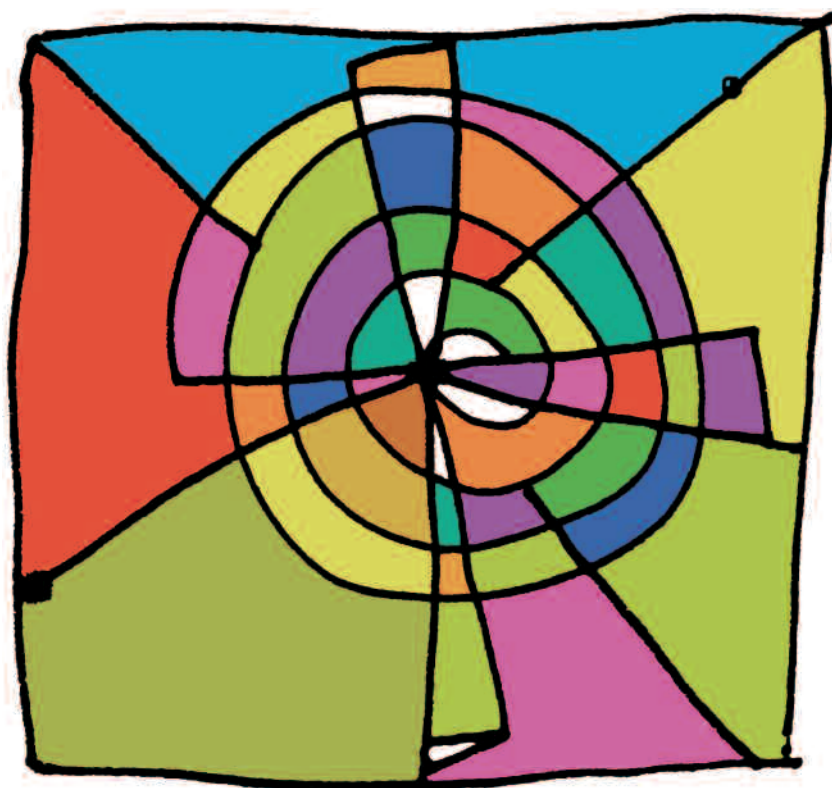


LISTENING TO THE EARTH

An Environmental Audit
For Benedictine Communities



by

Benedictine Sisters of Erie, Pennsylvania

at Lake Erie-Allegheny Earth Force



About the authors:

This Environmental Audit for Benedictine Communities in Central and South America was prepared under the direction of members of the Benedictine Sisters of Erie, PA whose work with Earth Force, Inc. gives expression to the Community's commitment to Ecological Stewardship.

Principal author, William L. Bartlett, graduated from Edinboro University of Pennsylvania with Bachelor's degrees in Philosophy and Mathematics; he has been an advocate for environmental protection and human rights through his work with various non-profit making organisations. Presently he is preparing to spend a year serving as an Americorps volunteer working with Lake Erie-Allegheny Earth Force, where he will continue to work with groups of youth trying to implement sustainable changes in their communities. He remains very grateful for the Benedictine community of Erie, and for his beautiful son who was born during the preparation of this manual.

Annette Marshall, OSB has served as Director of Administration for the Western Pennsylvania (USA) branch of Earth Force* since 1997. After twenty-five years as teacher and school administrator in Catholic elementary and high schools, she now enjoys sharing her love for nature and her commitment to developing the next generation of civic leaders with school teachers and youth leaders.

Pat Lupo, OSB has served as Program Director for the Western Pennsylvania (USA) branch of Earth Force since 1997. Daily through the education of teachers and students and in her personal commitment to local, state, national and bi-national boards, Pat models responsible citizenship and environmental stewardship.

Margarita Dangel, OSB has served as Education Director for the Western Pennsylvania (USA) branch of Earth Force since 1997. Her position as a summer camp director and assistant for environmental education at the Benedictine owned center prepared her in many ways to guide youth and educators to become actively involved in their community. Her goal is to help young people realize that they are really needed in their community and that they can contribute to finding solutions to environmental problems.

* www.earthforce.org/section/offices/lea

Cover image: "Web of Life" painting by Daniel Fallshaw
www.artofcreation.co.uk.

LISTENING TO THE EARTH

An Environmental Audit
for Benedictine Communities

by

William L Bartlett
Margarita Dangel OSB
Pat Lupo OSB
Annette Marshall OSB

Lake Erie-Allegheny Earth Force, Erie, PA, USA

This publication is funded by The World Bank's Faiths and Environment Initiative* with support from the President's Contingency Fund in partnership with ARC (Alliance of Religions and Conservation)†

The authors would like to thank:

Joanne Robinson – Handbook Co-ordinator, ARC
Tony Whitten – Coordinator, the World Bank's Faiths and Environment Initiative
Bekir Onursal and John Morton – World Bank peer reviewers
Richard Prime – designer
P. Martin Neyt OSB and Gisela Happ OSB – AIM, Alliance Inter-Monastères, Paris
Jordi Sánchez – translation into Spanish
IoL Language Services Ltd (Débora Chobanian) – translation into Portuguese

Published in London 2006
This edition is also published in Spanish and Portuguese

© Earth Force, Inc. 2006

* www.worldbank.org/faithsandenvironment

† www.arcworld.org

Contents

FOREWORD *by Joan D Chittister OSB* vii

ABOUT THIS MANUAL ix

INTRODUCTION 1

1 BENEDICTINE LIFE AND MINISTRIES

Environmental Stewardship in Benedictine Life: Assessment 5

Environmental Stewardship in Benedictine Life: Inventory 6

1. Prayer and Liturgy 6
2. Ministries 6
3. Community Policy 6
4. Community Leadership 7
5. Community Resource Management 7
6. Investments 7

Environmental Stewardship in Benedictine Life: Evaluation 7

1. Prayer and Liturgy 7
2. Ministries 7
3. Community Policy 8
4. Leadership 8
5. Resource Management 8
6. Investments 8
- Conclusions 9

2 AIR

Overview of Chapter: Air Pollution, Indoor and Outdoor 13

- Air, Earth's Sacred Gift 13
- Combustion 13
- Definitions 13
- Overview of Outdoor and Indoor Air Pollution 16

Outdoor Air Pollution: Assessment 16

- This Chapter's Assessments 16
- Our Atmosphere: A Gift to be Preserved . . 16
- Problems in the Air 17

The health effects of air pollution 18

What's causing the problems? 19

What's being done? 20

What can we do? 20

Outdoor Air Pollution: Inventory 20

1. Vehicles 20
2. Community Transportation Practices . . 21
3. Public Transportation 22
4. Other Internal Combustion Engines . . 22
5. Other Combustion 22
6. Ozone depleting substances 23
7. Herbicides and Pesticides 23
8. Community Tree Preservation 23
- 9A. Expert Environmental Information Source 23
- 9B. Expert Public Health Information Source 24

Outdoor Air Pollution: Evaluation 24

1. Community Vehicles 24
2. Community Transportation Practices . . 27
3. Public Transportation 29
4. Other Combustion Engines 30
5. Burning 30
6. Ozone Depleting Substances 31
7. Pesticides 31
8. Community Tree Preservation 31
9. Expert Information 32
- Conclusions 33

Indoor Air Pollution: Assessment 34

Air pollution—Inside 34

Indoor Air Pollution: Inventory 34

1. Types and uses of community fuel 34
2. Getting fuel; buying and gathering . . . 35
3. Fuel drying (for biomass fuels) 35
4. Health and Wellbeing 36
5. Smoking 36
6. Ventilation of the Kitchen area 36
7. The stove 36
8. Smoke extraction 37
9. Education, Policy, and Civic Engagement 38

Indoor Air Pollution: Evaluation 38
 1-2. Types, Uses, Costs of Community’s
 Fuel. 38
 3. Fuel Drying 39
 4. Health and Wellbeing 39
 5. Smoking 39
 6. Ventilation of the kitchen area. 39
 7-8. The stove and smoke extraction 40
 9. Education, Policy, and Civic Engagement 41
 Conclusions 41

3 DRINKING WATER

Water: Catalyst and Crisis. 45
 Water: The Catalyst of Life 45
 Water: Global Crisis 45
 Uses and Abuses of Water Resources 46
 Assessment of Community Practices 47

Drinking Water Quality and Source

Protection: Inventory 47
 1. Main Drinking Water Source. 47
 2. Potential sources of pollution: 48
 3. NGO involvement 48
 4. Community Water Governance 49
 5. Water Quality Testing 49
 6. Water Treatment by the Community. . . 49
 7. Water Storage. 50

Drinking Water Quality and Source

Protection: Evaluation 50
 1. Water sources 50
 2. Water Source Pollution Hazards 51
 3. Water resource protection committee . . 52
 4. Water Governance 52
 5. Water quality testing 53
 6. Water Treatment 54
 7. Water handling. 55
 Conclusions 56

Site-Specific Source: Assessment 57

A Surface Water 57
 B Dug Well 57
 C1 Borehole: Deep with Mechanized
 Pumping. 58
 C2 Borehole with Handpump. 58
 D Spring 59
 E Rainwater Collection and Storage 59
 F Vendors (Tanker Trucks) 59
 G Piped Water (General) 60
 G1 Piped Water (from Storage Tank) . . . 60
 G2 Piped Water (from Water Provider) . . 60

Site-Specific Source: Evaluations. 61
 Surface water (A) 61
 Ground Water: Overview 61
 Ground water: Dug wells (B) 62
 Ground water: Boreholes (C) 63
 Ground water: Springs (D). 65
 Rainwater (E) 67
 Water vendors (F) 67
 Piped Water (G) 67

Water Conservation: Inventory 69

1. Monitoring Water Consumption 69
 2. Leaks and plumbing fixtures 69
 3. Water Provider’s Practices 70
 4. Education and Personal Habits 70
 5. Using Greywater. 70

Water Conservation: Evaluation 70

1. Monitoring Water Consumption 70
 2. Leaks and plumbing fixtures 71
 3. Water Provider’s Practices 71
 4. Education and Personal Habits 72
 5. Using Greywater. 72
 Conclusions 73
 46 Ways of Saving Water. 74
 Saving Water Outdoors 75
 General Water Saving Tips. 75

4 SANITATION AND WASTE

Overview: Sanitation, Municipal Waste, and Hazardous Waste. 79

Community Excreta Handling and

Sanitation: Introduction 79
 Ecological Sanitation 79
 Sanitation and Population Explosion: A
 Deadly Mix? 80
 Excreta: Environmental Pollutant and Health
 Hazard 80
 Sewered Sanitation Technology: Problematic
 and Unsustainable 80
 Sustainable Approach to Sanitation, and this
 Assessment 82

Community Excreta Handling and

Sanitation: Inventory 82
 1. Mix or No-Mix. 82
 2. Soil conditions 82
 3. Characteristics of Sanitation System: . . 82
 4. Resource Recovery 83
 5. Sewer Network. 83
 6. Waste Water Treatment 84

7. Hygiene Behavior 85

8. General Sanitation Practices 85

Community Excreta Handling and Sanitation: Evaluation 85

1. Mix or No-Mix 85

2. Soil Conditions 86

3. General Characteristics of Sanitation System 86

3i. Characteristics of Sanitation System: Plumbing 93

3ii. Characteristics of Sanitation System: Components 94

3iii. Characteristics of Sanitation System: Emptying 97

Evaluation of Sanitation Facilities (3-3iii) . 97

4. Resource Recovery 97

5. Sewer Network 100

6. Wastewater Treatment 101

7. Hygienic Behaviors 103

8. General Sanitation Practices 103

Conclusions 104

Community Solid Waste Management: Assessment 105

Preserving the Gifts of Garbage 105

The Inherent Dangers of Solid Waste . . . 105

The Waste Crisis: A Burden Borne by the Poor 106

Contributions to the Mismanagement of Waste 109

What's Being Done? 109

Community Action 110

Community Solid Waste Management: Inventory 110

1. Community Waste Generation Survey 110

2. Community Waste Collection and Disposal 112

3. Solid Waste Collection 113

4. Recycling 113

5. Land Disposal 114

6A. Waste Handling Workers or Workers' Association 115

6B. Governmental Regulatory Agency . . . 116

6C. Environmental Information Source . . 116

6D. Expert Public Health/Safety Information 116

7. Cleaning of Public Areas 117

8. Education 117

Community Solid Waste Management: Evaluation 118

1. Community Waste Generation Survey 118

2. Community's Practice for Solid Waste Collection and/or End-Disposal 119

3. Solid Waste Collection 121

4. Recycling 122

5. Land Disposal 123

6. Seeking Expert Information 125

7. Cleaning of Public Areas 126

8. Education 127

Conclusions 128

Hazardous Products and Wastes: Assessment 129

An Overview of this Assessment 129

What is Hazardous Waste? 129

How Hazardous Waste Affects Health . . . 130

How Hazardous Waste Affects the Environment 130

What needs to be done? 132

Your Community's Responsibility 133

Hazardous Products and Wastes Handling: Inventory 133

1. Hazardous Product Survey 133

2. Hazardous Product Handling 134

3. Quantities and Priorities 135

4. Legislative Policy Framework and Regional Resources 135

Hazardous Products and Wastes Handling: Evaluation 136

1-2. Hazardous Product Inventory and Handling 136

3. Quantities and Priorities 149

4. Legislative Policy Framework and Regional Resources 149

Conclusions 150

5 ENERGY

Energy: The Animation of the Universe 155

Properties of Energy 155

Many Forms of Energy 155

Electricity, a Special Form of Energy . . . 156

Electricity: Modern 'Utility' 156

The Grid and Social Inequality 157

Producing Electricity, Creating Catastrophes? 157

Sustainable Alternatives 159

Keeping Energy Sacred 159

Electricity Production Practices: Inventory 160

- 1 Community Consumption 160
- 2 Community Generative Potential 160
- 3 Community Generative Practices 160
- 4. Sources of Expert Information 161
- 5. Electricity Provider Governance 162
- 6. Public and Environmental Safety 163
- 7. Provider Quality 163
- 8. Community Practices and Education . . 163

Electricity Production Practices:

Evaluation 164

- 1. Community Consumption 164
- 2. Community Generative Potential 164
- 3. Community Generative Practices 165
- 4. Sources of Expert Information 169
- 5. Electricity Provider Governance 169
- 6. Public and Environmental Safety 170
- 7. Provider Quality 171
- 8. Community Practices and Education . . 171
- Conclusions 172

Conservation Practices: Inventory 173

- 1. Community Energy Use 173
- 2. Air Conditioning/Cooling 173
- 3. Air/Space Heating 174

- 4. Refrigeration and Freezing 176
- 5. Water Heating 176
- 6. Lighting 177
- 7. Electric Motors and Pumps 177
- 8. General Conservation Practices 177

Electricity/Energy Conservation:

Evaluation 178

- 1. Community Energy Use 178
- 2. Air Conditioning/Cooling 178
- 3. Air/Space Heating 181
- 4. Refrigeration and Freezing 181
- 5. Water Heating 182
- 6. Lighting 183
- 7. Electric Motors and Pumps 183
- 8. General Conservation Practices 184
- Conclusions 184

6 AFTER THE AUDIT: DEVELOPING AN ACTION PLAN

- Prioritizing 187
- Evaluating Options 188
- Generating an Action Plan 189

Appendix: General Resources 190

Foreword

A Benedictine Consciousness Whose Time Has Come—Again

by Joan D. Chittister OSB

If you are wondering why you are even considering such a thing as an ‘environmental audit’ in a life that seems so removed from such processes, consider the time in which you live.

There are two moments in history when Benedictinism has been needed in a very special way: the first was in the 6th century; the second is now.

In the 6th century, Europe was reeling from the loss of civil order and the breakdown of agrarian communities. Farm lands lay in ruin from the movement of foreign invaders across Europe, trade routes were unsafe with the loss of the Roman Legions and the countryside was left overgrown and in ruins.

To that sorry state, Benedictinism brought a new system of order, a new pattern of life, a new commitment to the land and to life. Almost 700 years later, Cistercian groups again devoted themselves to the reforestation, the replanting and the reclamation of some of the worst land in Europe.

As a result of those conscious efforts, Europe became a garden again. Life thrived. People organized themselves into productive communities. Agriculture flourished everywhere.

Now, in this last century, our own century, after over 100 years of erosion, pollution, and the diminishment of natural resources by most unnatural means, the whole world is becoming alert to the relationship between the gift of creation and sins against creation again.

The garden we were given to live in as a people, we have failed to tend. The solemn commitment we made as a species to steward the fruits of the earth we have failed to honor.

On the contrary. We have all taken it for granted, even while it was being plundered right in front of our eyes.

The industrial revolution that made the robber barons rich also made the globe poor: We poisoned our fresh waters and drowned them in tin cans and coffee cups. We wasted our forests and drained the world of their medicinal herbs. We turned farmland into grazing land to make cheap hamburgers and so denied the people of the land, the very land they needed to live. We belched gasses into the atmosphere till people died from the lack of fresh air. We saturated our farmlands with chemicals which, in the end, ironically, bled them dry of nutrients. We stripped the globe of whole species of animals. We dealt carelessly, recklessly, heedlessly and arrogantly with the very resources that sustained us.

Now, we find ourselves locked in mortal struggle between those who are trying to redeem those resources and those who are simply committed to making even more quick money on what’s left of them. We find ourselves faced with those whose philosophy of life is “after me the deluge,”—who use what’s available without restraint and leave the problem of scarcity to generations to come—and those who simply fail to understand the magnitude of the problem and so go on blindly, using what we should be saving, destroying what we cannot do without.

Time is of the essence; the future is at stake. We are choosing between a philosophy of consumption that gobbles up the world for its own satisfaction and a philosophy of co-creation that is committed to preserving natural resources for the sake of those to come.

We are choosing now between those who are willing to drain the present for the sake of personal gratification and those who, loving the present, love it enough to preserve its richness for the sake of the future, as well.

Clearly the whole world needs Benedictinism again, needs a mindset that cares for the tools of life “as if they were vessels of the altar.” We need a sense of balance, of enoughness, of stewardship and a sense of the eternal presence of God. We need a life lived in harmony with the seasons, the sun, the self and the other.

For Benedictines, an environmental audit is not a fad. It is not a social nicety. It is certainly not an option. It is simply a contemporary manifestation of an ancient commitment to the rhythm of the earth, the needs of the community and the God of Creation.

Congratulations to those who see its sacramental value, its claim to the Benedictine heart. They shall be called blessed for centuries to come, just as our ancestors before us.

Preface

About This Manual

Intentions

This manual was assembled specifically for Benedictine religious communities in the Latin American and Caribbean (LAC) region. Nevertheless, the majority of the manual's content can easily be applied to any population, especially those living in the LAC region. While most of the explanatory text focuses on the conditions of the LAC region, the main environmental principles that underlie the regional—specific information are applicable to any region of the world. It was intended that this manual be as broad as possible, give attention to both rural and urban environments, but address only those issues that can be affected by the actions of ordinary citizens.

The main intentions of this manual are to (1) educate the reader about environmental problems and crises being faced by the world's populations today, (2) to provide the communities that utilize the manual with a means of assessing how their daily practices may contribute to these problems, and (3) offer ideas and resources regarding better practices.

Thus, each subject area consists of three segments: an introduction, an inventory, and an evaluation. The introductions provide background information about the subjects at hand, including the scope and importance of the problems, and how individuals' actions contribute to the problems. The inventories, then, are series of questions which are suggested approaches to inventorying the behaviors of community members. Lastly, each suggested inventory is followed by an evaluation section that provides more information specific to the questions asked in the inventory sections.

Terminology

Since this manual was written specifically for religious communities, throughout the work, the word "community" will often be used. When the word is left unqualified, it may be assumed that the referent of the word is your religious, or intentional community. If the larger population of a barrio,

municipality, or town is implied, the word "community" will be qualified with adjectives such as "larger" or "greater."

Premises

The following controversial presumptions underlie the content of this manual:

- 1) That a respect for Creation, or reverence for the environment to which we are intrinsically connected, is an essential spiritual attitude.
- 2) That industries, governments, and municipal operations (like water suppliers, trash haulers, etc) should be operated in a transparent and democratic manner; that is, that citizens should both be able to know how a system is operating and be able to directly influence the operation.
- 3) Best practices are those that minimize or eliminate adverse environmental impacts.
- 4) That despite the enormity of the environmental problems being faced—which are often large enough and serious enough to be called crises—there is still hope that future generations may still live on this earth, and thus that actions we take today can make a difference.

Guidance for using this manual

For ease of understanding, it is recommended that the introductory material—contained in the Preface and Introduction—is read in its entirety before reading the main text. It should be noted that the chapters in the main text are not organized in a chronological or methodological order; that is to say that the chapters may be used in any order. The last chapter, "Developing an Action Plan," is intended to help guide communities into a decision making and action planning process after conducting one or more inventories. Thus, this chapter can be read as soon as the community is ready to take action. The resources found in the appendix can be used throughout the process. It is recommended that

you review the appendix before beginning the work of the audit so that you may be familiar with the resources available to you in your work.

As mentioned before, each chapter begins with an introduction section that provides background information about the subject at hand. Following the introduction are one or more assessments which focus upon a particular set of practices. The assessments will vary in their applicability to an individual community's characteristics, and a community can choose which assessments it will perform. Nevertheless, it is recommended that an entire chapter be read over completely before making the decision, as some parts of an assessment may be found to apply even when most of it does not.

Content sources and acknowledgements

This manual was mainly edited in the United States by an English speaking editor. It was composed primarily with resources publicly available on the Internet, and all attempts have been made to acknowledge the actual sources used. (See the Endnotes.)

Given these characteristics, there are several weaknesses to the manual which suggest possible improvements. The three most important weaknesses, in the authors opinion are:

- 1) The resources used were written in English,

thus the entirety of available Spanish literature was not utilized, with very few exceptions.

- 2) The inventories are intended to analyze the practices that are shared in a general way by the population of the LAC region. As such, they do not adequately account for the vast diversity of living conditions encountered throughout this region. Thus, each inventory can at best be considered a suggested list of questions to ask. This work in no way can make a claim to provide a thorough analysis of a community's total contribution to environmental pollution.
- 3) The majority of entries provided in the appendix unfortunately assume that internet connectivity is available. As well, there is an overabundance of English resources.

Nevertheless, the amount of information provided by numerous citizens, agencies, industries, and governments around the world that is pertinent to the environment of LAC is truly amazing and beautiful. Much gratitude is given by the authors of this manual to all those working towards a sustainable future, especially those that publish their material for the benefit of all humanity.

Un otro mundo *es* posible!

Introduction

Steps to a Successful Environmental Program

Congratulations for your environmental stewardship! The very fact that you are reading this publication is evidence that your community has within it a seed for improving your community's environmental practices. Hopefully, like you, your religious community has the will to live sustainably; nevertheless it takes more than just will-power to achieve this, and the intention of this publication is to help you go further.

In our present world, it is becoming ever more important that communities adopt a sustainable manner of life that is in harmony with nature and not opposed to it. Today, in all countries, we are facing the grievous effects of atmospheric degradation, water pollution, and soil depletion. Aside from upsetting the intricate balances found within God's creation, we are now finding that chronic, debilitating, and often fatal, human diseases are on the rise. And it is our day-to-day habits that make the greatest contribution to the ongoing ecological devastation.

To get the most out of this manual, it is recommended that your community establish an ongoing Environmental Program. An Environmental Program implies that there is a team of people that are charged with the oversight of community environmental practices. This team, or committee, ensures that your community's practices are continually moving towards improving the relationship between your community and the Earth. Hopefully, with the resources found herein, you will be able to assess your community's ecological impact, find policies and practices that need to be changed, and gain ideas for more sustainable alternatives. The goal of a successful Environmental Program is to change your community's practices in a permanent manner. This requires thoughtful analysis, evaluation, and planning by a dedicated committee.

Guidelines for Establishing a Successful Environmental Program

1. Create a team or committee to take charge of the work of the Environmental Program.

In general, the best way to approach the implementation of an Environmental Program in your community is to form a team that is responsible for carrying out the work of the audit, assessing the results, producing ecological alternatives, and then helping the community to implement the changes. Perhaps this work may begin with one or more motivated individuals in your community who would like to increase the environmental stewardship of your community, or maybe it begins with a directive from above; but whatever provides the initial impetus for the project, it is important that there is an identifiable head or executive member of the project. Besides the executive member, it is important that representatives from each department or service branch of your community serve on the committee (e.g. housekeeping, administration, grounds-keeping, ministries, etc...) Beyond this, any other interested members of the community can volunteer to serve on the committee.

Characteristics of an Environmental Program Team

- **Leadership:** Someone in charge and accountable for the Program
- **Regular Communication:** Hold regularly scheduled meetings to discuss progress and share new information or ideas
- **Recordkeeping:** Record meetings, discussions, and progress
- **Shared vision:** Develop and share a vision of what your community will look like at the height of ecological stewardship.
- **Consensus:** Cooperative decision-making to ensure a unified orientation
- **Longevity:** Maintain the Program's team to continue progress

The committee should begin by establishing common ground by agreeing to fundamental principles that will guide the work of the program (e.g. a respect for Creation), and then extrapolating these principles into a shared vision of what your community could achieve someday if it were to realize all these principles in everyday practices.

2. Community Environmental Inventory

The next major task of the team is to identify your community's environmental problems or threats and related community information, including its strengths. This is the step where your team gains awareness and creates visions: i.e. seeing "what is" and "what can be" more clearly, in terms of environmental risks and sustainable development. This is the step in which the chapters that follow can be utilized most effectively.

In addition, it is recommended that you identify and analyze relevant public and private policies in addition to your community's policies and practices. Examine who makes policy and how, and strive to understand different perspectives on issues.

In using this manual, it may be helpful to choose to work on only one section, or environmental topic, at a time. Several of the assessments included in this manual are fairly involved, and so several problems may be identified within one assessment. Thus, to prevent being overwhelmed by data, problems, and options, it may be a good idea to limit your team's focus to one area until your team feels that it has the capacity to move onward.

3. Forging partnerships

As you conduct your inventory, you will have several opportunities to create relationships with experts, industries, and government officials. It is important to establish productive relationships and working alliances with these people whenever possible. These relationships provide a means of increasing your team's knowledge, experience, and power. Thus, these partnerships can enhance your ability to effect change not only within your religious community, but also throughout the larger community.

4. Setting Priorities and Evaluating Options

Generally, the results of your audit identify several areas that could be improved, but changing them all at once is impractical. Thus, it is important to prioritize your findings, and possibly even to

present your findings to the community at large for their input in prioritizing. Practices that were found to be critically important or dangerous should, of course, be addressed first if possible.

Once your team has assessed your community's present practices, has established relationships with people or agencies that can further your understanding of issues and alternatives, and has established priorities, you are ready to give serious consideration to alternative courses of action and their potential consequences. Your team should develop a list of alternative solutions to any one problem. In creating this list, the rationale, beneficial impacts, expected difficulties, costs, and measurability of each alternative should be included for analysis. Once this list is generated your team may wish to consult with the entire community and/or outside experts, for help in deciding which alternative to choose.

Characteristics of a Reasonable Option for Action

- Compatible with the overall program goals
- Acceptable to those who will work to achieve them
- Understandable by everyone
- Motivational to encourage participation of entire community
- Achievable with a reasonable amount of effort
- Measurable over time

5. Taking Action

Once your team has decided what it needs to do, an action plan needs be developed and implemented. This plan should include the specifics regarding how to acquire and mobilize the resources necessary for success, and a deadline established. A budget may need to be created, and funding secured. The plan should include how to effectively communicate the change to other community members. As well, the means of assessing the action's success should be developed. With all this accomplished, the action plan should be executed and the results measured over time.

6. Looking Back and Ahead

Periodically, especially after an action plan has been executed, the Environmental Program team should reflect upon and assess the Program itself. Identify successes and failures, strengths and weaknesses, difficulties and examples of efficient functioning. The overall progress and effectiveness

of actions taken should be assessed. It is important to address the problems identified with the Program, but it is equally important to celebrate its successes!

The goal of this reflection period is to update the Program with your learned experiences, and to identify the next steps to take to continue moving your community toward sustainability.

Chapter 1

Benedictine Life and Ministries

Environmental Stewardship in Benedictine Life: Assessment

In the past 1500 years, Benedictines have held Environmental Stewardship as an essential, defining value. It is an explicit policy of most Benedictine monasteries and communities worldwide to apply environmental stewardship principles to their land, buildings and work. This section of the Environmental Inventory is designed to examine the extent to which your community embraces this core value, grows in its understanding of environmental responsibility, and expresses it in prayer, ministry and community life.

The Earth Charter, forged at The Council for a Parliament of the World's Religions in 1993, challenges all of us: "We stand at a critical moment in Earth's history, a time when humanity must choose its future. As the world becomes increasingly interdependent and fragile, the future at once holds great peril and great promise... The choice is ours: form a global partnership to care for the Earth and one another or risk the destruction of ourselves and the diversity of life. Fundamental changes are needed in our values, institutions, and ways of living."

Just as our understanding of the universe in which we live and the interrelatedness of all of nature has been stretched and deepened by recent cosmological discoveries, stewardship needs to be stretched to recognize the co-dependence that we share with the rest of the natural world. Anne McCarthy, OSB, writes, "Stewardship assumes a relationship in which the human is dominant: primary, central, the superior species responsible for all other lesser species. This essential dominance, even if a very benevolent, responsible dominance is being critiqued in our day as troubling at best and destructive at worst." Humans were not placed on the earth to dominate. Rather, humans are one of many species sharing this earth, part of a vast web. If humans are to prosper, so must the entire web.

We are living in a time when the ability of the earth to support future generations has been called into serious question. Donella Meadows explains, "What the scientists and now also the economists

are telling us is that our planetary life-support system is in danger—and that it needn't be, if we take perfectly feasible steps to protect it." Environmentalists around the globe are calling for action on behalf of the planet. As earth citizens we have a responsibility to respond. As Benedictines we have a responsibility to help create a new vision for our planet by applying 1500 years of lived community experience to the new realities facing us. "When looking back at Benedict of Nursia and his legacy," McCarthy, OSB, offers, "humility emerges as the primary gift that Benedictines can offer a new millennium: a gift that will give positive shape to the human relationship with all the cosmos." Humility helps us recognize that as human beings we are not outside or above the community of life. As spoken by Native American Chief Seattle, "We have not woven the web of life; we are but a strand within it." We depend on the whole for our very existence.

Today, we are challenged to extend the traditional Benedictine value of stewardship by abandoning dominance and embracing interdependence. We must recognize that our care for the earth extends far beyond this time and place. Native peoples of the Americas have long taught us to evaluate all that we do in light of "the seventh generation." That is, our actions today must be viewed in terms of how they will affect those to be born seven generations from now.

Sustainability, meeting the needs of the present without compromising the ability of future generations to meet their own needs, is a call to justice. Sustainable living is an approach to social and economic, indeed, all activities, for all societies, rich and poor, which is compatible with the preservation of the environment. It is based on a philosophy of interdependence, of respect for life as well as non-living parts of Nature, and of responsibility for future generations.

Principles for sustainable living include:

- respect and care for the community of life
- improve the quality of human life
- conserve the Earth's vitality and diversity
- minimize the depletion of non-renewable resources

- keep within the Earth’s carrying capacity
- change personal attitudes and practices
- enable communities to care for their own environments
- provide a national framework for integrating environment and conservation
- create a global alliance

Caring for the Earth: A Strategy for Sustainable Living, WCU/UNEP/WWF

As we look to this section of the audit, we do so knowing that today’s call to Benedictine Stewardship is a call to sustainable living. If we hold stewardship as a core value in our lives, it will not be assigned to a segment of life; it will permeate what we think and how we pray, minister and live together in community.

Environmental Stewardship in Benedictine Life: Inventory

(please answer where relevant according to the following numerical gradation: 1 = not at all, 9 = to a great extent)

1. Prayer and Liturgy

To what extent does the community use songs/hymns, readings, and/or symbols during Community Prayer that call attention to creation?

1 2 3 4 5 6 7 8 9

To what extent does the community include reflection on stewardship, sustainability, creation, responsible living, etc. in its communal prayer?

1 2 3 4 5 6 7 8 9

To what extent does the community celebrate special days/ observances that give attention to the universal call to care for the earth? (i.e. Earth Day)

1 2 3 4 5 6 7 8 9

To what extent does the community promote the use of reflection materials that encourage ongoing development of ecological values?

1 2 3 4 5 6 7 8 9

2. Ministries

To what extent are sustainability practices promoted in

community ministry locations?

1 2 3 4 5 6 7 8 9

To what extent does the community include an understanding of sustainable living practices as part of its education/expectation of employees working in its ministries?

1 2 3 4 5 6 7 8 9

If your community offers retreats, to what extent is attention given to the relationship between humans and the cosmos, between humanity and the earth?

1 2 3 4 5 6 7 8 9

Is your community involved in teaching?

Yes / No

If so, to what extent does it recognize the need for ongoing environmental education and training for itself and all those engaged in religious instruction?

1 2 3 4 5 6 7 8 9

To what extent does it promote environmental education within its schools/ organizations, especially among youth and children?

1 2 3 4 5 6 7 8 9

To what extent does it pursue peacemaking as an essential component of conservation action?

1 2 3 4 5 6 7 8 9

In its ministry of hospitality, to what extent does the community model the use of sustainable practices and promote these for guests?

1 2 3 4 5 6 7 8 9

3. Community Policy

To what extent does the Community believe that sustaining environmental life systems is a religious duty?

1 2 3 4 5 6 7 8 9

To what extent do community members implement individual and communal actions on behalf of sustainable living?

1 2 3 4 5 6 7 8 9

Has the community committed itself to sustainable practices through the development of a community policy, expression in a corporate commitment or mission statement, and/or publication of a position paper?

Yes / No

4. Community Leadership

To what extent does the Community Leadership emphasize environmental issues in teaching and guidance to the community?

1 2 3 4 5 6 7 8 9

To what extent does the Community Leadership recognize the need for ongoing environmental education and training for themselves and for community members?

1 2 3 4 5 6 7 8 9

Has the Community Leadership called for a self-review and auditing process on conservation issues and its renewal on a regular basis?

Yes / No

5. Community Resource Management

If the community sponsors events/gatherings, to what extent does the planning include attention to sustainable practices such as purchasing locally grown food, avoiding excessive use of paper products, recycling, use of green products or services, mass transportation?

1 2 3 4 5 6 7 8 9

To what extent is the community involved in sustainable food production and consumption?

1 2 3 4 5 6 7 8 9

To what extent does the community encourage sustainable land use practices such as organic food production, pesticide/herbicide reduction, habitat protection, maintaining green zones and/or use of land for the poor?

1 2 3 4 5 6 7 8 9

6. Investments

To what extent does the community use investment criteria that promote ecological principals?

1 2 3 4 5 6 7 8 9

To what extent does the community use fair trade practices devoid of financial, economic and political exploitation?

1 2 3 4 5 6 7 8 9

Environmental Stewardship in Benedictine Life: Evaluation

At the end of each discussion section, there will be statements and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

1. Prayer and Liturgy

As prayer and liturgy are the central expression of a religious community's intentionality, these elements can be the most powerful means of expressing and reinforcing your community's core values. The content of your community's liturgical life serves as a profound teaching opportunity, as it raises the awareness of the praying community and helps to strengthen the members' commitment to the values expressed. Hence, if environmental sustainability is indeed a core value of your community, it should find expression in prayer and liturgy.

If, on the other hand, your community does not include environmental consciousness in its prayer life, you should determine why. Is it the case that environmental stewardship is not a shared value of your community? Is it a value that is simply unexpressed for lack of knowledge or resources? Or does the absence of inclusion reveal a division within your community regarding this value? Each reason has its own set of possible solutions, and God's inspiration should be sought to help guide your efforts in uniting your community to accept and express the importance of environmental sustainability in this most important aspect of your community life.

Consult the references listed at the end of this chapter for resources on incorporating environmental consciousness into your community's prayer life.

To what extent does the Community incorporate environmental consciousness into its prayer life?

1 2 3 4 5 6 7 8 9

2. Ministries

Ministries are the most direct way that your community can express its commitments and values to the greater community. As such, they can be the most powerful means of demonstrating

leadership through example. Whether your community expresses its service through education, spirituality programs, providing food or other alms to the poor, or other ministry, the deeply held values of your community are naturally expressed both by the content and structure of the ministry itself, and by the actions of the individuals delivering the ministry. Thus, it is important that your community ministries are informed by agreed upon principles, including environmental stewardship. Environmental stewardship can be expressed in any ministry.

Your community's ministries should exemplify environmentally sustainable practices and respect for Creation to the greatest extent possible. All those engaged in ministerial activities should be educated about both the importance of sustainable practices, as well as ways in which they can exemplify these in their ministry. A deep respect for Creation should be modeled in all activities.

The resources found at the end of this chapter may be helpful in improving the Earth-centeredness of your ministries.

To what extent does the Community incorporate environmental consciousness into its ministries?

1 2 3 4 5 6 7 8 9

3. Community Policy

The practices of individual members of your community are ultimately the true expression of your community's environmental stewardship; however, having policies in place which inform and guide the actions of community members helps to unify and clarify the community intentions and values. Furthermore, having policies in place provides the opportunity to hold community members accountable for their actions. Thus, it is important that your community adopt policies to strengthen and inform each member's commitment to environmental stewardship.

To what extent does the Community incorporate environmental consciousness into its community policy?

1 2 3 4 5 6 7 8 9

4. Leadership

Even if your community has policies regarding environmental stewardship and/or sustainability practices, without the support and espousal of these by the community leadership, there is a

greater chance that the policies may not be realized in everyday practice. Leaders play a tremendous role in unifying and influencing the actions of the community since they are ultimately responsible for executing community decisions. Thus it is important that your community's commitment to environmental stewardship be reflected in the communications and decisions made by the community leadership. The leader(s) of the community should see to it that sustainable principles are realized in ministries, liturgy, and educational activities, as well as in the administrative, fiscal, and domestic affairs of the community. It is suggested that a permanent committee should exist to continually review the sustainable practices of all community affairs, to be responsible for educating the rest of the community regarding environmentally conscious practices, and to regularly update the leadership on developments.

To what extent does the Community's leadership give expression to environmental consciousness?

1 2 3 4 5 6 7 8 9

5. Resource Management

The keystone to environmental sustainability is the proper management of resources. Thus, to express its commitment to sustainable principles, your community should definitely manage its own resources in the most sustainable manner possible. Community resources include the property, buildings, equipment, and other commodities owned by the community. Buildings, properties, and community events should be managed in a way that minimizes the impact on the environment.

The following chapters of this manual were designed to more closely examine how well your community incorporates sustainable practices into its resource management.

To what extent does the Community incorporate environmental consciousness into resource management?

1 2 3 4 5 6 7 8 9

6. Investments

While it is certainly the intention of investment to maximize the return, doing so without regard to what or who is being invested in is nothing short of irresponsible. Investments should be made in line

with community principles. Investing money is simply a way of encouraging those who receive your investment to succeed so that you can profit as well. Hence to realize your community's commitment to environmental sustainability, the environmental record of potential investments (companies and funds) should be reviewed before your community makes the decision to invest. Or, if there are already standing investments, these should be audited in the same way and adjustments made if deemed necessary. In addition, if your community does own stock in a company with questionable practices, you can exercise your rights as stockholders to bring attention to these issues at stockholder meetings, or directly influence company decisions if the company is small enough or your position large enough.

To what extent does the Community incorporate environmental consciousness into its investments?

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column on the right:

score

1 Prayer and Liturgy	
2 Ministries	
3 Community Policy	
4 Community Leadership	
5 Community Resource Management	
6 Investments	

If you found areas of your community life that could be improved in regard to environmental stewardship and sustainability, list them below:

Category (I-III)

Issue 1

Issue 2

Issue 3

Issue 4

Now categorize each issue listed above into one of the following three categories:

I = Most important. Should be addressed immediately

II = Important, but does not demand immediate attention. Must be addressed

III = Current practice should be improved, but is not immediately important

Acknowledgements for Chapter 1

The information contained in this chapter has been adapted from the following sources:

Caring for the Earth: A Strategy for Sustainable Living, World Conservation Union, United Nations Environmental Program and World Wildlife Fund, Geneva, Switzerland, 1980

The Earth Charter: A Religious perspective, in *A Source Book for the Community of Religions*, Joel Beversluis, International Coordinating Committee on Religion and the Earth, ed. Chicago: The Council for a Parliament of the World's Religions. 1993, Preamble.

A Humble Stance: Benedictines' Gift to the Cosmos, McCarthy, Anne, OSB. *American Benedictine Review*, Volume 58, 2nd edition. p. 52.

Expert Statements Worth Paying Attention To, The Global Citizen, Meadows, Donella, www.sustainer.org, Sustainability Institute, Hartland, VT

Resources for Chapter 1

Internet Resources

Alliance of Religions and Conservation: www.arcworld.org. ARC is a secular body that helps the major religions of the world to develop their own environmental programs, based on their own core teachings, beliefs and practices. The web site contains several resources, both online and available in print.

Catholic Conservation Center: <http://conservation.catholic.org/> Available en español. This site contains several resources on incorporating environmental consciousness into Catholic life.

National Catholic Rural Life Conference: <http://www.ncrlc.com/> The NCRLC is a membership organization grounded in a spiritual tradition that brings together the Church, care of community and care of creation. Their website contains a variety of information on environmental topics, particularly of interest to agricultural congregations.

Earth Ministry/ Caring for Creation: <http://www.earthministry.org/> The mission of Earth Ministry is to inspire and mobilize the Christian Community to play a leadership role in building a just and sustainable future. (In English only.) There are several resources available here, including a 225 page handbook of their own.

EcoCongregation: www.ecocongregation.org/ Based in Europe, EcoCongregation offers an ecumenical toolkit that encourages churches to weave creation care into their life and mission. They also provide an environmental audit manual with several modules.

Print Resources (in English)

Embracing Earth: Catholic Approaches to Ecology, by Albert J. LaChance and John E. Carroll, editors, 1994, Orbis Books, Maryknoll NY, 800/258-5838. Collection of seminal contributions by contemporary Catholic writers. Besides the editors, authors include: Thomas Berry CP; Miriam Therese MacGillis, Frederick G. Levine, David Toolan SJ, Mary Rosera Joyce, and more.

The Great Work: Our Way into the Future, by Thomas

Berry, 1999, Bell Tower NY. Dedicated to all children, the book calls us to experience creation as a source of wonder and delight. We are urged to move into the future making use of the four-fold wisdom available (of indigenous peoples, of women, of classical traditions and of science), using this moment of grace to transform this cenozoic era into the ecozoic.

Voices of Hope in the Struggle to Save the Planet, by Marjorie Hope and James Young, 2000, ApexPress, Council on International and Public Affairs, Inc., 777 United Nations Plaza, Ste. 3C, New York NY 10017; 800/316-2739. Beginning with the prophetic voice of Thomas Berry, the book continues with the lives and ideas of key spiritual leaders in Judaism, western and eastern Christianity, Islam, Buddhism, Taoism, Shinto, and faiths of Native Americans and two other indigenous peoples.

Environmental Books for Children. All available from Wordsworth, a publishing service. Write for catalogue to Wordsworth, 702 NE 24th St. Newton KS 67114, (316) 283-6708.

Ecology and the Jewish Spirit: Where Nature and the Sacred Meet, edited by Ellen Bernstein, Jewish Lights Publishing, Sunset Farm Offices, Rte.4, PO Box 237, Woodstock, VT 05091; 800-962-4544. The first book in the emerging field of religion and environment to reflect a Jewish ecological perspective.

Ecology and Religion: Scientists Speak, John E. Carroll and Keith Warner, OFM, editors, 2000, Franciscan Press, Quincy University, Quincy IL 62301; 217/228-5670; www.quincy.edu/press. An interfaith group of religious scientists articulate their understanding of the relationship between religion and ecology. The book challenges the various faith communities to address the environment as a legitimate religious concern.

Peace with God the Creator, Peace with All Creation, a resource packet of the US Catholic bishops' Renewing the Earth program, includes homily helps; articles on ecological spirituality, environmental hazards, the good life and the problem of consumption; guidelines to integrate environmental education into responsibilities of parish committees; environmental justice resources, and much more. Available from Environmental Justice Program, US Catholic Conference, 3211 Fourth St. NE, Washington DC 20078, 800/235-8722.

Love of Nature and Environmental Activism: Danger or Duty for Christians, by Paul Hansen, available from Hansen, 2899 Agoura Rd., West Lake Village CA 91361; 805/498-6066. A helpful booklet for Christians working with Christians who are new to, or opposed to, earthkeeping.

Discovering Your Life-Place: A First Bioregional Workbook, by Peter Berg, Planet Drum Foundation, 1998. Leads readers to a new appreciation of their bioregion through practical, hands-on map-making exercises, for rural or urban areas, all ages. Order from Planet Drum Foundation, PO Box 31251, San Francisco CA 94131; 415/ 285-6556; planetdrum@igc.org.

Ministering with the Earth, by Mary Elizabeth Moore (\$20), 1998, Chalice Press, St. Louis MO. Stories and theological discussion view the Earth as a sacred creation of God in which we participate in a covenantal relationship. Using the metaphor of quilt making, the author challenges us to orient our spiritual life and ministry in partnership with (rather than caring for)

the Earth. Appendix includes a retreat design "Quilting a life in Relation to God and to God's Creation."

Holy Ground: A Resource on Faith and the Environment (\$5) 1997, by Sojourners, 2401 15th St. NW, Washington DC 20009; 800/714-7474. Study guide for four sessions – Covenant with Creation; Systems of Environmental Degradation; Environmental Racism; Justice and Living Rightly with the Earth; writings, resources, activities and discussion questions.

Forty Nights; Creation Centered Night Prayer, by Daniel J. McGill, Paulist Press, 997 Macarthur Blvd., Mahwah NJ 07430, (201/ 825-7300) 1994. Blending ecology and ecumenism, these prayers are the author's personal response to the spiritual and intellectual transformation of our age. Each of the 40 prayer services may be used alone or with responses from a community.

Celebrating the Earth, by Scott McCarthy, 1998 Resource Publications, Inc., 160 E. Virginia St., San Jose CA 95112; 408/286-8505. An earth-centered theology of worship with blessings, prayers and rituals that link Christian spirituality with the natural cycles and patterns of earth.

Ponderings From the Precipice: Soulwork for the New Millennium, by James Conlon, 1998 Forest of Peace Publishing, 251 Muncie Rd., Leavenworth KS 66048; 800/659-3227. Forty-eight short reflections intended as companions for moments of meditation.

Nature, God and Pulpit by Elizabeth Achtemeier, 1992, paperback, Eerdmans. Intended primarily for preachers, this book draws together and interprets all the biblical materials dealing with the natural world and God's relation to it. It also relates the materials to findings of modern science.

The Greening of Faith: God, the Environment, and the Good Life, John E. Carroll, Paul Brockelman, and Mary Westfall, editors, 1996, University Press of New England, University of New Hampshire 1995. Fifteen philosophers, theologians and environmentalists, from

different religious perspectives, explore ways to respond to the environment as the spiritual issue of our time.

Ecotherapy: Healing Ourselves, Healing the Earth, by Howard Clinebell, Ph D, The Haworth Press, 1996; 10 Alice St., Binghamton NY 13904. Clinebell brings together long overlooked issues at the boundary between human health and the health of the natural environment; plus theories and methods of ecological diagnosis, treatment and education.

Divided Planet: The Ecology of Rich and Poor, by Tom Athanasiou (\$24.95), Little Brown, New York, 1996. A challenging analysis of social and economic conditions of the ecological crisis. A call to institute the radical social and economic changes required to shift the priorities of the New World Order with its ever widening gap between rich and poor.

Women and the Environment, by Annabel Rodda, 1991, United Nations Publications, 2 UN Plaza, Room DC2-853, Dept.COO3, New York NY 10017, 800/253-9646. Focusing on women's roles as users, producers and managers of the earth's resources, the book explains all the major environmental issues and reveals how women can be a major force for environmental change. Includes a glossary of environmental terms, a guide to education and action, bibliography and resource guide.

Your Health and the Environment: A Christian Perspective, by Shantilal P. Bhagat, 1998, Eco-Justice Working Group of the National Council of Churches. Each of 13 chapters provides a biblical anchor, information, suggestions and. discussion questions. Order from NCC Environmental Justice Resources, 800/762-0968.

Caring for Creation: Reflections on the Biblical Basis of Earthcare, by Lisa Lofland Gould, 1999, Friends Committee on Unity with Nature, Burlington VT. Five chapters focus on Celebration, Humility, Connections, Right Relationship and Stewardship; study guide included.802/658-0308

Chapter 2

Air Quality Assessment

Overview of Chapter: Air Pollution, Indoor and Outdoor

Air, Earth's Sacred Gift

Air is our most precious resource, even though it is often taken for granted. All living things need air to survive. Without water a person cannot live for more than a couple days, but without the oxygen found in air a person would die within minutes. In fact, *all* animals and even plants need air to survive. Unfortunately, poor air quality, or polluted air, can be dangerous to life. Air that contains human-produced pollutants can and does kill plants, trees, and small organisms, and can cause extreme illness in humans. It is up to us to become aware of and change those practices of ours which contribute to the poisoning of the Earth's atmosphere.

Combustion

The most common way that humans affect air quality is by burning different materials and fuels. The process of burning is called *combustion*. Combustion in its various forms is probably the main source of both indoor and outdoor air pollution, and thus it will be mentioned frequently in this assessment. For this reason, it may be helpful to briefly describe combustion.

The most obvious example of combustion is a simple fire like those used for cooking or heating, burning refuse or cropland. However, internal combustion engines, like those used in automobiles, trucks, generators, tractors, as well as other engines like those used in airplanes, or those used in lawn care equipment also use combustion for energy, and are very important sources of pollution. Combustion of fuels (usually oil, coal, or natural gas) is also used for the production of electricity, as well as other industrial processes that require heat.

Not only are combustion processes diverse, but the by-products emitted by them vary with

process efficiency and fuel type. Generally, combustion results in the emission of complex mixtures of gases, organic pollutants, metals, and fine particles.

As a result of our practices, indoor and outdoor environments are widely contaminated by complex mixtures of combustion-derived gases and particles, and these pollutants create both local and global human and environmental health problems.

Definitions

In order to understand and communicate about air pollution, it is quite helpful to know a little bit about the most common air pollutants. These are *particulate matter (PM)*, *oxides of nitrogen (NO_x)*, *oxides of sulphur (SO_x)*, *volatile organic compounds (VOCs)*, *carbon monoxide (CO)*, *ozone (O₃)*, *carbon dioxide (CO₂)* and *chlorofluorocarbons (CFCs)*. These are not by any means the only pollutants, but they are the most common. Each is described below.

Particulate matter, or *PM*, is the term for particles found in the air, including dust, dirt, soot, smoke, and liquid droplets. Particles can be suspended in the air for long periods of time. Some particles are large or dark enough to be seen as soot or smoke. Others are so small that individually they can only be detected with an electron microscope. They come from a variety of sources such as cars, trucks, buses, factories, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. PM is usually categorized by the size of the particles; e.g. PM₁₀= less than 10 microns, PM_{2.5}= particles up to 2.5 microns, etc.) In general, the smaller the particles the more dangerous they are to living tissue.

Carbon monoxide, or *CO*, is a colorless, odorless gas that is formed when carbon in fuel is not burned completely. It is a component of motor vehicle exhaust, and so higher levels of CO generally occur in areas with heavy traffic congestion. In cities, 85% to 95% of all CO emissions may come from motor vehicle exhaust. Other sources of CO emissions include industrial processes (such as metals processing and chemical

manufacturing), residential wood burning, and natural sources such as forest fires. Woodstoves, gas stoves, cigarette smoke, unvented gas and kerosene space heaters are sources of CO indoors. The highest levels of CO in the outside air typically occur during the colder months of the year when the air pollution becomes trapped near the ground beneath a layer of warm air (a process called inversion).

Carbon dioxide (CO₂) is also a pollutant, even though it is an important natural component of the atmosphere. Plants need it to grow; thus, vegetation removes CO₂ from the air, and in turn provides us with the oxygen we need. CO₂ is also a product of all combustion reactions. Carbon dioxide is not directly harmful to our health; however, one important characteristic of CO₂ is that it is able to reflect heat back towards the earth. This process is called the 'greenhouse effect,' and consequently, CO₂ is called a 'greenhouse gas.' When too much greenhouse gas exists in the atmosphere, the temperature of the earth begins to rise, and this can cause many severe problems. Since this is occurring, CO₂ is an important pollutant to consider. (The greenhouse effect and global warming will be discussed more fully below in the Outdoor Air Pollution section.)

Nitrogen oxides, or NO_x, is the generic term for a group of highly reactive gases, all of which contain nitrogen and oxygen in varying amounts. Many of the nitrogen oxides are colorless and odorless. However, one common pollutant, nitrogen dioxide (NO₂) along with particles in the air can often be seen as a reddish-brown layer over many urban areas. NO_x gases can also dissolve in water; when this occurs in the atmosphere, the NO_x causes acid rain. Furthermore, NO_x react with other pollutants to create smog. Nitrogen oxides form when fuel is burned at high temperatures, as in a combustion process. The primary manmade sources of NO_x are motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels. NO_x can also be formed naturally.

Sulfur dioxide, or SO₂, belongs to the family of sulfur oxide gases (SO_x). These gases dissolve easily in water. Sulfur is prevalent in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. SO_x gases are formed when fuel containing sulfur, such as coal and oil, is burned, and when gasoline is extracted from oil, or metals are extracted from ore. Like NO_x, SO₂

dissolves in water vapor to form acid, and precipitates as acid rain. SO₂ interacts with other gases and particles in the air to form sulfates and other products that can be harmful to people and their environment.

Over 65% of SO₂ released to the air, or more than 13 million tons per year, comes from electric utilities, especially those that burn coal. Other sources of SO₂ are industrial facilities that derive their products from raw materials like metallic ore, coal, and crude oil, or that burn coal or oil to produce process heat. Examples are petroleum refineries, cement manufacturing, and metal processing facilities. Also, locomotives, large ships, and some nonroad diesel equipment currently burn high sulfur fuel and release SO₂ emissions to the air in large quantities.

Volatile Organic Compounds, or VOCs, is a general term that covers a wide range of organic (i.e. carbon-containing) compounds. VOCs may result from combustion processes, or from the evaporation of gasoline, solvent, and other organic compound vapors. VOCs (especially methane) contribute to global warming, and they react with other pollutants to form ground level ozone. Some VOCs are in and of themselves toxic and hazardous to human health. Sources of VOCs include: paints, paint strippers, and other solvents; wood preservatives; aerosol sprays; cleansers and disinfectants; moth repellents and air fresheners; stored fuels and automotive products.

Finally, *Chlorofluorocarbons, or CFCs* are pollutants that affect the amount of ozone found in the upper levels of the atmosphere—called the 'ozone layer.' The ozone layer is the important component of the Earth's atmosphere that blocks dangerous radiation from hitting us on the ground. CFCs have been used extensively as refrigerants, aerosol propellants, and solvents, and are also used in some industrial processes. Once CFCs enter the atmosphere, it takes a very long time before they stop affecting the ozone layer. Thus, although their use and production has dramatically declined on account of a successful international agreement, called the Montreal Protocol, it will be at least 100 years before their effects on the ozone layer disappear because of their long atmospheric lifetimes.

Opposite is a table which summarizes the information about these pollutants.

Most Common Air Pollutants

Pollutant	Description	Sources	Health Effects	Welfare Effects
Carbon Monoxide (CO)	Colorless, odorless gas	Motor vehicle exhaust, indoor sources include kerosene or wood burning stoves	Headaches, reduced mental alertness, heart attack, cardiovascular diseases, impaired fetal development, death	Contribute to the formation of smog
Carbon Dioxide (CO ₂)	Colorless, odorless gas	Combustion of any fuel, including oil, coal, natural gas, diesel fuel, gasoline, etc. Deforestation	Does not directly impair human health	Major contributor to global warming
Sulfur Dioxide (SO ₂)	Colorless and reactive gas	Coal-fired power plants, petroleum refineries, manufacture of sulfuric acid and smelting of ores containing sulfur	Eye irritation, wheezing, chest tightness, shortness of breath, lung damage	Contribute to the formation of acid rain, visibility impairment, plant and water damage, aesthetic damage
Nitrogen Dioxide (NO ₂)	Reddish brown, highly reactive gas.	Motor vehicles, electric utilities, and other industrial, commercial, and residential sources that burn fuels	Susceptibility to respiratory infections, irritation of the lung and respiratory symptoms (cough, chest pain, difficulty breathing)	Contribute to the formation of smog, acid rain, water quality deterioration, global warming, and visibility impairment
Volatile Organic Compounds (VOC)	Reactive carbon containing compounds	Gasoline, solvents, industrial processes, pesticides and other chemicals	Eye, nose, and throat irritation; headaches, loss of coordination, allergic skin reaction, fatigue, dizziness, nausea; damage to liver, kidney, and central nervous system. Cancer	Major contributor, along with NO _x , to ground level ozone, or smog
Ozone (O ₃)	Gaseous pollutant when it is formed in the troposphere	Vehicle exhaust and certain other fumes. Formed from other air pollutants in the presence of sunlight	Eye and throat irritation, coughing, respiratory tract problems, asthma, lung damage	Plant and ecosystem damage
Chlorofluorocarbons (CFCs)	Compounds containing carbon, chlorine, fluorine, and hydrogen easily converted from liquid to gas and vice versa	Used as refrigerants, aerosol spray propellants, solvents, and foam-blowing agents	Generally do not directly impair human health	Reacts with ozone in upper atmosphere which destroys the ozone layer. Contributes to global warming
Particulate Matter (PM)	Very small particles of soot, dust, or other matter, including tiny droplets of liquids	Diesel engines, power plants, industries, windblown dust, wood stoves	Eye irritation, asthma, bronchitis, lung damage, cancer, heavy metal poisoning, cardiovascular effects	Visibility impairment, atmospheric deposition, aesthetic damage

Source: United States Environmental Protection Agency, 2006)

Overview of Outdoor and Indoor Air Pollution

The air surrounds us all, and we all share this gift with each other. Yet despite this many of our personal and communal practices are not in accord with the need to respect and protect this sacred gift. The quality of Earth's air has been deteriorating by alarming degrees over the past century because of humanity's use of fire, uncontrolled or inadequately controlled industrial processes, and internal combustion engines. Although many people are now aware of the problems, and the need to do something about them, much is still left to be done.

In addition to outdoor sources such as factories, power plants and vehicles, a person's health can be seriously affected by exposure to indoor air pollution. Polluting fuels (wood, coal, etc.), poor ventilation conditions, and long exposure times are responsible for conditions of ill-health. To make matters worse, relatively little attention has been paid to the significant risks associated with the indoor use of solid fuel for cooking and heating. Simple stoves burning solid fuel (mostly biomass fuel) are used by about half of the world's people. Poor ventilation and inefficient combustion result in significant daily exposure, particularly of women and young children, to a host of dangerous pollutants.

Outdoor Air Pollution: Assessment

This Chapter's Assessments

The two assessments in this chapter are intended to help you identify ways in which your community pollutes the air, and will hopefully encourage better practices. Specific attention is paid to indoor air pollution because it is such a widespread but overlooked problem, particularly in rural areas.

Besides these two assessments, it is recommended that your community also complete the Energy Assessment, Chapter Five, since a large portion of air pollution is a consequence of energy production.

Our Atmosphere: A Gift to be Preserved

The air is a vital environmental resource, a Sacred

Gift to Life, as it is used by all plants and animals to sustain life. While it is generally available everywhere, today it is often in a condition that is not suitable for human health nor for environmental sustainability. These unacceptable conditions tend to especially occur in larger cities where industrial activities are concentrated, transportation networks are intense, and population density is high. Wherever we live, it is our job to make sure that we do our part not to contribute to these problems, and to help correct them wherever possible. It is the intention of this assessment to help your community achieve these goals.

The Earth's atmosphere consists of a number of gases and water vapor which provide an environment within which life can flourish. Unfortunately, the atmosphere is being affected by human activities in ways that are threatening the life-sustaining ability of the air. The air is used by all forms of Life in a vital process called respiration, or breathing. People and other animals inhale oxygen and exhale carbon dioxide; plants are vice versa. Unfortunately, as pollutants deteriorate the air quality, we are now breathing in irritating and harmful gases along with the natural constituents of our atmosphere; thus, breathing air may now be contributing to disease.

The gases in our atmosphere provide other gifts to life on earth besides the ability to breathe. Some gases, particularly carbon dioxide, have the ability to trap heat inside the Earth's atmosphere, allowing the globe to maintain the stable temperatures necessary for life. However, an excess of these gases cause temperatures to increase around the world—a process called 'global warming.' The water vapor in the atmosphere is also an essential component for life. As part of the 'water cycle' (the endless cycle through which water flows from the earth to the sky and from the sky to earth), water on earth evaporates into the air before returning again as precipitation. The process of evaporation and precipitation helps to purify water so that life on the surface is continually provided fresh, clean water. Unfortunately, because human activities have contaminated the air, pollution is now mixing with the water vapor before precipitating as a contaminated solution. This effect of pollution is called 'acid rain.'

The upper levels of the atmosphere include a layer of a special type of oxygen, called 'ozone.' This ozone functions as a protective filter which

prevents the sun's harmful ultraviolet rays from burning the life that exists on the earth's surface—like us. However, some forms of air pollution are destroying this protective characteristic of the atmosphere, progressively increasing our exposure to harmful radiation from the sun.

The earth's atmosphere has also been a source of aesthetic pleasure; it has provided us with a window in which we may glimpse the grandeur that our Creator has wrought. However, especially in densely populated urban areas, the clear blue skies have been replaced by a hazy, murky, malodorous cloud. This phenomenon is also a result of pollution, and we call it 'photochemical smog,' or simply *smog*.

Each of these problems will be discussed more fully below.

Problems in the Air

Many Latin American cities are slowly becoming uninhabitable because of air pollution. Santiago, one of the most polluted urban areas in the world, is often forced to declare environmental emergencies on days of extreme air pollution, resulting in school closures and a severe reduction in outdoor activities. The emissions measured in other South American metropolises can reach dizzying heights. In Mexico City, for example, around 5 million gallons of gasoline and diesel fuel are consumed every day. As a result, 53,000 metric tons of gaseous substances are generated. Unfavorable topographic and meteorological conditions in some cities, like Mexico City, further exacerbate the impact of pollution: as the Valley of Mexico obstructs the dispersal of pollutants from its metropolitan area, the hills surrounding Santiago do the same. Thus the air pollution concentrates above such cities, seriously increasing both the visible and palpable effects of the pollutants.

When pollutants are emitted into the air, the area surrounding the source of emission is the first to experience effects; the most acute impacts of urban air pollution generally occur in this vicinity or region. However, since the atmosphere is always in motion, emissions from one area eventually disperse and mix with the flowing air. Hence, the impacts of air pollution extend beyond the immediate areas and become problems for neighboring locales and, indeed, the rest of the world.

The rapid and sustained growth of many cities

in Latin America aggravates the problems of air pollution. Without a sustainable policy framework to guide development, this growth is occurring at a considerable and often increasing cost. More people, more industry and more motor vehicles will continue to produce ever-worsening air pollution, unless serious changes are made to the practices and policies of city dwellers.

Below we will discuss four main phenomena that are caused by air pollution. These problems are found in geographic regions all around the world, some have severe implications for the future of life on this planet, and all are the result of human activity.

Smog or Ground-level Ozone

Ozone is the same molecule regardless of where it is found, but its significance varies depending on if it is up high (stratospheric) or closer to the ground (tropospheric). Stratospheric ozone is found in the region between 10 and 50 km high. This is called the 'ozone layer.'

On the other hand, a high accumulation of ozone gas in the lower atmosphere closer to ground level is air pollution and can be harmful to people, animals, crops, and other materials. Ground level ozone is a secondary product created by the reaction of different types of pollution. Nitrogen oxides and hydrocarbons (VOCs) are known as the chief 'precursors' of ozone. These compounds react in the presence of sunlight to produce ozone. The sources of these precursor pollutants include cars, trucks, power plants and factories, or wherever natural gas, gasoline, diesel fuel, kerosene, and oil are combusted.

These gaseous compounds mix like a thin soup in the atmosphere, and when they interact with sunlight, ozone is formed. Ground level ozone is generally called 'photochemical smog' or simply, 'smog.' Smog is the gas responsible for the hazy cloud that often surrounds cities. The general reaction is:



Ozone pollution, or smog, is mainly a daytime problem during summer months because sunlight plays a primary role in its formation.

Global Warming or Greenhouse Gas Emissions

Like light hitting a mirror, the sun's heat bounces off the Earth, back towards space; however, like the

roof of a greenhouse, carbon dioxide and certain other gases (called greenhouse gases) trap some of the heat inside the Earth's atmosphere. Without greenhouse gas, the Earth would be frozen; but with too much of it, temperatures rise around the globe. This phenomenon is called 'global warming.' Global warming is happening at an alarming rate as you read this, largely on account of humanity's combustion of fossil fuels. The ramifications of global warming are predicted to be severe: higher temperatures mean many areas will become deserts; ocean levels will be significantly higher, flooding coastal regions, and reducing the amount of available fresh water; weather patterns will be affected, potentially causing greater natural disasters. Scientists continue to speculate about and observe many other significant consequences. Scientists and world governments have been taking these consequences very seriously, and on account, have entered into several international agreements like the Kyoto Protocol, which has been signed by over 140 countries. For these countries, and for citizens throughout the world, reducing greenhouse gas emissions is now considered a necessity.

Making the situation more critical is the fact that Nature's own method of 'scrubbing' CO₂ out of the atmosphere—trees and other plants—is similarly being assaulted by human activity, in the form of deforestation. Deforestation, or the large-scale cutting down of trees, is a major problem throughout the world, and especially in Latin America. Lush forest land is destroyed or 'developed' so that humans can use the wood from the trees, or extract resources from under the trees, or utilize the land for grazing cattle or growing crops, while little or no effort is made even to replant some of what has been cut down.

Acid Rain

Acid rain is caused primarily by emissions of sulphur dioxide and nitrogen oxides (NO_x). When these chemicals mix with water, they become acidic compounds. Acidic precipitation kills plants and animals in bodies of water. It eats away the surface of buildings and structures, and damages soils and forests. It can also cause respiratory problems for humans. As a lake becomes more and more acidic, many of its small life forms die. This removes the food source for fish which then die as well. As soil becomes more acidic, vegetation that draws water from the soil can be damaged or die. Acid rain affects human health when tiny drops of it enter

the lungs. This narrows air passages and irritate the lungs, thereby contributing to pneumonia and bronchitis and the weakening the body's immune system.

Ozone Layer depletion

The ozone layer, i.e. stratospheric ozone located 10-50 km in altitude, is extremely important to us because it is how the Earth shields us against harmful ultraviolet rays from the sun, which would cause serious harm to living things if not filtered. It is suspected that a variety of biological consequences, including increases in skin cancer, damage to plants, and reduction of plankton populations in the world's oceans would result from increased UV exposure.

Unfortunately, the ozone layer is being destroyed, or depleted by chemicals that humans are releasing into the air. These chemicals include chlorofluorocarbons (CFCs) as well as other ozone depleting substances. Atmospheric levels of these chemicals have increased dramatically in the last 30 years, and consequences have been observed in the ozone layer.

Worldwide public and governmental concerns about ozone depletion led to the adoption of the Montreal Protocol in which it was decided that chlorofluorocarbons and other ozone-depleting chemicals, such as methyl chloroform, should have been completely phased out by the end of 1999. Some countries had proceeded to ban all production of chlorofluorocarbons even before this date. Many consider this international agreement to have been the most successful agreement ever implemented, as most countries have fully complied and atmospheric levels of ozone depleting substances have leveled off, and in some cases declined.

The health effects of air pollution

Air pollution is causing severe respiratory problems among city dwellers, with higher rates of pneumonia and many premature deaths from respiratory diseases. The World Health Organization estimates that 100 million people in Latin America have health problems related to air pollution. In the case of particulate matter (PM), recent PAHO studies show that more than 100,000 people die each year in the region due to PM exposure. For example, in São Paulo and Rio de Janeiro alone, 27 million people are exposed to high levels of particulate air pollution, which is

estimated to cause at least 4000 annual cases of premature mortality.

As with most social problems, urban air pollution generally has a higher impact on the urban poor than on the population in general. The health of the poor is often below average to begin with, and thus their resistance to disease is reduced, and the chances that they will suffer health effects from air pollution are increased.

Secondly, the housing of the poor is usually low in quality, poorly ventilated, heated by very basic systems using fuels and techniques which produce high levels of indoor pollution; the same is true of cooking facilities. In some poor urban areas, indoor air pollution is the most serious health threat.

Lastly, the urban poor often live in the less attractive areas which are often near air pollution sources in heavily exposed down-wind areas; this typically exposes them to highly localized concentrations of air pollution which are much more severe than the average levels measured elsewhere in the city.

What's causing the problems?

The vast increase in industrial facilities and activities, large-scale agricultural operations, and personal transportation vehicles over the past 30 years has been accompanied by a steady increase in airborne emissions. The increase of large-scale agricultural operations has also meant a vast decrease in the amount of forest cover. Since trees and other vegetation do a great deal to purify the air, the relationship between deforestation and agriculture is a particularly injurious one.

Industrial processes and Energy Production

The trends emerging from recent inventories suggest that more than 50% of emissions come from industrial production, most especially energy generation. Industrial pollutants originate mostly from fuel being combusted to generate electricity. In oil producing countries, emissions from the refining process are also significant—for example, in Mexico City, almost 60% of SO₂ emissions originate from industry, including oil refineries in the metropolitan area. In many countries, mining activities also result in local deterioration of air quality.

Use of Personal Vehicles

Depending upon the city and the particular type of pollutant in question, anywhere from fifty to

eighty percent of urban air pollution in the LAC region can be attributed to vehicle use. Vehicles are generally powered by either a gasoline or diesel engine, both of which spew a great deal of dirty emissions into the air, including CO, VOCs, NO_x, and CO₂. In some areas of LAC, engines release significant amounts of lead into the air (note, however, that leaded fuel is now illegal to use in most areas). Furthermore, the sprawling nature of contemporary urban development compounds the problem because residents must increasingly rely on personal vehicles for their needs. Public transportation, which can be an environmentally sound solution to the problem, is rarely successfully developed or implemented. Vehicle emissions regulations and on-board equipment exist that can also do a great deal to curb emissions, but their implementation is problematic and tardy for a variety of reasons. Nevertheless, it is ultimately the vehicle operators who are responsible for reducing and eliminating vehicular air pollution—and they can do a great deal simply by properly maintaining their vehicle, and following pollution-conscious driving practices.

Deforestation and agriculture

Natural forests cover 47% of the land area of Latin America, and the Amazon basin accounts for one-third of the world's tropical forest area. These forests are an important source of products, fuelwood and employment for local people, a major source of foreign exchange for governments, serve important functions in protecting watersheds and freshwater resources, act as a storehouse for carbon and support a significant portion of the world's biodiversity.

Unfortunately, Latin America is losing around 58 million hectares of natural forest per year, even though the rate of deforestation in, for instance, the Amazon has slowed considerably since the mid-1990s. Most deforestation in Latin America is due to expansion of the agricultural sector, considerably less is due to logging, and only about 4 per cent is due to the construction of infrastructure. In addition, demographic pressure, unemployment and inequitable land distribution are important drivers for the further degradation of forests. At the same time, there is a gross imbalance between destruction and reforestation, with only 1 hectare planted for every 25 hectares destroyed. The combination of these trends leads to the prospect of increased soil degradation, more frequent flooding and the degradation of

freshwater resources. This conversion of primary tropical forests to agriculture and to secondary vegetation is a significant change on a global scale.

What's being done?

Fortunately, urban populations are becoming better informed about the nature of the air pollution, and are increasingly unwilling to let it worsen. In many cities, both popular and official attitudes have changed and there is a growing political commitment to the need for change.

In LAC, there are at least three regional urban air quality programs that represent international partnerships. The first is the Clean Air Initiative in Latin American Cities, supported by a partnership that includes donor agencies, private companies and foundations, NGOs and a technical secretariat at the World Bank. One of the main goals of this initiative is to promote the integrated development or enhancement of action plans to improve air quality in metropolitan centres. Six cities are currently participating: Buenos Aires, Lima-Callao, Mexico City, Rio de Janeiro, Santiago, and Sao Paulo.

The second regional initiative is the Program Aire Puro in Central America, supported by Switzerland. The main goal of this program is to improve urban air quality through the training of professionals in the automobile industry sector, establishment of inspection and maintenance programs for automobiles, and public awareness.

Third, PAHO's Regional Plan on Urban Air Quality and Health proposes activities to be undertaken by countries to improve indoor and outdoor air quality. It covers areas such as policy, standards and regulation; environment and health surveillance; and education, training and public awareness.

Besides these international partnerships, each country and region generally has some initiatives, policies, or dedicated organizations that are intended to curb society's airborne emissions.

For example, the Brazilian program of adding alcohol to gasoline has reduced their carbon dioxide emissions by some 30 per cent, and has significantly decreased other pollutants as well. Despite this, Brazilians do not believe their efforts have been sufficient, and São Paulo now restricts private car circulation, as do Mexico City and Santiago.

How to reduce air pollution

- *If 190,000 car owners started to get regular tune-ups, they will keep some 40 million kilograms of carbon dioxide out of the atmosphere.*
- *If consumers set their air conditioners six degrees higher, it will save 190,000 barrels of oil a day—and eliminate all those pollutants that come from burning the oil to produce the electricity involved.*

(Source: US EPA)

What can we do?

When environmental scientists talk about air pollution, they talk in terms of millions of tons of pollutants. It is not easy to relate such figures to the smoke that comes out of your chimney or the exhaust coming out of your car. However, our individual contributions to air pollution, when added to hundreds or thousands of other small sources, do great harm to the environment and are dangerous to health. This means that we are all responsible for the pollution that occurs. Conversely, however, every habit that we change and teach to someone else is a direct benefit to the environment.

If we all do our share to reduce air pollution, the benefits will be tremendous—see the example opposite.

The following inventory is meant to evaluate your community's contribution to atmospheric (i.e. outdoor) airborne emissions, as well as to indicate several alternatives for more sustainable practice.

Outdoor Air Pollution: Inventory

1. Vehicles

Does your community own and operate any vehicles?

Yes / No

If **Yes** then complete the following questions for each vehicle—if more than one vehicle, use extra paper:

Year of manufacture of vehicle:

Make and Model of vehicle:

Record the distance driven by the vehicle, and the amount of fuel used over the course of a week:

Kilometers driven (km):

Liters of fuel used (L):

Now calculate the fuel efficiency by dividing the distance driven by the amount of fuel used: (for example 100 km / 10 L = 10 km/L)

Fuel efficiency (km/L):

What type of fuel is used to power the vehicle?

- Gasoline
 Diesel Fuel
 Ethanol or methanol (alcohol)
 Bio-Diesel
 Natural gas or Propane
 Electricity
 Other (name):

What pollution control, or emission control devices are present on the vehicle? (if unsure, you may need to ask a mechanic)

- Catalytic converter
 Positive crankcase ventilation valve
 Exhaust gas return valve
 Electronic fuel injection
 Evaporative collection and purge
 Fuel tank cap
 Other (name):

Observe the vehicle with the engine running and note the characteristics of the exhaust smoke:

Amount:

- Visible plumes
 Light wisps
 Not visible

Color:

- Blue
 White
 Black/grey

Who operates the vehicle?

Does the operator check the following fluid levels each time the vehicle is refuelled?

- Motor oil
 Transmission fluid
 Engine coolant

Is there a person in your community responsible for the maintenance of the vehicle(s)?

Yes / No

Name of person responsible:

Contact the mechanic that maintains and services the vehicle (may or may not be the person listed above):

Is the vehicle regularly maintained according to the manufacturer's suggested schedule?

Yes / No

(if maintenance schedule is unknown, you may contact the manufacture to request the information)

Has the mechanic been trained to service vehicles that have emissions control devices?

Yes / No

Are the maintenance expenses of the vehicle(s) incorporated into the regular budget?

Yes / No

2. Community Transportation Practices

What is the cumulative distance that your community members drove through the course of one month?

(This can be determined by listing all community vehicles, reading their odometers, waiting a month, reading their odometers again, subtracting the two readings, and adding all the distances together)

Does your community make an intentional effort (e.g. by use of policy or established protocol) to minimize the amount of distance driven?

Yes / No

In which of the following practices does your community participate?

- Car-pooling / ride sharing
 Trip planning
 Public Transit
 Bicycling or Walking
 Other (name):
 Other (name):

Are the members of your community educated about driving habits that reduce fuel efficiency?

Yes / No

3. Public Transportation

Is/are there any form(s) of public transportation available for use in your larger community?

Yes / No

If so, which modes are available?:

For each of public transportation modes available, determine the party that is responsible for the management of the service.

Name of Service:

Name of contact person:

Contact information:

What percentage of the population uses the transit service?

What problems is the service facing? Or, what restricts the expansion of these services?

If applicable, does the service enforce—or must the service comply with—emissions regulations for their fleet of transportation vehicles?

Yes / No

If so, describe:

What avenue(s) do(es) the public have to influence the management decisions affecting the service?

4. Other Internal Combustion Engines

Does your community own and operate any other internal combustion engines? (consider generators, tractors, power equipment, motorized bicycle/ cart, etc)

Yes / No

If **Yes** then complete the following questions for each vehicle (if there are more than one engine, additional paper will be required):

Item (type of equipment):

What type of fuel powers the engine (tick all that apply):

- Gasoline
 - Diesel fuel
 - Ethanol or methanol (alcohol)
 - Bio-diesel
 - Natural gas or Propane
 - Electricity
- Other (name):

Who is responsible for the maintenance of this engine?

(name of person)

Is the engine maintained according to the schedule provided by the manufacturer? (if maintenance schedule is unknown, you may contact the manufacture to request the information)

Yes / No

According to the operators of the equipment, as well as the community consensus, how important or essential is this equipment?

1 2 3 4 5 6 7 8 9

(Luxury item, unnecessary.....Critical for community life)

Do the operators of the equipment make an effort to run the engine only when necessary, and turn it off when not in use?

Yes / No / Sometimes

Are the maintenance expenses of the engine(s) incorporated into the regular budget?

Yes / No

5. Other Combustion

Besides a cooking fire or other indoor uses, does your community burn fuel or rubbish for any other purpose?

Yes / No

According to the community's consensus, how important or essential is this practice?

1 2 3 4 5 6 7 8 9

(Useless/unnecessary...Critical for community life)

(Refer to the next section, 'Indoor Air Quality Assessment' to evaluate indoor uses of combustion)

Is there a community policy that prohibits the burning

of the following materials?

- Plastics
- Motor oil
- Rubber
- Other petrochemicals
- Painted items
- Electrical equipment

6 Ozone depleting substances

Does your community use any aerosol products (i.e. products that have a propellant that sprays the product through a nozzle, and contained within a metal can)?

Yes / No

If so, does the product contain a chlorofluorocarbon (CFC) propellant?

Yes / No

Does your community use any refrigerators or air conditioners?

Yes / No

If so, does your community have a trained technician service this equipment, in the interests of preventing the release of refrigerant into the atmosphere?

Yes / No

7. Herbicides and Pesticides

Does your community, or a nearby agricultural operation (farm, plantation, etc.) regularly spray pesticides or herbicides on fields?

Yes / No

If so, do members of your community experience any of the following symptoms around the time of pesticide application?

- Irritated eyes
- Headaches
- Fatigue
- Difficulty breathing
- Incidence of asthma
- Disorientation

8. Community Tree Preservation

How would you rate the tree cover of the landscape of your geographical vicinity?

1 2 3 4 5 6 7 8 9

(Densely urbanized...Some tree cover...Wooded areas...Dense forest)

Does your community have a policy that is intended to preserve any trees that are on community grounds?

Yes / No / Not applicable

Does your community intentionally plant trees, or organize tree-plantings in your larger community?

Yes / No / Not applicable

Is your community active in the struggle to stop the deforestation that is occurring throughout forested regions in Latin America?

Yes / No

If Yes describe how:

9A. Expert Environmental Information Source

It will be helpful to contact an environmental advocacy organization or agency that can provide reliable, expert data about the atmospheric pollution occurring in your area.

Name of Organization:

Name of contact person:

Contact information:

According to these experts, what are the main sources of atmospheric pollution in your area?

According to these experts, what policies (i.e. laws or legislation) exist regarding airborne emissions that are applicable to your locale?

According to the organization, what are the most important actions people can take to reduce the pollution?

9B. Expert Public Health Information Source

It will also be helpful to contact a public health advocacy organization or agency that can provide reliable, expert data about the incidence of disease amongst the population.

Name of Organization:

Name of contact person:

Contact information:

According to these experts, what is the incidence of pulmonary and/or heart disease attributable to atmospheric pollution in your municipality?

According to the organization, what can people do to protect themselves from the harmful effects of air pollution?

Outdoor Air Pollution: Evaluation

At the end of each discussion section, there will be statements and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1= disagree, community practices unhealthy; 9 = agree completely, no change needed)

1. Community Vehicles

Vehicular air pollution is one of the largest environmental problems in Latin America, especially in urban and peri-urban areas, and it is largely due to the practices of individual citizens. All vehicles emit some amount of pollution, and most vehicles operated in Latin American emit a significant amount. Thus it is that Latin American vehicle operators and users can do a great deal to prevent atmospheric pollution.

If we are to preserve the Earth's air for ourselves, the Earth's other creatures, and future generations, we must prevent as much vehicular air pollution as we can. There are three primary ways to reduce vehicular air pollution: (1) Minimize distances driven, (2) Maximize fuel efficiency, (i.e. drive more distance per unit of fuel), and (3) Reduce emissions: Emit fewer pollutants per unit of fuel or unit of distance.

1. Minimizing distances driven: The best way to reduce emissions is to eliminate them by not generating them in the first place. Refer to point 2 on page 28 for a more in-depth look at reducing use of community vehicles.

2. Increasing Fuel Efficiency: Fuel efficiency can be easily calculated by determining how many kilometers were driven in between fuelings, and then dividing this number by the volume of fuel consumed. Greater fuel efficiency means that the amount of pollution emitted during a vehicle's trip is reduced simply because less fuel is used. Several factors influence a vehicle's fuel efficiency, including proper maintenance, engine wear, driving style, vehicle condition, engine calibration, as well as environmental considerations such as road surface condition and the relative flatness of terrain. Basically, the harder an engine has to work, the less fuel efficient it becomes. It is a good idea to keep records of the vehicle's fuel consumption, and to review them regularly so the person responsible for the vehicle's maintenance can be made aware of sudden changes in fuel efficiency. If there is a sudden change, take corrective action. The vehicle may have a leak or be in need of service.

3. Reducing Vehicular Emissions: Vehicular emissions can be reduced in many ways. The main factors that influence a vehicle's emissions are: (a) Type of fuel, (b) Emissions control devices, and (c) Preventative maintenance.

(a) Fuel Type: The type of fuel used to power the engine is probably the most important factor to consider. Emissions are greatest for the combustion of gasoline, a bit reduced for diesel fuel, and more so for bio-diesel; they are considerably reduced for alcohol, and minimal for vehicles powered by natural gas or propane. Electric vehicles do not emit air pollutants directly; however, the production of the electricity used to charge the vehicle does (See Chapter 5, Electric Energy Assessment).

Often different fuels are blended to reduce emissions without requiring equipment modification. The box on the next page describes some of the most common alternative fuels used to reduce emissions.

A note about leaded gasoline: It is now internationally illegal to manufacture or sell new vehicles requiring leaded gasoline. Similarly, the sale of gasoline containing lead or lead additives is also illegal. This regulation has dramatically reduced the amount of lead that enters the atmosphere. Lead was once one of the most prevalent pollutants, and also one of the most hazardous.

(b) Emissions control devices: In many countries, vehicles are required by law to be equipped with properly functioning emission control devices. Although similar legislation exists in some Latin American countries, in the few places where it does exist, the regulations are often not enforced. Nevertheless, with or without legislation, vehicle owners have the option to only purchase vehicles that are equipped with emission control devices.

The main emission control device is a catalytic converter. This device looks similar to a muffler, but is positioned nearer to the engine than a muffler. The catalytic converter does the most to remove a range of pollutants like carbon monoxide (CO), volatile organic compounds (VOCs), and sometimes nitrogen oxides. However, the life of a catalytic converter is not infinite, and it can be easily damaged by an engine that is not running properly. Furthermore, since the catalytic converter only functions properly when the engine's air/fuel mixture ratio is adjusted appropriately, this fact necessitates electronic engine controls and sensors.

Other emissions control components include an exhaust-gas return valve, which functions to reduce the amount of nitrogen oxides that the engine produces; a positive crankcase ventilation valve which prevents internal engine gases from being released; a fuel tank cap and evaporative vapor return valve, which both work to prevent VOCs from being released by the fuel; as well as a variety of sensors and actuators which function to continuously control the efficiency of the engine's operation.

Most modern cars are equipped with some emission control devices. However, not every new vehicle available in Latin America is guaranteed to be equipped with such components. Look for vehicles that are OBD-II compliant, as this indicates that the vehicle has a full range of such devices.

Alternative Fuels

Biodiesel

Biodiesel is a diesel fuel that is produced from organic materials. It can be processed from any number of suitable plant oils. Biodiesel offers the advantages of not releasing sulphur oxides, and does not release prehistoric carbon into the atmosphere in the form of greenhouse gases (CO₂). Bio-diesel is often sold as a blend with regular diesel fuel.

Alcohol

Ethanol is widely available and produceable throughout Latin America, and much is already produced from sugar cane, particularly in Brazil. Each ton of sugar cane has the energy potential of 1.2 barrels of oil. Between 2003 and 2004, Brazil produced 1.4 billion liters of alcohol. Of the 17 million light vehicles circulating in Brazil, some 3 million use bio-fuels or some other mixture.

Methanol is another liquid alternative fuel. However, methanol is corrosive, and thus it is expensive to convert existing vehicles to use this fuel. Today, it is sold as a blend of 85% methanol and 15% gasoline, commonly called M85.

The easiest way to integrate the use of alcohol is by using a low-level blend of ethanol and gasoline commonly referred to as 'gasohol.' Most conventional automobiles and trucks can use gasoline blended with up to 10% ethanol, without any modification to their fuel systems or engines, while still being covered by the manufacturer's warranty.

Propane and Natural Gas

Propane is currently the most widely available of the alternative fuels. Most vehicles produced in North America can be converted to propane operation. Propane is stored under pressure in cylinders that are located under the vehicle or in the trunk or rear compartment. It is also possible to leave the original gasoline system in place as a backup.

Natural gas (methane) is generally considered to be the cleanest of all the commercially available fuels and produces low tailpipe emissions. Most of the vehicles produced in North America can also be converted to operate on natural gas. As with propane, the gas is stored in high-pressure cylinders that are located under the vehicle, or in the trunk or rear compartment. Because the fuel has a low energy content, you need to refuel the vehicle more frequently. For convenience, most conversions leave the original gasoline system in place in case you need to refuel in a location where natural gas is unavailable.

Finally, be aware that pollution will increase dramatically if a vehicle’s emission control system is tampered with or leaded gasoline is used in a vehicle designed for unleaded gasoline. In many countries these activities are illegal—for individual vehicle owners as well as for fleet operators and auto technicians. Any tampering with emission control components may not only drastically increase emissions but is likely to have a negative effect on vehicle performance and durability.

(c) *Preventative maintenance:* A vehicle’s emissions can be reduced, and its performance enhanced if the manufacturer’s recommended maintenance guidelines are followed. The owner’s manual specific to a particular vehicle contains a wealth of information. It outlines recommended maintenance intervals, product specifications, and operating procedures. The manual also explains the manufacturer’s warranty of the emission control system, if so equipped. Contact the

manufacturer or a nearby dealer to obtain a copy of the owner’s manual if your community does not have one.

By taking proper care of a vehicle, its life is extended, its resale value increased, and its fuel efficiency optimized. Records should be kept of the preventive maintenance carried out to ensure that the manufacturer’s recommendations are followed.

Like all material creations, combustion-powered vehicles naturally tend to deteriorate with age and usage, and as a result, emission levels can rise significantly as the engine ages. Good maintenance is required to keep emission levels at or near design levels. A preventative maintenance program especially identify problem vehicles and assure their repair. If a modern car has high emissions, it is usually due to a defined malfunction that needs to be fixed.

Every vehicle has some items that need to be

Common Causes of Vehicle Smoke

(Note: it is normal for smoke to appear during only the first few seconds after engine startup)

Gasoline engines		
Color of smoke	Diagnosis	Probable causes
White	Coolant or water leaking into combustion chamber	<ul style="list-style-type: none"> • Bad head gasket • Cracked block or cylinder head
Blue	Engine oil being burned	<ul style="list-style-type: none"> • Oil leaking into combustion chamber • Worn piston rings, valves or cylinders • Bad exhaust manifold • Bad head gasket
Black/Gray	Incomplete fuel combustion	<ul style="list-style-type: none"> • Clogged air filter • Carburetor, choke, fuel injection, or emission system malfunction • Ignition timing off • Low compression due to engine wear
Diesel engines		
White	Improper air/fuel mixture	<ul style="list-style-type: none"> • Faulty fuel injection system • Incorrect fuel injection and valve timing • Engine overheating • Faulty fuel pump and/or injection pump
Blue	Engine oil being burned	<ul style="list-style-type: none"> • Excess engine oil • Worn piston rings, valves or cylinders
Black/Gray	Incomplete fuel combustion	<ul style="list-style-type: none"> • Damaged air filter • Faulty fuel injection system • Clogged air filter • Wrong grade of fuel • Incorrect fuel injection pump timing • Engine overheating • Low compression ratio

Source: Texas Commission on Environmental Quality, 2002

checked on a regular basis and others that need to be replaced periodically. These include the air filter, vacuum and coolant hoses, oil, oil filter, fluids, belts, and so on. It's also important to keep the tires inflated to the recommended pressure. This will minimize tire wear and help your vehicle get the best possible fuel economy. Check the tire pressure at least once a month and maintain the maximum tire pressure specified by the vehicle manufacturer. This will decrease fuel consumption and emissions.

The most important maintenance requirement is regular oil changes. Oil is the vehicle engine's 'life blood.' It reduces wear caused by friction between the moving parts of the engine and removes acids, sludge and other harmful substances. Oil helps to cool the engine, provides a seal between the cylinder walls and the pistons, and prevents the engine from rusting. Eventually, oil becomes contaminated and its performance additives deteriorate, so it is important that the oil be changed regularly. Neglecting to replace worn-out oil can result in severe damage to the engine. The oil filter should be changed with every oil change. (Refer to the Hazardous Products and Waste section of the Waste Handling chapter, page 138, for a discussion regarding the proper disposal of used motor oil, as well as other fluids and materials used on your vehicle.)

In addition to having the vehicle serviced according to the maintenance schedule a quick walk-around inspection to check for fluid leaks, low tire pressure, and exhaust smoke characteristics should be performed every time someone uses the vehicle. Routinely inspect the spot where the vehicle is parked for evidence of fluid leaks. Leaking fluids are not only a sure sign that the vehicle needs repair, but the fluids are also harmful to the environment. Below are common fluids that can leak from a vehicle:

<i>colour of drippings</i>	<i>fluid</i>
Black or dark brown:	<i>motor oil or grease</i>
Yellow or green:	<i>coolant or antifreeze</i>
Pink or red:	<i>transmission fluid</i>
Clear:	<i>brake fluid, power steering fluid or gasoline</i>

The table on the previous page describes some of the most common causes for vehicle smoke—a vehicle's exhaust should normally be very light, almost invisible.

Compulsory emissions inspections are required by law in some countries and are beginning to be

required in Latin American cities as well. Nevertheless, with the proper instruction and comprehension of engine controls, any individual can perform their own inspection. But, it remains important that a vehicle be serviced by a skilled technician who understands modern emission control systems. See the resources provided at the end of this chapter for more information regarding vehicle emissions inspection education programs.

Regular vehicle maintenance and inspections are an important priority in our community

1 2 3 4 5 6 7 8 9

Our community includes emissions reduction as a criterion for fuel choice

1 2 3 4 5 6 7 8 9

Our community includes emissions reduction as a criterion for vehicle purchases

1 2 3 4 5 6 7 8 9

2. Community Transportation Practices

Reducing cumulative distance driven

The most important way that your community can reduce their atmospheric pollution is to simply drive less—this means reducing the cumulative amount of distance that your community members drive. The world now realizes that vehicles are driven too much. Since most vehicles are compact to mid-sized sedans, they generally hold only 2-5 passengers, and are often operated for the purposes of only a single individual. This pattern of vehicle use is extremely inefficient. Thus, the most basic way to reduce your community's cumulative vehicle use is to reduce the need for individual trips.

While reducing cumulative distance may require a higher degree of coordination and planning than is presently practiced in your community, the benefits are numerous. Less wear-and-tear on community vehicles means less maintenance, less fuel expenses, more cooperation amongst community members, and less pollution. Probably the easiest ways to reduce distance are: advanced planning of trips, sharing rides, and using other means of travel besides the small pollution generators known as cars. Each are discussed below.

Trip planning: By planning errands such that several tasks are undertaken during a single trip, your community can get the most out of the time

any one member spends behind the wheel. Several tasks can be accomplished when you go somewhere by simply driving to a central location and parking, and then walking, biking, or using public transit between destinations.

Ridesharing: Ridesharing can also be an ideal way to reduce your community's contribution to pollution. Every time a ride is 'shared' (i.e. two or more people with their own itineraries use the same vehicle), at least one individual trip is eliminated.

Other modes of travel: Briefly, the main alternate modes of transportation to small vehicles are: public transport, pedestrian travel, and bicycling. Because public transport greatly reduces the number of individual trips needed by many people, the use of public transportation is a great way to reduce cumulative mileage. See question #3 for a more in-depth look at public transportation. Biking or walking to a destination creates no pollution at all. These activities have the benefit of also increasing a person's physical fitness level.

Unfortunately, as roads expand in cities, walking options are often reduced substantially. Limited investment in sidewalks combined with space constraints mean that sidewalks along streets are often either non-existent or very narrow, forcing individuals to walk in the streets, where they must compete for space with motorized vehicles. In addition, as motorized vehicle traffic grows, it becomes increasingly difficult for individuals to cross by foot without some supporting infrastructure such as stoplights. These problems are only exacerbated if decisions are made to widen the streets to accommodate more vehicle traffic.

Bicycles also face growing impediments. They, too, must compete for space with motorized vehicles, and are often outlawed altogether on major streets. Moreover, even if they can be used to reach a public transportation stop, there is no safe means of storing the bicycles, either by locking them up or by taking them onto the public transportation vehicles. In addition, bicycles are often treated as a luxury item and are assessed substantial tariffs, if imported.

Driving efficiently

Even a perfectly maintained car will pollute more than necessary if it is driven carelessly. Your car's emissions will be lower if you apply common sense to your driving and follow some basic rules like these below:

Avoid unnecessary idling: Do not allow a vehicle's engine to run when it is not being driven. If practical, this may extend to any situation in which you are going to wait for more than 30 seconds. To accomplish this, several car manufacturers now produce 'hybrid-electric' vehicles that incorporate an automatic shut-off into their design. 'Hybrid' vehicles also reduce emissions by supplementing the combustion engine with an electric motor which is charged by the vehicle's own braking energy.

Plan your route to reduce 'stop-and-go' driving: Driving in traffic is not always avoidable. But whenever possible, plan trips outside rush hour and peak traffic periods. Try to 'smooth' your driving by accelerating and decelerating gradually, anticipating stops and starts for traffic lights, changing traffic speeds, and so on. A vehicle that is crawling along releases about three times more smog-producing VOCs than one cruising at the most fuel-efficient speed. Also, avoid rough roads where possible: smooth road surfaces can reduce fuel consumption by 10 to 30%.

Reduce the use of air conditioning: Use of a vehicle air conditioner increases load on the engine. This can increase emissions and decrease fuel economy. Try opening the window or the fresh air vent to cool the inside of your vehicle. Also, park in the shade if you can to prevent the car from heating up in the sun. Besides keeping the interior temperature of your car more comfortable, you will lessen the pollution and waste that occurs when gasoline evaporates from the engine and gas tank.

Reduce vehicle weight: Your car burns more gas and emits more pollution when the engine is operating under high load; that is, when it is working especially hard. Extra load is created by carrying extra weight. Thus, remove excess weight from vehicle and keep the vehicle free of unnecessary objects which would add weight.

Drive vehicle as smoothly as possible: Maintain moderate speeds and accelerate smoothly—i.e. avoid speeding and abrupt starts and stops. The optimum fuel economy for most vehicles is achieved at a steady speed of between 80 and 100km per hour. Tests show that most cars use about 10% less fuel when driving at 90 instead of 100km/hr. Avoiding speed changes saves fuel. Accelerate and decelerate gradually. (This will also reduce engine wear.) Anticipating traffic movement will help you avoid frequent brake applications. Stepping on the accelerator too heavily can use up to four times as much fuel as

moderate acceleration. Refer to the owner's manual to determine optimum gear shift points for manual transmissions. When going up hills, let the vehicle's speed drop off gradually or shift to a lower gear when necessary. When driving down hill, ease up on the accelerator and let gravity move the vehicle.

Members of our community strive to minimize the amount of distance driven

1 2 3 4 5 6 7 8 9

Members of our community make every effort to drive efficiently

1 2 3 4 5 6 7 8 9

3. Public Transportation

Good public transportation systems used by a large fraction of urban citizens are critical in terms of minimizing costs, air pollution, oil dependence and traffic congestion. Yet, presently these systems are inadequate in most cities; they tend to be poorly maintained, highly polluting, often uncomfortable, and limited in accessibility.

There are many varied forms of public transportation, including buses, rapid transit bus lines, trains, subways, mono-rails, trolleys, taxi services, as well converted pick-up trucks.

The larger-scale public transit systems are found

Transformation of Bogotá

In just a few years, innovative planning transformed Bogotá, Colombia into the world's leading model for sustainable urban design. The once polluted and congested city, where many people were unable to reach vital destinations, now has one of the world's most efficient and accessible transportation networks.

Latin America's largest network of bicycle routes, 150 miles long (250 km)

A world-class Bus Rapid Transit system of dedicated bus lanes called TransMilenio

The world's longest pedestrian-only street, spanning 10.2 miles (17 km); and hundreds of miles of sidewalks, many through the city's poorest neighborhoods

Car-Free Sunday, when many streets are closed to motorized traffic to make space for thousands of cyclists and pedestrians

(Source: Institute for Transportation and Development Policy, 2003)

The Case of Mexico City

Using Transport Policy to Combat Air Pollution

Mexico City may well have the most polluted air of any city in the world. The city is nestled in a valley 2,300 meters high, surrounded by mountains and subject to frequent inversions. The thick layer of ozone and other air pollutants that blanket the city, 83% of which are produced by the area's 2.5 million vehicles, has reached such levels that the quality of life has been severely affected. To reverse the steadily deteriorating situation, in 1990 the government launched a comprehensive program centering on improved transportation. This involves reducing the number of private cars, cleaning the gasoline produced in the country's refineries, and replacing the engines on 3,500 old diesel public buses. In addition, the 1995-2000 Program to Improve Air Quality in Mexico City (Proaire) introduced new activities in the field of monitoring, education and public participation. Other initiatives included the establishment of the Valley of Mexico Environmental Trust Fund, which is maintained with tax revenue from petrol and finances air quality improvement activities, the Automatic Environmental Monitoring Network, Environmental Emergency Programs, 'A Day Without a Car' Program, a reforestation programme and environmental education in the metropolitan area of Mexico City. Some of the key actions being introduced to reduce urban air pollution include:

- Requiring drivers to leave their cars home one working day per week
 - Setting emission standards in bidding documents for new bus engines the same as those in effect in California
 - Raising subway fares to cover the costs of the new bus engines as well as subway improvements
 - Rationalizing the routes of the 60,000 private mini-vans that carry riders from low-density suburbs to the city center
 - Raising the price of gasoline by 12.5% and using ensuing revenues to fund the environmental program
 - Requiring that, by the end of 1990, all new vehicles sold must be equipped with catalytic converters
 - Regulating that all vehicles be inspected twice a year to check auto emissions, with a monitoring program to detect and penalize cheaters.
- In addition, the program involves tree planting, creation of new parks, substituting less-polluting fuels in power plants and other industries, and improving industrial efficiency.

(Source: Leitmann, 1991)

particularly in large metropolitan areas, while smaller systems exist in other areas. On any scale, there are problems that such service systems face. In some cases the problems overwhelm the service, and it becomes lost to the public. In other cases, the cost of the service prohibits the general public, from using it. In addition, a lack or deficiency of logistical control can severely affect the reliability and usefulness of the service. Thus, to be effective and beneficial, a public transit system should be well planned, accessible, and equitable.

In LAC, as in other parts of the world, the traditional pattern for developing urban transportation systems has been first to invest in road infrastructure. Public transportation systems and their associated infrastructure, whether road-based or not, are rarely planned for or invested in during this initial period. Such an investment strategy, similar to what has occurred in most of the cities in North America, breeds the creation of a personal automobile-based transportation system. As cities grow, the existing infrastructure fosters transportation demands being met by personal automobiles, further fueling demand for expanding the road-based system, which, in turn, stimulates the development of urban sprawl. As a result, when attention turns to designing public transportation systems and their associated infrastructure, the sprawling nature of a city's development limits the applicability of public transportation. Either only a small portion of a city's residents are able to make use of the public transportation system, or the cost of developing a transportation system sufficiently extensive to serve a large fraction of the city's population is prohibitively expensive. The consequence, inevitably, is to fortify and expand the personal car-based system instead. Because there are powerful interests (e.g. car manufactures, oil companies, etc.) that actively, if covertly, oppose public transportation initiatives, sometimes political action is necessary to oppose these forces. In these cases, as well as in areas where there is no public transit available, but there is a need, political action is often required to motivate the municipal leaders to commit to a project, or to keep them committed to the sustainability of an existing service. Your community should be aware of these and other issues surrounding the sustainability of public transportation in your area, and become actively engaged in ways your community feels appropriate.

For the areas in which public transportation

services do exist, the movement should be toward reducing the emissions from this service. Consider that a fleet of diesel-fueled buses driving in congested urban traffic use more fuel and emit considerably more pollutants than, e.g. the same buses driving in their own unobstructed lanes, or the same buses using a cleaner fuel.

Our community utilizes public transportation whenever it is a feasible alternative to driving

1 2 3 4 5 6 7 8 9

Our community publicly supports the development of and sustenance of public transportation

1 2 3 4 5 6 7 8 9

4. Other Combustion Engines

The evaluation information for this question can be reasonably adapted from the information provided in question number 1, as the operative principles are the same.

Our community strives to minimize emissions from the engines we use besides those belonging to vehicles

1 2 3 4 5 6 7 8 9

5. Burning

In some areas, particularly those that lack a comprehensive system of waste collection, open burning of waste by residents can be a major contributor to air pollution. Open burning of waste can produce mixed and very toxic fumes. Burn barrels often emit acid vapors, carcinogenic tars, and 'heavy metals' such as lead, cadmium and chromium, as well as dangerous levels of carbon monoxide. The closer you stand to the burn barrel, the more of these harmful chemicals you inhale.

Residual ash is another result of incomplete combustion. Frequently, a significant portion of material in the barrel—especially at the bottom—is not burned up. Ash disposal outside of a sanitary landfill can cause problems sooner (for those immediately exposed) or later (for example, if water contacting the ash becomes contaminated and gets into groundwater and/or surface water).

See the Waste Handling Assessment, Chapter 4 to take a closer look at your community's waste disposal practices.

Materials that absolutely should not be burned in a burn barrel are tires, plastics, electrical equipment, and rubber. These also should not be

burned in a furnace, wood stove or similar home heating system. Painted surfaces as well as various petrochemicals also release a great deal of pollutants into the air, so they also should not be burnt.

Even the smoke generated by a large number of simultaneous leaf fires can cause significant health problems. Leaf smoke can irritate the eyes, nose and throat of healthy adults. But it can be much more harmful to small children, the elderly, and people with asthma or other lung or heart diseases.

Our community strives to eliminate the use of fire as a waste disposal option

1 2 3 4 5 6 7 8 9

6. Ozone Depleting Substances

A single chlorine atom, released by the action of UV radiation on chlorofluorocarbons, or CFCs, is capable of destroying tens of thousands of ozone molecules during its residence in the stratosphere. CFCs are found mainly in either (1) aerosol cans that were manufactured more than a decade ago, (2) industrial processes, or (3) refrigerants used in air conditioners and appliances.

Prior to 1976, the most common propellants used for aerosol spray cans were CFC's, but their use has been subsequently banned by many governments. Therefore, many aerosol cans still have on their label, 'Does Not Contain CFC's'. CFC propellants were replaced by propane and other gases, most of which contribute to VOC emissions and pose other dangers like flammability. It is best if your community chooses not to use any aerosol products. However, if your community has any, be sure to use the product up before disposal. Refer to Chapter 4 for more information regarding waste handling. If your community possesses any CFC aerosol sprays, the best thing to do is to locate a service that is capable of safely handling the CFCs and turn the products over to them for disposal.

Vehicle air conditioning systems in models earlier than 1994 contain, and leak, CFCs. The air conditioners of most later models use refrigerants that are less harmful to the ozone layer than CFCs. If a vehicle air conditioner contains CFCs, ensure that it is properly maintained. Have the air conditioner serviced by a facility that is certified to capture, clean and recycle the used CFCs rather than simply venting them into the air and refilling the unit.

Refrigerant found in appliances should also be reclaimed before disposal of the appliance. A trained technician is capable of emptying a refrigeration system without leaking any refrigerant into the atmosphere. This refrigerant can then be re-used. Thus, it would be helpful for your community to locate a technician that is capable of performing this work.

Our community strives to eliminate the use of CFCs

1 2 3 4 5 6 7 8 9

7. Pesticides

Pesticides and herbicides that are sometimes used in agricultural operations are generally very biologically toxic substances. This means that they have many negative health and environmental effects. In general, these products should not be used unless they are deemed absolutely necessary.

Nevertheless, several farms—particularly larger scale operations—do use these products on a regular basis. Besides reaking havoc on the ecosystem within which the product is used, airborne particles of the product can be inhaled and may cause problems in humans. Health problems are exacerbated in cases of chronic exposure. Thus, if pesticides or herbicides are used in your vicinity, inventory the community for signs of exposure, and seek help or advice from environmental or health agencies if several people display similar symptoms associated with these chemicals.

Our community is aware of the dangers of pesticide and herbicide usage

1 2 3 4 5 6 7 8 9

Our community strives, through whatever means, to protect ourselves and our larger community from pesticide/herbicide use

1 2 3 4 5 6 7 8 9

8. Community Tree Preservation

It would be hard to overstate the value of trees. Trees are an extraordinarily valuable and essential component of a healthy environment. Trees are one of the largest sources of oxygen, which we need to breathe. One acre of trees generates enough oxygen each day for 18 people. Alternately, trees also consume and store carbon dioxide, the gas largely responsible for global warming; a single tree stores on average 28 kilograms of carbon annually.

Besides affecting these critical gases, trees also directly reduce pollution by filtering pollutants out of the air; they cleanse the air by intercepting and slowing particulate materials causing them to fall out of the air, and by absorbing pollutant gases into leaf surfaces. Pollutants abated by trees include nitrogen oxides, sulfur dioxides, carbon monoxide, carbon dioxide (required for tree growth), ozone, and small particulates less than 10 microns in size.

Trees are a critical part of the water cycle; one acre of trees on a summer day transpires close to 4000L of water back into the atmosphere. Trees prevent soil erosion, while increasing groundwater recharging by intercepting, slowing, evaporating, and storing water through normal tree functions. It is estimated that trees alone could reduce by 95% the amount of sediment that erodes from 'developed' landscape.

Trees provide shade and wind breaks, lowering the temperature in areas that would otherwise be under direct sunlight, and offering shelter against strong winds. Similarly, trees also reflect and absorb sound energy, while adding a natural 'white noise' through the movement of branches and leaves.

Trees are living systems that interact with other living things in sharing and recycling resources—as such, trees are living centers where living things congregate and are concentrated. It is a fact that people feel more comfortable and at ease when in shaded, open areas of trees as compared to urban areas surrounded by non-living things. People's preferences for locating areas of social interactions in calming, beautiful, and nature-dominated areas revolve around the presence of community trees and forests. Furthermore, people are not the only ones who thrive in an environment replete with trees; many forms of wildlife need trees as part of their habitat, and such bio-diversity increases the health of any ecosystem.

Thus, it is advisable that your community do all that it can to preserve and augment the number of trees on your grounds, as well as throughout the larger community.

Our community holds the preservation of trees and forest on our grounds as a priority

1 2 3 4 5 6 7 8 9

Our community makes explicit efforts to end deforestation throughout Latin America

1 2 3 4 5 6 7 8 9

9. Expert Information

It is important to be involved in local efforts to reduce air pollution. Aside from the air pollution that your community members may generate, there may be industries, utilities, or practices of your larger community that greatly contribute to the deterioration of air quality but that are beyond your community's direct influence. For this reason, it is important to educate yourself about the overall quality of air in your area, and to discover the main causes behind the pollution present in it, as well as what policy framework exists within which polluters must operate.

Expert agencies like environmental protection organizations and public health organizations are likely to have considerable knowledge about the prevailing environmental conditions, and they may also have ideas regarding action steps to take in order to correct problems. Unfortunately, funds are often limited, so the information that the organizations have to share does not end up being broadcasted throughout the population. Thus, your community, for example, can help spark more widespread citizen engagement by sharing any education that you receive from these organizations.

In general, it is a wise idea for your community to have relationships with such organizations. Let them know that you care. Learn about local efforts and issues, and what the agencies are doing about them. One of the driving forces behind reducing air pollution is citizen concern and involvement. Besides educating citizens, community members may speak up at public hearings to let officials know how they feel about air pollution problems in your community, they may report problems, or they may actually serve on administrative or advisory boards that work directly to solve air pollution problems.

Tackling urban air pollution requires coordinated actions at many levels. National governments are the level at which many needed policies and regulatory frameworks are set; the responsibilities for implementation are divided between several ministries including energy, industry, transport, trade, finance, environment and health. Sub-national authorities often have major enforcement responsibilities for environmental regulations, and local governments typically manage key areas such as land use and urban transport planning. There are also other, non-governmental stakeholders with important

roles. For example, of the approximately US\$1.3 Billion invested in the Santiago Metropolitan Region over the last decade, 90% was from the private sector.

The development of a comprehensive strategy for tackling air pollution requires a level of information and understanding that is often lacking. Thus, an important role that national and local authorities can also be influenced to play is to develop capacities and support activities to collect reliable air quality data, develop emissions inventories, model air quality and its impacts, identify measures for improving air quality and assess costs across sectors, besides drafting and enforcing environmental legislation.

It is important that the surrounding communities be aware of what is being released by manufacturers in their area. All appropriate measures should be taken to eliminate the release of hazardous substances into the air.

Our community has developed relationships with and utilizes the information available from expert organizations in our area

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each of the preceding sections in the column on the right:

score

1	Community Vehicles: maintenance	
	Community Vehicles: fuel choice	
	Community Vehicles: purchasing	
2	Transport: minimizing distance	
	Transport: efficient driving	
3	Public Transportation: use	
	Public Transportation: advocacy	
4	Other Combustion Engines	
5	Burning	
6	Ozone depleting substances	
7	Pesticides/Herbicides: education	

	Pesticides/Herbicides: action	
8	Tree Preservation: community land	
	Tree Preservation: deforestation	
9	Expert Information	

Now that you have comprehensively examined your community's contribution to air pollution, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Now categorize each problem listed above into one of the following three categories:

I = Critically important. Currently dangerous, must be addressed immediately

II = Important, but not immediately dangerous. Must be addressed

III = Current practice should be improved, but is not immediately important

Indoor Air Pollution: Assessment

Air pollution—Inside

Air pollution can affect our health in many ways with both short-term and long-term effects. Different groups of individuals are affected by air pollution in different ways. Some individuals are much more sensitive to pollutants than are others. Young children and elderly people often suffer more from the effects of air pollution. People with health problems such as asthma, heart and lung disease may also suffer more when the air is polluted. The extent to which an individual is harmed by air pollution usually depends on the total exposure to the damaging chemicals, i.e. the duration of exposure and the concentration of the chemicals must be taken into account. Consider that indoors, gases can rapidly become much more concentrated than outdoors.

Examples of short-term effects include irritation to the eyes, nose and throat, and upper respiratory infections such as bronchitis and pneumonia. Other symptoms can include headaches, nausea, and allergic reactions. Short-term air pollution can aggravate the medical conditions of individuals with asthma and emphysema.

Long-term health effects can include chronic respiratory disease, lung cancer, heart disease, and even damage to the brain, nerves, liver, or kidneys. Continual exposure to air pollution affects the lungs of growing children and may aggravate or complicate medical conditions in the elderly.

Indoor air pollution, like atmospheric pollution, is generally a result of combustion. Combustion is a chemical reaction that lets off a great deal of energy. We experience this energy as the light and the heat that comes off a flame. Harnessing this energy has been very useful to us. Fire is a reaction which breaks 'organic' matter down into smaller bits. (Organic matter is anything that has the element 'carbon' in it.)

'Incomplete combustion' means that the fuel is not being fully broken down. We see evidence of incomplete combustion whenever we see smoke. Most of the pollution from fire comes from incomplete combustion.

Smoke is made up of a wide variety of particles and gases. Carbon monoxide (CO) is a very deadly gas that is a result of incomplete combustion. There are many other dangerous components like nitrogen oxides, hydrocarbons, sulfur oxides, and suspended particle matter. In general, all these

pollutants add up to a great deal of disease and environmental degradation; however, when smoke is concentrated by walls and a roof, the dangers become much more critical.

Inside most Latin American households, the stove or cookstove is the major source of emissions. The indoor air pollution that comes from cookstove fires is the most harmful and deadly problem facing most people of the countryside, especially the women and children.

Indoor Air Pollution: Inventory

The following sections are designed to help your community make an inventory of its indoor air pollution. This is so that the community can assess both the sources of indoor air pollution, as well as what is being done (or can be done) to help improve the community's practices.

The following inventory is based around the likely main sources of a community's indoor air pollution: cooking/heating, and smoking; thus, it will especially examine the kitchen area. However, the principles of efficiency and ventilation of a cookstove readily apply to any other use of fire that your community might have. Each question is discussed in the section following the inventory, where you will be provided a means to evaluate your responses, and directions to go for improvement.

1. Types and uses of community fuel

Here is a list of fuels you might be using:

Biomass Fuels:

- Dung
- Wood
- Agricultural residues
- Other residues
- Residue briquettes
- Charcoal

Liquid and Gas Fuels:

- Kerosene (Paraffin)
- Bottled gas (LPG)
- Biodiesel or other liquid bio-fuel
- Biogas

Solar Energy:

- Solar cooker
- Solar electric (solar PV)

Other Fuels:

- Grid electricity

Batteries

Wax candle

Any other fuel (specify):

Using the list above, what types of fuel do you use for the following purposes?

main fuel secondary fuel

Cooking: _____

Lighting: _____

Keeping warm: _____

Heating water: _____

Cooking for selling: _____

Cooking animal feed: _____

Electrical equipment: _____

Other task 1 (specify): _____

Other task 2 (specify): _____

2. Getting fuel; buying and gathering

What is the source of your main type(s) of fuel?

- Raw biomass (wood, dung)
 Petroleum products
 Converted biomass (e.g. Biogas, biodiesel, plant oil, residue briquettes, etc)
 Grid electric—if so, is it generated from coal, oil, nuclear or hydro?

- The sun
 Other source (specify)
 Fuel 1
 Fuel 2

If you buy fuel, how much do you pay for it per week?
 (show unit of currency)

Wood: _____

Charcoal: _____

Kerosene (paraffin): _____

Bottled gas: _____

Grid electricity: _____

Batteries: _____

Wax candles: _____

Other (e.g. gelfuel): _____

Total cost: _____

If your fuel is gathered, who is responsible for gathering it?

How many hours a week are spent gathering fuel?

Check any problems encountered by those collecting fuel:

- Supply is scarce

- Falling down with load
 Twisted/sprained ankle
 Broken bones
 Cuts/lacerations from blades or saws
 Back strain
 Dehydration
 Dizziness or fainting
 Other problem reported
 Other problem reported:

3. Fuel drying (for biomass fuels)

Do you ever use 'green' fuel (i.e. wood or plants that are still growing, or have been growing very recently, when collected)

- not applicable—do not use biofuel
 never
 occasionally
 usually
 always

The main fuel that you use – about how dry is it usually?

- not applicable—do not use biofuel
 Very dry
 Dry
 Damp
 Wet
 'Green'

Definitions:

Very dry: wood that is completely dry having been outdoors in very dry weather for a long period, or kept to dry in the house for some weeks at least;

Dry: wood that does not feel damp, was gathered when the weather was variable and has needed to be dried in the house for several days;

Damp: wood that feels slightly damp, has not been dried in the house;

Wet: wood that is wet due to prevailing rain and dampness rather than because it is green (see below), and not having been dried to any degree in the house;

Green: wood that was cut while still growing, or was doing so very recently, so that the wood contains sap.

Do you dry your main fuel before use?

- not applicable (not biofuel or always very dry)
 always
 usually
 occasionally
 never

4. Health and Wellbeing

Survey the members of your community and any workers that work there. In what ways does smoke affect their health? Answer each question by indicating the percentage of people that report each symptom, i.e.:

- 1 = 0-25%
- 2 = 26-50%
- 3 = 51-75%
- 4 = 76%-100%

How many people are being interviewed for this question?

What percentage report itchy, watery or irritated eyes?

What percentage report a persistent cough?

What percentage presently have a chest illness?

What percentage report having a shortness of breath?

What percentage report having frequent headaches?

5. Smoking

How many members of the community smoke?

Do people smoke inside?

No / Occasionally / Yes, regularly

Has your community been educated about the health and environmental effects of smoking?

Yes / No

Does the community have a smoking policy? (e.g. smoke only in designated areas)

Yes / No

Is the community policy explained to all members and guests?

Yes / No

Are there designated smoking areas?

Yes / No

If Yes where are these areas located?

6. Ventilation of the Kitchen area

Is the kitchen:

- Enclosed

- Semi-open

Permanent ventilation in roof of kitchen:

- None
- Small holes (less than 10cm in diameter)
- Large holes (more than 10cm in diameter)
- No roof, or very open roof

Does the kitchen area have eavespace?

- none
- All round room
- Along outside walls
- Along walls within house

How many windows are in the room where cooking is done?

How many doors are there in the kitchen?

Are the door(s) usually open or closed?

Can any black soot or residue be found on the walls, ceiling, or other locations?

7. The stove

Type of stove—main stove and secondary stove (choose from the following):

main secondary

- Three-stone or two-stone fire (i.e. open fire)
- Shielded (from wind or air currents) mud fire or mud stove (including chimney stove)
- Wood-burning ceramic stove (made of fired clay)
- Metal stove
- Improved charcoal stove
- Pressurized kerosene stove
- Non-pressurized kerosene stove
- Gas stove
- Solar cooker
- Grid-powered electric stove

If unsure, or if you have 'other' type of stove, please describe:

If the stove burns biomass fuels, does the stove (or fire pit) have a grate upon which the fuel is placed?

Yes / No / Not applicable

Is the space between the flame and the burner plate(s) or pots minimized?

Yes / No

Does the burning area have insulation to absorb and retain heat? (e.g. Clay, sand, brick, etc.)

Yes / No / Not applicable

Can the burning chamber be closed, excepting an inlet for air?

Yes / No

If the stove has spaces for multiple pots, are there plates to block unused burner areas?

Yes / No / Not applicable

If the stove has spaces for multiple pots, can the air flow to each be controlled with internal baffles?

Yes / No / Not applicable

If the fire is internal, are there dampers on the air inlet to control the size of the flame?

Yes / No / Not applicable

Is there a flue (i.e. chimney) built into the design of the stove?

Yes / No

Observing the stove in operation, answer the following questions:

How much smoke does the fire produce?

- none visible
- light wispy
- gray and steadily produced
- fairly heavy with some soot
- thick with black soot

What color is the flame?

- Blue
- Yellow
- Orange
- Red
- Occasional flame, mostly smoldering coals

How many people usually sleep in the room with the main stove?

Is this stove usually kept alight at night?

Is a stove used in any other room in the house other than the kitchen?

Yes / No

If **Yes** do people sleep in that room?

(list who sleeps there)

8. Smoke extraction

Is there any type of smoke extraction in the kitchen (chimney stove, hood etc)?

Yes / No

If the answer is **Yes** rate the condition of each type of extraction device on a scale from 1-5 (1 being 'poor'). Consider things like rust, holes, cleanliness, state of repair:

Extraction method: 1-5

Chimney (built into structure of building):

Smoke hood (semi-permanent fixture):

Other (specify):

If 'other' smoke extraction method, please describe or sketch it:

If there is a smoke extraction device, watch the stove in operation and answer the following questions:

Can or does the smoke reenter the building through eaves, windows, or doors?

Yes / No

Does the smoke drift toward another home?

Yes / No

Maintenance:

Is there someone in your community that is charged with maintaining all exhaust systems (chimneys, etc)?

Yes / No

Does your community have a regular maintenance schedule for chimneys and vents?

Yes / No

9. Education, Policy, and Civic Engagement

Has everyone in your community been educated about the dangers of indoor air pollution?

Yes / No

Does your community have a policy on indoor air pollution?

Yes / No

Does your community have an active plan to help educate the public about air pollution, deforestation, and better practices?

Yes / No

Is your community taking steps to address or change public policies which affect air quality (e.g. forest use, emission standards, fuel standards, etc)?

Yes / No

Indoor Air Pollution: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given (1= disagree, community practices unhealthy; 9= agree completely, no change needed).

1-2. Types, Uses, Costs of Community's Fuel

The purpose of these questions is to inventory the types, uses, and costs of the community's fuel.

Making an inventory of the types of fuels used for various purposes helps your community develop a clear picture of your community's practical fuel choices. It is often the case that several different fuels are used within a community, but each for their own purposes. It should be your community's goal to maximize the efficiency and cleanliness of fuel for each purpose that fuel is needed, with the priority being set on those fuels which are used most often.

The choice of fuel has perhaps a greater effect upon the amount of pollution emitted by burning than any other single factor. Basically, the hotter and cleaner that a fuel burns, the less pollution it lets off. The gradient of efficient burning is as follows (this is general and does not include factors like dryness or stove capabilities): dung (least efficient), crop residues, wood, charcoal or

compressed residues, liquid fuels, gaseous fuels, solar energy (most efficient).

Thus, using dung as fuel (without first converting it into biogas) releases the greatest amounts of particulate matter, carbon monoxide, and several other pollutants. Burning corn cobs or stalks, or other crop wastes is slightly cleaner than dung. Cleaner yet is wood, charcoal, coal, or other solid fuel types. However, all these 'biomass' fuels release a great deal of pollutants because they do not often burn completely. This is why liquids and gases release much less air pollution.

Bottled gas, kerosene, and other heating liquids and gases are much cleaner relative to wood. Nonetheless, all of these fuels let off carbon dioxide and usually carbon monoxide, which are both pollutants that can concentrate into dangerous levels indoors. In addition, if the fuel is petroleum based, there are still a number of pollutants released besides carbon dioxide and carbon monoxide, like sulfur oxides and volatile organic compounds. 'Biofuels'—for example, gases made from the digestion of dung, or ethanol made from corn, or diesel made from seeds—release far fewer pollutants than their petroleum counterparts.

If your community uses electric power (from the grid) for heating or cooking, refer to the chapter in this manual about energy, Chapter 5.

By far, the cleanest, most efficient means of heating and cooking is the sun, or solar energy. The use of solar energy releases no pollution and uses no fuel. You can use passive solar warmers to bake bread, to boil water, to heat vegetables, as well as many other tasks that would normally require the burning of fuel. Solar technology is rapidly spreading throughout Latin America because the required materials are generally available and inexpensive, and, of course, because there is a lot of sun!

The cost is an important aspect to keep track of, because it measures how much of the community's resources are being used for fuel. These resources may be monetary or they may be in the form of personal labor. If a decision is made to change fuels, or to include the use of solar heating, keeping track of the fuel costs becomes an important means of judging the efficiency of the fuels.

Refer to the resources at the end of this chapter to find additional information regarding bio-gas, cooking fuels, and solar cookers. Resources for bio-gas production can also be found in the Waste Handling, Chapter 4.

Our community strives to use very efficient sources of fuel and monitors how much of our resources we spend on fuel

1 2 3 4 5 6 7 8 9

3. Fuel Drying

In some cases, the use of wood or other biomass fuels is unavoidable. In these cases it is most important to create situations in which the fuel burns as hot and completely as possible. This can be accomplished by using an efficient cookstove, and by drying the fuels being used.

If your community uses wood or other residues for fuel, be sure to have a sheltered area available in which to store recently collected wood or crop wastes. Fuels should be dried until they are as dry as possible (preferably a week or more).

There should be a regular program in place to rotate the fuels so that the driest are always what are burned, and recently collected fuels have ample time to dry before use.

Our community takes steps to ensure that any biomass fuels are thoroughly dried before attempting to burn them

1 2 3 4 5 6 7 8 9 10
(choose 10 if not applicable)

4. Health and Wellbeing

It is important to survey the members of your community, including any workers that spend time there, especially those that spend a lot of time in or near the kitchen.

Shared health problems (especially respiratory diseases) may indicate that indoor air pollution is a real problem in the community that should be addressed immediately.

The presence of smoke may immediately cause irritated eyes, headaches, or coughing. Longer term exposure may lead to upper and/or lower respiratory infections like pneumonia. In addition, long term exposure to smoke may lead to emphysema, lung cancer, chronic obstructive pulmonary disease, and other debilitating diseases.

Those most at risk are those who do the cooking, or those who sleep near sources of smoke.

Our community shows no signs of health problems related to smoke inhalation.

1 2 3 4 5 6 7 8 9

5. Smoking

Research has proven without a doubt that smoking is very injurious to both the smoker's health and to those who inhale second-hand tobacco smoke. It is extremely harmful to one's health, particularly to one's lungs and heart. Since the environmental tobacco smoke let off by smokers is as harmful to others in poorly ventilated areas as it is to the smoker, it is important to the health of the community to have a smoking policy that restricts smoking to open areas that are well ventilated.

Although adopting such a policy may represent a divergence from the normal cultural habits, it is very important that the policy be explained to everyone affected by it: community members, workers, and guests alike. The explanation of policy may serve as an opportune time to educate about the dangers of smoking. Educating smokers and non-smokers alike about the dangers of smoking is an important step to take to reduce the numbers of people smoking.

Our community strives to eliminate the dangers of environmental tobacco smoke

1 2 3 4 5 6 7 8 9

6. Ventilation of the kitchen area

The purpose of these questions is to provide the rational background to deciding how important it is for your community to increase the ventilation of your cooking areas.

A properly working cookstove will have the ability to pull in as much air (i.e. oxygen) as it needs to burn the fuel, and it will vent all exhaust outside into the atmosphere away from people or confined spaces; however, the ventilation of the kitchen area is also very important.

Roof vents (not including flue pipes or chimneys) and eavespaces are important in order that vapors are able to escape. However, any venting near the ceiling or roof must be coupled with venting closer to the ground, like doors, windows, or other openings. In addition, windows and doors also serve the important function of providing light to the working areas of the kitchen, which makes operating in the kitchen much safer.

Poorly ventilated kitchens will most likely show evidence of soot or smoke residues on the walls, ceilings, or settled on surfaces. If any evidence of poor ventilation is found, structural improvements should be considered.

Nevertheless, since several of the structural improvements that could be made to increase ventilation are costly and/or labor intensive, these questions about kitchen design can be used to indicate the relative importance of upgrading the efficiency of the cookstove, or the installation of a chimney or vent hood. For example, if your kitchen has no windows, only one door, and very little eavespace, it is very important that the smoke is vented. However, if there are roof vents, eavespace, windows, and a door, replacing a chimneyless stove is less important than making sure that the stove is burning efficiently.

It is important to include the comments of all those who work in the kitchen (not only those who are community members) in this inventory, since they may have a more intimate knowledge of the kitchen, stove and ventilation problems than anyone else.

Our community's kitchen is very well ventilated. It has adequate eavespace, is well lit, and shows no signs of soot or smoke build-up

1 2 3 4 5 6 7 8 9

7-8. The stove and smoke extraction

The cookstove and its smoke extraction device are the crux of the indoor air pollution matter. The cookstove should be as efficient as possible. Efficiency not only makes the operation of it cheaper, it greatly reduces the amount of air pollution released by it. There are a few simple principles to keep in mind when designing or upgrading a cookstove.

There are an incredible variety of cookstove designs; but the qualities of a good cookstove are as follows:

1. Maximize combustion of the fuel by keeping the temperature high and ensuring the presence of sufficient oxygen
2. Maximize radiative heat transfer from the fire to the pot(s) by keeping the pot as close to the flame as possible
3. Maximize convection from the fire to the pot(s) with a stove design that passes as much of the hot gases over the pot(s) as possible; reduce drafts
4. Maximize conduction to the food pot(s) by using an insulating material for the stove so that the heat is retained and concentrated near the pot(s)

5. Maximize user satisfaction by making the stoves convenient to use (with local fuels, cooking pots, and utensils) and able to easily prepare local dishes well

6. In summary, only a stove with what might be called robust efficiency will consistently save fuel under conditions of actual use. Stoves must be easy to use and fuel efficient under a variety of conditions: when it is boiling, simmering, baking, or frying food; when it is using only one opening of a large, three-pot stove; and when it is dirty or worn. Cookstoves are workhorses, not racehorses, and must be designed accordingly.

It is absolutely essential that all fires are vented. That is, each stove should have either a built-in chimney vented outdoors, or a vent hood which is similarly vented outside. If any fire in your community is not equipped with such a device, installing one is the highest priority in order to improve indoor air quality. Ample kitchen ventilation (with eaves, windows, roof vents, etc.) reduces the danger of concentrated exhaust smoke, but does not completely alleviate it. Consider that on a day where the air is stagnant, air currents do not flow through the kitchen, and thus do little to remove the smoke. References to resources to help you in this can be found in the categorized reference section in the back of this manual.

It is important that all chimneys, vents, stoves, or other heating device be checked on a regular schedule to ensure proper operation. The inspection schedule might be as infrequent as once a season, but it is very important that it occur. Any vent must be intact (without holes), clean and free of obstruction. All burners must be functioning properly, smoke shouldn't be escaping into the kitchen with a well designed cookstove. It is probably best if one person is put in charge of the regular maintenance of cooking, heating, and ventilation systems within the community.

Refer to the resources at the end of this chapter to find more information regarding indoor air pollution, cookstove designs, and ventilation.

Some care and thoughtfulness has been put into the design of our community's stove(s). All stoves are directly vented with either a chimney or a vent hood. They are as efficient as they can be for the primary type of fuel used

1 2 3 4 5 6 7 8 9

9. Education, Policy, and Civic Engagement

Reducing indoor air pollution is everyone's responsibility. Therefore it is important that everyone be aware of the dangers of smoke and how to avoid its concentration inside confined spaces. Reducing indoor air pollution should not only be a personal policy, but a community policy as well, since it affects all members of the community.

Spreading the principles of clean air needs to happen not only within your community, but within your municipality, country, and throughout the world. Thus to protect God's creation, it is important that your community work at all levels to educate and change policies regarding air pollution.

Our community has made a point to create policies to protect the quality of air both within and outside the community buildings. We are actively engaged in educating each other and the general public about air quality issues

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section:

score

1-2. Fuel types, uses and costs	
3. Biomass fuel drying	
4. Health and well being	
5. Smoking	
6. Kitchen ventilation	
7-8. Cookstove and smoke extraction	
9. Education, Policy, Civic Engagement	

Now that you have comprehensively examined your protection of indoor air quality, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Now categorize each problem listed above into one of the following three categories:

I = *Critically important. Currently dangerous, must be addressed immediately*

II = *Important, but not immediately dangerous. Must be addressed*

III = *Current practice should be improved, but is not immediately important*

Some suggestions for reducing Indoor Air Pollution

Fuel types / Alternate fuel-cooker combinations:

- Briquettes and pellets
- Charcoal, Kerosene
- Liquid petroleum gas (LPG)
- Biogas, Producer gas
- Solar cookers (thermal)
- Other low smoke fuels
- Electricity

Drying biomass fuels:

- All biomass is thoroughly dried

Tobacco smoking:

- Only in well ventilated areas or outdoors

Kitchen design and placement of the stove:

- Shelters/cooking huts
- Windows/ventilation holes
- Eavespaces
- Stove at waist height

Improved ventilation

- Hoods/fireplaces and chimneys (built into structure of house)

Improved cooking devices:

- Chimneyless improved biomass stoves
- Improved stoves with flues attached

Kitchen practices:

- Use of pot lids
- Good maintenance
- Sound operation
- Partially pre-cooked food

Source: ITDG, 2004

Chapter 2: Acknowledgements

The information contained in this chapter has been adapted from the following sources:

The Origin, Fate, and Health Effects of Combustion By-Products: A Research Framework. Avakian, Maureen D., Dellinger, et.al. Environmental Health Perspectives. VOLUME 110, NUMBER 11, November 2002.

Emissions of Rural Wood-Burning Cooking Devices, A thesis submitted to the Faculty of Engineering, Ballard-Tremeer, Grant, University of the Witwatersrand, Johannesburg, 1997. Available online: <http://www.wits.ac.za>.

Smoke, Health, and Household Energy, Volume 1. Bates, Liz and the Smoke Team, UK Department for International Development, 2005. Available online: <http://www.itdg.org>

Urban Transportation: Challenges facing Latin America. Bleviss, Deborah Lynn, 1999. Available online: <http://www.iadb.org/sds/doc/UrbanTransportBleviss.pdf>

Central America: Environmental Issues. Energy Information Agency, United States Department of Energy, 2002. Online: <http://www.eia.doe.gov/emeu/cabs/centamenv.html>

Your Car and Clean Air: What YOU Can Do to Reduce Pollution. EPA, Office of Mobile Sources, United States Environmental Protection Agency, document 420-F-93-002. Available online: <http://www.epa.gov>.

Energy-Environment Linkages in the Urban Sector. Leitmann, Josef, UNDP/World Bank/UNCHS Urban Management Program (UMP). Discussion paper, 1991.

Environmental Issues Information Sheet: Air Pollution. Smith-Sebasto, University of Illinois Extension. 2000. Full text available online: <http://www.nres.uiuc.edu/outreach/pubs/info-sheets.html>.

Urban Air Quality Handbook. Prepared and written by the staff and consultants of the Sustainable Cities Programme, UNCHS, Kenya. Available online: <http://www.unchs.org/scp>

GEO3: Global Environmental Outlook. UNEP, 2002. Available online: <http://www.unep.org/geo/geo3>

Smoke – the Killer in the Kitchen. Warwick, Hugh and Alison Doig, ITDG Publishing, London, UK; 2004

Ecological Cookers: An essential element in Bettering Household Health. Whitfield, David, Fundación CEDESOL. Available by request online: solar1@zuper.net.

Chapter 2: Resources for Air Quality

Sustainable Urban Transport Project for Latin America: <http://sutp.org/esp/espindex.htm> Cra. 14 # 94a- 24 of. 409; Bogotá, Colombia; Tel: (+571) 635 9048; Fax: (+571) 635 9015. SUTP is dedicated to advancing sustainable transportation practices throughout developing countries. They are a great resource for policy makers and concerned citizens. Their free **Sourcebook for Policy Makers in Developing Countries** (modules available in Spanish and English) provides a tremendous amount of information and guidance on topics such as: vehicle maintenance and inspection, cleaner fuels, eco-driving, mass transit options, and raising public awareness.

Clean Air Initiative: <http://www.cleanairnet.org>. The Clean Air Initiative is a project of the World Bank that advances innovative ways to improve air quality in cities by sharing knowledge and experiences through partnerships in selected regions of the world. La Iniciativa de Aire Limpio en Ciudades de América Latina (IAL-CAL) tiene como propósito revertir el deterioro de la calidad del aire urbano en América Latina, que es el resultado de la creciente urbanización, aumento del transporte vehicular, y de la producción industrial.

Environmental Protection Agency of the United States: <http://www.epa.gov>/Many pages available in spanish. Many resources on air pollution, mobile sources, and pollution prevention.

Resources for the Future: <http://www.rff.org/> Offer several articles and reports on air pollution, climate change, and pollution prevention.

Drive Green - Environmental guide to driving: <http://www.ns.ec.gc.ca/epb/factsheets/drive.html> From Environment Canada, a guide to better driving practices.

GREENTIE: <http://www.greentie.org/> GREENTIE was an international directory of suppliers whose technologies help to reduce greenhouse gas emissions. GREENTIE

ceased collecting new information at the end of March 2005. Nevertheless, the information will remain available through this web site's search facilities as it represents one of the World's most detailed repositories of such information.

Diesel Emissions Evaluation Program:

<http://www.deep.org/reports/> Check under their listed research projects for diesel maintenance guidelines and best practices.

Emissions of Rural Wood-Burning Cooking Devices:

<http://www.ecoharmony.com/thesis> Ph.D thesis by Grant Ballard-Tremeer which offers a detailed analysis of cookstove designs and their emissions.

Renewable Energy Policy Project (Center for Renewable Energy and Sustainable Technology):

<http://www.repp.org> REPP's goal is to accelerate the use of renewable energy by providing credible information, insightful policy analysis, and innovative strategies amid changing energy markets and mounting environmental needs by researching, publishing, and disseminating information, creating policy tools, and hosting highly active, on-line, renewable energy discussion groups.

Biomass Cooking Stoves discussion forums:

<http://www.crest.org/discussiongroups/resources/stoves/> This site exists to help people develop better stoves for cooking with biomass fuels in developing regions.
<http://www.repp.org/discussiongroups/resources/stoves/Countries/country.html> Links to biomass cooking stove resources in different countries.

Energia: International Network on Gender and Sustainable Energy: <http://www.energia.org/> Tel: +31.(0)33.4326044 (Netherlands). ENERGIA is an international network on gender and sustainable energy which links individuals and groups concerned with energy, sustainable development, and gender. ENERGIA's goal is to contribute to the empowerment of rural and urban poor women through a specific focus on energy issues. ENERGIA provides numerous publications and resources toward improving cooking practices.

Aprovecho Research Center: <http://www.aprovecho.net/> The Aprovecho Research Center website contains construction plans for many different cook stove designs

SPARKNET: <http://sparknet.info/home.php> SPARKNET is an interdisciplinary interactive Knowledge Network focusing on energy for low-income households in South and East Africa.

HEDON Household Energy Network:

<http://www.hedon.info/> The HEDON Household Energy Network is an informal forum dedicated to improving social, economic, and environmental conditions in the South, through promotion of local, national, regional and international initiatives in the household energy sector.

Professor Kirk R. Smith: University of California, Berkeley: <http://ehs.sph.berkeley.edu/krsmith/> Excellent resource on the effects of indoor air pollution from cookstoves.

Chapter 3

Drinking Water—Quality and Source Protection

Water: Catalyst and Crisis

Water: The Catalyst of Life

Water is essential to all forms of life on earth. It is a critical part of any ecosystem. Without water, neither vegetation nor animal life can survive. Our own bodies are made up of over 70% water.

Water is unique in that it is the only substance to naturally exist in all three of its physical states within the Earth's atmosphere. Water can be found as ice or snow in its solid form, as liquid water, and as gaseous water vapor.

Perhaps more importantly, water is the key ingredient that allows the environmental elements of the Earth to keep moving and intermingling. Water is the 'universal solvent' capable of dissolving almost everything. In an organism, water is needed as a medium for the transport of nutrients, minerals, and ions, as well as for hydration.

Unfortunately, this property of water means that both beneficial and harmful substances can be dissolved in and dispersed throughout a body of water, and then ingested by living organisms.

The Earth's water is continually cycling from the atmosphere, where it exists as water vapor or precipitation, to the earth's surface, where it either is absorbed as ground water or 'runs off' the land to become surface water. This cycle is called the hydrological (or 'water') cycle. Once upon the surface, the water returns to the air either through the process of evaporation, or via biological processes. Thus, plants, and animals (including us) help to return water back to the air.

Of the Earth's water supply, only 2.5% is fresh water; the rest is salt water. Of this amount, close to two-thirds is locked in glaciers or permanent snow cover. This means that less than one percent of the Earth's water is available to us to drink.

If the polar ice caps and glaciers are not considered (since their waters are locked in place), groundwater accounts for nearly all usable freshwater. Lakes, swamps, reservoirs and rivers

account for 3.5 per cent and soil moisture accounts for only 1.5 per cent.

Fresh water is a limited resource. Our demands on it can not be unbounded.

Water: Global Crisis

The Earth, with its diverse and abundant life forms, including over six billion humans, is facing a serious water crisis. All the signs suggest that it is getting worse and will continue to do so, unless corrective action is taken. This crisis is one of water governance, essentially caused by the ways in which we, as humans, mismanage water.

Despite its limited supply, the human demand for freshwater is increasing exponentially. Humans are now using groundwater at a rate much faster than the Earth can replenish it by absorbing precipitation. There are two main factors responsible for the increasing demand: 1) The human population is continuing to skyrocket, rapidly approaching 7 billion people; and 2) Individuals, per capita, are using more water.

While there are several factors affecting the population increase, per capita consumption is directly affected by our personal practices. Especially in urban areas, people tend to have very wasteful water-use habits. In rural areas, agricultural practices may make wasteful use of water; however, in many rural areas the critical problems are water scarcity and inadequate supply.

Adding to the crisis, the health or quality of existing water supplies is rapidly deteriorating. The environment has a natural absorptive, self-cleansing capacity. However, this capacity can be, and is being exceeded. Humans are polluting water much faster than the Earth can clean it.

As a result of these problems: millions of people die each year from thirst, or water-based illnesses; biodiversity is lost; livelihoods are affected; natural food sources (e.g. fish) are damaged; and high clean-up costs result.

This reduction in both water quantity and quality has serious impacts on not only ourselves, but on ecosystems, and the Earth's life in general.

In many areas of the world water has become a very scarce resource, and safe water has truly become a rarity. Correcting these critical impairments is of global significance.

Therefore, to ensure their own health, and the health of the environment, communities must:

- *Ensure source adequacy and quality of drinking water*
- *Take care to safely handle and/or treat drinking water*
- *Identify and eliminate wasteful and polluting practices*
- *Ensure sustainable protection of its water source*

Uses and Abuses of Water Resources

Humans affect the quality of the Earth's groundwaters, surface waters, and atmospheric waters. Ground and surface waters are being overconsumed and polluted, while atmospheric waters are greatly affected by air pollution. Thus, below we will discuss the uses and bad management practices that adversely affect groundwater and surface water, while reserving a discussion of air polluting habits for another chapter. (See the Outdoor Air Quality Assessment, Chapter 2).

Groundwater

Often the importance of groundwater is underestimated. It is customary to think of groundwater as being more important in arid or semi-arid areas and surface water as more important in humid areas. However, inventories of groundwater and surface water use reveal the worldwide importance of groundwater. The reasons for this include its convenient availability close to where water is required, its natural quality which is generally adequate for potable supplies, and the relatively low capital cost of development.

A principal feature of groundwater bodies which distinguishes them from surface water is the relatively slow movement of water through the ground. This means that residence times in groundwaters are generally orders of magnitude longer than in surface waters. Once polluted, a groundwater body could remain so for decades, or even for hundreds of years, because the natural processes of through-flushing are so slow.

As groundwater in its natural state is often of good microbiological quality, it is often the preferred source for drinking water. In many cases, groundwater sources do not receive any form of treatment, as they are low-cost supplies designed for community-management. Where boreholes or

other groundwater sources are linked to piped distribution, limited disinfection is usually carried out prior to consumption.

In addition to its use as drinking water, water from beneath the ground has been exploited for domestic use, livestock and irrigation since the earliest times. Groundwater use has grown consistently ever since successful methods of bringing the water to the surface have been developed.

In Latin America, many of the continent's largest cities, Mexico City, Lima, Buenos Aires and Santiago, obtain a significant proportion of their municipal water supply from groundwater. In the valley of Mexico City, over 1,000 deep wells supply 3.2 billion cubic meters per day, which is about 95 per cent of the total supply to a population of nearly 20 million people. (*WHO*)

Unfortunately, while groundwater may be cheap and abundant, the critical measure of these sources is not their volumes, but their renewability. When groundwater sources are tapped beyond their capacity for renewal, water levels drop, aquifers become brackish through salinization, pumping costs increase, and sooner or later the resource is depleted.

The dominant role of groundwater resources is clear and their use and protection is, therefore, of fundamental importance to human life and economic activity.

Surface water

Humans use surface water for a large variety of reasons. Some of the major uses of surface water are:

1. sources of drinking water supply
2. irrigation of agricultural lands
3. industrial and municipal water supplies
4. industrial and municipal waste disposal
5. navigation
6. fishing, boating and body-contact recreation
7. aesthetic value

Rivers are our most important freshwater resource. Social, economic and political development has, in the past, been largely related to the availability and distribution of fresh waters contained in riverine systems.

Upstream use of water must only be undertaken in such a way that it does not affect water quantity, or water quality, for downstream users. Use of river water is, therefore, the subject of major political negotiations at all levels.

In addition to the above list of uses, lakes are

prime regions for human settlement and habitation. It has been commonly believed that large lakes have an infinite ability to absorb or dilute industrial and municipal waste, and it is largely as a result of human waste disposal practices that monitoring and assessment are proving to be necessary in many large lakes.

Good surface water quality is essential for providing drinking water, maintaining fisheries, and for the provisions of recreation and bathing. The degradation of water induced by agricultural use and by industrial and municipal waste disposal practices must be stopped. It is incumbent upon every stakeholder in a watershed to protect it from degradation.

Assessment of Community Practices

We have seen that in order for communities to ensure their health, the health of their larger community, and the health of ecosystems, it is necessary that they:

- Ensure source adequacy and quality
- Take care to safely handle and/or treat drinking water
- Identify and eliminate wasteful and polluting practices
- Ensure sustainable protection of their water source

Communities in rural areas may not have wasteful habits, but may instead be faced with an inadequate supply. Assessment of source selection may thus be more important to consider for rural communities; however, communities in urban areas may have to focus more on their wasteful water use habits.

Safe handling of water is most important to assess in poorer communities, where source or tap sharing is more frequent, or compromised water sources are more prevalent.

Ensuring sustainable source protection is everyone's concern and responsibility. Aside from direct measures, (for example, protection of a spring,) source protection means becoming involved in all levels of water management. Communities should be aware of what decisions are being made that affect their water source, and become advocates for its protection. Political action may be necessary to ensure that protective policies are both made and enforced.

The inventories that follow are designed to help your community assess how well it strives towards

achieving these goals. In addition to these inventories, Chapter 4 on **Waste Management** provides information regarding safe sanitation practices and preventing diffuse chemical pollution, and the **Outdoor Air Quality Assessment** in Chapter 2 provides information about the ways in which our air pollution affects water quality.

Drinking Water Quality and Source Protection: Inventory

1. Main Drinking Water Source

What is/are the main source(s) of your religious community's drinking water? Check all that apply:

- | | |
|--|-----------|
| Surface Water | A |
| <input type="checkbox"/> Spring | |
| <input type="checkbox"/> River/ Stream | |
| <input type="checkbox"/> Pond/ Lake | |
| <input type="checkbox"/> Dam | |
| Dug Well | B |
| <input type="checkbox"/> Private well | |
| <input type="checkbox"/> Open public well | |
| Borehole | C |
| <input type="checkbox"/> Private well | |
| <input type="checkbox"/> Public well | |
| <input type="checkbox"/> Mechanical pump | C1 |
| <input type="checkbox"/> Handpump | C2 |
| Spring | D |
| <input type="checkbox"/> Open spring | |
| <input type="checkbox"/> Protected spring | |
| Rainwater | E |
| <input type="checkbox"/> Covered container | |
| <input type="checkbox"/> Open Container | |
| Commercial Water Vendor | F |
| <input type="checkbox"/> Small water vendor | |
| <input type="checkbox"/> Tanker Truck | |
| <input type="checkbox"/> Bottled Water | |
| Piped water | G |
| <input type="checkbox"/> House connection | |
| <input type="checkbox"/> Public standpipes | |
| <input type="checkbox"/> Gravity fed | G1 |
| <input type="checkbox"/> W/service reservoir | G1 |

Listening To The Earth

- Water Provider **G2**
 Other (specify):

Is the water collected off-premises? **Yes / No**

If so, how often is water collected?

- Everyday
 Once a week
 Longer

—how long does it take to travel to the source, collect the water, and return?

Do water shortages often occur in your community? **Yes / No**

In the case of a water shortage:

Where will water be collected?

Does your community share water with neighbors? **Yes / No**

How far away are alternative sources of water and how long does it take to collect the water?

Are there known problems with the alternative source's water quality? **Yes / No**

Now proceed to the section entitled 'Site-Specific Source Assessments,' found on pages 60-64 to further develop information regarding the safety of your water source. Use the capital bold-faced letters **A-G** next to your selections above to locate the questions pertaining to your source(s).

2. Potential sources of pollution:

Identify which activities occur within the vicinity of your water source. Remember to consider activities that occur upstream, if a moving body of water:

	Distance	Comment
<input type="checkbox"/> Residential		
<input type="checkbox"/> Construction		
Other (specify):		

	Distance	Comment
Agricultural activity		
<input type="checkbox"/> Livestock		
<input type="checkbox"/> Crops—commercial		
<input type="checkbox"/> Crops—small scale		
<input type="checkbox"/> Chemical storage		
Other (specify):		

	Distance	Comment
Industrial activity		
<input type="checkbox"/> Food processing		
<input type="checkbox"/> Textiles		
<input type="checkbox"/> Tanneries		
<input type="checkbox"/> Brewery		
<input type="checkbox"/> Small scale industry (including garages)		
<input type="checkbox"/> Slaughterhouse		
<input type="checkbox"/> Mining		
Other (specify):		

	Distance	Comment
Miscellaneous		
<input type="checkbox"/> Deforestation		
<input type="checkbox"/> Erosion		
Other (specify):		

3. NGO involvement

Is there an NGO, committee or group within your larger community that attends to the maintenance, preservation, and/or protection of your water source, e.g. a groundwater or watershed protection group? **Yes / No**

Name of Organization:

Does an individual from your religious community serve on this committee? **Yes / No**

4. Community Water Governance

Does your larger community have a body (i.e. Committee, organization, corporation, government bureau, etc.) which is in charge of water governance?
Yes / No

Is there an individual from your religious community serving as a member of the governing body?
Yes / No / Not applicable

How reliable is the governed water supply?

- Very Reliable (uninterrupted supply)
- Reliable (no disruptions for months)
- Fair (some disruptions in the past few months)
- Intermittent (disruptions on a weekly basis)
- Sporadic (only available a few times a week)
- Inadequate (supply is critical concern)

Are fees established for the water supply?
Yes / No

How were the fees established?

- Vote
- Decree with community input
- Decree without community input
- Other (specify):

Was everyone's interests represented in the vote?

- Yes, everyone was represented or could vote
- Only men were represented / could vote
- Only landowners were represented/ could vote
- Other restriction (specify):

What happens if someone does not pay on time?

- Receives a reminder
- Access refused
- Collector visits again
- Water turned off
- Other (specify):

Does your community include water expenses as part of the budget?
Yes / No

5. Water Quality Testing

Has a government regulatory agency, or other qualified entity (besides the Water Provider, if one exists) tested

the water source for drinking water quality?
Yes / No

Was the testing:

- A one time occurrence
- Part of a regular testing cycle

Testing interval:

Are the results of the tests made available to the public?
Yes / No

Does the water source have any chemical pollution problems?
Yes / No

Does the water source have any biological problems?
Yes / No

Explain the problems identified with the water source:

What are the recommendations for improving the water source, if any are known:

Does your community test source water quality itself?
Yes / No

6. Water Treatment by the Community

Does your religious community treat your water in any way to make it safer to drink?
Yes / No / Not applicable (water treated by supplier)

If you do, what methods do you use?

- Boil
 - Solar Distilled/Disinfected
 - Add Bleach/Chlorine
 - Sedimentation/Settling
 - Sieve it through cloth
 - Candle filters
- Other (specify):

Is water treatment a standard protocol?
Yes / No

If bleach or chlorine is used, does your community chemically test the water?
 Yes, chlorine levels are tested

- We have test kit, but do not use it
- We do not have test kit

Is there someone in charge of overseeing water treatment?

Name of supervisor:

Does the community include water treatment expenses as part of the budget?

Yes / No

7. Water Storage

Is drinking water stored in containers?

Yes / No / Sometimes

What type(s) of container(s) is/are used to store drinking/ cooking water?

- Narrow-mouthed vessels
- Wide-mouthed vessels
- bowls or pots

Are the containers covered?

All / Some / None

Are the containers clearly labeled or recognizable?

All / Some / None

How often are the water storage container(s) cleaned with soap?

- Once a day
- Once a week
- Less than once per week
- Never

Is this a regular habit/protocol?

Yes / No

How do you draw water from the water container(s)?

- Pouring
- Spigot/Tap
- Dipping
- Other (specify):
- Both pouring and dipping

If drawn by dipping, what is used to remove water?

- Same receptacle/cup used to drink from
- Special receptacle only for drawing drinking water

Drinking Water Quality and Source Protection: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

I. Water sources

Each water source listed as an option in this question is followed by a capitalized, bold-faced letter. This letter is meant to indicate the appropriate inventory to complete in the next section, called 'Site-Specific Source Assessments,' found on page 60. The sets of questions found therein help you determine the safety of your water sources, and describe standard protection methods. Following the inventories and evaluations, there is a list of things to consider if your community decides to improve its water source. The inventory for your source(s) should be completed at this point, and the results assessed below.

To promote community health, an easily accessible water supply should be available that provides sufficient safe water to meet community needs. There are many types of low-risk water supplies for drinking and other domestic uses. Often, communities have unprotected water sources, such as springs, traditional wells and ponds, which are open to contamination and pose a potential health risk. To ensure that the water is potable, the water supply should be protected and the water should be treated before use. Unprotected sources can be improved, and this may be preferable to constructing completely new supplies.

In general, it is best to be able to rely upon one source for all your community's drinking water needs. Relying only upon one source minimizes the amount of resources a community must spend monitoring the safety of their sources.

If your main source often goes dry, consideration should be given to undertaking the construction of an additional water supply. In cases of water shortages, water is often obtained from alternative sources, or from neighbors. In such cases, it is important to treat the water as if it were contaminated, since you cannot be sure of its quality.

Our community's drinking water source is nearby and measures are in place for its protection. The source consistently provides an adequate and safe supply.*

1 2 3 4 5 6 7 8 9

**NOTE: Source Inventory must be completed before answering this question.*

2. Water Source Pollution Hazards

There are a number of hazards to the sustainability of both groundwater and surface water resources. The World Health Organization points out these following pertaining to groundwater:

i. Unsewered sanitation

Contamination of groundwater supplies by unsewered sanitation. Problems usually arise where the water table is so shallow that on-site sanitation systems discharge directly into the saturated zone. Often the most serious problems arise in medium to smaller sized towns and in densely populated peri-urban and rural areas where local, shallower, and often untreated, groundwater sources are used. In these circumstances, direct pollution of the source at the wellhead by the users, by livestock and by wastewater can be a serious problem.

ii. Contamination at source

Unprotected extraction points allows contamination to enter well/ spring waters directly.

iii. Leaks in sanitary sewers

Leakage is a common problem, especially from old sewers, and may be caused by defective pipes, poor workmanship, breakage by tree roots, settlement and rupturing from soil slippage or seismic activity

iv. Disposal of waste

The most common method of disposal of solid waste is by deposition in landfills. Also, municipalities and factories will sometimes create ponds for liquid waste. Unfortunately, very few landfills or ponds are built to sanitary standards, and many are simply raw dumps. Contaminates leach from the landfills (dumps) into the groundwater.

v. Industrial accidents and spills

Groundwater pollution incidents from major industrial complexes are becoming more common and are often the subject of major, expensive investigations and clean-up activities. The causes include accidents during transportation, spillages

due to operational failures and leaks due to corrosion or structural failure of pipes or tanks. Petroleum and petroleum products are the most important because they are widely used.

The cost of aquifer restoration measures and/or provision of alternative water supplies after major incidents of this type can be extraordinarily expensive. All too often the expense is not paid, and the disasters do not get cleaned up.

vi. Agricultural habits

Agricultural land-use and cultivation practices have been shown to exert major influences on groundwater quality. Under certain circumstances serious groundwater pollution can be caused by agricultural activities.

vii. Mining activities

A range of groundwater pollution problems can be associated with mining activities. The nature of the pollution depends on the materials being extracted and the post-extraction processing. Coal, salt, potash, phosphate and uranium mines are major polluters

viii. General sources of contaminants to rivers and lakes:

a. Direct point sources

Municipal and industrial discharges.

b. Diffuse agricultural sources

Wash-off and soil erosion from agricultural lands carrying materials applied during agricultural land use, mainly herbicides, pesticides and pesticides.

c. Diffuse urban sources

Wash-off from city streets, from horticultural and gardening activities in the sub-urban environment and from industrial sites and storage areas. Street litter, fertilizers, pesticides, herbicides, pet and yard waste, motor oil, anti-freeze, household hazardous wastes, and paint are just a few of the pollutants that find their way into storm drains. This water travels from storm drains into local streams, ponds, and lakes, and ultimately into local streams and rivers.

d. Waste disposal

Pollution from solid and liquid industrial waste disposal sites and from municipal and household hazardous or infectious waste.

e. Fecal contamination

The primary water quality issue in rivers. Although this applies to both rural and urban areas, the situation is probably more critical in fast-growing cities where the population growth rate still far exceeds the rate of development of wastewater collection and treatment facilities

f. Salinisation

Increased mineral salts in rivers may arise from several sources: (i) release of mining wastewaters, (ii) certain industrial wastewaters, and (iii) increased evaporation and in the river basin (mainly in arid and sub-arid regions) resulting from reservoir construction, irrigation returns, etc.

g. Acidification

Occurs as a result of: (i) direct inputs of acidic wastewaters from mining or from specific industries, either as point sources (e.g. sewers) or diffuse sources (e.g. leaching of mine tailings), and (ii) acidic precipitation (acid rain) mainly from the burning of fossil fuels.

The hazards to our community's water source have been inventoried and no significant risks exist.

1 2 3 4 5 6 7 8 9

3. Water resource protection committee

Water resources are shared resources. The activities of many people affect the quality of the water source, and it is easy for the actions of just a few people to affect the entire community's water supply. Thus, it is important that all the stakeholders, (those people that use or affect the water source) are aware of the health of the water body and how their activities might affect the quality of the water.

It is also important that a group of local people, local stakeholders, are able to communicate both to other stakeholders, and to larger regulatory bodies (e.g. governments) about the conditions of their water resources, and about the problems facing it.

Although national or regional governments often have divisions whose stated purpose is the protection of water or environmental resources, these governmental entities are often slowed by their internal beaurocratic processes, and/or have a geographical region to cover that far exceeds the capacity of the staff.

For these reasons, it is advisable that each body

of water (surface water or ground water) have a committee consisting of stakeholders that attend to the environmental quality of the water resource. The committee should have broad participation from the surrounding populace, and should not be limited by gender, occupation, education, or income.

Your religious community could have at least one person serve on such a committee, if one exists, so that your community is able to contribute to the betterment of local water resources. This member can serve as a liason representing your religious community's interests to the committee, and the committee's interests back to the community.

If no such committee exists, a motivated individual of your community could be encouraged to organize one.

There is a committee that attends to the health of our water source and our religious community is represented in that committee.

1 2 3 4 5 6 7 8 9

4. Water Governance

Local water management is everywhere valuable, especially in times of water scarcity, but it requires good governance to fulfill its potential. Good governance is open, participatory, and responsible. It undertakes careful research so that decisions are made based on factual evidence, and works deliberately to better the lives of its poorest and most vulnerable members. The condition of women, minorities, and the landless poor is a specific responsibility of the institutional authority. It is now recognized that women in poor communities must be involved in local water and sanitation management. They work longer hours than anyone else on domestic water and hygiene, and they are experts.

Participation in the water management body should be broad, with the interests of all stakeholders represented. Thus, it is important that your religious community have a member serve on the body, if that is possible.

To make and carry out sustainable resource decisions, good governance requires institutional capacity. That includes the capacity to gather and assess relevant information, to deliberate, to execute policies, and to answer responsibly to members of the community. On the smallest, simplest scale, institutional capacity represents a

neighborhood's ability to build and maintain a shared network that stores and distributes rainwater around a few city blocks. It is the forum where villages up and down a hillside can apportion seasonal runoff for maximum usage and minimum losses of water and soil. It is the mechanism that can mobilize a community's capital investment in a wastewater recycling plant or in new-technology groundwater pumping systems. It is the recognition that management involves administrative and financial tasks, as well as technical ones, that regular maintenance is as important as initial construction, and that from time to time enforcement of rules and regulations will be necessary. It is the deliberation in which environmental quality is acknowledged as a value, and where the interests of future generations are heard and accepted.

Communities attempting local water management need supportive links with their 'senior' governments. This is especially important in the management of watersheds and aquifers that must be shared with others. Creating coherent relationships between local management and wider watershed approaches goes to the heart of good water management. Governments can encourage the diffusion of new and helpful knowledge, especially to its agencies and extension services. These arms of government have the organization with the expertise and resources to speed dissemination and promote education. By diffusing the results of research and development, governments multiply many times the value of new knowledge to local communities. So doing, with NGOs and others, they enlarge the national wealth and the welfare of citizens.

Unfortunately, there is a trend in Latin America toward the 'privatization' of water management. Meant to reduce the burden placed upon government, privatized water supplies are managed by corporate managers, with the goal of making a profit for the corporation's stockholders. The stockholders are most often not the stakeholders, and quite often live in distant countries. In most scenarios of privatized water supplies, the corporate management is not open, participatory, and not responsive to the needs of the poor.

Activism at all levels becomes essential if your community is suffering hardships due to poor management of water resources.

Our water supply is managed with good governance

principles, and our religious community is represented in the management body.

1 2 3 4 5 6 7 8 9

5. Water quality testing

Water of poor microbial quality can have a significant impact on the health of community members by causing disease and contributing to the spread of epidemics. Water quality should therefore be monitored on a regular basis. Ideally, it should be tested by staff working with qualified bodies such as a governmental Health Department/ Ministry of Health, or Ministry of Environment. There are also both national and international NGO's that provide water quality monitoring services. The community should request such support, particularly if it suspected that the community water supply is contaminated. The test results should be provided to the community and if any problems arise, the community should request recommendations for solutions.

Microbial quality

The principal method of assessing the microbial quality of water is to test for bacteria whose presence indicates that feces may be in the water. An analysis of the test results is usually beyond the resources of communities and will be carried out by health or water officials. Some kits have been developed for community use, but the results of these tests should be analysed with caution.

Water quality tests look at the microbiology of water samples to identify viral, bacterial and parasitical agents linked to hepatitis A, diarrhea, typhoid and other illnesses. The major concern of microbiological testing is whether feces have contaminated the water supply, as most of the infectious water-related diseases, such as cholera and dysentery, are caused by fecal contamination. Although these diseases can also be transmitted through poor hygiene and inadequate sanitation, control of drinking-water quality is one of the main ways of preventing their spread.

Microbiological testing should be conducted whenever a new water source is put into use. Regular monitoring should continue afterward, on at least a monthly cycle. More frequent testing should be conducted if a problem is identified until the problem has been corrected and the quality has stabilized. Furthermore, it is advisable to test water after a heavy rain, as flooding and increased flow

can change the properties of a water body.

Sanitary inspection

An analysis of water quality usually also includes a sanitary inspection. This is a visual assessment of the water supply, using standard forms to record information, to see whether fecal pollution exists and whether such pollution could reach the water source. Sanitary inspections can be undertaken by communities on a regular basis as part of operation and maintenance, and forms have been developed in several countries to help communities undertake these inspections. Many of the risks to the water supply relate to improper operation and maintenance activities in the area around the water source, and sanitary inspection can be used to ensure that these tasks are carried out to keep the water supplies safe. Refer to Chapter 7, **Waste Handling Assessment**, for more information regarding sanitary inspections.

Chemical quality

It may also be necessary to test community water supplies for harmful chemicals. Certain chemicals, such as fluoride, nitrate and arsenic, represent a health risk, whereas others, for example iron, manganese and sulfate, may cause consumers to reject the water because it is unpleasant to drink or stains clothes and causes other problems. Testing is usually done by health or water officials, but community members can play a key role by demanding that such analyses are carried out, and by informing officials of any developments that may cause contamination of the water supply. When a water supply is first developed, a full water quality analysis should be carried out. The community should request feedback regarding this analysis and ask for guidance concerning the suitability of the water source for drinking.

You should be able to find much information about water quality testing from the resources listed at the end of this chapter. For example, the World Health Organization promotes water quality monitoring through its Healthy Villages program.

We are satisfied that our community's water source is regularly tested for microbial quality, and has also been tested for chemical quality. The community is informed of the test results and no problems exist.

1 2 3 4 5 6 7 8 9

6. Water Treatment

Sometimes the best option for improving water quality is to treat water in the home, by boiling, filtering, chlorinating or leaving the water to settle. These options are discussed in more detail below.

Boiling

Bringing water to a rolling boil will destroy pathogens in the water and make it safe to drink. Boiled water tastes 'flat', but if it is left for a few hours in a partly filled, covered container, it will absorb air and lose its flat taste.

Canvas filters

Canvas bags are the simplest type of home filter. The bag is filled with water and the water is collected as it seeps out of the bag. This makes the water cleaner and, although it does not remove all pathogens, is particularly useful for removing Cyclops containing guinea-worm eggs. Bags that have been specially treated to prevent them from rotting are available.

Candle filters

Candle filters are hollow, porous ceramic cartridges. Although they do not filter out all pathogens, they should remove the larger ones such as protozoa, worms and bacteria (but not viruses). Ceramic candles need careful maintenance and should be cleaned and boiled at least once a week, even if they are not clogged. If a candle filter becomes clogged, it should be scrubbed under running water with a stiff brush free of soap, grease or oil. To reduce the risk that water will pass through a candle without being filtered, such as through a small crack, candle filters should be regularly inspected and replaced if necessary. In some countries it is common to both filter and boil water. Where this is done, the water

Household water treatment

In Bolivia, household water treatment was introduced into two communities where water quality was generally poor... After the treatment was introduced, fecal contamination of water samples was reduced by over 90% and the incidence of diarrhea dropped by almost 50%. Similar improvements have been observed in other countries, such as Bangladesh, demonstrating that household treatments can be effective.

Source: Diarrhoea prevention in Bolivia through point-of-use water treatment and safe storage, Epidemiology and Infection, 122:83-90, Quick RE et al, 1999

should be filtered first and then boiled. Some filters incorporate silver into the candle, but this does not disinfect the water and the candle acts simply as a normal filter.

Disinfection

One method of treating water in households is to add chlorine. This will kill most bacteria and some viruses. Since the taste of chlorine disappears when water is left in open containers, a very small lump of bleaching powder or one drop of household bleach can be added to a 20-liter water container and the mix left to stand for at least 30 minutes. After this time, if a faint smell of chlorine can be detected in the water, it should be low-risk and palatable to drink. Chlorine should only be added to clear water otherwise it will be absorbed by the dirt in the water. Moreover, chlorine that has been stored for some time will lose potency. The use of disinfectants as a household treatment system has been successfully implemented in Latin America and Asia.

Despite its effectiveness, the use of chlorine poses several risks that may be avoided by using other disinfection methods. Many of the compounds formed when chlorine reacts with contaminants in water are carcinogenic, and/or are 'persistent environmental pollutants,' meaning that they do not decompose and remain in the environment, often accumulating to unsafe levels. In addition, sodium hypochlorite (chlorine bleach) is very toxic, and poses severe health risks if consumed undiluted. Extreme caution should be taken whenever chlorine is used.

Other disinfection systems have been developed for treating household water, particularly the use of solar radiation. Simple methods of solar disinfection (e.g. SODIS, which requires little more than a capped plastic bottle and some tape or paint), can effectively treat water, although they may take longer than chlorine disinfection. Performed correctly, solar disinfection is very safe and ecologically friendly, and thus is a practical and preferable alternative for water treatment.

Sedimentation/Settling

Where water is cloudy or muddy, a simple treatment is to allow particulates in the water to settle overnight. Clear water at the top of the container is then poured into a clean container. Adding certain chemicals can help settling, such as a pinch of aluminium sulfate (alum), or powder

from the ground seeds of *Moringa oleifera* (horseradish tree) and *Moringa stenopetala*, sprinkled onto the water surface.

It should be stressed that settling does NOT remove all pathogens, silt or clay. The settling of particles may reduce pathogens but some will remain, and water should be boiled or disinfected before it is consumed.

Many of the resources listed at the end of this chapter will help you identify the various water treatment technology options that may be reasonable for your community.

Our community treats our water to ensure that it is safe to drink. We strive to use environmentally friendly treatment methods.

1 2 3 4 5 6 7 8 9

7. Water handling

Frequently, water collected from a communal point and transported back to houses for use becomes contaminated because of poor handling. Community members should therefore be aware of the risks of contaminating the water and how it can be prevented.

All water containers should be clean, especially inside. It is always best to clean the insides of storage containers with either detergent or chlorine. Leaving a capful of bleach in a sealed plastic or metal container full of water for 30 minutes will kill most pathogens. If detergent or chlorine is not available, the insides of clay pots can be cleaned with ash. If ash must be used, it should be from a fire of organic fuel, not metals, plastics, paints, or electronic equipment. Plastic or metal containers should be cleaned weekly by putting clean sand and water inside them and shaking for a few minutes. The top of the water container should be covered to stop dust and other contaminants falling into the drinking-water. For the same reason, water containers should also have a narrow neck. It is best for water to be poured from the container to prevent contact with dirty fingers and hands. When scoops are used to take water out of the storage container they should be clean and kept inside the water storage jar. They should never be placed on the floor.

Our community takes the utmost care to preserve the quality of our drinking water any time that it is stored for use.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right:

	<i>score</i>
1. Water source adequacy and safety	
2. Water source pollution hazards	
3. Water resource protection committee	
4. Water governance	
5. Water quality testing	
6. Water treatment	
7. Water handling	

Now that you have comprehensively examined your drinking water quality and source protection measures, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Now categorize each problem listed above into one of the following three categories:

I = Critically important. Currently dangerous, must be addressed immediately

II = Important, but not immediately dangerous. Must be addressed

III = Current practice should be improved, but is not immediately important

Site-Specific Source: Assessment

Below, each method of water extraction, as indicated by the boldface letters **A-G** found on page 50 in the preceding inventory, has an associated set of questions. Answer the inventory questions, and then continue to the discussion section. If at first some of the terminology used in the questions is unclear to you, go back and read over the previous discussion section associated with your source before completing the inventory.

The purpose of the following inventories is to assess the level of protection that exists at the point of extraction. Included within these analyses are abbreviated sanitation inspection questions, since the major cause of poor drinking water quality is poor sanitation.

In order to ensure that water supplies can provide water that represents a limited risk to health, adequate source protection measures should be in place that prevent pathogens or harmful chemicals from entering the supply. Source protection measures should be in place for all water sources that are used for domestic consumption, and different measures will be required at different levels.

It may be necessary to identify what basic measures are required at local and broader scales, and to identify the people responsible for undertaking protection work. This may include communities and users as well as water suppliers, planners and environment protection bodies. The preceding inventory should help you to assess the level of protection afforded by NGOs and/or water governance bodies, as well as what environmental problems may threaten your water source quality.

Following the inventories and discussions, there

Characteristics of low-risk water sources

- The water source is fully enclosed or protected (capped) and no surface water can run directly into it.
- People do not step into the water while collecting it.
- Latrines are located as far away as possible from the water source and preferably not on higher ground. If there are community concerns about this, expert advice should be sought.
- Solid waste pits, animal excreta and other pollution sources are located as far as possible from the water source.
- There is no stagnant water within 5 metres of the water source.
- If wells are used, the collection buckets are kept clean and off the ground, or a handpump is used.

is a list of questions to be considered if your community decides to improve its water supply.

A Surface Water

- 1) *Is there excessive logging or visible erosion on the banks/ shore of the water body?*
Yes / No
- 2) *Is there run-off from urban area(s), or other human settlements entering the water body?*
Yes / No
- 3) *Are there any farm animals or crop production upstream, polluting the source?*
Yes / No
- 4) *Is the water body used for public bathing?*
- 5) *Are industrial waste streams or sewage discharged into the water body?*
Yes / No
- 6) *Must people enter the water in order to withdraw it?*
Yes / No
- 7) *Is the intake (if one exists) unprotected?*
Yes / No
- 8) *Is the intake unscreened?*
Yes / No
- 9) *Is the means of intake protection in need of maintenance or repair?*
Yes / No
- 10) *Are algae blooms a problem in the water body?*
Yes / No

Refer to the evaluation below, labeled 'Surface Water (**A**)', on page 61.

B Dug Well

- 1) *Is there a latrine within 10m of the well?*
Yes / No
- 2) *Is the nearest latrine uphill of the well?*
Yes / No
- 3) *Is there any other source of pollution within 10m of the well? (e.g. Animal breeding, cultivation, roads, industry, etc)*
Yes / No

Listening To The Earth

4) *Is the drainage faulty, allowing ponding within 5m of the well?*

Yes / No

5) *Is the drainage channel cracked, broken, or in need of cleaning?*

Yes / No

6) *Is the fence missing or faulty?*

Yes / No

7) *Is the well uncovered or is the cover faulty or missing?*

Yes / No

8) *Does the well lack a cement pad (apron) or is the cement less than 1m in radius around the top of the well, or are there cracks in the floor?*

Yes / No

9) *Does spilt water collect in the apron area?*

Yes / No

10) *(if applicable) Is the handpump loose at the point of attachment to the well head?*

Yes / No

11) *Does the water change colour after heavy rain?*

Yes / No

Refer to the evaluation below, labeled 'Ground Water Overview' and then continue to 'Ground Water: Dug Wells (B)', on page 66.

C1 Borehole: Deep with Mechanized Pumping

1) *Is there a latrine or sewer within 100m of pumphouse?*

Yes / No

2) *Is the nearest latrine unsewered?*

Yes / No

3) *Is there any source of pollution within 50m?*

Yes / No

4) *Is there an uncapped well within 100m?*

Yes / No

5) *Is the drainage around the pumphouse faulty?*

Yes / No

6) *Is the fencing damaged, allowing animal entry?*

Yes / No

7) *Is the floor of the pumphouse permeable to water?*

Yes / No

8) *Does water form pools in the pumphouse?*

Yes / No

9) *Is the well seal unsanitary?*

Yes / No

10) *Does the water change colour after heavy rain?*

Yes / No

C2 Borehole with Handpump

1) *Is there a latrine within 10m of the borehole/well?*

Yes / No

2) *Is there a latrine uphill of the borehole?*

Yes / No

3) *Are there any other sources of pollution within 10m of borehole/well? (e.g. Animal breeding, cultivation, roads, industry, etc)*

Yes / No

4) *Is the drainage faulty, allowing ponding within 2m of the borehole?*

Yes / No

5) *Is the drainage channel cracked, broken, or in need of cleaning?*

Yes / No

6) *Is the fence missing or faulty?*

Yes / No

7) *Is the apron less than 1m in radius?*

Yes / No

8) *Does spilt water collect in the apron area?*

Yes / No

9) *Is the apron cracked or damaged?*

Yes / No

10) *Is the handpump loose at the point of attachment to the apron?*

Yes / No

11) *Does the water change colour after heavy rain?*

Yes / No

Refer to the evaluation below, labeled 'Ground Water Overview' and then continue to 'Ground

Water: Boreholes (**C**)'

D Spring

- 1) *Is the spring unprotected (i.e. unimproved)?*
[If the answer is yes, skip to 5. Answer yes to 2-4)]

Yes / No
- 2) *Is the masonry protecting the spring faulty?*

Yes / No
- 3) *Is the backfill area behind the retaining wall eroded?*

Yes / No
- 4) *Does spilt water flood the collection area?*

Yes / No
- 5) *Is the fence absent or faulty?*

Yes / No
- 6) *Can animals have access within 10m of the spring?*

Yes / No
- 7) *Is there a latrine uphill and/or within 30m of the spring?*

Yes / No
- 8) *Does surface water collect uphill of the spring?*

Yes / No
- 9) *Is a diversion ditch above the spring absent or non-functional?*

Yes / No
- 10) *Are there any other sources of pollution uphill of the spring (e.g. Solid waste)*

Yes / No
- 11) *Does the water change colour after heavy rain?*

Yes / No

Refer to the evaluation below, labeled 'Ground Water Overview' and then continue to 'Ground Water: Springs (**D**)'.

E Rainwater Collection and Storage

- 1) *Is rainwater collected in an open container?*

Yes / No
- 2) *Are there visible signs of contamination on the roof catchment? (e.g. Plants, excreta, dust, etc.)*

Yes / No

- 3) *Is guttering that collects water dirty or blocked?*

Yes / No
- 4) *Is the top, or the walls of the tank cracked or damaged?*

Yes / No
- 5) *Is water collected directly from the tank (no tap on the tank)?*

Yes / No
- 6) *Is there bucket in use and is this left where it can become contaminated?*

Yes / No
- 7) *Is the tap leaking or damaged, or absent?*

Yes / No
- 8) *Is there any source of pollution around the tank or water collection area?*

Yes / No
- 9) *Is the tank clean inside?*

Yes / No

Refer to the evaluation below, labeled 'Rainwater (**E**)'

F Vendors (Tanker Trucks)

- 1) *Is the discharge pipe dirty?*

Yes / No
- 2) *Can the discharge pipe touch the ground?*

Yes / No
- 3) *Is the delivery nozzle dirty or in poor condition?*

Yes / No
- 4) *Is the tanker ever used for transporting other liquids?*

Yes / No
- 5) *Is the inside of the tanker dirty?*

Yes / No
- 6) *Does the tanker fill through an inspection cover?*

Yes / No
- 7) *Does the tanker leak?*

Yes / No

Refer to the evaluation below, labeled 'Water Vendors (**F**)'

G Piped Water (General)

- 1) Do any tap stands leak? Yes / No
- 2) Does surface water collect around any tapstand? Yes / No
- 3) Is the area uphill of any tapstand eroded? Yes / No
- 4) Are the pipes exposed close to any tapstand? Yes / No
- 5) Is there any human or animal waste within 10m of any tapstand? Yes / No
- 6) Is there a sewer within 30m of any tapstand? Yes / No
- 7) Has there been a discontinuity in the last 10 days at any tapstand? Yes / No
- 8) Are there signs of leaks in the main pipes? Yes / No
- 9) Is the main pipe exposed anywhere? Yes / No
- 10) Does the water change colour after heavy rain? Yes / No
- 11) Is the system's water source untreated before being distributed? Yes / No

G1 Piped Water (from Storage Tank)

- 12) Does the pipe leak between the source and storage tank? Yes / No
- 13) Is the storage tank cracked, damaged, or does it leak? Yes / No
- 14) Are the vents and covers on the tank damaged or open? Yes / No
- 15) Is dirt or other debris present on the vents or covers? Yes / No

Refer to the evaluation below, labeled 'Piped Water (G)'

G2 Piped Water (from Water Provider)

Name your Water Provider:

Contact the Water Provider and answer these following questions:

1. Who is the contact person? Yes / No
2. When there is a problem with your water supply, who do you contact, and how? Yes / No
3. Does the provider treat the water? Yes / No
4. If Yes, what treatment method(s) do they use?
 Chlorination
 Sedimentation
 Filtration
Other (specify):
5. What are the most common water supply problems?
 Leaks
 Sediments
 Broken pipes
 Smells
 Illegal withdrawal
 Bacterial contamination
 Broken meters
 Treatment not working
 Fees not paid
Other (specify):
What is being done to correct these problems? (explain)

6. Do they test water quality? Yes / No
7. How often is it tested?
8. What percentage of tests conform to standards (e.g WHO Drinking Water Quality standards)?

Refer to the evaluation below, labeled 'G Piped Water'

Site-Specific Source: Evaluations

At the end of each discussion section, there will be a few statements and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

Surface water (A)

Surface water sources are always more vulnerable to contamination than groundwater sources and as a result should always be treated before consumption.

While protection measures are less effective than for groundwater, it is still important that catchments for reservoirs, river and lakes are protected as far as possible from polluting activities. Typically, pollutants will include microbiological contamination, suspended solids, inorganic and organic pollutants.

Defining protection of surface water catchments is often difficult as they often draw water from large areas. Critical components of surface water protection should include the prevention of excessive logging in upper reaches of rivers and lake catchments, prevention of untreated discharges of domestic and industrial wastes, control of urban run-off and prevention of encroachment into the immediate area around an intake or a reservoir. The latter is often a particular problem in Latin American countries and represents a major source of pollution.

In many water bodies, there are natural mechanisms that may reduce the pollutant load such as aquatic plants and the formation of heavy metal complexes in sediments. However, while these often provide reasonable protection, it should be stressed that a pollution-reduction strategy should be developed. Aquatic plants may die, and if not harvested, may release contaminants during decay. Sediments may become disturbed and release pollutants back into the water.

Sometimes aquatic life is hazardous to water quality, as is the case with algae blooms. When the water body is heavily loaded with nutrients (from agricultural run-off, sewage, etc.) fast-growing aquatic plants may bloom. These blooms may add unpleasant, and sometimes poisonous, tastes to the water. As well, they may deplete the water's dissolved oxygen, and destroy the ecosystem that

normally would be keeping the water healthy.

Surface waters have traditionally been used as sources of drinking-water. Although they are easily contaminated, the water quality can be improved by careful use. For example, if platform steps or ramps are constructed at the water edge, people can be encouraged not to walk into the pond or lake when collecting water. This improvement helps to stop the discharge of guinea-worm eggs into the water. Nevertheless, dirt deposited on these structures can enter the water, especially when it rains. Preventing urination and defecation close to or in a pond may reduce schistosomiasis.

Pumps mounted on the banks of ponds can also supply water to people away from the pond, but these may be difficult to maintain. Alternatively, a protected intake with a layer of sand as filter can be constructed in the pond or lake and be connected to a handpump. It is important to keep the intake protection works in good repair to prevent damage to the pump or clogging of pipes. Whichever method is used, however, domestic water drawn from ponds and lakes must always be treated before consumption.

Our community's water source has a protected intake which is well maintained.

1 2 3 4 5 6 7 8 9

Our community strives to make the point of water extraction, and the surrounding area sanitary.

1 2 3 4 5 6 7 8 9

Our community strives to maintain a zone of protection around the body of water used for drinking water.

1 2 3 4 5 6 7 8 9

Our community is satisfied with the quality and quantity of water provided by this source.

1 2 3 4 5 6 7 8 9

Ground Water: Overview

Groundwater sources, whether small community-managed point sources or utility-operated boreholes supplying distribution networks, often become contaminated. This may result from widespread contamination of an aquifer from pollutant sources or because the point of abstraction or discharge has been poorly protected or maintained and allows direct routes for contaminated surface water to enter the source.

The first level of ground water source protection

is the immediate sanitary protection works at the source. These works are primarily designed to prevent contaminated surface water or wastewater from directly entering the water source and preventing other hazards that may allow direct contamination of the aquifer.

Such works include measures such as casting concrete aprons on the ground surface and sealing of upper levels of boreholes and dug wells, and the construction of diversion ditches and covering of the backfill area of springs. Good source protection at this level depends in part on good design and construction, but the maintenance of such measures when put in place is extremely important. Well-designed sanitary protection measures may easily deteriorate if they are not maintained.

The next stage of source protection is to define areas where land-use and in particular the release of contaminants will be controlled—a process usually referred to as groundwater protection zones. Several zones may be defined, typically including an inner zone to protect against microbiological contaminants, a second zone to control chemical contamination and a final zone to protect recharge. All zones are usually determined by a travel time – i.e. the time expected for a microbe to reach a water source from the ground surface. Such zones must take into account the vulnerability of the aquifer, the nature of the hydrogeological regime and the likely hydraulic load applied.

For the inner zone, a value of 50 days is often used. Some research may need to be pursued in order to determine the characteristics of your groundwater aquifer. The hydrogeological department in the national water resource management body should define travel time safety zones based on hydrogeological surveys.

The further zone may be defined for chemical contaminants, again based on an estimated travel time that will reduce contaminants to acceptable levels. Where natural chemicals represent a problem, it is important to identify whether certain parts of the aquifer represent a higher risk and to define depths of abstraction that may reduce the problem.

A final zone may be defined to cover the recharge area to provide protection for both quality and quantity of water. The purpose of all these zones is to control land-use in such a way that it does not create a significant deterioration in source water quality.

Ground water: Dug wells (B)

Dug wells are usually shallow wells dug by hand, although some may be quite deep. Wells are often lined with bricks.

Unless artesian water is tapped, many dug wells go dry or have very little water in dry periods because it is difficult to sink wells below the water table without using more sophisticated excavation techniques.

Dug wells are often more vulnerable to contamination than other point sources because it is difficult to make the lining of the well impermeable and the means of withdrawing water can easily become unsanitary. In some cases, dug wells are constructed to reduce the specific risk of guinea worm transmission and therefore only have an headwall to prevent people from entering the well. However, such wells may still be contaminated and it is therefore preferred that dug wells should be covered and either a handpump or windlass installed to withdraw the water.

Where water is collected by a bucket, this may contaminate the well, particularly if each person uses their own bucket and the area is not well fenced to prevent animals from having access to the well. Dug wells can be improved by using a protected intake. This may use a filter box installed at the base of the well. Where wells are used, you should ensure that these are covered, have a headwall of at least 30cm above the apron and a handpump or windlass is used.

Ponding around the well provides a great environment for insect breeding which contributes to the spread of disease. Furthermore, ponding around a well which does not have a concrete apron (or one that is cracked), can easily contaminate the well water.

Rainwater may also affect the water quality of a dug well. If the water turns a different color after a period of rain, this indicates an unsanitary condition. Water is seeping into the well from areas of the ground that it usually doesn't, or is moving through the earth faster than it is able to be filtered.

The shaft of an improved dug well should have a concrete lining above the dry-season water table and a series of concrete rings (caissons) sunk below this level to ensure a year-round supply of water. The lining acts both to protect the shaft from collapse and to prevent surface water from infiltrating into the well at shallow depths.

The top of the well (the wellhead) should be

built up by at least 30 cm and an apron cast around it to prevent surface water from entering the well directly.

Generally, a permanent cover should be put over the well and water drawn by a handpump or windlass and bucket. A communal rope and bucket attached to the well can be used to draw water, but the bucket and rope should be kept off the ground. One way to do this is to put a hook inside the well and always store the bucket on it. Once a dug well is completed it should be cleaned with chlorine and the pump installed.

The advantage of improved dug wells is that they can be deepened and, if the handpump or windlass fails, water can still be collected, although care should be taken not to contaminate the water by using individual buckets. However, dug wells are more likely to go dry in prolonged dry periods, or if large volumes of water are pumped from nearby deep boreholes, and they are easily contaminated. Nevertheless, they provide a low-cost water supply and communities can be actively involved in their construction.

In some arid areas, dug wells have traditionally been constructed in sandy riverbeds. Where flooding is rare, such wells can be improved to provide dry-season water sources. To protect the well from river damage during the rainy seasons the well opening can be covered with a concrete slab and a concrete barrier built upstream from the well. In sandy riverbeds with water-resistant bedrock beneath, walls can be constructed under the sand to create sand dams. These collect the river water and can ensure that nearby wells are productive for longer periods in the dry season. However, keep in mind that changing the structure of the riverbed may have unwanted environmental effects and should be done only after an environmental impact study.

Abandoned wells should be closed to avoid polluting groundwater.

Our community's dug well has well maintained protection measures.

1 2 3 4 5 6 7 8 9

Our community strives to keep the point of water extraction, and the surrounding area sanitary.

1 2 3 4 5 6 7 8 9

Our community strives to maintain a zone of protection around the well.

1 2 3 4 5 6 7 8 9

Our community is satisfied with the quality and quantity of water provided by this source.

1 2 3 4 5 6 7 8 9

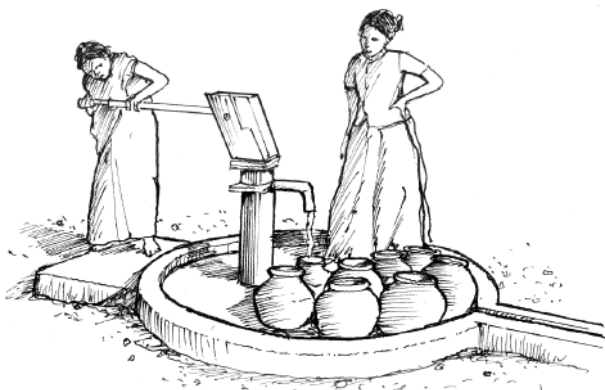
Ground water: Boreholes (C)

Boreholes are narrow holes drilled into the ground that tap into groundwater. Boreholes can be drilled using motorized rigs operated by trained staff, but this is expensive. Boreholes can also be drilled by hand using an augur, or by forcing water into the ground under pressure ('jetting'). If a community is involved in the actual sinking of the borehole, it is likely to use auguring or jetting because these are less expensive methods, but it is not possible to sink deep boreholes with these methods. Depending on the depth of the groundwater, a handpump may be required to bring the water to the surface. The practical limit for most handpumps is 45 metres; beyond this a motorized pump (diesel, electric, wind or solar powered) may be required.

As the borehole is drilled, a lining of plastic, steel or iron is sunk to protect the hole from collapse. The lining has slots in the bottom section to allow water to enter the borehole and gravel is placed around the bottom of the lining to improve flow and provide filtration. The top few metres around the borehole should be sealed using concrete, and a concrete apron is cast around the top of the borehole to prevent surface water from flowing into the lined shaft. A stand is usually cast into the apron to provide a stable base for the pump. Once the borehole is completed it should be cleaned with chlorine and the pump installed.

Unfortunately, many boreholes worldwide are no longer working because simple repairs have not been carried out. Consequently, if a borehole is drilled in a village, it is important that maintenance costs and activities can be met by the community. Finances should be managed to ensure that funds can be raised for maintenance. In addition, it is particularly important to make sure that all required spares can be purchased within a reasonable distance from the village. For major repairs beyond the skills of the community, clear information as to how these repairs will be carried out should be requested from the relevant agency.

Boreholes usually provide good quality water, but the water sometimes contains harmful chemicals, such as fluoride and arsenic, or nuisance chemicals such as iron. Community members should either carry out chemical tests, or request



Handpump on a borehole
 Source: World Health Organisation

that tests be carried out by the government agency or otherwise, and the results fully discussed with the community.

While it is often found that boreholes have a better water quality than other point sources because they are sunk deeper into the ground and often have greater protection against contamination, problems may exist which may reduce the quality of water from a borehole. Because of their depth, a larger protected area around them is required than for a dug well. In the general case, 10 meters surrounding a handpumped borehole, and 100 m surrounding a mechanized pump are recommended. However, the

actual recommended size for protection zones is dependent upon many factors. An expert's advice should be sought to determine the protection zones necessary for your particular borehole.

Such problems may include poor drainage of wastewater that allows stagnant water to form pools close to the borehole; the deterioration in the apron leading to undercutting of the borehole; or a handpump being loose at the base where it is attached to the apron. These all require attention to prevent future problems and the community should be encouraged to make minor repairs and clean the environment close to the borehole to prevent contamination. Again, where fences are lacking and there is no means of ensuring surface water cannot flood the apron area, the risks of contamination will increase and the community should work to address these problems.

For boreholes, it is often important to prevent latrines and animal enclosures from being constructed close to the borehole as these may allow direct contamination of the groundwater. You should always try to ensure that such hazards are a protecting distance away from the borehole and if there are latrines uphill, you should increase this distance if possible. Boreholes where the top of the rising main (the pipe that comes out of the ground) cannot be sealed represent a particular

Operational and Maintenance Tasks for a Borehole

Activity	Dry season	Wet season—routine	Wet season—after heavy rainfall
grease working parts of the handpump	at least once per week	at least once per week	at least once per week
check hand pump to see whether worn parts need replacement	at least once per quarter	at least once per quarter	at least once per quarter
make sure fence is in good condition and make repairs	at least once per quarter	at least once per quarter	at least once per quarter
check drainage channels and clean	at least once per month	at least once per week	clean if required
clear rubbish away from area around borehole, particularly uphill	at least once per week	at least once per week	clean if required
keep paths and grassed areas above borehole clear of rubbish	at least once per month	at least once per month	clean if required
check whether any water collecting close to the borehole and clear if required	at least once per month	at least once per week	clean if required
carry out regular inspections of the borehole and note any faults	at least twice per week	daily	after every heavy rain

Source: Howard, Guy. *Water Supply Surveillance*, 2002

hazard as this means that surface water may be able to directly enter. In this case, try to create a concrete ring around the top of the pipe and if possible seal this by making a small plinth for the handpump to rest on and extend the rising main into the base of the handpump.

Our community's borehole has well maintained protection measures.

1 2 3 4 5 6 7 8 9

Our community strives to keep the point of water extraction, and the surrounding area sanitary.

1 2 3 4 5 6 7 8 9

Our community strives to maintain a zone of protection around the borehole.

1 2 3 4 5 6 7 8 9

Our community is satisfied with the quality and quantity of water provided by this source.

1 2 3 4 5 6 7 8 9

Ground water: Springs (D)

A spring is where underground water flows to the surface. Springs may occur when the water table meets the ground surface; these are called gravity springs. Other times water is forced to the surface because the water-carrying layer meets an impermeable layer (gravity overflow springs or contact springs). In some cases, groundwater is held under pressure and springs come to the surface because of a natural break in the rock, or because a shallow excavation is made (artesian springs).

Springs can make very good water supplies provided that they are properly protected against contamination. If springs are found above the village, they can feed a pipe system for providing water close to homes. When a spring is at the same, or lower, level than the village, it can still be protected, but greater care is needed and it is unlikely that water will flow through the pipe system by gravity. The first step in deciding whether a spring should be protected is to determine whether it provides enough water for the expected number of users. This can be done by measuring the time it takes for the spring to fill a bucket of known volume, and estimating how many liters are used per day.

To protect a spring, a retaining wall or box is constructed, usually with concrete, around the 'eye' of the spring, where the water emerges from

the ground. The area behind the wall or box is backfilled with sand and stones to filter water as it enters the box and help remove contamination in the groundwater. The backfill area is capped with clay and grass is planted on top.

The whole area should be fenced and a ditch dug above the spring to prevent surface water from eroding the backfill area and contaminating the spring. The collection area should be covered with concrete and sufficient space left beneath the outlet pipe for people to place jerry cans and buckets. A lined drain should be constructed to carry spilled water away from the spring. The water could be used for laundry, to feed an animal-watering trough or for irrigating a garden. In other situations spilled water may be drained to a soak-away pit or to the nearest surface water body. To prevent mosquito breeding, water from the spring should not be allowed to form pools.

For protected springs, it is important to look at the state of the protection works—including the backfill area—to see whether these show any deterioration, like cracks, tilting, leaks, crumbling, etc... In many cases, the deterioration in the immediate sanitary protection works is more important in causing contamination than the hazards such as pit latrines. However, the deterioration in the sanitary protection measures are important to improve irrespective of what the quality of water is like from any samples taken. For instance, the catchment area may become eroded and lose its vegetation cover and at the same time there is no fence and the uphill diversion ditch is either absent or faulty. The erosion of the catchment areas results from two major factors: (1) The lack of a fence means that both people and animals can get access directly onto the catchment area and may cause erosion by creating footpaths or by making holes in the ground. (2) The lack of a diversion ditch allows surface water to run directly onto the backfill area that not only causes erosion but also may allow water to directly enter the water source. If only the backfill area is improved without putting in place the fence and diversion ditch, the risk of contamination in the longer-term will remain.

Designs for protected springs should be used that enclose the area for where backfill media will be placed, which enables both flow to be directed towards the outlet pipes and to ensure that filtration is maximised during flow through the backfill media. The backfill media should be gravel with a nominal diameter of less than 25mm. This



A well-protected spring
 Source: World Health Organisation

provides greater filtration potential than larger aggregates that are often used, thus increasing the possibility of removing contaminants that may enter the structure. The gravel pack should be overlain by layers of clay and sand to provide additional protection against the entry of contaminated surface water with a top layer of soil, which is essential to be able to support an adequate vegetation cover.

The spring box should always be protected from erosion and inundation. This can be done by providing an uphill diversion ditch that has a concrete lining, stone pitching or well-compacted clay and putting a fence around the protected area. The number and size of outlets of the spring should be carefully considered. In many cases, there is a problem of congestion at the source and this may lead to significant problems. This may be overcome by increasing the number of outlets by constructing a spring box with outlets on several sides. Where this is not possible, several filling points can be fitted to a single delivery pipe by using a 'T'-junction. It is also usually better to use smaller diameter pipes for the outlets. When large pipes are used, a large proportion of the water may be lost during collection and this may increase problems with congestion. By using a smaller pipe diameter, not only can the water be directed more effectively into the collection vessel, but may also allow more pipes to be used.

An example of a well-protected spring is shown opposite. Although protected springs require very little maintenance, far less than a borehole with handpump, basic checks should be carried out (see table).

Our community's spring has well maintained protection measures.

1 2 3 4 5 6 7 8 9

Operational and Maintenance Tasks for a Protected Spring

Activity	Dry season	West season—routine	Wet season—after heavy rainfall
Clear uphill diversion ditch	at least once per month	at least once per week	clean if required
Clear drainage ditch from outlets	at least once per month	at least once per week	clean if required
Slashing grass inside fence	at least once per dry season	at least once per month	not necessary
Make sure steps are clean and not broken	at least once per week	at least once per week	clean if required
Clear rubbish away from around spring, particularly uphill	at least once per week	at least once per week	clean if required
Keep paths and grassed areas above springs clear of rubbish	at least once per month	at least once per month	clean if required
Trim hedge once it reaches a height of 4 feet	do not trim in dry season	when hedge reaches 4 feet	not necessary
Carry out regular inspections of the spring and note any faults	at least twice per week	daily	after every heavy rains

Source: Howard, Guy. *Water Supply Surveillance*, 2002

Our community strives to keep the point of water extraction, and the surrounding area sanitary.

1 2 3 4 5 6 7 8 9

Our community strives to maintain a zone of protection around the spring.

1 2 3 4 5 6 7 8 9

Our community is satisfied with the quality and quantity of water provided by this source.

1 2 3 4 5 6 7 8 9

Rainwater (E)

Although rainwater can be a good source of water for drinking and domestic use, it may be seasonal, and it is often difficult for a community to rely on rainwater alone. Collecting sufficient rainwater for an entire community also requires relatively large roofs and tanks, and the supply may still not be sufficient. Nevertheless, using rainwater is a free and low-impact means of satisfying at least part of the community's drinking water needs.

If the rainwater is to be used for drinking it is better to collect it from a roof, rather than from a ground catchment where it may become contaminated. Ground catchments are more appropriate for agricultural use.

Using roofs to collect rainwater is relatively easy and a lot of water can be collected. For example, 50 mm of rainfall on a 4 m² roof yields 200 litres of water. All that is required are gutters around the roof that discharge into a collection tank. The roofing material is important and hard surfaces, such as iron sheets or tiles, allow more rain to be collected than softer surfaces such as thatch and grass, which absorb water. Hard surfaces are also easier to keep clean and are less likely to have insects and animals living in them.

Any roof used to collect rainwater for human consumption must be thoroughly cleaned at the start of the rainy period. Birds and animals may leave feces on the roof and these can be a source of pathogens. There should be a system for diverting the flow of water in gutters away from the tank, so that the first rains (which are more likely to pick up contamination from the roof) are not collected. A small filter may be added to the top of the collection tank as an added protection. The tank should also be cleaned every year and any silt or algal matter removed. After cleaning and before use, the tank should be scrubbed using a chlorine solution (bleach).

Water should be drawn from a tap at the base of the tank, rather than with a bucket, which may contaminate the water. It is better not to bury the collection tank, even partially, since contaminated water from the soil can enter the tank. Covering the tank is also essential for preventing contamination of the water and for reducing opportunities for disease vectors to breed.

The household should make sure that the roof is not overhung by trees or close to food stores as this may encourage rodents and lead to excreta being found on the roof.

Our community's rainwater collection apparatus is well maintained and sanitary.

1 2 3 4 5 6 7 8 9

Our community is satisfied with the quality and quantity of water provided by this source.

1 2 3 4 5 6 7 8 9

Water vendors (F)

In general, the better you know the source and handling of your purchased water, the more confident you can be in its quality. A great variety of water quality from various vendors should be expected since the water in a tanker can be contaminated in many ways. If the inside of the tanker is not regularly cleaned, or becomes contaminated (e.g. by filling the tank with a tube through an inspection cover), the water quality is compromised.

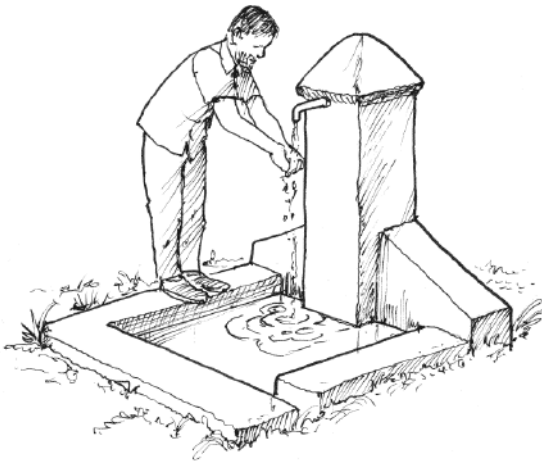
Nevertheless, if your country, province, or other governing body has enforceable standards for marketed drinking water, you may be reasonably assured of its quality.

Our community is satisfied with the service of our vendor, and are assured of its water quality.

1 2 3 4 5 6 7 8 9

Piped Water (G)

Many villages may have piped water systems that supply communal taps or yard taps. These piped water systems are often small and rely on community management, and many use untreated groundwater sources. Small piped water systems are usually fed by gravity, either from protected springs or from surface water above the village, although some may be supplied from boreholes fitted with motorized pumps. Most piped water supplies



Example of a standpost

Source: World Health Organisation

include storage tanks so that water is always available, even when demand is heaviest. Such tanks are usually necessary because the rate of water use at peak times of the day (often early morning and early evening) is greater than the average rate of use throughout the day. The tanks also provide emergency storage in the event of a breakdown. When planning a piped system, community members should consider carefully where to locate the taps, so that everyone has relatively easy access. However, the design of piped systems can be quite complicated and it may not be possible to place taps where people would prefer.

It is important to determine that the water used as the source for the pipe system is sanitary. The main source water should be treated before distribution, in order for potable water to be available to the taps. If your water source is not treated before distribution, be sure to treat the water yourself.

Piped systems require regular maintenance. Pipe leaks need to be repaired rapidly to prevent water loss, and to prevent surface water from entering the pipes and contaminating the supply. Also, communal taps are likely to be used heavily and users may not be as careful as they would be with their own taps. As a result, the taps are more likely to break and will need frequent replacement. One way of dealing with these issues is to give someone in the community responsibility for checking communal taps and making repairs. To prevent the accumulation of stagnant water around community taps, which could become mosquito breeding sites, community members could build a concrete 'apron' at the base of the taps and include a drain and a soakage pit. An example of a standpost is shown above.

Another problem with piped systems is that users often do not consider the impact of how much water they use, and may not think it is important to turn off the tap after use. When there is a lot of water, this may not have negative consequences. However, where the amount of water available is limited, if users at the high end of the system leave taps running, users lower down may suffer shortages or intermittent service. This can force them to use less safe sources of water. Moreover, if the pipes are dry or have very low flow rates, surface water may enter the pipes and contaminate the piped water. Users of piped water systems should thus be aware of the impact of their water use on others and good water use should be promoted. This could be supported through village regulations or by-laws that penalize people who persistently abuse the system.

Sanitary risks often occur within the environment immediately around the tap. These are problems like the exposure of a pipe close to the tap, finding stagnant water close to the tap or the erosion of the area around the tap. In many cases, contamination occurs because of these problems rather than as a result of poor supply management. In these cases, attention should be focused on ensuring that the area around the tap and the customer main is kept clean and that the pipe remains buried.

In many cases, the pipe that connects the tap riser to the supply main is buried at a very shallow depth and therefore is easily exposed and damaged. The particularly weak points are the joints at the connection to the supply main (where pressure may be highest) and the joint between the supply pipe and the riser pipe at the tap itself. In the latter case, this is often damaged when many people use the tap and the riser pipe has no support. Where this is the case, users of the taps should be encouraged to put in a support for the riser pipe. Where there are existing taps, this may have to be a metal support, but for new taps, the use of a concrete plinth should be encouraged.

Communities may sometimes put lengths of hose on the tap to improve the direction of flow of water where the tap design cause a wide stream of water to flow from the tap. These attached hoses may cause contamination and their use should be discouraged. One way to reduce the need for using such attachments is to use taps that have an insert that directs water into a single stream even at high pressure.

An alternative approach is to reduce the

distance between the tap outlet and the opening on the water container. The height of the riser pipe can be reduced to a level that is just above the height of the usual container. Riser pipes do not need to be 0.5m high if the usual container is only 0.3m high. Another approach, which may be appropriate when the tap is already in place, is to construct a small plinth to rest the container on that will raise the container up to close to the height of the tap. This will also help to support the tap against damage.

For more information regarding sanitary plumbing practices, refer to the WHO publication listed at the end of this chapter, 'Health Aspects of Plumbing.'

Our community is satisfied with the quality and quantity of water provided by the water system.

1 2 3 4 5 6 7 8 9

Our community does all it can to maintain the safety and sanitary conditions of its tapstands and piping.

1 2 3 4 5 6 7 8 9

Factors for communities considering water supply improvements

- Have community members been fully consulted about the type of water supply?
- Have community members had previous experiences with water supply improvements and have these been reviewed?
- How will the water supply be managed to ensure that it is reasonably accessible to everyone in the community?
- How will initial costs be paid and is the community expected to provide labour?
- Will labour be provided free or will the community have to raise funds to cover labour charges?
- What are the long-term financial implications of the choice of water supply?
- Can the community afford to pay expected operation and maintenance costs?
- What spare parts are required and how often should they be replaced?
- Who sells these spares and where are they obtained?
- What tools are required and where can they be obtained?
- Who will be trained to operate and maintain the water supply?
- What skills should operators have and what training will they receive?
- What long-term support can the community expect from the government and other agencies?
- If major repairs are required, whom should you contact and who will pay?
- Will the quality of the water be tested?
- How often will testing be done and how will the information be communicated to the community?

Water Conservation: Inventory

(These questions apply primarily to communities in urban areas with individually tapped piped water supplies.)

1. Monitoring Water Consumption

Estimate the number of liters of water that the community uses in a day. Try to minimize the guess-work by actually measuring as much as possible. If your water is metered, you can simply divide the amount of water used per period by the number of days in the period.

Amount of water used per day:

2. Leaks and plumbing fixtures

Is there a plumber (someone charged with maintaining water lines, faucets, toilets, sinks, etc.) in the community?

Yes / No

The following questions should be directed to the person responsible for making plumbing repairs:

Are all faucets or taps free of leaks or drips?

Yes / No / Not Applicable

Are all toilet fill lines free of leaks?

Yes / No / Not Applicable

Are all garden hoses free of leaks?

Yes / No / Not Applicable

Is all plumbing free of leaks?

Yes / No / Not Applicable

Does the community have replacement parts that are commonly needed (eg. washers, fittings, faucets/valves)?

Yes / No / Not Applicable

Are routine checks of pipes and faucets performed?

Yes / No / Not Applicable

Is there a procedure in place for reporting leaks?

Yes / No

Describe Procedure:

If available, are water-conserving devices in use in the community?

Yes / No / Not Applicable

Does your community use composting toilets?

Yes / No / Not Applicable

3. Water Provider's Practices

Contact your water provider and to answer the following questions.

Water provider:

Name of contact person:

Contact information:

How much water is lost from the system through leakage?

What measure(s) is/are the provider taking to alleviate any leakage problems?

Has the provider assessed the effect that the water system's intake has on groundwater levels? If so, describe it below; or if not, ask why it has not been done:

4. Education and Personal Habits

Is the community well-informed about the need for water conservation, and about personal habits that could be changed in order to not be wasteful of a valuable resource?

Yes / No

1. Is an effort made to reduce the amount of time spent in showers, or to reduce the amount of water used in the showering process?

Yes / No / Not Applicable

2. Is an effort made to shut off the tap/ faucet when water is not being used (e.g. When brushing teeth or washing dishes, etc)

Yes / No / Not Applicable

3. Is a mop and bucket or a broom used to clean the ground/ floor, instead of a hose or dumped water.

Yes / No / Not Applicable

5. Using Greywater

Is greywater (wash water, not contaminated with feces) collected and reused?

Yes / No / Not Applicable

Used water is collected from the following sources: (check all that apply)

- Showers
- Kitchen sinks
- Bath tubs
- Bathroom sinks
- Utility sinks
- Dishwasher
- Washing machines

Water Conservation: Evaluation

Communities need to conserve water resources for future generations; the following discussion addresses several ways in which this can be accomplished. Following the discussion section is a reference chart filled with a variety of ways to conserve water.

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

1. Monitoring Water Consumption

There are good reasons to determine the amount of water your community uses on a daily basis. For instance, by comparing month to month changes, your community can continually assess their consumption of water.

How much does a person need? To sustain a reasonable quality of living requires between 25 to 80 litres of water per person per day. If the consumption is much higher than this, much of extra use is probably due to careless wasting. In such a case, it may be important to assess the water needs of the community. Although tedious, by interviewing the various members of your

community about their water usage, you may determine why the consumption is so high. Inessential uses of water should be identified and eliminated, and less consumptive practices should be disseminated throughout your community.

Our community regularly keeps track of our water consumption and consistently strives to minimize the amount used.

1 2 3 4 5 6 7 8 9

2. Leaks and plumbing fixtures

Check for leaks, especially faulty washers, and repair them. It's probably best if the community has at least one person that is responsible for maintaining plumbing and plumbing fixtures.

The community should keep a small inventory of commonly needed parts and tools needed to repair the most common problems. A good inventory is best stocked according to the accumulated history of the community's plumbing problems (water leaks). The experience of a community plumber is one way to keep track of the history, but maintaining records is a wise idea also.

There should be routine inspections, especially in the most common problem areas, such as areas that receive high amounts of usage (community sinks, taps, etc.). In addition, all community members can be a part of a continual inspection by reporting any leaks encountered. The reporting process should be easy, standard, and known to all community members.

Fit water conserving devices. Many commonly used appliances can be modified to conserve water or bought specifically for their water conserving qualities:

- Spray taps and faucet aerators are an alternative to steady flow taps enabling a smaller volume of water to achieve the same results.
- Low flow shower heads can be fitted to maximise water coverage and minimise water volume.
- In the toilet: By adding a sealed plastic bottle filled with water inside your toilet cistern or by adjusting your ballcock, the amount of water used per flush can be reduced to a minimum. Alternatively a dual flush toilet system can be fitted which discharges a small volume of water for liquid waste and a larger volume for solid waste, efficient flushing depends upon the velocity of the water rather than the volume which tends to be

grossly out of proportion with the waste that the water flushes.

- Install a composting toilet, if appropriate, and you can do away with using water to flush away your wastes. The added benefit to this simple technology is the rich compost at the end of the process, returning nutrients back to the soil that would otherwise end up in rivers. In China and Japan night soil (as it is called) has been scrupulously collected for centuries to fertilise the fields. Composting toilets need no water and depend on bacterial action to break down harmful bugs in the waste.

(Consult the resources listed at the end of this chapter for more information regarding water conservation technologies. More information about composting toilets can be found in the **Sanitation Assessment** in Chapter 4.)

Our community has clear policies and procedures regarding water leaks, so that any leaks are quickly repaired.

1 2 3 4 5 6 7 8 9

Our community also strives to use water conserving devices whenever they are available.

1 2 3 4 5 6 7 8 9

3. Water Provider's Practices

Write to, or call your local Water Provider and find out how much water it loses in its pipes through leakage and what measures it is taking to alleviate the situation. In some areas this figure is over one third.

Communities should discuss with the Water Provider the short- and long-term impacts of water supply improvement on water resources. For example, sinking too many boreholes in an area may cause serious depletion of water held underground and even cause water sources to dry up.

This can also lead to deteriorating water quality: as the water table falls, domestic boreholes must be sunk deeper into underground water that may contain harmful chemicals such as fluoride or arsenic.

Because community members are the principal stakeholders of local water resources, they should always assess the longer-term effects of water pumping on the environment and should be actively involved in evaluating the risks.

Especially if shortages occur, if costs rise, if

metering is in place, if the water system is losing a lot of water, or the groundwater table is being rapidly depleted, the Water Provider is not being managed in the best interests of the community that it is serving. In such a case, the community should do what is necessary to ensure that the Water Provider's management practices are changed.

Our community actively pressures our Water Provider to use the best management practices it can to conserve water.

1 2 3 4 5 6 7 8 9

4. Education and Personal Habits

Water conservation

Although it is important that people use enough water for good hygiene, it is also important not to waste water. Piped water supplies are particularly vulnerable to wastage; if they are not properly managed, the community as a whole may suffer water shortages and people will have to wait longer to collect water. Most piped water systems leak and need to be checked regularly and repaired as soon as faults are discovered. Taps should also be turned off immediately after use and children discouraged from playing with taps.

Why conserve water?

Ultimately, the fresh water available to a community depends upon the amounts of rainfall, local hydrology and the geology of the area.

If the community takes out more water than the natural system will allow, then this leads to a lowering of the water table and possible dramatic effects upon water quality, future water supplies and agriculture. It also has harmful consequences for the wildlife/amenity value of the landscape, reducing flowing rivers to muddy puddles.

Faced with the problems of over abstraction from natural water bodies the knee-jerk reaction is to construct more reservoirs. This solution impacts heavily upon the wildlife/amenity value of natural landscapes and alters the hydrology of the area. The sane alternative to this tinkering response is to use the water you have in a sustainable way by conserving and recycling it.

A community must value their water supply and ensure that the community's demands upon it are not too great, so that the supply can last into the future.

Think twice

Much water conservation is common sense:

- Washing clothes: Use full loads in your washing machine, or if purchasing a machine look for economy features such as half load capability or reduced water consumption.

- Refrigerate drinking water in order to prevent running the tap for long periods waiting for cold water.

- Conversely, insulate hot water pipes to prevent running the tap for long periods waiting for hot water.

- Wash dishes by hand, using one bowl for washing and one for rinsing. Bowls are filled with less water than it takes to fill the sink.

- Use showers instead of baths. Have baths as a treat, a sensual experience to be relished once in a while. Showers with low flowheads use far less water than the average bath.

- Collect rainwater. This collected water can be used for most applications but care should be taken if you suspect any leaching of particles from your roof surface. If this is the case then the water can still be used for washing your car, or bicycle, and watering ornamental, (non edible) plants.

- Car washing: It is possible to wash a car with only one bucket of water. But does it really need washing?

- Garden watering: To save water and to give your plants the maximum benefit it is best to water out of direct sunlight, i.e., in the evening. This will cut down on water loss due to evaporation. Avoid sprinklers, which use water indiscriminately, and try to target the water precisely where it is most needed. Grow plants in beds, not containers.

- Save cooking water and use it as stock or as a base for soups; it can be kept for several days in a cooler or frozen.

Our community is well informed about the need for water conservation practices, and our members adapt their behaviour accordingly.

1 2 3 4 5 6 7 8 9

5. Using Greywater

Recycle greywater

All the water used in the community, apart from toilet flush water, can be re-used to some degree. Water can be collected from seven main sources:

- Showers
- Bath tubs
- Bathroom sinks

(These three together use 75% of non-flush water used in the home and contain less than 10% of the particulates)

- Washing machine
- Utility sinks
- Dishwashers
- Kitchen sinks

Making use of Waste Water

A temporary solution is to manually bucket the water, usually termed greywater, from the source to its eventual destination. A more sophisticated method is to re-route the drain pipes of the fixtures and appliances from which you intend to re-use water into a common discharge buffer tank. A small electric or hand pump may be needed if gravity feed is not possible, dishwashers and washing machines have their own discharge pumps which are capable of delivering water to an elevated storage tank.

Greywater qualities & uses

The quality of the greywater the community collects ultimately depends upon what it is collected from, and how well it is filtered before re-use. Greywater can generally be used as a flush water without any treatment besides simple filtration. Greywater can also be used on garden and potted plants, although more filtration might be considered for this application.

Particles can be filtered out by using a simple mesh filter on the plughole. Soap and detergent residues can be harmful to plants, so it is best to use bio-degradable cleaning products, sparingly.

If the greywater is passed through several filtering systems i.e a settling tank, then grease trap, then sand filter, the resulting water can be used with little worry over the potential accumulation of harmful chemicals. It can be applied to all types of vegetation.

If you do not possess the space or resources for this kind of filtration the greywater that you have so scrupulously saved can still be used to top up your toilet system, or used selectively in the garden. In this case, care should be taken to water only ornamental plants or mature well established vegetable plots, it is also advisable to avoid contact between the greywater and the vegetation itself, i.e water the soil around the plants only.

Sodium, contained in detergents, can build up after lengthy periods of application necessitating adding gypsum to the soil to lower the alkalinity which sodium causes. This build up can easily be

detected by making a test for pH. Any possible harmful effects can be minimised by diluting the greywater with collected/fresh or filtered water.

Explore the resources listed at the end of this chapter to learn of inexpensive and safe ways to adapt your plumbing to reuse greywater.

Our community makes the most reasonable use of our greywater.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right

score

1. Water consumption monitoring	
2. Leaks and plumbing fixtures	
2. Water conservation devices	
3. Water Provider’s practices	
4. Education and personal habits	
5. Using Greywater	

Now that you have comprehensively examined your community’s water conserving habits, how would you rate, overall, your community’s practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

continued

Problem 3

Problem 4

Problem 5

Now categorize each problem listed above into one of the following three categories:

I = *Critically important. Currently dangerous, must be addressed immediately*

II = *Important, but not immediately dangerous. Must be addressed*

III = *Current practice should be improved, but is not immediately important*

46 WAYS OF SAVING WATER

1. Never put water down the drain when there may be another use for it such as watering a plant or garden, or cleaning.
2. Verify that your community is leak-free, because many homes have hidden water leaks. Read your water meter before and after a two-hour period when no water is being used. If the meter does not read exactly the same, there is a leak.

3. Repair dripping taps by replacing washers. If your tap is dripping at the rate of one drop per second, you can expect to waste over 5,000 liters per year which will add to the cost of water and sewer utilities, or strain your septic system.
4. Check for toilet tank leaks by adding food colouring to the tank. If the toilet is leaking, colour will appear within 30 minutes. Check the toilet for worn out, corroded or bent parts. Most replacement parts are inexpensive, readily available and easily installed. (Flush as soon as test is done, since food colouring may stain tank.)
5. Avoid flushing the toilet unnecessarily. Dispose of tissues, insects and other such waste in the rubbish bin rather than the toilet.
6. Take shorter showers. Replace you showerhead with an ultra-low-flow version. Some units are available that allow you to cut off the flow without adjusting the water temperature knobs.
7. Use the minimum amount of water needed for a bath by closing the drain first and filling the bath only 1/3 full. The initial burst of cold water can be warmed by adding hot water later.
8. Don't let water run while shaving or washing your face. Brush your teeth first while waiting for water to get hot, then wash or shave after filling the basin.
9. Retrofit all wasteful household taps by installing aerators with flow restrictors.
10. Operate automatic dishwashers and clothes washers only when they are fully loaded or properly set the water level for the size of load you are using.
11. When washing dishes by hand, fill one sink or basin with soapy water. Quickly rinse under a slow-moving stream from the tap.
12. Store drinking water in the refrigerator rather than letting the tap run every time you want a cool glass of water.
13. Do not use running water to thaw meat or other frozen foods. Defrost food overnight in the refrigerator or by using the defrost setting on your microwave.
14. Kitchen sink disposals require lots of water to operate properly. Start a compost pile as an alternate method of disposing food waste instead of using a garbage disposal. Garbage disposals also can add 50% to the volume of solids in a septic tank that can lead to malfunctions and maintenance problems.
15. Consider installing an instant water heater on your kitchen sink so you don't have to let the water run while it heats up. This will reduce heating costs for your household.
16. Insulate your water pipes. You'll get hot water faster plus avoid wasting water while it heats up.
17. Never install a water-to-air heat pump or air-conditioning system. Air-to-air models are just as efficient and do not waste water.

18. Install water softening systems only when necessary. Save water and salt by running the minimum amount of regenerations necessary to maintain water softness. Turn softeners off while on vacation.
19. Check your pump. If you have a well at your home, listen to see if the pump kicks on and off while the water is not in use. If it does, you have a leak.
20. When adjusting water temperatures, instead of turning water flow up, try turning it down. If the water is too hot or cold, turn the offender down rather than increasing water flow to balance the temperatures.
21. If the toilet flush handle frequently sticks in the flush position, letting water run constantly, replace or adjust it

Saving Water Outdoors

22. Don't over-water your lawn. As a general rule, lawns only need watering every 5 to 7 days in the summer and every 10 to 14 days in the winter. A hearty rain eliminates the need for watering for as long as two weeks.
23. Water lawns during the early morning hours when temperatures and wind speed are the lowest. This reduces losses from evaporation.
24. Don't water your street, driveway or sidewalk. Position your sprinklers so that your water lands on the lawn and shrubs ... not the paved areas.
25. Install sprinklers that are the most water-efficient for each use. Micro and drip irrigation and soaker hoses are examples of water-efficient methods of irrigation.
26. Regularly check sprinkler systems and timing devices to be sure they are operating properly. It is highly recommended that anyone who purchases and installs an automatic lawn sprinkler system should also install a rain sensor device or switch which will override the irrigation cycle of the sprinkler system if inadequate rainfall has occurred. To retrofit your existing system, contact an irrigation professional for more information.
27. Raise the lawn mower blade to at least three inches. A lawn cut higher encourages grass roots to grow deeper, shades the root system and holds soil moisture better than a closely-clipped lawn.
28. Mulch to retain moisture in the soil. Mulching also helps to control weeds that compete with plants for water.
29. Plant native and/or drought-tolerant grasses, ground covers, shrubs and trees. Once established, they do not need to be watered as frequently and they usually will survive a dry period without any watering. Group plants together based on similar water needs.
30. Do not hose down your driveway or sidewalk. Use a broom to clean leaves and other debris from these areas. Using a hose to clean a driveway can waste hundreds of liters of water.
31. Outfit your hose with a shut-off nozzle that can be adjusted down to fine spray so that water flows only as needed. When finished, 'Turn it Off' at the tap instead of at the nozzle to avoid leaks.
32. Use hose washers between spigots and water hoses to eliminate leaks.
33. Check all hoses, connectors and spigots regularly.
34. Consider using a commercial car wash that recycles water. If you wash your own car, park on the grass to do so.
35. Avoid the installation of ornamental water features (such as fountains) unless the water is recycled.

General Water Saving Tips

36. Create an awareness of the need for water conservation within your community.
37. Be aware of and follow all water conservation and water shortage rules and restrictions that may be in effect in your area.
38. Encourage your employer to promote water conservation at the workplace. Suggest that water conservation be put in the employee orientation manual and training program.
39. Patronise businesses that practice and promote water conservation.
40. Report all significant water losses (broken pipes, open hydrants, errant sprinklers, abandoned free-flowing wells, etc.) to the property owner, local authorities or your Water Management District.
41. Encourage your school system and local government to help develop and promote a water conservation ethic among children and adults.
42. Support projects that will lead to an increased use of reclaimed waste water for irrigation and other uses.
43. Support efforts and programs to create a concern for water conservation among tourists and visitors. Make sure your visitors understand the need for, and benefits of, water conservation.
44. Encourage your friends and neighbours to be part of a water conscious community. Promote water conservation in community newsletters, on bulletin boards and by example.
45. Conserve water because it is the right thing to do. Don't waste water just because someone else is footing the bill such as when you are staying at a hotel.
46. Try to do one thing each day that will result in a savings of water. Don't worry if the savings is minimal. Every drop counts. And every person can make a difference. So tell your friends, neighbours and co-workers to 'Turn it Off' and 'Keep it Off'.

(Source: Water Ambassador)

Acknowledgements for Chapter Three

The information contained in this chapter has primarily been adapted from the works of Guy Howard, especially from the following three publications:

Howard, Guy. *Water Quality Surveillance: A Practical Guide*. WEDC, Loughborough University, 2002. Available online from <http://wedc.lboro.ac.uk>.

Howard, Guy. *Water Supply Surveillance: A Reference Manual*. WEDC, Loughborough University, 2002. Available online from <http://wedc.lboro.ac.uk>.

Guy Howard, with Claus Bogh, Greg Goldstein, Joy Morgan, Annette Prüss, Rod Shaw, Joanna Teuton. *Healthy Villages: A guide for communities and community health*. World Health Organization, 2002. Available online from: http://www.who.int/water_sanitation_health/hygiene/setting/healthvillages/

In addition, the World Health Organization's *Guidelines for Drinking Water Quality*, 3rd Ed. were used as a reference, as well as the WHO publication:

Water quality assessments: a guide to the use of biota, sediments and water in environmental monitoring, 2nd edition. Edited by Deborah Chapman. Published on behalf of UNESCO, WHO and UNEP. London, E & FN Spon, 1996.

The information used in the discussion regarding water governance (Question 4 of the *Drinking Water Quality Assessment*) was adapted from: David B. Brooks, In *Focus: WATER Local-level Management*. IDRC, 2002. Available online: <http://www.idrc.ca/water>. IDRC ID#21857

Resources for Chapter Three: Water

Capacity Building for Integrated Water Resources Management <http://www.cap-net.org/> Cap-Net is an international network for capacity building in integrated water resource management. It is made up of a partnership of autonomous international, regional and national institutions and networks committed to capacity building in the water sector.

Department of Water and Sanitation in Developing Countries <http://www.sandec.ch/> SANDEC's mandate is to assist in developing appropriate and sustainable water and sanitation concepts and technologies adapted to the different physical and socio-economic conditions prevailing in developing countries.

Life Water Canada <http://www.lifewater.ca/> is a non-profit organization training & equipping the rural poor in Africa to drill wells and build washrooms.

Inter-American Water Resources Network <http://www.iwrn.net/> IWRN is a network of networks whose purpose is to build and strengthen water resources partnerships among nations, organizations, and individuals; to promote education and the open exchange of information and technical expertise; and to enhance communication, cooperation, collaboration and financial commitment to integrated water and land resources management within the context of environmental and economic sustainability in the Americas.

UNICEF: United Nations' Children's Fund

<http://www.unicef.org> internet page contains technical and educational resources regarding water quality and hygiene.

Water Supply and Sanitation Collaborative Council (WSSCC) <http://www.wash-cc.org/> By UN mandate, the Council seeks to accelerate the achievement of sustainable sanitation, hygiene and water services to all people, with special attention to the unserved poor through: advocacy and awareness raising campaigns, and facilitating concerted action programmes focused at improved sanitation and hygiene service delivery.

Water, Engineering, and Development Centre (WEDC) <http://wedc.lboro.ac.uk/> is one of the world's leading institutions concerned with education, training, research, and consultancy relating to the planning, provision, and management of infrastructure for development. Their internet site provides access to numerous documents regarding safe water handling.

WaterAid <http://www.wateraid.org.uk/> is an international non governmental organisation dedicated exclusively to the provision of safe domestic water, sanitation and hygiene education to the world's poorest people. WaterAid helps local organisations set up low cost, sustainable projects using appropriate technology that can be managed by the community itself.

WELL—Resource Centre Network for Water, Sanitation and Environmental Health <http://www.lboro.ac.uk/well/index.htm> is a resource centre network providing access to information and support in water, sanitation and environmental health for the Department for International Development (DFID) of the British Government.

World Water Council <http://www.worldwatercouncil.org/> mission is 'to promote awareness, build political commitment and trigger action on critical water issues at all levels, including the highest decision-making level, to facilitate the efficient conservation, protection, development, planning, management and use of water in all its dimensions on an environmentally sustainable basis for the benefit of all life on earth.'

Young Water Action Team <http://www.ywat.org/index.html> is a global network of young water professionals and students aged 18-30 with members in more than 40 countries. In partnership with international water organisations, YWAT is creating a network of young people who are dedicated to tackling the world's challenges with water, sanitation and hygiene.

International Water and Sanitation Center (IRC): <http://www.irc.nl> P.O. Box 2869; 2601 CW Delft; The Netherlands. Tel: +31 15 219 2939. News and information, advice, research and training, on low-cost water supply and sanitation in developing countries. Information available in Spanish, including a large library of documents.

World Health Organization Water, Sanitation and Health Division, http://www.who.int/water_sanitation_health/en/. WSH division's aim is the reduction of water and waste related disease and the optimization of the health benefits of sustainable water and waste management, with an objective of assisting citizens to understand and act on the health impacts of their actions. WHO has hundreds of full text manuals available on-line and by order.

Pan American Health Organization (PAHO)

<http://www.paho.org> is the regional division of WHO with contacts and offices present in most countries:

Headquarters (USA): 1-202-974-3000

Cuba- (53-7) 831-0245

Nicaragua-(505) 289-4200

Argentina- (54-11) 4312-5301

Dom. Rep.- (1-809)562-1519

Panama- (507) 212-7800

Bahamas- (1-242) 326-7390

Ecuador- (593-2) 246-0330

Paraguay- (595-21) 450-495

Barbados: (1-246) 426-3860

El Salvador- (503)298-3491

Peru- (51-1) 421-3030

Belize- (501) 224-4885

Guatemala- (011-502) 332-2032

Puerto Rico- (787) 274-7608

Bolivia- (591-2) 241-2303

Guyana- (592) 225-3000

Suriname- (597) 471-676

Brazil- (55-61) 426-9595

Haiti- (509) 260-5700

Trinidad- (1-868) 624-7524

Chile- (56-2) 264-9300

Honduras- (504) 239-0136

Uruguay- (598-2) 707-3590

Colombia- (57-1) 347-8373

Jamaica- (1-876)967-4626

Venezuela- (58-212) 267-1622

Costa Rica- (506) 258-5810

Mexico- (5255) 5089-08-60

Fundacion Sodis para America Latina, Universidad Mayor de San Simon, Cochabamba, Bolivia, Castilla 5783 Telefono (+571) 4 454 2259

www.fundacionsodis.org Fundacion Sodis is a non-profit organisation whose mission is to promote the low-cost and effective Sodis method of water treatment throughout Latin America.

Print Resources

Cassinath, Natasha; R. Garcia; et.al. *Trabajando Juntos: Un manual de campo para trabajar con proyectos de agua.* (2nd Ed.). Red Centroamericana de Manejo de Recursos Hidricos (CARA), 2002. Available from the Universidad Nacional

Autónoma de Nicaragua: (505) 278-6981, or online at <http://www.caragua.org>.

World Health Organization (WHO). *Guidelines for Drinking-water Quality*: 3rd ed. WHO Press, 2004.

WHO. *Health Aspects of Plumbing*. Published jointly by WHO, and World Plumbing Council. WHO Press, 2006.

WHO. *Healthy Villages*. WHO Press, 2002.

Chapter 4

Sanitation and Waste Handling

Overview: Sanitation, Municipal Waste, and Hazardous Waste

Since the dawn of humanity, people have not only consumed the gifts of the Earth, but have also left behind things of their own creation. Important and ubiquitous items left behind include feces and corpses; furthermore, there are broken tools, clothes, vacated dwelling structures, and a whole host of other things that we broadly refer to as ‘waste’. Many of these ‘wastes’ pose significant health hazards to humans, but also to other animals, plants, and entire ecosystems.

In many ways it is unfortunate that we consider these ‘wastes’ as undesirable, as things to simply be disposed of, as a burden, etc. As a consequence of this attitude, humans have had to contrive ways to dispose of their wastes, and these means have generally consisted of concentrating (or collecting/centralizing) the waste into one location and burying it or piling it up. Landfills (i.e. garbage dumps), wastewater treatment plants, cemeteries, etc. are all examples of this response.

Unfortunately, as the human family has grown tremendously in size, this type of response has created numerous catastrophic messes around the globe. Sprawling garbage dumps are plaguing the landscape, they pollute groundwater and surface water, and are breeding grounds for many pests. Sewer systems have been responsible for poisoning the earth’s waters, making them unfit to drink or swim in. Hazardous wastes have been accumulating not only in waters and soils, but also in the living tissue of organisms—including us!

Perhaps the time has come for us to change our attitude into one in which we strive to recognize our ‘wastes’ as the gifts and resources that we naturally produce. A very great percentage of the waste we generate can actually be reused in a variety of ways. It is our challenge to find or create ways to recycle those wastes for which we haven’t currently any use.

In this chapter, three specific areas of waste generation and handling will be examined in depth. Each will be preceded with an introductory

section that provides background information on the topic under discussion. The first assessment deals with your community’s handling of human excreta; the second deals with your handling of the other forms of solid waste that are generated by your community; and finally some attention will be directed to your community’s handling of hazardous materials. The intention of the chapter is for you to assess with what level of respect your community regards its waste, and how ecologically sound your waste handling practices are.

Community Excreta Handling and Sanitation: Introduction

Ecological Sanitation

Sanitation refers to the supply of good-quality drinking water, proper disposal of excreta, hygiene in the preparation of meals, cleanliness in the home, and the collection and final disposal of solid waste. Basically, sanitation consists of our means of protecting ourselves from the inherent dangers of our own excrement, and the feces of other animals.

Sanitation practices, and sanitary habits are very important for the prevention of many diseases and parasitic infections. Parasites are living creatures that feed on other living creatures, causing the host organisms harm in the process. The eggs and larvae of parasites are often very small and are easily ingested. Similarly, many types of harmful bacteria are present in fecal matter that can cause painful and mortal infections, and which can occur quite easily.

‘Sanitation,’ for the purposes of this assessment, refers specifically to your system of handling and managing human excreta. A variety of styles of latrines, flush toilets, and sewer networks are all examples of sanitation technology that is presently used. Ecological, or sustainable sanitation means that all elements of sanitation are in balance, and that the system poses no threat to human health nor to the earth’s health.

Sanitation and Population Explosion: A Deadly Mix?

Unfortunately, sanitation is a critical problem in many places around the world because of rapid population growth and unsuitable technological responses. Sanitary conditions for much of the world's population are not improving despite the enormous suffering caused by poor sanitation.

For as long as the human population was small and dispersed over a large area, sanitation was not such a problem; however, the situation has dramatically changed. The human population is now 1000 times greater than it was 10 000 years ago. Today 2.5 billion people live in urban areas alone. People are living closer and closer together; alternately stated, more and more people are living in the same amount of space.

One consequence of this increasing population density is that we (humans) are putting higher and higher pressure on the environment, especially in the most densely populated regions. The closer together we live, the more important it is for us to have access to, and make use of, good sanitation facilities.

Excreta: Environmental Pollutant and Health Hazard

The failure to properly treat and manage wastewater and excreta is directly responsible for numerous adverse health and environmental effects. Poor sanitation gives rise to high rates of diarrheal diseases, to helminth (parasitic worm) infections like ascariasis and hookworm, and to vector-borne diseases like malaria, dengue fever and Japanese encephalitis. Human excreta has been implicated in the transmission of many other infectious diseases including cholera, typhoid, hepatitis, polio, cryptosporidiosis, and schistosomiasis.

Besides direct contact or ingestion, one of the main pathways of disease is being spread by vectors, or other living creatures. Such creatures—e.g. flies, rats, cockroaches, etc.—are particularly drawn to human excreta; and thus poor sanitary facilities are often the breeding grounds for several such creatures.

Human excreta-transmitted diseases predominantly affect children and the poor. Most of the deaths due to diarrhea occur in children (accounting for nearly two million) and especially occur in the poorest regions. Every year, 2.5

million children die of diarrhea, deaths that could have been prevented by good sanitation: millions more suffer the nutritional, educational, and economic loss through diarrheal disease that improvements in sanitation, especially human excreta management, can prevent.

Overall, the World Health Organization estimates that nearly 3.3 million people die annually from diarrheal diseases, and that a staggering 1.5 billion suffer, at any one time, from parasitic worm infections stemming from human excreta and solid wastes in the environment.

Besides the infectious diseases associated with poor sanitation, the wastewater from sewer systems also creates a host of environmental and health problems. Heavy metals, toxic organic and inorganic substances are also often present in wastewater. These pollutants can also pose serious threats to human health and the environment. Industrial wastewater and 'municipal sludge' (one by-product of sewage treatment which consists of the solids settled out of wastewater) may contain high concentrations of heavy metals such as cadmium, lead, nickel and chromium. Heavy metals concentrate in the tissues of many filter-feeding shellfish, fish, and in some cases terrestrial plants. For this reason, consumers of these products face significant health threats.

Excessive nutrients (primarily nitrogen and phosphorus) in wastewater, sludge, and excreta may contaminate surface waters and cause eutrophication. Eutrophication is a process whereby water bodies, such as lakes, estuaries, or slow-moving streams receive excess nutrients that stimulate excessive plant growth (algae, nuisance plants weeds). This enhanced plant growth, often called an algal bloom, causes other organisms to die. The eutrophication of freshwaters sometimes also causes the growth of toxin-producing cyanobacteria. Toxins produced by cyanobacteria can cause gastroenteritis, liver damage, nervous system impairment, and skin irritation.

Other chemicals such as pharmaceutical residues and potential endocrine disrupting substances have been identified in wastewater and excreta, but the effects of these pollutants have not yet been fully determined.

Sewered Sanitation Technology: Problematic and Unsustainable

In an attempt to deal with the critical problems of sanitation, humans have developed and built

sewerage systems, or networks of underground pipes, which are designed to convey human wastes away from homes to a central outlet point. In theory, a treatment plant is located at the outlet point, ostensibly making the water safe again before being released into the environment. These sewer networks require the use of 'flush' toilets which are basically machines for mixing human urine, faeces and water.

This technology has been considered the safest and most effective means of sanitation, and has been championed by numerous influential organizations and people around the world. Unfortunately humans have discovered that this technology is unsatisfactory, unsustainable, and a source of serious environmental damage.

Although well-intentioned, flush-and-discharge systems compound the problems of sanitation. With these systems a relatively small amount of dangerous material—human faeces—is allowed to pollute a huge amount of water. In spite of this, flush-and-discharge is almost universally regarded as the ideal option for urban areas. Almost without question it is promoted in cities and town around the world, even in the poorest regions where people cannot afford it and in arid areas where there is hardly enough water for drinking.

This preference for flush-and-discharge is based on a number of assumptions:

1. that the problem is one of 'sewage disposal'
2. that fresh water is an unlimited resource
3. that at the end of the pipe the sewage is treated
4. that the environment can take care of the discharge from the treatment plant

However, none of these assumptions is correct.

The basic problem is the disposal of human feces and urine, not 'sewage'.

A human body does not produce 'sewage'. Sewage is the product of a particular technology. The human body produces urine and feces. These are often referred to as 'human excreta' but it is important to remember that they are in fact two different substances which leave the body through separate openings and in different directions. Each person produces about 500 litres of urine and 50 litres of feces per year. Fifty litres of feces should not be too difficult to manage. It is not a very pleasant product and may contain pathogenic organisms. But the volume is small: when dehydrated it is actually no more than a bucketful per person per year.

The real problem is that in the flush-and-discharge system feces are not handled on their own. They are mixed with urine. This means that instead of 50 litres of a heavily polluted substance we have to take care of 550 polluted, dangerous and extremely unpleasant litres. One of the reasons behind the unpleasantness of the mixture of urine and feces is that feces contain a bacterium, *Micrococcus ureae*, which when mixed with urine produces a very unpleasant smell.

Outright shortage of water is often a major problem for Latin American cities.

A flush system does not work without water. To flush away the 550 litres of feces and urine in a sewer toilet each person uses about 15,000 litres of pure water every year. In most cities in the world there is nowhere near enough water to provide that amount for each of its inhabitants. The typical response is to provide flush-and-discharge only to the rich, which of course means that there is even less water available to the poor.

Globally, some 80 countries with 40 per cent of the world's population are already suffering from water shortages at some time during the year. Chronic freshwater shortages are expected by the end of the decade in much of Africa, the Middle East, northern China, parts of India and Mexico, the western United States, northeastern Brazil and in the former Soviet Central Asian republics. China alone has 300 cities facing serious water shortages.

Only a tiny fraction of all sewage produced in Latin America is treated.

A very high percentage of all sewage in Latin America is discharged completely untreated into surface waters. Many cities do not have any sewage treatment system at all, and of those that do, most serve only a small fraction of the population. Estimates suggest that less than 5% of all sewage in Latin America receives any treatment before it is discharged into the environment.

Even where there is treatment, the vast majority of sewage treatment technologies in use today still contribute significant amounts of pollutants to the environment. Even modern treatment facilities usually do not cope with phosphates and nitrates. Nor are treatment plants designed to detoxify chemical wastes. Primary treatment simply filters out floating and suspended material; secondary treatment facilitates the biological degradation of feces and urine and other similar material; and

disinfection destroys infectious organisms. Most of the industrial and household toxic wastes released into sewers are either discharged into receiving waters, or remain in the sludge.

In addition to pathological pollution, other pollutants found in sewer effluent are heavy metals and possible toxic household substances. Heavy metals include copper, zinc, cadmium, nickel, chromium and lead. The content and concentration are dependent on the pipe materials employed to convey drinking water, household cleaning agents used, and, for stormwater, the type of materials used for roofing and guttering. Toxic materials may also be disposed with household wastewater. In high enough concentrations these heavy metals are toxic to bacteria, plants and animals, and to people.

All over the world we can find examples of natural ecosystems destroyed by the discharge of untreated or partly treated sewage.

In the past it was a common assumption that the pollution which results from conventional sanitation technologies can be safely assimilated by the environment. This assumption is not correct. Some chemicals will decompose and be removed by natural processes, but most will remain in the environment.

The inevitable end products of a sewage system are polluted waters and toxic sludge. The four conventional sludge disposal methods are ocean dumping, landfilling, incineration and application on agricultural land. From an environmental point of view all these methods are unacceptable and from all over the world we have reports of the degradation of the environment due to sewage discharge and sludge disposal.

Thus, conventional sanitation in the form of sewer flush-and-discharge offers no solution to the global sanitation crisis. A different approach to sanitation is needed.

Sustainable Approach to Sanitation, and this Assessment

Environmentally sound practices in wastewater and stormwater management are practices that ensure that public health and environmental quality are protected. A range of technologies exist that can achieve this objective. Nevertheless, more effort must be extended towards finding sustainable approaches for reducing health hazards associated with wastewater, sludge and excreta,

and at the same time, closing the nutrient cycle and protecting limited fresh water sources and the environment.

The purpose of the following assessment is to help guide you in evaluating the state of your community's sanitation practices, with the view of molding your community's practices into sustainable, ecological sanitation. In addition to this assessment, refer to the 'Drinking Water Quality and Source Protection Assessment' in Chapter 3 to evaluate water supply sanitation, and to the other two assessments in this chapter to further evaluate your community's waste handling practices.

Community Excreta Handling and Sanitation: Inventory

1. Mix or No-Mix

Considering your sanitation facilities (latrines, lavatory, etc), does your community combine or release feces and urine into the same receptacle (a 'no-mix' facility keeps the urine and fecal matter separate)?

Mix / No-Mix

2. Soil conditions

One of the most important environmental factors to consider in your choice of excreta disposal is the depth of the water table in your area. The 'water table' refers to the underground depth at which freshwater is found.

1) Rate the permeability or porosity of the soil in your area:

1 2 3 4 5 6 7 8 9
stone or clay / humus / sand

2) What is the depth to the water table in your location (meters):

(can be estimated by determining the depth of local wells or boreholes)

3. Characteristics of Sanitation System:

Identify which of the following apply to your community's sanitation system, or method of handling human excreta:

- Open air (no sanitation facility)
- Overhung Latrine (directly into surface water)
- Bucket Cartage
- Shallow Pit/Trench
- Borehole Latrines
- Other (specify):
- Pit Latrine (simple covered)
- Pit Latrine (ventilated)
- Pit Latrine (raised)
- Aquaprivy
- Pour Flush
- Full Flush
- Composting toilet

1) Does your sanitation system include the use of plumbing?

Yes / No

If Yes then complete the following questions:

Is there someone in the community responsible for the maintenance of the community sanitary plumbing?

Name of person responsible:

Inspect the system's integrity. Is all plumbing free of leaks?

Yes / No

Identify the location of any leaks:

Do all toilets include a vapor lock, or 'drain trap' to prevent the backflow of gases?

Yes / No

Is there a protocol in place for reporting problems?

Yes / No

Describe the protocol:

2) Identify if your sanitation system includes any of the following components:

- septic tank
- soakaway
- drainage field
- vault
- not applicable

3) Does your sanitation system require periodic emptying?

Yes / No

What method is used:

- Manual shoveling
- Pump

- Vacuum truck

How often is emptying performed?

Who does it?

If the service requires a fee, how much does it cost ?

If known, how is the removed excreta disposed of?

4. Resource Recovery

What form(s) of resource recovery does your community use to utilize excreta? Indicate all that apply

- Compost solid waste
- Excreta-fed fish pond
- Use of urine to water plants
- Biogas digester
- Other (specify):
- None

5. Sewer Network

Does your community release its excreta into a wastewater sewer network, or other system of plumbing that is designed to operate with flush water?

Yes / No

If Yes then complete the following questions:

Is your community's sewer system:

- Conventional (i.e. deep): consists of house connections routed to main pipes that run along streets. System requires pipes, inspection manholes, pumps and pumping stations
- Simplified (i.e. shallow, a.k.a condominium): similar to deep sewerage, except that houses or individual connections are made to each other, rather than to a the main line. The shared connector pipes are smaller in diameter and do not need to be buried as deep
- Settled (a.k.a small bore): sewer system includes interceptor tanks, which are settlement tanks, and they require periodic emptying. In them, solids that can potentially sediment in the sewerage pipes are removed

Rate the quality or reliability of your sewer network (i.e. how often does it have major leaks or get clogged):

0 1 2 3 4 5 6 7 8 9
poor.....excellent

Listening To The Earth

Who is the party responsible for the administration, maintenance, and alteration of your community's sewer network?

- collective/ cooperative/ neighborhood
- municipality/ municipal government
- your religious community (owned/operated by your religious community itself)
- corporate entity, or other business
- not organized

If applicable, how do you contact this party?

Name of responsible party:

Contact person:

Contact information:

Does your community share in this management responsibility?

Yes / No

If so, in what way?

6. Waste Water Treatment

Does your community's sewer system include a waste water treatment process?

Yes / No

If Yes then complete the following questions:

Who is responsible for the operational decisions of the waste water treatment plant, if other than the party responsible for the sewer network, and how are they contacted?

Name of responsible party:

Contact person:

Contact information:

From what source(s) does the waste water treatment facility receive sewage flow?

- Purely residential sources
- Industrial sources
- Commercial agricultural
- Mining operations

- Urban run-off (land drainage)
- Other (specify):

What treatments (if any) are used at the facility?

- Preliminary:** this includes simple processes such as screening and grit removal to remove the gross solid pollution residue from the process:
- Primary:** usually plain sedimentation; simple settlement of the solid material in sewage can reduce the polluting load by significant amounts residue from the process:
- Secondary:** for further treatment and removal of common pollutants, usually by a biological process residue from the process:
- Tertiary:** usually for removal of specific pollutants e.g. nitrogen or phosphorous, or specific industrial pollutants residue from the process:

How are the residues disposed of?

Into what body of water, or onto what land does the facility discharge its effluent (or processed wastewater)?

What pollutant(s) does the effluent contain?

- Chemical (specify):
- Nutritional (esp. phosphorous and/or nitrogen) (specify):
- Biological (pathogens) (specify):

Expert Environmental Information Source

It would be helpful to contact an environmental protection or advocacy group that can provide reliable, expert data on the ecological impacts of your sanitation system. If you don't know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Name of organization:

Name of contact person:

Contact information:

According to these experts, what are the observed environmental effects of the sanitation practices of your area?

What, in their opinion, is the best step that your community could make to improve the sanitation problems in your area?

Expert Public Health Information Source

It would be helpful to contact a public health protection or advocacy group that can provide reliable, expert data on the *health effects* of your sanitation system. If you don't know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Name of organization:

Name of contact person:

Contact information:

According to these experts, what are the observed environmental effects of the sanitation practices of your area?

What, in their opinion, is the best step that your community could make to improve the sanitation problems in your area?

7. Hygiene Behavior

Are the facilities (latrine, toilet, etc) that your community uses kept clean (i.e. cleaned regularly) and free of fecal matter and other refuse?

Yes / No

If the toilet is located outdoors, is the door kept shut and the inside kept dark when not in use?

Yes / No

Is the toilet and areas surrounding it regularly sanitized?

Yes / No

Is the toilet area kept free of trash ?

Yes / No

Is a handwashing station (with soap) near the toilet?

Yes / No

Are the facilities within a convenient walking distance, and the path well-marked?

Yes / No

8. General Sanitation Practices

Does your community include expenses related to excreta handling (sewer fees, operational, maintenance, or improvement capital) as part of its regular budget?

Yes / No

Does your community educate itself and others in the larger community about both dangers and best practices pertaining to sanitation?

Yes / No

Does your community educate others about the productive and beneficial uses of excreta?

Yes / No

Community Excreta Handling and Sanitation: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

1. Mix or No-Mix

To meet the requirement of ecological sanitation we must have ecological toilets. 'No-mix' systems, if properly maintained, are ecological. By not mixing human excreta and flushing water the sanitation problem is limited to managing a comparatively small volume of urine and faeces. As a result, the problems of bad odours and fly-breeding are reduced or even eliminated, and storage, treatment and transport are made easier. A

lot of water can be saved, expenditure on pipe networks and treatment plants is reduced, jobs are created and the environment is preserved.

If your community has 'mix' type facilities, you may consider switching to a 'no-mix' system, especially if you presently use some type of pit latrine, or utilize some other on-site treatment. Composting latrines are perhaps the most ecologically sound device for handling excreta. There is a brief discussion of them later, under question 3 (see 'J' in the table below), and more information may be obtained about them from resources listed at the end of this chapter.

If on the other hand your community is connected to a sewer system, a conversion may not be immediately feasible nor appropriate. It may be more important in such a case to work at a regional level to help innovate alternative practices that both conserve water and take advantage of the useful qualities of urine and feces.

2. Soil Conditions

The conditions of the land in your community are the most important factors to consider in evaluating or choosing the method of excreta disposal. For example, if your soil is impermeable or the water table high, then it may be necessary to use a vault or a raised pit latrine rather than any other form of pit latrine or septic system. It is recommended that you complete the water supply sanitation inventories found in Chapter 3 to determine more about your community's protection of water resources.

If the conditions of the soil and groundwater of your area are unknown, it would be most advisable to contact a geological service, organization, or associated government agency to request that testing be performed. Some of the resources at the end of this chapter may be able to help direct you to an appropriate agency.

In any case, you should verify, with the help of qualified professionals, that your means of sanitation does not contaminate the water that you or anyone in your larger community uses as a source of drinking water.

Our community's sanitation facilities are an appropriate option for the prevailing soil and water conditions.

1 2 3 4 5 6 7 8 9

3. General Characteristics of Sanitation System

Evaluation statements for 3-3iii are found on page 101

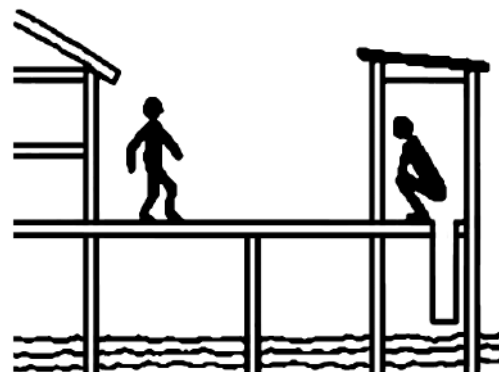
A. Open Air Defecation

Where there are no latrines people resort to defecation in the open. This may be indiscriminate or in special places for defecation generally accepted by the community, such as defecation fields, rubbish and manure heaps, or under trees. Open defecation encourages flies, which spread feces-related diseases. In moist ground the larvae of intestinal worms develop, and feces and larvae may be carried by people and animals. Surface water run-off from places where people have defecated results in water pollution. In view of the health hazards created and the degradation of the environment, open defecation should not be tolerated in villages and other built-up areas. There are better options available that confine excreta in such a way that the cycle of reinfection from excrete-related diseases is broken.

B. Overhung Latrine (direct entry into surface water)

A latrine built over the sea, a river, or other body of water into which excreta drops directly, is known as an overhung latrine. If there is a strong current in the water the excreta is carried away. Public should be warned of the danger to health resulting from contact with or use of water into which excreta has been discharged.

An overhung latrine usually consists of a superstructure and floor built over water. A squat hole in the floor allows excreta to fall into the water. A chute is sometimes provided from the floor to the water. Overhung latrines should never be built in places where pit latrines can be provided. However, they may be the only possible form of sanitation for people living on land that is



Overhung latrine

continuously or seasonally covered with water.

Despite the serious dangers inherent to this method, overhung latrines might be acceptable provided all the following conditions are met:

1. The receiving water is of sufficient salinity all year round to prevent human consumption.
2. The latrine is installed over water that is sufficiently deep to ensure that the bed is never exposed during low tide or the dry season.
3. The walkways, piers, squatting openings, and superstructures are made structurally safe for adults and children.
4. The excreta is not deposited in still water or into water that will be used for recreation.

While an overhung latrine may be the only feasible system for communities living over water, there are serious health risks that must be considered whenever this is the current practice.

C. Bucket Cartage/Latrine

Cartage is perhaps the most basic form of excreta disposal. Here, feces are collected in a container and disposed of daily. An example is the bucket latrine, in which household wastes are collected in buckets under a hole in the floor of a specific room. Each day, the bucket is emptied into a larger container and the contents disposed of. In practice this type of disposal may be designed as either a 'mix' type or a 'no-mix' type facility.

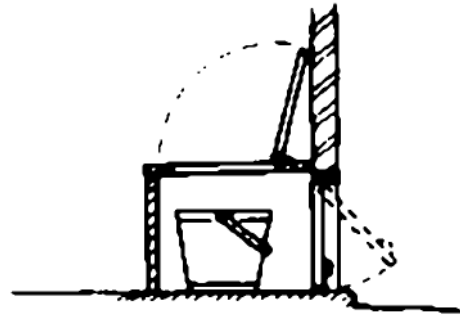
Bucket latrines pose health risks to both users and collectors and may spread disease. The number of bucket latrines is declining rapidly in favor of similar facilities which pose fewer health risks. For example, a vault latrine (a latrine where wastes are stored in a sealed container) that is mechanically emptied on a regular basis is often a more sanitary yet affordable choice.

Operation and maintenance:

A container made of non-corrosive material is placed beneath a squatting slab or seat in the bucket chamber, with rear doors which should be kept shut except during removal and replacement of the bucket. The bucket chamber should be cleaned whenever the bucket is removed.

The squat hole should be covered by a flyproof cover when not in use. The cover of the seat should be hinged and the cover of the squatting slab should have a long handle.

At regular intervals (preferably each night) the container should be removed and replaced by a clean one. Full containers should be taken to depots or transfer stations, or composting facility



Bucket latrine

where they are emptied, washed and disinfected with a phenol or cresol type of disinfectant. In some towns it is the practice to provide two buckets painted in different colors for each latrine. Containers should be kept covered with tight-fitting lids while in transit and the waste handling personnel should be provided with full protective clothing. Also, for health reasons, waste handlers should be educated in and practice proper hygienic behaviors. Defective buckets should be repaired or replaced and transport vehicles should be kept in good order.

It is quite possible with bucket cartage to have a 'no-mix' system. In some cartage systems, urine is diverted away from the buckets to reduce the volume to be dealt with. It is usually channelled to soakpits, but may be collected separately and used directly as fertilizer. However, water that is used for washing latrines and bucket-chambers should be handled with caution. It should pass to or be deposited into soakpits, and should not be allowed to pollute the ground around the latrines.

The practice of dumping nightsoil indiscriminately into streams or onto open land is a very poor practice for both environmental and health reasons.

D. Shallow Pit/Trench

People working on farms may dig a small hole each time they defecate and then cover the faeces with soil. This is sometimes known as the 'cat' method. Pits about 300 mm deep may be used for several weeks. Excavated soil is heaped beside the pit and some is put over the faeces after each use. Decomposition in shallow pits is rapid because of the large bacterial population in the topsoil, but flies breed in large numbers and hookworm larvae spread around the holes. Hookworm larvae can migrate upwards from excrete buried less than 1 m deep, to penetrate the soles of the feet of subsequent users.

E. Borehole Latrine

Borehole latrines are generally 'mix' type facilities which are most convenient for emergency or short term use. They can be prepared rapidly in great numbers, and light portable slabs may be used; however, there are several problems inherent to borehole latrines.

Borehole latrines have an augered hole which may be sunk to a depth of 10m or more, although a depth of 4-6m is usual. Augered holes, 300-500 mm in diameter, are dug quickly by hand or by machine in areas where the soil is firm, stable and free from rocks or large stones.

While a small diameter may be easy to bore, the life of the pit is very short. Furthermore, the small diameter of boreholes increases the likelihood of blockage, and the depth of an augered hole significantly increases the danger of groundwater contamination.

In addition, the sides of the hole easily become soiled near the top, making fly infestation probable. For this reason, holes should be lined for at least the top half-metre or so with an impervious material such as concrete or baked clay.

Particularly because of the danger to ground water, but also because of the difficulties in their operation, boreholes should only be used if no other sanitation facilities exist.

F. Pit Latrines (general)

The basic principle of all types of pit latrine is that wastes such as excreta, anal cleaning materials, sullage and refuse are deposited into a hole in the ground. Pit latrines may be either 'mix' or 'no-mix' systems. The liquids percolate into the surrounding soil and the organic material

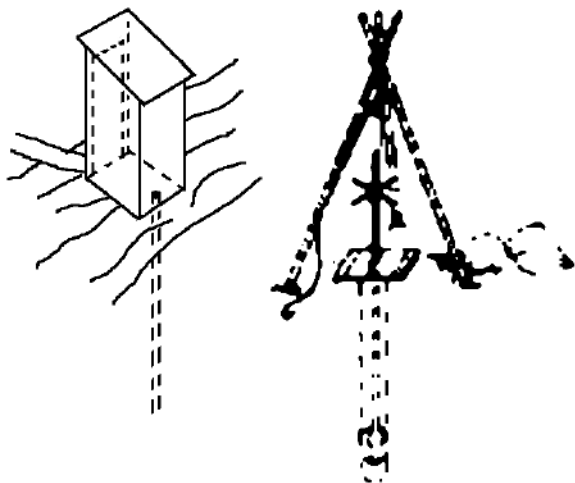
decomposes, thereby producing:

- gases such as carbon dioxide and methane, which are either collected, liberated to the atmosphere, or dispersed into the surrounding soil
- liquids, which percolate into the surrounding soil
- a decomposed and consolidated residue

The health benefits and convenience of pit latrines depend upon the quality of the design, construction and maintenance. At worst, pit latrines that are poorly designed, constructed and maintained provide foci for the transmission of disease and may be no better than indiscriminate defecation. At best, they provide a standard of sanitation that is at least as good as other more sophisticated methods.

In most pit latrine systems, fecal matter is stored in a pit and left to decompose. If the fecal matter is left to decompose in dry conditions for at least two years, the contents can be safely emptied manually, and the pit reused. Indeed, some pit latrines are designed to allow fecal matter to compost and be reused in agriculture. On the other hand, unless specifically designed, pit latrines do not require periodic emptying; once a pit is full it can simply be sealed and a new pit dug.

There is an enormous variety of styles of pit latrines. Some designs use one pit, others use two alternating pits, reducing the need for new pits. Some pit designs are meant to be completely dry, while some use small quantities of water. Ventilation to remove odors and flies is incorporated into certain designs, while others are very basic and use traditional materials and approaches. There are three pit designs covered in more depth below: *Simple Pit, Ventilated Pit, Raised Pit.*



Borehole latrine

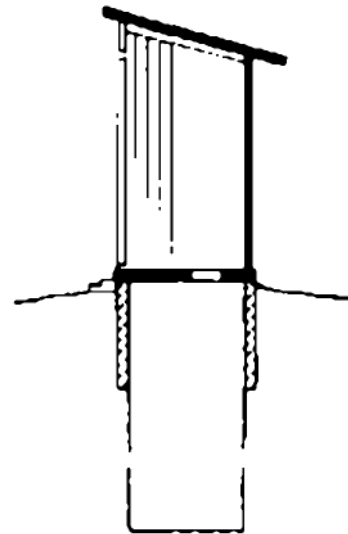
Operation and Maintenance of a Pit Latrine

The operation of pit latrines is quite simple and consists in regularly cleaning the slab with water (and a little disinfectant if available) to remove any excreta and urine. The door must always be closed when not in use so the superstructure can remain dark inside. The drop hole should never be covered as this would impede the airflow (if latrine is ventilated). Appropriate anal cleaning materials should be available in or near the latrine. Stones, glass, plastic, rags, and other non-biodegradable materials should not be thrown in the pit as they reduce the effective volume of the pit and hinder mechanical emptying.

Regular Inspections

- Rainwater should drain away from the latrine. Improper drainage should be corrected.
- Every month the floor slab has to be checked for cracks and, if applicable, the vent pipe and fly screen must be inspected to ensure they are not corroded or damaged. In addition, the superstructure should be inspected and repair undertaken, especially in the case of light leaks (toilet structure should be dark when door is fully closed).
- When the contents of the pit reach the level of 0.5 metre below the slab, a new pit has to be dug and the old pit covered with soil. Another possibility is to empty the pit mechanically. With double-pit systems, the second pit is used when the first is full. The full pit can be emptied safely by hand after a period of a year or longer and is then ready for use again.

In the case of pit latrines with double pits, each facility has two shallow pits, but only one superstructure. The cover slab has two drop holes, one over each pit. Only one pit is used at a time. When this becomes full, its drop hole is covered and the second pit is used. After a period of, at the very least, one year—but most safely two years—the contents of the first pit can be removed safely

*Simple pit*

and used as soil conditioner. The pit can be used again when the second pit has filled up. This alternating cycle can be repeated indefinitely.

At least one person in your community should be educated about aspects of pit latrine sanitation such as the reasons for using only one pit at a time, use of excreta as manure, and the need to leave the full pit for about two years before emptying. This person also needs to know how to switch pits and how to empty the pit, even if they do not perform these tasks themselves.

Operational and Maintenance Requirements and Schedule for Pit Latrines

<i>Activity</i>	<i>Frequency</i>	<i>Materials and spare parts</i>	<i>Tools and equipment</i>
Clean drop hole, seat and superstructure	Daily	Water, soap	Brush, bucket
Inspect floor slab. Inspect vent pipe and fly screen if equipped	Monthly		
Clean fly screen and vent inside if equipped	Every one to six months	Water	Twig or long bendable brush
Repair slab, seat, vent pipe, fly screen or superstructure	Occasionally	Cement, sand, water, nails, local building materials	Bucket or bowl, saw, trowel, hammer, knife
Dig new pit and transfer latrine slab and superstructure (if applicable)	Depending on size and number of users	Sand, possibly cement, bricks, nails and other local building materials	Shovels, picks, saw buckets, hammer, etc.
Switch to other pit when pit is full (if applicable)	Depending on size and number of users		Shovels, buckets, wheelbarrow, etc.

Source: IRC and WHO, 2000

Frequent problems

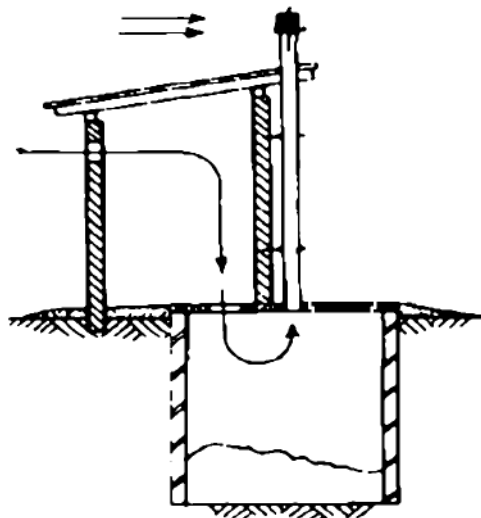
Contamination of groundwater can easily occur if the pit is dug either too deep or too close to groundwater sources. Pits should not reach groundwater level and latrines must be 15 to 30 meters away from ground and surface water sources. Poor quality of the floor slab due to inappropriate materials or improper curing of concrete. Inferior quality fly screens get damaged easily by the effects of solar radiation and foul gases. Improperly sited latrines can get flooded or undermined. Children may be afraid to use the latrine because of the dark or because of fear of falling into the pit. Leakages between pits can occur because the dividing wall is not impermeable or the soil is too permeable.

Simple Pit

This consists of a slab over a pit which may be 2 m or more in depth. The slab should be firmly supported on all sides and raised above the surrounding ground so that surface water cannot enter the pit. If the sides of the pit are liable to collapse they should be lined. A squat hole in the slab or a seat must be present so that the excrete fall directly into the pit.

Ventilated Pit

Ventilated improved pit (VIP) latrines are designed to reduce two problems frequently encountered by traditional latrine systems—smells and flies or other insects. A VIP latrine differs from a traditional latrine in having a vent pipe covered with a fly screen. Wind blowing across the top of the vent pipe creates a flow of air which sucks out



Ventilated pit

the foul-smelling gases from the pit. As a result, fresh air is drawn into the pit through the drop hole and the superstructure is kept free from smells. The vent pipe also has an important role to play in fly control. Flies are attracted to light and if the latrine is suitably dark inside, they will fly up the vent pipe to the light. They cannot escape because of the fly screen, so they are trapped at the top of the pipe until they dehydrate and die. Female flies, searching for an egg-laying site, are attracted by the odors from the vent pipe but are prevented from flying down the pipe by the fly screen at its top.

If the superstructure allows too much light to come in, flies will be attracted by the light coming through the squat hole and may fly out into the superstructure; this may jeopardize the whole VIP concept. Odor problems may occur during the night and early morning hours in latrines relying more on solar radiation for the air flow in the vent pipe than on wind speed.

Raised Pit

In hard soils it may be impossible to dig a proper pit. One way of dealing with this, and other difficult ground conditions is to construct raised pit latrines. The pit is excavated as deep as possible, working at the end of the dry season in areas of high groundwater. The lining is extended above ground level until the desired pit volume is achieved.

If the pit extends more than 1.5 m below the ground there will probably be sufficient leaching area below ground for a pit latrine having a full depth of 3.5 m. In such cases, the lining above ground should be sealed by plastering both sides. The minimum below-ground depth depends on the amount of water used in the pit and the permeability of the soil. Where insufficient infiltration area can be obtained below ground level, the raised portion of the pit can be surrounded by a mound of soil. The section of the lining above ground (excluding the top 0.5 m) can be used for infiltration provided the mound is made of permeable soil, well compacted with a stable side slope, and is thick enough to prevent filtrate seeping out of the sides. Earth mounds are not recommended on clay soils as the filtrate is likely to seep out at the base of the mound rather than infiltrate the ground.

Raised pits can be used in combination with any other type of pit latrine (VIP, pour-flush, double-pit). A common application is where the

groundwater level is close to the surface. A slight raising of the pit may prevent splashing of the user or blockage of the pit inlet pipe by floating scum.

G. Aqua-privy

An aqua-privy is a 'mix' type latrine set directly above or directly adjacent to a septic (collection and sedimentation) tank and is useful in situations where plumbing is required, but there is a limited water supply. An aqua-privy is similar to a septic tank; it can be connected to flush toilets and take most household wastewater. It consists of a large tank with a water seal which is connected to a soakaway to dispose of effluent. Unlike a septic tank, the aqua-privy tank is located directly below the house; but like a septic tank, it requires periodic emptying and must be accessible to a vacuum tanker. Since much of the technology is the same or similar, see the discussion below under 3ii regarding septic tanks and leach beds to more fully assess the maintenance and operation of your aqua-privy system.

Aqua-privies are expensive and require the use of water, making them a rather unattractive option for communities short of money or water. Since water is required, water conservation principles should be practiced. See the 'Water Conservation Assessment' in Chapter 3, for more information regarding water conservation.

The tank will produce hazardous and malodorous gases that should be vented and trapped in such a way that no gases escape up through the latrine. Furthermore, the tank can become a breeding ground for flies, mosquitoes, and other vector insects if they are not prevented from entering (or exiting) the tank. For these reasons, a necessary feature of an aqua-privy is some form of water seal. Often this seal is formed by the chute drop-pipe hanging below the squat hole or latrine seat and into the water. As long as the end of the pipe is submerged, this design prevents gases from escaping into the latrine superstructure, and it limits (but does not eliminate) the access of flies and mosquitoes to the tank. It should be noted that water must be added each day to maintain the water seal to compensate for evaporation and effluent discharge.

Alternatively, the toilet may be fitted with a pan with a water seal to prevent the escape of gases. If the latrine is offset from or adjacent to the tank, the water seal can be accomplished with the use of a drain trap ('U' or 'J' section of pipe).

Since an aqua privy is necessarily a 'mix' type

system, more ecologically sound sanitation options do exist. Nevertheless, the feasibility and importance of changing your sanitation system is for your community to decide.

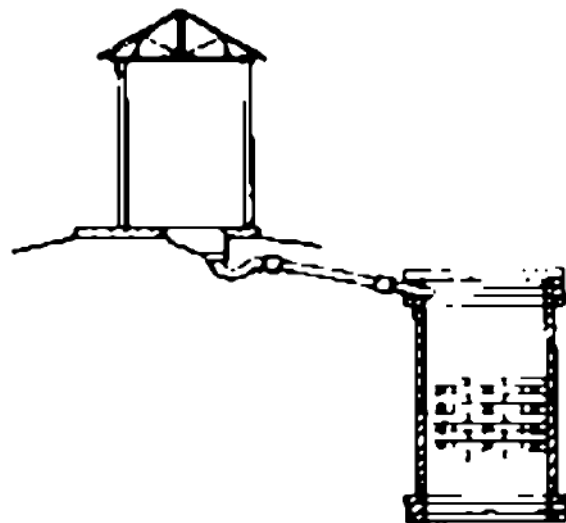
H. Pour-flush latrines

A pour-flush latrine is a 'mix' type of pit latrine where small volumes of water (commonly 1-3 litres) are used to flush feces into the pit. The operation and maintenance of pit latrines is covered in more depth above under the heading 'Pit latrines (general).'

Pour-flush latrines are most appropriate where people use water to clean themselves after defecating (e.g. in Muslim cultures) and where people have access to reliable water supplies close to the home. However, pour-flush latrines are also attractive because the problems of flies, mosquitos and odors in simple pit latrines may be overcome simply and cheaply by the installation of a pan with a water seal in the defecating hole. The pan is cleared by pouring (or, better, throwing) a few litres of water into the pan after defecation.

The flushed wastes flow through a section of pipe bent into a 'U' or 'J' shape which maintains a water seal for reducing fly and odor problems. The pit of a pour-flush latrine may be located directly beneath the slab or set to one side, but offset pits may require more water to prevent blockages. The pit is usually connected to a soakaway to allow liquids to infiltrate the soil, leaving solid waste to decompose.

The amount of water used varies between one and four litres depending mainly on the pan and trap geometry. Pans requiring a small amount of



Pour-flush latrine

water for flushing have the added advantage of reducing the risk of groundwater pollution.

The flushing water does not have to be clean. Especially if access to clean water is limited, laundry, bathing or any other similar water should be used.

Solid materials should not be disposed of into pour-flush latrines, as this could block the pipe and even cause it to break. In addition, efforts to clear blockages often result in damage to the water seal. There is a likelihood of blockage if solid materials such as hard paper, corncobs, material used by menstruating women are put in the pan. Such materials should be disposed of separately, but careful attention must be given to the handling of the waste and sterilizing of the container.

Since the pour-flush design is necessarily a 'mix' type facility, more ecologically sound options exist, and may be feasible depending upon priorities of your community.

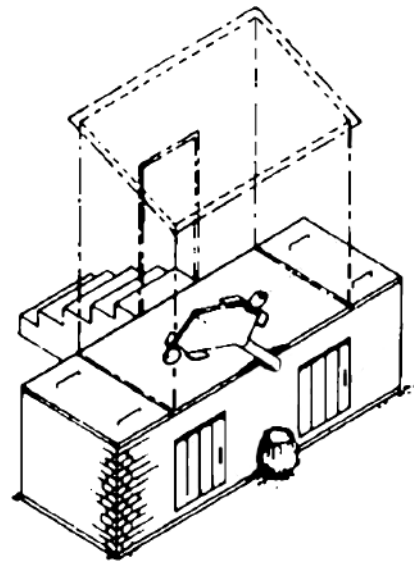
I. Full Flush

A full flush latrine is a 'mix' type system, and it implies the use of a running water system (piped water distribution). Refer to the 'Water Conservation Assessment,' Chapter 3, in this manual for water conservation practices.

A full flush system also requires either a septic system with sufficiently large capacity, or a connection to a piped sewer network. Refer below to Section 3i regarding plumbing; Section 3ii is applicable if your community has a septic system; and Section 4 applies if you are connected to a sewer system.

J. Composting Toilet

A composting latrine is most generally a 'no-mix' facility in which urine is kept separate and excrement falls into a watertight tank to which ash or vegetable matter is added. If the moisture content and chemical balance are controlled, the mixture will decompose to form a good soil conditioner in about four months. Pathogens are killed in the dry alkaline compost, which can be removed for application to the land as a fertilizer. There are two types of composting latrine: in one, compost is produced continuously, and in the other, two containers are used to produce it in batches. In general, most instances of composting toilets are of the double-vault design, and so the operational and maintenance requirements for the more common double-vault design are covered in depth here.



Composting latrine

Besides providing a reusable resource, the double-vault latrine has the added advantage that it can be built anywhere. Since the vault contents are kept dry, there is no pollution of the surrounding ground, even if the vault is buried. In rocky areas or where the water table is high the vaults may be built above ground. Double-vault latrines are successfully used in Guatemala, Honduras, Nicaragua, El Salvador, and many other places around the world.

Operation and maintenance

The double-vault composting latrine consists of two watertight chambers (vaults) to collect feces. Urine is collected separately as the contents of the vault have to be kept relatively dry.

The two chambers or vaults are used alternately. Initially a layer of about 100 mm of absorbent organic material such as dry earth is put in the bottom of one vault, which is then used for defecation. After each use, the feces are covered with wood ash or similar material to deodorize the decomposing faeces and soak up excess moisture.

When the vault is three-quarters full, the contents are levelled with a stick and the vault is completely filled with dry powdered earth. The squat hole is then sealed. While the contents of the first vault are decomposing anaerobically, the second vault is used. When the second tank is full, the first one is emptied through a door near the bottom and the chamber is reused. The contents may be used as a soil conditioner.

Each vault should be large enough to hold at least two years' accumulation of wastes so that

most pathogenic organisms die off before the compost is removed.

Normally the superstructure is built over both vaults, with a squat hole over each vault. A cover sealed with lime mortar or clay should be fitted in the squat hole above the chamber not in use. A flyproof lid should be placed on the other hole when it is not being used for defecation. Fly-proof vent pipes may be provided to avoid odor nuisance in the latrine, although covering the feces with ash is reported to be sufficient to eliminate bad smells.

Control of the moisture content is vital for proper operation of the latrine. Consequently, composting latrines are not appropriate where water is used for anal cleaning. It is usual to collect urine separately, dilute it with 3-6 parts of water and use it as a fertilizer (although this may cause a health hazard).

Some latrines are constructed with soakpits below the vaults so that excess moisture can drain into the ground. This allows for the disposal of urine into the vaults but with consequent loss of a valuable fertilizer and possible pollution of the groundwater. Wood ash, straw, sawdust, grass cuttings, vegetable wastes and other organic material must be put into vaults to control moisture content and improve the quality of the

final compost.

If insects are a problem in the toilet, growing insect-repelling plants like citronella around the latrine may help.

It is important that someone (at least one) in your community knows and understands the process of the composting toilet, as improper use poses sanitary risks.

3i. Characteristics of Sanitation System: Plumbing

Several types of 'wet' or 'mix' sanitation facilities require some type of plumbing, or pipes used to conduct excreta from the toilet to either the sewer system or the collection tank. Flush water is needed to help move the excreta through the pipes. The amount of water used should be minimized in the interests of conserving water, but enough must be used to prevent clogging.

For community safety, all plumbing should be intact and without leaks. Leaks or clogs should be repaired immediately. If there are leaks in the piping, the contaminated water that leaks should be contained and the area sanitized as soon as possible. The leaked water should not be allowed to accumulate, as the water may contain pathogens

Operational and Maintenance Tasks for Double Vault Composting Toilet

<i>Activity</i>	<i>Frequency</i>	<i>Materials and spare parts</i>	<i>Tools and equipment</i>
Clean toilet and super-structure, empty urine collection pot	Daily	Water, lime, ashes	Brush, water container
Add ashes or other organic material	After each defecation and whenever available	Wood ashes and organic material	Pot to contain the material, small shovel
Inspect floor, super-structure and vaults	Monthly		
Repair floor, super-structure or vaults	When necessary	Cement, sand, water, nails, local building materials	Bucket or bowl, trowel, saw, hammer, knife
Close full vault after levelling and adding soil, empty other vault, open its squat hole and add absorbent organic material before starting to use, store humus (or use directly)	Depending on size and number of users	Water, absorbent organic material	Shovel and bucket
Use humus as fertilizer	When needed	Humus	Shovel, bucket, wheelbarrow

Source: IRC and WHO, 2000

and may attract insects that can spread diseases. It is greatly advantageous if the person doing the repairs is at least somewhat experienced in plumbing, and thus it is recommended that there be a person in your community that is charged with maintaining the plumbing system. This person should be responsible for receiving reports of leaks and executing the repairs necessary.

All openings in the plumbing (e.g. a toilet, a sink, or any drain) should have 'drain traps,' that are U-shaped sections of pipe, installed near the opening. These traps form a water seal in the pipe that prevents gases from escaping into the air. These traps are commonly the location of obstructions, and so should be the first place checked if a clog is detected.

3ii. Characteristics of Sanitation System: Components

Septic Tank

A septic tank is a form of on-site sanitation that is usually linked to flush toilets and can receive domestic wastewater (or sullage). It is designed to hold solids and is linked to a soakaway/leach bed or small-bore sewer to dispose of liquid waste, or effluent. The tank is offset from the dwelling structures and linked to the toilet and domestic wastewater by a short drain.

If your community has a septic system and piped water, water conservation principles should be practiced (see Chapter 3).

Septic tanks generally require relatively large amounts of land and periodic emptying by vacuum tankers. This makes a septic system expensive, and further requires that trucks are afforded easy access to the tank. It is important that your community include these expenses in the regular budget.

Operation and Maintenance

Septic tanks and aqua-privies have a water-tight settling tank with one or two compartments, to which waste is carried by water flushing down a pipe connected to the toilet. These systems do not dispose of wastes; they only help to separate the solid matter from the liquid. The systems need a means to discharge their liquid effluent, a means to vent gases released, and they also require some form of seal that prevents gases from backing up into the latrines or other drains.

In the case of an aqua-privy, there is a tank immediately under the latrine and excreta drop directly into the tank through a pipe submerged in

the liquid layer. The seal is formed because the pipe is submerged. In this case, then, a minimum liquid level must be maintained.

The amount of liquid in the tank should be kept high enough to keep the bottom of the drop pipe at least 75 mm below the liquid level. A bucket of water should be poured down the drop pipe daily in order to clear scum (in which flies may breed) from the bottom of the drop pipe and to maintain the water seal.

In other cases, the tank is located away from the latrine, and thus require the use of a 'U'-trap to prevent gases from backing up.

The tank collects and digests solid waste. Some of the solids float on the surface, where they are known as scum, while others sink to the bottom where they are broken down by bacteria to form a deposit called sludge. The sludge accumulating in the tank must be removed regularly, usually once every 1–5 years, depending on size, number of users and kind of use.

Routine inspection is necessary to check whether desludging is needed, and to ensure that there are no blockages at the inlet or outlet. A tank needs to be desludged when the sludge and scum occupy the volume specified in the design. A simple rule is to desludge when solids occupy between one-half and two-thirds of the total depth between the water level and the bottom of the tank. Desludging is essential because septic tanks *will continue to operate even when the tank is almost full of solids*—in this situation the in-flow scours a channel through the sludge and may pass through the tank in a matter of minutes rather than remaining in the tank for the required retention time.

When a septic tank is desludged it should not be fully washed out or disinfected. A small amount of sludge should be left in the tank to ensure continuing rapid digestion. Regular cleaning of the toilet with soap in normal amounts is unlikely to be harmful, but the use of large amounts of detergents or chemicals may disturb the biochemical process in a tank, especially the use of chlorine bleach.

The liquid effluent flowing out of the tank is, from a health point of view, as dangerous as raw sewage and remains to be disposed of, normally by soaking into the ground through a soakaway (leach bed) or with a connection to small-bore sewers. When sullage disposal is also in the tank, a larger capacity is required for both the tank and the liquid effluent disposal system. Connection to

small-bore sewers may then be a necessity—where high groundwater tables or rocky, impermeable ground exist, this may also be the case.

Many problems are due to inadequate consideration being given to liquid effluent disposal. Large surges of flow entering the tank may cause a temporarily high concentration of suspended solids in the effluent due to disturbance of the solids which have already settled out. Leaking tanks may cause insect and odor problems in aqua-privies because the water seal is not maintained.

Every tank must have a ventilation system to allow escape (or collection) of explosive methane and malodorous gases (generated when bacteria decompose some of the sewage constituents) from the tank.

Leach bed/Soakaway/Drainage field

Most septic systems drain their effluent into underground water-absorption channels of various designs. The most common examples of this technology are called leach beds, soakaways, and drainage fields. Drainage fields consist of gravel-filled underground trenches called leachlines or

drainage trenches, into which the liquid effluents coming from a septic tank are led through open-jointed (stoneware) or perforated (PVC) pipes, allowing the effluents to infiltrate into the ground. Soakaways and leach beds are similar but are of a smaller scale, and can handle less effluent.

Due to the hazardous nature of the liquid effluent that they handle, these drainage areas must be sufficiently deep and must lie within soil that is sufficiently absorbent to prevent the liquids from seeping up from the ground. Furthermore, the risk of contaminating groundwater is high, and this fact must be taken into consideration, particularly if wells exist nearby.

Operation and Maintenance

It is important to regularly clean the septic tank outflow and other integral plumbing and check if it is still in order. The plumbing must occasionally be cleaned to clear accumulated deposits.

Initially the infiltration into the ground may be high, but after several years the soil clogs and an equilibrium infiltration rate is reached. If the sewage flow exceeds the equilibrium rate of the soil, eventually the sewage will surface over the

Table: Maintenance Requirements for Septic Systems

Activity	Frequency	Human resources	Materials and spare parts	Tools and equipment
Clean squatting pan or seat and shelter	Daily	Household	Water	Brush, water container
Unblock U-trap when blocked	Occasionally	Household	Water	Flexible brush or other flexible material
Inspect if entry pipe is still submerged (for aqua-privies)	Regularly	Household		
Inspect floor, squatting pan or seat and U-trap	Monthly	Household		
Repair squatting pan or seat, U-trap or shelter	Occasionally	Household or local artisan	Cement, sand, water, nails, local building materials	Bucket or bowl, trowel, saw, hammer, knife
Control vents	Annually	Household	Rope or wire, screen material, pipe parts	Scissors or wire-cutting tool, pliers, saw
Empty tank	Every 1-5 years	Service crew	Water, fuel, lubricants, etc.	Vacuum tanker (large or mini) or MAPET equipment, if possible

Source: IRC and WHO, 2000

drainage field. As a good practice, then, an area of land equal to the size of the drainage area should be kept in reserve for possible extension or replacement of the drain field if it becomes clogged.

The area over the waste water absorption area should have a good cover of grass or other shallow-rooted vegetation. Control plant growth to prevent the roots from entering the pipes or trenches. Don't plant trees or shrubs near the leaching bed. Such deeply rooted plants have roots that will travel significant distances to reach water and will invade the drainage channels and thus impede or sabotage their function.

Good ventilation of the area and adequate sunlight should also be maintained to promote evaporation. This means that you should avoid constructing parking areas, patios, or structures over the area. The weight of such constructions could crush the pipe in the leaching bed preventing it from working properly. Covering the drainage area could also prevent oxygen from getting into the soil.

The micro-organisms responsible for digesting the waste material need oxygen to survive and function. Vehicles and machinery should not be driven over the bed, as their weight could crush the pipe or compact the soil. If the soil over the pipes becomes compacted, it will be less able to absorb the wastewater.

It is also important not to dispose of water onto the ground over the area—it may interfere with the

ability of the soil to absorb liquids and break down waste.

Vault

In areas where the groundwater level is high, the use of septic tanks and drainage areas is not suitable since such systems are likely to contaminate the groundwater. In these areas, watertight tanks called vaults can be built under or close to latrines to store excrete until they are removed by hand (using buckets or similar receptacles) or by vacuum tanker. Similarly, household sewage may be stored in larger tanks called cesspits, which are usually emptied by vacuum tankers. Vaults or cesspits must be emptied when they are nearly full, or on a regular basis.

There must be a water seal between the vault and any drains or latrines to prevent the backflow of gases. Generally this is accomplished with a 'U'-shaped section of plumbing pipe being positioned near each drain.

Vaults should be checked on a regular basis (at least each time they are emptied) for structural integrity. There should be no cracks, holes, or faulty seams. Vaults must also be regularly checked to determine whether desludging is needed and to ensure that no blockages exist at the inlet.

Regular emptying is required, and thus there must be space enough for a truck or other equipment to access the vault. This is a regular expense which should be included in the regular budget.

Table: Maintenance Requirements for a Drainage Field

<i>Activity</i>	<i>Frequency</i>	<i>Human resources</i>	<i>Materials and spare parts</i>	<i>Tools and equipment</i>
Control plant growth	Regularly	Household or caretaker		Shovel, bucket, panga etc.
Switch to other drainage field	Once every 6-12 months	Household or caretaker	Bricks or other material to block pipes	Tools to open diversion box
De-block delivery pipe	Occasionally	Household, caretaker or local artisan	Water, piece of pipe, glue	Brush, shovel, long stick or flexible brush, knife, saw
Clean diversion boxes	Every month	Household or caretaker	Water	Shovel, brush
Check, outflow of tank and clean	Once a month	Household or caretaker	Water	Brush, tools to open access hole

Source: IRC and WHO, 2000

3iii. Characteristics of Sanitation System: Emptying

The emptying of single pits containing fresh excreta presents problems because of the active pathogens in the sludge. In rural areas, where land availability is not a constraint, it is often advisable to dig another pit for a new latrine. The original pit may then be left for several years and when the second is filled it may be simplest to re-dig the first pit rather than to excavate a new hole in hard ground. If left for years, the sludge will not cause any health problems and is beneficial as a fertilizer.

However, in urban areas, where it is not possible to excavate further holes and where the investment in pit-lining and superstructure has been substantial, the pit must be emptied. Since the sludge removed from a pit presents a risk of transmission of diseases, care must be taken to ensure that sludge is not spilled around the tank during emptying. Thus, the most satisfactory method of sludge removal is by vacuum tanker. The sludge is pumped out of the pit or tank through a flexible hose connected to a vacuum pump, which lifts the sludge into the tanker. If the bottom layers of sludge have cemented together they can be jetted with a water hose or broken up with a long-handled spade before being pumped out. There are also high-powered vacuum trucks that can handle solidified sludge; however, their use is considerably more expensive.

Although from the public health point of view, manual removal should be avoided, if a vacuum tanker is not available, the sludge must be bailed out manually using buckets or shovels. This is unpleasant work which exposes the workers and the community to health hazards. Careful work and disposal is therefore necessary.

Emptying pits may also pose these problems:

- The machinery may be too large to get to the latrines. Conventional vacuum trucks are too big to be driven into the centre of many ancient cities or urban/periurban unplanned or squatter settlements where pedestrian routes predominate.
- Maintenance of vacuum tankers is often poor. Their engines must be kept running all day, either to move the truck or to operate the pump when stationary. This causes rapid wear and makes them particularly susceptible to breakdown if preventive maintenance is neglected. In addition, these vehicles add considerable amounts of pollution to the air.

Refer to Chapter 2 for more information about outdoor air pollution.

- Management and supervision of emptying services is often ineffective, leading to poor work practices which expose the workers and the public to health hazards.

Evaluation of Sanitation Facilities (3-3iii)

Our community is well-informed about the service requirements of our sanitation systems.

1 2 3 4 5 6 7 8 9

Our community regularly implements all necessary operational and maintenance protocols required for sustainable operation of our sanitation system.

1 2 3 4 5 6 7 8 9

Our community strives to minimize the amount of water used by our sanitation system (e.g. by choosing not to mix, fixing leaks, etc.)

1 2 3 4 5 6 7 8 9

Our community takes every necessary precaution to prevent contamination of ground and/or surface waters by our sanitation system.

1 2 3 4 5 6 7 8 9

4. Resource Recovery

Human excrete and urine can be regarded as natural resources to be conserved and reused provided they are handled with respect, rather than being discarded. Especially if your sanitation facilities are of the 'no-mix' type, the 'wastes' can be transformed into very nutritious food for the earth, for plants, and for particular types of fisheries; in addition, the decomposition process can release gas that is useful as fuel.

Urine and feces are both quite beneficial to plants. Urine contains nitrogen and phosphates in forms that are easily absorbed by plants; as well, human excrete, or 'nightsoil' contains nitrogen, phosphorus and potassium, all of which are valuable plant nutrients. Human excreta can also be used in an aquatic environment to stimulate the growth of particular fish for consumption.

On the other hand, handling raw excreta is not only very unpleasant because of odors, but also it is considerably hazardous to human health. The pathogens that live within the excreta pose serious dangers to us as humans. The main risk is

infection, and this can be by any number of bacteria, parasites, viruses, or other pathogenic organisms that are present in excreta. Fortunately, the knowledge and techniques exist which allow us to transform raw excreta into safer, more pleasant, and useful substances.

Caution should be taken, and good hygiene practiced, when handling nightsoil—processed, decomposed or otherwise—from any source.

Before your community reuses sludge, health officials should be consulted about the minimum time for sludge decomposition. If possible, the quality of the sludge should occasionally be tested. However, testing for microorganisms such as protozoa and helminths is expensive, and it may be more effective to use retention time to judge whether the sludge will be safe to use.

When organic material sits and ages, nature decomposes the material, or breaks it down into more elemental substances. The process of decomposition may be aerobic (requiring oxygen) or anaerobic (not requiring oxygen).

Depending upon the product desired, you can control the conditions to encourage one form of decomposition over the other. In either case, nightsoil or sludge is generally first combined with other organic wastes. The mixture is then placed into controlled conditions either: by ventilating the mixture to stimulate aerobic digestion (composting); or by placing the mixture into an airtight chamber to stimulate anaerobic digestion. Aerobic digestion produces compost, or humus, and is discussed below under the heading 'Composting.' Anaerobic decomposition processes produce a significant amount of methane, or natural gas, making it useful as a renewable source of fuel. This process is discussed below under 'Biogas Production.'

Successful composting will completely sterilize the mixture; however, while anaerobic digestion does kill most pathogens, it will not necessarily kill hookworm and roundworm eggs.

The use of excreta as an aquatic fertilizer is also discussed below under 'Aqua-culture.'

Composting

Solid waste (sludge) from pit latrines and sewage-treatment plants can be a valuable resource for farmers as an organic fertilizer and soil conditioner, provided that it has been allowed to properly decompose and contains no pathogens. Solids from a pit latrine should be innocuous if the latrine has not been used for two years or so; although this

time is longer if the pit has been wet. However, this time interval can be decreased if the decomposition of the feces is accelerated, and the temperature of the pile increased—which is what is accomplished by composting.

Composting consists of the biological breakdown of solid organic matter into a soil-like substance called compost or humus. Compost is quite valuable as a fertilizer and soil conditioner. Composting has been practiced by farmers and gardeners throughout the world for many centuries. Besides nitrogen, phosphorous, and potassium, the humus formed by decomposed feces also contains trace elements which reduce the susceptibility of plants to parasites and diseases. The humus improves the soil structure, enhances its water-retaining qualities and encourages better root structure of plants. Soil containing humus is less subject to erosion by wind and water and is easier to cultivate. In China, the practice of composting human wastes with crop residues has enabled the soil to support high population densities without loss of fertility for more than 4000 years. Composting is a beneficial way of giving back to the Earth what we have taken in the form of food.

Composting can accelerate the decay process and sterilize the excreta, but to do so requires careful attention and the process must be controlled by someone who understands it. If performed correctly, however, the process generates enough heat to eradicate most and sometimes all pathogens, and simultaneously eliminates disagreeable odors.

Composting Process

Aerobic bacteria combine some of the carbon in organic matter (excreta mixed with plant materials) with oxygen from the air to produce carbon dioxide and energy. Some energy is used by the bacteria to reproduce; the rest, however, is converted to heat, often raising the temperature to more than 70°C. No objectionable odor should given off if the material is not saturated with water and is frequently turned.

For optimum value to plants, the ratio of available carbon to nitrogen in compost should be about 20:1. In the composting process carbon is used by the bacteria, so the best raw material for composting has a higher carbon:nitrogen ratio, say about 30:1. The carbon: nitrogen ratio of nightsoil is about 6:1, of fresh vegetable waste around 20:1, and of dry straw over 100:1. Thus, by

appropriately adjusting the mixture, the most optimum balance can be achieved. It is rarely practical to determine the carbon:nitrogen ratio by chemical analysis; a good operator learns to judge what mix of materials will produce the best compost.

Absence of an unpleasant smell and absence of flies also indicate satisfactory aerobic composting. An experienced operator can check that all is well from the appearance of the composting material. It should look moist, but not so wet that liquid seeps out. While aerobic stabilization is progressing the appearance will change from day to day. During composting the volume is reduced by 40-80% and the weight by 20-50%.

The key to successful sterilization is to raise the temperature of the mixture sufficiently high to kill any pathogens. At high temperatures there is rapid destruction of pathogenic bacteria and protozoa, worm eggs and weed seeds. All fecal microorganisms, including enteric viruses and roundworm eggs, will die if the temperature exceeds 46 °C for one week. Fly eggs, larvae and pupae are also killed at these temperature.

Tests of compost during and after stabilization show whether the process is going well and whether the finished product is suitable for agricultural use. Except in a large mechanical composting plant, the condition of the compost is gauged by simple methods. It is reasonable to assume that pathogenic organisms will be killed if the temperature rises above 65°C. This can be confirmed by poking an iron bar or wooden stick into the heap and pulling it out after about ten minutes. It should then be too hot to hold. The temperature falls when stabilization is complete.

Once stable, the mixture has been aerobically digested and has become humus and poses far slighter health risks.

Biogas Production

The search for alternative sources of energy has led to widespread use of organic waste to produce a combustible fuel which can be used for domestic cooking. Basically, biogas production requires an air-tight chamber in which excreta are fermented. The gas produced contains about 60% methane, also known as natural gas. The 'biogas' is collected at the top of the chamber, from which a pipe leads to domestic appliances or to flexible storage containers.

A few biogas plants operate entirely on human excreta. For example, in Patna, India a 24-seat

pour-flush latrine serves several thousand people and generates sufficient energy to light a 4-km length of road. However, most plants, of which there are more than 7 million in China (Li, 1984), are dependent on animal excreta with which human excreta are processed. A medium-sized buffalo or cow provides about twenty times as much gas as a person. The minimum feed is that from one cow and a family of people, although it is more usual to add excreta from at least four cows. In China it is customary to produce biogas from the excreta of pigs.

Excreta are often mixed with straw or other vegetable waste, such as that used for animal bedding, and equal quantities of water added to make a slurry. This is fed to the inlet side of the chamber. Effluent slurry is removed after a retention time of 30-50 days. Biogas production is greater at higher temperatures; for example, at 30°C the rate of gas generation is about twice that at 25°C, and little gas is produced if the temperature is below 15°C.

After processing, the effluent slurry can be dried in the open and used as a fertilizer.

Retention of excreta in biogas tanks results in the death of many pathogens, including *Schistosoma* eggs. A few hookworm eggs survive, and there is high survival of roundworm eggs. Thus, proper care must be taken when handling the effluent from the process.

Use in Aquaculture

The practice of depositing excreta into fish ponds or tanks is also a common practice in some areas. In some places, latrines are placed immediately over or alongside ponds (not used for drinking water); elsewhere nightsoil is tipped from carts, tankers or buckets. Nutrients in excreta result in a rich algal growth, which encourages aerobic conditions and provides food for certain fish.

Carp and tilapia are especially suitable for such ponds, but a variety of fish species may coexist, some feeding on large algae, some on small algae, some on zooplankton; some prefer the bottom layer, some the top. Fish are usually netted for human consumption, but in some places they are dried and ground up for feed for poultry or animals. Ducks may also be kept on the ponds.

There are three health risks associated with fish farming in ponds that receive excreta:

- Pathogens may be transmitted on the body surfaces or in the intestines of the fish without causing overt disease in the fish; the pathogens

- may then be passed to people handling the fish.
- Helminths, particularly flukes, may be transmitted to people who eat infected fish that has not been properly cooked.
 - Helminths with intermediate hosts (such as *Schistosoma* with water snails) may continue their life cycle in ponds.

(The WHO publication, 'Guidelines for the Safe Use of Wastewater and Excreta in Agriculture and Aquaculture,' gives further useful information about utilizing this natural resource. Further information may be found about using excreta as a resource at the end of this chapter. In addition, several of the general resources found in the back of this manual contain technical and educational material regarding biogas digestion, composting, and aquaculture.)

Our community strives to recover the useful value of our excreta.

1 2 3 4 5 6 7 8 9

5. Sewer Network

Sewerage systems are designed to collect excreta and domestic wastewater and transport them away from homes to a treatment and/or disposal point. Sewer systems are an attractive option because they can greatly improve the sanitary conditions of a household while requiring little maintenance for proper operation. Nevertheless, such flush-and-discharge systems make the problems of sanitation much worse, as they allow relatively small amounts of material to pollute large amounts of water.

All sewerage systems require water for flushing waste away. Conventional sewerage requires the most. It is also a high-cost sanitation option; it is usually deep-laid and must be maintained by professional staff. A small bore sewer works on different principles from conventional sewerage systems, and does not require high-volume flush toilets to operate. Nevertheless, these still require water for proper function.

All sewerage systems should end in a treatment process or plant, as the raw faeces they carry represent a significant public health risk.

In any sewerage system, care should especially be taken to not dispose of hazardous or toxic chemicals into the sewer drains. Such chemicals could be medicines, pesticides and herbicides which are no longer used, excess solvents, paints and other household chemicals. These substances can corrode sewer pipes and seriously affect operation of treatment plants. They will also limit the potential of water reuse, and therefore should

not be disposed with household wastewater. Refer to the last assessment in this chapter to evaluate your community's handling of hazardous chemicals and wastes.

Conventional Deep and Shallow (Condominium) Sewerage

These systems require a great deal of capital to build and maintain. Similarly, they require that a large, relatively continuous volume of water flow through the system to function properly. Shallow sewerage is a bit less capital intensive, but still requires 'full flush' toilets to keep the system from clogging.

If your community has such a sewer connection, it is important to ascertain that each drain is protected from receiving dry waste (i.e. screens and drain covers) and that all toilets are functioning correctly. No sewer gas or odors should be present near any drain. All pipes should have sealed threads and should not have any holes, cracks, or other leaks. If your community is responsible for underground sewer pipes that are on the property, these should be checked for leaks or stoppages on a regular basis.

Small Bore/Settled Sewerage

Small-bore (or 'settled') sewerage is a system that is designed to receive only the liquid fraction of household wastewater. The small-bore sewer system consists of a house connection, an interceptor tank, sewers, cleanouts/manholes, vents, sewage treatment plant, and lift stations (if there is no gravity flow). The system is most appropriate in areas that already have septic tanks but where the soil cannot (or can no longer) absorb the effluent, or where land-use is so great that there is no room for soakaways.

The solid components of the waste, which settle, are kept in an interceptor tank (basically a single-compartment septic tank) which needs periodic desludging. Because the sewers only receive the liquid sewage, they are designed differently from conventional sewers and have the following advantages:

- the system needs less water because solids are not transported;
- excavation costs are reduced because the pipes can be laid at shallow depths and do not need to maintain self-cleansing velocity;
- material costs are reduced because the diameter of the pipes can be small (peak flow is attenuated by the interceptor tanks) and there

is no need for large manholes;

- treatment requirements are reduced because the solids are kept in the interceptor tanks.

The main operational requirement for the community is to ensure that no solids can enter the system and that the interceptor tank functions properly. Maintenance of the system requires regular removal of the sludge from the interceptor tank; this regular expense should be included in your community's main budget.

Systemic maintenance tasks may also include the removal of blockages, regular control of sewage pipes, and periodic flushing. The performance of accessories in the pipeline system such as cleanouts, manholes, (possible) lift stations, and ventilation points should be regularly checked and maintained (although these tasks are generally the responsibility of the body in the larger community which is responsible for the operation of the system).

Party Responsible for Sewerage

If your community does not process its own wastewater, it is important that you be aware of the group who is responsible for the maintenance and administration of your sewer network. Since sewage is both an environmental and health hazard, it would be helpful to assess the integrity of your local sewerage system by contacting the party responsible for its operation.

You should also be prepared to contact them if your community discovers a leak or a blockage in the system. Furthermore, your community can serve the larger community by being involved in the workings of the sewerage system: as administrative help, as a source of ideas for improvement, or in a variety of other ways.

Our community regularly implements all necessary operational and maintenance protocols required for sustainable operation of our sewer system.

1 2 3 4 5 6 7 8 9

Our sewer system is managed with good governance principles, that reflect our community values.

1 2 3 4 5 6 7 8 9

6. Wastewater Treatment

All sewerage systems should end at a wastewater treatment facility so that surface water and groundwater sources are not contaminated and communities are not exposed to health risks from

untreated sewage. Unfortunately, this is not always the case, and far too often the raw sewage ends up being dumped straight into waterways. This practice wreaks havoc on both the wildlife and human populations that depend upon the downstream water. Thus, it would be helpful to determine if your local sewage is treated before being released back into the environment.

It is common practice in many areas to release sewage into the environment, untreated, as a means of agriculture irrigation. Unfortunately, this practice is quite unacceptable. *The use of untreated wastewater in agriculture or aquaculture poses high health risks to farmers and consumers alike. In the interests of public health, only treated wastewater should ever be reused.* Poor irrigation practices with untreated or partially treated wastewater severely impact the quality and safety of groundwater in shallow aquifers and surface waters that may supply drinking water.

If your community's sewage is treated before being released, this process may be overseen by the same party that is responsible for the sewerage system, but it need not be. Thus, begin by determining who the party responsible for wastewater treatment is. By contacting them, you should be able to determine the strengths and limitations of the treatment process.

Treated wastes should not contain pathogens (bacteria, viruses, helminths or protozoa). Properly operated sewage-treatment plants should produce treated effluent of good enough quality for use in irrigation or fish-breeding ponds. The operator of the sewage-treatment plant or the local health body should carry out regular monitoring to ensure that the quality of the treated effluent is safe. You should be able to obtain the results of such tests, if they are performed.

Of primary importance is the microbial quality of any sewage effluent. That is, the microscopic pathogenic organisms pose the greatest danger to public health.

Nutrient pollution is also a major concern; that is, the organic content of the wastewater greatly increases the nutrients available to aquatic plants. This causes overgrowth conditions which choke other life from the water. This process is called *eutrophication* and is signified by an explosion of algae populations, often called an 'algae bloom.'

Chemical contamination is also a consideration. Industrial effluent may contain chemicals harmful to health or the environment, such as heavy metals. If industrial sewage is mixed with domestic

sewage, the resultant effluent is a highly toxic mix, and is considerably more difficult to treat. Industrial discharges should be pretreated by the industry itself to prevent toxic chemicals from entering any treatment facility—or worse, from being released untreated into the environment. Sometimes untreated sewage is used to irrigate fields. Although this is quite a hazardous practice in itself, the inclusion of hazardous chemicals in the effluent poses additional health risks to consumers, and the repeated application of solid or liquid wastes to fields will cause chemical build-up in soils, leading to long-term problems for water resources.

Wastewater treatment can be accomplished either through high-cost ‘conventional’ treatment systems, through a series of waste stabilization ponds (or lagoons), or a combination of methods. In addition, there are some other rather experimental methods of treatment, like deep well injection, but they are unrefined and won’t be discussed further. (There is little that is ‘conventional’ about the highly technical and expensive means of sewage treatment labeled as such, aside from the fact these processes have been the favored responses of scientists and engineers in places like the United States and Europe for several decades now.)

Below, conventional and stabilization pond methods are each briefly reviewed.

‘Conventional’ Sewage Treatment

While the Earth has a natural purification process, the natural purification capacity of the environment is limited. For example, even when wastewater is disposed into the ocean, the area surrounding the outfall can be sufficiently polluted and the pollutants (including pathogens) can be washed towards the beaches. Thus, technical processes have been developed to theoretically augment and accelerate the natural purification process.

Conventional water treatment technologies include physical, chemical and biological processes which function to remove pathogens and pollutants from the water. These processes are somewhat akin to the purification and recycling processes taking place in nature, although they generally produce concentrated hazardous residues that are not produced by nature (at least in concentrated form). Nevertheless, properly designed, constructed, maintained and operated, these

technologies can achieve protection of public health and the environment, and can recycle water and nutrients, which are beneficial to sustaining ecosystems and life.

There are a variety of such treatment processes, and the selection of them depends on the types of pollutants found in the wastewater. Sewage treatment options may be classified into groups of processes according to the function they perform and their complexity:

- Preliminary treatment: this includes simple processes such as screening (usually by bar screens) and grit removal. (through constant velocity channels) to remove the gross solid pollution.
- Primary treatment: usually plain sedimentation; simple settlement of the solid material in sewage can reduce the polluting load by significant amounts.
- Secondary treatment: for further treatment and removal of common pollutants, usually by a biological process.
- Tertiary treatment: usually for removal of specific pollutants e.g. nitrogen or phosphorous. In lakes and sensitive water environments the removal of nutrients should be undertaken with a tertiary treatment process to prevent algae blooms and eutrophication.

Stabilization Ponds

Waste stabilization ponds require more land, but are cheaper, easier to operate and maintain, and need fewer trained staff than other treatment systems. The final water from waste stabilization ponds can be very good if the ponds are properly maintained, as wetlands are nature’s time-tested and preferred method of purifying wastes and recycling nutrients.

Without proper maintenance, however, the quality of the final effluent may be poor and still pose considerable risks to health if it is used for irrigation. Thus, it is most important that the operators of the ponds are well educated as to the proper operation of the ponds and the biological processing occurring within them.

In usual configurations, sewage flows through a series of ponds where the solid and liquid wastes undergo natural breakdown processes, including microbial activity.

Usually, at least two ponds are used, and more commonly three. The ponds must be constructed to a size that can handle the volume of wastewater

brought in by the sewer system by retaining it long enough for purification.

Wastewater in stabilization ponds tends to have a high organic content and can serve as breeding sites for *Culex* mosquitoes that transmit lymphatic filariasis and other infections. The ponds should therefore be sited well away from human habitation, at least beyond the flying distance of the mosquitoes (over a kilometre with wind assistance).

Health and Environmental Impacts of Wastewater Pollutants

- Pathogens (bacteria, viruses, protozoa) can cause life-threatening infections in humans and other wildlife, both directly and indirectly through insects.
- Toxic compounds and elements (organic compounds from pesticides and industrial processes, heavy metals from metal finishing, tanning, etc.) may cause cancers, birth defects, miscarriages, and damage to various organs.
- Suspended solids may increase the cost of water treatment, reduce the attractiveness of water bodies, and inhibit the growth of aquatic plant and animal life.
- Nitrogen at high concentrations may cause methemoglobinemia.
- Nitrogen, phosphorus, and high BOD (biological oxygen demand) wastes may cause oxygen depletion in water bodies and consequent damage to aquatic life.

Our sewage is treated sufficiently to release zero pollution into the environment.

1 2 3 4 5 6 7 8 9

7. Hygienic Behaviors

While having sanitation facilities is the most important element of safely dealing with human excreta, it is not the only requirement. Your community should also keep the facilities hygienic by regularly cleaning and sanitizing them, so that refuse and fecal matter are not able to collect within them. Furthermore, behavioral protocols like keeping the door shut (if an outdoor facility), and washing hands after each use are both important to ensure safe sanitation practices.

If the toilet is allowed to collect waste or the door is left open, pests such as flies and other disease-spreading insects are attracted to the

location and may breed there, causing a health hazard.

Facilities should be located within a reasonable walking distance from common areas, and should be well marked so that their use is encouraged.

Our community models hygienic behaviors by incorporating proper practices into our standard protocols.

1 2 3 4 5 6 7 8 9

8. General Sanitation Practices

Diseases from poor sanitation and hygiene are very common in Latin America, as they are elsewhere—especially in economically disadvantaged areas that have no infrastructure for handling wastewater. Fortunately, most of the danger can be alleviated by changing people’s behaviors where they relate to sanitation and hygiene. Simply incorporating the use of toilets and handwashing has repeatedly reduced disease burdens by significant amounts in many areas. If your larger community is not well educated about hygienic behaviors, perhaps it would be possible for your religious community to conduct educational campaigns. Further information regarding hygiene education can be obtained from the Pan American Health Organization, and other organizations working for public health. Consult the resources listed at the end of this chapter for more information.

The most important thing your community can do is to model sustainable sanitation practices. This means first adequately maintaining the sanitation system that you have, which includes ensuring that financial requirements of the system are met. Beyond that, your community should strive to have the least environmental impact as possible, by conserving water and by not mixing and reusing excrete.

But, perhaps the most important thing that your community can do towards increasing the sustainability of sanitation practices is to get informed, stay informed, and to educate others about sanitation. This means getting to know the local sanitation situation, what the current practices are, what dangers are inherent to the current practices, what other options exist, what alternatives have proven successful elsewhere, and how changes can be effected locally. Performing this assessment is a great first step, but your efforts should not end here. As mentioned in the Introduction to this chapter, current sanitation

Listening To The Earth

practices are tantamount to a global crisis, and alternatives must be created and implemented for a sustainable and healthy human and animal population. In the best case, many communities will engage in this challenge and will create several diverse and creative ways of overcoming this problem.

In general, our community strives to make our sanitation systems ecological and sustainable.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right

score

2 Soil and ground conditions	
3 Community operative knowledge of system	
3 Operation and maintenance of system	
3 Water conservation	
3 Ground and surface water protection	
4 Resource recovery	
5 Sewer: maintenance & operation requirements	
5 Sewer management	
6 Waste water treatment	
7 Hygienic behaviors	
8 Ecological and sustainable sanitation	

Now that you have comprehensively examined your excreta handling and sanitation measures, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Problem 5

Now categorize each problem listed above into one of the following three categories:

I = Critically important. Currently dangerous, must be addressed immediately

II = Important, but not immediately dangerous. Must be addressed

III = Current practice should be improved, but is not immediately needed

Community Solid Waste Management: Assessment

Preserving the Gifts of Garbage

In general, 'waste' is defined as materials or objects that have no use, or that have become dangerous to the humans that own or produce it. 'Solid waste management' refers to the system of practices that either recycles, treats, destroys, or otherwise 'disposes' of waste products, specifically those other than excreta and wastewater. Basically, the 'solid waste' referred to in this section pertains to those items generally considered 'refuse,' 'trash,' 'garbage;' and includes food scraps, textiles, tools, appliances, packaging, etc. Refer to the last section of this chapter for a closer look at handling hazardous materials.

Below is a chart that briefly describes the different types of solid waste typically produced by a Latin American population. ('MSW= municipal solid waste' in column three)

Sustainable solid waste management consists of a series of activities linked with the control of waste generation, segregation, presentation, storage, collection, hauling, sweeping, treatment, and final disposal that are carried out in such a way as to harmonize with the best principles of public health, economy, engineering, and aesthetics and also to meet public expectations. Put simply, sustainable waste management means that we need to produce less waste, recycle as much as we can, and, we must safeguard our environment from damage resulting from waste disposal.

An important aspect to consider about the concept of waste is that it consists of items that have lost their value to one person or group of people. While certainly not always the case, often enough, something that is 'trash' to one person is (or can become) a useful product to another. Since the preservation of God's gifts (i.e. our natural resources) is preferable to wasting them, the heart of a sustainable waste management system should include a network of connections between people and industries that produce 'waste' materials and those that can utilize them.

Unfortunately, most management efforts are not presently able to cope with the tremendous volume of waste produced by humanity today. Compounding this problem is the fact that when different types of wastes are mixed, they lose much of their potential commercial, or recyclable, value.

As a consequence, the mixed wastes usually end up in dumps which are hazards both to the health of local populations, and to nature's ecology. Once in dumps, the poorest of society risk their health by separating, sorting, and selling the 'waste' products of value.

It is in this context that the need to seek effective solutions for waste management and final disposal is an imperative one.

The Inherent Dangers of Solid Waste

The most obvious environmental effect of inadequate solid waste management is the aesthetic deterioration of both urban and rural landscapes. The degradation of the natural landscape caused by uncontrolled waste disposal is increasing. Open dumps and other piles of garbage have become an increasingly common sight throughout Latin America.

On the other hand, the most serious impact on the environment, although perhaps less apparent, is the pollution of surface and ground waters. Water pollution results from solid wastes thrown into surface waters like rivers and seas and also from the leachate produced by the decomposition of solid wastes in open dumps. The pollution of groundwater (also known as the water table or aquifer) calls for special attention since groundwater is often the water source for large populations. Contamination of groundwater should be avoided as it may cause adverse health impacts and/or high treatment costs for restoration.

The disposal of solid waste in surface waters, like rivers and streams causes the death of fish, produces bad odors, and detracts from the natural beauty of the aquatic environment. Such consequences have discouraged the use of surface waters as sources of drinking water, sites for bathing, or for recreation in many regions of Latin America and the Caribbean.

Another important albeit indirect risk is the proliferation of animals that are carriers of micro-organisms, and that transmit diseases to people. These animals, known as vectors, include flies, mosquitoes, rats, and cockroaches. As well as feeding on the solid wastes, the vectors find in the garbage a favorable environment for reproduction and it becomes a breeding ground for the transmission of diseases, from a simple diarrhea to severe cases of typhoid or other more serious illnesses.

Flies

Their reproductive cycle varies according to the temperature. A fly can reach adulthood in 8-20 days and it can fly up to 10 km in 24 hours. It reproduces in moist human and animal excreta (farms, badly built latrines, open defecation, treatment sludge, garbage, etc.). It is estimated that one kilogram of organic matter serves for the reproduction of some 70,000 flies.

Refuse is the main source of reproduction of the housefly, which transmits diseases and is responsible for millions of deaths worldwide. The key to protection against the housefly is, therefore, the proper storage, collection, and final sanitary disposal of garbage in sanitary landfills.

Cockroaches

These insects have existed for 350 million years. Given their extraordinary resistance to most insecticides and ability to adapt to any environment, they are believed to be the only living beings capable of surviving a nuclear war. They live around garbage bins, on kitchen shelves, near the dining room table, and in bathrooms. They feed on wastes and at night they walk on food, and sleeping animals or human beings contaminating them with their vomit and excrement. They transmit more than 70 diseases. Nearly 8% of the human population are allergic to cockroaches and develop serious respiratory diseases when exposed to places frequented by these vermin. Although the cockroach is one of the oldest and most repulsive insects, health and hygiene problems associated with this pest continue to affect us and are even on the increase.

Rats

Rats have accompanied the human species over the centuries, and have always been regarded as one of the world's worst pests. In addition to transmitting serious diseases—eptospirosis, salmonellosis, typhus, bubonic plague, and parasitism—they also attack and bite human beings. Rats may seriously damage the electric and telephone urban infrastructure by peeling and eating the network cables, thereby causing fires. They also contribute to the deterioration and contamination of food. They reproduce quickly; they have from six to twelve pups per litter and a couple of rats may have up to 10 thousand offspring per year.

The Waste Crisis: A Burden Borne by the Poor

The poor management of solid waste is a problem in most cities and small urban communities, but it is a growing problem throughout rural regions as well. The serious problems caused by inadequate solid waste management are common, to a greater or lesser degree, throughout most of Latin America and the Caribbean. Among the many factors aggravating these problems are: rapid population growth and high concentration of the population in urban areas, industrial development, changes in eating habits, and the increased use of packaging materials.

The growth of human settlement and urban density has resulted in increased waste production, such that today greater than 300,000 tons per day are generated by the urban populations of Latin America and the Caribbean.

Activities producing solid waste in Latin America and the Caribbean

<i>Generating activities</i>	<i>Components</i>	<i>% of total MSW</i>
Residential	Kitchen waste, paper and cardboard, plastics, glass, metals, textiles, garden trimmings, soil, etc.	50-75
Commercial: warehouses, offices, markets, restaurants, hotels, and others	Paper, cardboard, plastics, wood, food wastes, glass, metals, special and hazardous wastes	10-20
Institutional: public offices, schools, universities, public services, and others	Similar to commercial	5-15
Industrial (small and cottage industries): manufacturing, clothing and shoe industries, tailor's shops, carpenter's workshops, etc.	Industrial waste, scrap iron, etc. This heading also includes food wastes, ashes, rubble from building and demolition work, and special and hazardous waste	5-30
Street sweeping	Waste left in public areas by pedestrians, dirt, leaves, excreta, etc.	10-20

The economic crises and institutional weaknesses experienced by many governments in the region have also had a negative influence upon waste management. Governments are pressured by their debt obligations to reduce spending on domestic services, while at the same time they are pressured to maintain low tariffs for public cleaning services by the population. In addition, insufficient education on hygiene and sanitation, and a lack of community involvement contribute to a great reluctance on the part of the population to pay for waste management and disposal services. The often poor quality of these services further aggravates the problem. This whole situation places public health at risk, increases the pollution of natural resources, and leads to a deterioration in the life quality of the population.

Unlike the affluent areas wherein regular pick-up services routinely collect household refuse, there are still many neighbourhoods where garbage is not collected. In poor neighborhoods it rots in the streets, thereby providing a breeding site for flies, mosquitoes, rats and other disease-carrying pests, blocks street drains and causes flooding, or it is burned and increases urban air pollution levels. Many of the affected households are located in poor peri-urban communities where municipal trucks cannot enter because streets are too narrow. These populations that have settled on the outskirts of large cities are usually affected by both the absence of a refuse collection service, and the presence of garbage dumps. Open dumps are

generally located in these areas where the poorest members of the community live, compounding the deterioration of all conditions, and in consequence causing property prices to drop, and jeopardizing the development of the town or city.

Of particular note regarding solid waste and the poor, is the case of waste pickers (or informal recyclers) and their families that live in, on, and around the garbage heaps found near urban areas. Because of hard economic conditions and accelerated rural migration, many families struggle to cope by harvesting, utilizing, and selling the resources contained in the waste. These families often live in extremely unsafe and degrading conditions. Aside from the serious risks to their health from the hazardous and medical wastes to which they are exposed, such environments are particularly rife with violence, including fights with knives and guns, as well as traffic accidents. Despite these grave risks, the recycling that they do provides a valuable service to the economy and the environment. Thus, an improvement of their conditions is in the interests of both environmental and social justice.

Final Disposal

The state of final disposal services at the present time in Latin America provides perhaps the most convincing evidence of the inadequacy of the current solid waste management situation in these countries. Only about 60% of the solid waste collected from the principal cities of Latin America

Vector-borne diseases associated with municipal waste

<i>Vectors</i>	<i>Transmission routes</i>	<i>Main diseases</i>	
Rats	Bites, urine, feces Fleas	Bubonic plague Murine typhus Leptospirosis	
Flies	Mechanical route (wings, feet and body)	Typhoid fever Cholera Dysentery	Salmonellosis Amebiasis Giardiasis
Mosquitoes	Female mosquito bites	Malaria Yellow fever Filariasis	Lishmaniasis Dengue
Cockroaches	Mechanical route (wings, feet and body)	Typhoid fever Cholera	Feces Giardiasis
Pigs	Ingestion of contaminated meat	Cysticercosis Trichinosis	Toxoplasmosis Taeniasis
Birds	Feces	Toxoplasmosis	

Source: Departamento de Engenharia Sanitaria e Ambiental, DESA/UPMG

is treated and/or disposed of in accordance with modern technical and public health standards. This corresponds to only about 35% of the total waste generated in the region. The rest normally ends up in unregulated open dumps which fail to meet even the minimum criteria for environmental safety, and which are permanent sources of contamination and health risk. The situation in small and medium-sized cities is worse: rough estimates are that no more than 20% of the waste produced in these municipalities is being treated. Again, it is usually the waste generated by the poorest people which is handled improperly.

Even where controlled landfills do exist, leachates from these landfills are generally allowed to seep unrestricted into the ground, or to flow directly into irrigation ditches or surface streams without any treatment.

Recovery and Recycling

Recovery and recycling are usually not considered to be part of the formal waste management system in Latin America, as they have come to be in some countries, and as such they are still perceived as being completely outside of public or municipal responsibility. In many cases, in an ostensible effort to protect the public's health, these activities have been forbidden and the violators punished, despite the fact that waste picking allows vast sectors of the urban population to generate subsistence income. Between 50,000-100,000 people, often assisted by their families, are estimated to be involved in largely informal recovery and recycling activities in the principal cities alone.

Nevertheless, there is a growing trend toward resource recovery and recycling, particularly within larger industries. Large scale recycling programs of non-hazardous industrial solid wastes have been established in Colombia, Mexico, and Venezuela. Wastes (mostly paper, cardboard, bottles, plastics and ferrous metals) are separated in the industrial premises and sold to specialized private recyclers. In Colombia, this program resulted from a cooperative effort to find jobs for former landfill waste pickers. Generally, except for plastics, this type of recycling is profitable and environmentally adequate.

In some large Argentine, Brazilian, Colombian, and Mexican cities, recycling bins have been set up outside supermarkets, where glass and paper products can be deposited. The most successful experience is that of glass recycling in Colombia. In

this case, the recycling bins were placed by a specific glass manufacturer, which also carried out a public education program. The other experiences have not been as successful, mostly because of the lack of public education on the benefits of this practice.

Only a few organisations, usually NGOs or development aid organisations, act to support those involved in informal recovery or recycling. The municipalities usually take no responsibility for these activities despite the role which they could be playing to stimulate source separation, to reduce the volume of waste requiring disposal, and to conserve natural resources.

Nevertheless, in some cases the conditions of waste pickers have been improved through their organization and training. The most notable experiences are found in Colombia, but a number of other countries (Argentina, Brazil, Panama, Peru, and Venezuela) have followed suit. Recycling organizations have led to the formation of cooperatives or small-scale enterprises. In all cases, the organizations have been promoted by outside institutions such as NGOs or the local solid waste authority (the best cases for this can be observed in Belo Horizonte and Porto Alegre, Brazil, and in Mexico City). In the Brazilian cases, the waste authority has provided a site where those in charge of recycling can carry out their work. This is also the case for Mexico City, where a recycling plant that processes more than 3,200 tons per year has been installed. In both cases, all revenues go to those who separate the material, while the municipal authority benefits by increasing the lifetime of the landfill and reducing the transportation time to the landfill.

Public Education

In spite of the general deficiencies in urban services, there are few existing educational programmes which seek to reduce, prevent, or minimise the generation of solid waste at source. Unfortunately, product advertising actively promotes a shift to less recyclable products and packages. Many supermarkets and commercial establishments seem to confuse the term 'modern' with 'disposable packaging.' Only a few organisations have attempted to address this trend and to increase public understanding of and conduct towards a more environmentally sound approach to 'modernization.'

Nevertheless, there is a trend toward the development of environmental awareness in

children. The underlying concept here is that the most important target group in public education is children, and that schools can be the avenue to teach them. Thus, environmental awareness, including proper handling of solid waste, is increasingly incorporated as part of the elementary school curriculum. The programs include development of textbooks, teacher training, and hands-on activities. The latter mainly concentrate on recycling, but also deal with environmental health education. These activities also aim to be financially self-sustaining; income from the sale of recycled products is used to improve the sanitation systems in the schools and, in some cases, to purchase teaching materials.

Contributions to the Mismanagement of Waste

Considered broadly, there are a number of root causes for the solid waste management crisis in general, and its acuteness in poor communities in particular. The most important are:

- accelerated urban growth, which outstrips the capacity of the state (as represented by municipal government) to meet the needs of the steadily increasing population for basic urban services;
- the growing quantity of waste generated each day;
- the economic crises of Latin America, which result in the reduction of public expenditure, which in turn has a negative effect on municipal budgets;
- the structural inability of municipal corporations to adequately offer this and other services, due in part to the obsolescence of the political systems which support them;
- the generally high cost of solid waste services, as they are normally conceived, compounded by inadequate or non-existent systems for collection of service fees, and the lack of willingness of the population to pay for solid waste management services.
- the population's indifference to the problem, which is exacerbated by a lack of public health education or access to civic or political participation.

The structural difficulties of the municipalities stand out among these causes. While the municipalities theoretically fulfill the principal functions of operating, regulating, and supervising the range of activities related to urban waste management, shrinking budgets have led to an

inability to invest in and operate basic sanitary landfills. Municipalities in Latin America generally lack the managerial, technical, and financial capacities necessary to adequately administer solid waste services. Departments in charge of solid waste management are generally of lower rank in the administrative hierarchy, and staff lack the appropriate technical background, while resources for capacity enhancement (such as training) are slim. In addition, high staff turnover following the local elections contributes to these difficulties. Moreover, solid waste management generally ranks as a lower priority than, for example, water supply and sanitation services, and therefore receives even less attention and budget.

In general, one can say that far too many municipalities have failed to reach minimum levels of institutional, administrative and economic capacities, and are far behind in attaining technically adequate waste handling procedures. Most municipal waste management or public works organizations are severely limited in their ability to offer service. It is not exaggerating to characterize as deficient virtually all the services related to waste management in many Latin American countries.

What's Being Done?

Solid waste management is a growing environmental and social problem in the urban areas of Latin America, despite many well-motivated attempts at solutions in recent decades. There are only a few municipalities in the region which have been able to adequately manage the accelerated production of urban waste.

Although a series of formal, largely imported solutions ostensibly aimed at technology transfer and institutional capacity-building have been tested in Latin America in the last fifteen years, the products of these efforts—sewers, wastewater plants, landfills, and etc.—have yielded little progress in spite of the large investments made, and debt incurred.

Despite these failures, or perhaps because of them, significant sectors of the Latin American population are seeking to invent effective alternatives to waste management problems through their own direct and active participation in solving the problems. They are opting to take responsibility for urban waste management services into their own hands. This has led to an increase in the efforts of collectives, cooperatives,

non-governmental organizations and the private sector businesses—both small and large—to take on in increasing measure of what is, theoretically, municipal work and responsibility, despite a generalized lack of municipal support or acknowledgment.

In many ways, this arrangement is preferable because it requires that a community take ownership of, and responsibility for its own waste production and disposal. However, any serious analysis of the solid waste problem in Latin America must look past the deficiencies in service to the persistent marginalisation of the poor, who repeatedly are brought to suffer the most. One can say without exaggerating that the lowest income sectors bear the brunt of the solid waste problem, even though the other sectors generate far more waste.

Legislative Efforts

Norms and regulations applying to solid waste management are often unclear, contested among various entities, and woefully inadequate. In addition, current legislation often lacks adequate organisation and/or clear jurisdictional authority for formulating and enforcing legal requirements. A variety of government entities tend to be involved in establishing and managing the legal framework surrounding and affecting solid waste management.

Nevertheless, in the last several years, the legislative and constitutional context for urban services has changed significantly in some areas, including Bolivia and Colombia. In Bolivia, legislation has been altered in recent years to facilitate the participation of community based organisations in the provision of public services. Here, the Public Participation Law (*Ley de Participación Popular*) anticipates improvements in the system of oversight, control and evaluation through assigning neighborhood and regional organisations and community committees the power to monitor, document, and budget the quality of the public services, including those offered by the small enterprises and cooperatives. In Colombia the newly formed constitution strongly promotes decentralisation and citizen participation, while a separate law regulating the participation of the private sector also permits recycling cooperatives to compete for public contracts for the implementation of waste management operations.

These new laws have created enhanced

opportunities for stakeholders to actively participate in waste management operations.

Community Action

Why do the solid waste problems in Latin America resist solution? Why do the negative effects of the situation fall so heavily on the poor? In any case, it is indispensable for municipalities, other institutions, and citizens to tackle the issue of solid waste management decisively and pragmatically. The population must be educated about the significance of properly handling waste, and there must be an environment within which creative solutions to the waste management problems are encouraged.

To be effective, implementing best practices in solid waste management requires action within both your religious and larger community levels. Community members should decide how important solid waste management is and determine the best ways to achieve waste-management goals.

The following assessment is meant to help your community identify aspects of your present solid waste management practices that could be improved. Furthermore, it will hopefully guide you in the development and implementation of better practices.

Community Solid Waste Management: Inventory

The following assessment pertains to the solid wastes that your community produces with the exception of human excreta, as this subject was covered in the previous assessment. Similarly, further attention to specific hazardous wastes is given in the next assessment.

1. Community Waste Generation Survey

In the space provided below, create a list of solid waste generating sources, i.e. 'waste streams' (excluding excreta) within your community. (For example, 'Kitchen/food preparation,' 'residents' trash,' 'housekeeping,' etc.)

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Now, for each waste stream (source of waste) listed above, using the table below as an example, perform an extensive waste inventory for the duration of one week, as follows:

1. Notify the affected members of your community that a waste audit will be conducted throughout the week. Request them not to dispose of their waste before you (or your team) has a chance to inventory and record the contents.

2. Plan your method of collecting, sorting, inventorying, and recording the waste contents. Make sure to keep the waste streams separate until inventoried.

3. Record, into a table similar to the one below, the contents of the waste each day, being as specific as you find to be reasonable. However, try your best not to combine wastes of different material composition (e.g. metal and plastic) into

(Partial) Waste Inventory Table (example only)

(revise the list of waste components in this table according to the waste components present in your waste stream)

Waste Component	Waste Stream #1 (Kitchen)								Waste Stream #2 (Residential)								Totals
	M	T	W	Th	F	Sa	Su	Sum	M	T	W	Th	F	Sa	Su	Sum	
Cardboard																	
Organic																	
Styrofoam																	
Paper																	
Rubber																	
Rope																	
Plastic Bottles (PET)																	
Glass																	
Iron/ Steel																	
Plastic container (PP)																	
Batterie																	
Alum. Cans																	
Fabric																	
Wood																	
Cigarette butts																	
Etc.																	
								<i>total</i>									<i>total</i>

the same category. If possible, record the weight of the contents. If you are not able to directly measure weight, it may be helpful to create some form(s) of standardized measuring unit(s) (e.g. a 2cm. ball of plastic wrap; a 2cm. square of cardboard, etc) for each type of waste.

4. At the end of the week, total the categories you used for each waste stream; if you did not record weights, make your best estimate of the weekend total weight, basing the estimate on whatever standardized measure(s) you used. Then, calculate the total amount of waste generated by each stream by summing the weights of all the components found in each waste stream.

5. As a final step, once all waste sources identified above have been inventoried, sum the weights of each category of waste components (horizontal rows on the below table) to find the total amount of each particular form of waste that your community generates in a week.

6. Create a final list that ranks, in order of greatest to least amounts, the most prevalent components of waste that you identified.

Solid Waste Analysis

From the inventory above, identify the three waste streams that generated the most waste. For each source, answer the following questions:

Waste stream/source of waste:

Total waste generated weekly (kg):

Name of supervisor for this community unit:

Why is so much waste generated?

Has your community implemented a plan to minimize the waste generated by this particular waste stream?

Yes / No

Describe the plan:

Again, from the inventory above, identify the five largest categories of waste. For each category (waste component), answer the following questions:

Waste component:

Waste sources containing this component:

Quantity community produces per week (kg):

How is this waste product generated?

Is the waste hazardous?

Yes / No

(If unsure, refer to page 138 for definition of 'hazardous waste')

Describe the present disposal method for this component:

Is this component 'recyclable'?

Yes / No

(If unsure, refer to page 130)

Is a recycling program for this material available in your region?

Yes / No

Can this waste be re-used by your religious (or greater) community for another purpose, including composting?

Yes / No

Has your community implemented a plan to minimize the generation of this particular waste component?

Yes / No

Describe plan:

2. Community Waste Collection and Disposal

How does your community rid itself of the solid waste that it generates? Check all that apply:

- Disposal into open pit/pile/dump on community grounds
- Disposal into open pit/pile/dump shared with larger community
- Incineration/burning
- Dumping into ocean or other nearby waterway

- Discarding on side of highway (without regular collection service)
- Periodic collection (either communal or individual property collection points)
- Direct disposal into a managed landfill/controlled community dump

About how often does your community rid itself of its accumulated solid waste?

- Daily
- Weekly
- Monthly
- Quarterly
- Longer

About how much weight is disposed at each interval (kg)?

Is there a community member in charge of solid waste disposal?

Yes / No

Name of individual:

Based on information from this person in charge, has there been any injury or infection as a result of handling the community's solid waste?

Yes / No

If yes, how frequently have these injuries/infections occurred?

Does your community pay a fee for the collection/disposal of solid waste?

Yes / No

If yes, to whom is this fee paid?

(e.g. municipality, private company, individual, etc.)

Does your community include this expense in its regular budget?

Yes / No

3. Solid Waste Collection

Is there a collection service in your greater community that collects rubbish from residences on a regular basis?

Yes / No

If so, who is the party responsible for this service? It would be helpful to record this information below, and to contact them for help in answering the following questions:

Name of collection service:

Contact information:

Contact person:

According to the Collection Service, what policies (if any) does the Service have regarding what will and will not be collected?

According to the Collection Service, what is expected of residents; i.e. how are residents expected to cooperate with the Service (including payments)?

Does your community make an effort to cooperate with the Service?

Yes / No

Why/why not?

What is the final destination, or end disposal practice for the waste that the Collection Service collects? (e.g. landfill, incinerator, etc.)

4. Recycling

Does community recycle materials, or participate in a recycling program with your larger community?

Yes / No

If the recycling program is a service of your larger community, who is the party responsible for this service? It would be helpful to record this information below, and to contact them for help in answering the following questions:

Name of recycling service:

Contact information:

Contact person:

What waste components are recycled?

Plastics

- Polypropylene (PP)
- Polystyrene (PS)
- Polyethylene (HDPE or LDPE)
- Polyethylene Terephthalate (PET)
- Other (specify):

Paper products

- Cardboard / corrugated
- white paper
- Other (specify):

Organic waste for compost

- Automotive parts
- Other (specify):

Metals

- Steel / Iron
- Aluminum
- Copper
- Tin
- Other (specify):

Glass

- Clear
- Brown
- Green
- Other (specify):

- Electronic components/ devices
- Textiles
- Batteries

Are these waste components separated:

- directly by your community
- by others in your larger community
- by the staff at the recycling center

What limitations do(es) the recycling service(s) face that restrict the materials that can be accepted for recycling?

To what extent does your community participate in the recycling of solid waste components?

0 1 2 3 4 5 6 7 8 9

(0= not at all, 9= recycling is genuine policy and practice in our community)

5. Land Disposal

Is a landfill or controlled dumping location the final destination of your community's waste?

Yes / No

If so, who is the party responsible for the operation of the landfill? It would be helpful to record this information below, and to contact them for help in answering the following questions:

Name of Agency/Company:

Contact information:

Contact Person:

Considering the landfill location, what is the approximate distance to the nearest:

Human dwelling?

- <100m
- 100-500m
- 500m-1km
- >1km

Hospital?

- <100m
- 100-500m
- 500m-1km
- >1km

School?

- <100m
- 100-500m
- 500m-1km
- >1km

Playground?

- <100m
- 100-500m
- 500m-1km
- >1km

Have the managers/supervisors of the landfill been trained in operating practices for sanitary landfills?

Yes / No

What policies (if any) does the landfill service have regarding what wastes will or will not be accepted?

Does the landfill protect surface and ground waters from contamination?

Yes / No

If Yes, what design and/or operating features are in place (e.g. use of impermeable layers at the base and sides of landfill, leachate collection and treatment, daily soil cover, etc.)?

Is the final wastewater discharge from the landfill monitored for environmental pollutants?

Yes / No

Are the surrounding ground and surface waters (those which accept wastewater discharge from the landfill) monitored for contamination?

Yes / No

What pollutants, if any, have been found in the wastewater discharged by the landfill?

Has a regulatory agency found the landfill to have been in violation of applicable environmental regulations in the past three years?

Yes / No

What measures are in place to manage and/ or utilize the gases produced by the decomposing wastes?

Are waste-pickers/ informal recyclers often present in the landfill?

Yes / No

What is the landfill management policy regarding waste pickers, informal recycling services, and/ or squatter settlements within the landfill?

Do waste pickers at the landfill use any personal protective equipment (e.g. gloves, aprons, etc.)

Yes / No

If not, has the landfill management done anything to improve the situation? Please describe:

By what means or avenue may the public provide their input into landfill operation and management decisions?

6A. Waste Handling Workers or Workers' Association

It will be helpful to contact the workers who are involved in waste handling. Such employees include but are not limited to: collection workers, landfill employees, recycling service employees, or an association or union of such employees.

Name of association:

Contact information:

Contact person:

Have these workers been provided personal health and safety training to be able to perform their duties safely?

Yes / No

Besides training, what other measures are in place to ensure worker safety ? (e.g. personal safety equipment, limitations to work-hours, equipment inspections, etc.)

According to the workers, how frequently are injuries or infections experienced by workers as a direct result of their occupation?

1 2 3 4 5 6 7 8 9

(infrequently...occasionally...frequently)

What is the average wage that workers are paid for their labor?

What avenues exist for workers to influence the policies that govern their working conditions?

6B. Governmental Regulatory Agency

Your government should have an agency/ministry that is responsible for enforcing any environmental regulations that apply to the operation of the landfill or dump in your area, as well as administering other environmental regulations. Consult such agency to answer the following questions.

Name of agency:

Contact information:

Contact person:

What environmental regulations are applicable to the operation of solid waste handling facilities in your area?

How can citizens report violations that they observe?

Has the landfill/ dump been cited for any violations in the past three years?

Yes / No

If yes, describe:

Are there any other environmental laws or initiatives regarding solid waste that apply to citizens in your county? (e.g. recycling laws, import bans, etc...)

6C. Environmental Information Source

It will also be helpful to contact an environmental protection or advocacy group that can provide reliable, expert data on the ecological impacts of the landfill or dump in your area. If you don't know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Name of organization:

Contact information:

Contact person:

According to these experts, what threats to the surrounding environment does the landfill or dump pose?

If the present measures being taken to safeguard the environment are inadequate, what do these experts recommend for improvement?

Of the other laws and/or regulations regarding solid waste in your country and region (e.g. recycling laws, disposal restrictions, etc.), do these experts consider them to be adequate? If so, are they adequately enforced?

According to these experts, what actions might your religious community take to work toward improving the sustainability of local solid waste handling?

6D. Expert Public Health/Safety Information

It will also be helpful to contact a public health/safety advocacy group that can provide reliable, expert data about the health hazards resulting from your municipality's current waste handling practices. If you don't know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Name of organization:

Contact information:

Contact person:

According to these experts, what threats to public health

do your municipality's present waste management practices pose?

If the present measures being taken to safeguard the public health are inadequate, what do these experts recommend for improvement?

According to these experts, what actions might your religious community take to work toward public safety in these regards?

7. Cleaning of Public Areas

Consider the amount of litter (scattered solid waste and debris) observed in the surrounding area of your larger community. You may conduct an inventory of the litter found within a area representative of the general condition with a form similar to the one used in question one.

Rate the amount of litter found:

0 1 2 3 4 5 6 7 8 9
none...scattered...everywhere

What are the most prevalent waste components found?

Are any of these waste components from a common source(s) ? If so, what is/are the common source(s)?

Are there easily visible trash receptacles present in public areas for people to dispose of their incidental trash?
Yes / No

Who is responsible for emptying or carting the accumulated trash away from the site?

Are the trash receptacles generally emptied before they are overfilled?

Yes / No

Does there exist a public cleaning service that is charged with removing solid waste from such places as roads and sidewalks, etc.?

Yes / No

How is this service funded?

How does the service dispose of the waste collected?

If the cleaning service does not satisfactorily maintain clean public areas, what impediments or limitations are affecting their service? (It would be most helpful to contact the service or employees thereof to answer this)

8. Education

Awareness and Education of Larger Community

Is the general population of your larger community well informed about safe and ecological waste handling practices?

Yes / No

Is the general population well informed about the environmental dangers inherent to present waste handling practices?

Yes / No

Religious Community Awareness, Education and Action

Are the members of your religious community well informed about safe and ecological waste handling practices?

Yes / No

Are the members of your religious community well informed about the environmental dangers inherent to present waste handling practices?

Yes / No

Is your religious community engaged in any action to change the present waste handling practices of your larger community?

Yes / No

Community Solid Waste Management: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

In general, the formula used to guide best waste management practices can be represented as this hierarchical decision tree:

The waste management hierarchy:

- 1 Prevent or reduce waste generation
- 2 Reduce the toxicity or negative impact of the waste
- 3 Recycle waste in its current form
- 4 Reuse waste after further processing
- 5 Treat waste before disposal
- 6 Dispose of waste in an environmentally sound way

1. Community Waste Generation Survey

Waste prevention and, if this is not possible, waste reduction should be considered the first option in waste management because it is less expensive and less resource intensive than the other options such as recycling, treatment, and disposal. Thus, waste prevention and reduction should be the basic goal of your community's solid waste management. Minimizing waste generation will save resources (energy, materials, and labor) and costs; as well it reduces the associated adverse environmental impacts during the entire cycle of raw materials extraction, product manufacturing, and waste management.

Waste can be reduced by products requiring less material per unit (smaller cars, thinner containers); products with longer lives (more durable tires and appliances); reusable products (refillable containers) that replace single-use disposable products; limiting the number of units in your community (fewer cars, bicycles, etc); and adopting standards to reduce the amount of packaging (buying dry goods from bulk storage rather than by package). Emphasizing good operating and 'housekeeping' practices also help to prevent waste from being generated in the first

place. Waste reduction can be promoted by education campaigns and by rewarding those who cooperate.

Although in many areas conserving materials, reusing products, and minimizing waste are imposed by economic necessity, these are general principals that should be practised by all the population.

A waste reduction assessment (or inventory) is a tool used to identify opportunities for waste reduction and prevention. It can form a strong foundation for a successful waste minimization program. The assessment can be as simple or as extensive as resources, time, and commitment allow. The point is to use a systematic approach to ensure that the sources of waste are thoroughly examined so that several opportunities for reduction and prevention can be identified and assessed.

The following steps are part of the waste reduction assessment process:

1. Perform a preliminary review of current waste generation patterns and management practices, and determine which waste streams to monitor.
2. Perform waste inventory for chosen waste streams.
3. Identify waste reduction and prevention possibilities.
4. Evaluate and prioritize waste reduction and prevention alternatives.
5. Recommend and/or implement the most appropriate waste reduction schemes.

The preliminary review will help you to identify people you need to contact for information, what type of working space will be necessary for sorting and tallying the collected waste, and, if resources are limited, which waste streams are the most significant to examine.

The actual inventorying process should help to identify various waste reduction and prevention opportunities by quantifying the amounts of wastes generated, providing concrete data upon which to focus improvement efforts.

'Brainstorming' sessions can then be used as an effective means to identify opportunities for waste prevention and reduction. To 'brainstorm'—individually or as a group—simply list all perceived opportunities, regardless of technical or economic feasibility, and encourage innovative ideas. The following suggestions can be used to facilitate identification of waste prevention and reduction possibilities. The first one is to identify which

waste stream produces the largest volume of waste. Reduction efforts can then be directed toward improvements in that specific area. The second suggestion is to focus on the types of waste that are most frequently discarded. Here waste reduction efforts can be applied more generally throughout your entire community.

The most challenging phase of assessment involves evaluating and prioritizing waste reduction alternatives for immediate, short-term, and long-term attention. The number of alternatives selected and their order of priority will depend on the resources available and other priorities of your community. A clear understanding of the time and money that can be allocated for implementation of alternatives is needed in order to make appropriate recommendations.

You must set some initial priorities. Some waste reduction options are obviously easier and less expensive to implement than others. For example, planning to eliminate waste before it enters your community and other measures that require little, if any, capital expenditure, technical resources, or disruption of operations should be readily approved and implemented as soon as practical.

If you or your team are not directly responsible for the implementation of new community policies and practices, and must instead present your ideas to another committee or community member, be sure to spend adequate time preparing your presentation. From the data collected in the inventory it should be possible to generate visual aids such as charts and graphs, which may be valuable additions to your presentation.

Our community is continually identifying and implementing new ways to reduce the amount of waste we produce.

1 2 3 4 5 6 7 8 9

2. Community's Practice for Solid Waste Collection and/or End-Disposal

Before referring below to the specific method of rubbish removal, it should be stressed that the amount of, and types of waste discarded should be minimized. Preferably nothing besides unrecyclable waste should be discarded to a dump/landfill. Waste minimization efforts should include composting of organic materials or recycling of items that can be reused or remanufactured. Hazardous waste should be

disposed of separately in a manner specific to the type of waste. Refer to the next section ('Hazardous Waste') for more information regarding hazardous waste management.

Your community should keep track of waste disposal expenses, and include them in the regular budget. Furthermore, the staff that is involved in handling community waste should be interviewed for information regarding any problems that they encounter with present practices.

Community staff that handles waste should be well-informed about the hazards of being exposed to and working with waste. Heavy gloves, aprons, boots, and other protective gear may be appropriate. See the information contained below under Seeking Expert Advice—Labor, page 134.

To keep your community and village/municipal environment clean, and to reduce health risks, solid waste must be disposed of properly. Untreated refuse is unsightly and smelly and degrades both the quality of life in the community and the quality of the environment. It also provides a breeding ground for disease vectors, such as mosquitoes, flies and rats. If waste is not properly disposed, animals can bring it close to homes and children especially can come into contact with disease vectors and pathogens. Below, the various methods of ultimately removing solid waste from your community are discussed with the intention of highlighting the most frequent problems with each method.

A. Open pit/pile/dump located on community grounds or in larger community

The garbage 'dump' is one of humanity's oldest methods for getting rid of the waste matter resulting from different activities. A place where solid waste is thrown without any attempt at sorting or treatment, that operates without technical criteria—having no sanitary control, nor measures to prevent environmental contamination—is called a dump. Such sites severely impact the air, water and soil with released gases, leached liquids, smoke, dust, and nauseating odors; in addition they pose serious health hazards as they are breeding grounds for a number of vectors, diseases, and if unguarded, they pose serious risks for physical injury.

Because of these problems and their severity, if open dumping is your community's practice, it should be discontinued—or at the very least, improved if possible.

If a dump is being operated nearby, it is most

important to ensure that the dump is not be located close to a water source, because toxic chemicals and pathogens can leach into the water. The dump absolutely should be fenced off to prevent access by scavenging animals and children. At the end of each day, any new waste should be covered with a layer of clean soil 0.1 metre deep to prevent flies from breeding. While these measures may help to reduce some of the most immediate risks, it is most important that your community work to change this prevailing practice. Refer to the List of Categorized References for information regarding sanitary solid waste disposal practices.

B. Incineration /burning

Disposal of household waste by burning outdoors, commonly in 55-gallon barrels or sometimes directly on the ground, occurs in urban, as well as rural or agricultural areas, where feed bags and other commercial packaging are burned. Many view open burning as a low-cost, convenient solution to deal with household waste, especially in rural areas where waste management infrastructure is limited. Unfortunately, this practice is a significant source of air pollution and has been shown to be highly toxic to animals and humans. Hence, if this is your community's practice, alternatives should be sought and implemented as soon as possible.

C. Dumping into ocean or other nearby waterway

Dumping refuse into waterways is a very poor practice and should be avoided at all costs. This practice contaminates both fresh waters and oceans with a variety of toxins, some of which are difficult or impossible to remove. This is an especially critical problem where the contaminated water is used for drinking. Refuse disposed in water also causes more direct health hazards to people who use the water for bathing and/or recreation, like punctures, cuts, and infections. Aquatic wildlife are also negatively impacted by wastes of many sorts. Thus, in the interests of preserving waterways and water sources for this generation and the next, refuse should not be disposed of in waterways.

Unfortunately, a significant number of entities (including industries, municipalities, and individuals) use this as an end disposal method for solid waste and sludge residues from incineration facilities. If this practice occurs in your area, you should help to work to find new alternatives.

D. Discarding on side of highway (without regular collection service)

In many areas, especially near cities, it is a common practice to place small piles of refuse alongside a highway or other well-traveled roadway. This practice certainly increases the visibility of items that may be reused or recycled to citizens who are in that market; however, for the most part, the practice is a nuisance and potentially dangerous. Aesthetically, it is very unappealing and contributes to increased vector populations. Furthermore, the waste often scatters and becomes an injury hazard especially for children. Thus, if this is the practice of your community, more suitable options should be discovered and implemented.

E. Periodic collection (communal or individual property collection points)

In some communities where a periodic collection service exists, there are a series of shared communal collection points that are emptied or cleared at regular intervals, usually by paid employees; in others there is a regular (e.g. weekly or bi-weekly) collection service that picks up refuse from individual properties. In either case, the collected refuse is then taken (usually trucked) to its final disposal site, which is often a municipal landfill, incinerator, or other facility.

If either service is available in your area, you may want to assess the efficacy and safety of the service. It is also important to discover the final disposal site that the service utilizes. Continue to number 3 for further discussion of these practices.

F. Direct disposal into a managed landfill/ community dump

If your community disposes of its refuse directly into a dump or landfill without the assistance of a collection service, it is important that the community members involved in this work be afforded means of protecting themselves from the hazards of working with waste. Similarly important is the maintenance of whatever equipment is used to transport the waste from your community to the disposal site. The site of end disposal should preferably be a sanitary landfill. This topic is discussed more fully in number 4 below.

Our community strives to dispose of its waste in the most environmentally benign manner possible

1 2 3 4 5 6 7 8 9

3. Solid Waste Collection

In some areas, residents may need to transport their solid waste to a disposal site themselves; however, in others a collection service exists that performs this function for them. Such a service offers many benefits to a community, most particularly by saving them the effort of transporting rubbish to a disposal site (including the associated vehicle costs), as well as reducing the associated risks of such labor and those associated with accumulated rubbish. Having solid waste collected and disposed of by well-trained professionals may be the safest way to guarantee that your community's solid waste is handled in a manner that is environmentally safe and does not pose risks to public health, especially if the final disposal site is operated according to sustainable environmental standards.

In most areas where a collection service exists, it is related in some way to the municipal government. Municipal governments may own trucks and employ collection workers themselves, or they may contract a private business to provide the service to residents. Other arrangements exist, however, which make a collection service available without direct involvement of local government; for example, neighborhood or regional cooperatives may exist, or can be organized, that offer this type of service. In some areas, collection services might exist, but are unavailable to particular neighborhoods because of very steep or narrow street conditions.

A collection service may be easily organized in areas without one, as long as there is an appropriate transport vehicle available. While pushcarts or animal carts may be the only vehicles that can negotiate very narrow or steep urban streets, such vehicles can generally be constructed locally to meet neighborhood needs. Transporting waste to its final destination, on the other hand, usually requires the use of a truck, which may be owned by a local resident, a cooperative, or one may be contracted or leased from an area business. Your own community can organize waste collection, for example, by purchasing a suitable vehicle, and offering the service for a small fee. If this is done, it is essential that the community members who perform the service are provided with protective equipment and are trained to handle waste safely.

As responsible citizens, the members of your community may participate in or cooperate with

waste collection services in any number of the following ways:

1. Placing your community's solid waste outside for collection in a manner desired by the service
2. Paying for the service
3. Monitoring and the collection service's work, offering suggestions for improvement when necessary
4. Managing the work of the collection service, particularly if it is a local or neighborhood enterprise
5. Pressuring municipal authorities to ensure that the service continue or be modified as necessary to make it both available and affordable for all residents

While collection services offer both environmental and health benefits to a community, it also means employment to those citizens who work for them. Nevertheless, the nature of this work is rather hazardous, especially if proper precautions are not taken, and if the employees are not adequately trained for personal safety. Ensuring that the health and dignity of collection service employees are respected is important, as they are taking personal risks in order to provide benefits to the public. Speaking with present or past employees of your collection service is recommended to discover the prevailing working conditions, and if problems are discovered, your community may find some way to help remedy the situation (refer to 6(A) below).

One of the biggest sources of tension between the collection services and the communities is delayed payment. Regardless of whether the collection service has been contracted by the municipality or whether it deals directly with residents, serious problems can arise for the enterprise if it does not receive its payment on time, especially if the service is a relatively small or local operation. Delayed payment may significantly affect the quality of the service and it may also harm the service's relationship with the community. In some cases, to be sure, the service may simply be unaffordable for local residents. In such a case, you could serve your larger community by campaigning for increased government support, educating local citizens about reducing waste (reducing waste can have significant financial implications, since some municipalities spend as much as half their budget on solid waste collection and transport) and handling it safely, or by helping to create a practical and sustainable means of solid waste collection yourself.

Our community works to increase (or sustain) the benefits of our waste collection service.

1 2 3 4 5 6 7 8 9 / not applicable

4. Recycling

‘Recycling’ is a term that means returning products or materials back into productive use after they have lost their original value (to their original owner). In other words, ‘recycling’ means turning solid waste components into products with a value—financial or otherwise. Recycling may or may not require a treatment or remanufacturing processes; however there are considerable benefits in either case. (Often, the term ‘recycle’ is used to denote the use of solid waste components after a treatment or remanufacturing process, whereas ‘reuse’ is used to denote their use without any special processing.)

Compared to reducing the amount of solid waste generated, recycling and/or reusing solid waste components is the next most important element for the sustainable management of solid waste. There are three primary reasons for this. First, recycling is essential for the conservation of natural resources, since it reduces the demand for raw materials. Second, recycling has the potential to significantly reduce the total volume of solid waste needing treatment and disposal, which preserves the land required for landfilling, reduces costs, and reduces the associated discharges (gases and leachates). Third, the use of recycled materials and products greatly reduces the amount of energy required in manufacturing processes, a topic which is covered in more detail in Chapter 5 of this manual. Consequently, recycling and productively using ‘wastes’ are important activities for the sustainable management of solid waste

There are several solid waste components that have the potential to be recycled. These include but are not limited to plastic, glass, metals, paper, and corrugated packaging; as well, organic wastes (which form a large percentage of the solid waste in Latin America), can be collected and composted rather than dumped. Fruit and vegetable waste, animal dung and even leaves from trees can break down to form the valuable soil conditioner and fertilizer called ‘compost.’

At least two components are necessary for a recycling program: 1) the material to be recycled must be separate (or separated from) other solid waste components, and 2) there must be a useful destination or a market for the recyclable material.

Thus, any recycling effort will generally involve both the collection and sorting of materials, as well as finding markets for the recyclable materials.

The most efficient means of separation is at the source: i.e. by not mixing recyclable materials together with other solid waste components in the first place. However, even if recyclable materials are separated from other solid waste components, they are often collected as a mixture including different types of material. Thus, some amount of sorting and separation is often required, which adds expense to the recovery process. At a recycling plant, either manual or mechanical means may be employed for separating recyclable components; nevertheless, public cooperation in separating at the source is critical for the optimum collection of materials for recovery.

Markets for recovered products often consist of the products’ original manufacturers. For example, aluminum manufacturers are generally interested in purchasing recovered aluminum; similarly for steel, plastic, and paper products. Nevertheless, diverse markets may exist for recovered materials; for example, paper wastes can be compacted into dense fuel briquettes and used for cooking to supplement firewood. Municipal governments and local cooperatives may be involved in the collection and composting of organic wastes for use by residents or farmers as valuable soil. In addition, public policy and laws may be instituted that require product manufacturers to reclaim the waste components that their products generate, particularly if those waste components are hazardous.

An important aspect of recovery and recycling activities in Latin America especially is the role that ‘scavengers’ play. Since many areas either have no collection and separation program, or lack the resources for one with an adequate capacity, several people earn their living by picking materials from the waste stream, (either from the roadside or from garbage dumps), and then finding the markets for the products themselves. The informal recovery of recyclable materials represents a significant contribution to the amount of material recovered, and as well they help to relieve the financial burden of a municipalities and recycling centers that must pay workers to separate materials. Unfortunately, scavengers (or ‘waste-pickers’) often work under very poor conditions. They are often not well trained in personal safety which makes their work particularly hazardous, and they are often public denigrated for the work, especially

in regions where their activities are considered illegal. In some countries and regions, however, the value of informal recovery has been recognized and efforts are made to improve the conditions. This is especially the case in Brazil, where special efforts are made to organize scavengers into cooperatives, which help to increase the efficiency of the activities, while also increasing the scavenger's market exposure.

Although coordinated and successful recycling efforts are not yet widespread in Latin America, considerable progress has been made in the past decade. At least six countries in the region have national laws regarding solid waste, and some countries have quite successful programs. For example, again Brazil ranks among the most successful, as it leads the world in recycling steel and aluminum cans (85% of those consumed are recycled), on a par with European countries in recycling plastics, and comes close to the U.S.A in recycling cardboard.

In regions where recycling efforts have been successful, public education has been one of the most important elements. People appreciate knowing why recycling is important, what can be recycled, and how they can help to protect the environment by recycling. Thus, along with separation and marketing, education can be considered a third necessary element to a successful recycling program.

Recycling efforts can be coordinated on any level, from your own religious community to the municipality at large, while national networks can greatly aid in the dissemination of educational information, technological developments, success stories, and potential markets necessary for successful recycling efforts on local levels. Governments also can play a significant role by establishing public policies that, for example, mandate recycling, require material reclamation by manufacturers, or decriminalize the informal activities of scavengers.

See the resources listed at the end of this chapter for more information regarding composting and recycling.

Our community strives to maximize the amount of waste that is recycled, within both our religious and larger communities.

1 2 3 4 5 6 7 8 9

5. Land Disposal

The final destination of your community's solid waste may likely be a land-disposal site, especially if you live in an urban area. A land-disposal site is a location where wastes from a large number of sources are accumulated and left to decompose over time. Despite the prevalence of the practice (or exactly because of its prevalence), land-disposal can not be considered a sustainable solution to our solid waste problems, simply because the earth does not provide us enough land to cope adequately with the rising population and the amount of waste we produce. This is another reason why the goal of a sustainable solid waste management program is to eliminate waste generation, and, failing that, to minimize the amount generated, while reusing and recycling as much as possible. (**Reduce, Reuse, Recycle!**)

Nevertheless, since land disposal is a widespread practice at this time, it is important that it be done with high regard to both environmental and public safety. Identifying and evaluating the prevailing conditions of the land-disposal site which receives your solid waste is an important step in assessing the effects of your community's solid waste management practices.

When solid waste is dumped or buried, the organic components of the waste begin to undergo the natural process of decomposition. Besides the natural elements of air and water, microorganisms and other fauna are involved in this process. The rate at which decomposition occurs depends upon a large number of factors; however, the most important factor is the material composition of the waste. For example, while plant matter, paper and cardboard decompose rather quickly, plastics require hundreds—and sometimes thousands of years to decompose.

Inorganic components of waste also undergo transformative processes which vary depending upon the substance. Some may dissolve with water, others with oils, some may react with other elements and substances, while still others may remain inert and unchanged.

Thus, inside a land-disposal site, there are several processes occurring simultaneously, each of which have respective byproducts. These byproducts include both liquids and gases (in addition to the solid matter that remains), which are briefly described below.

Liquids: The natural decomposition or putrefaction of solid waste produces a foul-

smelling black liquid, known as leached or percolated liquid, that looks like domestic water waste, but is much more concentrated. The volume of the leachate is greatly increased by rainwater filtering through the layers of waste. Leachate is highly toxic, as it contains an abundance of pathogens and dissolved substances.

Gases: Once buried, organic waste decomposes anaerobically—meaning without oxygen. As a result, the decomposing waste produces quantities of methane gas (CH₄), carbon dioxide (CO₂), as well as traces of foul-smelling gases, such as hydrogen sulfide (H₂S), ammonia (NH₃), and other gases. Methane gas deserves the greatest attention because, although it is odorless and colorless, it is inflammable and explosive if it becomes concentrated. Since gases have a tendency to accumulate in empty spaces inside a landfill, explosions are possible if proper measures are not taken to prevent them.

Left unmanaged, these byproducts obviously pose several environmental and health risks; however, when managed properly the risks can be greatly reduced. The most serious risk that land-disposal sites can pose to the environment is the pollution of surface waters and groundwater by leachates. Air quality can also be negatively impacted not only by bad odors, but by smoke from burning waste and by wind-borne dust that can spread harmful pathogens that irritate the nose and eyes, or cause respiratory infections.

Land disposal can also pose several public health risks. Besides the possibility of explosions and other direct physical risks (e.g. punctures, cuts, other injuries) for those present in/on the disposal site, if proper operational measures are not taken, land-disposal sites become the breeding ground and habitat of harmful animals and insects that can transmit many diseases. Any animals that visit or live in disposal sites are a hazard for the health and safety of local inhabitants, in particular for families who near (or on) the site. The health risks are particularly severe if medical wastes are included in the accumulated wastes, since they contain highly infectious materials combined with extremely sharp objects.

A land-disposal site that operates without any regulations, controls or safety measures, and so poses the serious environmental and safety problems discussed above, is called an open dump. In contrast, a sanitary landfill is a land-disposal site that attains to high standards of air quality, groundwater and surface water protection, control

of vermin and other vectors, access restrictions, and controls over what types of waste are accepted. A sanitary landfill is operated by trained and knowledgeable managers that use engineering principles to confine the waste to as small an area as possible, and anticipate the problems that could be caused by the liquids and gases produced by the wastes. Sanitary landfills incorporate both design features and operational procedures to maintain high levels of environmental protection and public safety, some of which are briefly described below:

- To protect ground and surface waters from the leachate, the sanitary landfill will be contained by an impermeable barrier underneath and around the waste which prevent leachate from seeping or flowing into the environment. The landfill should be designed so that the leachate can be intercepted, collected and treated (on or off site) before it is released. As part of operational policy, the surrounding ground and surface waters will be regularly analyzed to ascertain that no pollution is occurring.
- A sanitary landfill will also incorporate features which either vent, reclaim, or utilize the methane gas generated by the decomposition process. Since methane gas can be used as a fuel, several options exist for its ultimate handling; however, for the purposes of safety it is most important that it be safely vented.
- The operation of the landfill will use cover material (earth) to confine the waste at the end of each working day, to prevent (or greatly reduce) vector breeding.
- A sanitary landfill will restrict the accepted waste to include only non-hazardous and non-medical materials; as well, the accepted wastes will be compacted so that they occupy less space in the landfill—items like rubber tires will not be accepted because they do not compact.
- Access to the site will be regulated so that only those who are knowledgeable about the hazards present may enter. All those who are present are provided personal protective equipment to protect themselves against the hazards. (This does not imply that waste pickers/ informal recyclers are to be excluded—on the contrary, efforts should be made to improve their health and work

conditions, as the recycling they do is valuable and necessary, both for them and for the environment.)

- A sanitary landfill should be located several kilometers away from any public gathering space to protect the public especially from the risks of vectors. Because of the risk of disease, it is especially important that no schools, playgrounds, nor hospitals are nearby.

Land-disposal sites can be operated anywhere within the spectrum of conditions between sanitary landfills and open dumps. Unfortunately, there are very few sanitary landfills throughout Latin America, and open dumps are not at all uncommon; nevertheless, it is irresponsible toward present and future generations, as well as contrary to sustainable development principles for a municipality to dispose of its waste in a disposal site that does not attain to high levels of environmental and public safety. Thus it is incumbent upon all those who utilize the sites to make sure that operations are safe and sustainable. For this reason, it is important to ensure that avenues exist by which the public can both be aware of, and influence the management decisions being made by the land disposal operation.

Our community is actively involved in improving the way our landfill operates, and/or monitoring it for safe operation.

1 2 3 4 5 6 7 8 9

6. Seeking Expert Information

One of the most valuable steps in your effort to achieve sustainable solid waste management practices is to seek the input and advice from experts that are knowledgeable about the specific aspects of solid waste management that you are trying to evaluate and improve. Experts can help you understand problems or alternatives about which you are unclear; in addition, they may be aware of what others have done and are doing to improve problems you have identified, and are therefore likely to be able to provide much good advice. Thus, in this section, it is suggested that you contact and make relationships with as many of these organizations and agencies as possible, so that your progress towards sustainable solid waste management may be accelerated.

A. Labor

Contacting employees or representatives of employee associations can be very helpful in determining how your community's waste generation affects the health of others in the population, especially that of the workers who handle your waste. In addition, knowledgeable workers can provide your community with tips about how to most safely deal with waste within your community, and how your community can best cooperate with the workers.

As well, since the workers that handle solid waste are exposed to several hazards, their safety and fair compensation are equally important elements to consider when evaluating the effects that your community's solid waste has on others. If the workers are not adequately trained, not adequately protected, or not adequately paid, and if your community is complacent about their conditions, your community is in effect directly contributing to their suffering. Thus, by learning about their working conditions, your community may identify a social need that deserves attention.

The main unsafe working conditions are:

- Using bare hands when handling the waste, which can produce cuts if the garbage contains broken glass or sharp objects.
- Working excessively long hours, which causes fatigue.
- Not having appropriate clothing or personal safety equipment, including heavy gloves, thick clothing that is not loose, safety glasses, foot protection, etc.
- Not showering or washing at the end of the day's work.
- Having to eat at the working place without washing their hands with soap and water.

B. Government Regulatory Agency

Perhaps the most important group of experts to contact is the government body that is responsible for enforcing the environmental regulations of your country or province. This agency can provide you with the current environmental laws and regulations that exist, as well as how they are enforced. Often it is possible for citizens to directly report violations that they observe. Learning how to report violations provides your community (and those you educate in your larger community) with a potentially powerful tool that you can use to protect the environment in your region.

Understanding the environmental laws of your country/province is very important, as these policies can be the powerful measure that ensure that environmental conditions improve, since they must be adhered to by everyone under penalty of law. There have been several legislative initiatives around the world which have produced notable environmental benefits. For example, restrictions are widely used to prevent dumping and littering, restrict improper disposal of hazardous liquids, poisons, and tires in municipal landfills, and forbid combustion of materials containing toxic metals. Product standards, which establish quality levels for particular goods such as paper bags, permit more flexible use of recycled materials. Product standards can also be used to restrict toxic ingredients. The European Community, for instance, prohibits non-biodegradable detergents, and many countries restrict the contents of insecticides, herbicides, and fertilizers. Germany has pioneered the use of take-back requirements that compel manufacturers and retailers of specified products to take them back for recycling or disposal when they are discarded. Some countries require that pesticide containers be recycled. This could be extended to batteries and tires, consumer electronics, and even containers and packaging materials, thus transferring the disposal responsibility and costs back to the producers and distributors and giving them the incentive to plan these costs into product design.

The regulatory agency may also be able to provide you with data regarding violations of the environmental laws that occur in your area, such as by a land-disposal site. This knowledge is very important as it describes the known conditions that directly affect the health of local inhabitants.

Furthermore, a governmental agency may have educational materials that you and your community can use to help educate yourselves and others about best solid waste management principles, including information about recycling, hazardous waste, or safe handling instructions.

Lastly, this agency may share with you problems with which it must cope. For instance, while strict laws may exist that could do much to improve environmental conditions, perhaps there are no means with which to enforce the regulations; perhaps the regulatory agency is understaffed or underfunded. Understanding the agency's problems can help guide your community in taking political action to improve the efficacy of the environmental regulations of your country/ province.

C. Environmental Information Source

Contacting an expert or group of experts engaged in environmental advocacy can be extraordinarily helpful in identifying the environmental problems of waste handling practices of your region. As well they may provide your community with ideas about how you can become more directly involved in improving conditions in your area. Because such an agency is probably not affiliated with the government, it should have more latitude in criticizing current policy and conditions, and thus be able to offer a different and more critical perspective on issues. Such organizations and/or individuals are often engaged in educational campaigns, legislative lobbying campaigns, and also more direct forms of action. Whatever their particular actions are, they are generally quite knowledgeable about prevailing conditions, and may have many reasonable suggestions for your community.

Hopefully such an advocacy group exists that is reasonably local to your community. If there is no such organization, there is probably a need to develop one, and possibly your community could help in this undertaking.

D. Public Health

Another important angle from which to view your community's waste management practices is from the point of view of public health and safety. Poor practices often result in both environmental and health problems. Furthermore, the particular health problems that your locale experiences may differ from other areas. Thus, again it is helpful to find a reasonably local health organization to interview. Aside from gathering important information about public health and safety as it regards waste handling, the organization may also be able to provide instructions for safely handling your community's waste.

Our community has developed relationships with and utilizes the information available from expert organizations in our area.

1 2 3 4 5 6 7 8 9

7. Cleaning of Public Areas

Public cleaning and street sweeping tend to be restricted to paved streets with high pedestrian traffic, while the areas where unpaved streets predominate, usually in the lower income sectors, are ignored. Very few municipalities foster active

community participation in this service; and when they do, the public response tends to be apathetic in response to the deficient quality of the waste collection services, which leave the streets and surrounding areas littered and dirty.

Coverage by waste collection services averages about 70% in large Latin American cities having populations in excess of a million inhabitants; in smaller cities this coverage is estimated to range between 50% and 70%. Here too, it is normally the high and middle-income areas that enjoy regular service, while low-income neighbourhoods can count only on erratic service when they have any at all.

In many of the capital cities of Latin America, including Tegucigalpa, Managua, San Salvador, Caracas, Lima and Asunción, waste collection coverage remains below 40% for the low-income areas.

Transport of waste to its final disposal site is becoming increasingly difficult and costly, given the lack of adequate or conveniently located final disposal sites. Because of this, it is common for a large part of the solid waste which does get collected to end up in open dumps located along the road to the final disposal site.

The remoteness of final disposal sites has also caused an increase in the use of waste transfer points or transfer stations as a more efficient and cost-effective method of moving the waste to disposal. Notwithstanding, the use of transfer points or stations remains the exception, and these are in use in only a few cities.

Communal collection points are particularly important at places such as markets and bus stations, where large numbers of people congregate and food is prepared, sold and eaten. Communal containers (trash receptacles), such as empty oil drums, skips or concrete bunkers, can be located strategically, so that solid waste is collected at a single site. If communal concrete bunkers are constructed, they should have holes at the base to encourage drainage away from the bunkers, but care must be taken not to cause contamination of either groundwater or surface water sources. Ideally, water from the waste bunkers should flow into the drainage system and be treated before it enters a river or stream. It is preferable that vegetable waste is not disposed of in communal collection points unless these are emptied on a daily basis. Vegetable matter decomposes rapidly, is often very smelly and may cause significant contamination of groundwater sources.

All waste from communal collection points should be collected several times a week and taken to a designated disposal site. It can be transported in boxes, or by handcarts, animal carts, bicycles with box containers, tractors with trailers and skip-trucks. The waste should preferably be collected by staff wearing protective clothing and masks, who are trained in safe disposal methods.

If your area has a problem with litter, it is often necessary that the attitude and habits of a significant portion of the population be changed, and that the public become active participants in litter control. These undertakings require well-organized and energetic campaigns towards which your religious community may contribute.

Our community is doing all that it can to help eliminate public litter.

1 2 3 4 5 6 7 8 9

8. Education

Public Awareness and Education

Sanitary and environmental education are essential if populations are to effectively address the problems caused by inadequate solid waste management. Awareness is essential for a change of attitude that will enable people to understand the complexity of the problem and the requirements for a good collection, treatment, and final disposal system. It is equally important that the public be made aware of the costs involved and the obligation of all citizens to pay for waste handling services to ensure their sustainability.

Educational campaigns help citizens understand that the problem of waste disposal is a complex one, and that it is not going to be solved by their dumping the garbage somewhere on the outskirts of their neighborhood. A community that perceives waste management as a matter of self-interest should thus be willing to give cooperative and enthusiastic support, and similarly should be committed to long-term participation.

An important context for community education is the general tendency of many citizens to look down on the collectors of recyclables and other waste workers. For this reason, cooperatives in Brazil and Colombia pay a lot of attention to the organisation of educational campaigns which feature the importance of recycling. In this way they facilitate the public's collaboration in recovery activities.

Community Awareness, Education, and Action

Within your own community, knowledge of safe, sustainable practices, as well as the consequential problems from poor waste management practices are important to help facilitate community waste handling improvements.

Since cooperative community participation in efforts like recycling is essential for the success of any campaign or change of protocol, it is important that members understand how their waste management practices directly affect the rest of creation, whether in the form of workers, the environment, or the health of the general population. A focus on the health effects of improper waste disposal can help to forge a direct, personal connection to these issues such that proper waste disposal becomes a matter of self-interest.

Since several of the problems that you may encounter require changes to policies and practices of your larger community, it may be necessary to campaign for improvements with a coalition of others concerned in the larger community. Sometimes there are direct actions that your community can make to improve the conditions of the larger community. For example, a community might become the organizers of a small-scale collection and recovery service, and might possibly even staff the service if the resources are available.

The most important thing is to recognize that there are critical problems with many present waste management systems. These problems are dangerous not only to today's population, but are also a threat to tomorrow's children. Thus, it is incumbent upon us as Earth's present stewards, to do all we can to ensure that our waste is both minimized and disposed of in an ecological manner.

Our community strives to educate ourselves and others about ecological waste management practices.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right

score

1. Waste reduction and monitoring practices	
2. Ecological disposal practices	

3. Collection service	
4. Recycling	
5. Land Disposal	
6. Relationships with expert organizations	
7. Cleaning of public areas	
8. Public and Community Education	

Now that you have comprehensively examined your solid waste handling practices, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Problem 5

Now categorize each problem listed above into one of the following three categories:

I = Critically important. Currently dangerous, must be addressed immediately

II = Important, but not immediately dangerous. Must be addressed

III = Current practice should be improved, but is not immediately needed

Hazardous Products and Wastes: Assessment

The following assessment pertains to products that, when improperly handled or disposed, pose particular and serious dangers to life and to the environment. For these substances, special treatment and handling are required for personal, public, and environmental safety.

An Overview of this Assessment

The intention of this assessment is to address your community's handling of a special type of waste, specifically household hazardous waste. Household hazardous waste consists of substances which pose serious dangers to life and to the environment. Most often these products are chemicals and petroleum-derived products, but also include elemental products (e.g. mercury) and biological wastes (e.g. medical wastes). In addition, because of the particularly dangerous nature of these substances, this assessment will also give some attention to your community's handling of hazardous products while they are in use before they become wastes.

The underlying philosophy of this assessment is that it is best to reduce or eliminate the use of hazardous products whenever possible; that they should be handled with appropriate care when it is necessary to use them; that the goal of your community should be to not generate any hazardous waste, but when necessary, that your community use best practices to dispose of the products and their containers.

Despite the dangers posed by hazardous products and wastes, the number of educational and disposal-related resources pertaining to them are quite limited, even in countries like the United States where the use of hazardous products is considerable and ever-increasing. In the Latin American and Caribbean region, special facilities and programs are only now coming into existence. This situation makes it particularly difficult for your community to handle and dispose of hazardous products in the most environmentally benign manner; and as well it may limit the applicability of portions of this assessment to your community's practices. Despite this, your community can benefit by considering the content of this assessment, if only by allowing it to help you identify and more safely handle hazardous substances.

What is Hazardous Waste?

Components of waste that pose particular dangers to either the environment or human health are hazardous waste. While there is no internationally agreed-upon definition of hazardous waste, the following definition is reasonably explicit and useful for the purposes of this assessment.

Hazardous wastes:

- i. cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or
- ii. pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.
- iii. Hazardous wastes include at least one of the following characteristics:
- iv. ignitable or flammable (can catch fire and burn rapidly),
- v. corrosive (can eat away the containers that hold them or can cause living tissue to be destroyed),
- vi. reactive (explosive or causes a reaction when mixed with other materials), or
- vii. toxic (poisonous, can cause injury or death if swallowed, absorbed or inhaled; can cause birth defects, cancer or other health problems).

(From the United States Environmental Protection Agency)

Hazardous waste is often considered to be a by-product solely of various industries. Oil refineries, paper mills, mining operations, chemical plants, and large-scale agriculture are all well-known toxic waste sources. It is true that industries produce the most toxic chemical waste—in terms of both quantity and concentration; however, households also share in the responsibility of contaminating the environment with hazardous chemicals. Here we will focus on household hazardous waste (HHW), as a full treatment of industrial sources is beyond the scope of this assessment.

Hazardous products require proper handling for safety. That is, extra precautions must be taken when handling them in order to safeguard your health, the health of others, and that of the environment. Similarly, when such products are discarded, precautionary measures must be taken to ensure that their toxicity is contained and is not

able to broadly contaminate the environment.

Tens of thousands of synthetic chemicals are currently in common use throughout the world, and between one and two thousand new chemicals appear on the market each year. A large number of these are hazardous to both the environment and human health. Altogether, there are about one million commercial products that are mixtures of chemicals. Even in the poorest regions, households are increasingly using modern chemical products. HHW typically consists of cleaning products, as well as lawn and garden products, pesticides and herbicides, fuels and paints, as well as dry and wet-cell batteries. The table below lists some of the most common hazardous household products, as well as the component chemicals responsible for their toxicity.

How Hazardous Waste Affects Health

While the massive expansion in the availability and use of chemicals during the past few decades has led to increasing awareness by the public, the medical profession, and public authorities of the risks to human health posed by exposure to these chemicals, the actual global incidence of chemical poisoning is not known. Nevertheless, it is speculated that several hundred thousand people die each year as a result of various kinds of poisoning. The World Health Organization conservatively estimates that the incidence of pesticide poisoning, which is particularly high in Latin American countries, has doubled during the past 10 years; however, the number of cases that occur each year throughout the world, and the severity of cases that are reported, are unknown.

How health effects manifest and become noticeable depends upon the nature of the substance to which a person is exposed, as well as both the concentration and duration of exposure. For instance, long-term low-level ('chronic') exposure can be equally as dangerous as short-term high-level ('acute') exposure, although in the latter case the effects would most likely manifest very soon after exposure, while in the former, effects often can only be seen after many years. Additionally, many substances can have both long and short-term effects, and the particular effects depend upon the substance to which a person has been exposed. Each substance affects the body differently.

Health effects of exposure can be more dangerous if certain other factors exist. For

example, exposure to a combination of toxic substances may alter and amplify the toxic effects of individual substances, since chemicals may continue to interact with each other after they are within a person's body. Personal characteristics are important factors as well, as the risks from exposure are greater for certain people; for example, pregnant women (and their fetuses), asthma patients, and diabetics have a higher risk to suffer from exposure-related health problems than the rest of the population. Furthermore, the fact that many hazardous chemicals tend to accumulate in a mother before being passed to her growing fetus means that hazardous waste is directly and palpably affecting the next generation. On the previous page is a small table briefly listing reproductive effects of some hazardous chemicals.

How Hazardous Waste Affects the Environment

Industrial accidents can be very severe catastrophes which destroy the vitality of entire ecosystems, kill people, animals, and plant life; and can leave the affected area ravished for decades. These large-scale releases of toxic chemicals poison the life exposed to them, but the more lasting damage is due to the fact that the soil and groundwater become contaminated, and it requires a very long time for these to be purified. Furthermore, as chemicals enter water, whether above ground or below, they are carried by the current and thereby contaminate everything downstream. Contaminated groundwater also means contaminated drinking water.

The severity of industrial spills is due to the highly concentrated nature of the chemicals released. Thus, one may be tempted to think that household hazardous waste, being much more dilute and diffuse, is not a cause for concern, especially when compared to the dangers of industrial wastes. However, the release of household hazardous waste into the environment can actually have serious consequences, especially for drinking water supplies. Indeed, the disposal of household hazardous waste into landfills or sewer systems directly contributes to major environmental problems on the scale of those created by industry.

When hazardous chemicals enter a landfill, two very important and dangerous processes occur.

First, as water and other liquids 'leach' through the wastes, different chemicals begin to react. The reactions, of course, are highly varied depending

Common Household Hazardous Products and their Components

Product	Typical Toxic or Hazardous Components
Antifreeze (gasoline or coolants systems)	Methanol, ethylene glycol
Automatic transmission fluid	Petroleum distillates, xylene
Automobile battery acid (electrolyte)	Sulfuric acid
Degreasers for driveways and garages	Petroleum solvents, alcohols, glycol ether
Degreasers for engines and metal	Chlorinated hydrocarbons, toluene, phenols, dichloroperchloroethylene
Engine and radiator flushes	Petroleum solvents, ketones, butanol, glycol ether
Hydraulic fluid (brake fluid)	Hydrocarbons, fluorocarbons
Motor oils, waste oils, grease and lubes, gasoline, diesel fuel, kerosene, #2 heating oil	Hydrocarbons
Rustproofers	Phenols, heavy metals
Carwash detergents	Alkyl benzene sulfonates
Car waxes and polishes; bug/tar removers	Petroleum distillates, hydrocarbons, xylene
Asphalt and roofing tar	Hydrocarbons
Paints, varnishes, stains, dyes	Heavy metals, toluene, polycyclic aromatic hydrocarbons, trichloroethylene
Paint and lacquer thinner	Acetone, benzene, toluene, butyl acetate, methyl ketones
Paint and varnish removers, deglossers, strippers	Methylene chloride, toluene, acetone, methanol, xylene
Paintbrush cleaners	Hydrocarbons, toluene, acetone, methanol, glycol ethers, methyl ethyl ketones
Metal polishes	Petroleum distillates, isopropanol, petroleum naphtha
Laundry soil and stain removers	Hydrocarbons, benzene, trichloroethylene, 1,1,1-trichloromethane
Other solvents	Acetone, benzene, trichloroethylene
Refrigerants	1,1,2-trichloro-1,2,2-trifluoroethane
Household cleansers, oven cleaners	Xylenols, glycol ethers, isopropanol
Drain cleaners	1,1,1-trichloromethane
Toilet cleaners	Xylene, sulfonates, chlorinated phenols
Disinfectants	Cresol, xylenols, heavy metals
Ointments	Heavy metals
Pesticides (all types)	Naphthalene, phosphorus, xylene, chloroform, heavy metals, chlorinated hydrocarbons, polycyclic aromatic hydrocarbons
Photochemicals	Phenols, sodium sulfite, cyanide, silver halide, potassium bromide
Printing ink	Heavy metals, phenol-formaldehyde
Wood preservatives	Pentachlorophenols, polycyclic aromatic hydrocarbons
Swimming pool chlorine	Sodium hypochlorite
Lye or caustic soda	Sodium hydroxide
Jewellery cleaners	Sodium cyanide
Electronic components	Heavy metals, polycyclic biphenyls, brominated flame retardants
Cosmetics	Heavy metals

Adapted from Household Hazardous Wastes, Fact sheet no. 88-3, University of Rhode Island, 1988

upon the substances involved; these reactions can be explosive, let off poisonous gas, create heat, or create a more toxic substance than either of the original components. This poses serious hazards particularly to employees of landfills, recycling services, informal recyclers or scavengers, and anyone present in or around a waste disposal site. However, the emissions resulting from these reactions are dangerous to everybody since they may be particularly poisonous forms of air and water pollution.

Secondly, the hazardous wastes concentrate in a landfill simply by design (as a landfill is a 'central' depot for a wide geographic area), and also by the leachate action. The toxicity of a landfill's leachate is directly related to the quantity and toxicity of hazardous materials mixed in with other solid waste. This is a pernicious problem since most landfills are not capable of containing nor treating this hazardous leachate. Thus landfill leachate is similar to the concentrated wastes of other industries. The landfill leachate will naturally enter and contaminate both surface waters and groundwaters, as well as the surrounding soil.

A similar situation occurs in a sewer network, since the wastes of several sources are combined and often released to a single location, making this a site of concentrated chemical waste.

Thus, it is important to keep household hazardous wastes out of landfills and sewers. So, what should be done with such wastes?

What needs to be done?

Unfortunately, there is no easy answer to this question. In some countries there are special collection programs that are intended to keep hazardous components out of the main waste streams. However, it is rationally argued that this process further concentrates the toxic substances, and thus is only staving off one problem to create another, potentially more fatal problem elsewhere. Thus, as a second step to the segregation process, the chemicals are reacted in order to form less hazardous compounds. The expense of this procedure can be very high, and thus out of the reach of many municipalities, states, and even nations.

This fact, along with a few others, led the United Nations Environmental Programme to conclude, 'There are no specific, cost-effective sound practices that can be recommended for household hazardous waste management in [the Latin American region]. Rather, since concentrated wastes tend to create more of a hazard, it is best to dispose of household hazardous wastes jointly with the municipal solid waste stream in a landfill...' Clearly, this weak advice is not adequate, as landfill leachate and untreated, chemically contaminated sewage are serious sources of environmental contamination.

Simply put, hazardous wastes need to be eliminated, or at least drastically reduced. This should be the goal of any hazardous waste

Reproductive Effects of Selected Hazardous Chemicals

Chemical	Adverse Reproductive Effect
Arsenic	spontaneous abortion, premature labour
Cadmium (heavy metal)	spontaneous abortion, decreased birth weight
Chlorinated compound	menstrual disorders, spontaneous abortion, adverse effects on sperm
Lead (heavy metal)	hormonal imbalances, premature labour, spontaneous abortion
Mercury (heavy metal)	still birth, low birth weight, spontaneous abortion, neurobehavioural deficits, mental retardation, delayed development, brain damage
Polycyclic aromatic hydrocarbons	menstrual disturbances, spontaneous abortion, blindness, deafness, mental retardation, delayed development, brain damage
Trichloroethylene	preterm delivery, low birth weight, reduced head circumference, growth deficiencies, neurobehavioural effects
Benzene	congenital heart disease

management program. Any hazardous product should be used up entirely so that it does not become waste. Less hazardous, or preferably non-hazardous substitutes should be utilized in place of their toxic alternatives. Reducing consumption of hazardous products is perhaps the only true method to effectively address the problem of hazardous waste.

When disposal is unavoidable, however, there are two alternatives: recycling or landfilling/sewer disposal. Recycling programs exist, or have the potential to exist for a number of hazardous substances. However, these programs are not widely available in Latin America, and their development can be quite costly. Landfilling, it would seem, may indeed be the only option left.

This apparent dilemma is neglecting one important fact: that the producers of the hazardous products have the means (or are the most likely to have the means) to either treat or recycle their toxic products. Thus, throughout the world there is a growing trend to make the producers responsible for the end-of-life treatment of hazardous products.

In fact, the concept of responsibility should underlie all consideration of the hazardous waste problem and what to do about it. Responsibility for the problem includes the concepts of producer responsibility (for the entire life cycle of a product, including efforts to enhance product longevity, toxics use reductions, energy efficiency, and design for recycling); individual consumer responsibility, (to make informed and responsible choices in consumption and disposal practices); national and international governmental responsibility (to embark on national waste reduction strategies, and to become self-sufficient in waste management); and social/democratic responsibility (the fabric that holds the other three tiers of responsibility dictates that we respect human rights and democratic involvement in all phases of decision making including the right to corporate planning and product design.

Your Community's Responsibility

This assessment is meant to achieve the following five goals:

- 1 Hazardous product identification—Members of your community should be able to recognize hazardous products and identify the main hazards associated with

use, storage and disposal.

- 2 Health and environmental effects—Members of your community should learn to identify the risks involved with choosing products and materials that generate hazardous waste.
- 3 Safer alternatives and least toxic products—Members of your community should know of alternatives to resolve the issues identified.
- 4 Safe handling—Since not all hazards can be avoided, members of your community should know techniques to safely handle hazardous wastes and provide consumers with information to protect themselves.
- 5 Waste management options—Members of your community need to know that the available disposal options represent least desirable alternative for waste management, while prevention represents the most favorable option.

Hazardous Products and Wastes Handling: Inventory

1. Hazardous Product Survey

Identify which of the following substances or items are present in your community. Check all that apply.

i. Cleaning Products

- Ammonia
- Chlorine bleach
- Drain openers
- Disinfectants
- Wood and metal cleaners and polishes
- Toilet, tub, tile, shower cleaners
- Dry cleaning fluid, spot removers and carpet cleaners

Other chemical cleaning product (specify):

ii. Indoor Pesticides

- Ant sprays and baits
- Cockroach sprays and baits
- Flea repellents and shampoos
- Bug sprays

- Houseplant insecticides
- Moth repellents
- Mouse and rat poisons and baits
- Other pesticide (specify):

iii. Automotive Products

- Motor oil
- Fuel additives
- Carburetor/ fuel injection cleaners
- Starter fluids
- Automotive batteries
- Transmission and brake fluid
- Antifreeze
- Other (specify):

iv. Workshop/Painting Supplies

- Adhesives and glues
- Oil or enamel based paint
- Stains and finishes
- Paint thinners and turpentine
- Paint and varnish strippers/removers
- Photographic chemicals
- Other solvents (specify):

v. Lawn and Garden Products

- Herbicides
- Insecticides
- Fungicides
- Wood preservatives

vi. Medical/ Infectious Materials

- Mercury Thermometers
- Syringes, scalpels, other sharps
- Medications
- Bandages, other wound dressings

vii. Flammable Products

- Propane tanks and other compressed gas cylinders
- Kerosene
- Home heating oil
- Diesel fuel
- Gas/oil mix
- Lighter fluid

viii. Electronics

- Batteries
- Computer components
- Televisions or radios
- Telephones/ Cellular phones
- Mercury thermostats
- Fluorescent light bulbs
- Other (specify):

2. Hazardous Product Handling

Answer these following questions for each type of potential hazardous product identified in your community (from above), and as you do so, complete the information sheet on the page opposite (note that not all questions may apply for every product).

A. *Is the container clearly labeled such that:
The contents are accurately identified?*

Yes / No

Hazardous component(s) (specify):

The label identifies the product as hazardous?

Yes / No

The label clearly indicates proper storage requirements?

Yes / No

The label clearly indicates what measures should be taken to protect the user from harm?

Yes / No

B. *Does your community have product information that describes the contents of the product, specific hazards of the product, and specific first aid procedures for emergencies (May be included on the product container, or available as a Material Safety Data Sheet)?*

Yes / No

Is this information stored in a well-known and advertised location within the community, so that it can be easily accessed in the case of emergency?

Yes / No

C. *Are the members of the community who use/work with, or around, the substance educated about the hazards and proper handling procedures for the product?*

Yes / No

D. *Is the product stored appropriately, as indicated by label or data sheet?*

Yes / No

If not, describe how the product is stored presently, including the location:

E. Rate how well those who use this product adhere to the person protection measures recommended:

0 1 2 3 4 5 6 7 8 9
 (completely ignore... ..adhere fully)

Considering the personal protection measures recommended for this product, does your community possess all items that are necessary for safety (e.g. gloves, aprons, safety glasses, masks, foot coverings, eye wash equipment, etc.)?

Yes / No

If not, describe which supplies are recommended but not presently available in your community:

F. Has your community sought to find an alternative product which presents fewer hazards, but which can be used for the same purpose(s)?

Yes / No

Safer alternative product(s) (specify):

G. Concerning the disposal of the substance:
 How do members of the community presently dispose of this substance?

Is your community aware of the environmental hazards related to the disposal of this substance?

Yes / No

Has your community identified a disposal method which prevents the substance from entering and poisoning the environment?

Yes / No

If this differs from the present practice, what is the best disposal method:

Is the disposal procedure posted so that anyone who uses the product will be informed of it?

Yes / No

3. Quantities and Priorities

Provide an estimated ranking of the five hazardous wastes that are most generated by your community:

Type of Waste:	Estimated Quantity
.....
.....
.....
.....
.....
.....
.....
.....

Has the use of hazardous products caused any observable effects or hazards in the past three years?

Yes / No

List observed effects/hazards to human health:

List observed effects/hazards to environment:

4. Legislative Policy Framework and Regional Resources

It is recommended that you contact expert agencies to answer the following questions. The List of Categorized References may list the Environmental, Consumer Protection, and Public Health agencies that exist in your county or region.

Does your national or regional (local) government have any laws concerning hazardous waste disposal, especially regarding household hazardous waste?

Yes / No / Pending Legislation

Notes:

Do any recycling programs exist in your country for motor oil, automotive batteries, dry cell batteries, antifreeze, or any other hazardous material?

Yes / No

If so, are they accessible to your community? List any available programs below:

Does your country have laws that mandate labeling requirements for products containing hazardous components?

Yes / No / Pending Legislation

Notes:

Does your country have any laws pertaining to manufacturer take-back policies for products which contain hazardous components?

Yes / No / Pending Legislation

Notes:

Hazardous Products and Wastes Handling: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

1-2. Hazardous Product Inventory and Handling

Although the checklist provided at the beginning of the inventory section (page 143) is by no means an exhaustive list of hazardous products that may be present in your community, it is intended to be a guide in your effort to identify the types of products most likely to contain hazardous compounds, as well as the areas of activity that hazards are likely to be found.

In order to identify which products are hazardous, check the product's container. Especially if your country has mandatory labeling requirements for hazardous products, you will find signal words on the label like 'DANGER', 'TOXIC', 'WARNING', or 'CAUTION' if the product is hazardous.

To learn what chemicals are included in the product, you may need to use an outside reference if they are not listed on the product container. Besides contacting the manufacturer directly, there is a large database of products, their components, hazards, and safe handling suggestions maintained by the United States National Institute of Health, called the Household Products Database. Although this database is only available online in English (<http://hpd.nlm.nih.gov/>), it contains a tremendous amount of valuable information.

Safe handling suggestions for the product may also be included on the manufacturer's product label, or found in the above database. However, if you are unable to find safe handling instructions from these sources, perhaps a call to your Environmental Ministry or a Consumer Advocacy organization could help. You may find these resources in the List of Categorical References found at the back of this manual.

As mentioned in the introductory material to this section, safe disposal options for household hazardous waste are limited or even non-existent for much of Latin America at this present time. Nevertheless, your community should seek out

expert advice to learn what options are available in your area. It is most important that your community protect your water and air resources by not burning or dumping any chemical. Certainly the most important thing your community can do is eliminate the use of as many hazardous products as possible, by substituting them with less hazardous alternatives wherever possible.

Change in buying, storage and usage habits may reduce your exposure to household hazardous wastes. The general tips listed below are offered as a guide for best practices concerning hazardous products.

Questions to Answer Before Purchasing Hazardous Products

- Do we really need this product?
- Does it contain an ingredient that is hazardous to people or pets?
- Could we use a less hazardous substance?
- Are we keeping too many different chemicals in our community?
- Will we be able to properly dispose of this product and its packaging?
- Can we store this product safely in our community?
- Are we buying only as much as we will use?

Read the Label

Read all precautionary statements and warnings

Buying Practices

- Reduce the amount of HHW you generate by buying less toxic or non-toxic alternatives.
- Buy only what you need.

Storage Practices

- Keep unused products in original containers.
- Never store chemicals in food or beverage containers.
- Preserve labels for directions, disposal suggestions and warnings.
- Store in a cool, dry place.
- Never store household chemicals where small children and pets may reach them.
- Store flammable products outside living quarters and away from ignition sources.

Handling Procedures

- Avoid mixing different products and/or mixing different brands of the same

product, as explosive chemical reactions or toxic materials may result.

- Follow directions carefully. Use the amount directed, under the conditions specified, for the purpose listed.
- Do not smoke while working with flammable chemicals.
- Keep away from open flame.
- Provide adequate ventilation.

Protection Devices

- Wear protective gloves, long sleeves and goggles when indicated by contact hazards
- Use chemical cartridge respirators or other breathing masks when respiratory protection is indicated by harmful vapors

Additional information regarding each category of products provided on the checklist is given below.

Cleaning Products

Common Ingredients and their Hazards:

- *Ammonia* (glass cleaner)
Lung and skin irritant. If mixed with chlorine, releases toxic chloramine gas. Short-term exposure to chloramine gas may cause coughing, choking and lung damage. Asthmatics may be particularly vulnerable to chloramine fumes.
- *Sodium hypochlorite* (chlorine bleach)
Lung and eye irritant. Household bleach is the most common cleaner accidentally swallowed by children. If mixed with ammonia or acid-based cleaners (including vinegar), releases highly toxic chloramine gas.
- *Phenol and cresol* (disinfectants)
Corrosive; can cause diarrhea, fainting, dizziness, and kidney and liver damage.
- *Petroleum distillates* (metal polishes)
Short-term exposure can cause temporary eye clouding; longer exposure can damage the nervous system, skin, kidneys, and eyes.
- *Nitrobenzene* (furniture and floor polishes)
Can cause shallow breathing, vomiting, and death; associated with cancer and birth defects.
- *Perchloroethylene or 1-1-1 trichloroethane solvents* (dry cleaning fluid, spot removers and carpet cleaners)
Eye, skin and lung irritant. Can cause liver and kidney damage if ingested;

perchloroethylene has caused cancer in some laboratory animals and is considered a probable human carcinogen. Can accumulate and persist in human fatty tissues and breast milk.

- *Naphthalene or paradichlorobenzene* (mothballs, toilet bowl cleaners)
Naphthalene fumes can irritate eyes, skin, and respiratory tract. Chronic exposure to naphthalene can cause damage to liver, kidneys, skin, and the central nervous system. Paradichlorobenzene is a probable carcinogen that can also harm the central nervous system, liver and kidneys. High concentration of fumes may irritate eyes, nose, throat and lungs.
- *Hydrochloric acid or sodium acid sulfate* (toilet bowl cleaners)
Either can burn the skin or cause vomiting, diarrhea and stomach burns if swallowed; also can cause blindness if inadvertently splashed in the eyes.
- *Lye and Sulfuric acid* (drain opener/cleaner):
Extremely corrosive and dangerous to use. These chemicals work by eating away materials, including your skin if it should come in contact. Likewise, vapors are harmful.
- *Formaldehyde, phenol, and pentachlorophenol* (spray starch)
Any aerosolized particle, including cornstarch, may irritate the lungs.

Less Hazardous Alternatives

'The Five Basics for Non-toxic Cleaning', from the Environmental Law Center, UK:

- *Baking Soda*
A commonly available mineral full of many cleaning attributes, baking soda is made from soda ash, and is slightly alkaline (it's pH is around 8.1; 7 is neutral). It neutralizes acid-based odors in water, and absorbs odors from the air. Sprinkled on a damp sponge or cloth, baking soda can be used as a gentle nonabrasive cleanser for kitchen counter tops, sinks, bathtubs, ovens, and fibreglass. It will eliminate perspiration odors and even neutralize the smell of many chemicals if you add up to a cup per load to the laundry. It is a useful air freshener, and a fine carpet deodorizer.
- *Washing Soda*
A chemical neighbor of baking soda,

washing soda (sodium carbonate) is more strongly alkaline, with a pH around 11. It releases no harmful fumes and is far safer than a commercial solvent formula, but you should wear gloves when using it because it is caustic. Washing soda cuts grease, cleans petroleum oil, removes wax or lipstick, and neutralizes odors in the same way that baking soda does. Don't use it on fibreglass, aluminium or waxed floors—unless you intend to remove the wax.

- *White Vinegar and Lemon Juice*
White vinegar and lemon juice are acidic—they neutralize alkaline substances such as scale from hard water. Acids dissolve gummy build-up, eat away tarnish, and remove dirt from wood surfaces.
- *Liquid Soaps and Detergent*
Liquid soaps and detergents are necessary for cutting grease, and they are not the same thing. Soap is made from fats and lye. Detergents are synthetic materials discovered and synthesized early in the 20th century. Soap is better for your health and the environment than detergents. Detergents are very toxic to fish and wildlife. Nonetheless, soap reacts with minerals in water to leave an insoluble film, which can turn clothes grayish, and leave a residue on shower stalls. If mineral content of your water is high, and these above results are unacceptable, detergent may be the only option acceptable to your community.
- *Mould Killers and Disinfectants*
There are many essential oils, such as lavender, clove, and tea tree oil (an excellent natural fungicide), that are very antiseptic, as is grapefruit seed extract, even though they aren't registered as such. Use one teaspoon of essential oil to 2 cups of water in a spray bottle (make sure to avoid eyes). A grapefruit seed extract spray can be made by adding 20 drops of extract to a quart of water.

Some Home-made Formulas

Caution: Make sure to keep all home-made formulas well-labeled, and out of the reach of children.

- *All-purpose cleaner* can be made from a vinegar and salt mixture or from 4 tablespoons baking soda dissolved in 1

quart warm water.

- *Disinfectant* means anything that will reduce the number of harmful bacteria on a surface. Practically no surface treatment will completely eliminate bacteria. Try regular cleaning with soap and hot water. Or mix 1/2 cup borax into 1 gallon of hot water to disinfect and deodorize. Isopropyl alcohol is an excellent disinfectant, but use gloves and keep it away from children.
- *Drain opener*—try a plunger first, though not after using any commercial drain opener. To open clogs, pour 1/2 cup baking soda down drain, add 1/2 cup white vinegar, and cover the drain. The resulting chemical reaction can break fatty acids down into the soap and glycerine, allowing the clog to wash down the drain. Again, do not use this method after trying a commercial drain opener—the vinegar can react with the drain opener to create dangerous fumes.
- *Floor cleaner and polish* can be as simple as a few drops of vinegar in the cleaning water to remove soap traces. For vinyl or linoleum, add a capful of baby oil to the water to preserve and polish. For wood floors, apply a thin coat of 1:1 oil and vinegar and rub in well. For painted wooden floors, mix 2 teaspoon washing soda into 1 bucket of hot water. For brick and stone tiles, use 1 cup white vinegar in 1 bucket water and rinse with clear water.
- *Metal cleaners and polishes* are different for each metal—just as in commercial cleaners:
 - Clean aluminum with a solution of cream of tartar and water.
 - Brass may be polished with a soft cloth dipped in lemon-and-baking-soda solution, or vinegar-and-salt solution.
 - Polish chrome with baby oil, vinegar, or aluminum foil shiny side out.
 - Clean tarnished copper by boiling the article in a pot of water with 1 tablespoon salt and 1 cup white vinegar, or try differing mixtures of salt, vinegar, baking soda, lemon juice, and cream of tartar.
 - Clean gold with toothpaste.
 - Clean pewter with a paste of salt, vinegar, and flour. Silver can be polished by boiling it in a pan lined with aluminum foil and filled with

water to which a teaspoon each of baking soda and salt have been added.

- Stainless steel can be cleaned with undiluted white vinegar.
- *Toilet bowl cleaner*—baking soda and vinegar or borax and lemon juice.
- *Tub and tile cleaner* can be as easy as rubbing in baking soda with a damp sponge and rinsing, or wiping with vinegar first and following with baking soda as a scouring powder.
- *Window and glass cleaner*: Use a vinegar-and-water solution, cornstarch-vinegar-and-water solution, or lemon-juice-and-water. Wipe with newspaper. To avoid streaks, don't wash windows when the sun is shining.

Automotive Products

Common Ingredients and their Hazards

- *Ethylene glycol (Antifreeze)*: Very toxic; 3 ounces can be fatal to adult; damage to cardiovascular system, blood, skin and kidneys. Toxic vapors are emitted if heated.
- *Petroleum distillates (Car wax, polish, fuel and oil additives)*: Associated with skin and lung cancer; irritant to skin, eyes, nose, lungs; entry into lungs may cause fatal pulmonary edema
- *Petroleum hydrocarbons/ Benzene (Motor Oil/Gasoline)*: Highly flammable; associated with skin and lung cancer; irritant to skin, eyes, nose, throat, lungs; pulmonary edema; benzene is a carcinogen and a bone marrow poison.
- *Heavy Metals (Used Motor and Transmission Oils)*: Cause nervous system and kidney damage, carcinogenic.
- *Glycols (Brake Fluid, Transmission fluid)*: cause kidney damage, absorb into skin, corrosive.
- *Methylene chloride (Carburetor cleaner)*: known also as methylene dichloride and dichloromethane, is a colorless, volatile liquid with an ether-like odor. Skin irritant; when inhaled, it mimics carbon monoxide toxicity. Memory loss and liver and kidney damage are reported with chronic exposure. Carcinogenic. When heated, methylene chloride emits a highly toxic phosgene gas (nerve gas). The use of products containing methylene chloride by people with heart conditions has resulted in fatal heart attacks.

- *Sulfuric Acid (Automotive Batteries)*: Batteries contain lead and a solution of sulfuric acid. When activated, the electrolyte solution in the battery produces explosive gases which are easily ignited. Sulfuric acid is extremely caustic. Fumes are strongly irritating, and contact can cause burning and charring of the skin; it is exceedingly dangerous to the eyes. Lead is poisonous in all forms and accumulates in our bodies and in the environment.

Safer Alternatives

Unfortunately, automobiles and other vehicles require the use of these hazardous products. No safer alternatives are generally in use. Indeed, the normal use of a vehicle produces a number of hazardous wastes, including solids (e.g. batteries, metal parts, filters), liquids (e.g. motor oil, antifreeze) and gases (exhaust). The best way to reduce automotive wastes, then, is to reduce the use of vehicles.

The proper disposal of the liquid and solid automotive wastes is essential to prevent environmental contamination. At the present time, however, there are few options for citizens of the LAC region to exercise proper disposal methods. In most cases of automotive waste, proper disposal would mean recycling the used product. Used motor oil, transmission oil, batteries, and antifreeze can all be profitably recycled; however few such facilities exist in the region. In the absence of recycling capacity, you may want to contact your Environmental Ministry or an Environmental NGO to ask them what disposal options they would recommend as the best for your location, as well as to become a voice to encourage the development of these capacities.

Lawn/Garden Products

Common Ingredients and their Hazards

Pesticides (insecticides, herbicides, fungicides, etc.): There are over 1500 different chemical agents used as the 'active' ingredients in pesticides, in addition to several thousand more 'inert' components which are also components of pesticide solutions and may also be hazardous. Below are three common categories of these products, although several more actually exist.

- *Organophosphates and carbamates*: Carbamate and organophosphorous insecticides, which act as neurotoxins, are among the most toxic classes of pesticides, as they: affect the

nervous system; are acutely toxic causing headache, dizziness; twitching, nausea; are carcinogenic; mutagenic (mutating genes), and cause birth defects.

- *Organochlorines*: are typically very persistent in the environment, and are known for accumulating in sediments, plants and animals. Organochlorines have a wide range of both acute and chronic health effects, including cancer, neurological damage, and birth defects. Many organochlorines are also suspected endocrine disruptors. Several common organochlorines have been banned for use in several countries including DDT, aldrin, dieldrin, toxaphene, chlordane and heptachlor. Those that still remain in use include lindane, endosulfan, dicofol, methoxychlor and pentachlorophenol.
- *Other naturally derived pesticides*: Several naturally derived pesticides exist which, in some cases, are less toxic to humans than the organophosphates, carbamates, or organochlorines, but are still quite hazardous:
 - Nicotine is the most toxic, poisonous both to humans and to other mammals, as well as to birds and fish. It is not available commercially for home gardeners because of its hazards.
 - Rotenone, moderately toxic to humans, kills a wide range of insects; however, it should never be used near a waterway, as it is very toxic to fish.
 - Ryania kills only a few species, including the European corn borer, codling moth, and cranberry fruit worm.
 - Pyrethrum is relatively nontoxic to humans and only slightly toxic to aquatic life, so it may be the best choice for home gardens.
 - Sabadilla controls lice, leafhoppers, squash bugs, striped cucumber beetles, and chinch bugs. It has low toxicity to wildlife, but it may be toxic to bees.
- *Wood Preservatives*: Wood preservatives are products containing pesticides which protect wood from pests and rot. Three widely used wood preservatives—creosote, inorganic arsenic compounds (CCA), and pentachlorophenol (penta) are highly toxic. Treated wood should never be burned, as the fumes are toxic.
 - PENTACHLOROPHENOL: Toxic to fetus and causes birth defects, toxic if inhaled, absorbed, or ingested

Hazardous Waste Information Sheet for Product:

List of specific hazards:

Corrosive Combustible/Flammable Pathogenic Reactive Poisonous/Toxic

Other:

Locations of product:

Precautions to be undertaken for safe use of product:

Storage instructions:

Personal protection:

First Aid Procedures:

Skin Contact:

Swallowing/Ingestion:

Contact with Eyes:

Inhalation:

In case of fire/ combustion:

Disposal procedure:

- **CREOSOTE:** Vapors cause eye and nasal irritation, it is a skin carcinogen and can be absorbed through the skin.
- **COPPER NAPHTHENATE:** An eye, skin, and lung irritant, a possible carcinogen and affects the nervous system; combustible; harmful to aquatic life

Best Practices and Safer Alternatives

- Do not use any pesticide if not absolutely necessary for reasons of health or property protection.
- Demand product stewardship from manufacturers (e.g. select those that accept back empty product containers)
- Triple-rinse containers and apply rinsewater on site just treated before disposing
- Purchase pesticides in packaging that is reusable, recyclable, or biodegradable (e.g. dissolvable packets)
- Routinely check application equipment for leaks
- Only mix what you can use and spray out that day
- Spot-treat pests whenever possible to reduce chemical usage, exposure, and expense
- Clean application equipment and vehicles at site where chemicals are applied
- Dedicate application equipment systems to reduce rinsing (especially with herbicides)
- Use end-of-hose 'proportioners' to meter appropriate amount of pesticide
- For lawns: Herbicides are most often used to kill 'unsightly' weeds in gardens and yards, and by lawn care companies to maintain the perfect appearance of turf around homes and on lawns and golf courses. Basically, the safe alternative to herbicides is simple: pull weeds by hand. There are no really safe herbicides.
- Reduce the use of pesticides by using appropriate integrated pest management (IPM) methods:
 - **Physical Controls:** Barriers, traps, cleanliness, caulking, handpicking, and environmental manipulation (i.e. environmental controls such as climate regulation and limiting availability of pest habitat)
 - **Biological Controls:** Establish populations of predatory and parasitoid insects that feed upon the problem pests.
 - **Cultural Controls:** Planting disease/pest-resistant plant varieties
 - **Least-toxic Chemical Controls:** Insecticidal

soaps, horticultural oils, desiccating dusts (e.g. diatomaceous earth), insect growth regulators (interrupt reproductive cycle; e.g. methoprene for fleas), pyrethrin-based products, etc. (Also, select the most pest-specific chemical available; choose biodegradable rather than persistent organochlorine insecticides; and choose water-based formulations in place of oil/solvent-based products.)

Flammable Products

It is important to know which products are flammable and/or explosive, so that your community is sure to store and handle them safely. Generally, any petroleum-based product is inflammable, including all fuels, some oils, stains, varnishes, and adhesives, as well as many aerosol products. All aerosol cans are explosive if heated. In addition to being flammable, many such products are hazardous in other ways such as being poisonous, corrosive, or reactive. Again, check product labels—if they exist—or an expert source for a more complete listing of product hazards.

Below are some general guidelines for the safe handling of flammable products:

- Flammables are often explosive under the right conditions. Thus, propane cylinders, gas cans, charcoal lighter and automotive fluids should **NOT BE STORED INDOORS**, but should instead be stored outside or in sheds that are very well ventilated. Never store flammable liquids or gasses near sources of heat or ignition.
- Keep chemicals in original containers if possible, or in containers approved for flammable liquid or gas. (e.g. do not use empty soda pop bottles to store kerosene).
- Make sure that lids and caps are tightly sealed and childproof.
- Use hand pumps or dispensers to reduce the risk of spilling liquids such as gasoline and kerosene.
- Store rags used with flammable products in a sealed marked container.
- Know where flammable materials are located and how to extinguish them. Keep a working fire extinguisher nearby.
- Prevent leaks and spills by keeping metal containers dry and cool, and handling them with care. Keep clean-up materials close at hand to quickly contain spills should they occur.

- Use products only as they are intended; (e.g. do not use gasoline as a cleaning solvent.)
- Use all of the product on hand, or donate remaining product to someone who can use it to keep flammable products out of the waste stream.

Indoor Pesticides

Common Ingredients and their Hazards

- Warfarin, strychnine (rodent poison): poisonous if ingested, very toxic to aquatic organisms, may cause long-term adverse effects in the aquatic environment. Warfarin is easily absorbed through the gastrointestinal tract and skin, and can cause hemorrhaging, excessive bruising, bleeding from nose and gums, or paralysis. Strychnine is toxic if ingested or inhaled; can cause convulsions, paralysis—including breathing, lethal in small doses (30 to 100 mg).
- Baygon, dichlorvos, chlorpyrifos, propoxur, diazinon (indoor insecticides): Harmful or fatal if swallowed, inhaled or absorbed through skin. Most are organophosphates or carbamates. See above, under ‘Lawn/Garden Products’ for more information about these hazardous products.
- Naphthalene, paradichlorobenzene (mothballs): Naphthalene can enter your system through inhalation, skin absorption, ingestion, and eye and skin contact. Naphthalene may produce possible damage to eyes, liver, kidneys, skin, red blood cells, and the central nervous system. Hemolytic anemia, caused by the breakdown of the red blood cells, has been reported following immediate and long-term exposure. Infants exposed to clothes, blankets, and diapers stored in naphthalene mothballs are at risk for hemolytic anemia. Mild degrees of anemia often cause only slight symptoms like a lack of energy and fatigue. In more severe cases, hemolytic anemia can cause acute kidney failure. Paradichlorobenzene, if inhaled, may result in headache, swollen eyes, stuffy head, anorexia (loss of appetite), nausea, vomiting, and throat and eye irritation; if ingested, symptoms include include nausea, vomiting, diarrhea, liver and kidney damage, and methemoglobinemia (which interferes with the uptake of oxygen).

Best Practices and Safer Alternatives

Against indoor pests, the best offense is a good defense. The first step is to make the house—especially the kitchen—unattractive to insects by cleaning up food spills immediately, keeping hard-to-reach areas reasonably clean, and removing clutter that can hide pests. Store foods attractive to pests, such as flour, in the refrigerator, or another sealed location. Water attracts pests, so leaky faucets and pipes should be promptly repaired. Doors and windows should be well screened. Clothes should be regularly cleaned and aired, and properly stored in paper or cardboard boxes sealed against moths.

A number of nontoxic substances can be used to repel insects. Generally, they are highly fragrant or volatile herbs or spices. Powdered red chili pepper, peppermint, bay leaves, cloves, citrus oil, lavender, rosemary, tobacco, peppercorns, and cedar oil can repel various types of insects.

Insects can be trapped and killed without resorting to dangerous chemicals: generally a poison nontoxic to humans is mixed with a food that insects find attractive, and spread in the infested area. Examples are oatmeal (attractive) and plaster-of-Paris (poisonous), and cocoa powder and flour (attractive) and borax (poisonous). Old-fashioned flypaper—not a hanging strip of insecticide—is an effective trap.

For specific house pests, try these solutions:

- For ants: Sprinkle powdered red chilli pepper, paprika, dried peppermint, or borax where the ants are entering.
- For beetles: Kill manually when you see them.
- For cockroaches: Mix by stirring and sifting 1 ounce TSP (trisodium phosphate), 6 ounces borax, 4 ounces sugar, and 8 ounces flour. Spread on floor of infested area. Repeat after 4 days and again after 2 weeks.
- For fleas: Feed pet brewer’s yeast in powder mixed with food or by tablets.
- For moths: Air clothes well in the sun; store in airtight containers, and scatter sachets of lavender, cedar chips, or dried tobacco in with clothing.
- For rats and mice: Again, prevention may be the best cure. Holes in exterior or interior walls should be closed off and storage spaces kept orderly. Garbage should be kept tightly covered, and food scraps should be made unavailable. To catch rodents, the most efficient system is the oldest: a cat. Next best

are mouse and rat traps.

- For termites: Any wooden parts of the house should be at least 18 inches off the ground, as subterranean termites cannot tolerate being exposed to air and light. They have to build easily visible mud tunnels to get at available wood. Metal shields may help discourage termites, but they cannot prevent infestations.

Workshop/ Painting Supplies

Common Ingredients and their Hazards

- *Glues and adhesives* (may contain naphthalene, phenol, ethanol, vinyl chloride, formaldehyde, acrylonitrile): Glues, rubber cement, epoxy, and other adhesives contain a solvent which, when applied, evaporates out leaving the solid adhesive portion behind. Often this solvent is hazardous. Many adhesives are extremely flammable. Some adhesives are skin and lung irritants and allergy-sensitizers while others can cause burns to skin and eyes. Many of the solvents used in adhesives and glues have narcotic, possibly fatal, effects when inhaled in high concentrations. Inhalation of fumes from cured epoxy resins may result in coughing and bronchial spasms for several days. Vinyl chloride and acrylonitrile cause liver dysfunction, and are suspected carcinogens. Formaldehyde (preservative in many household products, glue in particle board and plywood furniture) is a probable human carcinogen. Levels of formaldehyde in air as low as 0.1 ppm (0.1 part formaldehyde per million parts of air) can cause watery eyes, burning sensations in the eyes, nose and throat, stuffy nose, nausea, coughing, chest tightness, wheezing, rashes and allergic reactions.
- *Oil or enamel based paints and varnishes*: With the exception of latex paint, which has water as a solvent, solvents commonly used in paints include mineral spirits (naphtha), toluene, xylene, and other petroleum distillate solvents. These solvents can irritate your eyes, skin, and lungs. Inhaling paint fumes can result in headaches, nausea, dizziness, and fatigue. Toxic fumes can accumulate in closed spaces and areas with poor ventilation. Acute and chronic symptoms include muscle weakness, liver and kidney damage, and respiratory problems.

Due to the high solvent content of oil-based paints and varnishes, women should avoid using these products while pregnant.

- *Paint thinners* (may contain toluene, turpentine, ethyl acetate, mineral spirits): Turpentine and mineral spirits are commonly used in thinning paints and varnishes. Both ingredients are flammable and toxic, though mineral spirits are of lower toxicity. Mineral spirits, a petroleum distillate, can be harmful through inhalation, skin and eye contact, and ingestion. Contact and inhalation can cause eye, nose, and throat irritation, dizziness, and dermatitis. Ingestion can induce central nervous system depression. Damage to lungs may result if mineral spirits are swallowed and then vomited. Turpentine, a sticky mixture of resin and oil obtained from pine trees, is an irritating substance that can cause tissue death as well as damage to kidneys. Intoxication from vapors produces central nervous system depression with possible symptoms of headache, nausea, confusion and disturbed vision. Continued inhalation of vapors can cause a predisposition to pneumonia and chronic kidney inflammation. Vapors even in low concentrations can irritate eyes, nose, and throat.
- *Paint/varnish removers*: Most paint and varnish removers contain organic solvents which are hazardous to human health. Most are highly flammable. Some nonflammable products will produce a toxic gas when in contact with flame. Paint and varnish removers may contain some of these hazardous ingredients: acetone, benzene, isopropyl alcohol, methanol, methylene chloride, petroleum distillates, toluene, trichloroethane, and xylene. Although not presently used in paint and varnish removers, benzene, a known human carcinogen, was an ingredient in older products. Hazardous ingredients in paint and varnish removers can harm your body through skin contact, skin absorption, ingestion, and inhalation. A common ingredient, methylene chloride, is a powerful narcotic which break down in the body to form carbon monoxide, potentially resulting in oxygen deprivation. The use of paint and varnish removers containing methylene chloride by people with heart conditions has resulted in fatal heart attacks. Methylene chloride is also a known animal carcinogen

and a suspected human carcinogen.

- *Photography chemicals:* The most commonly used solutions are developer, fixer, and stop bath. Photography chemicals that require special handling include intensifiers, dyes, and toners, which may contain selenium, uranium, iron, gold, and platinum. Color film processing is more complex. In particular, the developing baths of color transparency and color negative processing and home color printing require special precautions. Many chemicals used to develop photographs are corrosive and can cause skin, eye, and lung irritation. Inhalation and skin contact are the primary routes of hazardous exposure. These chemicals are toxic if swallowed. Acids used in developing can burn and blind you. Products which contain benzene, a known cancer causing agent in humans, can be especially hazardous. Photography chemicals have a longer shelf life in a powder form than in liquid concentrate, but the powder form does produce dust when poured and can possibly form vapor droplets. These droplets are easily inhaled and can carry photography chemicals into the lungs.

Best Practices and Safer Alternatives

- *Glues and adhesives:* The safest glues on the market are white glue, library paste, yellow wood glue, and glue sticks. White glue effectively bonds most porous and semi-porous materials such as paper, cloth, wood, and pottery. White glue can also be used for big jobs such as laying hardwood floors. Use white glue, glue sticks, or yellow glue when ever possible. Never use toxic adhesives on laminated cutting boards, bowls, or a product which contacts food. Carefully read the label. Wear protective gloves with adhesives and cements. If the glue contains solvents, use only in a well ventilated area with plenty of fresh air. Avoid wearing soft contacts, which may absorb solvent vapors. If the adhesive is flammable be certain to extinguish sources of ignition (such as pilot lights) if you will be using a large quantity of the solvent in a room where a source of flame is located. Keep the lid tightly closed when the glue is not in use. However, if the glue or adhesive has hardened, it may be thrown in the trash destined for the landfill.
- *Paints:* If possible, use latex paint rather than oil-based or other paints that require a

solvent to clean up. Not only will you eliminate the hazards from the solvents in the paint, you will eliminate the need to use additional solvents to clean brushes. Wear protective gloves. If you need to clean oil-base paint from your skin, massage with a few drops of baby oil, butter, or margarine. Wipe dry and wash with soap and water. Whenever possible, paint outdoors. When painting inside make sure ventilation is adequate. Use a fan to direct fumes away from the area where you are working and to the out-of-doors. Take plenty of fresh air breaks. Do not place flammable paints near flames, sources of sparks, or areas of intense heat. Never smoke around paints or while painting. Paint is usable if it will mix up when stirred. Oil paint can be usable for up to 15 years. The best way to dispose of paint is to use it up. Some suggestions to use up old paint are to paint boards, signs, dog and bird houses, or use it as an under coat for another project. If your paint has completely dried inside the paint can, can be placed in the trash destined for the sanitary landfill.

- *Paint thinners:* Dirty paint thinner can easily be recycled at home for reuse. Pour the dirty paint thinner into a clearly labeled container with a good seal. Plastic jugs such as milk jugs may not be strong enough to withstand the vapor pressure in a warm environment. Glass jars work well but never use a beverage container because it can be easily mistaken for something to drink. Clearly label the container with the type of solvent and the date. Draw or write a clearly visible warning (such as a skull and crossbones or the word Danger). Store it away from sources of sparks for several weeks to months until the paint sludge settles on the bottom. Carefully pour the clean solvent off the top. This solvent can be reused. Allow the remaining paint sludge to dry completely in a well-ventilated area, outside of your home and away from pets and children. When all of the liquids have evaporated, the hardened sludge can be discarded in the trash. Small amounts of dirty paint solvent can be poured into a paint can of the same color and mixed well. This thinned paint can then be used for a second coat or another project. The best way to get rid of left over paint thinners is to use them as intended or find someone else who will.

- *Paint/varnish removers:* Never use paint and varnish removers containing benzene. If you have a heart condition, do not use products containing methylene chloride. Follow label directions carefully. Do not smoke while using these products. Do not use paint and varnish removers near flames, sparks, sources of ignition, or areas of intense heat. Beware of using paint and varnish removers when the gas furnace is operating. The vapors may destroy your furnace by corrosion and the pilot light can ignite the vapors which will then explode. Wear protective gloves and safety goggles. Work outdoors and in the shade. If you must work indoors, be sure to have adequate ventilation. Take plenty of fresh air breaks. If you can smell the product, you are inhaling the solvents and should wear an approved respirator with an organic solvent cartridge. Never use paint and varnish remover to clean your hands
- *Photography chemicals:* Always read and follow the product label instructions. Wear protective gloves, safety goggles, and an organic vapor respirator and cover all exposed skin. Photography product manufacturers recommend at least 10 air changes per hour for workrooms and recommend exhaust ventilation for the processing and mixing tanks. A canopy-type exhaust hood should be sufficient for photograph development done occasionally in the home; using a bathroom-type exhaust fan is not adequate. Be sure the exhaust fan draws fumes away from you and the work area. When mixing chemicals, always add acid to water; i.e. never add water to acid. Avoid products containing benzene. Store acids in nonmetal, unbreakable containers. Store all chemicals in nonbreakable containers or place bottles inside plastic containers and clearly mark the contents on the outside. Label the working (diluted) solution with the date it was mixed up in order to avoid using outdated solutions. It is best to use up your chemicals or check with a school or photographic materials supplier to see if they can use your unwanted supplies to avoid disposing of these materials. If you have color photography chemicals and solutions contact the manufacturer for disposal instructions. Kodak has a referral number for its products (1-800-242-2424 [USA]; ask for environmental/technical services).

Medical/ Infectious Waste

Hazards of Medical/ Infectious Waste

- *Mercury Thermometers:* Mercury has become a contaminant of great concern. Mercury is found in the air, waterways, lakes, and the ocean. Mercury is readily absorbed into your body when you touch it; it also easily evaporates into the air. If you are near enough to touch mercury, for instance after a mercury thermometer breaks, you are most likely also inhaling mercury. Broken thermometers containing mercury are only one source the mercury in the environment. It is also released by the combustion of coal for electricity, improperly discarded fluorescent lights, electrical switches and other mercury containing products. Mercury may be transported from the air to soil and water by rain. In humans, mercury vapor affects the nervous system, lungs, kidneys, skin, and eyes. In waterways, mercury builds up in fish tissue and increases in concentration as it is transferred along the food chain. Mercury that has accumulated in fish tissue is passed on to wildlife and to humans. Mercury can have a permanent impact on fetal and child development.
- *Infectious waste* (sharps, bandages, wound dressings, etc.) is any waste capable of producing an infectious disease in a susceptible person. Improper disposal of these wastes carries the risk of infection, can physically injure unsuspecting people that come in contact with it, and can pollute the environment. Infectious wastes include items like sharps (needles, syringes, lancets) and contaminated bandages and dressings. In general terms, sharps waste means any device having acute rigid corners, edges, or protuberances capable of cutting or piercing, such as hypodermic needles, hypodermic needles with syringes, blades, needles with attached tubing, syringes. It is important to remember that your community's solid waste may be handled by people at recycling facilities, landfills, or dumps. These people could be stabbed by needles that poke through clothing, including heavy gloves and boots. This could result in serious injury, including infection by pathogens either from the needle user, or by pathogens that adhere to a needle after it is disposed.
- *Pharmaceuticals/ medications:* Although not yet

extensively studied, the presence of pharmaceutical compounds in the environment (particularly drinking water supplies) has been causing a greater concern around the world. As the prevalence and consumption of medications continues to increase, so too does their concentration in the environment, albeit in very sub-therapeutic concentrations. The effects of this 'new' form of pollution are not presently known, although it is agreed that aquatic life is affected the most. It should be noted that, unlike other chemicals which enter the environment, medications are created to be maximally biologically active, meaning they are designed to affect living things.

Best Handling and Disposal Practices

- *Mercury spills:* If a mercury spill (as from a broken thermometer) is not promptly and thoroughly cleaned up, then the mercury will eventually volatilize and might reach dangerous levels in indoor air. The risks increase if a vacuum cleaner is used (as the mercury will be vaporized and broadcast), or if the mercury is heated for some reason. The danger of significant mercury exposure is greatest in a small, poorly-ventilated room. Thus, even small mercury spills must be cleaned up properly. The following procedure should be followed as closely as possible:
 - i) Increase ventilation in the room with outside air and close the room off from the rest of the house. If available, use fans for a minimum of one hour to help ventilate the room.
 - ii) Pick up the mercury with an eyedropper or scoop up beads with a piece of heavy paper (e.g., playing cards, index cards).
 - iii) Place the mercury, contaminated instruments (dropper/heavy paper) and any broken glass in a plastic zipper bag. Place this zipper bag in a second zipper bag and then in a third zipper bag (triple bag), tightly sealing each bag. Place the bags in a wide-mouth, sealable plastic container.
 - iv) Call your local health department for the nearest approved mercury disposal location. If disposal at such a location is not possible, dispose of the plastic container with the solid waste.
 - v) If weather permits, leave windows open for approximately two days to assure the area is completely ventilated.
- x DO NOT use household cleaning products to clean the spill, particularly products that contain ammonia or chlorine. These chemicals will react violently with mercury, releasing a toxic gas.
- x DO NOT use a broom or paint brush to clean up mercury. It will break the mercury into smaller beads and spread them around.
- x DO NOT use an ordinary vacuum or shop vacuum. The vacuum will put mercury vapor into the air and increase the likelihood of human exposure.
- x If possible, exchange any mercury thermometers with non-mercury containing thermometers to prevent the possibility of spills in the future.
- *Infectious waste:* Since household hazardous waste programs and mail-back programs are likely to be unavailable or unaffordable to your community, needles and other sharps can be placed into a strong plastic or metal container with a tight cap or lid, such as a plastic bleach jug, plastic liquid detergent bottle, coffee can, or etc. Seal the container with strong tape and clearly label it to indicate that infectious sharps are enclosed. Dispose of the container with the rest of your community's solid waste. Be sure that this container is not sent to be recycled! Soiled bandages, dressings and disposable sheets should be placed in securely fastened plastic bags before being placed in your regular trash.
- *Medications/pharmaceuticals:* Pharmaceuticals, including over-the-counter drugs and prescription medicines, can usually be disposed of safely without presenting a threat to the environment, as long as they are kept out of water. Out-of-date or otherwise unusable or unwanted household medicines may be disposed of in the trash if the materials are securely wrapped to minimize tampering. Your community might check to see if there are any medication collection or exchange programs available that could help keep the drugs out of the environment. Flushing even small quantities of household medicines down the drain is discouraged. Some medicines can disrupt or destroy the useful microorganisms in the sewage treatment system (especially septic tanks)

and/or may pass through the system intact and potentially contaminate downstream water resources.

Electronic Products (e-Waste)

Hazards of Electronic Waste

Electronic waste results when products containing electrical components such as wiring, circuit boards, motors, transformers, cathode ray tubes, etc., are disposed. Thus, products such as these below are considered components of electronic waste (e-waste):

Household Appliances: Washing machines, Dryers, Refrigerators, Air-conditioners, Vacuum cleaners, Coffee Machines, Toasters, Irons etc.

Office, Information & Communication Equipment: Personal Computers, Laptops, Telephones, Fax Machines, Copiers, Printers etc.

Entertainment & Consumer Electronics: Televisions, VCR/DVD/CD players, Hi-Fi sets, Radios, etc

Lighting Equipment: Fluorescent tubes, sodium lamps etc. (Except: Incandescent or halogen bulbs)

Electric and Electronic Tools: Drills, Electric saws, Sewing Machines, Lawn Mowers etc.

Computers and other electronic equipment are made from hundreds of different materials, both found naturally as well as synthetic. While some naturally occurring substances, such as chromium, are harmless in nature, their use in the manufacture of electronic equipment often results in compounds which are hazardous. These highly toxic compounds are especially harmful to human health and the environment if not disposed of carefully. The table below lists some of the most common hazardous materials that are found in electronics waste. Televisions and CRT monitors contain four pounds of lead, on average (the exact amount depends on size and make). Mercury from

Hazardous Substances Found in Electronic Waste

Substance	Component of Electronic Waste
Halogenated compounds:	
PCB (polychlorinated biphenyls)	Condensers, Transformers
TBBA (tetrabromo-bisphenol-A) PBB (polybrominated biphenyls) PBDE (polybrominated diphenyl ethers)	Fire retardants for plastics (thermoplastic components, cable insulation). TBBA is presently the most widely used flame retardant in printed wiring boards and casings.
Chlorofluorocarbon (CFC)	Cooling unit, Insulation foam
PVC (polyvinyl chloride)	Cable insulation
Heavy metals and other metals:	
Arsenic	Small quantities in the form of gallium arsenide within light emitting diodes
Barium	Cathode Ray Tubes (CRT)
Beryllium	Power supply boxes which contain silicon controlled rectifiers and x-ray lenses
Cadmium	Rechargeable NiCd-batteries, fluorescent layer (CRT screens), printer inks and toners, photocopying-machines (printer drums)
ChromiumVI	Data tapes, floppy-disks
Lead	CRT screens, batteries, printed wiring boards
Lithium	Li-batteries
Mercury	Fluorescent lamps, in some alkaline batteries and mercury wetted switches
Nickel	Rechargeable Nickel Cadmium batteries or NiMH-batteries, electron gun in CRT
Rare Earth elements (Yttrium, Europium)	Fluorescent layer (CRT-screen)
Selenium	Older photocopying-machines (photo drums)
Zinc sulphide	Interior of CRT screens, mixed with rare earth metals

Source: Adapted from EMPA: Materials Science and Technology, eWaste Guide, 2006. <http://www.ewaste.ch>

electronics has been cited as a leading source of mercury in municipal waste. In addition, brominated flame retardants are commonly added to plastics used in electronics.

If improperly handled, all these above toxics can be released into the environment.

Landfilling e-waste, one of the most widely used methods of disposal, is prone to hazards because of leachate which often contains heavy water resources. Older landfill sites and uncontrolled dumps pose the greatest danger of releasing hazardous emissions. Mercury, Cadmium and Lead are among the most toxic leachates. Mercury, for example, will leach when certain electronic devices such as circuit breakers are destroyed, or when fluorescent light tubes are broken. Lead has been found to leach from broken lead-containing glass, such as the cone glass of cathode ray tubes from TVs and monitors. When brominated flame retarded plastics or plastics containing cadmium are landfilled, both PBDE and cadmium may leach into soil and groundwater. In addition, landfills are also prone to uncontrolled fires which will release toxic fumes if these electronic components are burned. Thus, to the extent possible, electronics waste should be prevented, and older electronics should be reused and recycled.

Best Handling and Disposal Practices

Because there are many valuable substances (mostly metals) in electronic devices, recycling operations are increasingly being established throughout Latin America. Nevertheless, many recyclers are not operating in a sustainable manner; in fact recyclers can easily increase the amount of pollution produced by the waste being processed. For example, some recyclers will burn the PVC insulation off wires in order to isolate the metal (e.g. copper). Burning PVC however, releases corrosive gases when burnt and also induces the formation of dioxins. Thus, if your community is able to locate an electronics recycler, some preliminary questions regarding the sustainability of their operation would help to assure you that utilizing their services is indeed an advisable decision.

Some countries, most notably Switzerland and the European Union members, have implemented Producer Responsibility plans which guarantee that consumers can return electronic products to collection points so that the manufacturer can resume responsibility for the product's disposal, reuse, or remanufacture. You may want to discover

whether any such program is being developed or advocated in your country or region, and join in the effort to successfully implement the program.

If there are no environmentally safe recycling options available, your community may try to contact the manufacturer directly to ask what take-back options they offer.

Now, review and consider the information presented above for the various types of hazardous products that your community uses and disposes of in order to evaluate your community's practices with the questions below:

Our community strives to continually have identified all the hazardous products that are in use in our community.

1 2 3 4 5 6 7 8 9

Our community strives to eliminate the use of hazardous products.

1 2 3 4 5 6 7 8 9

Our community strives to label, safely handle, and store all hazardous products in our community.

1 2 3 4 5 6 7 8 9

Our community strives to educate all its member about the dangers and proper handling of products used in our community, especially those members who use them regularly.

1 2 3 4 5 6 7 8 9

Our community strives to keep hazardous products out of our local landfills and/or dumps.

1 2 3 4 5 6 7 8 9

3. Quantities and Priorities

The intention of this question is simply to facilitate your community's prioritization of goals regarding household hazardous waste. As well, the collection of this information will aid in the task of presenting this information to the membership or leadership of your community. Those wastes that are produced most, and/or those products which have caused noticeable harm should be considered the highest priority.

4. Legislative Policy Framework and Regional Resources

Perhaps the most powerful means of improving society's hazardous waste disposal practices is to

implement legislated policies at a governmental level which either mandate producer responsibility or require certain actions of the citizens. Keeping hazardous waste out of the environment is of utmost importance for our health and the health of the next generations. Thus, your community is encouraged to support, in any way possible, legislative efforts towards achieving this goal. Producer responsibility for both labeling and end-of-life product take-backs, are policy tools that have already been implemented with success in several countries throughout the world. Laws which govern the behavior of citizens (such as mandatory recycling) are most likely to be effective only after the population has been educated about the environmental and health consequences of hazardous waste, but such education can easily be incorporated into existing curricula. This could be a very simple but meaningful contribution by members of your community, if any are already involved in educations.

Inventorying the existing recycling resources provides a service to both your religious community, but also to your greater community if you are able to share the information obtained. You may be surprised to learn how many resources already exist, but of which people just simply are not aware. Disseminating this information may be the most important thing your community can do to address the critical hazardous waste problems.

Our community has compiled a thorough list of applicable laws and resources pertaining to household hazardous waste.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right

score

1. Identification of hazardous products	
1. Reducing use of hazardous products	
2. Handling and storage of hazardous products	
2. Community Education	
2. Disposal of hazardous products	

4. Compendium of legislative & regional resources

Now that you have comprehensively examined your hazardous products and waste handling practices, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Now categorize each problem listed above into one of the following three categories:

I = Critically important. Currently dangerous, must be addressed immediately

II = Important, but not immediately dangerous. Must be addressed

III = Current practice should be improved, but is not immediately important

Acknowledgements for Chapter Four

The information contained in this chapter has been adapted from the following sources:

Andrews, Richard N; Lord, w.B.; O'Toole, L.J.; and Requena L.F. Guidelines for Improving Wastewater and Solid Waste Management. Environmental Health Project, 1993. WASH Reprint: Technical Report No. 88. EHP, Arlington, Virginia, U.S.A. Available online.

Arroyo, J; F Rivas; I. Lardinois. SOLID WASTE MANAGEMENT IN LATIN AMERICA: The Role of Micro- and Small Enterprises and Cooperatives. IPES, ACEPESA, WASTE (Urban Waste Series, 5), 1999. ACEPESA: Apartado 1257-1002, San Jose, Costa Rica.

Agency for Toxic Substances and Disease Registry. ToxFAQs. Center for Disease Control. Available online (also in Spanish) at <http://www.atsdr.cdc.gov/toxfaq.html>. 2005.

Brikké, François. Operation and Maintenance of rural water supply and sanitation systems. IRC International Water and Sanitation Centre, 2000. Available online: <http://www.irc.nl>.

Franceys, R, J Pickford & R Reed. A guide to the development of on-site sanitation. World Health Organization, 1992. Available online: http://www.who.int/docstore/water_sanitation_health/on_sitan.

Jaramillo, Jorge. GUIDELINES FOR THE DESIGN, CONSTRUCTION AND OPERATION OF

MANUAL SANITARY LANDFILLS: A solution for the final disposal of municipal solid wastes in small communities. Pan American Center for Sanitary Engineering and Environmental Sciences, 2003.

Available online at <http://www.cepis.ops-oms.org>.

Kleinau, Eckhard (EHP) and David F. Pyle (JSI). Strategic Report 8: Assessing Hygiene Improvement, Guidelines for Household and Community Levels. Environmental Health Project. Prepared under EHP Project 26568/CESH.TOOLS.HIQAT, August 2004. Available online.

Purdue University, Agricultural and Biological Engineering Department. 'HOUSEHOLD WASTE MANAGEMENT.' Computer program available for download at <http://www.purdue.edu/dp/envirosoft>, or available in an online version at <http://www.purdue.edu/dp/envirosoft/housewaste/src/title.htm>. 2003.

Santa Clara County Materials Advisory Committee. HAZARDOUS WASTE SURVIVAL GUIDE: A Small & Medium Business Resource for Hazardous Waste Reduction Management. Available online: <http://www.westp2net.org/hazwaste/>.

Simpson-Hebert M & Wood S, eds. (1998) Sanitation Promotion. Geneva, World Health Organization/ Water Supply and Sanitation Collaborative Council (Working Group on Promotion of Sanitation) (unpublished document WHO/EOS/98.5). Available online: <http://www.who.int>.

Winblad, Uno. 'Towards an ecological approach to sanitation.' Ibid.

WSSCC. 'The Challenge—A sanitation revolution.' Ibid

UWEP. Hazardous Waste: Resource recovery of

household batteries, photographic materials and used motor oil. Edited by I. Lardinois and A.v.d. Klundert. WASTE - Urban Waste Expertise Programme, 1995. Available online: <http://www.waste.nl>.

United Nations Environment Programme. International Sourcebook on Environmentally Sound Technologies (ESTs) for Municipal Solid Waste Management (MSWM). Technical Publication No. 6. UNEP/DTIE/IETC. November 1996. Available online.

UNEP/DTIE/IETC. International Source Book on Environmentally Sound Technologies for Wastewater and Stormwater Management. International Environmental Technology Centre; United Nations Environmental Program, 2000. Available online: <http://www.unep.or.jp/ietc/Publications/TechPublications/>

WHO. Healthy Villages: A guide for communities and community health. World Health Organization, 2002. Available online from: http://www.who.int/water_sanitation_health/hygiene/settings/healthvillages/

WHO/ILO/UNEP. Guidelines on the prevention of toxic exposures: Education and public awareness activities. International Program on Chemical Safety, World Health Organization, 2004. Available online: <http://www.who.int/ipcs/publications>.

Resources for Chapter Four

Internet Resources

Agency for Toxic Substances and Disease Registry (ATSDR) <http://www.atsdr.cdc.gov/toxfaq.html>

Part of the mission of the Agency for Toxic Substances and Disease Registry (ATSDR), as an agency of the U.S. Department of Health and Human Services, is to serve the public by providing trusted health information to prevent harmful exposures and disease related to toxic substances. Their ToxFAQs (TM) is a series of summaries about hazardous substances that are easy to understand guides about exposure and its health effects. These are available in Spanish. The Agency can be contacted toll free at: 1-888-422-8737.

Asociación de Entidades de Aseo Municipal (ASEAM) Telephone: 591-2-431946 Email: gtzaseam@ceibo.entelnet.bo

The main mission of ASEAM is to strengthen municipal waste agencies and to promote the establishment of small-scale enterprises for difficult-access areas. This mission is accomplished through training and provision of information of personnel in municipal agencies. ASEAM is also working on strengthening the, fee collection system. ASEAM also produces videos and pamphlets on public consciousness development on the need to pay waste collection fees, as well as the need to improve MSW handling behaviour.

Asociación para la Promoción del Saneamiento Ambiental en Comunidad (APROSAC)

<http://www.panenet.com/aprosac/>. Telephone: 507-263-3370

APROSAC, an NGO established in 1995, develops integrated solid waste management projects and promotes the development of small-scale basic

sanitation enterprises. APROSAC organises workshops, provides professional services, and develops training programs on this subject.

Compromisso Empresarial para Reciclagem (CEMPRE) <http://www.cempre.org.br/> <http://www.cempre.org.uy/>

CEMPRE surge con el fin de constituir una institución que colabore con la promoción de proyectos educativos y de investigación, y en el establecimiento de vínculos entre la comunidad científica, autoridades, instituciones públicas y privadas, contribuyendo a la búsqueda de caminos posibles hacia el manejo integral de los residuos, en particular del reciclaje de los mismos.

Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente (CEPIS) <http://www.cepis.ops-oms.org/>

CEPIS is a specialised centre of the Pan American Health Organisation, which provides technical assistance, training, and information to countries in the Latin American region on several topics, including MSW. A very large document library. Telephone: 51-1-437-1077

Companhia Municipal de Limpeza Urbana <http://www.rio.rj.gov.br/comlurb/> Telephone: 55 21-2204-9999

COMLURB is part of the Municipality of Rio de Janeiro, but it functions as a private enterprise. It is responsible for solid waste collection and disposal in this city. COMLURB also does research in landfill development and gas use. As part of this program, it is presently using landfill gas to power light transportation equipment. It has also developed compost and recycling systems on a pilot level. The enterprise also manufactures waste collection equipment. It evaluated the implementation of an incinerator, but determined that it was not feasible. COMLURB has an open library specialising in solid waste.

Department of Water and Sanitation in Developing Countries <http://www.sandec.ch/>

SANDEC is involved in applied research, capacity building, and training to contribute towards integrated, and sustainable solid waste management systems, new concepts, transdisciplinary approaches and cross-sectorial technologies.

Instituto Brasileiro de Administração Municipal <http://www.ibam.org.br/> IBAM is an NGO working on the improvement of municipal management in Brazil. It has a group that works on solid waste, providing technical assistance on technologies and management, training courses and documents on the subject. IBAM has developed a Manual on Public Cleansing and a Manual on Recycling, focusing on the role of municipalities. IBAM carries out studies for municipalities and other organisations on MSW.

Recuperar Telephone: +57-4-372-0720 Email: recuperar@epm.net.co Recuperar is a recycling cooperative that has had a significant impact on the perception of recycling in Colombia. It has shown that recycling can have significant social and economic, as well as environmental, benefits. Recuperar initiated its activities as a result of the need to provide jobs for landfill waste pickers who had been displaced as a result of the closure of the Medellín city dump. The organization trains and provides health and life insurance benefits to its members, who number over

700. As a result of this success, a number of cooperatives have been created in other cities in Colombia. Recuperar publishes information on its activities as well as public information and education materials.

Red de Accion en Plaguicidas <http://www.rap-al.org/> Pesticide Action Network (PAN) is a network of over 600 participating nongovernmental organizations, institutions and individuals in over 90 countries working to replace the use of hazardous pesticides with ecologically sound alternatives. The international internet page is <http://www.pan-international.org>. The Latin American regional center, coordinated by the Alianza por una Mejor Calidad de Vida, can be contacted by telephone at 562-3416742.

Sanitation Connection: An environmental sanitation network <http://www.sanicon.net/> Sanitation Connection is an Internet-based resource that provides access to accurate, reliable and up-to-date information on technologies, institutions and financing of sanitation systems around the world. Institutions of international standing contribute to the information base by providing and maintaining a topic of their specialization. It is a World Wide Web-based resource intended to facilitate access to information on sanitation. It aims to extend its reach through paper and telephone-based services in selected locations. In the first phase of its development, it is predominantly English language in orientation. Information in other languages will be increasingly available as it develops further.

Silicone Valley Toxics Coalition—E-Waste Backgrounder <http://www.svtc.org/> Silicon Valley Toxics Coalition (SVTC) is a diverse grassroots coalition that engages in research, advocacy, and organizing around the environmental and human health problems caused by the rapid growth of the high-tech electronics industry. Available in English only.

Software for Environmental Awareness <http://www.purdue.edu/dp/envirosoft/>

Alternative link: <http://www.epa.gov/seahome>. Free interactive software on environmental topics. These programs are produced by Purdue University in cooperation with US EPA. Included here are programs on Household Waste Management. Some information available in Spanish.

WASTE: Advisors on Urban Environment and Development: <http://www.waste.nl/> WASTE advises in sustainable improvement of the urban environment. The focus of activities is on low-income urban areas in order to develop, together with local residents, tools and means for their own development, enabling them to improve their living conditions, the environment and to create employment as a sound economic base for their future. Another important focal point for WASTE the role of small-scale entrepreneurs and their (potential) contribution to the provision of urban services and their integration in the municipal services e.g. in resource recovery and the removal of urban waste.

Water, Engineering and Development Centre (WEDC): <http://wedc.lboro.ac.uk/> WEDC is concerned with seeking solutions to the serious problems associated with inadequate collection and poor disposal of waste in low- and middle-income countries where indiscriminate dumping of waste creates serious health

and environmental hazards and blocks drains and sewers.

World Health Organization - division of Water, Sanitation and Health:

http://www.who.int/water_sanitation_health/ The aim of the WSH division is the reduction of water- and waste-related disease and the optimization of the health benefits of sustainable water and waste management, with an objective of assisting citizens to understand and act on the health impacts of their actions. WHO has hundreds of full text manuals available on-line and by order. The Pan American Health Organization is the

regional division of the WHO. National office listings can be found at the end of the previous chapter.

zoomZap: Resources from Chiapas, Mexico
<http://www.zoomzap.com/>

The goal of ZoomZap is to provide practical ideas and tools for achieving a more just and sustainable world and for living freer, more fulfilling and more independent lives in healthy communities. Their 'Manuals Project' features a very detailed manual on dry composting toilets.

Chapter 5

Energy Assessment

Energy: The Animation of the Universe

Energy is the force behind movement. It is the power that gets work done—work being movement through resistance. It is the force we get from food, that we feel as heat, that we see as light, and hear as sound. It is the mechanical power of an engine, a system of levers, or the volume and intensity of your voice.

We tend to think of energy as being apart from matter. Matter is the stuff that has mass, or weight, and texture. Energy is what makes it move, get warmer, do work, etc. But, any physicist will tell you that energy is not that simple. Indeed, it is a fascinating entity.

It turns out that ultimately, all matter is energy, and all energy is matter. If you look at them very closely, the two entities are indistinguishable. In short, this means that the entire physical universe is made of energy.

Properties of Energy

In all but the notable exception of nuclear reactions, the total amount of energy in a closed system remains the same, or is ‘conserved.’ This means that energy is continually changing into various forms (e.g. light, heat, movement, magnetism, electricity, X-rays, etc.), but never disappearing from the universe.

The Earth is not a closed system, as the sun is continually showering energy onto the Earth. Nevertheless, the energy does not disappear once it hits the Earth. Instead, it is converted into all sorts of other forms, including life (or bio-mass), heat, light, electricity, and many other forms of energy.

The exception to the conservation rule occurs in the case of nuclear reactions. In these reactions matter ‘becomes’ energy. Nuclear reactions convert a small bit of matter into a tremendous amount of energy. These are some of the most powerful reactions known in the universe. There are two types of nuclear reactions: nuclear fusion, and nuclear fission.

The energy for all the life on earth, the sun, is

the result of nuclear fusion reactions taking place billions of kilometers away. The nuclear bomb is one of the only earthly uses of nuclear fusion. An example of nuclear fission, or the splitting an atom, is the atomic bomb. The same type of fission reaction is used in a ‘controlled’ manner to create electricity in many generation plants around the world. It turns out that one of the most dangerous waste products of nuclear generation, plutonium, is the raw material for the nuclear weapons that threaten the continued existence of human life on earth.

Many Forms of Energy

There are many different ways by which energy can express itself. It may be the light emitted by a star, a flashlight, or a phosphorescent animal, or it may be in the form of ‘invisible’ radiation like gamma rays, X-rays, or radio waves. It may be in the form of wind, or the movement of the atoms of the air. It might be mechanical or physical, as in the form of a spring, a lever, or a rolling stone.

Energy can also be stored; i.e. there is ‘potential energy’ that can create force, but isn’t doing so at the moment. Electricity can be stored in the form of a battery, or, similarly, physical/mechanical energy is stored in a rock on top of a cliff.

Energy is stored in the structure and organization created by life forms, and in the structure of chemical bonds. When these structures are broken or changed, energy is either released or absorbed, depending on the type of reaction.

Heat is the vibrational energy of matter. The faster the atoms are vibrating, the higher the temperature.

Energy is continually converted from one form into another. For example, the sun’s energy may be converted into bio-energy in the form of a plant (which includes all sorts of chemical reactions), which is then made into food for us, or into light and heat if it is combusted. The sun’s energy can be focused into a point that becomes very, very hot. The movement of air, or wind, can be made to force wheels and shafts to turn (like a windmill).

Humans also use steam energy, which is using the force of pressurized steam to do work, like to power a locomotive, or to turn a turbine.

Truly, energy is a Sacred Gift, and we have many uses for it. A few of the most important uses include the basic services of cooking, heating, lighting, space conditioning, and safe storage of food. In addition, the provision of clean water and sanitation, which is facilitated by energy, affects public health in cities as well as rural areas. Societies also require services such as transportation, power for industry and agriculture, and heat for materials processing.

Energy is essential to economic and social development and improved quality of life. Much of the world's energy, however, is currently produced and consumed in ways that could not be sustained if technology were to remain constant and if overall consumption continues to increase substantially.

Electricity, a Special Form of Energy

Electricity is the flowing of electrons, or negatively charged particles through a medium. The medium is then said to be 'conducting' electricity; or, in other words, it has electrons flowing through it.

Electricity occurs naturally, for example, as lightning. Lightning is an electric charge traveling through the atmosphere. Electricity also can be produced by humans. Electricity is an extremely versatile, clean and 'user-friendly' form of energy. There is an almost limitless range of applications for electricity. Electrical motors provide shaft power that can be used for a multitude of industrial and agricultural activities, as well as for transport. Lights allow us to peer into the dark, which has greatly impacted the lives of humans. Batteries allow electricity to be stored for periods when it will be required for any of these purposes.

The social impact of introducing electricity to a region is enormous. There are the obvious benefits of improved social services; lighting at health centres, hospitals and schools, refrigeration of vaccines, etc. There are other social gains such as street lighting, cinema and television, community services such as milling of grain, sawmills or battery charging (often an alternative to grid connections).

Electricity: Modern 'Utility'

Electricity is most commonly produced by

converting an energy source into mechanical shaft power, which in turn drives a generator which produces electricity. The energy source can vary depending on the available resources. Typical sources include fossil fuels, nuclear fuels (rare in Latin America), hydro power (very prevalent in Latin America), solar power, wind power, geothermal, etc.

Traditional thermal power generation uses oil, coal or gas to produce heat which in turn is used to create steam which drives a steam turbine. The turbine provides the mechanical power for the generator. Similarly, nuclear power generation uses nuclear fuels such as uranium, which undergo nuclear fission in a reactor, to provide heat to drive the turbine. Hydropower uses the stored or potential energy of water which has a 'head' or height above a certain point. The water is dropped through a turbine which provides shaft power for directly driving a generator. Windpower uses a similar principle but the energy is extracted from the wind to drive the turbine. Geothermal energy is heat energy stored in the earth's crust which can be tapped to heat water for driving a turbine. Solar energy for providing electricity can be derived using one of two methods.

Heat from the sun can be concentrated to drive a steam turbine, or the more popular method uses the photovoltaic (PV) principle to convert sunlight directly into electricity. Solar and wind technologies are not used on a widespread basis for producing electricity which is fed into large grid systems, though examples do exist.

In the Latin American region, as far as electricity is concerned, the predominant source is hydro (i.e. water) energy. The region holds 19% of total world hydropower potential, with Brazil having the largest share and the largest installed capacity.

Mexico has the most conventional fossil fuel electricity generation in the region. Nuclear power is a reality in only three countries: Argentina, Brazil and Mexico. Geothermal electricity generation only contributes marginally to the total, with Mexico having the largest installed capacity. Sugar cane biomass is the most important source of commercial biofuels. Non-commercial biomass (e.g. dung, agricultural residues, wood, etc.) as a direct fuel is very important in rural areas; it is estimated that it contributes about 8% of the energy supply of the region.

The Grid and Social Inequality

Latin America has the highest electricity coverage (84%) of any region in the South. This high electricity service coverage disguises the fact that approximately 75 million people still lack it, mostly in the countryside. Indeed, about 60% of the rural population has no access to electricity. Much of the energy consumed in the countryside is still 'traditional' (mainly burning of biomass materials in cooking). These traditional practices, which involve unsustainable consumption of resources, not only cause major damage to the environment by reducing vegetation and forest cover; but also cause severe respiratory health problems, particularly in women and children. Despite the fact that the rural population without access to electricity has been dropping in absolute terms over the past 20 years in Latin America, the shift to modern forms of energy is not occurring as rapidly as it could be.

Cost of Rural Grid Connection

There are many constraints to rural grid based electrification. Firstly there is the question of cost. The cost of grid connection is influenced by the voltage and proximity of the grid and whether there is a step down transformer already serving the area in question. Capital cost of the distribution system is very high and demand in rural areas is very low. Households can be widely dispersed and often rural consumers will want to use only a few light bulbs and a radio in the evening. The cost-benefit relationship shows that there is little incentive for an electricity producing utility to extend the grid into remote rural areas. Often rural regional centres will be electrified but the network will usually stop there or bypass the more remote villagers as high voltage cables passing overhead.

Other barriers to grid connection

Although introduction of electricity to a community often stimulates income generating activities and hence a gradual increase in the uptake of electricity use, the conditions for introducing electricity do not normally exist in rural areas, since most commercial and industrial activities are concentrated at the regional centres.

In many countries the existing generating capacity is unable to cope with demand.

Blackouts are a common occurrence in many major cities, especially as the process of rapid

urbanisation continues. The utilities often find it difficult to cope with the existing demand, let alone to think about catering for an increased demand from rural areas.

Positive political will and subsidies or loan schemes for rural electrification can remove some of these obstacles but often neither are forthcoming. It seems, therefore, in many countries, that little progress will be made if rural communities are to wait for the grid to reach them. In conclusion we can see that an alternative is required. One such alternative is found in the form of decentralised power generation using renewable energy technologies. Another alternative, which is used widely, is to utilise small diesel generating sets to provide electricity for local networks.

Producing Electricity, Creating Catastrophes?

What catastrophes?—Hidden Costs of Electricity

Often, the cost of electricity is relatively small when compared to other household expenses. That is because the real costs of generating electricity are usually hidden and unaccounted for. The electric power industry is the largest toxic polluter in the world. Producing electricity from coal and oil releases a wide range of pollutants into the environment. In addition to toxic air pollution from power plant smokestacks, large volumes of toxic chemicals are produced at coal and oil-fired power plants and include millions of tons of solid and liquid wastes that are typically disposed of at or near the power plants that generate these wastes. Unfortunately, soot emissions from coal-burning power plants, diesel fumes emitted by portable generators, and other pollution emitted by generation are 'social costs' that usually are not incorporated into the cost of the service.

For example, an old coal-fired power plant might produce cheaper electricity than a new natural gas-burning plant, because the plant requires more expensive equipment and more expensive fuel; but if the coal emissions are fouling the local town's air, and the cost of that pollution is included in the electricity pricing structure, electricity from the coal-burning plant would actually be more expensive than the new plant. It is a frequent situation in which energy is priced below its actual social cost.

Burning 'fossil fuels' (coal, gas, oil) is one of the most common methods of generating electricity. Burning any fossil fuel releases a great deal of CO₂

(carbon dioxide) into the atmosphere, which directly contributes to the global warming of the Earth. Of the fossil fuels used, natural gas burns the cleanest, meaning that it only emits water and CO₂; however, other fossil fuels do not burn as purely. Coal is the 'dirtiest' fossil fuel used for power generation. In addition to CO₂, it releases particulate matter (PM), sulfur dioxide (SO_x), nitrogen oxide (NO_x), and carbon monoxide (CO), as well as soot, sludge, and wastewater discharges.

The environmental discharges of these pollutants can be controlled through selection of the fuel and its properties (such as low sulfur coal) as well as operation of the fuel burning process (e.g. use of low-NO_x burners reducing nitrogen oxide emissions) and end of process controls such as use of particulate control equipment (electrostatic precipitators or baghouses) for flue gases or settling tanks for process wastewaters. In addition, ash generated from fuel burning can be managed and disposed of properly so as not to contaminate surface or ground waters. Nevertheless, it is often the case that these controls are not utilized, and even when they are, many produce a large volume of very concentrated, often toxic substances. This is known as toxic waste. Toxic waste disposal practices are another severe environmental problem in many areas.

Besides the environmental reasons that make the use of fossil fuels unsustainable, it is important to recognize that fossil fuels such as coal, oil, and gas are non-renewable natural resources, which take millions of years to form. Therefore, we need to be very mindful if and/or when we consume these fuels so that future generations may continue to enjoy these gifts of the earth.

Hydroelectric dams, the most common form of generation in Latin America, do not release any chemical pollution into the air or water. Despite this fact, dams are often the cause of critical and catastrophic effects to the ecosystem in which they are built. Dams can effectively block all upstream movement by any form of aquatic species. Furthermore, they disrupt the habitats and patterns of behavior of the wildlife that once occupied the land area that becomes a reservoir. Humans are often forced off their ancestral land by governments eager to supply their cities with cheap and 'efficient' electricity.

Dams can be built to a size and in a manner that would produce minimal damage to an ecosystem, and attempts can be made to mitigate the environmental and social impacts that they do

have. Most generally, an environmental assessment is conducted before a dam is constructed to assess the negative environmental and social impacts of the project, and to recommend mitigation measures. Nevertheless, most Latin America dams that are constructed are massive structures erected with little regard to the ecological effects that their construction will cause. All too often the mitigation efforts suggested by environmental assessments are ignored or their implementation is not funded.

Nuclear (fission) energy is currently utilized to produce electricity in about thirty countries, including a few in Latin America. The waste products of this reaction are of the most dangerous, most poisonous, and toxic substances known on earth. Aside from being used as ammunition for weapons of war (nuclear weapons, for example), there are very few known uses for the radioactive residues leftover from nuclear reactions. Thus, the accumulation of nuclear waste, both in dump sites and in armaments of the weapons made from it, is a very serious environmental concern. The radiation from nuclear waste causes a staggering array of mutagenic effects to occur in the world of biology. Besides burns and other direct tissue damage, it can cause disruptions in a living cell's genetic code; thus radiation causes cancer, birth defects, and other chronic conditions. Often nuclear energy is portrayed as 'clean energy' because the direct atmospheric pollution is considerably less than that of a fossil-fuel burning plant. Nevertheless, one can easily question the 'cleanliness' of nuclear power.

The environmental impacts of a host of energy-linked emissions – including those listed above – contribute to local, regional, and global air pollution and ecosystem degradation. Human health is threatened by high levels of pollution resulting from particular types of energy use at the household, community, and regional levels. The effects of this pollution result in significant human illness, like lung diseases, allergies, cancers, as well as having destructive effects on habitats and wildlife.

Furthermore, while economic and social analyses are conducted prior to investments in conventional energy generation, with the vision to reach as many as possible, there are still those who fall outside this vision. Wide disparities in access to affordable commercial energy and energy services in both urban centres and rural areas are

inequitable, run counter to the concept of human development, and threaten social stability. Investments in centralised, capital-intensive conventional energy enterprises such as coal-fired power-generation and large dams in practice largely benefit high- and middle-income urban communities, commercial establishments, and industries through electricity distributed through power grids. Poor, dispersed rural communities that are often far from the grid rarely benefit from such investments. Even in urban areas, low-income neighbourhoods and shantytowns are often not connected to the grid.

The production and consumption of energy causes serious economic crises in many countries that are dependent upon fuel provided by other countries. Dependence on imported fuels leaves such countries vulnerable to disruptions in supply, which can cause physical hardships and economic burdens; however, it is the relative weight of fossil fuels imports on the balance of payments, that is absolutely unbearable for many poorer countries.

Thus, while electricity may be a very desirable utility, the current methods used to generate it are causing many critical environmental and social problems.

Sustainable Alternatives

Finding ways to expand energy services while simultaneously addressing the environmental impacts associated with energy use represents critical challenge to humanity. Major changes are required in energy system development world-wide. Resources and technology options exist and are available that meet these challenges—energy efficiency, renewable energy sources, decentralized networking—but they require the creativity, advocacy, and implementation by communities like yours to make sustainable energy use a reality.

As mentioned earlier, one of the main obstacles to national grid connection in remote rural areas is the prohibitive cost of the distribution network. One way of avoiding these costs are to decentralise the power generating capacity and install local small scale, low voltage grids, otherwise known as micro-grids. Localised grid networks allow local, renewable resources to be exploited. Energy sources such as small-scale hydropower, solar (photovoltaic), wind power and biogas are all being employed successfully in rural electrification projects. A growing number of studies find that renewable and other decentralised small-scale

energy technologies (such as diesel motors and hybrids) are important options for poverty alleviation, particularly technologies that are locally made and that operate using locally available fuels (e.g., hydro power, wind power, solar power, and modern biomass resources). Decentralisation of generation also allows control of the system to remain in the hands of the users and removes the dependency on external supplies and market forces. These decentralised energy technologies can be a source of enterprise creation and employment for both the rural and urban poor, and can be competitive and affordable in isolated areas and other markets. Access to decentralised small-scale energy technologies is an important element of successful poverty alleviation.

Keeping Energy Sacred

The assessments that follow will help your community evaluate its policies and practices regarding energy use, most especially the production and use of electricity.

The first assessment, is meant to help you evaluate your community's productive capacity, and your community's relationship to the Earth via your electricity provider. If your community uses diesel or gas-powered generators, completing the Outdoor Air Quality Assessment is recommended. Similarly, if your community uses batteries, it is recommended that you complete the Waste Handling Assessment as well. This assessment should be applicable to your community whether you live in an urban area or a rural area, and as well, whether you have grid electricity or not.

The second assessment is meant to help you evaluate your community's energy consumption practices. The content of this section applies mostly especially to communities that are within an urban area, or are otherwise connected to grid electricity. Nevertheless, it may still be helpful to review the assessment even if your community is rural.

Each question is discussed in the sections following the inventories, where you will be provided a means to evaluate your responses, and directed to resources to help your community improve its energy sustainability.

Electricity Production Practices: Inventory

The following inventory is designed to help you assess your community's present situation in regards to the consumption and generation of electricity. Following the inventory there is an evaluation section that will help you interpret your results.

1 Community Consumption

Is your religious community connected to an electricity power grid?

Yes / No

What is the average amount of electricity purchased from the grid source (answer in kilowatt hours/month)?

If your community uses a fuel-based generator, how many liters of fuel does your community use per month? List all that are used:

Natural gas (methane)L

Kerosene (Paraffin)L

Other bottled gas (LPG)L

GasolineL

BiogasL

Diesel fuelL

OilL

Biodiesel or other liquid bio-fuelL

Other fuel: _____L

If your community consumes non-rechargeable batteries for use, about how much money is spent each month on purchasing batteries?

2 Community Generative Potential

Consider your community's geographical location and property. Assess the following characteristics:

Rate the amount of direct sunlight that is available on

your community grounds, by circling a number 1–9:

1 2 3 4 5 6 7 8 9

no direct sunlight.....consistent direct light

Rate the quantity and quality of wind experienced at your location:

1 2 3 4 5 6 7 8 9

little or no wind...steady breezes...consistently strong wind

Choose a number to represent the quantity of compostable organic matter that your community produces (especially crop residues and animal wastes; consider human excreta):

1 2 3 4 5 6 7 8 9

minimal... (food scraps only) ...large scale agricultural (ton(s)/week)

If your community is situated on or near a body of water, choose a number that represents its volume:

1 2 3 4 5 6 7 8 9

pond.....lake.....ocean

Similarly, indicate the flow of the water:

1 2 3 4 5 6 7 8 9

stagnant.....high-velocity river

If your community has ever had its location explored and assessed for geothermal resources by an expert, how suitable is your location for access to this resource?

1 2 3 4 5 6 7 8 9

prohibitive.....very suitable

Choose a number that describes the amount of your community's property upon which a structure could be built:

1 2 3 4 5 6 7 8 9

no space available...small structure(s) possible...ample space to build (>1000m²)

3 Community Generative Practices

Considering your community's electricity consumption, estimate or specify the percentage of the energy that is self-produced, i.e. generated by your community by means of a generator, water, solar or wind energy:

%

(Portion of self-generated electricity)

If your community generates electricity, which technology(s) do you use?

Wind energy

Active (PV) Solar Panel

Passive Solar

- Hydrological/Water Energy
- Geothermal
- Generator using non-renewable fuels
- Generator using renewable fuels
- None

Who is responsible for the upkeep and maintenance of your generative equipment?

Does the community have a maintenance plan for the equipment?

Yes / No

Does your community include these maintenance expenses as part of the budget?

Yes / No

Does your community share its productive technology with the larger community (either by directly sharing the electricity produced, or by educating about energy production)

Yes / No

If batteries are used by your community, especially as components of a generative system, what types of batteries are used (see page 177-180 for descriptions)?

Primary cells or dry batteries:

- standard zinc-carbon
- alkaline or heavy duty

Secondary cells or rechargeable batteries:

- lead-acid battery
- vented lead-acid
- automotive (car)
- deep-discharge or traction
- stationary
- low-antimony solar battery
- sealed or valve-regulated

Nickel-Cadmium batteries:

- vented
- sealed

Describe the quantity and frequency of replacement (life span) for the batteries that your community consumes:

Battery type	Quantity	Life span (weeks/mo/yr)

How does your community currently dispose of its used batteries?

Is your community educated about the health hazards associated with the particular types of batteries used?

Yes / No

Is your community aware of the environmental risks associated with improper disposal of your batteries?

Yes / No

Notice before continuing

If your community purchases, or electricity is otherwise provided by, an ‘outside’ source such as an electric utility corporation or cooperative, governmental or otherwise, continue on to complete this assessment. Otherwise, if your greater community does not have electrical infrastructure, or your religious community does not use any ‘outside’ electricity, skip the rest of this inventory, and start the evaluation process on page 175, **Electricity Production Practices Evaluation**.

4. Sources of Expert Information

Electricity Utility Provider/Generation Network

It will be helpful to contact the Provider directly to help answer the questions that follow. Thus, record below information specific to your Provider:

Name of Provider:

Contact information:

Contact Person:

When there is a problem with your electricity supply, who do you contact, and how?

Governmental Regulatory Agency

Your government should have an agency/ministry that is responsible for enforcing environmental regulations. If you don’t know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Name of Agency:

Contact information:

Contact Person:

What section(s) of law regulate the environmental emissions of electricity providers?

Expert Public/ Consumer Safety and Health Information Source

It will also be helpful to contact a public/consumer health protection or advocacy group that can provide reliable, expert data on the safety of electricity generation plants. If you don't know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Do you know of a public/consumer protection/advocacy group that can provide reliable, expert data on the safety of generation plants?

Yes / No

Name of Organization:

Contact information:

Contact Person:

Has your community ever contacted or received information from this group before?

Yes / No

According to these experts, what is the most important issue regarding electricity generation that your community should support?

Expert Environmental Information Source

It will also be helpful to contact an environmental protection or advocacy group that can provide reliable, expert data on the ecological impacts of electricity generation plants. If you don't know of one, refer to the List of Categorized References in the back of this manual to help locate one.

Do you know of a environmental protection/advocacy group that can provide reliable, expert data on the safety of generation plants?

Yes / No

Name of Organization:

Contact information:

Contact Person:

Has your community ever contacted or received information from this group before?

Yes / No

According to these experts, what is the most important issue regarding electricity generation that your community should support?

5. Electricity Provider Governance

Does the Provider have a governing body, such as a committee or an elected assembly to make management decisions?

Yes / No

Does your religious community have a member that serves on this governing body, if one exists?

Yes / No / Not Applicable

Do the consumers of the provided energy have the ability to make or influence decisions regarding how the utility is governed (e.g. decisions regarding coverage area, fee structures, changes to the generating facility, etc.)?

Yes / No

If 'yes', Describe the ways in which this influence may be effected:

Are fees established for the service provided?

Yes / No

If so, how were the fees established?

Vote

Were everyone's interests represented in the vote?

Yes, everyone was represented or could vote

Only men were represented / could vote

Only landowners were represented/ could vote

Other restriction (specify):

Decree with community input

Decree without community input

Other (specify):

Does your community include electricity expenses as part of your budget?

Yes / No

6. Public and Environmental Safety

What type of generation facility(ies) are used to produce electricity for the network? Specifically, what type(s) of fuel is/ are used?

Fossil Fuels

- Natural gas (methane)
- Coal
- Oil
- Diesel/other petro-fuel

Other 'Conventional' Fuels

- Nuclear reactor
- Large scale hydro-power
- Rubbish/incineration

Renewable Earth Energies

- Solar collection
- Wind farm
- Geothermal
- Mini/micro-hydro

Renewable (bio-) Fuels

- Ethanol/methanol (alcohol)
- Bio-diesel
- Biogas (methane from digestors)

Other (specify):

According to the Provider, describe the quantity and identity of the main emissions that the plant(s) releases into the atmosphere, as well as the residues that are a product of the generation and how they're disposed of:

According to the Provider, describe the safety measures that are in place to protect the public from the utility's hazards, such as downed lines, accidental electricutions, meltdowns, etc., as well as filters that reduce environmental impacts (e.g. pollution scrubbers, cogeneration, etc.):

According to the governmental regulatory agency, is your Electricity Provider in compliance with all environmental statutes?

Yes / No

If so, describe:

Pollutants that are noncompliant

Pollutant concentration

Reason for noncompliance

7. Provider Quality

In your community's experience, how reliable is the service provided?

1 2 3 4 5 6 7 8 9

poor...intermittent...continuous service

According to environmental or health experts, what emissions and wastes does the Provider release into the environment?

According to these experts, are the public safety measures that the Provider has in place adequate?

Yes / No

If the answer is 'no,' describe why.

8. Community Practices and Education

Does your community agree with the recommendations for action prescribed by the expert organizations?

Yes / No

If so, describe the actions your community is taking to change the present situation:

How well is your community educated about the adverse environmental impacts of electricity production?

1 2 3 4 5 6 7 8 9

(1= not at all, 9= experts)

How well is your community informed about ways in which to conserve electricity?

1 2 3 4 5 6 7 8 9

(1= not at all, 9= experts)

Electricity Production Practices: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

1. Community Consumption

The purpose of this first question is to provide your community with indicators that you can use to assess your electricity consumption. The total electricity used in your community would be equal to the sum of the amount you purchase from a grid source, plus the amount you generate, plus the amount of primary-cell (i.e. disposable) batteries that you use.

More simply, however, this question is meant only to provide a measurable way of assessing your community's electricity use, especially in terms of the dependencies that its use requires. It may depend upon money, fuel, and/or the availability of an electrical network.

If your community is committed to reducing their demand for energy, indicators like these can be used to track your progress; at the same time, they can provide a record of the economic savings that result from conservation practices.

Our community monitors our energy consumption (or at least how much of our resources we expend upon fuel).

1 2 3 4 5 6 7 8 9

2. Community Generative Potential

Generating your own electricity has many benefits. The less your community has to depend upon outside sources for electricity, the more power your community has over the cost and environmental effects of its generation. Although the initial capital expense of generation equipment is often high, the equipment usually pays for itself within a reasonable amount of time. Nevertheless, there are benefits besides financial savings. As discussed in the introduction to this assessment chapter, the most equitable, sustainable and secure type of electrical grid (or network) is one that is decentralized with numerous independent generation points. By generating your own electricity, you safeguard your community from

network outages, inflationary utility costs, and the lack of control over the generation process itself.

There are numerous grants available from the international community for sustainability projects, and grants for the use or implementation of renewable fuels. See the List of Categorized references for some further grant opportunities. It is very helpful for your community to make consistent efforts to solicit funds, both from benefactors and grantors, for your sustainability efforts.

If constructing an electricity generating apparatus of any sort is beyond the means of your religious community, it may still be possible within your larger community. With the right amount of cooperation within your larger community, small-scale generating facilities can be constructed and governed locally.

The questions here are meant to focus on the environmental conditions that would favor the generation of electricity by your community in manners that are ecologically sound.

If your location receives a great amount of direct sunlight, solar arrays and collectors are certainly indicated as viable options. Solar energy can be captured and used in a variety of manners, but can be generally grouped into either (a) passive systems, or (b) active systems. Passive systems simply collect the sun's energy, concentrate it, and apply it to something that needs to be heated. This may be an oven, an apparatus for heating water, or even for the boiling of liquid for steam generation. Steam may be used to turn a turbine to produce electricity. Active systems rely upon photo-voltaic cell arrays, or solar panels, to convert sunlight into electricity. The intensity of the light determines the amount of power generated, and thus, collecting and focusing the sun's rays toward the solar panel will help to maximize the generative potential of an active system.

If your location has reliable and steady amounts of wind, converting this energy into electricity is an option that would require the construction of one form of windmill or another. There are many different designs in use today, and some are much more efficient than others. Beside generating electricity, windmills can be used to convert wind energy into a mechanical form that can turn water pumps, corn grinders, paddle wheels, etc.

If your community produces a large amount of organic waste, as would be the case if your community farmed animals, for example, the organic waste can be collected and 'digested,' or

composted in a special way, so that the methane gas released from the process can be collected and pressurized for use as a renewable fuel. This gas can be used as a cooking or heating fuel, or can be used to fuel a boiler that generates steam in order to turn a turbine to produce electricity.

If your community is situated upon some body of water like a stream, river, lake, or ocean, then the water's energy may be harnessed and converted into a more usable form. This is usually accomplished by means of a turbine which is turned by the motion of the water. Large scale hydrological power (or hydro-electric) facilities use a dam to increase the potential energy of the water, before letting it fall across the turbine. However, technology is available allows for a much more efficient conversion process. Implementing such technology reduces the need for large dams. The current of a river or the wave motion of an ocean may both be captured and utilized to make electricity.

Geothermal energy is heat that comes from the core of the earth. The deeper one digs towards the earth's core, the higher the temperatures become. When a borehole is drilled into these heated regions (often two kilometers deep or more), pressurized water is vented to the surface which can be used in a variety of ways. If the water is steam, the steam can be used to turn a turbine, or the heat can be exchanged for use as part of an air heating or air cooling system. Most of Latin America lies upon zones which are easily accessed and have very high temperatures. Thus, much of Latin America is an area quite apt for exploiting high-temperature geothermal energy. If designed correctly, the water released from the earth is reinjected back into it, making the system closed-looped. This style of system creates the least of environmental impact and is the recommended design.

Low-temperature (shallow pipe) geothermal energy can also be harnessed to use for air heating and cooling. This installation does not require deep boreholes, but rather utilizes a heat pump and a heat exchanging network of pipes that are buried close to the end-use site at a depth of less than a few meters.

Lastly, any of these projects would require the construction of some amount of equipment or structure, whether it be storage space for things like batteries, generators, and switches, or land for structures like a windmill. Thus, it is necessary to assess the amount of space available to build the

required infrastructure.

Use the resources listed at the end of this chapter to learn more about your community's energy generating potential.

Rate your community's potential for sustainable energy generation, based upon its location, geography, and prevailing environmental conditions.

1 2 3 4 5 6 7 8 9

3. Community Generative Practices

There are many advantages to maximizing the amount of energy your community produces, including greater autonomy and greater control over the generative process. In most cases, if thoughtful plans are assembled and the installation is well-maintained, self-production is not only cheaper over time, but also more environmentally sound. Thus, if the generative capacity of your community has been assessed by experts, your location is suitable for an installation, and the capital requirements of the project have been considered, it may be wise to invest in such a project.

Alternative means of producing energy or electricity abound, and a community is not limited to just using one means or another. It may be the case that wind is used to pump water, solar energy is used to heat it, and stream water is used to provide the small amount of electricity needed for lighting, while geothermal energy is used to heat and cool the community facilities. Although such an arrangement is not frequently found, especially where financial resources are limited, the point is that many options exist, and more energy can always be produced with some creativity and ingenuity.

Any generative system will require maintenance, both preventative and repair. Within your community, there should be at least one member that is responsible for the operation and maintenance of the generative equipment. This person should be trained in the system's operation, should know about the dangers and safety issues inherent to the system design, and should be experienced or trained in performing all the periodic maintenance procedures that the system requires. While this person may not be able to perform all repairs that may become necessary, this person more than any other will be able to know when outside technicians are indicated for repairs.

When a system is installed in your community,

the manufacturer or expert who helped to design the system should provide you with a written or printed maintenance plan for the life of the system. This plan should be executed by the person responsible for the system's maintenance.

Such a plan or the experience of the person responsible for maintenance should provide an indication of what parts or accessories are necessary for the upkeep of the system. In order to obtain sustainable functioning of your generation system, the community should allocate part of its budget towards paying for these needed expenses.

Lastly, if your community does utilize some form of sustainable energy production, the technology (including both the actual infrastructure or product and the technical knowledge) should be shared with those in your larger community, if possible. If your community produces enough energy, it may be able to share the energy with its neighbors directly. However, if your capacity is not that large, your community can help to educate others about how it would be possible for them to build and maintain a similar system themselves.

*Our community strives to find creative and sustainable ways to utilize our generative potential, if it exists.
Answer 'O' if not applicable.*

0 1 2 3 4 5 6 7 8 9

Our community takes care to keep all generative equipment well maintained.

1 2 3 4 5 6 7 8 9

About Batteries

As many small-scale methods of electricity generation are available only intermittently, some form of electricity storage or battery is needed if people want to have electricity available at all times.

Primary cells—Dry batteries

The familiar flashlight battery is perhaps the most commonly used battery. This type of battery comes in standard sizes of AAA, AA, C, and D.

Although the purchase or first cost of dry cells is relatively low, it is one of the least cost effective electrical power sources in terms of the cost per unit of useful energy delivered. Furthermore, only a limited energy yield can be obtained before the battery has to be thrown away. Dry batteries are used in especially large numbers by the poor, as they are convenient, just about affordable, and

generally all that is available. Their high cost makes them only suitable for powering small appliances that can only be used economically for short periods or emergencies.

Primary cells are based on an irreversible electrochemical reaction, and consequently cannot be recharged. Once the chemicals inside the battery are exhausted the battery is useless and must be disposed of. In recent years primary cell technology has improved dramatically, and two distinct qualities of cell are usually available in any size: standard zinc-carbon, and alkaline (also called 'heavy duty' or 'long life').

The electrical capacity of a cell is the total quantity of electricity that a cell can deliver. The potential electrical capacity of fresh cells of the same size and type is the same, but the true capacity is not fixed, it depends on many factors, such as cell size, cell type, rate of discharge, temperature, and mode of use.

In order to optimise the use of dry cells, it is a common practice to use them in radios and cassette players until their voltage falls (most electronic devices need a minimum voltage to function at all), and then the cells are finished off' in flash-lights, where a battery with low voltage simply results in a rather dim and yellow light.

Factors affecting useful life

The capacity of dry cells, like most other batteries, increases at higher temperatures. The capacity is usually given at 20°C; above this temperature the capacity is increased, and below this temperature capacity is decreased, so warming the batteries before use will result in extra power.

Primary cells are stable in terms of self-discharge. Some of the alkaline 'heavy duty' types can be kept for several years with no more than a few per cent loss of capacity.

The cheaper zinc-carbon type deteriorate more quickly, but even so they retain their capacity better than any other type of portable electrical power source. The self-discharge rate is adversely affected by high temperature, so store the cells at between 10 and 25°C and at a relative humidity of below 65 per cent.

Cost

The cost of electricity from primary cells varies widely between US\$140 and \$1300 per kWh, and is about 700 to 6500 times more expensive than grid electricity taken at \$0.2 per kWh. The initial cost of primary cells is low, but the unit cost of

electricity from them is extremely high. Despite this, the use of primary cells remains common, partly because the cost is spread over a period of time, partly because they are convenient, but mainly because they are often the only source of power available, particularly in rural areas.

Secondary cells: Rechargeable cells and batteries

There are two main types of secondary cell in general use: lead-acid and nickel-cadmium (NiCd).

Nickel-cadmium batteries

The main alternative to the lead-acid battery is the nickel-cadmium or 'ni-cad' battery. Like lead-acid, ni-cad batteries are available either vented or sealed. Vented ni-cad are designed for applications which require robust energy storage with long operating lifetimes and minimal maintenance. Sealed and usually small (i.e. sized AAA, AA, or D), ni-cad batteries are used as an economical replacement for dry cells.

The nominal voltage of a ni-cad cell is 1.2 volts, so a nominal 12V ni-cad system needs 10 cells. Ni-cad cells can withstand a greater depth of discharge than lead-acid batteries, and so generally a smaller capacity can serve a given duty. They also tend to last longer, 10 to 20 years for the larger ones. Ni-cads are less easily damaged by over-discharge or overcharging, and so simpler and cheaper charge control systems can be used to compensate for their extra unit costs. They are also more tolerant of extreme temperature variation than lead-acid batteries, and can operate at sub-zero temperatures.

Although ni-cad batteries are robust and reliable, they do have a few shortcomings that can cause problems. One major problem is that reversing the polarity when recharging a ni-cad cell usually destroys it completely. This can sometimes happen, not because a cell was reversed by carelessness when wiring it up for recharging, but when one cell in a battery of ni-cad cells is weaker than the rest: then the good cells can cause reverse charging of a weak one in certain circumstances, destroying the weak one completely. This is one reason why it is not a good policy to mix old cells and new ones either for recharging or for actual use.

Another characteristic of ni-cad batteries is a tendency to self-discharge rather more quickly than lead-acid cells and much more quickly than primary cells. Ni-cad primary cell substitutes therefore need regular recharging and are less

useful for occasionally used loads than for regularly used ones. They are particularly well suited for small photovoltaic application where they are being charged with daily sunshine.

Memory effect of ni-cad batteries

The memory effect is the tendency of a battery to adjust 'its electrical properties to a certain duty cycle to which it has been subjected for an extended period of time. Vented pocketplate batteries do not develop this effect, but sealed cells, such as the AAA, AA, C, and D sizes do. To remedy this problem, they need to be 'awakened' by being fully charged and discharged for three or four cycles before their memory is 'stretched' enough to hold a full charge.

Costs

The small ni-cad batteries have a higher initial cost than a primary cell, but work out much less expensive in the long run since they can be recharged and re-used from 100 to 1000 times before they lose their capacity and need to be replaced. Obviously, a suitable power source is necessary to recharge them, which could be a special low-voltage charger powered by the mains or a generating set, or by solar photovoltaics. Large nickel-cadmium batteries can also be financially competitive with large (over 100Ah) lead-acid batteries, bearing in mind that they can be 100 per cent discharged while a lead-acid battery generally should be limited to 50 to 70 per cent discharge of its rated capacity.

Lead-acid

The least expensive option for any significant size of electrical battery storage is the lead-acid battery. Lead-acid batteries have a nominal fully charged voltage of 2V per cell, so a 12V battery typically has six cells in series. A lead-acid battery will only withstand a certain number of charge-discharge cycles, before it fails and needs to be replaced. The greater the depth of discharge (that is the more on average that the battery is 'flattened'), the fewer cycles it will survive. For example a battery that is discharged regularly by 80 per cent of its total capacity may last 800 cycles, but if it is discharged by only 20 per cent each time it may last 6000 cycles. If the battery were discharged at 20 per cent rather than 80 per cent, the rated capacity will have to be four times larger to deliver the same energy, but will last at least four times as long. The size of the battery is therefore a compromise

between making it large but too expensive, and small and affordable but too easily discharged and therefore too short-lived.

A lead-acid battery's capacities are usually specified for 25°C operating temperature. The capacity is typically reduced by 1 per cent per 1°C going down to 0°C, but increases approximately 1 per cent per 1°C, going up from 25°C to 40°C. The problem is that the life of the battery decreases with increased temperature so, in a tropical climate, a battery should be kept whenever possible in a cool and well ventilated room.

As many small-scale methods of electricity generation are available only intermittently, some form of electricity storage or battery is needed if people want to have electricity available at all times. Lead-acid batteries can be simply subdivided into five categories, the first four of which are vented:

- Automotive
- Deep-discharge or traction
- Stationary
- Low-antimony solar battery
- Sealed or valve-regulated battery

Automotive batteries

Automotive batteries have a poor capacity for their size and a poor cycle life. A typical automotive battery will only withstand about 20 deep-discharge cycles before it becomes completely useless. Car batteries are also easily damaged if left discharged for any length of time. The cell design in a car battery is optimised to deliver heavy currents, and it is therefore poorly suited to supplying smaller currents for many hours before being recharged.

Car batteries are, however, usually the cheapest batteries when compared by rated capacity; they are often produced locally; and they are widely available and repairable.

Deep discharge or traction batteries

Deep-discharge batteries can tolerate discharge to as much as 80 per cent of their rated capacity, with a cycle life of from 1000 to 1500 deep cycles. They tend to lose water at a faster rate than other types of lead-acid batteries, and need frequent maintenance. They are commonly used for electric vehicles and are often known as traction batteries. Their self-discharge rate is also high. These batteries are relatively expensive, require a lot of maintenance, and are not often available locally.

Stationary batteries

These batteries are often called stand-alone or standby batteries, and have been designed to supply power when there is a grid failure. In most applications they are kept fully charged by the grid supply and are ready to take the load whenever needed. They are extremely reliable, have a low self-discharge rate, and a long cycle life with shallow cycles, lasting up to ten years. These batteries are usually oversized when used for stand-alone applications, to ensure that they only run with shallow cycles and last a long time.

Low-antimony solar batteries

These batteries are similar to stationary ones, but have been designed for photovoltaic systems. The self-discharge rate and distilled water consumption are both low. The cycle ranges from 1200 to 3000 depending on the discharge rates. These batteries are fairly expensive and available only to run with photovoltaic systems.

Sealed or valve-regulated batteries

The hydrogen produced by these batteries is absorbed by chemicals inside them and they contain enough electrolyte for their entire life, so they are often called 'maintenance-free'.

Sealed batteries have a short cycle life for deep cycles. They have a low rate of self-discharge and can support a full discharge, but must be recharged as soon as possible to prevent permanent damage. Overall, a sealed battery is likely to have a shorter life than a well-maintained unsealed battery with the same alloy contents, but will obviously last longer than a poorly maintained unsealed battery. The main disadvantage of sealed lead-acid batteries is their need for regular recharging to prevent sulfate build-up. Batteries in storage will need to be recharged about once every three months, more often in countries with high ambient temperatures where self-discharge will happen more quickly.

Safety and environmental hazards of lead-acid batteries

Vented Batteries: Care is obviously needed as, part from the battery acid being extremely corrosive, hydrogen gas is produced, which is highly flammable and potentially explosive when mixed with air. Thus care should also be taken to avoid flames or sparks in the battery enclosure, especially if the battery is housed in a confined space. Never check the electrolyte levels with an unprotected flame such as a kerosene lamp or a candle. For the

same reason, battery storage areas should be well ventilated

Sealed Batteries: These contain the electrolyte in 'dry' form so that no electrolyte can be spilt, and so there is less of a hazard. Even so, care must be taken not to damage the casing.

Disposal/Recycling: Both types of batteries should be disposed of safely. Where practical, it is a good idea to give away lead-acid batteries to local battery manufacturers for lead and plastic-casing recycling. Ni-cad batteries should be disposed of carefully to avoid cadmium pollution.

(Refer to the Hazardous Products and Waste Handling Assessment in Chapter 4 of this manual to learn more about the proper disposal of batteries)

Our community is well educated about the hazards of battery use and disposal practices.

1 2 3 4 5 6 7 8 9

Our community strives to protect ourselves and the Earth from these hazards by disposing of our batteries in a manner that is safe for humans and the environment.

1 2 3 4 5 6 7 8 9

4. Sources of Expert Information

Much of the information that is useful for your community to know about the adverse environmental impacts of energy production in your area is generally available from non-governmental organizations that are concerned with the health of the environment or the health of people. The Energy Provider itself should be contacted to learn of specific technical information, in the case of problems, or to advocate for changes in the Provider's policies or practices.

Our community has developed relationships with the parties relevant to electricity production, and frequently use them to stay informed about current issues.

1 2 3 4 5 6 7 8 9

5. Electricity Provider Governance

Depending upon the organizational structure of your Electricity Provider, there may be a regulation

committee, management committee, or the like whose function it is to make the operational decisions affecting the ways in which the Provider generates and distributes its electricity. Although in many regions the energy providers are private corporations which are closed to public management, others may not be. They may be governmental operations, which may have a citizens advisory panel, managers that are voted into office, or some other connection between the public and the management. Frequently, smaller and more local Providers may be cooperatives in which every member has a vote. Having power over the operational decisions being made can be an effective means of reducing the environmental costs of energy production.

Similarly, even if your community does not have the ability to directly influence the decisions being made, it is still possible that the public is able to give advisory input for, or even organized resistance against policies or practices of the Provider. Since air pollution resulting from energy production is a major environmental concern, it is important to know of such avenues of influence.

As with any public service that is used by a majority of the population, the public should be given the opportunity to express their opinions regarding the fees demanded for continued service as well as those regarding the environmental impacts of the operation. As we know from above, the generation of electricity does require some amount of capital expense, and it is the beneficiaries of the utility that are ultimately responsible for the generation of this capital. Nevertheless, in many cases, fee structures are determined by an internal source whose primary concern it is only to generate profits for shareholders. The shareholders may not be, and often are not, the stakeholders or end-users. Thus, overly expensive rates sometimes result which preclude a large portion of society from utilizing this basic utility. In the interests of social equality and justice, it is important for your religious community to be sensitive to the organizational structure of utility providers, and to understand how this structure affects the utility's responsiveness to public input. If the utility consistently ignores the needs of its consumers despite well-organized efforts, your community might well decide to campaign for an alteration of the utility's structure.

Our electricity supply is managed with good governance principles

1 2 3 4 5 6 7 8 9

Our community has power to influence decisions made by the electricity provider.

1 2 3 4 5 6 7 8 9

6. Public and Environmental Safety

Knowing the type or types of generation plant that supply your grid with electricity gives you a good indication of what the environmental impacts might be. Below is a list that gives an overview of the negative impacts that each type of generation plant may have:

Type of Generation

Environmental Impacts

Coal

Non-renewable resource.

Air emissions: volatile organic compounds (VOCs), nitrogen oxides (NOx), carbon monoxide (CO), particulate matter less than 10 microns in diameter (PM¹⁰), sulfur dioxide (SO₂), mercury, and lead. *Effects:* health problems (lung cancers, chronic obstructive pulmonary disease, etc.), neurological damage, acid rain, global climate change.

Mining: surface or ground water pollution by acid mine drainage, disposal of large quantities of ash; change in scenic view and ecosystem disruption by surface mining; and compromised worker safety in deep mining

Oil

Non-renewable resource.

Air emissions: similar content, but to a lesser degree than coal; oil spills contaminating soil, surface and ground waters during exploration, transport, and use at the power plant; safety hazards (fires and explosions)

Natural gas (methane)

Non-renewable resource.

Air emissions: CO₂

Effects: global climate change, safety hazards (fires and explosion) during exploration, transport, and use at the power plant

Rubbish/incineration

Renewable resource.

Air Emissions: PM10, SO₂, NO_x, CO₂, heavy metals, mercury, dioxins and furans;

Other residues and hazards: contaminated ash disposal; explosion hazards.

Nuclear reactor

Non-renewable resource.

Radioactive waste: requires special procedures for management and disposal. *Catastrophic damage* in the case of meltdown.

Mining: of uranium generates a great deal of environmental damage.

Hydro-power

Renewable resource.

The construction of dams greatly impacts the local ecosystems and often requires displacement of people indigenous to the area.

Flooding hazards may exist if proper infrastructure is not in place downstream. May severely impact wildlife migration, especially aquatic species.

Wind farm

Renewable resource.

May interfere with wildlife migration.

Solar Collection

Renewable resource.

Manufacture of Photovoltaic cells is itself very energy intensive, and requires mining.

Besides environmental pollution, there are other hazards inherent in the distribution of electricity. Usually the main lines which conduct the power from the plant to neighborhoods are very high voltage lines that could easily kill a person if someone were to contact them. Thus, ensuring that lines are out of reach, and that voltage will shut off should a line be broken, are very important safety measures that need to be taken. Furthermore, some electric power lines are buried, and thus need to be marked in the case that someone digging comes into contact with them. The public should be well educated about these dangers.

Similarly, high-voltage transmission lines pose dangers to wildlife, as animals may have occasion to short out the wires and thereby electrocute themselves.

Our community is well informed about the environmental risks associated with our electricity generation, and we are strong advocates for better generative practices.

1 2 3 4 5 6 7 8 9

7. Provider Quality

A responsible and responsive electricity provider will inform the public honestly about the hazards of its operation. It should be open and transparent about its limitations and its aspirations.

The electricity provider may disclose information to the public, regarding the utility's environmental performance through such means as reports, brochures, or Internet. Information on the utility's environmental performance may also be obtained from the regulatory (environmental) agency that receives periodic environmental reports from the utility regarding environmental discharges and ambient quality. The regulatory agency may also conduct independent monitoring of environmental discharges from the utility and the associated environmental quality. Furthermore, non-governmental organizations concerned with public and environmental health may provide further information that both the utility and the government may be reticent to disclose, and they may have procedural strategies to advocate for better laws and governmental regulation.

Information from all these sources should be analyzed and compared. If it is found that the provider is not open nor transparent, they likely are in discordance with their responsibility to the public which they serve. It is important that the energy provider be an ally in the preservation of the Earth, and thus it is necessary to ascertain their intentions.

Our Electricity Provider fulfills its responsibility to the public which it serves by being open and transparent regarding its operation.

1 2 3 4 5 6 7 8 9

Our Electricity Provider strives to be environmentally benign and sustainable.

1 2 3 4 5 6 7 8 9

8. Community Practices and Education

The advice of the environmental and public health organizations can be used to direct the efforts of community activism, should your community place value upon those things recommended by the organizations.

It is important that your community be educated about the environmental impacts of electricity generation, so that the members may incorporate the information into the decisions they make and actions they take every day. Individual electricity conservation practices are a big step towards making decisions that are environmentally responsible. The next inventory should help assess your community's performance in this regard.

Our community is educated about current issues regarding electricity generation and is active on many levels to improve the quality of these activities.

1 2 3 4 5 6 7 8 9

Our community strives to manage our energy consumption practices in the most environmentally benign and sustainable way.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right:

	<i>score</i>
1. Monitoring community consumption	
2. Community's generative potential	
3. Community's generative practices	
3. Community's generative equipment	
3. Community education regarding battery use	
3. Battery disposal practices	
4. Relationships with provider & experts	
5. Governance of electricity provider	
5. Community's influence on provider governance	
6. Public and environmental safety	
7. Provider quality: openness and transparency	
7. Provider quality: ecological performance	
8. Community education and activism	
8. Community energy management practices	

Now that you have comprehensively examined your electricity production capabilities and practices, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Now categorize each problem listed above into one of the following three categories:

I = *Critically important. Currently dangerous, must be addressed immediately*

II = *Important, but not immediately dangerous. Must be addressed*

III = *Current practice should be improved, but is not immediately important*

Conservation Practices: Inventory

The following inventory is designed to help you assess how much energy (especially electricity) your community uses, as well as assessing community energy conservation practices. Although the focus is on electrical energy, many of the questions may relate to other types of fuel energy. For example, questions regarding room insulation are applicable to electric systems, but also to gas, liquid, or solid fuel systems.

Although the majority of these questions presuppose having a connection to an electric grid, and/or major appliances, it would be good to look through this inventory whether your community is in a rural environment or in an urbanized area; decide which questions, if any, are applicable to your community; and complete only those sections.

Following the inventory is an evaluation section that will help you interpret your results.

I. Community Energy Use

In the list of appliances in the table opposite, identify which ones are used in your community. For each appliance answer the following questions and record your answers in the table:

- How many such devices does the community have (eg. how many lamps)?
- Estimate how many hours per day each type of device is used (add multiple instances of one type of device, e.g. lights or fans).
- For each use, write the main form of energy required as fuel (Grid Electricity, Stored Electricity (batteries), Gas, Solid Fuel, Wind, Solar).
- If the device is electrically powered, what is the rated energy usage of the appliance in Watts? (this information is often listed on device itself—see table for estimates to guide you) If the device is fuel-driven, quantify the energy usage by Liters of fuel per day, or Liters per month if more appropriate.
- Classify the device/appliance as either:

I Necessary or important to community's daily life

II An appreciated convenience to the community

III An unimportant convenience to the community

IV An unnecessary luxury

2. Air Conditioning/Cooling

Does your community have an air conditioning unit?

Yes / No

If Yes please answer the following questions:

i. What type of system is it?

- Gas
 Electric
 Geothermal
 Solar

Other (specify):

ii. Does the capacity of the unit or system match the volume of the room(s) being cooled (it may be necessary to consult an expert/professional to answer this question)?

Yes / No

Rated capacity (should be found on the unit, or in the literature supplied with it):

Total volume of room(s) being cooled (m³):

iii. When purchased, was care taken to purchase the most efficient variety?

Yes / No

iv. While operating the air conditioner, is care taken to maximize the thermostat setting to the highest acceptable temperature?

Yes / No

Thermostat setting:

v. Are the rooms that receive cooled air fairly leak proof (no open windows or doors, no cracks, etc.)?

Yes / No

vi. Rate the insulation of the rooms that receive cooled air:

- fully insulated with good insulation
 insulated
 partially insulated
 not insulated

vii. Has the performance of the air conditioner declined in performance over time? (e.g. does it take longer now to cool a given space than it did last year?)

Yes / No

viii. What type of refrigerant does your unit use?

Listening To The Earth

Is your community aware of the hazards associated with the type of refrigerant used?

Yes / No

Is your community aware of a trained technician that is capable of dealing with refrigerants and air conditioner repair?

Yes / No

Is your community aware of safe disposal options for discarding the air conditioning unit, should that become necessary?

Yes / No

ix. Is the air conditioning unit a centralized system?

Yes / No

Is there ample airflow space around the coils located outdoors?

Yes / No

Is a regular maintenance protocol established and followed?

Yes / No

Is someone in the community trained to perform routine system maintenance including filter changes?

Yes / No

Are all the ducts intact and without leaks?

Yes / No

If 'No,' list problems observed:

x. Describe your community's 'natural' air conditioning. For example, trees and vines, when selectively placed around a structure, provide a great deal of shade from the sun:

3. Air/Space Heating

Does your community have a furnace or other heating device?

Yes / No

If Yes please answer the following questions:

i. What type of system is it?

- Gas
Electric
Geothermal
Solar

Other (specify):

ii. Does the capacity of the unit or system match the volume of the room(s) being cooled (it may be necessary to consult an expert/professional to answer this question)?

Yes / No

Rated capacity (should be found on the unit, or in the literature supplied with it):

Total volume of room(s) being cooled (m3):

iii. When purchased, was care taken to purchase the most efficient variety?

Yes / No

iv. While operating the furnace, is care taken to minimize the thermostat setting to the lowest acceptable temperature?

Yes / No

Thermostat setting:

v. Are the rooms that receive the warmed air fairly leak proof (no open windows or doors, no cracks, etc.)?

Yes / No

vi. Rate the insulation of the rooms that receive cooled air:

- fully insulated with good insulation
insulated
partially insulated
not insulated

vii. Is the heating unit a centralized system?

Yes / No

Is a regular maintenance protocol established and followed?

Yes / No

Is someone in the community trained to perform routine system maintenance including filter changes?

Yes / No

Are all the ducts intact and without leaks?

Yes / No

If 'No,' list problems observed:

viii. Is the heating unit a 'space heater,' (i.e. an individual, portable unit)

Yes / No

Is the unit(s) well maintained with all safety features intact?

- Fuses
Guard around coils
Thermostat
Wiring intact

Is there ample space around the heater (at least 2m, or as specified by manufacturer)?

Yes / No

Appliances	Quantity	Usage (hours/day)	Type of Fuel	Energy Rating (Watts or Liters/day)	Device Class (I, II, III, or IV)	average energy use of common appliances (Watts)	
Water heater						Water Heater	4500
Air conditioning						Air Conditioner (Room)	750
Heating (stove/furnace)						Air Conditioner (Central)	3500
Refrigerator/freezer/food storage						Refrigerator-Freezer	600
Lighting							
Motors/pumps (includes fans)						Fan	60
Radio						Radio	25
Television						Television	150
Stove or oven						Electric stove	7500
Flashlights							
Outdoor lighting							
Computer						Computer, monitor & printer	200
Sewing machine						Sewing Machine	75
Other (specify):							
Other (specify):							

Is the heater used only when absolutely necessary?
Yes / No

Is the unit positioned as close as possible to where the heat is needed?
Yes / No

4. Refrigeration and Freezing

Does your community use one or more refrigerators or freezers?
Yes / No

If Yes please answer the following questions:

i. *What form of energy does the appliance require?*

- Gas
- Electricity
- Other (specify):

ii. *What type of refrigerant does the appliance use?*

Is the community aware of and educated about the hazards associated with the type of refrigerant used?
Yes / No

Is the community aware of safe disposal options for the appliance?
Yes / No

Is a trained technician capable of servicing refrigeration units available to your community?
Yes / No

iii. *Is the appliance maintained according to the prescribed maintenance schedule by the manufacturer?*
Yes / No

Does the storage container seal tightly all around the edges of the door or lid?
Yes / No

Is the storage container well insulated?
Yes / No

Are all vents around the compressor regularly cleaned (at least once per year)?
Yes / No

Are all exposed coils clean and regularly cleaned?
Yes / No

iv. *Is the size, or capacity, of the storage space within the appliance well matched to the volume of items placed in it (i.e. it is neither over-full, nor mostly empty)?*
Yes / No

Is care taken to rotate stock, so that food is used in a 'first in, first out' order, and spoiled food is routinely disposed of?
Yes / No

v. *Does your community take care to minimize the period of time the door or lid of the appliance is left open?*
Yes / No

vi. *If your community has a freezer, are the coils and fins inside the appliance free of built-up ice (less than 0.5cm)?*
Yes / No

Is the freezer regularly defrosted before the ice is 0.5cm thick?
Yes / No

5. Water Heating

Does your community use a water heater?
Yes / No

If Yes please answer the following questions:

What type of energy is used to heat the water?

- gas
- electricity
- geothermal
- solar
- other (specify):

When purchased, was care taken to purchase the most efficient variety?
Yes / No

If water is heated by a flame, is the flame vented by a chimney?
Yes / No

Is the chimney in good repair and cleaned regularly?
Yes / No

Is the output water temperature setting minimized to the lowest practical temperature?
Yes / No

Temperature setting:

Are water conservation practices followed in your community, especially for heated water?
Yes / No
(see Chapter 3, page **)

Is the water tank insulated?
Yes / No

Are all water pipes that carry heated water insulated?
Yes / No

Is the water tank regularly drained and cleared to remove sediment?

Yes / No

6. Lighting

If your community uses lighting, answer the following questions:

Number of incandescent lamps

Number of fluorescent fixtures:

Number of fuel based flame lamps:

Other (specify):

Quantity:

Do the members of your community make a concerted effort to use lighting only when necessary, turning lights off when not being used?

Yes / No

Are lighted rooms painted or otherwise colored with reflective colors (e.g. yellow, white, other light colors)?

Yes / No

7. Electric Motors and Pumps

If your community uses any sort of electric motors (fans, pumps, etc.), observe each motor in operation, and answer the following questions:

Rate the performance of the motor by the sounds that it makes:

1 2 3 4 5

(1= very noisy, uneven 'clunking', sounds strained, nearly inoperable)

(3= intermittent noises, rattling, but motor seems to have full power)

(5= near noiseless operation, motor is well lubed and fully functional)

If the motor requires lubrication, is this procedure part of a regular maintenance schedule?

Yes / No

If the motor drives a fan, is the fan positioned such that the flow of air is not impeded either in front of nor behind the fan?

Yes / No

Is an effort made to only operate the motor when

necessary?

Yes / No

If the unit is a pump, is there an automatic pressure-regulated shut off switch that actuates when the line pressure is not being relieved (e.g if a water pump, the pump will not operate if no water is being used)?

Yes / No

8. General Conservation Practices

For any other electric appliances not specifically mentioned above, answer the following questions:

Is your community well informed about both the economic and environmental benefits of energy conservation (especially electricity)?

1 2 3 4 5 6 7 8 9

(1= not informed, 9= most informed and continually updated)

Do all community members make a concerted effort to shut off electric devices when not in use (1= no effort, 9= excellent efforts by everyone)?

1 2 3 4 5 6 7 8 9

Does the community rank energy efficient performance as an important criteria when making purchasing decisions (1= not at all, 9= most important consideration)?

1 2 3 4 5 6 7 8 9

Does the community incorporate energy conservation as a criteria for in policy making (1= not at all, 9= most important consideration)?

1 2 3 4 5 6 7 8 9

Electricity/Energy Conservation: Evaluation

At the end of each discussion section, there will be a statement and a list of numbers from which to choose. Choose a number from 1-9 to indicate your assessment of how well your community represents the statement given. (1 = disagree, community practices unhealthy; 9 = agree completely, no change needed)

1. Community Energy Use

The purpose of this first question is to guide you in making a total assessment of your community's use of energy. In the best case scenario, ALL of your community's energy uses will be inventoried; however, for the purposes of this particular inventory, the most important devices to be inventoried are those that use a significant amount of energy on a daily or monthly basis (e.g. electric appliances as opposed to a flashlight).

It is recommended that you make your own chart to fit the particular inventory of devices that your community has. In the best case, each device should be itemized on its own line (thereby eliminating the purpose of the 'Quantity' column. Doing this will prevent you from having to do any calculations to find sums and averages because you can have an individual line for each light bulb, for example. Furthermore, your community may have several devices that would fall under the 'Other' category.

Nevertheless, if you don't make your own chart (see page 185), the following calculations should be used to determine the total 'Usage' and 'Energy Usage':

It is important that you note the quantity of similar devices, and add the hours of usage of each instance. In such a case, the 'Energy Usage' column should reflect an average of the items considered. For example, if you have 3 lamps as follows:

- Lamp 1: 75 W bulb, about 3 hours per day
 - Lamp 2: 125 W bulb, about 8 hours per day
 - Lamp 3: 40 W bulb, about 2 hours per day
- Here, the 'Quantity' column should read '3'

The 'Energy Usage' should be evaluated as a weighted average as follows:

$$\begin{aligned} \text{'Energy Usage'} &= [(Wattage \text{ of Lamp } 1) \times \\ &\text{time/day} \\ &+ (\text{Watt. of Lamp } 2) \times \text{time/day} \\ &+ (\text{Watt. of Lamp } 3) \times \text{time/day}] / \text{sum of times} \end{aligned}$$

$$\begin{aligned} &= (75)(3) + (125)(8) + (40)(2) = 1305/13 \\ &= 100.4 \text{ W} \end{aligned}$$

When evaluating your inventory with the interests of conservation, first you should identify all devices that have a non-renewable source of fuel. Non-renewable fuel sources tend to release much more environmental pollution than renewable sources, and, by definition, there is a limited supply of non-renewable energy sources. Non-renewables may include your grid electricity, anything that uses petrol fuel, dry cell batteries, etc. **It is important to conserve non-renewable resources.**

After identifying the non-renewably fuelled devices, use the 'Device class' ranking to prioritize conservation efforts. Your community may cease using luxury items altogether, or may eliminate relatively unimportant conveniences, while striving to reduce the use of any equipment that doesn't need to run continuously.

Another option is to switch the fuel sources from non-renewables to renewable sources like wind energy, solar energy, or biomass fuels.

Although the source of your grid electricity may be hydroelectric, and thus 'renewable,' remember that grid networks have a certain capacity or limit to the amount of electricity that it can generate and distribute. Furthermore, the construction and operation of hydroelectric dams involves a great ecological upset and usually displaces indigenous inhabitants. Thus, even if your grid source is renewable, there may still be very good reasons to conserve your electricity use.

Our community has extensively inventoried our energy usage.

1 2 3 4 5 6 7 8 9

2. Air Conditioning/Cooling

An air conditioner is an appliance or mechanism designed to extract heat from an occupied space using a refrigeration cycle. An earlier form of air conditioning was invented in Persia (Iran) thousands of years ago in the form of wind shafts which were built on top of roofs in order to catch the wind and pass it through water and blow the cooled air into the building. An electrical version of air conditioning was invented around 1900 to control temperature and humidity for improved manufacturing process control. Later, air conditioning was applied to increase productivity in the workplace. Later still, air conditioning use

was expanded to improve comfort in homes and automobiles.

The most common types of air conditioners employ a working fluid called a refrigerant in a cycle where the refrigerant repeatedly changes state from liquid to vapor and back to liquid. The refrigerant is condensed to release heat in one part of the cycle and is boiled (or evaporated) to absorb heat in another part of the cycle. 'Freon' is a trade name for a family of chlorofluorocarbon (CFC) refrigerants manufactured by DuPont and other companies. Although these refrigerants were initially used due to their superior stability and safety properties, unfortunately, evidence has accumulated that these chlorine-bearing refrigerants reach the upper atmosphere when they escape. A decline in performance over time may indicate a refrigerant leak.

The chemistry is poorly understood, but a consensus is growing that chlorine atoms of these CFC refrigerants are released in the presence of strong ultraviolet radiation (UV) and these chlorine atoms cause severe damage to the ozone layer that shields the earth's surface from the strong UV radiation. The ozone layer is extremely important in terms of human health, particularly for our skin and eyes. The intense UV rays from the sun, if unblocked by the ozone layer, greatly contribute to premature skin aging, are a contributing factor to skin cancers (melanomas), degenerative eye problems like cataracts, and UV radiation has been found to suppress the function of our immune systems. Thus, the use of CFC refrigerants should be eliminated if possible.

The *Montreal Protocol*, officially the *Protocol on Substances That Deplete the Ozone Layer*, is a treaty that was signed on Sept. 16, 1987, at Montreal by 25 nations. 168 nations are now parties to the accord. The protocol set limits on the production of chlorofluorocarbons (CFCs), halons, and related substances that release chlorine or bromine to the ozone layer of the atmosphere. According to the phase-out schedule set by the treaty, Latin America should have completely phased out CFC usage by 2010. Any appliance purchased today should not contain CFC's.

Contact the manufacturer of your air conditioner to find out if CFCs are used in your unit, and what options exist for refrigerant replacement. It is important that only a trained technician perform such internal maintenance.

The use of electric air conditioning puts a major demand on many electrical power grids in warm

weather, when most units are operating under heavy load. Unfortunately, many air conditioners are not very efficient, and much of the energy used does not actually go towards cooling, but instead is wasted as heat. This means that there is a huge opportunity to conserve energy by making wise air conditioning choices. Air conditioner use should be minimal and efficient. The inventory questions here are meant to help reduce the energy that your community expends on air conditioning.

While most units are electrically powered, some use liquid or gaseous fuel to power the refrigeration cycle. These units may or may not be more efficient and polluting, depending upon the fuel used and the design of the unit. In general, the following advice applies to these models equally. Along with electric models, use of gas-fueled models should also be minimized and made efficient.

In addition, geothermal energy is often used for air conditioning. Advantageously, most of Latin America is in an area where geothermal energy can be utilized relatively easily. See the resources listed at the end of this chapter for more information about geothermal air conditioning systems.

Furthermore, although the technology is not in widespread use, solar energy can also be used to drive air conditioners. While this option seems to make the most sense, implementing it at this time would most likely involve a capital investment greater than the other options would require.

It might surprise you to know that buying a bigger room air-conditioning unit won't necessarily make you feel more comfortable during the hot summer months. In fact, a room air conditioner that's too big for the area it is supposed to cool will perform less efficiently and less effectively than a smaller, properly sized unit. This is because room units work better if they run for relatively long periods of time than if they are continually, switching off and on. Longer run times allow air conditioners to maintain a more constant room temperature.

Sizing is equally important for central air-conditioning systems, which need to be sized by professionals. If your community has a central air system, the fan should be set to shut off at the same time as the cooling unit (compressor). In other words, don't use the system's central fan to provide circulation, but instead use circulating fans in individual rooms.

Air conditioners are manufactured with various degrees of efficiency. Usually the energy efficiency

information is available from the manufacturer. It is best to opt for the most efficient model that fits your specifications when purchasing a unit.

It is important to limit the temperature setting of the air conditioning thermostat. Many people are tempted to use their air conditioners to achieve a temperature much lower than the air outside. It requires a great deal of energy to achieve these luxurious conditions, and so it is best that the thermostat be set as near to the outside temperature as is possible.

As cooled air will seep out of an air conditioned room, warm air will take its place and then must itself be cooled. Thus, it is important to keep the areas that receive cooled air fairly leak proof. This means that windows should be closed and sealed, there should be no obvious holes in the walls, doors should be closed and sealed tightly, etc.

Similarly, the rooms' insulation should be adequate for the purposes. An easy way to detect this is to feel the walls and the ceiling (and possibly the floor) for heat. If the surfaces are about room temperature, your insulation is adequate. If, on the other hand the surfaces are warmer than the room, the air conditioner is working harder than it has to. If your community decides to improve the insulation, the energy used for cooling should be significantly reduced.

As part of most air conditioning units, there are coils through which the compressed refrigerant flows, and over which the room's air is blown. Because of their cold temperature, these coils have a tendency to become coated with water condensed from the air. This water may then freeze, and thus reduce the unit's efficiency because the heat is not being properly transferred to the refrigerant. Thus, to save energy, the coils should be kept free of excessive ice.

If your community has central air conditioning (or heating), your community's duct work may be wasting a lot of energy. The duct system, a branching network of tubes in the walls, floors, and ceilings, carries the air from a furnace or central air conditioner to each room. Ducts are made of sheet metal, fiber glass, or other materials. Unfortunately, many duct systems are poorly insulated or not insulated properly. Ducts that leak cooled (or heated) air into uncooled (unheated) spaces can add hundreds of dollars a year to your heating and cooling bills. Insulating ducts that are in unconditioned spaces is usually very cost effective. If you are buying a new duct system, consider one that comes with insulation already

installed.

Sealing your ducts to prevent leaks is important, especially if the ducts are located in an unconditioned area such as an attic or vented crawl space. If the supply ducts are leaking, heated or cooled air can be forced out unsealed joints and lost. In addition, unconditioned air can also be drawn into return ducts through unsealed joints. In the summer, hot attic air can be drawn in, increasing the load on the air conditioner. In cold weather, your furnace will have to work longer to keep your building comfortable. Either way, your community could be losing energy, and wasting money. Although minor duct repairs are easy to accomplish, ducts in unconditioned spaces should be sealed and insulated by qualified professionals using the appropriate sealing materials.

Routine maintenance of central systems is important both to the proper operation of the system, but also to the energy efficiency of the system. Fixing duct leaks, changing filters, inspecting fans and other system components for proper function, and other such tasks must be performed on a regular schedule. For this reason, it is recommended that your community place at least one person in charge of system maintenance. The manufacturer of the system should provide the maintenance schedule recommended for your system.

During the summer months, the most effective way to keep your dwellings cool is to prevent the heat from building up in the first place. A primary source of heat build-up is sunlight absorbed by the roof, walls, and windows. Dark-colored exteriors absorb 70% to 90% of the radiant energy from the sun that strikes the building's surfaces. Some of this absorbed energy is then transferred into dwelling spaces by way of conduction, resulting in heat gain inside the building. Thus, the use of light-colored exterior paints effectively reflects most of the heat away from your buildings.

Energy Efficient Air Cooling Practices

- Whole-house fans help cool your home by pulling cool air through the house and exhausting warm air through the attic. They are effective when operated at night and when the outside air is cooler than the inside.
- Set your thermostat as high as comfortably possible. The less difference between the indoor and outdoor temperatures, the lower your overall cooling bill will be.
- Don't set your thermostat at a colder setting than

normal when you turn on your air conditioner. It will not cool your home any faster and could result in excessive cooling and, therefore, unnecessary expense.

- Consider using an interior fan in conjunction with your window air conditioner to spread the cooled air more effectively through your home without greatly increasing your power use.
- Don't place lamps or TV sets near your air-conditioning thermostat. The thermostat senses heat from these appliances, which can cause the air conditioner to run longer than necessary.
- Plant trees or shrubs to shade air-conditioning units but not to block the airflow. A unit operating in the shade uses as much as 10% less electricity than the same one operating in the sun.
- Trees that lose their leaves in the fall (i.e., deciduous) are the most effective at reducing heating and cooling energy costs. When selectively placed around a house, they provide excellent protection from the summer sun but permit winter sunlight to reach and warm your house. The height, growth rate, branch spread, and shape are all factors to consider in choosing a tree.
- Vines provide shading and cooling. Grown on trellises, vines can shade windows or the whole side of a house.
- Install white window shades, drapes, or blinds to reflect heat away from the building.
- Close curtains on windows that face the sun during the day.
- No matter what kind of heating, ventilation, and air-conditioning system you have in your community, you can save energy and increase comfort by properly maintaining and upgrading your equipment. By combining proper equipment maintenance and upgrades with appropriate insulation, weatherization, and thermostat settings, your community may be able to cut your energy consumption and your pollution output in half.

Our community strives to use the least amount of energy on air conditioning as possible, using clean, efficient, and sustainable practices and equipment.

1 2 3 4 5 6 7 8 9

3. Air/Space Heating

In the interests of brevity and avoiding redundancy, refer to the discussion of the previous question (regarding air conditioning), simply substituting the concept of cooling by heating. You

will notice that most of the same advice applies to heating systems.

However, you may disregard the information regarding refrigerants, as heating systems obviously do not use them. Instead, heating systems often burn some type of fuel. Refer to the section on Indoor Air Pollution, Chapter 2, for more information regarding proper exhaust venting and choice of fuels. It is important that adequate safety measures are in place if inflammable fuels are used. (e.g. storage away from heat/flame, sealed containers made from material appropriate for the type of fuel used, etc.)

Our community strives to use the least amount of energy on air heating as possible, using clean, efficient, and sustainable practices and equipment.

1 2 3 4 5 6 7 8 9

4. Refrigeration and Freezing

Refrigeration is generally the cooling of a body by the transfer of a portion of its heat away from it. Applications include preservation, especially of food, and lowering the temperature of drinks to one that is more agreeable for consumption. One of the first uses of 'home' refrigeration was installed around 1895. Domestic refrigerators are common in kitchens, with separate sections or separate machines for cooling and freezing. Most units are electrically powered, but the gas absorption refrigerator, which cools by the use of a source of heat is used in homes that are not connected to the electrical grid, and in vehicles.

Refer to the information regarding refrigerants found above under the discussion of Question 2: Air Conditioning, as much of the technology is the same in these two applications. Similarly, the capacity of the unit is one of the most important factors to consider to obtain the most efficient use of the appliance, as it is for choosing heating/cooling systems.

Energy Efficient Refrigerator/Freezer Practices

- Look for a refrigerator with automatic moisture control. Models with this feature have been engineered to prevent moisture accumulation on the cabinet exterior without the addition of a heater. This is not the same thing as an 'anti-sweat' heater. Models with an anti-sweat heater will consume 5% to 10% more energy than models without this feature.

- Don't keep your refrigerator or freezer too cold. Recommended temperatures are 3°C to 5°C for the fresh food compartment of the refrigerator and -15°C for the freezer section. If you have a separate freezer for long-term storage, it should be kept at -18°C.
- To check refrigerator temperature, place an appliance thermometer in a glass of water in the center of the refrigerator. Read it after 24 hours. To check the freezer temperature, place a thermometer between frozen packages. Read it after 24 hours.
- Regularly defrost manual-defrost refrigerators and freezers; frost buildup increases the amount of energy needed to keep the motor running. Don't allow frost to build up more than one-quarter of an inch.
- Make sure your refrigerator door seals are airtight. Test them by closing the door over a piece of paper or money note so it is half in and half out of the refrigerator. If you can pull the paper or note out easily, the latch may need adjustment or the seal may need replacing.
- Cover liquids and wrap foods stored in the refrigerator. Uncovered foods release moisture and make the compressor work harder.
- Rotate foods on a first-in, first-out cycle to prevent spoilage and to prevent the unnecessary accumulation of food.
- Move your refrigerator out from the wall and vacuum its condenser coils at least once a year unless you have a no-clean condenser model. Your refrigerator will run for shorter periods with clean coils.

Our community strives to use the least amount of energy on refrigeration and freezing as possible, using clean, efficient, and sustainable practices and equipment.

1 2 3 4 5 6 7 8 9

5. Water Heating

Again, with this technology the most important points to consider for energy efficiency are insulation, system integrity, and temperature minimization. See the above discussions for further rationale about these points.

Water conservation practices are especially important for heated water, so performing the

Water Conservation Assessment, found in Chapter 3, is highly recommended. Furthermore, if your water heater burns fuel, review the Indoor Air Quality Assessment found in Chapter 2.

Energy Efficient Water Heating Practices

- Repair leaky faucets promptly; a leaky faucet wastes gallons of water in a short period.
- Insulate your electric hot-water storage tank and pipes, but be careful not to cover the thermostat.
- Insulate your gas or oil hot-water storage tank and pipes, but be careful not to cover the water heater's top, bottom, thermostat, or burner compartment; when in doubt, get professional help.
- Install aerating low-flow faucets and showerheads.
- Buy a new energy-efficient water heater. While it may cost more initially than a standard water heater, the energy savings will continue during the lifetime of the appliance.
- Although most water heaters last 10-15 years, it's best to start shopping for a new one if yours is more than 7 years old. Doing some research before your heater fails will enable you to select one that most appropriately meets your needs.
- Lower the thermostat on your water heater; water heaters sometimes come from the factory with high temperature settings, but a setting of 46°C provides comfortable hot water for most uses.
- Drain a quart of water from your water tank every 3 months to remove sediment that impedes heat transfer and lowers the efficiency of your heater. The type of water tank you have determines the steps to take, so follow the manufacturer's advice.
- If you heat with electricity and live in a warm and sunny climate, consider installing a solar water heater. The solar units are environmentally friendly and can now be installed on your roof to blend with the architecture of your community's building(s).
- Take more showers than baths. Bathing uses the most hot water in the average household. You use 15-25 gallons of hot water for a bath, but less than 10 gallons during a 5-minute shower.

Our community strives to use the least amount of energy on water heating as possible, using clean, efficient, and sustainable practices and equipment.

1 2 3 4 5 6 7 8 9

6. Lighting

In general, the best piece of advice for using lighting efficiently is simply to turn lights off when not in use. Take advantage of natural lighting as much as possible, and maximize the reflectivity of lighted areas to reduce the needed luminescence of the bulb.

If your community has electricity, compact fluorescent (CFL) bulbs are an excellent replacement for incandescent bulbs (the kind that have a small wire filament that glows). Although their initial expense is considerably greater than incandescent bulbs, CFLs last much longer and consequently are usually cheaper, especially when energy costs are also considered.

If your community does not have electricity and uses fuel based lanterns, remember to use them only when necessary, extinguishing them when light is no longer needed. It is also important to make sure that wick and vents are adjusted properly so that the flame burns efficiently. No soot should be visible around the lantern, nor should black smoke be emitted from the flame. (This presumes the use of liquid or gaseous fuel.)

Energy Efficient Lighting Practices

- Compact fluorescent (CFL) bulbs are four times more energy efficient than incandescent bulbs and provide the same lighting.
- Turn off the lights in any room you're not using, or consider installing timers, photo cells, or occupancy sensors to reduce the amount of time your lights are on.
- Use task lighting; instead of brightly lighting an entire room, focus the light where you need it. For example, use fluorescent under-cabinet lighting for kitchen sinks and countertops under cabinets.
- Consider three-way lamps; they make it easier to keep lighting levels low when brighter light is not necessary.
- Use 4-foot fluorescent fixtures with reflective backing and electronic ballasts for work areas, garage, and laundry areas.
- Consider using 4-watt mini-fluorescent or

electro-luminescent night lights. Both lights are much more efficient than their incandescent counterparts. The luminescent lights are cool to the touch.

- For spot lighting, consider CFLs with reflectors. The lamps range in wattage from 13-watt to 32-watt and provide a very directed light using a reflector and lens system.
- Take advantage of daylight by using light-colored, loose-weave curtains on windows to allow daylight to penetrate the room while preserving privacy. Also, decorate with lighter colors that reflect daylight.
- Use outdoor lights with a photocell unit or a timer so they will turn off during the day.
- Exterior lighting is one of the best places to use CFLs because of their long life. If you live in a cold climate, be sure to buy a lamp with a cold-weather ballast.

Our community strives to use the least amount of energy on lighting as possible, using clean, efficient, and sustainable practices and equipment.

1 2 3 4 5 6 7 8 9

7. Electric Motors and Pumps

In general, an electric motor or pump that is functioning efficiently will have a steady, smooth sound. There should be no whining, clunking, dinging, etc, and the running rhythm should be steady and not uneven. Any of these noises, or an uneven operation indicate that there is a mechanical problem with the motor. Mechanical problems require the motor to work harder than it would otherwise, and thus such problems imply that energy is being wasted.

Likely problems may include need for lubrication, worn bearings, worn bushings, poor electrical contacts, shaft slippage, and many others. If your community has a handy person around, often small motors can be repaired quite easily. And, as with most equipment, a little bit of preventative maintenance generally goes a long way towards preserving the quality and integrity of the equipment. Thus, if your community has a capable person, it is very helpful and wise to have this person perform routine maintenance on equipment like motors and pumps.

If your community uses any fans, it is important to have freely ventilated air both in front of and behind the fan. If air flow is impeded,

the fan must work harder to compensate. Thus, to maintain energy efficiency, make sure there is plenty of space around fans.

Our community strives to minimize the energy used by motors, pumps, and fans; and we use clean, efficient, and sustainable practices and equipment.

1 2 3 4 5 6 7 8 9

8. General Conservation Practices

Miscellaneous Energy Efficient Practices

- Clean dryer lint filter after each load.
- Do laundry and other energy intensive chores during off-peak hours (at night and on weekends).
- Purchase clean (renewable) energy where available (where not available, call your utility company and demand it).
- Install window film to reduce heat loss/gain.
- Caulk or weather-strip doors and windows.
- Upgrade/ replace leaky windows
- Improve your community buildings' insulation.
- Replace furnace, air conditioner, or other appliances with more efficient models.
- Purchase solar panels and solar water heating system.
- Use passive solar design in building a new home.
- Purchase micro wind turbines.
- Turn off computers and other office equipment when they're not being used, especially overnight and weekends.
- Clean all air filters (for furnace and air conditioner) monthly
- Install LED exit signs. They're 100% longer lasting than conventional exit signs and the most energy efficient of their kind.

In general, our community recognizes the importance of conserving energy, includes the philosophy in our policy making, and continually strives to improve our conservation practices.

1 2 3 4 5 6 7 8 9

Conclusions

Now enter the scores from each section in the column at right:

1. Inventory of energy consumption	
2. Air Conditioning	
3. Air Heating	
4. Refrigeration and Freezing	
5. Water Heating	
6. Lighting	
7. Electric Motors	
8. General conservation practices	

Now that you have comprehensively examined your energy conservation practices, how would you rate, overall, your community's practices in these regards?

Excellent / Satisfactory / Poor / Critically deficient

If you found that problems exist, list them below:

Category (I-III)

Problem 1

Problem 2

Problem 3

Problem 4

Now categorize each problem listed above into one of the following three categories:

I = *Critically important. Currently dangerous, must be addressed immediately*

II = *Important, but not immediately dangerous. Must be addressed*

III = *Current practice should be improved, but is not immediately important*

Acknowledgements for Chapter 5

The information contained in this chapter has been adapted from the following sources:

Coviello, Manlio and Huo Altomonte. "Energy Sustainability in Latin America and the Caribbean: The Share of Renewable Sources." Document presented at the Regional Conference for Latin America and the Caribbean on Renewable Energy, held in Brazil 29 and 30 October 2003. English translation available online at <http://www.eclac.cl>.

Intermediate Technology Development Group (ITDG). "Technical Brief: Batteries." Available online: <http://www.itdg.org>. Also published in *Appropriate Technology*, Volume 21/Number 2. September 1994

Intermediate Technology Development Group (ITDG). "Technical Brief: Grid Connection." Available online: http://www.itdg.org/docs/technical_information_service/grid_connection.pdf.

World Commission on Dams. *Dams and Development: A New Framework for Decision-making*. Earthscan Publications; London, UK, 2000. Available online: <http://www.dams.org/report/>.

United Nations Development Program. *World Energy Assessment: Energy and the Challenge of Sustainability*. UNDP; New York, USA, 2000. Available online: <http://www.undp.org/seed/eap/activities/wea/index.html>.

United Nations Development Program. *World Energy Assessment: Overview 2004 Update*. Edited by José Goldemberg and Thomas B. Johansson. UNDP; New York, USA, 2004. Available online: <http://www.undp.org/energy>.

Resources for Chapter 5

Internet Resources

African Energy Policy Research Network (AFREPREN): <http://www.afrepren.org/>

AFREPREN, brings together 106 African energy researchers and policy makers from Africa who have a long-term interest in energy research and the attendant policy-making process. Its mission is to develop feasible policy options for the delivery of affordable and cleaner energy services to the poor in Africa, with a vision of ensuring more sustainable energy services for all in Africa.

CADDET - Energy Efficiency and Renewable Energy at your fingertips: <http://www.caddet.org/>

CADDET stands for Centre for Analysis and Dissemination of Demonstrated Energy Technologies. It is an international information source pertaining to renewable energy and energy-saving technologies that have worked in other countries. Along with its sister programme, GREENTIE, CADDET ceased collecting new information at the end of March 2005. Nevertheless, the information will remain available through this web site's search facilities as it represents one of the World's most detailed repositories of such information.

Centro de Informacion en Energias Renovable: <http://www.ciner.org/>

CINER busca contribuir a la conservación de los recursos naturales con miras al uso racional de la

energía, orientando, asesorando y promoviendo el intercambio de información, investigación y avances tecnológicos entre instituciones, empresas y personas que trabajan en el tema energético, estimulando la relación entre el uso de energía y la productividad. Contamos con un plantel de profesionales adscritos y especialistas con amplia experiencia, tanto en el ámbito nacional como internacional en los diferentes rubros. Telephone: (591) 04 4280702

Centro Nacional Salud Ambiente y Trabajo: <http://www.censat.org/>

CENSAT Agua Viva es una organización ambientalista para la comunicación, la educación, la investigación y la organización, cuyas acciones están dirigidas a fortalecer la capacidad de acción ambiental y social de los actores históricamente empobrecidos en nuestra sociedad. Buscamos el desarrollo de procesos democráticos que conduzcan al conocimiento y transformación de las relaciones sociales y técnicas y de las condiciones de vida, trabajo y producción que sean adversas a la salud, al medio ambiente y a la plena realización de la humanidad.

CleanEnergy: worldwide renewable energies portal: <http://www.cleanenergy.de/index2.html>

CleanEnergy maintains a large worldwide companies directory, which compiles companies that provide products or services related to renewable energy. Available in English and German.

Enersol: Solar energy serving people: <http://www.enersol.org/>

Enersol is a non-profit charitable organization developing and introducing sustainable energy solutions for rural communities, especially supporting the use of clean, renewable solar energy for health and education applications in Latin America. Telephone: 978-251-1828

GREENTIE: <http://www.greentie.org/>

GREENTIE was an international directory of suppliers whose technologies help to reduce greenhouse gas emissions. GREENTIE, and its sister program CADDET, ceased collecting new information at the end of March 2005. Nevertheless, the information will remain available through this web site's search facilities as it represents one of the World's most detailed repositories of such information.

Mexican Renewable Energy Program (MREP): <http://www.re.sandia.gov/>

The Mexico Renewable Energy Program's objective was to promote the appropriate and sustainable use of renewable energy technologies in Mexico. MREP assisted Mexican program partners in implementing large-scale renewable energy replication and new application programs, worked to increase the technical and operational capacity of partners to carryout renewable energy based projects & programs, and provided technical assistance and conduct workshop/trainings on renewable energy technologies, applications, financing, and project implementations. MREP is now integrated into the U.S./Mexico Bilateral Agreement for Energy Cooperation (Annex 1 - Renewable Energy); however, their internet page stores numerous publications, both instructional and technical. For more information, Tel: 1 (505) 844-3301

INFORCE: International Network for Sustainable

Energy:

<http://www.inforse.org/>

INFORSE is a worldwide network consisting of 140 Non Governmental Organisations working in about 60 countries to promote sustainable energy and social development, so that energy services that are necessary for a just and human-centred development, are provided in a sustainable way using renewable energy. Telephone: 45 86 22 70 00

Organizacion Latinoamericana de Energia:

<http://www.olade.org.ec/>

OLADE es la organización política y de apoyo técnico, mediante la cual sus Estados Miembros realizan esfuerzos comunes para la integración y el desarrollo del mercado energético regional. Mision: promover acuerdos entre sus Estados Miembros y realizar acciones para satisfacer sus necesidades energéticas, mediante el desarrollo sustentable de las diferentes fuentes de energía.

Renewables for Sustainable Village Power (RSVP):

<http://www.rsvp.nrel.gov/>

National Renewable Energy Laboratory (US Dept of Energy) resources for practical and renewable power sources for rural areas.

REPP-CREST : Renewable Energy Policy Project and Center for Renewable Energy and Sustainable Technology <http://www.repp.org/>

REPP's goal is to accelerate the use of renewable energy by providing credible information, insightful policy analysis, and innovative strategies amid changing energy markets and mounting environmental needs by researching, publishing, and disseminating information, creating policy tools, and hosting highly active, on-line, renewable energy discussion groups.

Universal Sustainable Energy Services:

<http://www.uses.net/>

Universal Sustainable Energy Services assists developing nations in their transitions to a sustainable energy paradigm by offering expert knowledge and communications to practitioners of sustainable energy worldwide

Windustry: <http://www.windustry.com/>

Windustry is a non-profit organization working to create an understanding of wind energy opportunities for rural economic benefit by providing technical support and creating tools for analysis. Web page contains links to several print and web-based resources. (English only)

World Alliance for Decentralized Energy (WADE):

<http://www.localpower.org/>

WADE was established in 2002 as a non-profit research and promotion organisation whose mission is to accelerate the worldwide development of high efficiency cogeneration (CHP) and decentralized renewable energy systems that deliver substantial economic and environmental benefits.

World Energy Council (WEC):

<http://www.worldenergy.org/>

The World Energy Council (WEC) is the foremost multi-energy organisation in the world today. The organisation covers all types of energy, including coal, oil, natural gas, nuclear, hydro, and renewables, and is UN-accredited, non-governmental, non-commercial and non-aligned. WEC's Mission: "To promote the sustainable supply and use of energy for the greatest benefit of all people" by collating data about and undertaking and promoting research into the means of supplying and using energy having, short and long term, the greatest social benefit and the least harmful impact on the natural environment, and publishing or otherwise disseminating the useful results of such research.

World-wide Information System for Renewable

Energy (WIRE): <http://wire.ises.org/>

The World-wide Information System for Renewable Energy is a service provided by the International Solar Energy Society (ISES - <http://www.ises.org/>). The purpose of this service is to facilitate and accelerate the flow of knowledge among renewable energy professionals worldwide.

Printed Resources

Allerdice, April; John Rogers. Renewable Energy for Microenterprise. National Renewable Energy Laboratory, 2000. Full text available online: http://www.rsvp.nrel.gov/vpconference/vp2000/handbooks/microenterprise_handbook.pdf. Order from: National Technical Information Service, Telephone: 800-553-6847

Jimenez, Antonio; Ken Olson. Renewable Energy for Rural Health Clinics. National Renewable Energy Laboratory, 1998. Spanish version available: Energia Renovable para Centros de Salud Rurales. Full text available online: http://www.rsvp.nrel.gov/vpconference/vp2000/handbooks/health_clinic_handbook_spanish.pdf. Order from National Technical Information Service, Telephone: 800-553-6847.

Chapter 6

After the Audit: Developing an Action Plan

This brief chapter is intended to help your committee decide which actions you should take after completing one or more sections of the environmental audit. It would be helpful to review the Introduction to this manual, specifically “Steps for Establishing a Successful Environmental Program” in order to remember the process recommended. The information below is meant to help guide you through Step Four of the process described in the Introduction. First you must prioritize the problems to be addressed, and then evaluate possible solutions before deciding upon an action to take.

Prioritizing

As you completed the evaluation section of an assessment, you were asked to list the problems you identified, as well as to rank them according to their relative importance. Thus, at this point you should have a list of problems divided into three categories. You now need to prioritize in order to choose which problems to address first.

You may begin by collating the identified problems into a single table like the one below:

Category I problems should be addressed first, since any dangerous practice should be corrected as soon as possible. If you have identified multiple Category I problems, your team should identify which problems pose the greatest and most immediate hazards, and correct the problems as close to this ordering as possible. The order in which you address Category II and III problems, however, may vary depending upon the resources available, your community’s preferences, and any other criteria that your team may use to establish priorities. For example, correcting some problems with simple and visible solutions first may help generate needed enthusiasm for the environmental program within your community. Nevertheless, unless your team is large enough to establish subcommittees, only one problem should be selected at a time so that your team’s efforts may remain focused and easily tracked. If subcommittees are able to be formed, each should similarly tackle only one problem at a time.

Category I (Critically important)	Category II (Important)	Category III (Not immediately important)

Evaluating Options

Converting your problem into potential solutions is a necessary step before choosing an action to correct your selected problem. Beginning with the Category I problems, your team should brainstorm about what actions could solve the problems; this is done at first without much or any regard for the feasibility of the actions proposed. The main idea here is simply to create a list of options. Your team should explicitly list all options generated, as shown below:

<p>Problem: contaminated well water (latrine is most likely source) <i>[example only]</i></p>
<ul style="list-style-type: none"> • excavate latrine pit, build above-ground latrine toilet • boil water before use • develop chemical treatment process • dig new well further away from latrine • bring piped water in from elsewhere • purchase water for drinking and cooking

The next step is to decide upon the criteria your team will use to evaluate the potential solutions. Your team may want to generate a large list first, and then narrow it down to the most reasonable and agreeable items. Your team should agree upon at least four or five criteria to both ensure that several aspects are considered, and to increase the likelihood that a clear “best choice” will be delineated by using the criteria. Your team may also decide that some criteria are more important than others. You may represent the varying importance by introducing multipliers, or “weights.” Notice that your list of criteria will uniquely represent the values that your team holds, which highlights the importance of developing a shared vision.

The two tables that follow illustrate the development of criteria:

<p>Proposed Criteria: <i>[example only]</i></p>
<ul style="list-style-type: none"> • Other communities have successfully done it (i.e. high probability of success) • Expected cost is within community means (Affordable) • Technology is understandable to everyone within the community (explainable) • Will not cause other environmental or health hazards (safe) • Is energy efficient • Can produce measurable results • Requires little maintenance • Requires only materials produced locally • Can be salvaged for another use

<p>Selected Criteria /Weights Added <i>[example only]</i></p>
<ul style="list-style-type: none"> • Safety (3) (= most important) • Likely to succeed (2) • Affordable (2) • Efficient (1) • Explainable (1) • Low Maintenance (1) • Measurable results (1)

Once the criteria have been decided and weighted (optional), it is time to apply the criteria to each of the proposed solutions developed above. This requires serious discussion, and expert input is advisable. There are many ways to evaluate each proposal by the criteria; however, perhaps the most simple is to judge the proposal against the criteria and assign it a numeric value. The weights can be used as multipliers. Thus, applying the criteria above to our contaminated water example, and using a numeric valuation between 0 and 5 (0

Solution [example only]	Safety	Likely.	Afford.	Effic.	Expl.	Maint.	Meas.	TOTAL
Excavate pit contents, build above-ground latrine/toilet	4x3=12	1x2=2	3x2=6	4	4	2	4	34
boil water before use	3x3=9	3x2=6	3x2=6	1	3	3	4	32
implement chemical treatment process	2x3=6	4x2=8	2x2=4	2	3	2	4	29
dig new well further away from latrine	4x3=12	3x2=6	4x2=8	3	5	4	4	42
Attach to piped water	5x3=15	3x2=6	1x2=2	0	2	4	4	33
purchase water for drinking and cooking	3x3=9	5x2=10	1x2=2	0	5	4	4	34

being the worst and 5 best), the option of digging a new well a safe distance away from the latrine was the solution identified as the best choice, as shown in the table opposite.

Generating an Action Plan

Once your team has decided upon an action, a detailed plan should be developed before attempting to execute the solution. As discussed in the introduction, the action plan should detail what resources are needed and how they will be obtained; how the project will be communicated to the rest of the community and who shall explain it;

a goal for the length of time until completion as well as intermediate achievements; a plan for assessing the results, and a maintenance plan to ensure the solution does not itself become a future problem. These elements of the action plan should be made explicit and recorded so the plan can function as a blueprint for the implementation of the action. After the plan has been developed, the elements can be mobilized to achieve the desired ends. Hopefully by using this process your environmental program can achieve many successes, and continue to lead your community into a sustainable future.

Appendix: General Resources

Environmental Audit Resources

The following four resources contain information that can greatly aid your environmental auditing process. These resources are an invaluable benefit, and you may find them indispensable in your efforts to acquire pertinent information.

Temas Actuales maintains lists of governmental environmental, health, and consumer protection ministries for nearly every country in the Latin American and Caribbean region. In addition it maintains lists and profiles of international agreements, laws, and other useful information pertinent to LAC environmental protection.
<http://www.temasactuales.com>.

A very large database of Latin American organizations can be found at **Latin American Network Information Center** of the University of Texas. The database is very well organized, frequently updated and available in Spanish. This database can be an invaluable aid to finding environmental organizations, labor unions, health care associations, and consumer protection entities working in your area.
<http://www.lanic.utexas.edu>

Centro Panamericano de Ingeniería Sanitaria y Ciencias del Ambiente: CEPIS is a specialised centre of the Pan American Health Organisation that provides technical assistance, training, and information to countries in the Latin American region in a variety of sanitary and environmental engineering issues. CEPIS also has an environmental education program.
<http://www.cepis.ops-oms.org/>

Practical Action / Soluciones Practicas (formerly Intermediate Technology Development Group, ITDG), is a charity registered in the United Kingdom which works directly in four regions of the developing world – Latin America, East Africa, Southern Africa and South Asia, with particular concentration on Peru, Kenya, Sudan, Zimbabwe, Sri Lanka, Bangladesh and Nepal. In these countries, Practical Action works with poor communities to develop appropriate technologies in food production, agroprocessing, energy, transport, small enterprise development, shelter and disaster mitigation. They also maintain a database of technical papers and other resources intended to offer sustainable solutions which are practical and affordable. Examples include composting toilets, water supply solutions, biogas collectors, composting, and indoor air pollution prevention. <http://www.itdg.org>. Their website specifically for Latin America: <http://www.solucionespracticadas.org.pe/> Telephone: 511-446-7324. Mailing address: Casilla Postal 18-0620 / Lima 18

Sustainable Practice Resources

The following resources consist of organizations whose scopes include many areas of sustainable practices. The information provided for each resource has mostly been provided by the organizations themselves, and are not to be considered reviews by the authors of this handbook.

Aprovecho Research Center:

<http://www.aprovecho.net/> Aprovecho's mission is to develop and test technology appropriate and affordable for Latin American communities. Main areas are Stoves, Gardening, Forestry, and EcoBuilding.

Biodiversidad en América Latina:

<http://www.biodiversidadla.org/> Un sitio destinado al encuentro y el intercambio entre las organizaciones latinoamericanas y todos y todas aquellos/as que trabajan en defensa de la Biodiversidad.

Centro Nacional Salud Ambiente y Trabajo:

<http://www.censat.org/> CENSAT Agua Viva es una organización ambientalista para la comunicación, la educación, la investigación y la organización, cuyas acciones están dirigidas a fortalecer la capacidad de acción ambiental y social de los actores históricamente empobrecidos en nuestra sociedad. Buscamos el desarrollo de procesos democráticos que conduzcan al conocimiento y transformación de las relaciones sociales y técnicas y de las condiciones de vida, trabajo y producción que sean adversas a la salud, al medio ambiente y a la plena realización de la humanidad.

EARTHACTION Network:

<http://www.earthaction.org/> EarthAction's goal is to mobilize growing numbers of people around the world to press their governments (or sometimes corporations) for stronger action to solve global problems. The network already includes more than 1,900 citizen groups in 161 countries, two thirds of them in developing countries, together with hundreds of legislators and thousands of individual citizens. LAC regional office in Chile; telephone: (56) 9-826 1727.

Eco-Portal - The Environmental Sustainability.Info

Source: <http://www.environmentalsustainability.info>
An Information Gateway Empowering the Movement for Environmental Sustainability

Eco Sustainable Gateway & Resources:

<http://www.ecosustainable.com.au/links.htm> Resources and tools on ecology, environment and sustainability. Nearly 1000 categorized links.

Energia: International Network on Gender and Sustainable Energy:

<http://www.energia.org/> Energia links individuals and groups concerned with energy, sustainable development, and gender. ENERGIA's goal is to contribute to the empowerment of rural and urban poor women through a specific focus on energy issues.

Environmental Protection Agency of the United

States: <http://www.epa.gov/> Many educational resources on a variety of environmental topics. (Available in Spanish)

Global Development Research Center:

<http://www.gdrc.org/> GRDC is a virtual organization that carries out initiatives in education, research and practice, in the spheres of environment, urban, community, economy and information, and at scales that are effective.

Global Village: Institute for Appropriate

Technology: <http://www.i4at.org/> Global Village is a

non-profit organization created for the purpose of researching promising new technologies that can benefit humanity in environmentally friendly ways. The philosophy of the Institute is that emerging technologies that link the world together are not ethically neutral, but often have long-term implications for viability of natural systems, human rights and our common future.

Green Pages - The Global Directory for Environmental Technology: <http://www.eco-web.com/> Features 7000 leading suppliers and environmental organisations from 145 countries.

GreenTreks Network, Inc.: <http://www.greentreks.org/> GreenTreks Network has a wealth of educational resources, perfect for your classroom, community group or home. Materials convey important messages in engaging and easy to understand ways.

IRDC: International Development Research Centre: <http://www.idrc.ca/> IDRC is a Canadian Crown corporation that works in close collaboration with researchers from the developing world in their search for the means to build healthier, more equitable, and more prosperous societies.

OneWorld Network: <http://www.oneworld.net/> The OneWorld network spans five continents and produces content in 11 different languages, published across its international site, regional editions, and thematic channels. Many of these are produced from the South to widen the participation of the world's poorest and most marginalised peoples in the global debate.

Peace Corps Master's International Program: Resources and Links:

<http://www.cee.mtu.edu/peacecorps/resources.html> Contains technical information on several topics, especially focused on water and sanitation.

Red Ambiental Latino America - CLAES: Centro Latino Americano de Ecología Social: <http://www.ambiental.net/> Informaciones ambientales para América Latina.

Renewable Energy Policy Project: <http://www.repp.org/> REPP's goal is to accelerate the use of renewable energy by providing credible information, insightful policy analysis, and innovative strategies amid changing energy markets and mounting environmental needs by researching, publishing, and disseminating information, creating policy tools, and hosting highly active, on-line, renewable energy discussion groups.

Resources for the Future: <http://www.rff.org/> RFF is a nonprofit and nonpartisan organization that conducts independent research on environmental, energy, and natural resource issues.

Skat Foundation: Swiss Resource Center and Consultancies for Development: <http://www.skat-foundation.org/> The Skat Foundation is a not-for-profit organization that promotes the exchange of knowledge and experiences in development

cooperation. The Skat Foundation produces and distributes publications and provides other resources for development cooperation, hosts international networks for knowledge sharing. The Foundation regularly launches and carries out innovative projects.

TERI: The Energy and Resources Institute: <http://www.teriin.org/> TERI works for global sustainable development, with particular application to the diverse challenges faced by India, focusing on equity, efficiency and optimal utilization of natural and human resources.

The Alliance for Sustainability: <http://www.mtn.org/iasa/> The mission of the Alliance is to bring about personal, organizational and planetary sustainability through support of projects that are ecologically sound, economically viable, socially just and humane. The Alliance for Sustainability is a Minnesota-based, tax-deductible nonprofit supporting model sustainability projects on the local, national and international levels.

The World Wide Web Virtual Library: Sustainable Development: <http://www.ulb.ac.be/ceese/meta/sustvl.html>

A comprehensive list of internet sites dealing with sustainable development, including organizations, projects and activities, electronic journals, libraries, references and documents, databases, directories or metadatabases

Trees, Water & People <http://www.treeswaterpeople.org/> TWP is helping communities sustainably manage their natural resources.

United Nations Development Programme: <http://www.undp.org/> The UNDP offers a tremendous number of resources in both English and Spanish, on topics such as energy, sustainable development, ecological sanitation, and other environmental topics.

Vitae Civilis - Institute for Development, Environment and Peace: <http://www.vitaecivilis.org.br/> Vitae Civilis is a not-for-profit non-governmental organization that has been working to contribute to the construction of sustainable societies – an expression that covers at least five basic pillars: social justice, environmental conservation and integrity, diversity (cultural, ethnic, religious, etc.), democracy and economic viability. To promote sustainable development through supporting the participatory development and implementation of integrated public policies; generation and dissemination of knowledge and practices in the areas of climate, energy, water and environmental services; and strengthening civil society organizations and initiatives in these areas. Tel.: +55 (11) 4686-1814

World Resources Institute: <http://www.wri.org/> World Resources Institute (WRI) is an environmental think tank that goes beyond research to find practical ways to protect the earth and improve people's lives