

15. Define the type of materials convenient for building trails; consider also the difficulty of terrain, conditions of climate and season.
16. Make an inventory of all local materials that could be sustainably used for trails (see Chapters 1 and 3 for more details).
17. Analyze likely effects of tourism, particularly on trails, and establish a permanent monitoring system for your ecolodge and whether it uses public protected areas such as national parks, biological reserves, etc. (see Chapter 1 for more details).
18. Familiarize yourself with all management plans, and observe corresponding guidelines, especially those on visitor management; i.e. number of people allowed in the area, transport parameters, opening times, restricted activities, etc.
19. Work with protected-area staff and respect regulations of the protected area.
20. Cooperate with all plans launched by the protected area. Foster establishment of wildlife corridors and restoration of disturbed areas, making sure to use only seed stock endemic to the area.
21. Have your ecolodge function as an extension of the protected area if any, acting as a wildlife corridor that will help perpetuate your project's resources.
22. Promote creation of wildlife corridors and restoration projects, always with endemic plant species.
23. Use the system of "living fences" with local arboreal species. Where feasible, use native trees and shrubs to fence the property as well as internal "parceling."
24. Work with protected-area managers to coordinate efforts on resource use and conservation.
25. Join and participate actively with local organizations involved in conservation and protected areas.
26. Invest in a Habitat Management Plan of the site, which are essential for all ecolodges.

2.6 ESTABLISHING HABITAT AND SPECIES MANAGEMENT PLANS

After the limits of use have been determined, the next step is to establish a Habitat and Species Management Plan (HSMP.) An HSMP helps the site manager sustain the habitat and species in line with current conservation thinking and helps ensure that resources are available for tourists in the distant future. The HSMP is based on establishing not only a sustainable use of the

environment, but establishing a sustainable business and assuring sustainable long-term profitability.

The HSMP is established to ensure that habitats and species important to the area are sustained or enhanced in sometimes degraded circumstances. These plans are pivotal tools in establishing and maintaining a sustainable destination. The quantifiable costs of habitat management and monitoring should be incorporated into the business plan.

GUIDELINES

1. Ensure that the HSMP takes into account the site's management history, including its regional context. If it is a ranch and will continue to be a ranch, then it requires a plan that will incorporate ongoing enterprises as well. On protected areas, the goal is to work within the framework of proven management plans. However, in many cases, existing plans may fall short of enough data to demonstrate potential sustainable use and management. In this case, the tourism developer should work with the site manager to upgrade existing management plans.
2. Look at construction of infrastructure and how it can be maintained with least possible impact. Infrastructure types should be based on the volume and needs of each user type expected. Note: prior to any construction, a monitoring program should be in place and baseline data should have been collected at all monitoring points.
3. Collect the data of all habitats, natural and manmade, including:
 - Detailed maps of all habitats
 - Zoning scheme
 - Goals for management of each type and location
 - Management methods in detail including target dates; i.e. seasonal checklists or annual business review
 - Cost per acre
 - Contingency plans for emergency management (catastrophic events)
 - Responsive change in management and monitoring analysis
4. Beyond ensuring habitat and microhabitat requirements, it is important to establish a list of rare and endangered flora and fauna for each protected area, and also those species important to the tourism product. Also, management should include visitor program activities, research or specific programs revolving around species management. All management should have short- and long-term goals and a review period for analyzing progress, and setting goals, objectives and tasks for the following season.

5. Long term management plans must have fiscal plans that include staff, staff training, operations and equipment budgets, and of course a plan to coordinate management with program staff or site management staff.

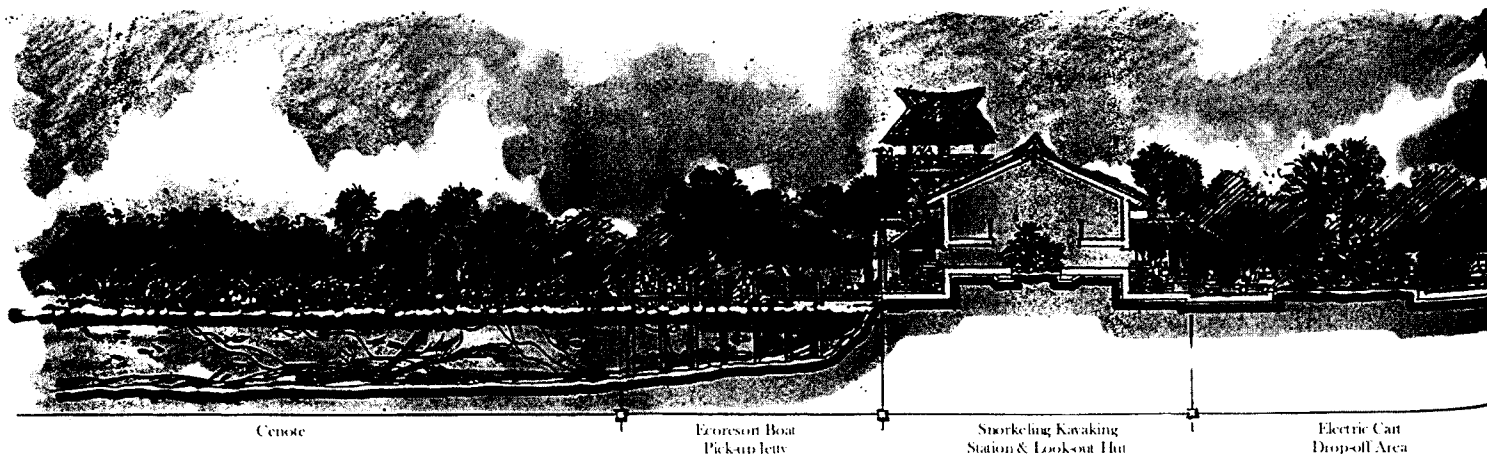


2.7 ECOLOGUE DESIGN AND CONSERVATION

Ecologues should play a “proactive” role in conservation of nature and cultural traditions. Since ecolodges are to be used mainly by tourists, who are concerned with conservation matters, ecolodges should provide practical examples of harmonious interaction with nature. They should not only strive to minimize negative impacts but also to provide alternative, more sustainable ways of living. Visitors spending several days in a good ecolodge should be motivated to apply at home many of the environmentally friendly practices experienced on holiday. Also, ecolodges should serve as models for local communities wishing to improve their standard of living and their interaction with nature by applying simple, cost-efficient and ecologically wise solutions.

GUIDELINES

1. Keep in mind matters relative to control of harmful insects, reptiles and rodents. The right approach is to minimize opportunities for pest species to establish themselves and breed, which means treating still water against mosquitoes, for example. The next step is to minimize pest intrusion (ensuring the building structures and plumbing are cockroach-proof at the construction stage; using mosquito netting and flyscreens on doors and windows and bird screens for eaves and chimneys, for example), more than resorting to the extermination of noxious fauna.
2. Consider raising your buildings on stilts. This will help minimize the risk of flooding, allow the free movement of wildlife under buildings, separate the ecolodge from soil dampness and possible pests, and provide an insulating air chamber between the floor and the ground that allows for necessary ventilation and service access. Obviously, you will need mainly still air to help insulate buildings in cold climates, where, in places, some peoples have housed animals below the home living area to benefit from the warmth of their sheltered animals.
3. Strictly limit and control artificial lighting, so as to avoid disruption of nocturnal life cycles of plants and animals.
4. Do not leave or offer any food to local wildlife. Although it may attract local fauna (which may also prove attractive for certain tourists), on the medium and short term this leads to dependency and semi-domesticated behavior among wildlife, which must be avoided.
5. Whenever possible, operate a small farm for breeding certain wildlife species (rabbits, capybaras, crocodiles, etc.), so as to diminish hunting pressures on wild populations, and also to supply your ecolodge with fresh food. Even if no wildlife is available, a small farm with domestic animals may be a good idea. As mentioned earlier, chickens, pigs and other animals can recycle garbage and serve as a food source.



6. Require conservation clauses in your contract with the building contractor, establishing specific do's and don'ts to avoid ecological degradation and loss of habitat and species. Be sure your agreement specifies economic penalties in case of breach of contract. These areas should be fenced off and signed, noting that no construction material storage, vehicles or other activity be allowed to disturb these areas.
7. Provide ecological restoration and interpretative programs to help enhance the local ecology and educate guests as to the sensitivities of particular ecosystems. Establish a local eco-fund that guests can contribute to so that the restoration and vitality of the local ecosystem is a continuing mainstream element of eco-management, making sure that the money is visibly spent directly on the project contributed to.



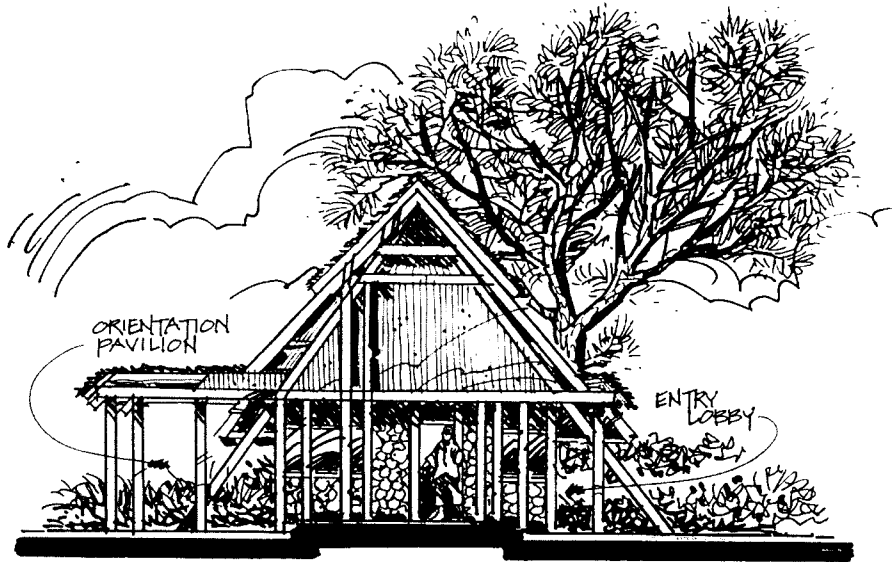
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*“All good architecture which does not express
serenity fails in its spiritual vision.”*

—Luis Barragan



CHAPTER 3

ARCHITECTURAL DESIGN

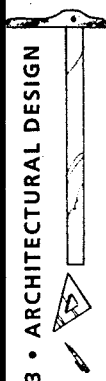
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3.1 INTRODUCTION

A fresh view of lodge architectural design is necessary if the hospitality industry is to be extended successfully into sensitive areas: ecolodge design is based on a blend of traditional technology and materials, along with modern concepts and appropriate technology. The considered inclusion of local people and the proper conservation of natural and cultural resources are crucial determining factors, particularly as typical ecolodges are sited in or around protected areas, and in most cases, are neighbor to traditional peoples.

Architectural design must be based on specific market analysis outlining target clientele for your ecolodge. It is indispensable to have a deep knowledge of the kinds of activities your tourists wish to carry out, their purchasing power and their expectations.

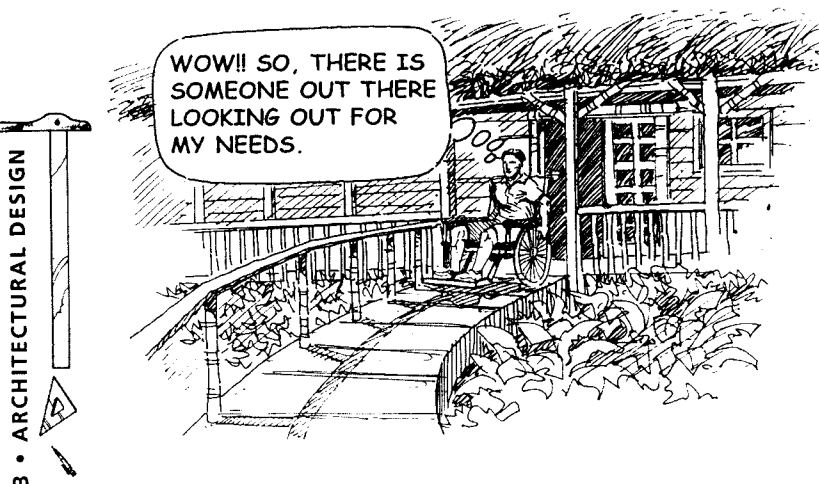
The authors of this chapter acknowledge the overlap between Chapters 1 and 3, as this book is intended as a guidelines reference work, and may be read separately by different persons. Also, there is a fine line between certain elements of site planning and architecture, and it would be impractical to eliminate all overlap.

GENERAL GUIDELINES

1. Maintain, restore and enhance the natural ecosystem: It is more important than achieving dramatic or impressive architectural expressions.
2. Define the easiest, fastest, most economical and least destructive way in which your ecolodge may be built, at the design stage. Make the most of all-available local natural resources and plan for long-term economic return.
3. Incorporate ease of maintenance, cleaning, repairing and operation of your ecolodge at the design stage.
4. Consider the possible incidence of natural catastrophes in your area: earthquakes, landslides, floods, cyclones and hurricanes, volcanic activity, etc., and comply with the corresponding requirements.
5. Try to include in the design of your ecotourism complex an interpretative center (also known as a visitor center). Even if it's a small, it should be aesthetic. Include a mock-up topographical model of your natural area, diagrams, good color photos of local wildlife and plants, mineral and vegetable samples, examples of handcrafts and man-nature interactions. Avoid using stuffed or caged specimens of local wildlife (they are generally frowned upon by ecotourists). In addition to the interpretative center, provide walks that incorporate living examples of what you are displaying in their natural setting.
6. Create an architectural style always consistent with an environmental philosophy and with the goals of ecotourism, avoiding design contradictions. Local traditional building forms and materials may provide clues to efficient and ecologically sensitive design.
7. Minimize negative environmental impacts by designing an ecolodge with rational and economic use of space.
8. Ecolodge architectural design should concentrate on the following key factors:
 - a) Context and aesthetics
 - b) Energy use and conservation
 - c) Water conservation and management
 - d) Waste management
 - e) Building technology, materials, and construction
9. Ensure your ecolodge conveys a sense of place. Even within the building, guests should find a harmony with the natural environment. Terraces, elevated open walkways (skywalks), skylights, and verandas facing outwards can be used to achieve a communion with nature.



10. Design for the disabled; provide ramps for wheel chairs instead of steps, special-design toilet services, Braille language signs, etc. However, note that the rugged nature of some nature-based activities and sites may preclude access for many disabled persons. Be frank with your guests and potential guests: provide them with accurate information on program limitations.



3.2 CONTEXT AND AESTHETICS

Existing tourism lodges too often violate or intrude upon the environment with both physical and visual pollution. An ecolodge architectural design must demonstrate unique responses to the local environment, climate and culture. Therefore, the ecolodge's architectural form should not compete with the natural landscape and surrounding vegetation, but should be harmoniously integrated with the environment.

The ecolodge's presence should not disturb or intrude upon its natural setting. It is also important to consider any existing architectural forms in the region, whether they are synchronized with the landscape or not. These local building forms have evolved over hundreds of years and normally make the most efficient use of local materials, orientation and space and are a response to the relative climatic environments.

Two of the fundamental considerations in designing an ecolodge are the physical and cultural context; sensitivity to the local environment and culture are essential to a sustainable ecolodge design.



3.2.1 Physical Context

An ecolodge should be designed within the natural physical context of the area in which it is situated. It should be designed in keeping with its natural surroundings and should not violate or intrude upon the physical landscape as a foreign structure. The lodge should interact with the natural ecological/geological features, aiming to blend into them as much as possible. This, in turn, would render the design visually sustainable, as it would act as a timeless piece of architecture and an organic feature of the natural landscape.

The following principles should be given particular attention in addressing such issues as physical context:

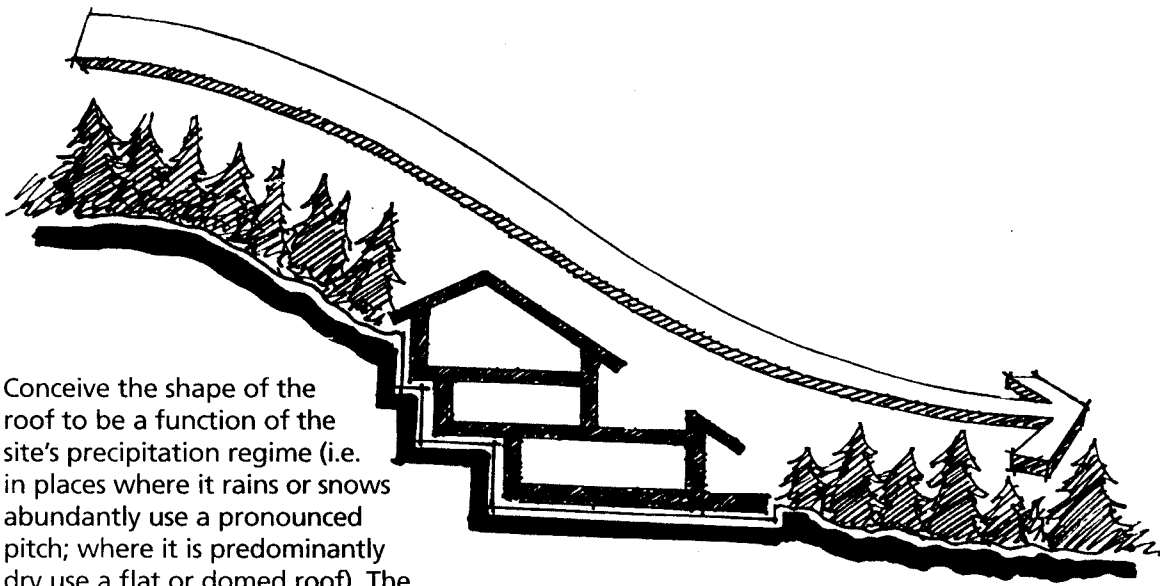
- Form
- Color
- Integration with the surrounding landscape

3.2.1.1 Form

Architects should draw on the beauty of the existing landscape as a vital theme for the ecolodge's form. The lodge should be planned and designed such that it follows the contours and forms of the natural landscape features, and therefore, enhances itself by such interplay.

GUIDELINES

1. Buildings and other structures should not dominate the landscape and/or surrounding vegetation, which constitute the main attraction, together with the local wildlife (and, this being the case, the local cultural environment). Try to have your ecolodge look as if it has sprouted like a plant or emerged from the landscape like a geological formation. Use clues from the local landscape for materials, building forms and siting of the buildings.



2. Conceive the shape of the roof to be a function of the site's precipitation regime (i.e. in places where it rains or snows abundantly use a pronounced pitch; where it is predominantly dry use a flat or domed roof). The degree of overhang or extension of the roof beyond the building line can provide shelter from sun or rain and protect the building from the elements.
3. Avoid building high structures, so that the architectural form does not stand out above the vegetation or surrounding rock formations. Besides aesthetic considerations, low structures also gain protection against intense weather conditions. However, some sites may be ideally adapted to tree house-type structures, which may reduce ground footprint.
4. Anticipate any possible future expansion of your ecolodge and plan carefully so as not to leave things to improvisation.

3.2.1.2 Color

The color and texture of exterior finishes are particularly important design elements for an ecolodge, and can enhance the feeling of harmony and unity between the final built form and the natural environment.

On the other hand, color can diminish the feeling of the physical context if used incorrectly. The wrong colors can sharply contrast the shades of color found in the natural landscape, and can create a feeling of intrusion upon that environment.

GUIDELINES

1. The colors used for the ecolodge should be drawn from shades found in the surrounding elements — leaves, barks, rocks, soil, etc., (commonly referred to as earth tones) — that should soften the presence of the built form within the environment.

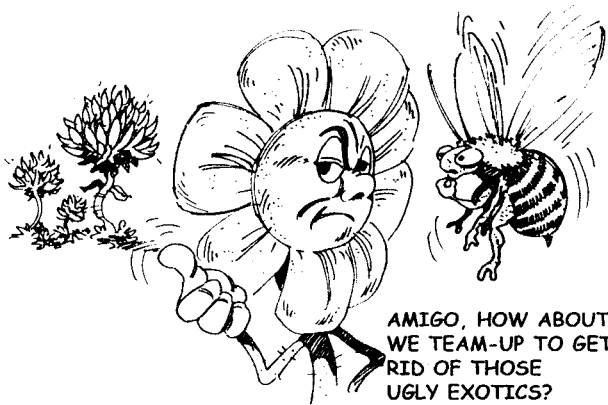
2. Use colors that blend with their surroundings and be inspired by rocks, the sea, desert sand, plants and distant mountains. Remember that although white reflects solar radiation and may cause comfort inside the lodge, it may provoke annoying glare outside and may clash with the surroundings. Also, remember that black absorbs solar radiation.

3.2.1.3 Integration with the surrounding landscape

The built structure of the ecolodge can be made to blend in with and appear as an extension of the natural environment through carefully designed minimal landscape plantings. Refer to Section 1.6 for more detailed information on landscaping.

GUIDELINES

1. Integrate the lodge into the surrounding landscape through the planting of various indigenous trees and shrubs whenever and wherever possible. Landscaping should be guided by the patterns of the existing natural landscape as much as possible, and native vegetation (e.g. shrubs and trees) and rocks should be laid out in an informal, natural manner.
2. Build the lodge on stilts where feasible to allow existing vegetation to grow and to allow for natural drainage and ventilation. Obviously, this will not suit all lodges and sites.
3. Use plants that are native to the area (endemic) since they will be in greater harmony with the existing surroundings, require less maintenance, be well adapted to the local climate and soil conditions, and in some cases, attract native bird and butterfly species.



4. Avoid superfluous landscaping and the use of exotic plants. Preserving the existing landscape should be a priority.
5. Remember that landscape plantings can also assist in re-establishing diverse natural habitats that may have been lost or diminished within the larger natural site.
6. Your buildings should be placed sufficiently apart to allow for natural growth of plants and movement of wildlife.

3.2.2 Cultural Context

An ecolodge should demonstrate the same level of sensitivity to the cultural context as it does to the physical context. The design of the ecolodge should be congruous with the cultural environment in which it operates, incorporating cultural motifs and traditional styles of vernacular architecture wherever possible. The use of vernacular architectural principles in the design will allow the ecolodge to reflect the local cultural history, and be visually and culturally sustainable over time.

The use of an area's vernacular architecture helps assimilate buildings into the local cultural context, and here the ecolodge can serve two additional roles: First,

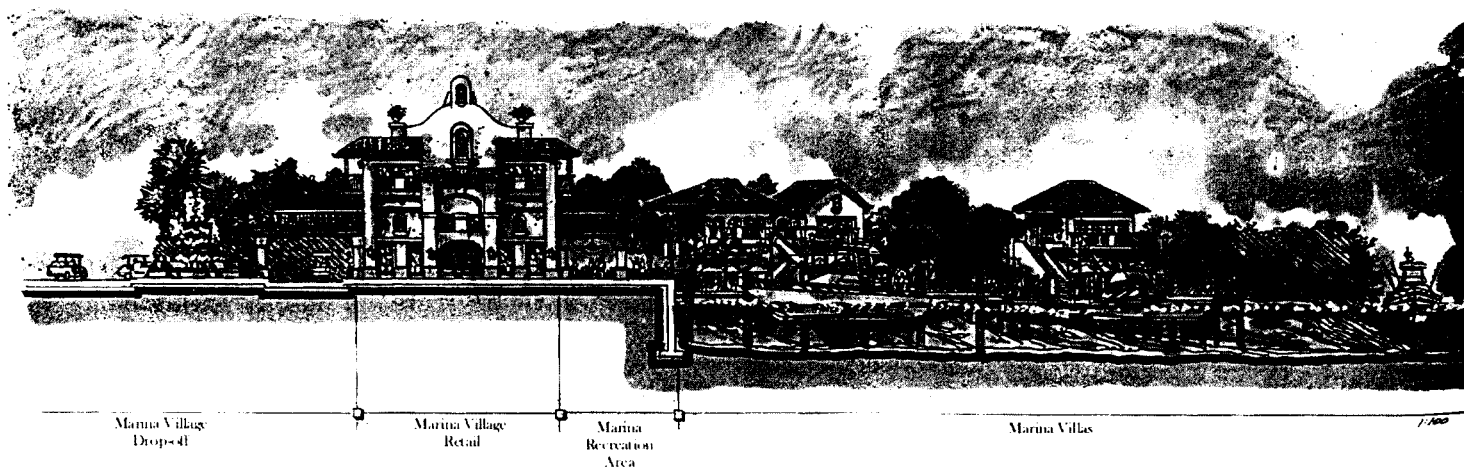
it can help reduce any feelings of cultural intrusion that may be felt toward the lodge by local traditional peoples. Secondly, if it is done well, it can enhance the tourists' experience and appreciation of the local cultural forms and styles.

It does not suffice to merely copy the native forms however. The architect may be forced to incorporate modern appropriate technology so as to adapt the traditional forms to the present requirements of hygiene and lifestyle of the contemporary tourist — without making a parody of the original.

Traditional building forms can indeed lead us to a new synthesis of architectural expression by providing us with a new architecture that integrates the most modern technology with local materials and methods of construction. Architects and developers should therefore help demolish barriers between old and new, (while recognizing the potential folly of replacing worthy original features with faddish monuments to a powerful ego) and evolve a viable regional ecolodge "language" that draws upon timeless indigenous forms.

GUIDELINES

1. Consult with local elders or historians in your attempts to draw on themes and concepts from local culture and in examining and adopting various aspects of the vernacular architecture. Respect for religious/spiritual symbolism is very important, and the guidance of local people will be needed in order to avoid causing offense: you don't want to build your ecolodge on a local theme which turns out to be a traditional monument to the dead, for example.
2. Base your design on local building techniques and forms (if there are any) and use local cultural images as much as you can. Think about: the form of the built structure and traditional materials and technology used in their construction; spatial relationships



between and within structures; and cultural artifacts, which, with respect to their origins may be adopted for lodge decorations. Many native techniques are time-honored and are frequently the ones that bring out the best in relationships between people, architecture and its environment. But don't merely copy; employ local craftsmen to use traditional skills, and acknowledge their work. This helps bring a sense of local "ownership" to the project and apart from improving community relations, it gives you a chance to help them improve and modernize their work with the benefit of recent research and materials.

3. Construction, interior furnishing and decorating (which should be discreet) should always take advantage of local materials and hand labor (including native artists and artisans), if they exist. This is something that ecotourists will usually appreciate; however, be genuine and do not resort to cheap imitations.
4. Respect local traditions, including religious aspects, magical objects, ceremonial dates, etc. Create spaces in your ecolodge that can accommodate local dances, rituals, plays, etc.

3.3 WATER MANAGEMENT

Most futurists agree that water will become the most important resource in this century, even more than land. Because of the remote nature of most ecolodges, water is often a precious resource. Water is scarce in many parts of the world, and it is important that your ecolodge enhances the ecological and educational experience of your guests by demonstrating world-class water conservation and management.

Many lodges around the world experience problems with water supply. The lack of drinking and secondary water has been a major constraint for coastal lodges as well as those in semi-arid and arid regions. The architect should seek alternative, sustainable means of acquiring water for the ecolodge, as well as means of reducing consumption. Capturing and reusing any rainwater would be a prudent first step to take.

The architect should pay special attention to water management when planning an ecolodge, especially in regions with a history of drought. Extravagances such as swimming pools, spas and lawns in such areas not only may be inappropriate and unsustainable, but they may generate resentment and ill will among local people. At all times, however, the quality of water for consumption is of paramount importance, as is the intelligent re-use of "grey" secondary water. Lodges only use about 10% to 15% of processed water for

drinking and cooling, and it is plainly extravagant to use it for flushing the toilet, bathing and showering, and watering the lodge gardens.

Sections 2.3.2 and 2.3.3 discuss mitigation measures when developing the ecolodge to avoid disturbance to surrounding water sources. This chapter deals with issues of reducing water use, reusing and recycling water, and with treating waste-water.

In every case, it is advisable to have a hydrologist look into the main water sources of your ecolodge site, considering the impacts of maximum use versus availability, and also the impacts on the natural environment and nearby communities. The hydrologist also should assess the minimum of water that must be present for natural systems to work during all seasons in order to avoid negative impacts. A careful analysis of water sources and any required dam building or groundwater extraction must be undertaken. Interference with natural watercourses may result in unacceptable environmental impacts, including the irreversible destruction of habitat and loss of species, feral species invasion, unexpected erosion problems, etc.

At least a basic knowledge of the hydrologic or water cycle is required to truly plan for the wise management of all available water resources. It is very important to monitor the effects of water uptake — the sustainability of your supply depends on it.

GENERAL GUIDELINES

1. Employ a professional hydrologist to survey and draw up a monitoring program to predict and measure the impacts caused by water uptake: lowering the water-table can cause permanent damage, including the collapse of underground structures and the ingress of salt. Your hydrologist should provide a report on existing uses and capacity, water quality and content, and a monitoring timetable for measuring levels of salt and other contaminants and indicators. This program could prove crucial to your sustainability.
2. Carefully manage and monitor water resources, as well as waste handling and disposal, which can prevent the ecolodge from depleting or contaminating the natural resources surrounding it, and therefore enable it to sustain the very same flora and fauna that have attracted visitors to it.
3. When water isn't a problem, use it as an element of design in the interior spaces of your ecolodge, providing horizontal or vertical flow (small waterfalls, lily ponds with moss-covered stones and ferns, etc.) using solar-powered pumps. Apart from the pleasant aesthetic effect and sense of freshness,

the sound of running water produces a calming effect. In every case, try to recycle your water.

4. Investigate how the water supply system for your project may or may not affect the availability of water for neighboring communities.

WATER WARS IN THE

21ST CENTURY!!



There are four main ways to manage water:

- Water conservation
- Water harvesting
- Water re-use
- Water treatment

3.3.1 Water Conservation

Examples of modern, water-conserving devices include low water-use toilets, tap aerators, showerheads, and drip-irrigation systems that use filtered “grey” water from showers, kitchens and so on.

Designers should also shy away from unnecessary “luxuries,” such as swimming pools or golf courses, that require large quantities of water (such facilities seriously contradict the ecolodge philosophy). This contradiction deepens in many arid and semi-arid regions, where water is a scarce commodity for the local inhabitants and at times, is even absent in sufficient quantity for their basic sustenance. If a swimming pool becomes a necessity for any reason in such circumstances — i.e. market demands — then it should be built and operated in a very environmentally-friendly way, it should look natural and it must have the community’s blessing. (See Section 1.5.6 for specific design guidelines for swimming pools.)

GUIDELINES

1. Use low-flow showerhead sprayers, aerators, and restrictors; flow-control aerators for taps; water-conserving dual-flush toilets; “dry” composting toilets, waterless urinals, tap-aerators and night-timed drip-irrigation systems. Be aware that some of these technologies may require

qualified and regular maintenance. Check that maintenance expertise and training would be available, should you decide to use them.

2. Avoid water leaks. Plan simple water systems with as few joints as possible and specify a pressure meter to help pick up water losses. Periodically check your plumbing and make sure that it is in good working condition.
3. Swimming pools are serious consumers of water and should be made as sustainable as possible in terms of treatment and filtration. Carefully investigate and recommend water treatment systems that offer the least impact for your water hardness and other circumstances. Non-chlorine methods for purifying water (Floatrons, ozone-bromine systems, copper/silver ions or salt) are available. Whenever possible and appropriate, use solar heating and solar-assisted circulation pumps.
4. Sand gravel filters do not require chemicals for their operation and can be used to filter domestic water for re-use in gardens, toilets, etc. Filtration and plumbing for water re-use must be planned.

3.3.2 Rainwater and Snow Harvesting

Rainwater or snow harvesting is one sustainable method of capturing water for the ecolodge. Rainwater can be a liability by causing soil erosion if concentrated run-off from hard surfaces is not well managed. However, rainwater can be an asset if it is collected from roofs, large cisterns or rain barrels for use in drinking water (after treatment) or secondary water-use purposes. Although not drinkable without treatment, it can be of adequate and in some cases superior quality for gardens, toilets, clothes and car washing, and possibly hot tubs and swimming pools.

Historically, the collection of rainwater from roofs has been common practice in many parts of the world, and is entirely suited to any ecolodge. Several innovations in cistern design have originated from traditional types of food storage spaces (e.g. granaries). Rainwater pollution may be a problem depending on the region where you live because of acid rain. Roofs with lead flashings or valleys also can affect the quality of water collected. Again, it is prudent to have a chemist analyze the rainwater collected before specifying the end uses for rainwater.

Please note the importance of groundwater recharge for wells, local streams and the effects on the local aquifer if rainwater is artificially drained away. Again, the advice of a hydrologist is essential before relying on groundwater sources.

Snow, being another form of precipitation, can also be harvested to provide an alternative supply of freshwater. Snow harvesting requires the construction of a pit, generally ranging in size from about 6 to 8 meters in diameter and about 10 meters in depth. The pit is heavily compacted and the collected snow is dumped into the pit to a depth of 2 to 3 meters. The compacted snow is covered with earth, which acts as an insulator, and a bamboo tube is placed about 50 cm above the base of the pit to serve as an outlet. As the snow melts around the bamboo pipe, water trickles along the bamboo and into a pot placed beneath the outlet. The water collected in the pot may be used for household drinking water and can supply water to up to 14 families.

GUIDELINES

1. Have all potential water sources analyzed by a hydrologist, if nearby. A competent local chemist is qualified and able to perform routine, inexpensive analysis of drinking (and swimming pool) water. Setting up a regular water analysis has the added benefit of providing some protection against speculative claims from mischievous clients.
2. Specify guttering, pipe-work and tanks to catch and use water efficiently, including any filtration necessary to ensure a clean drinking water supply.
3. Since fresh water supply is frequently a major problem in coastal areas, consider installing a desalination plant near your ecolodge. This option has a number of drawbacks, including the disposal of large quantities of "waste" salt that can substantially damage land and marine habitats. Additionally, desalination is very energy intensive, despite recent major technology improvements. If there is no alternative to desalination, however, don't go for sophisticated technology or large machines, since these produce too much concentrated high-salinity waste (normally at least 5 m³ per day), which will have to be filtered (and disposed of) before being released into the sea. Avoid buying an oversized plant and look for the lowest kWh/1000gal. Purchase those plants that have a good service contract. If you choose seawater for desalination purposes, it should preferably be obtained from beach holes or other underground seawater. The siting of your source should not interfere with tourism activities such as snorkeling or diving. Brine water from desalination plants should not be infiltrated into the soil or discharged to the sea without sufficient treatment to avoid adverse effects of increased salinity or temperature on the biota or soil.

4. Deep beach wells are recommended in some locations. In other locations discharge to the sea can be accepted if pipes are not visible and the discharge occurs from vertical pipe extensions in water deeper than 15m. The difference between the effluent's salinity and ambient salinity should not exceed 10%. Also, temperature should be lowered to the ambient temperature before discharge.

3.3.3 Water Re-use

Wise use and conservation of water should be a byword in ecolodge design and operation. Water reuse should be standard in the industry and a very high priority for designers.

Wastewater from ecolodges, if treated properly, can be re-used for various purposes. The water from kitchens, sinks and showers can be collected in a tank, filtered and treated. This water can then be re-used for flushing toilets, watering gardens, etc. If biodegradable soaps and detergents are used in the showers and kitchens, then treatment is much easier.

GUIDELINES

1. Where there is fresh surface water (rivers, lakes, reservoirs, etc.) available for human use, test and treat it according to the application.
2. Grey water should only be used in sub-surface irrigation.
3. Do not discharge any untreated wastewater (grey or black) or other wastes (especially non-biodegradable) into the sea or other water bodies. This would ruin the resource base of any coastal ecotourism industry. Refer to Section 3.4.3. Under NO circumstances should treated grey water be used for washing dishes. Should you need to re-use water to this standard, you would require either high technology filters or low technology systems and constant quality monitoring.

3.3.3.1 Grey-water irrigation

There are four stages for grey-water reuse:

- Collection (all the points generating grey water, pipes and grades)
- Treatment (grease traps/arrestors, septic tanks, aerated treatment, etc.)
- Filtration (reed beds, sand filters, etc.)
- Storage (tanks, etc.)

Waste-water from showers, bathroom sinks, and other wash sinks is known as grey water. Water from kitchen

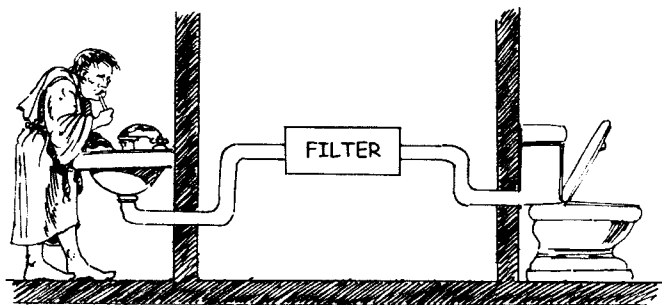


sinks, dishwashers and washing machines — where the water is more heavily contaminated with food particles, grease and detergents — is known as black water. However, if you use arrestors and biodegradable detergents, the vast amounts of water from washing machines and kitchen sinks should be just fine for irrigation.

The wastewater from the above sources is then treated and filtered using sand, gravel, mechanical and biological filters. It is absolutely vital that no toxic or harmful substances are used in the water that goes into the system or it will be impossible to filter and reuse it. The filtered wastewater is then piped from storage for use in the garden or landscaped areas.

GUIDELINES

1. Reuse wastewater (both grey and black) as much as possible. Create systems in which water goes through several uses before being disposed, using it as irrigation or fertilizer for gardens, for flushing toilets, etc.



2. Avoid using potable water for irrigating.
3. Install separate lines and septic systems should you reuse both grey and black waters.
4. Specify and provide biodegradable soaps, shampoo, hair conditioner, etc. and post signs in baths urging guests to use them instead of other products they may have brought.

3.3.3.2 Flushing toilets

Since the widespread introduction of the flushing toilet in the 19th century, little has changed in its basic design. As is generally believed, flush toilets are NOT the largest indoor users of water. This is a key point as toilet waste is usually seen as the main waste problem whereas it is actually the grey-water that is more difficult in both volume (over 80%) and quality.

An ordinary toilet uses anywhere between 9 and 20 liters (2.5-5 gallons) for every flush. Obviously, this is excessive (in no case should more than 6 liters per flushing cycle be used) and several ways exist to save water consumption. In old-fashioned high-flow toilets,

you can achieve a 30% saving in water consumption simply by taking up space in the toilet cistern. Cheap and effective ways to do this are putting a rock or any other solid, heavy object that will not move around or flake off particles like a brick will (in fact, a bottle filled with water is ideal). Use caution in selecting your object so that pieces don't come loose and jam the mechanism. Retrofit kits are available, including toilet dams to reduce tank flush volume.

GUIDELINES

1. Water-conserving flush toilets are widely manufactured and should now substitute for older, more water-consuming models. Characteristics that should be evaluated before purchasing a low-flow toilet include operational noise, solids evacuation, bowl cleaning, and water surface seal area (water standing in bowl after flush cycle; i.e. more water surface area requires less cleaning of skidmarks).
2. Double-flush units also save water by providing a partial flush for liquid waste and a complete flush (6 liters/1.5 gallons) for solid waste. Use waterless urinals wherever possible; besides enormous water savings (160,000-500,000 liters per year), they have lower maintenance costs.

3.4 WASTE MANAGEMENT

The management of waste is a critical conservation problem for protected areas, particularly given the impacts on wildlife and indigenous flora, which stand to suffer from the adverse effects of the irresponsible handling and disposal of waste, such as the introduction of problematic pest species. The design of an ecolodge should fully incorporate every aspect of waste management in order to avoid any harm to surrounding natural resources.

A basic premise of an ecolodge operation is minimizing waste generation, since this is one of the main causes of degradation of surrounding natural environment. This may be achieved by recycling, reusing, refusing, reducing and repairing.

One sustainable principle to keep in mind is that no nutrients should be released that are naturally found in the environment. It is very important to research waste treatment methods used elsewhere in the region: how far away are recycling facilities? Do they collect, and if so, what can they take? What options are available for sewage treatment? Many areas where ecolodges are built are places where aquatic or marine environments have adapted to and require low nutrient levels (mountain streams, springs, coral reefs, etc). The slightest extra flow of nutrients can cause problems such as blue-green algae.

The best attitude towards waste is to avoid it as much as possible, instead of finding ways of treating it.

Waste can be classified in various ways: liquid and solid, organic and inorganic, biodegradable and non-biodegradable, recyclable and non-recyclable. The types of waste addressed in this chapter are:

- Construction waste
- Solid waste
- Wastewater

3.4.1 Construction Waste

Construction sites generate a lot of waste and it is important that it be dealt with in an environmentally friendly way. In most cases, little thought is given to waste removal from “ecolodge” sites. A waste disposal schedule should be created by the contractor before beginning the project and approved by the architect. Effort should be made to reuse as much waste as possible.

GUIDELINES

1. Bring construction crews into the program. Providing initial training for workers that properly explains the project’s aims, rules and reasoning, and encourage questions. Building mutual respect in this way will foster a “team” atmosphere where people have the tools and are motivated to excel in helping meet the project’s aims. You may decide to introduce incentives, such as awards or cash prizes for tidiness, etc. Remember that people can be your strongest asset or worst liability.
2. Specify waste removal contracting as part of the construction stage.
3. Generate the minimum amount of waste possible and treat appropriately all your refuse, recycling and reusing as much as you can.
4. Reduce building waste and packaging at the source; i.e. do not take unnecessary materials to the site and return packaging regularly on trucks to leave the site empty.
5. Design for the most economical use of construction materials; e.g. order materials prepared to length off-site. Also, use full lengths of framing materials and full sheets of plywood rather than requiring cutting.
6. Specify the safe storage and disposal of hazardous waste (toxic materials, used car oil, unused thinners and turpentine, ammonia-based cleaners, etc.). Do not discard them in your site; ship them out to the nearest available waste collection center.

7. Building material waste should be sorted into organized piles by size and length and placed near the “new” materials. This makes it very easy to grab the “short” piece needed before using a new full size one; it also encourages good husbandry.
8. Form boards and panels should be specified that are not necessarily sized for the form but instead sized for reuse in the structure later, and specified as such.
9. Any construction equipment leaking fluids of any kind should not be allowed on site and should be stated in the specifications.
10. Specify or encourage car pooling by limiting parking on-site; provide secure parking for individual vehicles instead.

3.4.2 Solid Waste

Every ecolodge basically has two basic sources of solid waste: management and guests. The following basic strategies may be applied:

- Use products that minimize waste and are not toxic.
- Reject all unnecessary packaging.
- Convert biodegradable waste to compost or submit the waste to digestive anaerobic systems. Many biodegradable wastes would be better suited to an aerobic system.
- Reuse materials in situ and collect materials suitable for recycling off site. If that is not possible, outdoor facilities may be used, provided that they are well sealed and contained.

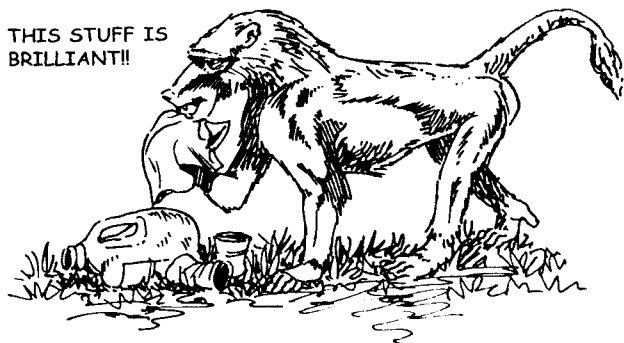
GUIDELINES

1. In selecting a location for outdoor waste disposal, the architect should consider various issues. For example, the site should be inaccessible to wildlife and located far from water sources such as streams and rivers, especially as local people, flora and/or fauna use these sources. Attention should be paid to water table levels and groundwater flows, in order to eliminate the possibility of contamination by leachates. Also, prevailing wind direction must be considered when selecting the site, so as to avoid the smell being carried toward the lodge or neighbors.
2. Discard waste responsibly. Non-biodegradable wastes should be regularly sorted according to various categories (glass, plastics, etc.) and transported out of the protected area to the nearest dumping and processing facilities. Biodegradable waste can be turned into compost and used for landscape purposes around the lodge. Incinerator use should be avoided as they cause air pollution.



- Given the frequent presence of large numbers of mammals, birds and other wildlife around lodges, all outdoor waste disposal sites and compost heaps should be secured from scavenging animals and birds.

THIS STUFF IS
BRILLIANT!!



- Specify only durable, biodegradable or recyclable goods and materials for an ecolodge. A material is not converted into waste until it is thrown into the garbage can. If you can find ways of reusing a material, then it is not a waste but a resource. Remember that reusing is better than recycling. Allow for the lodge's complete flow of goods and materials in, and rubbish out via properly separated containers. Establish a specific recycling program in your ecolodge. From the beginning, instill a "recycling ethic" among your staff through good design of waste and recycling facilities and proper training. Ensure that your system — i.e. compost, metal, paper, glass and non-recyclable containers — is foolproof and easily accessible to guests. Design around the usual drawbacks of waste disposal — smell and pest insects in particular — so ensure bins are airtight; plan for a capacity to rinse out containers nearby.
- Coordinate waste management systems with neighbors and the local community. It may be that you need to commit the ecolodge to take on initial responsibility for wider recycling management. If so, it is possible that you may use this to negotiate public services in return, such as inclusion for the ecolodge on bus routes.
- At worst, if you must bury your inorganic garbage in sanitary landfills on site, seal the base of the landfill with clay or plastic, taking care to avoid creating a flooding problem either from or into watercourses. Alternate a one-meter layer of garbage with a 300 mm layer of clay or compressed mud, avoiding in all cases contaminating the water table.
- Domestic animals such as chickens, ducks and pigs can be effective consumers of food

wastes, and can later become healthy food themselves. This can be the ultimate recycling of food waste — converting it from one form to another.

3.4.2.1 Biodegradable materials

GUIDELINES

- Emphasize the use of biodegradable and environmentally friendly materials in the construction and operation of your ecolodge, including aspects of cleaning, maintenance, acquisition of products, and kitchen design.
- Whenever possible, use only natural paints, varnishes and finishes.
- Use non-biodegradable materials only if local materials are exhausted. This will save the local ecosystems by not having to hack vegetation for walls, beams or thatching materials for building or maintenance, whether they are found within or outside the reserve.
- Strictly limit the use of "virgin" plastics (not made from recycled material), especially as containers and packaging, unless it is returnable or reusable.
- Specify only biodegradable soaps and detergents.
- Advise your guests in advance against bringing materials that might result in non-biodegradable waste (including soaps, foodstuff and other products that use excessive synthetic wrapping).

3.4.2.2 Organic waste treatment

Composting and "biogas" (extracting natural gas from waste) are two popular examples of organic waste treatment. With new technology, it is becoming much easier to treat waste organically. Many ecolodges, however, prefer to use appropriate technology to build their own composters and biogas plants.

GUIDELINES

- Consider using organic waste for producing compost (an excellent organic soil fertilizer) and biomass. You can build a compost processor using a discarded oil barrel, providing it with a double lower base (the higher of the two being a grill where you will place your organic waste). As the refuse decomposes, it is sieved through the grill and accumulated in the lower base of the barrel, from which it is periodically gathered as compost. A shaft made of sheet metal (at least 2 m long) should be provided at the top end of the

composting barrel, so as to eradicate bad odors. For better results (better solar absorption and speeding up of the biodegradation process), paint the barrel black.

2. Consider using anaerobic digestion (wet fermentation process) for breaking down food, animal waste, human fecal matter, and for the total array of solid waste such as waste paper, green waste, and landscape (garden) waste. This converts the waste stream into three usable by-products:
 - a) Biogas, an energy-rich gas stream, comparable to natural gas, that can be used to offset the cost of energy to the ecolodge.
 - b) A high-quality solid organic fertilizer that may be useful in landscaping efforts or even crop production.
 - c) A diluted liquid organic fertilizer that may be used in drip irrigation as an additive to any planting program, for feeding ornamentals, or in landscape plots for replenishing native species of plants.
3. Again, anaerobic processes are better suited for much of this waste, especially the food scrap, green and landscaping waste, and even human fecal waste in the proper composter.

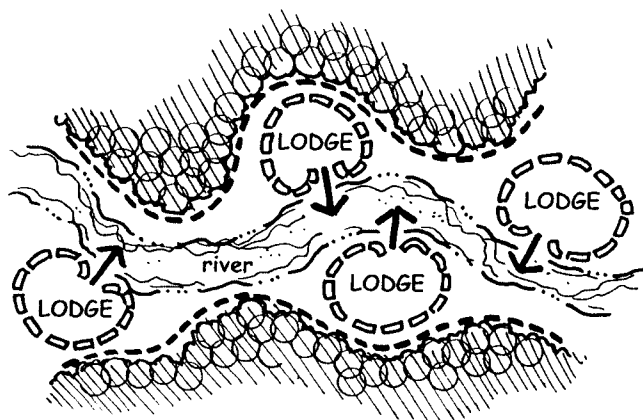
3.4.3 Waste-Water Treatment

A wide variety of onsite wastewater treatment systems may be chosen for a given site. The primary criterion for selecting one design over another is protection of public health while preventing environmental degradation. Other important criteria are cost and ease of operating and maintaining the system. The fate and toxicity of any residuals resulting from the treatment and disposal system must be considered in the selection process.

On-site wastewater treatment systems include a variety of components and configurations, the most common being the septic tank/soil absorption system. Traditionally, subsurface soil absorption has been used almost exclusively for onsite disposal of wastewater because of its ability to meet public health and environmental criteria without the necessity of complex design or high cost. A properly designed, constructed and maintained subsurface absorption system performs reliably over a long period of time with little attention. This is because of the large natural capacity of many soils to assimilate wastewater pollutants.

Unfortunately, not all soils are suited for conventional subsurface soil absorption fields. If soil absorption cannot be used, wastewater also may be safely disposed into surface waters after appropriate filtration or evaporated into the atmosphere. However, more complex and costly

systems may be required to reliably meet public health and environmental criteria where these disposal methods are used. Therefore the first step should be to analyze soil characteristics and composition of your site.



Most lodges have had difficulty when faced with the question of where and how to dispose of their wastewater. Some coastal lodges have released their waste into the ocean while a few have disposed of sewage in rivers. In such cases, marine, riparian and terrestrial wildlife — along with humans — all stand to be harmed by the water contamination. Sewage should be disposed and treated in a responsible fashion. The economical and relatively low-technology “solar aquatic” wastewater treatment (“a poop to flowers”) system uses the sun’s energy, combined with bacterial and animal/plant systems to break down waste and create marketable flowers and plants as a by-product. The resulting water is adequate for irrigation and other similar uses.

In this book it is not possible to discuss in detail all the different wastewater treatment and disposal methods under various site constraints. Many technical books deal specifically with wastewater treatment, but the reader is referred to the following sources: Salvato 1995, EPA 1990, Faruqui et al 1995, Rapaport 1996, Robertson & Sieber 1996, and Kruzic & White 1996.

Generally speaking, the following disposal methods are possible:

- Trenches
- Beds
- Pits
- Mounds
- Fill systems
- Sand-lined trenches or beds
- Artificially drained systems
- Evaporation infiltration lagoons
- Lined evaporation lagoons
- “Evapotranspiration” beds or trenches
- Lined trenches

With sufficient treatment and presence of receiving waters, surface water discharge is always a potential disposal option. You should install a sewage system that does not allow contamination to reach groundwater or other water sources, such as the ocean, river, lakes, etc., by ensuring that the system does not extend below the water table.

The six types of sewage treatment discussed here are:

- Pit latrines
- Septic tanks
- Dry toilets
- Anaerobic waste treatment
- Aerobic waste treatment
- Constructed wetlands

3.4.3.1 Pit latrines

This is the most rudimentary method for disposal of human waste matter (widely used around the world in less developed rural areas). It is not advisable as the permanent solution to the main body of your ecolodge, but may be justified during construction or at the very beginning of your operation, as well as in remote camping areas or in distant portions of nature trails.

In short, a pit latrine is a hole in the ground (covered by a cabin) in which human waste is dropped. When the hole is filled to about 1 m (3 ft.) from the surface, the cabin with the defecating platform must be moved somewhere else and the hole completely covered by soil. A new hole is dug near the previous one.

The use of conventional pit latrines should be extremely limited. None should be constructed in a floodplain.

It is best to install Ventilated Improved Pit latrines (VIP), which is a modified version of the conventional pit latrine.

GUIDELINES

1. To avoid unpleasant smells and proliferation of flies that occur in traditional pit latrines, it is highly recommended to use improved ventilated latrines, preferably with the pit offset from the latrine. Put an external ventilating pipe (diameter of 6 or 8") coming out directly from the pit (fix a wire netting on the upper end of the vent to keep flies away). Paint the vent black so that the air inside will heat up, creating a rising current of air and avoiding bad smells. Ventilation is the key to successful operation. An older method is encouraging visitors to sprinkle a handful of lime into the pit before leaving.
2. In the case of sloping terrain, all pit latrines should be placed below the point where the local water source (well) is found, and at least 1.5 m above the water table, to avoid contamination.

It is not convenient to use pit latrines in sandy soils that are too close to the water table.

3. As a method of sewage disposal, the architect can use the VIP in the ecolodge. A VIP is a modified version of the conventional pit latrine. It is built out of durable materials (walls are of brick or stone, and the floor is of a permanent finish of cement over concrete) and its pit is lined with a permanent brick or stone wall. Also, the VIP is ventilated through a pipe. The VIP is inexpensive in construction and like its conventional counterpart, is designed for use without water; this is an important factor given the frequent lack of water in large areas of many countries.
4. Point the vent flue toward the sun and fit a self-closing lid to the toilet to stop flies from entering.

3.4.3.2 Septic tanks

A septic tank is a closed chamber, usually made of concrete, in which microbes digest solid wastes, creating a liquid effluent that is absorbed into the ground through a leaching field, or series of perforated pipes. This substantially reduces the amount of leachate, which has to be absorbed by the soil below. Septic tanks can be purchased ready-made in some locations and may be field-constructed where they are not available.

It is important to understand that burying the septic tank does not remove the odors. It needs regular inspection, pump-out points and venting. They also do not accept waste that will not break down naturally.

GUIDELINES

1. Perform soil tests to determine the percolation rate of the ground, or the rate at which the leachate can be absorbed.
2. Design septic tanks and leach fields to accommodate the volume of waste flow. They can be designed to serve more than one unit to reduce their number and costs.
3. Locate leach fields where heavy rains won't saturate them and reduce their effectiveness. The leachate can also provide irrigation for plants, but beware of the tendency for fast growing roots to clog pipes.

3.4.3.3 Dry toilets

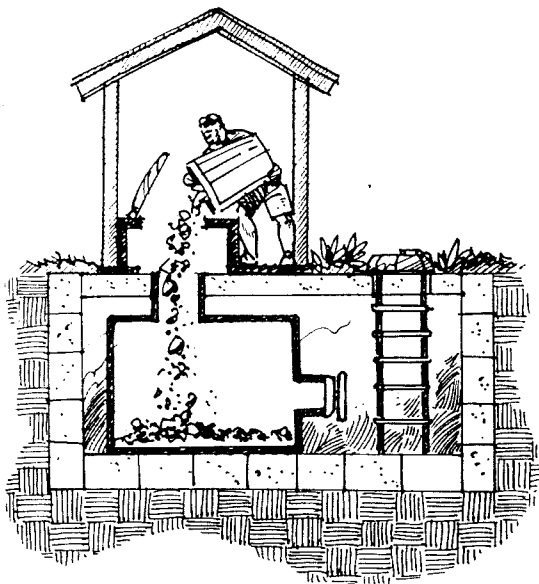
Dry toilets, also called composting toilets, offer one of the simplest and most economic ways to prevent pollution by converting excreta into fertilizer. A composting toilet is a large tank located directly below the toilet room. Wastes enter the tank through

a larger diameter chute connecting to the toilet, and decompose in an oxygen-rich environment. No water is used for the toilet, but a carbon-based bulking agent (such as wood shavings) is added to improve liquid drainage and aeration, and to provide fuel. A small fan draws air through the tank and up the vent pipe to ensure adequate oxygen for decomposition and odorless operation. Ducts, baffles and rotating tines also help the composting process, and about once a year compost can be taken from the tank for use in gardens.

However, it is important to mention that this type of toilet is not acceptable to some local authorities in certain countries, such as Australia and the U.S. Several commercial options of dry toilets are available in many countries around the world. An interesting variant, common in many developing countries, is the Double-Vault Composting (DVC) toilet. This batch composting arrangement allows decomposing excreta to be kept for a period of time in isolation from fresh materials (and pathogens), whereas in simple composting toilets, fresh excreta is continuously added to a single composting chamber. One of the most efficient composting toilets is the Clivus Multrum type, in which decomposing waste gradually moves across an incline from one end of the chamber to the other, where the humus (compost) is gathered.

GUIDELINES

1. Before using a dry toilet for the first time, partially fill the tank with vegetable waste including woodchips, grass and dry leaves, which will absorb liquids, provide carbon for decomposing and stop the contents from solidifying.



2. The bottom of the dry toilet tank should have a slope of some 30° to facilitate the sliding of waste and to conduct it to a lower chamber, from where composted material may be periodically removed.
3. Be sure to provide a mild temperature, moisture, fuel (vegetable material) and air for the toilet to function. Liquid may have to be added to the tank to keep the compost pile moist during periods of little use, or more solid matter added periodically to improve the compost texture.
4. Remember that composting or dry toilets have several advantages over other systems: no water is used and only a small amount of energy is needed for an exhaust fan; valuable nutrients can benefit soils; and proper maintenance requires little time. However, without proper maintenance, the tank can become clogged and unpleasant smells will arise.

3.4.3.4 Anaerobic septic treatment

Anaerobic waste treatment (bioseptic systems) is accomplished by micro-organisms living in the wastewater. Anaerobic microorganisms work in an environment where no free oxygen exists. A by-product of this method of breaking down waste is the smell; nevertheless, these unpleasant odors are the best indication that the anaerobic process is working well.

This technology is already offered commercially in many countries (both developed and less developed), using prefabricated bioseptic tanks (usually made out of concrete) containing an initial bacterial strain. The tank is buried to a minimum depth of 1.5 m/5 ft (to avoid unpleasant odors), to which the sewage pipe from the ecolodge toilet is connected. From the septic tank, a sloping exit pipe (minimum 3% slope) connects with an absorption pit (with brick walls forming a trellis), so that the treated water slowly seeps underground.

Only normal biological waste should enter this system: tampons and other materials that do not break down naturally — or, more seriously, kill micro-organisms, can impede or ruin the system. Toilet paper also affects the performance of septic systems and it pays to experiment with different brands, or disposing of paper separately.

Also, the impact of tourism seasons, with their alternative periods of light and intensive use, affect biological systems.

GUIDELINES

1. Consider having large, isolated treatment and disposal areas since slow treatment means longer holding periods (shallow depth tanks).



2. Dispose treated wastewater (effluent) in an underground system that passes effluent through carefully selected undisturbed soil profiles, as these soils must further filter and remove nutrients as the effluent returns to the water cycle.
3. Ensure that stored recycled effluent receives some aeration to facilitate odor-free recycled water in toilets. One variation of this type of treatment uses part of its treated effluent for toilet flushing.
4. Prior to committing time and resources, it is advisable to contact users of similar systems — talk with a designer, system operator, an owner, and possibly a regulatory agency inspector who has observed performance of anaerobic waste treatment systems in similar conditions to yours.

3.4.3.5 Aerobic septic treatment

Aerobic waste treatment is also accomplished with microorganisms, but in this system air is introduced through various systems into the treatment process to ensure plenty of free oxygen (which these types of bacteria need to thrive). Aerobic organisms work about 20 times faster than anaerobic organisms. Since the process is so much faster, much less holding time is required and less treatment area is needed.

Several options treat waste aerobically. The Center for Clean Development (CCD), a non-profit organization based in Eugene, Oregon (US), promotes the use of waterless toilets and other zero discharge technologies to international development organizations and domestic health agencies. Several different versions of the CCD toilet have been developed for use mainly in developing countries. The primary concern is to prevent pollution of groundwater and sensitive coastal environments. The basic design consists of two watertight chambers built above ground or partially buried. What distinguishes the CCD toilet from other composting toilets is that it is designed to promote aerobic conditions in the digestion chambers without the need for manual turning.

Another variation is a very economical thermophilic aerobic composting latrine, which uses typically local materials of the tropics like wood, bamboo and thatch. If built correctly, it is free of odor, flies and pathogen transmission. This option may be “pioneered” by the local people who can learn from working with the ecolodge. Construction materials include wood, posts, thatching material used for the compost bin, and the plastic bucket and wooden seat for the indoor component of the toilet.

GUIDELINES FOR CCD TOILET

1. Build two watertight concrete chambers side by side, with inside dimensions of each chamber approximately 1.5 meters by 1.2 meters and about 1.2 meters high.
2. A concrete slab covering the chambers serves as the floor of two separate toilet rooms, each with its own toilet seat pedestal molded in place (although the toilet would function no differently with squatting plates instead).
3. Make an inclining access hatch on each chamber facing the sun. Provide separate ventilation pipes for each chamber of at least 20 cm in diameter. Paint these and the digestion chambers matte black, and position the units so that they are exposed to as much direct sunlight as possible to boost evaporation and biological processes.
4. Excreta falls on a mat woven from coconut palm fronds resting on top of a nylon fishing net suspended inside the digestion chamber, separating the solids from the liquids and allowing air to penetrate the compost pile from all sides. Although the woven mat decomposes during the digestion process, the composting material has adequate time to bond together to keep from falling through the net.
5. The large diameter vent pipe draws air up through the pile from an air intake opening located below the net along the rear wall of the chamber. The airflow also helps to evaporate liquids that accumulate on the floor of the digestion chamber. Evaporation is further enhanced by wicks made from strips of polyester or rayon rags (from old clothing), which are hung from the net to draw up the liquid from below to increase the surface area exposed to the air stream.
6. For start-up, a few buckets full of organic material — such as finely shredded coconut husks that have been soaked in water — are placed on top of the mat, along with a scoop of garden soil to inoculate the chamber with anaerobic microorganisms.
7. Bulking agents such as coconut husks, small wood chips, leaves or vegetable food scraps are added periodically during use both to provide a source of carbon and to increase the porosity of the pile so air can penetrate all the way through. For this reason, fine particles of organic matter such as ashes or sawdust are not adequate.

GUIDELINES FOR THERMOPHILIC AEROBIC COMPOSTING LATRINE MADE OF LOCAL MATERIALS

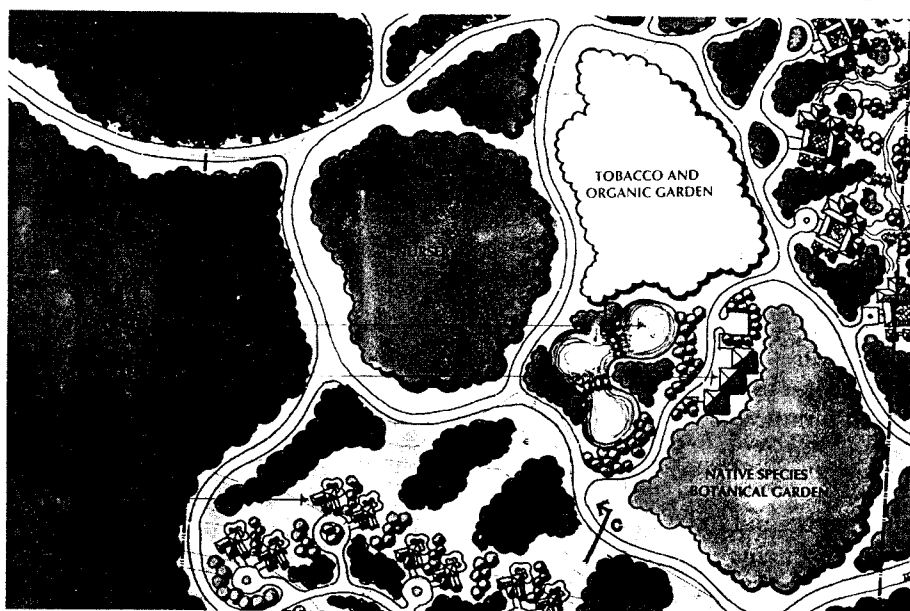
1. A very economical thermophilic aerobic composting latrine can be built that uses only typically local materials of the tropics like wood, bamboo and thatch. It is simple enough for villagers to build and maintain themselves.
2. Briefly, excrement is collected in a five-gallon plastic bucket (locally available in most rural communities of the developing world) and after each use, fresh excreta is covered with dry rice chaff, which eliminates odors and flies.
3. When the bucket is filled, usually in four to seven days, it is emptied into an above-ground, double-vaulted composting bin made of wood, with a thatched roof. Each vault measures 1.5 m x 1.5 m x 1.5 m, which, for an average family of six to eight should be useful for at least six months. The roof is necessary where there are seasonal extremes of sun and rain.
4. After emptying and rinsing the bucket into the compost bin, the fresh deposit is covered with dry leaves, grass or hay. Food scraps also may be added and covered. Only one vault is used at a time; when one vault fills, it is left to age and the other vault is used. When the second vault is full, the first is emptied of aged compost and is reused. Finished compost is applied as a soil conditioner.
5. The pile should not be turned or actively aerated. Aerobic conditions are maintained inside the pile by air trapped in the large, bulky cover materials.

3.4.3.6 Constructed wetlands

Natural wetlands (e.g. swamps, bogs, marshes, fens, sloughs, etc.) have been developed around the world to help provide water quality improvement, flood protection, shoreline erosion control, wastewater treatment, heat exchange and recreation opportunities — they also are pleasing to look at. Many freshwater, brackish and saltwater wetlands have inadvertently received polluted runoff and served as natural water treatment systems for centuries. The functional role of wetlands in improving water quality has been a compelling argument for preservation of natural wetlands and in recent years the construction of wetland systems for wastewater treatment.

Constructed wetland treatment systems have been designed and engineered to use natural processes involving wetland plants, soils and their associated microorganisms to treat wastewater. They are designed to take advantage of natural wetland processes, but do so within a more controlled environment. Some of these systems have been designed and operated with the sole purpose of treating wastewater, while others have been built with multiple-use objectives in mind, such as using treated wastewater effluent as a water source for building and restoring wetland habitat for wildlife and environmental enhancement.

Properly constructed wetland systems are able to provide an effective means of improving water quality without creating problems for wildlife. However, it must be underlined that in every case you will need the technical assistance of a hydrologist with ample experience in wetlands to carry out extremely complex biological and hydrological evaluations, before determining the volume of the operation. No toxic



Site plan of constructed wetland.

Source: E D S A

materials should go into the process. Also, necessary on-going monitoring needs to be programmed by the hydrologist.

Constructed wetland treatment systems generally fall into one of two general categories: subsurface flow systems and free-water surface systems. Subsurface flow systems are designed to create subsurface flow through a filter, keeping the water being treated below the surface, and helping to avoid the development of odors and other nuisance problems. Free-water surface systems, on the other hand, are designed to simulate natural wetlands, with water flowing over the soil surface at shallow depths. Both types of wetland treatment systems typically are constructed in basins or channels with a natural or constructed subsurface barrier to limit seepage.

Constructed wetland treatment systems have diverse applications and are found across the world. While they can be designed to accomplish a variety of treatment objectives, for the most part subsurface flow systems are designed and operated with a focus on water quality improvement only. On the other hand, free-water surface systems are frequently designed to maximize wetland habitat values and reuse opportunities, while providing water quality improvement.

The ecolodge architect should consider a constructed wetland system as a possible sewage treatment where wastewater can be cleaned and filtered through ponds planted with wetland species (e.g. sedges, bulrushes, etc.) that are able to remove pollutants. By using a Gravel Bed Hydroponic system and a subsequent series of ponds, one can successfully treat sewage water and at the same time create an aesthetically pleasing environment, surrounded mainly by indigenous plants.

Constructing wetlands involves turning nutrients into plant matter and can be profitable. Sidelines such as growing aquarium plants for sale, cultivating organic orchards, and using reeds and sedges from the wetlands in their traditional capacity as materials for building roofs or weaving floor mats and baskets are a few ideas.

The “living machine” is a wastewater purification system similar to the organic process found in nature’s ponds and marshes. Living machines incorporate and accelerate natural processes used to purify water. With the help of sunlight and a managed environment, a diversity of organisms including bacteria, plants, snails and fish break down and digest organic pollutants. The treated water is then pumped to a holding tank for reuse in non-drinking situations. This purified water is clean enough for non-potable reuse applications such as irrigation and toilet flush water.

Depending on the climate, living machines can be housed in a protective greenhouse, under light shelter or in open air.

GUIDELINES

1. Investigate the feasibility of a constructed wetland system should sufficient funds and space on site permit. Keep in mind the various secondary purposes of a purpose-built wetland: for example, treated water can be used to breed freshwater fish or used for landscape irrigation; it also attracts wild birds and other wildlife, which in turn attracts ecotourists.
2. Consult an experienced wetlands expert from the final stages of deliberation should feasibility, impact and cost analysis be favorable to the idea.
3. Strict monitoring is required to ensure proper functioning of the wetland system.

3.5 ENERGY

Ecolodges may be powered in various ways. Ideally, you should maximize natural ventilation, heating and lighting. However, you may be able to consider alternative energy sources such as hydroelectricity, geothermal power, diesel-powered generators, natural gas, kerosene, trees grown for fuel and “organic diesel oil” (which comes from crops like oilseed rape), depending on your circumstances. Solar power is also used in a few instances, but so far is not exploited to its full potential in most lodges. The extra energy available through alternative generation is one of our most underused and invisible resources. Some are simple and cheap to put together, but all have particular constraints. Many of these problems have been widely discussed in scientific literature and will not be examined for the purposes of this chapter.

The various alternative and low-impact energies that will be discussed are:

- Solar
- Wind
- Natural Gas
- Geo-Thermal
- Generators
- Wood Combustion
- Hybrid Systems
- Low-Energy Lighting

3.5.1 Solar

3.5.1.1 Passive design

Passive and low-energy systems have a number of positive characteristics that have brought them to the attention of a world now acutely aware of energy scarcity and high energy prices, such as: