the Canton of Moravia is to change the attitudes of the population to protect the watershed. Currently they are exploring the use of labeling environmentally critical areas within the municipality. This allows the municipal department to place stricter regulations in the areas that were identified as critical.

The municipality is aware that waste is currently discarded illegally in the canton. This waste is left in a variety of places throughout the urban and rural areas. The debris accumulation sites range in location from vacant lots and construction sites, to public places like parks and open space (Figure 4.1). The complete notes from meeting with the municipality can be viewed in Appendix E.

Figure 4.1: Discarded waste in the Canton of Moravia

4.1.2 Views on Waste

It was mentioned by several of our contacts that the residents and businesses of the Canton have a disregard for proper waste disposal practices. We spoke with Dr. Ronald Arrieta of the chemistry department of the University of Costa Rica. He

presented information to us about the general perceptions of waste and the society's resulting waste practices.

Particular difficulties are encountered when promoting waste management in San José because the concepts of 'waste' and 'trash' are often misused. Waste, or *desechos* in Spanish, should be viewed as something that is no longer useful to the person who is discarding it, but it is still a valuable product to someone. It can be used by others in their processes or for recycling back into raw materials. Conversely, trash or *basura* is something that no longer has value to anyone. It is vital when promoting sustainable practices that there is an increase in use of the concept of waste.

Costa Rica passed a very progressive law regarding the separation of solid waste and recyclables in 1972. This has, however, met with a large opposition in its implementation and has been difficult to enforce. It is Dr. Arrieta's belief that by changing society's views of unwanted end products from trash to waste, a greater responsibility will be felt towards these products and they will retain greater value as reusable resources. The complete notes from our meeting with him can be found in Appendix G.

We met with Rolando Castro (Appendix F), an environmental lawyer in San José to further investigate the policies of the Costa Rican government in regards to waste management and practices. He gave us insight into the reasons that businesses may be disregarding adherence to the policies. The laws that currently regulate the environmental standards that a business should follow are written by several different divisions of the Costa Rican government. This includes the Department of Health, the Department of Environment, and the local municipalities. These often all have individual policies on how a business needs to operate in regards to environmental standards, waste management practices, and health and safety practices. While the laws can be hard to completely comply with and knowledge of the entire system is rare, by constitution the businesses are supposed to be aware of all of these things and conform to them. The difficulty often faced with this task is exemplified in the research that even a lawyer must complete to be fully informed on the situation. The discovery of

how difficult this process can be has assisted us in the formulation of our interview questions for automotive businesses.

The third contact we spoke with about environmental views was Gerald Aguilar at CNFL's Brasil Hydroelectric Plant. He informed us about the unusual increase in waste arriving at this particular plant. He believes that this is due to the concentration of families and businesses located upstream of the plant that possess a low environmental conscious. The amount of waste coming from the five Canton's surrounding the Virilla River is much greater than that which arrives from the Uruca River (which is also deposited at the facilities dam). It is vital to the economic operation of the plant that the amount of waste arriving there be decreased. See Appendix H for the complete notes from our visit to the plant and our discussion with Gerald Aguilar.

4.2 HYDROELECTRIC DAM

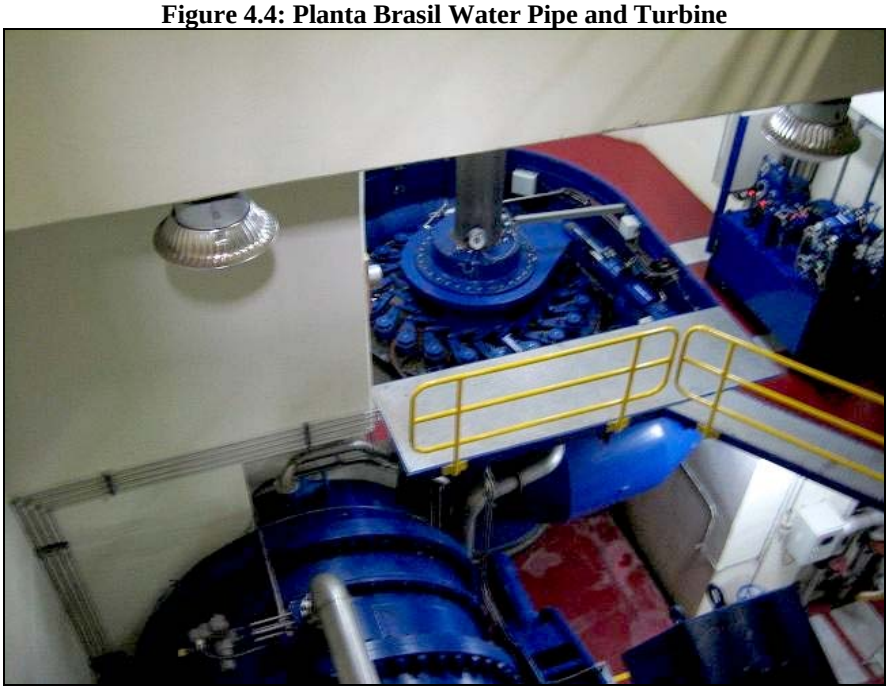
CNFL owns five hydroelectric plants in the Virilla River Basin. The largest is the Planta Hidroelectrica Brasil, an impoundment facility with a dam, and has been in operation since 1998. We visited the plant to further understand the impacts of waste on the facility and in the canton (Figure 4.2).

Figure 4.2: Dam and debris accumulation at the Brasil Hydroelectric Plant

The dam is located at the junction of the Rio Uruca (from the Canton of Santa Ana) and the Rio Virilla (from the Cantons of Heredia and Moravia), with the hydropower works connected downstream by an 800 meter concrete canal (an underground tunnel) and a 600 meter long pipe. The pipe's diameter measures approximately 3 meters (Figure 4.3).

Figure 4.3: Planta Brasil Water Pipe

Figure 4.4: Planta Brasil Water Pipe and Turbine



This system results in a 27 megawatt (maximum) facility. The water travels over a fall of 72 meters from the water intake at the dam to the turbine in the Brasil Plant. The turbine at the facility rotates at 300 revolutions per minute on a typical day, drawing 21 meters cubed per second of flow input and generating 14 megawatts of power (Figure 4.4). The maximum water flow is 34 meters cubed per second.

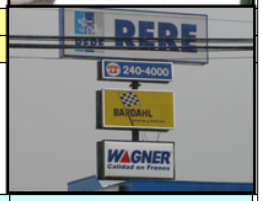
Because of the initial cost of investment CNFL has only one turbine at the plant, which causes difficulty when maintenance is required. The plant must be completely shut down and the water emptied from the system for the turbine to have parts replaced. A large portion of production is lost during this process, and due to the high amount of impurities (debris and sediments) in the water at this particular location, maintenance is needed more often than at any of CNFL's other plants. This dam collects from 6,000 to 7,000 tons of solid waste per year while others in the area only collect about 1,000 tons. Reducing the amount of debris in the waterway is therefore a pertinent goal for the company. More information on CNFL and its practices can be found in Appendices B, E, and H.

The waste at the dam is the end result of waste getting into the river. To reduce the amount of debris clogging the dam, which overall will increase energy production, the waste must be prevented at its source. Identifying the location of these point sources was beyond the scope of our project, but a methodology for this is included later in this chapter. To ease in the process of identifying these sources of waste, a database was compiled of the location of all of the automotive businesses in the Canton of Moravia.

4.2.1 DATABASE

The result of our identification of automotive businesses in the Canton of Moravia is an Excel document containing the information. This includes the GPS coordinates, photograph of the storefront, and the name of the business (Figure 4.5).

Figure 4.5: Photo of Excel business database

	A	B	C	D
1	**Numero**	**GPS Coordinates**	**Nombre**	**Storefront**
2	1	N 09°57.66'	Municipalidad de Moravia	
3		W 84°02.883'		
4	2	N 09°57.67'	Shell	
5		W 84°02.810'		
6	3	N 09°57.771'	Dom Mario	
7		W 84°02.822'		
8	4	N 09°57.771'	Estacion Moravia	
9		W 84°02.854'		
10				
11	5	N 09°57.775'	Rere Autocenter	
12		W 84°02.884'		
13				
14	6	N 09°57.923'	Valca Repuestos Usados	

This information was also placed in Google Earth to assist us with visualizing the location of the businesses in relevance to the Canton's geographical features. We found the majority of these businesses to be located in the urban area of the Canton. More analysis of the data showed that there were very few automotive businesses near rivers or streams and there was limited access to the waterways.

Difficulties in using the AutoCAD program of the Municipality of Moravia motivated us to research a way to make the data we were gathering easier to relate to the data already in the possession of the municipality. We researched Google Earth as an option.

4.2.2 Google Earth

Google Earth is available on the internet as a free program. It can be purchased with additional features, but the free version has full access to almost all of the features. This is the version we used. The program has many features that we employed during our project work. The most advantageous of these is the ability to placemark locations.

A placemark is an icon that is associated with the satellite photos of the program. This icon can be titled and additional information can be associated with it. This includes text and the Google GPS location. By inputting this information into the software, all of the information from the Excel database we created can be directly associated with the location of the business (Figure 4.6).

Figure 4.6: Google Earth screenshot with placemark information

4.3 INTERVIEWS

We completed six interviews with automotive businesses in the Canton of Moravia. Three were painting shops and three were repair shops. The full interviews can be found in Appendices K-O. From these interviews we received an understanding of the cleaner production awareness and current practices of the automotive companies in Moravia.

4.3.1 Current Practices

We identified businesses in the Canton of Moravia that fall into two distinct categories; that of automotive painting shop and automotive repair shop. We found that automotive painting businesses specialize in auto body reconstruction such as straightening and repair of dents as well as painting of cars. Automotive repair businesses focus on oil changes, alignment, balancing, tire repair, brakes, suspension, steering, and tire sales. Some of the shops also did some work in the other category. The average number of employees for these businesses is 8 and they have an average of 10 to 12 customers a day.

4.3.2 Disposal of Waste

When completing interviews we identified several common wastes generated by the businesses. These fall into two categories: liquid waste, and solid waste. Table 4.1 contains a complete list of the wastes produced in the six shops that we interviewed.

Table 4.1: Common Waste Materials from Automotive Businesses

Solid Waste	Liquid Waste
Used tires	Paint thinner
Cleaning rags	Used oil
Oil filters	Transmission fluids
Used parts	Coolant
Car body parts	Grease
Scrap metal	Painting mask
Fabrics	
Plastics	
Electronics	

We found variations between the disposal methods used in each shop for their wastes, as well as among types of waste in the same shop. The information that we collected lead us to investigate the options that some of the shops employed. This information was used in the creation of our brochure. The disposal methods used by each of the shops are displayed in Table 4.2.

Table 4.2: Waste disposal methods

	Enderezado y Pintura Vegasa	Autos Kattia	Taller Albo	Rere Autocentro	Tramalin S.A.	Autocentro
Liquid Waste Transportation Company	CRC	None	None	Castrol	ESSO	Castrol
Final Destination of Liquid Waste	Cement Plant	N/A	N/A	Cement Plant	Not Known	Cement Plant
Paint Thinner Disposal	REMSA	REMSA	Re-use	N/A	N/A	N/A

Chavarria Racing Car, or CRC, is a disposal company that takes both used oil and scrap metals. REMSA collects paint thinners, solvents, and plastics while ESSO and Castrol take only used oil. The Holcim Cement Plant takes almost all materials, except heavy metals and batteries.

4.3.3 Cleaner Production Awareness

Out of the six businesses we interviewed, four provided information on their current educational programs and the need for a new system. We were specifically interested in the access that businesses had to cleaner production materials. We found that although the majority of businesses interviewed had access to these materials, the majority of businesses also wanted access to additional materials. To provide CNP+L with an effective way to communicate their information to businesses, we also explored options for producing materials to educate businesses in the future. The information that was gathered is presented in Table 4.3.

Table 4.3: Questions and responses on cleaner production

	Enderezado y Pintura Vegasa	Autos Kattia	Taller Albo	Rere Autocentro	Tramalin S.A.	Autocentro
Do you currently have access to cleaner production materials?	No	No	No	Not Sure	Yes	No
Would you be interested in access to additional materials?	Yes	Yes	No	Yes	Yes	Yes
What kinds of materials would be most useful to your business?	Not Known	Brochure/Technical Training	N/A	Brochure	Not Sure	Not Known

Some of the companies that we spoke with indicated that they were already aware of materials designed to assist them in cleaner production. We learned that the two companies sponsored by Castrol had attended brief information sessions on the oil program that they were involved with.

4.4 RECOMMENDATIONS FOR IMPROVEMENT

While interviewing businesses we noticed several areas requiring improvement. Health and safety and the proper disposal of waste materials, both solid and liquid were of great concern to us.

Both of these areas are essential to the well being of the business. Without proper waste disposal methods and proper health and safety practices, the businesses could incur charges from the government or municipality and the occurrence of accidents is likely to be higher.

4.4.1 Health and Safety

When we questioned businesses about their health and safety practices, all of them indicated that they practiced some form of general safety practice. This varied, however, from casual suggestions that employees wear masks, to rules about smoking in the building. Most wear some combination of safety goggles or glasses, a uniform, gloves, coveralls, and masks if necessary, however minor accidents are still common. The general lack in strict health and safety practices is a concern because a large number of materials used in the automotive industry are hazardous and can lead to serious health problems later if not handled properly. This, for example, includes skin coming in frequent contact with oil, coolant, or battery acid. Caution and additional safety practices need to be used when working with these liquids. A large portion of the materials are also flammable. Although cautioned, workers did not seem to understand the severity of smoking near flammable liquids. An awareness of the practices that should be employed when storing or using these materials around sparks and flames (like those resulting from welding) is vital in preventing accidents in the workplace.

4.4.2 Disposal Options

While all of the businesses that we interviewed had at least one formal way to dispose of their waste products, this often was not applicable to all of the waste, and it was not always the best solution. In some cases they were not aware of the final destination of the waste material.

Most of the automotive businesses in the canton have disposal or transportation companies that come and pick up their waste. These companies dispose of the waste in a variety of ways. The final destination of the waste was an area of interest to the project. Scrap metal and engines are collected (or sold) to be recycled by the disposal company. Paint thinners, solvents, and oils are collected, although some automotive businesses do not know where or what happens to this waste. Tires, another large waste issue, are thrown into regular trash containers. Alternatively some businesses hire a truck to collect the tires for 15,000-25,000 colones, ($30-50 dollars), per truckload. It is not known by the business where these tires are brought.

We investigated the final destination of the waste through each of the waste removal companies. This information is included in Table 4.2 above. In several businesses the final destination of some waste, while much better than illegal dumping, was not an official solution. In one case, the used oil was sent through a transportation company to a potato chip factory within Costa Rica. This food processing plant used the oil as a partial fuel substitution. While this use is innovative, it is not a permitted use of the material. The proximity that the waste has with food products in this method makes the situation one requiring special caution.

When discussing these current practices with our liaison Carlos Perera, we found that this practice is not rare. Often unauthorized companies will pay larger dividends to accept the used oil than those who are permitted to purchase and reuse the material. This is because of the additional processing cost and permitting procedure associated with handling and using these materials in an environmentally responsible manner.

4.5 WASTE DISPOSAL OPTIONS

After gaining an understanding of the waste materials generated by the automotive companies we investigated options for the disposal of these products. Criteria for choosing the companies and methods that we researched was the environmental impact of the destination, the common solutions discovered during our interviews, and the alternative options known to our liaison Carlos Perera, who assisted us greatly in discovering these companies.

4.5.1 Fundellantas

Fundellantas, a tire recycling center, is a privately owned and managed by Danilo G. Rodríguez. The center processes passenger (psr), light truck (lt), and truck (t) tires, but does not use off road tires or farming tires. The size of the tires that they can process is a unique aspect of Fundellantas, since tire baling companies in the United States usually only accept tires up to light truck size. This is because in the United States it is too expensive to pay workers to go through the preparation required to process larger tires.

The tires are used to make bales (Figure 4.7). These bales are used as fill, retaining walls, riverbank erosion barriers and slope erosion barriers; the bales have also been considered to be used as a floating foot bridge. The bales allow water to run through them without collecting, and can be covered with soil and foliage. Some projects it has been involved with include a riverbank erosion project in Limón and a government project with several municipalities to keep a section of road from washing away. They mostly do business for private customers building retaining walls, and landslide barriers.

Figure 4.7: Tire bales at Fundellantas

Tires are processed by removing side walls, cutting tires in half, and then baling the tires (Figure 4.8). Truck tires need to be cut because they will not fit into the baling machine whole.

Figure 4.8: Stacks of cut tires at Fundellantas

Each finished bale contains 100 to 120 tires and future research is being preformed to make custom size bales. Bales are constructed using a baling machine. This machine places 75,000 pounds per square inch (psi's) on the tires to compact them. Tires are placed in the machine about 20-25 at a time and then compressed. One-way fingers on the side of the chamber hold the compressed tires down until the next set is loaded. Once all the tires were placed and compressed the chamber is opened and tires are held by the press while the Alumiwell wire (a combination of steel and aluminum metal wire) loops are fastened (Figure 4.9). The press is then slowly released from the tires and they are allowed to expand until the wire is taut.

Figure 4.9: Fastening the bale at Fundellantas

About 12,000 tires are processed into bales a month. Every part of the tire is used when it is baled, so there is no excess waste. The wire used on most bales is tested under extreme conditions to last 50 years. Finished bales weight just under one ton (2,000 pounds) and measure 30 inches tall, 54 inches wide, and 60 inches long

Most of the tires Fundellantas receives are from large distributors like Bridgestone/Firestone, SuperServicio, Trac-Taco S.A., and Gollo. These companies charge a disposal fee for every tire sold, so when the tire is replaced, there is money to recycle the old tires. Fundellantas charges 200 colones per tire and receives them every Monday and Thursday. Customers who wish to recycle tires should call ahead of time. It is preferred by Fundellantas that the tires are clean; a charge may be included if they are not. They must not include rims. Fundellantas sells the tire bales for 15,000 colones each.

Fundellantas is also trying to push a decree through the health department that would make it mandatory for all tire distributors to charge for disposal. This would also make the dealer responsible for disposing tires properly, but this process is proceeding slowly. Notes from the visit can be found in Appendix J.

4.5.2 Holcim Cement Plant

Ecolcim is a division of the Holcim group, a cement producing company with branches in several countries around the world. Ecolcim calls the service it offers 'Integrated Waste Management'. At their facility in Cartago they take both solid and liquid waste materials and use them as a partial fuel substitute in the manufacture of their clinker (a main component of cement, see Glossary). They are permitted by the Costa Rican government to use materials in this manner, as up to 15 percent fuel substitution. We learned that they currently substitute less than 10 percent of their fuel with the waste materials. This is because at this time, they do not receive enough waste materials

The important aspect of this alternative use of waste materials is the types of materials that they can and cannot accept for fuel substitution. Based on the different properties of individual materials, there is a limitation to the variety of things that can be processed in the plant. Table 4.4 below outlines the common waste materials that automotive shops are concerned with and whether the cement plant can accept the materials or not.

Table 4.4: Acceptable Waste Materials- Holcim Cement Plant

Accept	Do not accept
Painting supplies and containers	Batteries
Cleaning supplies	Heavy metals
Used safety equipment (gloves, masks)	Mercury
Oils and containers	Mineral acids
Car parts:	Cyanides
Plastics (from the car body)	
Glass (tempered)	
Cloth (or upholstery)	
All Fluids	
Paper	
Packaging	

The use of the waste materials for fuel substitution is a process called co-production. Because the material will come in direct contact with the product pre-processing is required. For this reason, the plant charges a fee for the disposal of most of the waste that it collects. This is based on the amount of pre-processing required of each material, as well as its burning efficiency as a fuel. Most materials are charged for disposal; however used oil is something that the plant pays the source for. This is because the pre-process required to effectively use the material is very little, and it burns very well as a fuel. The cement plant will pay 1000 colones per drum of used oil.

The plant is in the process of expanding its operations. They have been in operation as a co-processing facility since 2000. Because of this short lifespan, several of the intended services and infrastructure are still being implemented. They do not have a reliable service for collecting the materials in place yet, though a system for gathering materials is a large priority. They have one truck authorized to transport oil and liquid waste materials. It is vital to their standards that they do not allow businesses to transport their hazardous waste materials to the plant unless they have the proper, permitted means of moving it. They are currently researching a system of collecting waste. The ideas in formation include a truck route for collection, or a collection station. The collection station process would involve the automotive (or other businesses)

companies transporting the material a short distance to a central drop-off location. The cement plant would then gather the materials from this location, reducing pickup costs.

A new logistical division has been created within Ecolcim to evaluate the feasibility of collection options. They will then oversee the collection and transportation divisions of the operation. The development of this system is essential in making the connection between the sources of waste and the plant.

The company representatives that we spoke with indicated that the cement plant expressed an interest in increasing the amount of used oil that they received from companies. Because it is so easy to process, and burns so well for them, it is of great use. The facility is under construction for expansion and they will soon have the ability to substitute a greater amount of fuel for waste materials.

For solid waste materials the pre-process is longer to reach the state where the materials can be used in the cement kiln for fuel. First they must be shredded. This is done using a shredding machine at the Ecolcim facility in Cartago (Figure 4.10).

Figure 4.10: Ecolcim solid waste processing facility

After shredding the materials can be trucked directly to the cement factory proper, and are moved up a conveyer belt to the kiln where they are burned. The complete notes from our visit to the Holcim plant can be found in Appendix P.

4.5.3 Chavarria Racing Car (CRC)

A smaller option for waste removal is Chavarria Racing Car, a private company owned by Gilbert Chavarria. An oil drum is provided to the business for the storage of oil and solvents. When the oil drum is full, the business calls CRC, and they will go pick it up at no cost to them and transport it directly to the cement plant in Cartago. Solid waste is also picked up for free and recycled or resold to other countries.

4.5.4 REMSA

An option for the removal of paint thinners is REMSA, a private company owned by Walter Corrales Villalobos. An oil drum collects all of the used paint thinners and when full, is collected by REMSA. When there, it is recycled and reused if possible.

4.6 EDUCATIONAL MATERIAL

The business interviews, field visits, and research meetings we have collected have all contributed to the design a brochure that presents recommendations for cleaner production in the automotive industry. This publication focuses in particular on proper waste disposal, and health and safety practices.

4.6.1 Brochure

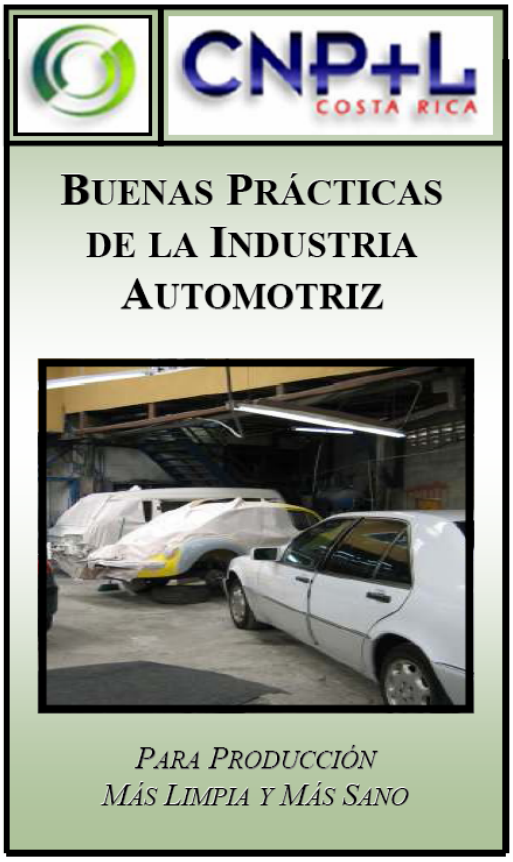
Our brochure has been designed in such a way that the information it contains is readily available to the automotive repair and painting industries in the community of Moravia. Problems and concerns that the businesses interviewed exhibited are highlighted, as well as improvements we feel most shops require and information about places to dispose of waste.

The brochure is in booklet form. It has 8 panels presenting information under the following headings: current situation, benefits of proper disposal, disposal options, recommendations, and health and safety. The brochure design was chosen for easy reading and visual interest. The brochure can be viewed (as a flat version, in Spanish and English) in Appendices T and U.

4.6.1.1 Front Page

The title of the brochure is “Buenas Practicas de la Industría Automotriz,” or Good Practices in the Automotive Industry (Figure 4.11).

Figure 4.11: Brochure Title Page- Buenas Practicas de la Industría Automotriz

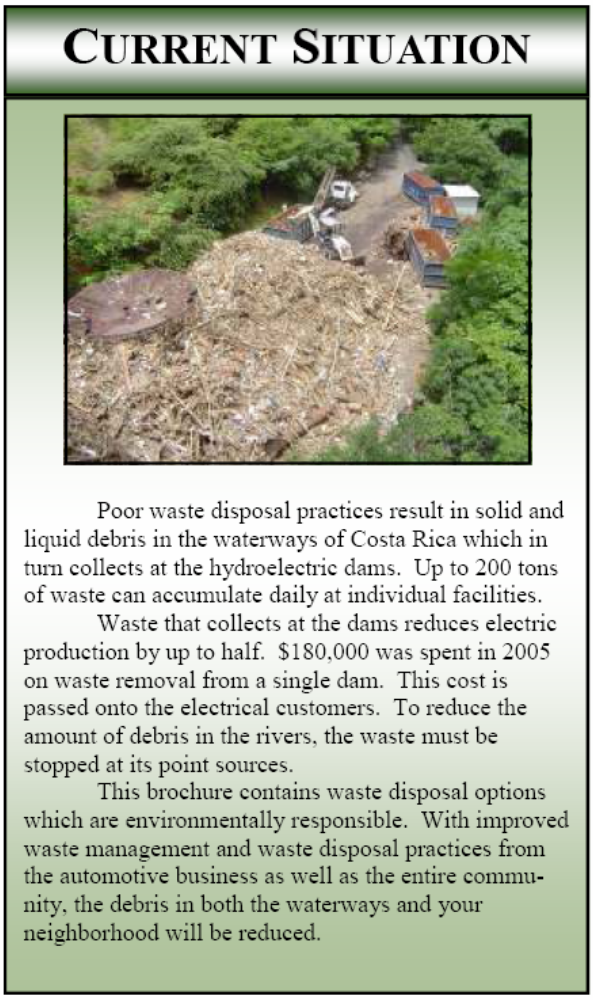


This purpose of this brochure is to increase cleaner and healthier production in this industry.

4.6.1.2 Current Situation

This section in the brochure lets the reader know the current situation, or problem with waste disposal in the area. It gives facts about the amount of waste that is found at hydroelectric dams as well as the cost to remove this waste (Figure 4.12).

Figure 4.12: Brochure Page- Current Situation

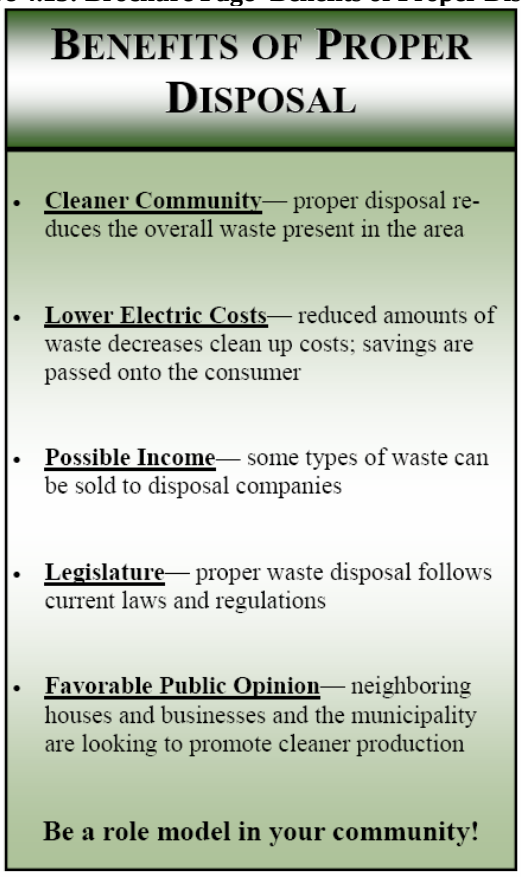


This page also states that the brochure contains waste disposal options that are environmentally responsible and that the debris in both the waterways and neighborhood will be reduced with better waste management and waste disposal practices.

4.6.1.3 Benefits of Proper Disposal

This page contains some benefits of proper disposal. This is aimed at the owner of the business (Figure 4.13).

Figure 4.13: Brochure Page- Benefits of Proper Disposal



Since we found that the environment was very important to the businesses, the first benefit listed is a cleaner community, since proper disposal reduces the overall waste present in the area. Proper disposal can also lower electric costs, possibly generate income, follows current laws and regulations, and promotes a favorable public opinion. The last statement, "Be a role model in your community!" is used to empower the reader to improve their current practices.

4.6.1.4 Waste Disposal Options

This page contains information on four companies that specialize in environmentally responsible waste disposal (Figure 4.14). The four companies are Fundellantas, a tire recycling facility, Holcim Cement Plant, which burns solid and liquid waste to be used as fuel, Chavarria Racing Car, which disposes of used oil and scrap metal, and REMSA, which disposes of paint thinners and plastics. A chart is used to easily view which companies take which wastes.

Figure 4.14: Brochure Page- Disposal Options

DISPOSAL OPTIONS

	Fundel-lantas	Holcim Cement Plant	CRC	REMSA
Tires	**YES**	**YES**	No	No
Oil	No	**YES**	**YES**	No
Paint Thinners	No	**YES**	No	**YES**
Plastics	No	**YES**	No	**YES**
Scrap Metal	No	No	**YES**	No
*Other**	No	**YES**	No	No

* This material includes used safety equipment, containers, glass, cloth, foam, cleaning and painting supplies, all fluids, paper, and packaging. Things not included are batteries, heavy metals, mercury, mineral acids, and cyanides.

Disposal Options	Cost	Services
Fundellantas	200 colones per tire	Produce tire bales for retaining walls
Holcim Cement Plant	Call for Current Prices/ Pays 1000 colones per oil drum	Use materials as fuel to operate their cement plant
Chavarria Racing Car (CRC)	Free	Collects materials
REMSA	Free	Collects materials

A second chart is also included which shows the four disposal companies along with the cost of waste removal and exactly what each does with the waste. This will be useful to the businesses because the information is concise and easily read.

4.6.1.5 Contact Information

This page contains contact information for the four companies previously mentioned (Figure 4.15).

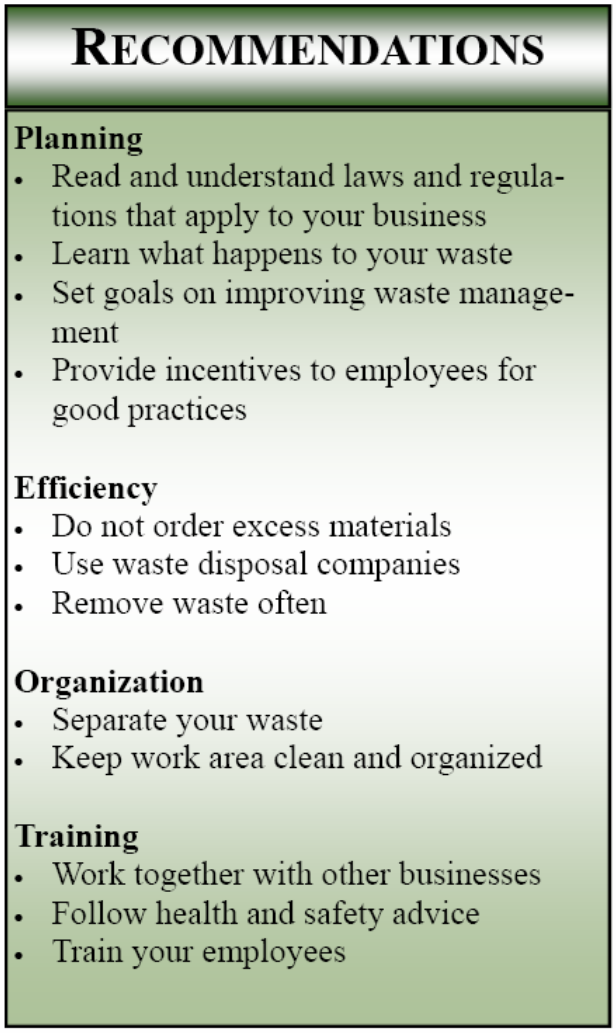
Figure 4.15: Brochure Page- Contact Information

This information will be helpful to the businesses to set up better waste disposal practices.

4.6.1.6 Recommendations

This page contains easy recommendations for businesses to follow to improve on four specific parts: planning, efficiency, organization, and training (Figure 4.16).

Figure 4.16: Brochure Page- Recommendations

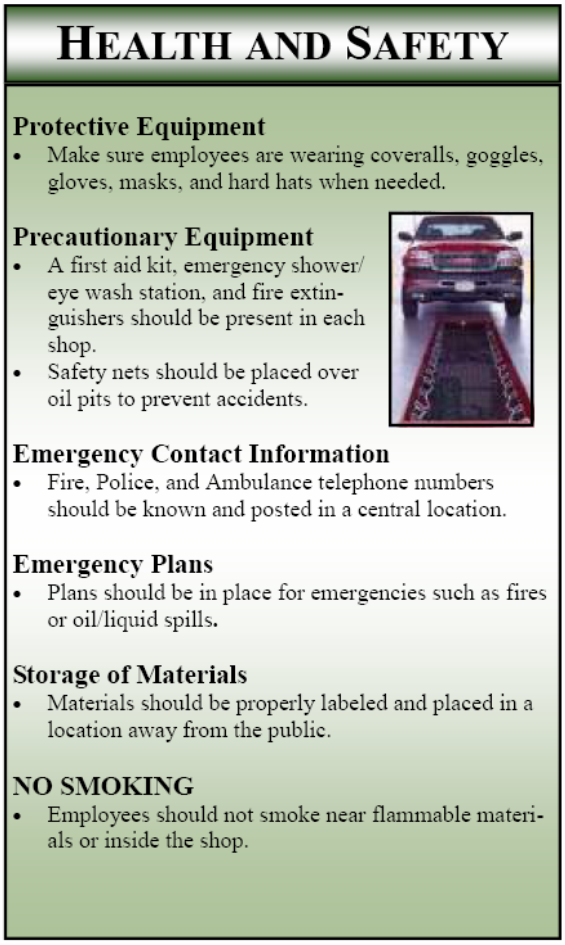


These recommendations can be used by the businesses to increase better practices in the automotive industry in the Canton of Moravia.

4.6.1.7 Health and Safety

This page contains Health and Safety advice and recommendations for the automotive industry (Figure 4.17).

Figure 4.17: Brochure Page- Health and Safety



HEALTH AND SAFETY

Protective Equipment

- Make sure employees are wearing coveralls, goggles, gloves, masks, and hard hats when needed.

Precautionary Equipment

- A first aid kit, emergency shower/ eye wash station, and fire extinguishers should be present in each shop.
- Safety nets should be placed over oil pits to prevent accidents.

Emergency Contact Information

- Fire, Police, and Ambulance telephone numbers should be known and posted in a central location.

Emergency Plans

- Plans should be in place for emergencies such as fires or oil/liquid spills.

Storage of Materials

- Materials should be properly labeled and placed in a location away from the public.

NO SMOKING

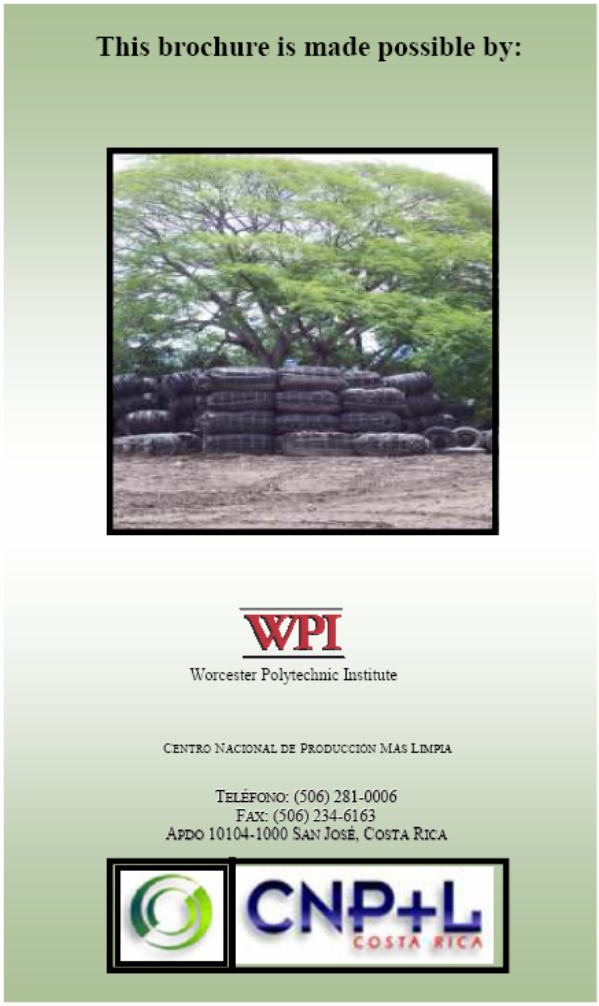
- Employees should not smoke near flammable materials or inside the shop.

This information is split up into six categories: protective equipment, precautionary equipment, emergency contact information, emergency plans, storage of materials, and no smoking. The included information was decided based on our visits to businesses and our first hand look at their practices.

4.6.1.8 Back Cover

This page contains contact information for CNP+L incase businesses have any questions on cleaner production (Figure 4.18).

Figure 4.18: Brochure Page- Back cover



4.6.2 Implementation

After we designed the brochure, we revisited the previously interviewed automotive repair and painting shops and gathered feedback on the material presented and the design. We specifically questioned them about the efficiency of the information presented, its usefulness and general opinion on what was conveyed well and what needed improvement. This information was used in redrafting the publication before passing the design to CNP+L.

We also recommended to the businesses improvements that they could make to improve the sustainability of their practices. An example recommendation to one business would be that they should dispose of their oil in a drum and call the CRC every

2 weeks to pick it up at no cost. Another example is to ask the businesses to hold onto their old tires and to bring them to Fundellantas once a month. We explained the reasoning for our suggestions, as well as provided multiple advantages of following our proposed plan. We hope to find that our recommendations are implemented and that we see improvement in their business production and disposal practices.

4.7 PROTOCOL DEVELOPMENT

The final portion of our project was the development of a protocol that CNP+L can follow. This is an explanation of how our project was completed, and it gives suggestions for debris sampling methods, identifying point sources, conducting interview, and developing printed materials. We have written a methodology for them to follow to collect this information.

Our protocol has been distributed will hopefully be used as a starting point for CNP+L, CNFL, the Municipality Department in the Canton of Moravia, and anyone else that is interested. CNP+L can use it to expand this project to other industries and locations in Costa Rica. CNFL will use our proposed methodology to identify illegal dumping sites. The Canton of Moravia's Municipality Department can use this to continue development of better business practices in the automotive repair and painting industry.

4.7.1 Methodology to Identify Point Sources

Due to accessibility, safety, water conditions and time issues, the original methodology that we developed was not feasible in the area we were working in. This involved finding point sources of waste on the water ways. We have developed a preliminary alternative methodology for gathering this information for CNP+L to use in the future.

4.7.2 Screen Method

This new method involves dividing the waterways into sections to study the composition of waste in that particular section. Since the waste that is of most concern is debris that travels down waterways to hydroelectric dams, it is important to stop this

at its point source. To do this, the waterway should be sectioned off. Each section of the waterway would have a screen placed in it that would collect the waste as it travels downstream. Since the waste will not pass through the screen, it can be concluded that the waste in the screen originates in that specific section, unless the debris had collected in the water before the study was implemented. The composition of the waste can then be found and a review of the businesses, residencies, and dumping spots can be conducted and matched to the composition of waste.

Screening sites can be placed at bridges that cross over the water ways. These sites are easily accessible and provide a narrow section of water in which to set up the screen.

There are a few anticipated problems and undeveloped areas of our screen site method. They are bulleted below.

- There needs to be research conducted on the laws for obstructing waterways from people and the effects on the environment.
- Due to the changing size and shapes of the water ways, each screen will have to be built to fit the specific site and attached to a fixed location.
- The strength of the screen has to be taken into consideration. If the screen is placed in a waterway that has a high flow rate, it will create more pressure on the screen. Screen design should consider pressure caused by flooding during the rainy season as well as the pressure created by the waste that collects at the screen.
- For the waste collected at the screen site a system and disposal method needs to be developed including how often it should be removed. It would be best to clean the screen of waste often to relieve pressure from the structure and to keep the neighboring residents in a clean healthy area.

There are several advantages to this method of collecting data. The area of origination is decreased dramatically in this method. Because the screens are placed at intervals, the possible sources are narrowed to the area between screens. If the screens are cleaned on a schedule then the observer can also determine the timeframe that the

waste was discarded in. These are two large problems with looking at waste at natural point source locations.

If the screen sites were made permanent, the system could be used in the future. This would keep the waste from ever making it to the hydroelectric dams by being collected at the screening sites. Options for removing the waste from screens on a long term basis are canton workers, hired trash companies, or the neighborhood. However, further research needs be conducted on this method before it is implemented.

4.7.3 Cost

The following table (Table 4.5) is the estimated cost of the materials needed to build the screen. This chart does not take in to account the cost of workers or installation due to the change in pay and skills of the workers from place to place. It also does not include the cost of tools or specialty materials. Prices may vary depending on the area of purchase.

Table 4.5: Cost- Screen Materials

Materials	Quantity	Cost per Material
Wire mesh/or fencing	1	3ftX25ft $11
Wood	8	2inX4inX8ft $1.30
Screws	1	100 count $9
Sand bags	3	$2
Total		~$36.40

4.7.4 Collection Methods

This section is for information collection at already occurring debris accumulation sites. Debris accumulation sites should be split up into small, medium, and large sizes. A small accumulation site is identified as anything less than 3 square meters, a medium site is from 3 to 8 square meters, and a large site is identified as anything greater than 8 square meters. These sizes can be changed according to the

nature of the information gathered. Survey samples from the identified debris accumulation sites should then be taken. This involves the following collection method.

The composition of each site maybe determined by visiting the location and photographing the debris found in the top layer, assuming the percentage of waste by composition to be about equal throughout the depth of the whole site. The waste can also be collected and sorted for a more accurate sample.

These methods should give an accurate sample of debris found along the river and allow determined composition of waste in relationship to its location and size.

4.7.5 Waste Composition

This methodology applies to both the occurring debris accumulation sites, and the waste collected at screening sites. This should be used when determining the composition of debris accumulation.

The items found in the study area can be classified in the following categories: as plastic, metal, paper and wood products, or rubber. These sub-categories are separated into three umbrella sections of residential waste, natural debris, and commercial waste. A sample of waste classification can be seen in Table 4.6 below.

Table 4.6: Sample of Waste Classification

SAMPLE: COMPOSITION IN AREA 3				
	SOURCE			
	RESIDENTIAL WASTE			
SIZE	*Plastic*	*Metal*	*Paper/wood products*	*Rubber*
small	grocery bags-10	blender- 1	Newspaper-4	scraps-5
	Laundry detergent bottles-6	fork- 4		
	wrappers from food-14			
medium			Cardboard boxes-5	
			wooden chairs-1	
large		bed frame- 1	cardboard boxes-1	
	NATURAL DEBRIS			
small	leaves			
	sticks-18			
medium	branches-5			
large	tree trunks-1			
	COMMERCIAL WASTE			
SIZE	*Plastic*	*Metal*	*Paper/wood products*	*Rubber*
small	milk crate- 4			
	packaging- 2			
medium		rims- 4	cardboard boxes (for parts)- 4	truck tire- 3
large		car hood- 1		construction tire- 2
		oil drum- 2		

Residential waste includes most goods that are specifically manufactured for that setting. This includes any children's toy, most furniture, and other products such as televisions and sinks. Commercial waste includes objects manufactured for an industrial or business setting. Examples of this are painting masks, safety equipment such as fire extinguishers, wooden pallets for moving things, and other products commonly found in the setting (desks, office chairs). Natural debris is anything that occurs naturally in the area surrounding the location of the waste. This includes tree branches, leaves, and sticks.

The items can also classified by size. Specific parameters should be set for determining the size of an object; approximations should be employed for the actual sampling process to ensure efficiency of time. The general sizes are best based on the

volume of the object. Objects bigger than .5 meters square (cannot be picked up with two hands) are considered large. Objects between .25 and .5 meters square are considered medium (can hold in two hands) and objects smaller than .25 meters square (can be held in one hand) are considered small. This composition analysis is done after visiting the location (as outlined below) of debris accumulation.

Once a survey of the waste at the accumulation sites is completed a classification of debris should be collected. Photographs of each accumulation site should be analyzed by different individuals, to determine the composition of waste in the debris accumulation site. The method used to categorize the debris accumulation by composition should be as follows.

Each observer should review the photographs separately and classified all of the objects into the predetermined categories. To classify the waste into divisible categories a table should be employed. A sample of a table can be seen above (Table 4.6). The size of debris and the materials found are then both recorded. The percent composition can then be calculated. Each individual's results should then be compared to the others for accuracy.

4.7.6 Database Creation

The information on the location and composition of waste can be put into a mapping system. Depending on the GIS available, the GPS locations of debris accumulation sites can be added as a layer to the system and linked to the information collected at each site pertaining to its specific size and composition. GPS locations of businesses can also be added as a layer. These maybe linked to information on the business' industrial category and size.

Information pertaining to the hypothesized sources of dumping, concentration of debris buildup, and types of pollutants should be determined during data analysis and included in a database as an additional layer; it is linked to the GPS location of each business. This database will serve as a foundation for further application to other studies in the area and should also serve as a basis for expansion in the study area.

Chapter 5: CONCLUSIONS AND RECOMMENDATIONS

This chapter contains conclusions that we have drawn from our project work and recommendations on how these can be applied. We have concluded that waste is a problem in the Canton of Moravia which affects the municipal administration, the citizens in the area, and the general operation of businesses.

We have developed recommendations for CNP+L and the municipal office based on the results we have obtained and the conclusions we have drawn. These include a suggestion for implementing a new GIS in the municipal office and for CNP+L to use to incorporate the information we have gathered during our project into their work towards cleaner production. We have also outlined how our project may be expanded to other industries in Moravia and to other locations. It is our hope that the project work will be continued by following the preliminary procedure we have developed.

5.1 CONCLUSIONS

While interviewing automotive business we discovered they shared an interest in sustainable behavior. They specifically are:

- Looking for information on environmentally responsible options for waste disposal.
- Interested in improving their waste management practices.
- Interested in the specific contact information for waste disposal companies.
- Interested in the possibility of working with companies, such as Holcim Cement, who is looking to create a common drop off point for automotive businesses.

The businesses showed concern for the disposal of their waste, but were unsure what the final destination of their waste materials was. Many owners were willing to change their waste disposal habits, even at greater cost, if caused less damage to the environment. From this we conclude that there is hope for the implementation of better waste management practices.

5.2 RECOMMENDATIONS

We have developed a few recommendations through the completion of our project. If implemented, these recommendations will assist in improving the waste problem in the Canton of Moravia. The recommendations are as follows:

1. A GIS program, that can be easily changed, expanded, and updated, should be integrated.

This program should include GPS coordinates, name of business, phone number, primary services offered, and an exterior photograph. It would also be useful to integrate the zoning plan of the canton as a layer into the system. This GIS program can be used by the Canton of Moravia and CNFL to further their efforts in identifying all automotive shops in the area, as well as expanding our work to include other industries and areas.

2. The methodology previously mentioned should be implemented to identify point sources of debris accumulation and concentration of waste in different areas.

This methodology should be followed and implemented to also expand our project to other industries and locations in Costa Rica. The complete procedure can be found in Appendices Q-S.

3. A method of determining the effectiveness of our educational brochure should be discussed.

A method should be developed to determine how things can be modified in the future to expand the program and maximize the amount of impact it can generate. We feel that our brochure contains information that can directly benefit the automotive community. For this information to reach those who can most benefit from it, we will be leaving our brochure design with CNP+L.

4. The preliminary procedure for identifying and assessing waste disposal practices should be used to further our study to other industries and locations in Costa Rica.

We feel that the methods we have developed for identifying sources of illegal waste disposal and the classification of waste are beneficial to CNP+L in their path

towards cleaner production. If these are implemented, they will be able to identify the locations and industries that require the most attention and begin working with these industries to improve waste management practices.

It is our hope that those who utilize our recommendations, specifically CNP+L, CNFL, and the Municipal Department in the Canton of Moravia will be able to effectively decrease the amount of illegally discarded waste in the canton, as well as other areas in Costa Rica.

APPENDIX A

Profile of El Centro Nacional de Producción Más Limpia

El Centro Nacional de Producción Más Limpia (CNP+L) is a private non-profit organization sponsored by the United Nations Industrial Development Organization (UNIDO) and the Chamber of Industries of Costa Rica. The organization consists of three administrative positions, a group of part-time assistants and external consultants. It was established in Costa Rica in 1998, primarily by a grant from the Swiss government. The office is located in the Cámara de Industrias de Costa Rica (Chamber of Industries) building on the third floor. The building is 300 meters south of the San Pedro Mall.

Currently CNP+L receives funding from many sources, the largest contributors of which are: Cámara de Industrias de Costa Rica, Instituto Tecnológico de Costa Rica, Centro de Gestión Tecnológoca e Informática Industrial (Center for Technology and Industrial Information Management, CEGESTI), Organización de Naciones Unidas para el Desarrollo Industrial, Programa de Naciones Unidas para el Medio Ambiente, Secretariá Federal de Asuntos Económicos del Gobierno Suizo (Dugan et al, 2004).

The mission of CNP+L is to promote cleaner industrial and manufacturing production processes, eco-efficiency (joint improvement in economic and environmental performance), and pollution prevention in Costa Rica (Huppes, 2006). The organization acts as a consultant to members of various industries. It assists with the establishment and promotion of cleaner production by providing technical assistance, distributing technical information (via handouts and pamphlets), and by identifying clean production opportunities and assessing their economic and technical feasibility (Cámara de Industrias de Costa Rica, 2005).

Specific goals of the organization include:

- reducing raw material usage, the volume of waste, and the cost of waste management
- enhancing the quality and efficiency of production processes

- improving work conditions
- preventing industrial contamination of the environment
- bolstering the image of the industries it supports

These goals also support other broader objective to provide open access to new markets, increase competitiveness, and stimulate private-public partnerships (Sanchez, 2006).

To work towards these objectives the Centro Nacional de Producción Más Limpia seeks assistance in its endeavors from various external consultants, including WPI. Since 2002, the two organizations have worked on a variety of topics in different fields including managing waste from mobile phones, finding disposal methods for dry cleaning solvents, reduction of agro-water pollution, and developing a model for a sub-product exchange system.

WPI will be working with CNP+L this summer to identify and reduce illegal dumping in the Canton of Moravia. The main focus of the study will be to develop an accessible database of automotive businesses, to develop a standard of "good housekeeping" practices for the automotive industry, and to develop a protocol for CNP+L to follow to expand the scope of the project to include other areas and industries. This supports CNP+L's goals and objectives by conducting research that will be vital to reduce the volumes of waste that enter the waterway, therefore reducing the cost of waste management and assisting with the prevention of industrial contamination to the environment.

Carlos Perera is the liaison for this project. He is currently the Technical Director at CNP+L and has been working there for six years. He is overseen by Sergio Musmanni, the Director of CNP+L, Costa Rica.

APPENDIX B

Profile of La Compañía Nacional de Fuerza y Luz

La Compañía Nacional de Fuerza y Luz, or CNFL is a government supported energy company which has been in business for over 60 years. It is part of ICE, the main energy corporation in the country. CNFL provides energy to over 900 square kilometers in Costa Rica and provides service to over 400,000 clients. They currently have five hydroelectric plants in the Virilla River basin, the largest being Planta Hidroelectrica Brasil. This plant's dam is located at the junction of the Río Virilla and the Río Uruca, with the plant in the Canton of Mora.

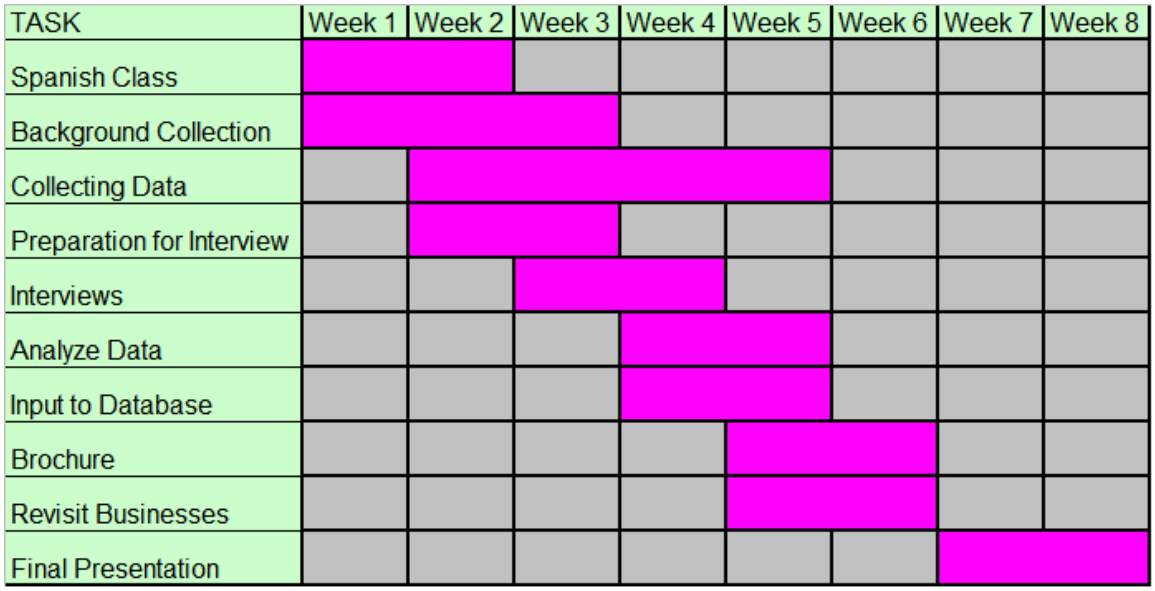
The mission of CNFL is to offer public services in the national market, to be committed to client satisfaction, to develop essential services, and to optimize the use of resources to contribute to social and economic growth and the environmental development of the country. Its vision is to be a model business for the environment both nationally and internationally and to strive to reach a high value of services for their customers based on new technology, social responsibility, and the technical and human quality of its personnel.

Some goals of CNFL are to:

- be aware of the correct uses of natural resources and energy
- promote the conservation of energy
- promote the recovery of the Virilla River Basin
- promote electrical transport
- continuously strive to improve the quality of life

APPENDIX C

Timeline of Project Completion



APPENDIX D

Interview Outline

General Information

- Name of business?
- Contact Person?
- Contact Information?
- Number of employees and working hours?
- Client profile?
- What permits do you have for the operation of your business?
    - Permiso sanitano
    - Patente municipal

Production

- How many customers on average do you have each day?
- What are your main services/products offered?
- What type of equipment/machinery is used?
- What different types of waste are produced?
- How often is waste collected from the premises?
- How do you dispose of your waste products?
- Do you know alternate methods of waste disposal? What are they?

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials?
- What material do you have the most trouble storing on site?
- What material do you have the most trouble properly disposing of?

Storage

- Are there any materials that are stored on site?
- Do you also store waste?
- Where do you store this waste?
- For how long?
- What environmental safety equipment is installed, if any?

Safety

- What sort of safety precautions are in place?
- What types of safety equipment is available?
- What safety regulations do you currently practice?
- Have you had any on-site accidents?
- Do you feel that there is a particular area of safety that needs to be improved on?

Evaluation of Working Methods

- Are there waste-related process problems?
- Do you currently have access to materials designed to assist you with cleaner production?
- Would you be interested in information on possible solutions? How would you like this information to be presented?

Environmental Policy

What do you feel is the best way for you to make these improvements?

APPENDIX E

Meeting Notes May 17th, 2006: CNFL and Canton of Moravia

Location: CNFL Biblioteca
Time: 8:30am-10:00am
Attendance: Tiffany Lufkin (WPI), Whitney Rock (WPI), Nick Kohlstrom (WPI), Carlos Perera (CNP+L), Carlos Rosas (CNFL)

Meeting with CNFL company

- Have read document (proposal)
- Have list of permits
    - All of the businesses in Moravia that they provide light to, that are registered as businesses
        - Can see where businesses should be located.
- Set up meeting with environmental manager of municipality
- Need to identify shops for identification of housekeeping
    - 2 shops in painting (one big y un pequeño)
    - 2 shops in repair
- Transportation to Canton
    - CNP+L and CNFL have means
- Criteria for selection of shops
    - Near river
    - Tipico de Moravia
- Waste classification:
    - Categories okay
    - Access to debris accumulation sites:
        - Will coordinate with municipality and each other for access over private property
        - Access to public things usually easier: easy to dump here.
        - Will work with municipality
- CNFL's interest in the project:
    - Interested in improving the quality of the water.
    - Started in watershed already
        - 3 areas:
            - Forestry
            - Conservation
            - Cleaning technology
    - In 1993 work with environmental issues
    - 2002: environmental office established within company
        - Upper watershed
            - 4 main areas of involvement (where plants are located)
                - Rio Aranjuez

        - Rio Cole (in production, registered project under clean production, emission reduction)
        - Rio Virilla
        - Rio Uruca
    - Responsible for distribution in the city
    - Lots of construction happening
    - Urban forestry project:
        - Promoting trees and environmental appreciation
        - Has asked CNP+L to join project
        - Most beautiful tree contest
            - 3 years ago
            - Prizes for photographs and stories
                - Look for history of tree in community and importance. Committee chooses winner
- Problems with the plants:
    - Solid waste
        - Interested in upper watershed and urban level
- UCR student: David
    - Environmental Health major
        - Graduate work (5th year)
            - Identifying businesses in area, that are potentially polluting (agriculture focus)
            - Looking at cleaner technologies (Corronal)
                - May have ideas and information for us too

- Augusto Otarola: environmental manager of Moravia
    - Try to set up tour/meeting

- Brasil Plant:
    - Have several watersheds. Varilla main watershed for urban human activities.
        - This is why they have such a problem with solid waste.
        - Dam does not have a big lake or reservoir.
    - Where CNFL has collection of debris
        - 6 or 7,000 tons per year of solid waste (Brasil)
        - (others only collect 1,000 tons)
        - Crane has problem right now, some trash washed down past the dam.
            - Have to reduce capacity to keep clean
            - They remove waste from the intake and with the big crane
        - ISO 1401- environmental management system
    - 1st plant was San Ramon
        - All have “environmental plan” from MINAE

Received call -> going to Moravia

Municipality of Moravia

- Municipal building:
  - Met with Alexandro
    - Explained project
    - Municipality
      - Focused on big agriculture, dairy
    - "good housekeeping"
      - Getting people to talk
        - Receive recommendations
- Final report
  - Reproducible methodology
    - Leather crafts probably most important to Canton
- Canton uses AutoCAD
  - Zoning plan
  - Location of businesses
  - Satellite photos
  - Can get access through municipality
    - National geographic institute
- Moravia:
  - Manufacturing processes
    - 90% small and medium businesses
    - (ISO 9000) Big businesses are regulated, small and med. Not regulated in the same way.
    - Trying to change the attitude of the population to protect the watershed. Más importante.
  - On Wednesday mornings Augusto Otarola Guerrero is there
    - E-mail: aotarola31@yahoo.com
    - Tele: 369-5030

APPENDIX F

Meeting Notes June 2nd, 2006: Rolando Castro, Environmental Lawyer

Rolando Castro works with companies as a consultant, to assist them by researching laws and regulations and help them to follow them.

His process when researching laws:

-When conducting specific research on laws in Costa Rica

First step is to get a general overview of the legal framework

Then an overview of that sector (like graphics, schools, water management)

Then find specific laws for sector: can sometimes find regulations or ordinances for the sector.

In researching sectors:

Visit, review laws, talk to professionals, visit again, review where improvement is needed.

General CR Law:

1973- waste management law

Concerns sewage, water management, pollution control.

Was very advanced for the time, and still is very good.

Problem with enforcement in CR:

-no word for enforcement in Spanish

-think of it as coming from top down (government to local officials, then to people)

-compliance is from bottom up

-where do these two thought methods meet?

-"urban environment" or "brown environment" was never a priority. Always was abut "green agenda" (tourism)

-parks are kept for tourism, people have to live in the city (not well kept), not fair.

Automobile shops-> usually small , sometimes work is done in the street.

-whose responsibility? (legally)

1973 Health and Sanitation Law- usually before this was written the human urban environment was under the Health Department, and Environmental stuff was under agriculture.

1988- Ministry of Conservation started, along with the Ministry of National Resources.

1996- the Ministry of Environment was created from the Min. of Natural Resources.

Some duties of environmental issues are still outside of Min of Env. (MINAE)

Some people (government officials) say that this should change, so that one Ministry is responsible for all things concerning the environment.

Other option is to have many organizations, but one leader, so as to present one voice.

Currently on issues of air pollution, water pollution and waste management there is a lot of overlap between MINAE and the Health Department.

The Ministry of Environment and Water also has some overlapping responsibilities.

The Department of Health has been reduced

-other duties are not directly under health, but should be. These are sometimes in disagreement with other policies.

"Polluter charge"- under MINAE, may not be the same as other ordinances.

Municipality and local control-

Issues permits for businesses, is not only concerned or confined to taxes now. Private sectors may be receiving directions from many organizations.

Administration may need to sit and figure out which sectors should control what. General principles of law -> best practices at the moment, and strictest regulations should be the ones to follow.

Laws are hard to comply with completely, because they are so spread out.

-but by constitution, businesses and people are supposed to be aware of the laws.

Common auto practice: giving back old parts (so you can see that it has been changed) Options: metal scraps are taken to El Salvador.

In CR legislation:

-general reg. and requirements

How can you know how to follow this?

-sometimes do not have standards.

They do in:

-waste water (set in 1998)

-this is still very permissive

-people try to follow

-agriculture fighting this law

They say, if you are complying with the standard, then why do you still pay as polluting?

But in air quality there are regulations on emissions. Standards for boilers and chimneys. Sometimes CR uses WHO (World Health Organization) standards.

For company trying to follow ISO:

-need to research how law applies to you

-how can you follow/comply with this. Need to figure out how to avoid dead ends.

Ex: storing hazardous things:

-do you keep it? Who can you send it to? How can you ensure proper disposal?

Possibilities for researching or finding laws:

"General Attorney"- system for looking up laws

-need to know law number or name

US Embassy- copies of CR laws in English?

When looking at laws:

-need to identify aspects in air pollution, waste management, hazardous materials, health regulations.

If we have specific questions that need to be researched, when we know more about where we need specific knowledge, can e-mail: rcastro@cedarena.org

Not a lot of information available for businesses (small), that are looking to comply, whether just opening the business, or changing practices.

Case example: man smoking, throws cigarette in sewer, water explodes. Gas station and dry cleaning polluting water. Had to identify where and who was putting things there.

Suggested questions for automotive businesses:

-permits? Questions on getting one?

-if no, have they been visited by the municipality?

-where does waste go?

-oil collection

-parts ->

Batteries

Filters

Tires

Some people do not feel responsible enough to pay for waste disposal.

Other industries can benefit from waste

-who?

-what do the shops need to do?

-occupational health

-environment

APPENDIX G

Presentation Notes May 31st, 2006: Dr. Ronald Arrieta, University of Costa Rica

Tibias as example (touches Moravia) of waste problem
- Politicians do not understand the problem
- Excuses: do not have money and no governmental support

Laws have been in place since 1949
- Everyone pays for garbage service
  - Municipalities can enforce payment

Law in 1973
- Established that solid waste must be separated and recycled
- Has been working for 15 years
  - No easy answer, "no book with recipe"

You can't be a technical pessimist or a technical optimist
- Don't eliminate technology, but don't depend on it alone

Must study problem in depth
- When a society event occurs a pattern can be observed
- Most important symbol is rights and ethics

There is a difference between trash, basura, and waste, desechos
- Trash is not valuable while waste can be reused
- Waste is not a product of an efficient system

Attitudes and bad habits of the population have a great impact on Costa Rica
- Tourism has a negative impact

Anti-ecological habits
- Reduce to solid waste is trash concept
- Main causes- Judeo religions give impression that man is in charge of the planet

Limitations to human perceptions
- Cannot see impacts of all actions

Capitalist society
- Driven by profit
- Not able to manage development

4 sins, 4 virtues
- Concept of waste
- Recycling
- Sustainable Development
- Integration and System that includes education, technology, and management

Administration
- Planning

Education
- In schools
- Media

Technology
- Recollection – recycling centers
- Compost
- Cooperatives

Municipalities do not want to take responsibility
- But private companies are not really allowed to

There are many small collectors
- Santa Ana recycling center
  - 8 years
  - Started by handicapped individuals

Germany in the 1970's
- Built cost of waste into the cost of the product
- Supermarkets cut down on extra packaging
  - But they do not want to get rid of all because of advertising
- Industries create consortium that started the new practice "green point"

Politicians are slowing down the process
- 10 years ago bad technology and education
  - Has improved a little

APPENDIX H

Visit Notes May 24th, 2006: Planta Hidroelectrica Brasil

Information on plant:

In operation since 1998

200 tons a day removed, 120 truck loads

31,000 tons since the plant has opened have been transported

The most waste is removed from the Brasil plant (compared to CNFL's other plants in the basin)

CNFL Budget:

$180,000 per year in waste collection

Looking for options to use materials:

Fuel? Other: recycling?

So far the cost is too great, still looking for other options.

Each year amount of waste increases

Haven't found financially feasible way to use it. There is more waste in the rainy season, not in the dry season.

Material removed is low density, it is floating.

When it rains heavily some material is not able to be collected at the top of the dam, so it flows over the dam.

Water is brown. Trouble in the maintenance of the turbines, because water is heavily particulate.

Plants are in urban areas, so the activities of all of these people are greater than if it was in a rural area.

Lifetime of plants is shorter in urban areas than in rural.

Gam -> Spanish (big, metropolitan area)

CNFL's programs

Education in schools

Have worked with 25,000 children, has not made an impact

Reforestation in mountains

To help reduce erosion and sedimentation in the water.

Location

Dam is located at the junction of the Uruca (from Santa Ana) and Virilla rivers.

It is in the Canton of Mora in the city of Colon.

At the hydroelectric plant

1912- small plant 2.8 megawatts

Then there was an increase in population, CNFL improved and increased plants.

After studies, they decide to build a dam.

Results: 27 megawatts at peak hours

540,000 meters cubed is the capacity of the reservoir.

In the rainy season the problem is the waste

In the dry season the problem is low water

Trash was not considered as a potential problem

Lots of poor families live in the basin. Don't have awareness of waste management.

Hydroelectric plant was built by a Norwegian company. All computerized to open and close gates. One person can operate, but problems with waste, sand, debris cause more than one person to be needed. Program is not able to operate properly.

In computer room: Can monitor plant from there. Gates are controlled with program. 24 megawatts currently being produced because of waste problems. Gates are controlled by optic fiber. When there is a lot of water they can open the gates fully.

They bought the crane from the Norwegians to help with waste.

- They must sometimes be concerned with containers of special waste.
  - Like from car repair shops.
    - They have to treat these cautiously, do not know the contents.
- They remove 200 tons per day with the crane.

There is 800m of canal (cement tunnel) and then 600m of pipe used to bring the water from the dam to the plant. 72m fall from the dam to the beginning of the turbines (where energy comes from).

Pelton Turbines- have just one, must shut down plant to maintain.
Software is currently ABB, but is planning on being changed to CNFL's software. The computer is full, per day it prints 34 pages of information on alarms, production, water level, etc.

In basement: 20,000 volts per line (3 lines) are produced. When we visited: 21 meters cubed per second of flow input for 14 megawatts. The maximum is 34 meters cubed per second with 27 megawatts produced.

The transformer is outside the plant.

The turbine spins at 300 rpm.

The output from the turbines aerates the water. You can see that it is visibly cleaner when it leaves the plant then when it enters. Above the dam no fish live, below there are species that can live in the water.

CNFL is studying building a new plant, with 92m head (drop from dam to turbines) and 36 megawatts produced.

CNFL paid $40,000 in an environmental warranty when they built the plant, to replace vegetation. They paid it back two years quicker than required.

APPENDIX J

Visit Notes June 6th, 2006: Fundellantas

Contact information:
- Owner/manager: Danilo G. Rodríguez
- Tels: 386-2722/433-8101
- E-mail: zanacr@racsa.co.cr
- Location: 400 Este de RITEVE, El Coyol de Alajuela, Alajuela, Costa Rica

Service/product:
- Collects tire/recycles
- Produces llantion (tire bales)

What do they accept:
- Passenger tires (psr.)
- Light truck tires (lt.)
- Truck tires (t.)

Does not accept:
- Off road tires
- Farming tires

Tire Prep:

Bailer Machine:
- Can only process up to light truck tires
- Truck tires must be cut
  - Side walls removed
  - Cut in half
  - Plus more if needed
- Use all of the tire/No waste
- 75000 psi on bail
- Held together with alumiwell (lasts 50years) or a mixed aluminum and steel (last 8-10 years) number 9 wire
- 100-125 tires per bail
- Processes about 12,000 tires a month

Where tires come from:
- Companies on brochure
  - Represents 50% of Costa Rica's tire market
- Buy for 200 colones
- 2 campaigns for collection in the community
  - Problem with tires being muddy and full of water
- Tires preferred clean
- Tires accepted Mondays and Thursdays
  - Call ahead of time

Bails:
- First started 2, July 2004
- Water can run through bails, does not collect

Weighs approximately a ton
Bails are sold for 15,000 colones per bail
Sold almost 700 this month
Only place that puts 3 treads on the outside of the bail
Due to high volume of truck tires available
Uses for bails:
Build wall and cover with cement
Retention wall
Large walls may need mesh wire and cement
Fill
Helps support ground
Prevent landslide erosion
Cover with dirt
Plants with small root systems can be grown
River erosion
Looking into uses as a floating bridge
Past projects:
Mostly private
Government project 104 bails
Municipalities 132 bales
Two million colones
One week project
San Ramon 111 bales
Limon
River erosion prevention project
Bails were donated
San Carlos
Cattle knoll
Legislation:
Working on writing a “tipping fee” for disposal
It not liked
Automotive shops can charge a disposal fee
Can use this to pay for transport and disposal cost
Decree to be issued by health department
Then every time a tire dealer would charge for disposal
Tire dealers must dispose of tires properly
Cement plant:
Agreement with the cement plant in 2003 to send tires to the cement plant
Cement plant started charging to receive tires

APPENDIX K

Interview June 7th, 2006: Enderezado y Pintura Vegasa

Summary

Juan Carlos Vega is the owner of the shop which specializes in auto body reconstruction, painting, and minor maintenance and repairs to cars, tourism buses, and student transportation vehicles. Eight employees work in three separate shops which combined see 10-20 cars a day. The full interview can be found in Appendix K.

The maintenance shop mainly rebuilds and modifies engines, creating both solid and liquid waste. Their oil as well as solvents, brake fluids, and all other liquid wastes are placed into a single oil drum for disposal, so that it does not contaminate the water. Scrap metal such as aluminum, old engines, brakes, and plastics are also kept in the shop. Once every two weeks, the private company Chavarria Racing Car (CRC), owned by Gilbert Chavarria picks up the full oil drum as well as all of the solid waste for no charge. The liquid waste is brought directly to the Cement Plant in Cartago, while the solid waste is reused or sold to other countries.

The painting section of Enderezado y Pintura Vegasa disposes of their waste, which is primarily liquid, in a similar fashion. An oil drum is kept inside the shop, in which they collect all of the used paint thinners. The drum is then picked up by REMSA, owned by Walter Corrales Villalobos, and brought to their company where it is recycled and reused if possible. No excess paint is generated from the services provided. The painting shop also has a ventilation system. This is a one foot by two foot hole in the ceiling which was attached to a fan and filter. The fumes are filtered before being blown out of the building.

General Information

- Name of business? **Enderezado y Pintura Vegasa**
- Contact Person? **Juan Carlos Vega (owner)**
- Contact Information? **Phone Number: 245-0751, 363-4498**
- Number of employees and working hours? **8 employees, 7:30am-6pm, Monday-Friday**

- Client profile? **All kinds of clients**
- What permits do you have for the operation of your business?
    - Permiso sanitano **Yes**
    - Patente municipal **Yes**

Production

- How many customers on average do you have each day? **3 workshops, 10-20 customers/day total**
- What are your main services/products offered? **Mechanical engine work, straightening, painting, and precision**
- What type of equipment/machinery is used? **Painting chambers, jacks, hydraulics, tools**
- What different types of waste are produced? **Oil, paint thinners, old engines, scrap metal, brake fluid, solvents, degreasers, plastics**
- How often is waste collected from the premises? **Once every 2 weeks**
- How do you dispose of your waste products? **Oil, brake fluid, solvents and degreasers go into one large oil drum which is collected by Chavarria Racing Car (CRC) and brought to the Cement Plant in Cartago. Old engines, plastics, and scrap metal is collected by the same company and reused and recycled. Paint thinners are kept in a separate oil drum and collected and recycled by REMSA.**
- Do you know alternate methods of waste disposal? What are they? **They know about the cement plant and that some metal and used engines can be collected and exported to other countries.**

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials? **All hazardous waste is put into oil drums and collected.**
- What material do you have the most trouble storing on site? **No trouble since the oil drums are collected when they are full**
- What material do you have the most trouble properly disposing of? **No trouble since all material is collected from their shop.**

Storage

- Are there any materials that are stored on site? **Oil, paint thinners, other liquids, used engines, plastics and scrap metal are stored on site until they are picked up.**
- Do you also store waste? **Yes for short periods of time**
- Where do you store this waste? **Liquid waste is stored in oil drums.**
- For how long? **Maximum of 2 weeks (until it is picked up)**

Safety

- What sort of safety precautions are in place? **They use masks and goggles**
- What types of safety equipment is available? **Masks and goggles and a filter and fan in the ceiling to remove fumes.**
- What safety regulations do you currently practice? **Use correct equipment and train their employees.**
- Have you had any on-site accidents? **No accidents in the past 25 years**
- Do you feel that there is a particular area of safety that needs to be improved on? **Not safety but that people don't understand the consequences of their actions**

Evaluation of Working Methods

- Are there waste-related process problems? **No**
- Do you currently have access to materials designed to assist you with cleaner production? **No, very limited materials.**
- Would you be interested in information on possible solutions? How would you like this information to be presented? **Yes**

Environmental Policy

- What do you feel is the best way for you to make these improvements? **They feel that they have a well run business and do not have waste issues.**

APPENDIX L

Interview June 7th, 2006: Autos Kattia Enderezado y Pintura

Summary

We interviewed Luis Diego Sandi, the owner. This was an auto body repair and painting shop with 10 employees. They use a method different from the usual used for shielding cars that are waiting to be painted. Instead of covering cars with paper and masking them, they apply a non-toxic liquid called Spray Mask to other cars in the area to prevent them from getting paint on them. This can easily be removed with soap and water. As with the previous company, their paint thinners are collected in oil drums by REMSA. Scrap metal is kept at the shop until a truck is filled. This is brought to MACO International, a company which buys the excess metal and recycles it.

It was mentioned that there were no brochures or literature available to employees on waste management because they believe that the automotive industry is not of top priority to the municipality. They suggested including more information on the recycling of materials for different uses.

General Information

- Name of business? **Autos Kattia Enderezado y Pintura**
- Contact Person? **Luis Diego Sandi**
- Contact Information? **Phone Number: 236-1708**
- Number of employees and working hours? **10-12 employees, 8am-6pm, Monday-Friday**
- Client profile? **All kinds of clients**
- What permits do you have for the operation of your business?
    - Permiso sanitano **Yes**
    - Patente municipal **Yes**

Production

- How many customers on average do you have each day? **8-10 customers/day**
- What are your main services/products offered? **Straightening, painting, and precision**
- What type of equipment/machinery is used? **Painting chambers, jacks, hydraulics, tools, welding**

- What different types of waste are produced? **Paint thinners, solvents, scrap metal**
- How often is waste collected from the premises? **Once every 2 weeks**
- How do you dispose of your waste products? **Paint thinners are kept in a separate oil drum and collected and recycled by REMSA. Scrap metal is put into a truck, and when filled, sold to MACO International**
- Do you know alternate methods of waste disposal? What are they? **Yes, but they have no specific trouble**

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials? **All hazardous waste is put into oil drums and collected.**
- What material do you have the most trouble storing on site? **No trouble since the oil drums are collected when they are full.**
- What material do you have the most trouble properly disposing of? **No trouble since all material is collected from their shop.**

Storage

- Are there any materials that are stored on site? **Paint thinners, other liquids, \ and scrap metal are stored on site until they are picked up.**
- Do you also store waste? **Yes for short periods of time**
- Where do you store this waste? **Liquid waste is stored in oil drums.**
- For how long? **Maximum of 2 weeks (until it is picked up)**

Safety

- What sort of safety precautions are in place? **They use masks and goggles**
- What types of safety equipment is available? **Masks and goggles and fire extinguishers**
- What safety regulations do you currently practice? **Use correct equipment and train their employees, risk policy from the National Insurance and Social Security Institutes.**
- Have you had any on-site accidents? **No**
- Do you feel that there is a particular area of safety that needs to be improved on? **Yes, people do not want to wear masks, and sometimes do not. Also, smoking near flammable liquids is a problem.**

Evaluation of Working Methods

- Are there waste-related process problems? **No**
- Do you currently have access to materials designed to assist you with cleaner production? **No, very limited materials.**

- Would you be interested in information on possible solutions? How would you like this information to be presented? **Yes, in a brochure highlighting more ways to recycle and reuse waste.**

Environmental Policy

- What do you feel is the best way for you to make these improvements? **They want more government support such as investments, loans, training courses, personal visits.**

APPENDIX M

Interview June 7th, 2006: Taller Albo

Summary

Taller Albo is a family business run by Mauricio Bolanos and has been in operation for 43 years. There are 5 employees that currently work at the shop. They focus on auto body reconstruction and painting; their waste consists mainly of paper as well as dust and paint thinners. They reuse their paint thinners until they become "mud-like". When this happens, they are able to dispose of it with the regular garbage. They send their used oil to Papas Irazu, a potato chip factory in Cartago which uses the old oil as fuel (this is not an authorized use for the chip factory).

General Information

- Name of business? **Taller Albo**
- Contact Person? **Mauricio Bolaños**
- Contact Information? **Phone Number: 240-7840**
- Number of employees and working hours? **5 employees, 7:30am-5:30pm, Monday-Friday**
- Client profile? **All types of clients**
- What permits do you have for the operation of your business?
    - Permiso sanitano **Yes**
    - Patente municipal **Yes**

Production

- How many customers on average do you have each day? **8 customers/week**
- What are your main services/products offered? **Straightening and painting**
- What type of equipment/machinery is used? **Painting chambers, hydraulics, tools, machine to fix dents**
- What different types of waste are produced? **Paper for covering cars while painting, dust, paint thinner, used oil**
- How often is waste collected from the premises? **Not specified**
- How do you dispose of your waste products? **Paint thinners are reused until they turn into a "mud-like" substance and then discarded in the regular garbage. Oil is sent to Papas Irazu, a potato chip company in Cartago.**
- Do you know alternate methods of waste disposal? What are they? **Yes, but they have no specific trouble.**

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials? **Only two people handle the waste.**
- What material do you have the most trouble storing on site? **They have trouble with all of the paper materials.**
- What material do you have the most trouble properly disposing of? **Paper used to protect cars from paint.**

Storage

- Are there any materials that are stored on site? **Paint thinners, until they are able to be thrown away, paper.**
- Do you also store waste? **Yes for short periods of time.**
- Where do you store this waste? **Paint thinners are stored in oil drums and reused. Oil is stored in oil drums.**
- For how long? **Until the paint thinners are ready to be thrown out or the oil is picked up (usually every 2 weeks).**

Safety

- What sort of safety precautions are in place? **They use masks and goggles and suits, and have a fan and a filter in the ceiling to decrease the fumes.**
- What types of safety equipment is available? **Masks, goggles, fire extinguishers, gloves, and suits**
- What safety regulations do you currently practice? **Use correct equipment and train their employees.**
- Have you had any on-site accidents? **Not many, but a few minor accidents**
- Do you feel that there is a particular area of safety that needs to be improved on? **Yes, people do not want to wear masks, and sometimes do not. Also, smoking near flammable liquids is a problem.**

Evaluation of Working Methods

- Are there waste-related process problems? **No**
- Do you currently have access to materials designed to assist you with cleaner production? **No.**
- Would you be interested in information on possible solutions?
- How would you like this information to be presented? **They have been in operation for so long that they are not willing to make changes.**

APPENDIX M

Interview June 12th, 2006: Rere Autocentro

General Information

- Name of business? **Rere Autocentro**
- Contact Person? **Bernardo Sequiera**
- Contact Information? **Phone Number: 240-4000**
- Number of employees and working hours? **9 employees, 7:30am-6pm, Monday-Friday**
- Client profile? **All types of clients**
- What permits do you have for the operation of your business? **Have been in operation 8 years**
    - Permiso sanitano **Yes**
    - Patente municipal **Yes**

Production

- How many customers on average do you have each day? **Did not give information.**
- What are your main services/products offered? **Oil change, alignment, balancing, tire repair, brakes, suspensions, tire sales.**
- What type of equipment/machinery is used? **Gas emission detector, tire balancer, car lifts, oil hoses**
- What different types of waste are produced? **Used oil and engine fluids, used tires, oil filters**
- How often is waste collected from the premises? **Oil: once a week from tanks, tires are collected when they run out of room for them.**
- How do you dispose of your waste products? **Oil is picked up by tank truck, brought to cement plant, it is a contracted collector (follows regulations). Tires are sent out with regular trash, unless there are a lot, then they hired a separate truck, 15,000-25,000 colones. Do not know where these tires go.**
- Do you know alternate methods of waste disposal? What are they? **No. Would like to know where trucks take waste.**

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials? **Yes, from Wagner.**
- What material do you have the most trouble storing on site? **They have trouble with tires.**

- What material do you have the most trouble properly disposing of? **Tires, they are hard to store, do not know where they go. If only a few, they are placed in the regular trash.**

Storage

- Are there any materials that are stored on site? **Used oil.**
- Do you also store waste? **No.**
- Where do you store this waste? **Oil is stored in tanks below maintenance area.**
- For how long? **Picked up every week.**

Safety

- What sort of safety precautions are in place? **They train employees in safety.**
- What types of safety equipment is available? **Goggles, gloves, uniforms, coveralls (to avoid burning).**
- What safety regulations do you currently practice? **Use correct equipment and train their employees.**
- Have you had any on-site accidents? **A few minor accidents, common things (slips, cuts).**
- Do you feel that there is a particular area of safety that needs to be improved on? **No**

Evaluation of Working Methods

- Are there waste-related process problems? **No**
- Do you currently have access to materials designed to assist you with cleaner production? **Not sure.**
- Would you be interested in information on possible solutions? **Yes would like better options for disposing of tires, what is common practice in other shops, would like to know where tires can be reused,**

How would you like this information to be presented? **Said a quick brochure would be useful, a reference to browse that has information at hand.**

APPENDIX N

Interview June 16th, 2006: Tramalin S. A.

General Information

- Name of business? **Tramalin S. A.**
- Contact Person? **Fransisco Bejarano**
- Contact Information? **Phone Number: 240-7794**
- Number of employees and working hours? **2 employees, Monday-Friday (* hours a day)**
- Client profile? **All types of clients including government.**
- What permits do you have for the operation of your business?
    - Permiso sanitano **Yes**
    - Patente municipal **Yes**

Production

- How many customers on average do you have each day? **20 cars a day**
- What are your main services/products offered? **Oil change, general mechanics, tune-up, electrical**
- What type of equipment/machinery is used? **Elevator, alignment computer, manual tools**
- What different types of waste are produced? **Used oil and engine fluids, used tires, oil filters, old parts**
- How often is waste collected from the premises? **Oil: Once a month, tires: anytime needed, old parts: once a week**
- How do you dispose of your waste products? **Oil: have contract with ESSO (oil company); buy oil from them, and then once a month they come and pick it up, and they auto company gets a discount on the next purchase. Tires: RTV a government company picks them up. Old parts go to metal yard.**
- Do you know alternate methods of waste disposal? What are they? **No, believes that they have a good system currently.**

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials? **Yes, 2 employees, so it is not hard.**
- What material do you have the most trouble storing on site? **No**
- What material do you have the most trouble properly disposing of?

Storage

- Are there any materials that are stored on site? **Used oil.**
- Do you also store waste? **No.**
- Where do you store this waste? **Oil is stored in drums before pick up.**
- For how long? **Picked up every month.**

Safety

- What sort of safety precautions are in place? **They are both technically trained.**
- What types of safety equipment is available? **Goggles, gloves, cream for washing oil and fluids off (these can cause cancer).**
- What safety regulations do you currently practice? **Use caution, have insurance for medical treatment.**
- Have you had any on-site accidents? **No**
- Do you feel that there is a particular area of safety that needs to be improved on? **No**

Evaluation of Working Methods

- Are there waste-related process problems? **No**
- Do you currently have access to materials designed to assist you with cleaner production? **Yes, oil company gives instructions and training on how to handle waste.**
- Would you be interested in information on possible solutions? **Yes, believes it is important to know what to do with old parts, so they are disposed of properly.**

How would you like this information to be presented? **Not sure.**

APPENDIX O

Interview June 16th, 2006: Autocentro

General Information

- Name of business? **Autocentro**
- Contact Person? **Jonny Winston**
- Contact Information? **Phone Number: 240-8560**
- Number of employees and working hours? **5 employees, Monday-Friday 8am-5:30pm**
- Client profile? **All types of clients (including companies)**
- What permits do you have for the operation of your business?
    - Permiso sanitano **Yes**
    - Patente municipal **Yes**

Production

- How many customers on average do you have each day? **Did not estimate**
- What are your main services/products offered? **General mechanics, oil change, tune-up, tire repair, brakes**
- What type of equipment/machinery is used? **Gas, scanner, computer**
- What different types of waste are produced? **Oil, used parts, not many tires (give these back to customers).**
- How often is waste collected from the premises? **Oil: every week, old parts: whenever**
- How do you dispose of your waste products? **Oil: is a Castrol company, they come often and have a program for collection. Old parts: collected by individuals who come and ask for them. Oil drums: sold to individuals to clean and reuse.**
- Do you know alternate methods of waste disposal? What are they? **Yes, and also is aware of improper disposal that may be occurring in other shops.**

Handling of Materials

- Do you have any regulations or company policies on how to handle waste or hazardous materials? **Yes, have policies. Old parts just keep together.**
- What material do you have the most trouble storing on site? **None (lots of space).**
- What material do you have the most trouble properly disposing of? **Parts.**

Storage

- Are there any materials that are stored on site? **Parts, oil drums.**
- Do you also store waste? **No.**
- Where do you store this waste? **Oil drums stacked on premise, parts piled together.**
- For how long? **Undetermined.**

Safety

- What sort of safety precautions are in place? **Proper training, equipment, use caution when lifting cars, use jacks.**
- What types of safety equipment are available? **Fire extinguishers, jacks, proper clothing.**
- What safety regulations do you currently practice? **Use caution, do not lift cars by hand.**
- Have you had any on-site accidents? **Minor accidents**
- Do you feel that there is a particular area of safety that needs to be improved on? **Yes, customers get curious, peer into oil changing pits, shouldn't stand so close.**

Evaluation of Working Methods

- Are there waste-related process problems? **No**
- Do you currently have access to materials designed to assist you with cleaner production? **No, Castrol has program information though,**
- Would you be interested in information on possible solutions? **Yes, when people buy batteries don't know where it goes. Other companies should be educated so that they dispose of materials properly.**

APPENDIX P

Visit Notes June 20th, 2006: Ecolcim- a division of Holcim (Cement Plant)

Attended presentation "Integrated Industrial Waste Management Services"
(Above is the self-descriptor of the company)

The name is a new brand, will be changing soon per the request of the head company in Switzerland.

Topics-

AFR- alternative fuel and raw materials

History behind program and idea:

Switzerland has a bad history with landfills, so they started looking at incineration options.

Main process-> kiln, used in making cement. Clinker is the resultant material from the kiln. This is one of the main ingredients in making cement.

Idea-> use energy from waste as industrial fuel, looking for other alternative (cheaper).

5-6 years ago the program started in Cartago. Costa Rica is a small country, the cement plant only distributes materials nationally, does not export cement internationally (though clinker is sent to Nicaragua).

The idealistic goal is to have 100% substitution of fuel to waste materials. Currently the plant is permitted 15% substitution, but is processing less than 10%.

The expensive part is pre-processing- getting the waste ready to go into the kiln.

History:

2000-2004

Tests, obtaining permits, development of infrastructure.

AFR-> ecolcim transition 2005-2006

2007-2010 (Goals)

Service and waste diversification

Expansion of operation within CR and Central American countries (as far as where waste is collected from)

Waste Used:

Small percentage: tires

Used oil-> looking to expand. It is a nice material to use, high energy output. Easy to process.

Large percentage: rubber, iron oxide (scrap metal), vessel sludge.

Looking on INCREASING used oil percentage. Need more collection places.

Main source of tires: was Firestone. These were new, incompliance tires. Now Firestone gives these to Fundellantas and similar companies. A very small amount of the tires they receive are used tires.

Statistics:
This year have used 500 tons of used oil, would like to use 2000 tons.

EQUIPMENT AT FACILITY
Main Burner-> really huge Bunsen burner. Rate of liquids: 1 ton an hour.
Liquids reception bay and contention-> new, still in construction.
Liquids Pre-processing Platform-> when liquids come in drums, it can cause a problem (solvents). They do not process the drums. These are cleaned crushed and sold as scrap metal.
Mixing platform-> gases, volatiles are a problem
Solids Pre-Processing Platform
Grinding, shredding
2"x2" pieces result
Now grinding is no longer used. Only shredding.
Goes to burner as fuel
Laboratory
To check new materials, and pre-processing materials before they are sent to the kiln.
700-1000kg/hr was old facility. Now have a new system. Averages 1,500kg/hr, can go up to 2000kg/hr.

What they would like to offer (not all of these services are currently in place):
AFR
Co-processing
Transport (of materials to facility)
Temporary storage (of materials before processing and burning)
Waste sampling and composition (of materials at source and upon arrival to facility, so they can make suggestions for destination-whether to them or to recycling)
Labeling and packaging (of waste, to make suggestions on disposal)
Audited Destructions (very profitable, not in place yet)
Other waste treatment and handling options
Technical Advisory
Special Cleaning Services
Spill control (because they must have this in place for themselves anyway)
Permitting management (because they have been through the process, so they can give advice)
Waste Monitoring

(All of these come together to form integrated waste management)

Mexico plant has most of these services in place. The cement plant is also much bigger there.

They have a new image, a new vision, new message
Market message "Don't worry about your waste, worry about your business"
(implying that they will handle the waste properly and environmentally)

Still a small operation, trying to expand.

Oil-> have an agreement with Castrol.
ESSO-> goes to other cement company
Shell-> have a truck, take it themselves to the plant
Independent truck-> will go to pick things up
Ecolcim wants to have own truck (currently do not)

Options for small auto shops-> communication seems to be the problem currently, they do not know who to contact, where waste can go.

Program-> shops are looking for disposal options, Ecolcim is looking for waste….needs to be connected.

To get started-> contact commercial department (550-8063)
They will ask:
What type of waste
What it will cost the business

Ecolcim can receive:
Painting
Cleaning supplies
Used safety equipment (gloves)
Oil containers (plastic)
Wants things that can not be recycled (have been contaminated to be hazardous)

Problem with Co-processing
-people do not want to pay to dispose of waste
-small companies will have to pay to dispose of waste.
-they are looking for constant streams, not big deliveries.
CURRENTLY ONLY PAY BUSINESSES FOR USED OIL
-all other wastes cost to leave here, because of the processing expense.
-pays about 1000 colones per drum of used oil.
Small quantities are hard to transport
They do not want businesses trying to transport themselves, they do not have the proper equipment.
Dangerous waste needs a permit to transport. 3-4 drums are okay to pick up.
Small quantities are not able to be picked up.

Able to accept mixed materials?

-Ex: Amanco

Sends three sets of bags: masks, gloves, solvents.

-Prefer waste to be separated and in clear bags, so they can identify it.

-Able to process most things, they just have to be able to separate it.

This is not just incineration-> co-processing

THE "NO" LIST- things they can't or don't want to process

- Anatomical waste
- Hospital waste
- Radioactive items
- Heavy metals
  - Mercury
  - Car batteries
  - Small batteries
- Mineral acids
- Cianides

WOULD NOT LIKE SO MUCH

- PVC
- Fluorescent lamps

Inorganics are better, 14000 tons a week (would like to process, better)

Things that can cause problems with cement:

- Chlorine
- Sulfur
- Heavy metals
- Aluminum
- Phosphorous
- Magnesium

FROM CARS (EXAMPLES): They will take all sorts of plastic (as long as it can't be recycled), foam and cloth (like from seats), tires, glass (if not recyclable), fluids.

The current collection of rubber and pre-processed materials will be gone in 6-7 months if operation runs smoothly (only rubber, plastic). Comes from Terramix (rubber gasket company in Santa Ana). Said that they only have about 4% rejection.

Main goal-> to increase the amount of used oil received, because it is high in energy, simple to pre-process.

Appendix Q

Protocol for Identifying Point Sources

We have developed a preliminary methodology for gathering information on sources of solid waste. This is an important step when researching waste disposal practices because it will allow you to identify what locations and industries require the most focus. The industries can then be prioritized to ensure an effective approach to reducing illegal dumping and debris accumulation. The following steps can be taken to assist in identifying the sources of waste.

Screening Methodology

This method employs a set of screens to determine the amount of waste accumulating in an area, The advantages of implementing this system are a reduction in the possible sources of the waste, an increase in the accessibility of debris accumulation sites, and a method to determine the timeframe that the debris originated during.

The sources of waste are reduced during this method by sectioning off the waterway with the screens. This will confine the waste that accumulates at one screen to the area between that and the screen located directly upstream. This narrows the possibilities to an identifiable number of access locations, businesses, and residences.

Screens increase the access to debris accumulation by collecting waste at the locations where they have been placed. These locations can be selected based on accessibility and favorability to installation. Because screens are able to be viewed on a scheduled basis, a timeframe for the waste accumulation can be observed.

Location Selection

Access points are located at places that are easy to get to. These should be selected for this quality. Access points are commonly located where bridges and roads cross the waterway. It is advantageous to place screens at accessible location because this is also where illegal dumping is most likely to occur. Screens should be located a short distance from each other. It is logical to place these continuously along access points so that a sample can be taken of a larger section of the river. The shorter the

distance between the sites, the easier it will be to conclude where the waste is coming from, and the longer distance that the screens span, the most accurate picture of waste can be determined.

Screen Construction

When constructing a screen consideration must be given to the environment it is installed in. The screen should be tailored to fit the location. This includes adjusting the screen width, mesh size, and support structure.

The mesh should be small enough to collect all of the waste, but allow water to pass through unhindered. The larger the mesh, the less pressure there will be on the screen,

The frame should also be built to the site. The frame needs to support the waste as it accumulates and the increase of water pressure when the mesh gathers debris. The length of time that the screen will be in place should also be considered. Wood will rot and deteriorate faster than metal. The frame of the screen should be fixed to the riverbank in a secure manner.

The screen should be regularly cleared of debris accumulation to reduce pressure on the structure. In scheduling cleaning the amount of waste that collects at each screen must be observed, as well as water level and flow; the schedule can be set after the initial observations.

When recording waste data, waste that is already present in the waterway should be considered as an influence on the outcome. When applied, this methodology will provide an accurate sample of illegally discarded waste.

APPENDIX R

Protocol for Classifying Waste

We have developed a preliminary methodology for classifying waste. This can be used to obtain knowledge of the current situation involving waste practices and illegal dumping in the Canton de Moravia. In order to fully comprehend the situation information must be gathered on the amount and composition of solid waste dumping occurring in the area.

Collection Methods

To collect data on debris location, amount, and composition it is necessary to view the waterway and take visual inventories.

After a study area has been selected, it is necessary to survey the area to obtain a general understanding of the waterway and surrounding land. This includes identifying and recording the location of debris accumulation sites, as well as access points to the waterway. GPS can be used to specify the location of each site, which will be identified through general observations of trash and debris buildup into piles of substantial size (substantial size is defined as accumulation bigger than 1 square meter). Accumulation sites should be split up into small, medium, and large sizes. A small site is anything less than 3 square meters, a medium site is from 3 to 8 square meters, and a large site is anything greater than 8 square meters. Survey samples from both the identified accumulation sites and the general area then must be taken. This involves one collection method.

This collection method should be conducted at the accumulation sites. The location will have already been identified from the general survey, including the size category. We assume that it is not possible to completely inventory every site, so a number of sites using stratified random sampling based on size class should be selected. A random number generator can be employed to select which numbered sites from each classification will be sampled. The composition of each site can be determined by

visiting the location and recording the debris found on the top layer, assuming the percentage of waste by composition to be about equal throughout the whole site.

This method should give an accurate sample of debris found along the river and will allow classification and the composition of the waste in relationship to its location and size, as well as give an estimate on the amount of debris found in the entire study area.

Composition of Waste Determination

After taking samples of waste at the dumping sites and throughout the study area, it is necessary to classify the debris. This can be done through visual observations of the waste and the waste should be classified according to several characteristics. The size of debris and materials found should both be recorded. In order to classify the waste into divisible categories a table should be employed. A sample can be seen below.

Table: Sample of Waste Classification

SAMPLE: COMPOSITION IN AREA 3				
	SOURCE			
	RESIDENTIAL WASTE			
SIZE	*Plastic*	*Metal*	*Paper/wood products*	*Rubber*
small	grocery bags-10	blender- 1	Newspaper-4	scraps-5
	Laundry detergent bottles-6	fork- 4		
	wrappers from food-14			
medium			Cardboard boxes-5	
			wooden chairs-1	
large		bed frame- 1	cardboard boxes-1	
	NATURAL DEBRIS			
small	leaves			
	sticks-18			
medium	branches-5			
large	tree trunks-1			
	COMMERCIAL WASTE			
SIZE	*Plastic*	*Metal*	*Paper/wood products*	*Rubber*
small	milk crate- 4			
	packaging- 2			
medium		rims- 4	cardboard boxes (for parts)- 4	truck tire- 3
large		car hood- 1		construction tire- 2
		oil drum- 2		

The items found in the study area should be classified in the following categories: as plastic, metal, paper and wood products, and rubber. These sub-categories are separated into three umbrella sections of residential waste, natural debris, and commercial waste. Residential waste includes most goods that have been specifically manufactured for that setting. This includes any children's toy, most furniture, and other products such as televisions, and sinks. Commercial waste includes objects manufactured for an industrial or business setting. This includes painting masks, safety equipment such as fire extinguishers, wooden pallets for moving things, and other products commonly found in the setting (desks, office chairs). Natural debris includes anything that occurs naturally in the area surrounding the location of the waste. This includes tree branches, leaves, and flowers.

The items should also be classified by size. Approximations can be employed for the actual sampling process to ensure efficiency of time. The general size should be based on the volume of the object. Objects bigger than .5 meters (cannot be picked up with two hands) are considered large. Objects between .25 and .5 meters are considered medium (can hold in two hands) and objects smaller than .25 meters (can be held in one hand) are considered small. To get the most accurate data, different people should classify the composition of the same waste collected and compare their results. An average should be taken so that the results can be deemed accurate. The waste that is classified can then be compared to the businesses in the area to determine where this waste is coming from.

This method for characterizing waste can be used at accumulation sites that are already occurring in the study area and are accessible, or at sites employing the screening method for identifying sources of illegal dumping, or at a combination of both locations.

APPENDIX S

Protocol for Applying Methodology to Other Areas and Industries

This section will describe how we gathered information on the location of automotive businesses and what we did with this information. It will also describe some of the problems we encountered while performing this methodology.

Locating Businesses

When working in an unfamiliar area maps are needed as a primary step to gain knowledge of the area. We found while in the United States that it is difficult to get detailed maps off location.. However, local governments and companies will have greater access to these resources and should be consulted as project work begins. Once a map is found and analyzed, the field work will proceed with greater ease.

Because this study was intended to located point sources of waste in waterways we first attempted to locate businesses in this area. We found, however, that this was difficult; waterways were hard to find and inaccessible. As an alternative method we located businesses in the urban area. We found that many businesses are located in this area and that they are easy to find and identify. Businesses may also be located in rural areas. These are more difficult to identify due to the large distances that must be traveled to find these.

Data Collection

When collecting primary data to be used in a spreadsheet or database, the name, telephone number, GPS coordinates, a photograph of the business, and the services the business offered are all desired. Difficulties may be found in the following areas when collecting this information:

- The names of the businesses are not always displayed on the outside of the shop.

- Telephone numbers are not always available and some businesses list multiple numbers.
- The accuracy of a handheld GPS can be poor at times.
- It is sometimes difficult to get near the businesses when there is traffic.
- Due to weather, traffic, and obstacles, it may be difficult to get pictures of the fronts of the businesses. Also, business employees are wary of people photographing their shops.
- The services available are not always listed, although in some cases these services are very apparent. General observations of shop services should be double-checked, however, because can be confusing if the business offers multiple services or shares a location with another industry.
- Some businesses operate out of residential districts and in converted buildings; when surveying an area keep in mind that some shop locations may be discreet.

Presentation of Data

Data on business location can be entered into an Excel spreadsheet. This allows a user to update and change information if needed. Business location and information can also be utilized by entering it into a GIS mapping program. This will allow the viewer to connect the geographical and spatial information of the area with the business and industry information.

Conclusions and Recommendations

As stated there can be difficulties encountered when surveying business locations. While gathering information, be aware that signs may be outdated and businesses may be hidden behind walls or gates. This can make distinguishing businesses time consuming and difficult. Preliminary data can be gathered in this way, although more accurate methods should be developed if a detailed survey of the businesses in an area is required.

Interviews

Interviews should be conducted to gain a better understanding of what current business practices are and to get an idea of the level of interest in the industry of changing these. There are some guidelines that should be followed when interviewing businesses to obtain the best results.

Selecting Businesses and Gathering Information

Businesses should be selected based on location, types of service, and size. Determining which characteristics are desirable is a process that should be completed with the intention of gathering information from a diverse and accurate sample of the industry. Advice may be obtained from the Cleaner Production center and the municipal government of the area of interest.

Business interviews can be scheduled ahead of time or conducted without prior communication. As long as the business agrees to the interview, the quality of data obtained is consistent.

We have found that many businesses were very willing to give us information and to answer our questions. Before beginning the interview, the purpose of gathering the information should be explained to the contact. This will assist in gathering information that may be applicable, but that the questions may not directly uncover. It is important to expand upon the prepared discussion topics as the meeting proceeds. Unexpected knowledge may result. Do not let the limitations of the prepared questions restrict you from gathering potentially valuable information.

The interview should be kept to a reasonable length. Interviewees tend to get weary and will not provide all information if they see a long list of questions prepared. It is acceptable to skip a few less important prepared questions in order to pursue a new or innovative piece of information. Be considerate of the contact's time. Do not spend a large amount of time on information that may be gathered through other means. When writing questions consideration should be taken on presenting the material in a method that encourages the response. If the interviewee feels attacked they will not feel comfortable conveying the information desired. Questions that attack the business' practices should be avoided. For example "What wastes do you dispose of

improperly?" is an attacking question. A more effective way of phrasing the question is "What wastes do you have the most trouble disposing?" This question will result in similar information, and will give you an idea of what information the business may be missing, and what they most need assistance with. This methodology should allow accurate and relevant information to be collected easily and effectively.

APPENDIX T

BROCHURE IN SPANISH

CNP+L
COSTA RICA

BUENAS PRÁCTICAS DE LA INDUSTRIA AUTOMOTRIZ

PARA UNA PRODUCCIÓN MÁS LIMPIA Y MÁS SALUDABLE

SITUACIÓN ACTUAL

Las prácticas inadecuadas de disposición de desechos causan que muchos desperdicios y chatarra se tiren directamente en los ríos de Costa Rica y que estos se acumulen en las presas hidroeléctricas afectando su operación. Aproximadamente se acumulan 200 toneladas de deshechos diariamente en cada una de estas presas.

El deshecho que se acumula en las presas reduce la producción de electricidad a la mitad de su capacidad. En el año de 2005, se gastaron cerca de 92 millones de colones para remover estos desechos de una sola presa. Este costo lo terminan pagando aquellos consumidores que consumen la electricidad. Para reducir la cantidad de desechos que se tiran en los ríos, se necesita hacer algo para eliminar esta mala costumbre.

Este folleto contiene información sobre métodos de disposición de desechos que las empresas automotrices en particular así como la comunidad puede seguir para reducir la contaminación ambiental en los ríos y para reducir el costo de generación eléctrica.

VENTAJAS DE LA DISPOSICIÓN APROPIADA

- **Una Comunidad más Limpia** — la disposición apropiada reduce los desechos totales visibles en el área
- **Bajar Los Costos Eléctricos** — la reducción de deshechos en los ríos reducen los costos de su eliminación en las presas y los ahorros logrados se pasan al consumidor
- **Generación de Ingreso** — algunos tipos de desecho se pueden vender a las compañías dedicadas a su disposición
- **Cumplir con la Ley** — al disponerse correctamente de los desechos se esta cumpliendo con la ley
- **Opinión Pública Favorable** — las comunidades vecinas, las empresas y el municipio están tratando de promover una producción más limpia

Opciones De Desecho

	Fundel-lantas	Holcim Cement Plant	CRC	REMSA
Llantas	**SÍ**	**SÍ**	No	No
Aceite	No	**SÍ**	**SÍ**	No
Deluentes	No	**SÍ**	No	**SÍ**
Plásticos	No	**SÍ**	No	**SÍ**
Metal	No	No	**SÍ**	No
*Otro**	No	**SÍ**	No	No

Estos materials incluyen equipo usado do seguridad, recipientes, vidrio, textiles, espumas, materiales de pintura y limpieza, toda clase de fluidos, papel y empaques, Entre materiales no incluidos se encuentran baterías, metales pesados, mercurio, ácidos minerales y cianuros.

Opciones de Desecho	Valor	Servicios
Fundellantas	200 colones/ la llanta	Produce los llantiones (balas de llantas)
Holcim Cement Plant	Llamar para conseguir pagos corrientes/ recibir 1000 colones por el barril de aceite	Utililzan los materials como combustible para funcionar su planta del cemento
CRC	Gratis	Recoge desechos
REMSA	Gratis	Recoge desechos

Información de Contacto

FUNDELLANTAS

Información del Contacto:

Dueño/encargado: Danilo G. Rodríguez
Tel: 386-2722/433-8101
E-mail: zanacr@racsa.co.cr

PLANTA DE CEMENTO (HOLCIM)

Información del Contacto:

Ecolcim– un división de Holicim
Teléfono del Departamento Comercial:
550-8063

CHAVARRIA RACING CAR (CRC)

Información del Contacto:

Dueño/encargado: Gilbert Chavarría M.
Tel: 253-5379
E-mail: crccr@rasca.co.cr

REMSA

Información del Contacto:

Dueño/encargado: Walter Corrales Villalobos
Tel: 110-1213

RECOMENDACIONES

Planeacion

- Leer y entender las leyes y las regulaciones que se aplica a su negocio.
- Aprender qué le sucede al desecho que usted produce
- Establecer metas para mejorar el manejo de desechos
- Motivar a los empleados a que sigan las buenas prácticas

Eficacia

- No ordenar materiales innecesarios
- Utilizar a compañías de la disposición de desechos como las mencionadas previamente
- Remover los desechos a menudo

Organizatión

- Separar sus desechos
- Limpiar derramamientos de líquidos inmediatamente.

Entrenamiento

- Trabajar en conjunto con otros negocios
- Seguir el consejo de salud y de seguridad
- Entrenar a sus empleados

SALUD Y SEGURIDAD

Equipo Protector

- Asegurarse que todos los empleados llevan batas, guantes, anteojos, máscaras, y cascos si es necesario.

Equipo Preventivo

- Cada taller debe tener a kit de primers auxilios, una ducha y lavaojos para emergencia, y extinguidor de fuegos.
- Se deben usar redes de seguridad sobre los pozos para cambio de aceite para evitar accidentes.

Información del Contacto de la Emergencia

- Numeros de telefono para las estaciones de bomberos, policia, y ambulancia deben ser conocidos y exhibidos en una locación central.

Planes de Emergencia

- Se deben tener planes como incendios y derramientos de aceite o otra clase de líquidos

Almacenaje de Materiales

- Materiales deben ser marcados y almacenados en una locación lejos del público.

¡NO FUMAR!

Este folleto se hace posible por:

WPI

Worcester Polytechnic Institute

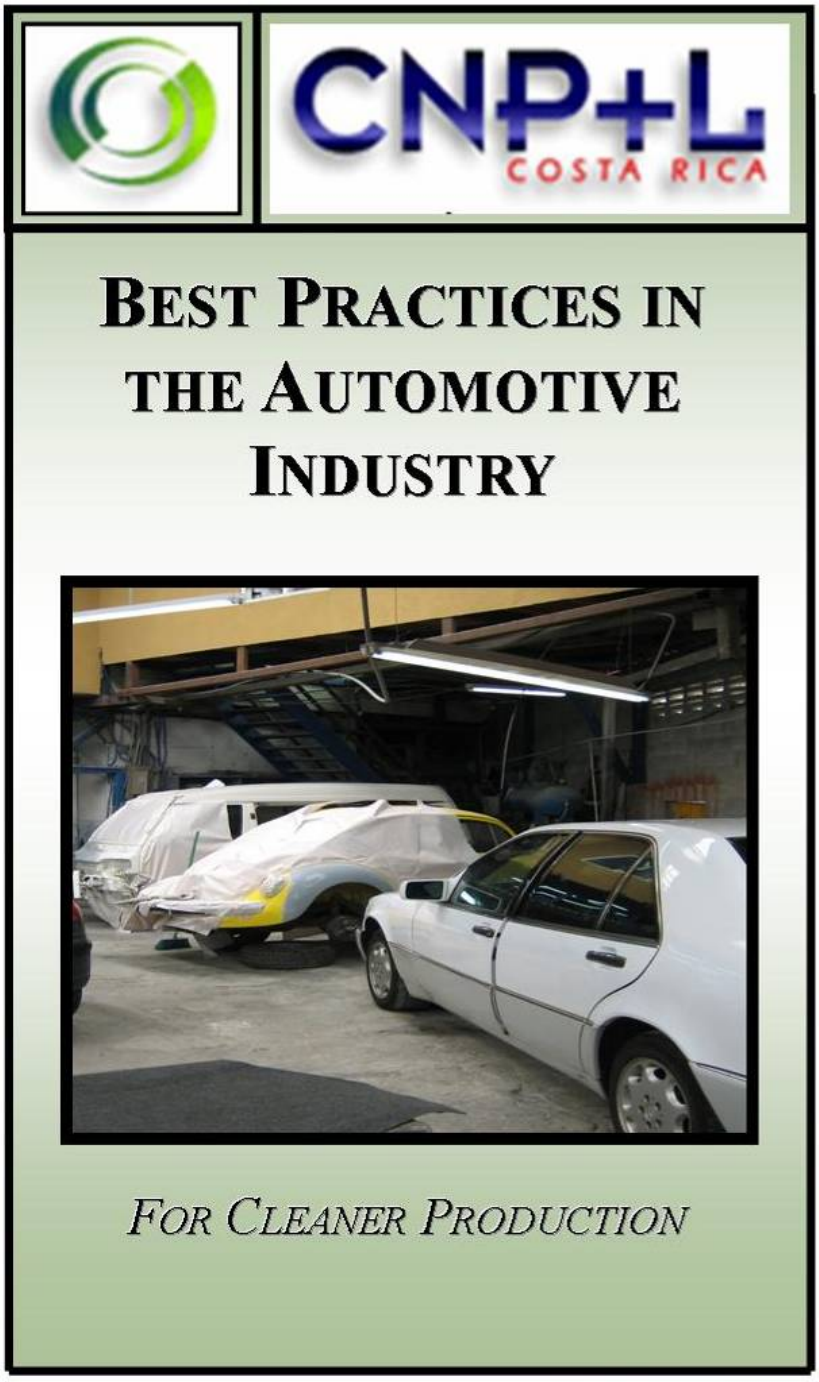
CENTRO NACIONAL DE PRODUCCIÓN MÁS LIMPIA

TELÉFONO: (506) 281-0006
FAX: (506) 234-6163
APDO 10104-1000 SAN JOSÉ, COSTA RICA

CNP+L COSTA RICA

APPENDIX U

BROCHURE IN ENGLISH



CURRENT SITUATION

Poor waste disposal practices result in solid and liquid debris in the waterways of Costa Rica which in turn collects at the hydroelectric dams. Up to 200 tons of waste can accumulate daily at individual facilities.

Waste that collects at the dams reduces electric production by up to half. $180,000 was spent in 2005 on waste removal from a single dam. This cost is passed onto the electrical customers. To reduce the amount of debris in the rivers, the waste must be stopped at its point sources.

This brochure contains waste disposal options which are environmentally responsible. With improved waste management and waste disposal practices from the automotive business as well as the entire community, the debris in both the waterways and your neighborhood will be reduced.

BENEFITS OF PROPER DISPOSAL

- **Cleaner Community**— proper disposal reduces the overall waste present in the area
- **Lower Electric Costs**— reduced amounts of waste decreases clean up costs; savings are passed onto the consumer
- **Possible Income**— some types of waste can be sold to disposal companies
- **Legislature**— proper waste disposal follows current laws and regulations
- **Favorable Public Opinion**— neighboring houses and businesses and the municipality are looking to promote cleaner production

DISPOSAL OPTIONS

	Fundel-lantas	Holcim Cement Plant	CRC	REMSA
Tires	**YES**	**YES**	No	No
Oil	No	**YES**	**YES**	No
Paint Thinners	No	**YES**	No	**YES**
Plastics	No	**YES**	No	**YES**
Scrap Metal	No	No	**YES**	No
*Other**	No	**YES**	No	No

* This material includes used safety equipment, containers, glass, cloth, foam, cleaning and painting supplies, all fluids, paper, and packaging. Things not included are batteries, heavy metals, mercury, mineral acids, and cyanides.

Disposal Options	Cost	Services
Fundellantas	200 colones per tire	Produce tire bales for retaining walls
Holcim Cement Plant	Call for Current Prices/ Pays 1000 colones per oil drum	Use materials as fuel to operate their cement plant
Chavarria Racing Car (CRC)	Free	Collects materials
REMSA	Free	Collects materials

CONTACT INFORMATION

FUNDELLANTAS TIRE RECYCLING PLANT

Contact Information:

Owner/Manager: Danilo G. Rodriguez
Tel: 386-2722/433-8101
E-mail: zanacr@racsa.co.cr

CEMENT PLANT (HOLCIM)

Contact Information:

Ecolcim- a division of Holcim
Commercial Department Tel: 550-8063

CHAVARRIA RACING CAR (CRC)

Contact Information:

Owner/Manager: Gilbert Chavarría M.
Tel: 253-5379
E-mail: crccr@rasca.co.cr

REMSA

Contact Information:

Owner/Manager: Walter Corrales Villalobos
Tel: 110-1213
E-mail: remsai@rasca.co.cr

RECOMMENDATIONS

Planning
- Read and understand laws and regulations that apply to your business
- Learn what happens to your waste
- Set goals on improving waste management
- Provide incentives to employees for good practices

Efficiency
- Do not order excess materials
- Use waste disposal companies
- Remove waste often

Organization
- Separate your waste
- Keep work area clean and organized

Training
- Work together with other businesses
- Follow health and safety advice
- Train your employees

HEALTH AND SAFETY

Protective Equipment
- Make sure employees are wearing coveralls, goggles, gloves, masks, and hard hats when needed.

Precautionary Equipment
- A first aid kit, emergency shower/ eye wash station, and fire extinguishers should be present in each shop.
- Safety nets should be placed over oil pits to prevent accidents.

Emergency Contact Information
- Fire, Police, and Ambulance telephone numbers should be known and posted in a central location.

Emergency Plans
- Plans should be in place for emergencies such as fires or oil/liquid spills.

Storage of Materials
- Materials should be properly labeled and placed in a location away from the public.

NO SMOKING
- Employees should not smoke near flammable materials or inside the shop.

This brochure is made possible by:

WPI

Worcester Polytechnic Institute

CENTRO NACIONAL DE PRODUCCIÓN MÁS LIMPIA

TELÉFONO: (506) 281-0006
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GLOSSARY

Canton of Moravia- A section of San José located in the northeast portion of the city with a population of 50,419 people and a total area of 2,862 square kilometers.

Clinker- a product of cement processing. Composed of tricalcium silicate, dicalcium silicate, tricalcium aluminate, and calcium aluminoferrite, it has been kilned and then crushed.

Debris- Carelessly discarded refuse; litter. Or in the case of *natural debris* the remains of some natural object (plant, animal or mineral) that has been broken.

Dengue Fever- A disease common to tropical and sub tropical areas and is carried by mosquitoes. Symptoms of typical uncomplicated (classic) dengue usually start with a fever within 5 to 6 days after being bitten by an infected mosquito and include high fever, up to 105 degrees Fahrenheit, severe headache, retro-orbital (behind the eye) pain, severe joint and muscle pain, nausea and vomiting, and rash

Good Housekeeping- Practices that can greatly decrease the amount of waste that is generated and provides a safer environment.

Head- The height of the standing water above a dam; a body of water kept in reserve at a height.

Hydrological Cycle- The cyclic transfer of water vapor from the Earth's surface via evaporation into the atmosphere, from the atmosphere via precipitation back to earth, and through runoff into streams, rivers, and lakes, and ultimately into the oceans.

Installed Capacity- The total of the capacities shown on the nameplates of the generating units in a power plant.

Maximum Expected Conditions- these are the worst conditions that the structure can be expected to undergo. For example: Heavy winds on a cold night with flooding and rising water.

Open Dumps- Any facility or site where solid waste is disposed of which is not a sanitary landfill and which is not a facility for disposal of hazardous waste.

Silt- A sedimentary material consisting of very fine particles intermediate in size between sand and clay. Silt is produced by the mechanical weathering of rock due to grinding by glaciers, eolian abrasion (sandblasting by the wind) as well as water erosion of rocks on the beds of rivers and streams. Silt can occur as a deposit or as material transported by a stream or by a current in the ocean.

Solid Waste- Any unwanted solid substance or material, which could result from industrial, commercial, mining, and agricultural operations, and from community activities.

Suspended Matter- Matter that remains in suspension in water for a considerable period of time without contact with the bottom. Such material remains in suspension due to the upward components of turbulence and currents and/or by suspension.

Turbine- Any of various machines in which the kinetic energy of a moving fluid is converted to mechanical power by the impulse or reaction of the fluid with a series of buckets, paddles, or blades arrayed about the circumference of a wheel or cylinder.

Virilla River Basin- Consisting of 1000 square kilometers in the western Central Valley in Costa Rica, the Virilla River Basin defines a portion of the Tarcolés River Basin and contains both the Virilla and Uruca Rivers.

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