PROXIMITY TO MAJOR HARBORS
ISLAND NATIONS
CONTINENTAL LAND MASS
MAJOR HARBOR

ECOBALANCE OPEN SOURCE PLANNING
ISLAND NATION INITIATIVE
Sea Surface Temperature + Active Systems
Tracks of nearly 150 years of tropical cyclones weave across the globe in this map. The map is based on all storm tracks available from the National Hurricane Center and the Joint Typhoon Warning Center through September 2006. The accumulation of tracks reveals several details of hurricane climatology, such as where the most severe storms form and the large-scale atmospheric patterns that influence the track of hurricanes.

http://exploreourpla.net/tropical-storms/
SUITABILITY ANALYSIS

Haiti Topography

The mainland of Haiti has three regions: the northern region, which includes the northern peninsula; the central region; and the southern region, which includes the southern peninsula. In addition, Haiti controls several nearby islands.

The northern region consists of the Massif du Nord (Northern Massif) and the Plaine du Nord (Northern Plain). The Massif du Nord, an extension of the central mountain range in the Dominican Republic, begins at Haiti’s eastern border, north of the Guayamouc River, and extends to the northwest through the northern peninsula. The Massif du Nord ranges in elevation from 600 to 1,100 meters. The Plaine du Nord lies along the northern border with the Dominican Republic, between the Massif du Nord and the North Atlantic Ocean. This lowland area of 2,000 square kilometers is about 150 kilometers long and 30 kilometers wide.

The central region consists of two plains and two sets of mountain ranges. The Plateau Central (Central Plateau) extends along both sides of the Guayamouc River, south of the Massif du Nord. It runs eighty-five kilometers from southeast to northwest and is thirty kilometers wide. To the southwest of the Plateau Central are the Montagnes Noires, with elevations of up to approximately 600 meters. The most northwestern part of this mountain range merges with the Massif du Nord. Southwest of the Montagnes Noires and oriented around the Artibonite River is the Plaine de l’Artibonite, measuring about 800 square kilometers. South of this plain lie the Chaîne des Matheux and the Montagnes du Trou d’Eau, which are an extension of the Sierra de Neiba range of the Dominican Republic.

The southern region consists of the Plaine du Cul-de-Sac and the mountainous southern peninsula. The Plaine du Cul-de-Sac is a natural depression, twelve kilometers wide, that extends thirty-two kilometers from the border with the Dominican Republic to the coast of the Baie de Port-au-Prince. The mountains of the southern peninsula, an extension of the southern mountain chain of the Dominican Republic (the Sierra de Baoruco), extend from the Massif de la Selle in the east to the Massif de la Hotte in the west. The range’s highest peak, the Morne de la Selle, is the highest point in Haiti, rising to an altitude of 2,715 meters. The Massif de la Hotte varies in elevation from 1,270 to 2,255 meters.
SUITABILITY ANALYSIS

Haiti Urban Area

Principal City | Population
---|---
Port-au-Prince | 875,978
Carrefour | 430,250
Delmas | 359,451
Petionville | 271,175
Citie Soleil | 241,055
Gonaives | 228,725
Cap-Haitien | 155,505
Les Cayes | 71,236
Hinche | 30,595
Jacmel | 39,643
Jeremie | 34,788
Hinche | 30,595
Fort Liberte | 20,463
Miragoane | 10,947

Metropolitan City | Population
---|---
Port-au-Prince | 2,296,386
Cap-Haitien | 244,660
Gonaives | 228,725

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Population Density

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX

0 20 40 kilometers
0 20 40 miles

40 kilometers
40 miles

20
0
20
0

persons per square km

Port-au-Prince

Cap-Haitien

Fort Liberte

Jeremie

Gonaives

Hinche

Delmas

Citie Soleil

Port-au-Prince

Carrefour

Miragoane

Les Cayes

Jacmel

Petionville

SUITABILITY ANALYSIS

Haiti Population Density
SUITABILITY ANALYSIS

Haiti Population Displacement

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX

persons displaced destination
SUITABILITY ANALYSIS

Haiti Road Infrastructure

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Harbor Locations

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS
Haiti Waterways

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
Other than Haiti’s three major plains, over 80% of the land area has a varying slope. These plains areas offer a land slope of less than 3%. A majority of the sloped land area can change from ranges of 3% to 47%. Along the three major mountain ranges cutting across Haiti, land slope can vary upwards of 47%.

The plains in Haiti offer the best opportunity with minimal foundation effort. The sloped areas of 3% to 47% may require significant foundation interventions. While the areas of greater than 47% slope would not be recommended for development.
SUITABILITY ANALYSIS

Haiti Soil Suitability

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Earthquake Propensity

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Landslide Areas

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degredation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Wave Height

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Wave Surge Height

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Storm Intensity

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Average Rainfall

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Average Humidity

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Average Wind Speed
SUITABILITY ANALYSIS

Haiti Flood Areas

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degradation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Drought / Land Degredation

- topography
- urban area
- population density
- population displacement
- road infrastructure
- harbor locations
- waterways
- slope
- soil
- earthquake
- landslide
- wave height
- surge height
- storm
- rainfall
- humidity
- wind speed
- flood
- drought / degredation

MAP OVERLAY INDEX
SUITABILITY ANALYSIS

Haiti Harbor Scenario

Harbor Scenario highlights potentially suitable areas for self-sufficient communities based on adjacency to harbors and infrastructure. The highlighted areas are 100 square mile quadrants of Haiti that seem to not be hindered by some of the mapped hazards and correlate well with existing, as well as essential, infrastructure (i.e. roads, ports, and urban areas).
Disaster Avoidance Scenario highlights potentially suitable areas for self-sufficient communities based on minimal impact from natural forces. The highlighted areas are 100 square mile quadrants of Haiti that seem to not be hindered by some of the mapped hazards such as earthquake propensity, surge height, landslide, etc.
Urban Relief Scenario highlights potentially suitable areas for self-sufficient communities based on adjacency to urban areas and location of displaced persons. The highlighted areas are 100 square mile quadrants of Haiti that seem to be located near urban infrastructure and harbors to deliver materials and be placed on or near more productive soils.
Reparative Scenario highlights potentially suitable areas for self-sufficient communities based on damaged or otherwise potentially not suitable land to be repaired. The highlighted areas are 100 square mile quadrants of Haiti that seem to be located near poorly productive soil and may be prone to landslides.
HAITI SUITABILITY SCENARIOS
Harbor, Disaster Avoidance, Urban Relief, Reparative

WINDS
HIGH

HUMIDITY
LOW

NO FLOODING FLOODING

Suitability scenarios - bioclimatic adaptive strategies
HAITI HOUSE

Typical Village Center
THE SITE
10 Rue L Union  Carrefour Mariani  HAITI
PHASE 1
60X90
7 BUILDINGS
14 PEOPLE

PHASE 2
100X148
28 BUILDINGS
56 PEOPLE

PHASE 3
140X190
57 BUILDINGS
114 PEOPLE
HAITI HOUSE
TENT OPTIONS
HAITI HOUSE
8 foot module

PLYWOOD

2x 8x 4x 4x 4x 4x 16x 16x 4x 4x 4x

HARDWARE

12x
HAITI HOUSE
12 foot module

PLYWOOD

HARDWARE

4x 1x 24x 24x 3x 8x 4x 8x 4x 4x 6x 2x 4x 4x 4x 12x
HAITI HOUSE
16 foot module

PLYWOOD
8x
4x
4x
4x 16x 4x 4x

HARDWARE
8x
32x
32x
12x 4x 4x 4x
HAITI HOUSE
EVOLUTION: FROM TENT TO PERMANENT HOME

1. small tent
2. basic 8’ module
3. gutters & downspouts become space for formwork to pour concrete structure
4. concrete structure

1. medium tent
2. basic 12’ module
3. gutters and downspouts
4. concrete structure

1. large tent
2. basic 16’ module
3. gutters and downspouts
4. concrete structure
HAITI HOUSE
EVOLUTION: FROM TENT TO TWO STORY HOME

1. medium tent
2. 2
3. 3
4. 4
5. 5
6. 6

basic 12' module
ROOF STYLES

GABLE

PYRAMID

SHED
<table>
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<th>No. in 12' Module</th>
<th>No. in 16' Module</th>
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<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>floor panel C</td>
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<td>beam A</td>
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<tr>
<td>beam B</td>
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<tr>
<td>beam C</td>
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<td>4</td>
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</tr>
<tr>
<td>beam D</td>
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<tr>
<td>roof panel C</td>
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<tr>
<td>roof panel D</td>
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</tr>
<tr>
<td>triangle sides</td>
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<td>24</td>
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<td>triangle ends</td>
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<td>$1,347.22</td>
<td>$2,281.25</td>
<td>$3,277.78</td>
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- Total sheets of plywood for one of each module:
- Total sheets of plywood for 1,000 of each module:
- Total cost per module:
  - Plywood = $50/sheet plus 25%

- 6500 people housed in 3,000 modules
- 1500 people housed in 1,000 modules
- 2000 people housed in 1,000 modules
- 3000 people housed in 1,000 modules

- 5250 people housed in 3,000 modules
- 1000 people housed in 1,000 modules
- 1750 people housed in 1,000 modules
- 2500 people housed in 1,000 modules
HAITI GROFORM HOUSE 12 X 12 VERSION - 03C
FLOOR PLAN
HAITI GROFORM HOUSE 12 X 12 VERSION - 03C
FRONT ELEVATION
HAITI GROFORM HOUSE 12 X 12 VERSION - 03C
SIDE ELEVATION
HAITI GROFORM HOUSE 12 X 12 VERSION - 03C
PLYWOOD - BASE ELEMENTS

3/4" PLYWOOD (8)

1800 [5'-10 7/8"]

3/4" PLYWOOD (2)

1800 [5'-10 7/8”]

3/4" PLYWOOD (6) [MIRROR HOLES FOR 3 PAIRS]

2400 [7'-10 1/2’’]

COPYRIGHT 2010 CMPBS
INFRASTRUCTURE
POP-OUT FURNITURE INSTALLATION
EVOLUTION OF FORM
Opening and Closing the Home
REGULATES AIR FLOW, ALLOWS FOR SECURITY AT NIGHT AND INCLEMENT WEATHER

ALL PANELS OPEN

SELECTED PANELS OPEN

PANELS CLOSED
INFRASTRUCTURE
SOLAR STILL

- slick, self-made plastic cloth
- black surface
- water
- white surface
- +30% efficiency
- access door
- folded infrastructure
SCREENED GROWER

- screen
- plastic bags
- wet paper towels
- sprouts
- access door
- folded infrastructure
- sand, seashells, volcanic ash
tevlar
reflective surface
cooking box
reflective surface
access door
folded infrastructure
coconut coir
teflon
black surface
perforated surface
food grade grating
drying food
access door
folded infrastructure
bricks
ECO BALANCE - LIFE CYCLE DESIGN HAITI

**SOURCE**
- container garden
- solar sprouter
- livestock

**PROCESS**
- harvesting
- cleaning and preparation
- electricity production
- drying
- burning for biochar
- biofuel harvesting

**USE**
- water stored
- water for livestock consumption
- crop irrigation
- water for livestock consumption
- filtered non-potable water for bathing
- portable water for human consumption
- natural fibers gardens irrigation
- ecosystem regeneration
- ventilation system in the structure
- excess heat redirected into productive action
- organic waste composted or biocharred for fertilizer
- biofuel harvested
- electricity production
- drying
- burning for biochar
- biofuel harvested
- livestock

**RESOURCE**
- material recycling
- lighting
- cooking
- fueling
- carbon dioxide absorption (photosynthetic process)
- oxygen release (photosynthetic process)
- crop irrigation
- water for livestock consumption
- filtered non-potable water for bathing
- portable water for human consumption
- natural fibers gardens irrigation
- ecosystem regeneration
- ventilation system in the structure
- excess heat redirected into productive action
- organic waste composted or biocharred for fertilizer
- biofuel harvested
- electricity production
- drying
- burning for biochar
- biofuel harvested
- livestock

**AIR**
- Natural fibers (sisal, palms, torchwood) (garden also as blackwater treatment)
- material harvesting
- sorting and preparation
- building component manufacturing
- building configuration
- building system expansion
- weaving
- sorting
- natural by-products (bagasse)
- natural fibers (sisal, palms, torchwood) garden (also as blackwater treatment)

**WATER**
- rainwater
- solar distiller
- UV water purifier
- infiltration
- greywater supplies container gardens and solar sprouter
- blackwater filtered through natural fibers gardens
- rainwater filtered through container gardens

**FOOD**
- container garden
- solar sprouter
- livestock
- harvesting
- cleaning and preparation
- social engagement
- consumption
- organic waste composted or biocharred for fertilizer
- biofuel harvested
- electricity production
- drying
- burning for biochar
- biofuel harvesting

**ENERGY**
- photovoltaics
- solar drier
- solar sprouter
- container garden
- solar sprouter
- livestock

**MATERIALS**
- scrap and recycled wood (plywood)
- natural by-products (bagasse)
- natural fibers (sisal, palms, torchwood) garden (also as blackwater treatment)
- material harvesting
- sorting and preparation
- building component manufacturing
- building configuration
- building system expansion
- weaving
- sorting
- natural by-products (bagasse)
- natural fibers (sisal, palms, torchwood) garden (also as blackwater treatment)

**ECO BALANCE - LIFE CYCLE DESIGN HAITI**

- air recirculation
- human exhalate used by flora gardens contribute to carbon sink plant material filters particulate matter
- greywater supplies container gardens and solar sprouter
- blackwater filtered through natural fibers gardens
- rainwater filtered through container gardens
- organic waste composted or biocharred for fertilizer
- biofuel harvested
- electricity production
- drying
- burning for biochar
- biofuel harvesting
- livestock

**OXYGEN RELEASE**
- (photosynthetic process)
- (photosynthetic process)
- carbon dioxide absorption
- air circulation

**CO2-content**
- greencard
- biochar

**BLACKWATER**
- greywater supplies container gardens and solar sprouter
- blackwater filtered through natural fibers gardens
- rainwater filtered through container gardens

**NATURAL FIBERS**
- sisal
- palms
- torchwood

**FUELING**
- biochar produced
- organic waste composted or biocharred for fertilizer
- excess heat redirected into productive action
- organic waste composted or biocharred for fertilizer
- livestock

**WASTE**
- waste
done
- recycling
- composting
- output to food and energy cycle
- output to food cycle
- output to energy cycle

**MULTIPLICATION**
- improved air quality of inner / outer space
- human and fauna respiration increases CO2 content ventilation system in the structure
- greywater supplies container gardens and solar sprouter
- blackwater filtered through natural fibers gardens
- rainwater filtered through container gardens
- organic waste composted or biocharred for fertilizer
- biofuel harvested
- electricity production
- drying
- burning for biochar
- biofuel harvesting
FOOD PROVISIONS
AVERAGE PRODUCTION SPACE NECESSARY PER CAPITA

HIGHEST PRODUCTION YIELDS:
- small scale
- high density
- labor intensive

general focus on vegetative diets
greatly reduces resource needs

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<th>DATA SOURCE</th>
<th>DESCRIPTION</th>
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<td>New Guinea, swidden agriculture</td>
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<td>Uganda, Dodo tribe</td>
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<td>U.S., self-sufficiency small farm</td>
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<td>India, low meat diet - 2 kg/yr</td>
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<td>New Guinea, swidden agriculture with livestock</td>
<td>0.2</td>
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<td>CASE STUDIES</td>
<td>New Guinea, swidden agriculture</td>
<td>4.4</td>
<td>11</td>
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<td>0.2</td>
<td>1/2</td>
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<td>THEORETICAL STUDIES</td>
<td>Allotment garden, UK (extrapolated)</td>
<td>0.08</td>
<td>1/5</td>
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<td></td>
<td>U.S. community garden, labor intensive, all-year</td>
<td>0.04</td>
<td>1/10</td>
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<tr>
<td></td>
<td>China small scale farming, labor intensive</td>
<td>0.02</td>
<td>1/20</td>
</tr>
<tr>
<td></td>
<td>U.S. small-scale, raised bed garden, all-year</td>
<td>0.01</td>
<td>1/40</td>
</tr>
</tbody>
</table>

Extreme erosion has lead to wide spread loss of land productivity

Community driven efforts are essential in coping

Container gardening has been shown to be highly effective

GENERAL EROSION CONTROL:
- tree planting
- container gardening
- permaculture

GARDEN CONTAINERS:
- mounding rubble
- tires
- building system components

SOIL RECHARGE:
- mounding soil
- food waste compost
- garden compost
- biochar
- composting toilets
- plantings

COMMUNITY GARDENS - ORGANOPONICOS
PLANT MATERIAL

STAPLE CROPS - VEGETABLES - HERBACEOUS FRUITS

STAPLE CROPS
Amaranthus spp. – hardy grain, species variable
Colocasia esculenta – malangá – taro – tropical
Pacific tuber
Chenopodium quinoa – hardy grain; will grow where corn will not
Maize spp. – corn
Manihot esculenta – manioc – cassava – starchy tubers pre-dating colonization
Oryza sativa – rice
Phaseolus spp. – beans
Saccharum spp. – sugarcane
Sorghum spp. – Giza sorghum variety; stalks for fuel sometimes worth more than grains

VEGETABLES AND HERBACEOUS FRUITS
Abelmoschus asculentus – okra
Ananus comosus – pineapple
Beta spp, par. vulgaris – chard
Celosia argentea – quail grass; large spinach-like leafy greens
Citrus lanatus – watermelon
Curcubita moschata – seminole pumpkin; gourd
Fragaria spp. – strawberry
Luffa acutangula – gourd
Musa spp. – banana – flimsy, but rapid re-growth
Solanum lycopersicum var. cerasiforme – tomato – small cherry variety

CLIMBING VINES
Pachyrhizus erosus – jicama – vigorous legume w/ water-chestnut like tubers
Passiflora ligularis – sweet passionfruit – for higher climates, good commercial crop
Rubus glacus – Andean blackberry – fruits year round
Vitis rotundifolia – Muscadine grape – native to FL; must be forced into dormancy
Vigna unguiculata – Thailand Long Bean
PLANT MATERIAL
TREES - MATERIALS - CASH CROPS

TREES
Amyris balsamifera, elemifera – torchwood – Haiti native, termite resistant, even green stems burn
Attalea crassipatha – endangered palm with a seed similar to coconut, but richer in fat and oils
Byronima crassifolia – Nance – sweet, edible fruit
Citrus spp.
Coccothrinax concolor, fragrans, montana, and scoparia – palm trees endemic to Haiti
Coffeea spp.
Crescentia cujete – Calabash tree, medicinal
Juniperus gracilior – threatened species found only on Hispaniola
Mangifera indica L. – mango – fast-growing, popular fruit
Minosa scaprella – Brazil native, fast growing, nitrogen fixating, prolific leaf shedder
Persea americana – species of Avocado native to Hispaniola
Persea americana – avocados – fruit-bearing, grows in coastal limestone soil
Pinus occidentalis – pine that grows in poor, acidic soil
Pouteria sapote – mamey sapote – southern Mexican fruit, ornamental evergreen
Pseudophoenix lepiniana – palm species found in the L-Ouest peninsula, near Leogane
Theobroma cacao – cocoa tree

ESSENTIAL OILS
Amyris balsamifera - torchwood; native to Haiti, good building material, repels termites, even green burns
Chrysopogon zizanioides – vetiver; roots grow straight down; non-invasive, good for soil stabilization
Citrus aurantium - key lime; shrubby and thorny, edible
Citrus aurantium - bitter orange; produces neroli oil, edible

TEXTILES
Agave sisalana – sisal
Gossypium hirsutum – cotton

COFFEE
TORCHWOOD
ATTALEA
MANGO
HISPANIOLAN PINE
CITRUS
COCCOTHRINAX
CHOCOLATE
CONSTRUCTED WETLANDS

Guidelines for Design, Construction and Permitting of Constructed Wetlands for On-site Domestic Wastewater Treatment and Disposal
**Table of Contents**

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CONSTRUCTED WETLANDS

Constructed Wetlands
Standard Design and Permit Guidelines

Introduction to This Manual

For the last three years the Pineywoods Resource Conservation and Development Inc., in Nacogdoches, Texas, has provided leadership in transferring innovative waste treatment technology to East Texas. One of the most important technologies to be introduced and promoted is the small scale, low cost, constructed wetlands for single family dwellings. A TNRCC commission appointed committee with representatives from the Pineywoods RC&D, Texas A&M University, the TNRCC, and regional river authorities, has met and approved a pilot project for constructing a limited number of demonstration on-site wetlands systems in Texas.

This manual has been prepared to assist those who are interested in designing, installing, and permitting these wetlands to do so with a modicum of uniformity and ease. The design promoted in this manual has been simplified as much as possible in order to make it easy and inexpensive to install and inspect.

Included in this manual are a standard site analysis form, a standard design drawing and a standard design narrative which are to be used for a 3 bedroom (350 gpd) home application. An installer may use the drawing and narrative for a similar sized system. Any variances can be noted on the narrative check-off sheets. To use the drawing, photocopy the model and change the elevations to fit the actual project site. An installer will need to note the name of the project in the technical summary and on each sheet including the drawings.

This manual is also intended to assist permitting and inspection by TNRCC officials who can check off the designs and variances both in the permit request and then in the actual construction inspection. The same sheets turned in for a permit application can be used for approval and again for final inspection.

The permitting of these initial wetlands begins by an installer answering the site evaluation questions on the technical summary sheets at the beginning of this workbook. They must write in the name of the project for which this workbook is being submitted on each sheet of technical information so that if the pages are separated they can be returned to the correct file. These forms and model drawings do not replace the application forms already in use for innovative systems. This manual is intended to provide a clear model for many with little experience in wetlands design, construction and/or permitting to have a uniform set of guidelines to start with. An attachment of a model for a 225 (two bedroom) system will follow along with a useful sizing chart for other variances in soil and treatment quality.

Your feedback on the usefulness and completeness of this approach to design and permitting are welcome and should be sent to:
Mr. Warren Samuelson
C/O The Coordinator
Pineywoods RC&D
2900 Raguet St.
Nacogdoches Texas 77890.
CONSTRUCTED WETLANDS

**Constructed Wetlands**

**Standard Site Study Guidelines**

10. Elevation/fall from the house tie-in to the farthest edge of the disposal trenches = _____ ft.

11. Slope of property from the house to the farthest edge of the disposal trench = _______ ft.  % of slope = __________ (rise divided by length)

12. Rainfall for this county = _______in. annually.

13. Evaporation in this county = _______inches annually.

14. Soil analysis done by: ___________________________ License # ____________

15. Percolation rate determined for cells = _______ min per in.

16. Percolation rate for trenches= _______ min. per inch.

17. Soil Ra. rating = _______ Soil is suitable_______ Unsuitable_________

18. Auger boring depth if completed to _______ feet.  Mottles present _____yes_____no.

19. High water table signs if any are: ____________________________

20. Average number of days below freezing annually = ___________

21. Fill out the model maintenance form at the back and turn it in signed with this workbook.

**Additional Information or Items to Add:**
Conducted Wetlands
Design and Permit Form 350 GPD
For Single Family Residence

[Please fill out this technical site questionnaire and the following narrative section of this form and turn them in with your drawing of the site, the treatment cell and the disposal system with both elevation and plan views.]

Technical Summary:

1. Number of Bedrooms = ________

2. Total gallons of water used from previous 12 months by adding all bills = ________

3. Find average monthly usage by dividing line 2 by 12 = ________

4. Find daily use by dividing line 3 by 30 = _______

5. Size of septic tank is determined by flow as follows:
   (Insert TNRCC sizing chart)

6. Size of septic tank for this project = ________

7. Septic filter fitted on final outfall piping of septic tank required.
   Type to fit = __________________

8. Fall determined between outfall of septic tank and the water level of the first cell = ________ inches.

9. Proposed elevation (fall) from the outfall pipe of the last cell to the distribution pipe of the lateral or disposal trenches = ________ inches.
### Constructed Wetlands

#### Standard Design Narrative Guidelines

<table>
<thead>
<tr>
<th>#</th>
<th>Guidelines for Component Selection</th>
<th>Guidelines for Installation</th>
<th>Project Name/</th>
<th>Inspection Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Tie in to existing sewer pipe drain:</td>
<td>Select rubber (Fernco type) gasket with stainless steel screw strap to tighten.</td>
<td>☐ Varies Explain:</td>
<td>☐ Not okay Reason:</td>
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<td></td>
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<td>☐ Complies</td>
<td>☐ Okay</td>
</tr>
<tr>
<td>2</td>
<td>Clean-out:</td>
<td>Place clean-out within 3 ft. of the house foundation or as close to the tie-in as possible.</td>
<td>☐ Varies Explain:</td>
<td>☐ Not okay Reason:</td>
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<tr>
<td></td>
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<td>☐ Complies</td>
<td>☐ Okay</td>
</tr>
<tr>
<td>3</td>
<td>Piping from the house to the septic tank can be 3 or 4 inch diameter solid PVC pipe: S&amp;D ASTM SDR ASTM:</td>
<td>Install pipe selected with minimum fall of 1/8 inch per foot of pipe.</td>
<td>☐ Varies Explain:</td>
<td>☐ Not okay Reason:</td>
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<tr>
<td></td>
<td></td>
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<td>☐ Complies</td>
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<tr>
<td>4</td>
<td>Septic tank/s must be sized according to the number of bedrooms and/or daily flow: 3 bedrooms = 350 gpd 360 gpd requires 1000 gallon capacity, two chambered septic tank.</td>
<td>Install the septic tank as close to the ground level as possible. Minimum coverage of 6 inches of topsoil, maximum of 24 inches.</td>
<td>☐ Varies Explain:</td>
<td>☐ Not okay Reason:</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>☐ Complies</td>
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<tr>
<td>5</td>
<td>A septic filter must be fitted to the outfall pipe in place of the normal Tee fitting to prevent solids entering the wetlands media. (Do not use a screen, only a certified filter.)</td>
<td>Center filter in the manhole opening. Glue the body of the filter to the outfall pipe so that the removable cartridge in the middle of the filter can be easily reached and pulled out for inspection and cleaning.</td>
<td>☐ Varies Explain:</td>
<td>☐ Not okay Reason:</td>
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<td>☐ Complies</td>
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<tr>
<td>6</td>
<td>Piping from the septic tank to the wetlands treatment cell must comply with the same specifications as that from the house to the septic tank.</td>
<td>Install all pipes with a minimum fall of 1/8 inch per foot.</td>
<td>☐ Varies Explain:</td>
<td>☐ Not okay Reason:</td>
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## CONSTRUCTED WETLANDS

### Constructed Wetlands

#### Standard Design Narrative Guidelines

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<tr>
<td>7</td>
<td>A two cell filter system with a total of 330 sq. ft. area will be constructed to receive septic tank overflow and treat this wastewater to 30/30 mg/l of BOD and TSS.</td>
<td>Total length is 33 ft. x 10 ft. wide measured from the top inside berm to opposite top inside berm. Ideal 1: w ratio is 3:1, 2:1 or 4:1 to fit a particular site. Build a 3 ft. wide berm all around the system.</td>
<td>□ Varieties Explain:</td>
<td>□ Not okay Reason:</td>
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<td>□ Complies</td>
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<tr>
<td>8</td>
<td>Cell A is a deep zone as the first stage of treatment to receive septic tank inflow. A deep zone serves to mix and distribute water. Fill this area with an approved media and proper plants.</td>
<td>The depth of the normal water level in Cell A is 24 inches. Ideal configuration of Cell A is 10 ft. wide x 12 ft. long. Media may be washed river rock or chipped tires and should cover water by a minimum of 2 inches.</td>
<td>□ Varieties Explain:</td>
<td>□ Not okay Reason:</td>
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<tr>
<td>9</td>
<td>Backflow from the treatment cell to the septic tank must be prevented. Freeboard is created by creating space between the normal water level and the cell berm top and/or the septic tank outfall pipe.</td>
<td>The septic tank outfall pipe elevation must be equal to or greater than the outside berm elevation around the cell. The distance between the berm top and the normal water level is the freeboard of this system.</td>
<td>□ Varieties Explain:</td>
<td>□ Not okay Reason:</td>
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<tr>
<td>10</td>
<td>Freeboard for the first stage of the treatment cell must not be less than 6 inches and ideally 12 inches where annual rainfall is equal to evaporation. Freeboard for the second stage will be the same.</td>
<td>Use the excavated soil to build up a berm to provide added depth to the cell. Hold the berm level around the entire system. Cut in the aeration berm only after cells are complete.</td>
<td>□ Varieties Explain:</td>
<td>□ Not okay Reason:</td>
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<td>□ Complies</td>
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<tr>
<td>11</td>
<td>An aeration berm will be constructed at the end of Cell A. It will force water up near the surface for contact with air as it flows to the second stage. This berm sets the water level for the entire system.</td>
<td>Construct a berm that extends the width of the cell. The height of this berm creates the normal water level for the system. The width of the berm is not less than 24 inches and not more than the outside berm width. Lane the berm and cover with minimum 2 inches of media.</td>
<td>□ Varieties Explain:</td>
<td>□ Not okay Reason:</td>
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<td>□ Complies</td>
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<tr>
<td>12</td>
<td>Following the aeration berm the final stage of treatment occurs in a shallow zone 2/3 the length of entire cell filled with an approved media.</td>
<td>Excavate Cell B to a depth of 14 inches below the aeration berm and fill with 14 inches of media. Cell area is 180 sq. ft. (10 ft wide x 18 ft. long). Normal water depth is 12 inches. Fall from the aeration berm to water level will vary with evaporation.</td>
<td>□ Varieties Explain:</td>
<td>□ Not okay Reason:</td>
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<tr>
<td>13</td>
<td>Overflow/water level control piping from the cell to the drainfield:</td>
<td>Excavate a narrow channel through the end berm of Cell B and place a 4 in. PVC pipe and Tee fitting at the desired water level depth of 12 inches. Place short, perforated extensions on this Tee to 3 ft. wide and allow the ends to be open.</td>
<td>□ Varies Explain:</td>
<td>□ Not okay Reason:</td>
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<td>□ Okay</td>
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<tr>
<td>14</td>
<td>Backflow control must be prevented from the drainfield trenches into Cell B.</td>
<td>The outflow pipe from Cell B to the drainfield must be at least 24 inches above the drainfield manifold piping to ensure that no water flows back into Cell B even if the trenches are</td>
<td>□ Varies Explain:</td>
<td>□ Not okay Reason:</td>
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<td>□ Complics</td>
<td>□ Okay</td>
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<tr>
<td>15</td>
<td>Flood control drainage around the entire system must be constructed to prevent inflow of storm water.</td>
<td>In addition to the berms constructed around the entire system, a drain 8 ft. wide at same elevation as the normal water level in the system must be created beyond where the outside</td>
<td>□ Varies Explain:</td>
<td>□ Not okay Reason:</td>
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<tr>
<td>16</td>
<td>The correct type of plants in Cell A are necessary to ensure effective treatment:</td>
<td>Cell A plants must be true hydridophytes that can sustain growth when their roots and stems are flooded. These plants include cattails, reeds, rushes and thalia. Cell B plants are ornamental bog varieties and include canna, iris, taro, elephant ear.</td>
<td>□ Varies Explain:</td>
<td>□ Not okay Reason:</td>
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<tr>
<td></td>
<td>Cell A plants must be added immediately before tie in.</td>
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<td>□ Complics</td>
<td>□ Okay</td>
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<td></td>
<td>Cell B plants can be added as desired and water level is sufficient to support plantings.</td>
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<tr>
<td>17</td>
<td>Security and access to the treatment cell must be addressed to prevent contact with septic water and contaminated media.</td>
<td>Measures should be taken to exclude small children and pets from contact with the media in the treatment cells which may contain viruses and coliforms. Some warning and perhaps a low fence is recommended.</td>
<td>□ Varies Explain:</td>
<td>□ Not okay Reason:</td>
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<tr>
<td>18</td>
<td>Final disposal trenches. Because the wastewater overflowing from the treatment cell will be treated, the rate of percolation should increase and thus the total area for final disposal can be reduced.</td>
<td>Disposal trench total area is Total disposal area for 360 gpd @30/30 = 969 sq. ft. less 330 sq. ft. of filter = 639 sq. ft. of dield line. Recommend 3 trenches 3 ft. wide and 76 ft. long if on contour.</td>
<td>□ Varies Explain:</td>
<td>□ Not okay Reason:</td>
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</tbody>
</table>
CONSTRUCTED WETLANDS

The top of the perimeter berm should be sloped down and out slightly to drain storm water away from the cells.

The surface of the ground must not be higher than the 9' elevation at any point within 8' of the top of the perimeter berm.

Interior slopes are 1 to 1

Exterior slopes are 3 to 1 maximum (i.e., 4 to 1 is OK, 2 to 1 is not)

Dotted line is the intersection of the water surface and the side of the berm

Water Level at 9' (controlled by the level of the overflow pipe to the field in)

Top of media at 9'2"

Model 350 GPW Design
CONSTRUCTED WETLANDS

Model Site Plan
Includes:
- structures
- contours
- utilities
- CW plans

Dock
Main 3 Bdrm House
Old Septic tank
Power underground
New 1000 gal septic tank + line
Treatment Bed = 10'x 30' ft
Drainfield 3'x width x 5' trenches 75 ft long
Drainage

Lake

sheds
Parking

fence

Water line

Constructed Wetlands

Project Name

Designer
CONSTRUCTED WETLANDS

- Slotted PVC pipes infiltrate partially treated storm water from last chamber into constructed wetland gravel substrate
- Infiltration overflow pipe discharges treated water into adjacent fill & soils
- Return flow with one-way check valve (optional)
- Inflow from catch basin
- Outlet control valve regulates discharge rate (normally set at 2 gals/min) and can be closed in the event of a hazardous materials spill
- Slotted PVC pipe exfiltrates treated water to outlet
- Inverted elbow for trapping oil and other floatables
- Pent-bolts are removed to open manhole cover for maintenance purposes
- Water flows through root zone of wetlands, where microbes metabolize petroleum hydrocarbons, nitrogen and other pollutants
- Plants uptake metals, and gravel soils filter bacteria, phosphorus and metals
- Series of (4) skimmers which transfer clarified water from 3-4 inches below the surface of water to next chamber
Quilting as community planning

Game Table
AUSTIN HATIAN BIKE TRUCK

- Tent Roof
- Large Flip Caster
- Power Hub on Wheels
- Recumbent Delivery Trailer/Home Hoist
- Power Hub Wheel
- Rechargeable Battery Pack
- Recumbent Pedal Gears
- Power Hub
- Hill Pedal Gears
AUSTIN HATIAN BIKE TRUCK

material delivery  moving of roof tent  lifting roof up
EVOLUTION OF THE GROFORM DELIVERY SYSTEM

PROBLEMS IN HAITI:
- poor roads
- narrow lanes
- gas/petroleum deficit
- underused labor force
- vehicle unfriendly terrain
- decentralized distribution

POSSIBILITIES IN HAITI:
- bikes use narrow lanes
- bikes trucks can be built from two bikes
- slopes + topography for power regeneration
- need for a green transportation system in Haiti

MINIMUM ENERGY/MINIMUM ENVIRONMENT IMPACT