

# Eco-Balance

## A Resource Balancing Approach To Community Planning

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Fellow Center for Housing and Urban Development  
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Austin, Texas

THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS



w w w

c m p b s

o r g

## DESIGN

Flexible Open Building Systems  
Incorporating Life Cycle Design

Internationally recognized green architecture  
Greenhouse gas-balanced design  
Prototype building systems  
Healthy building design and specifications



Blueprint  
Demonstration Farm  
Laredo, TX



Advanced Green  
Builder Demonstration  
Austin, TX



2007 Solar Decathlon  
Texas A&M University



GroJoint™  
CMPS Farmstand  
Austin, TX

## MASTER PLANNING

Ecologically-Balanced Land Use  
Master Planning

Nature centers & camps  
Community-supported architecture  
Educational facilities  
Integrated landscape/infrastructure systems



School for Field Studies  
Baja Del Sur, Mexico



CMPS 30th Year  
Master Plan  
Austin, TX



Verano Development  
San Antonio, TX



Community Supported  
Architecture  
Mississippi

## POLICY & EDUCATION

Sustainable Guidelines, Training  
& Policy Initiatives

Intern program  
Green building programs and guidelines  
Life cycle planning procedures  
Professional development training seminars  
Environmentally preferred materials and methods  
Green health care initiatives



Green Guide for  
Health Care



Green Building Guidelines;  
Mueller Green Resources Guide  
Austin, TX



Professional Training,  
Conference Seminars,  
and Workshops  
Image copyright Bill Reardon



Guidebooks, Manuals,  
Publications

## TOOLS

Environmental/Economic Impact  
Baselining and Benchmarking  
Life Cycle Evaluation

BaselineGreen™  
GreenBalance™  
Materials library and assessment  
LEED® and sustainability consulting



Block 21  
Austin, TX



LEED® Consulting  
Image: The Children's Medical Center of  
Central Texas, courtesy of Paragon Companies



Materials and Building  
Systems Library



EcoBalance™ Game

# Global Scale







## National Scale IO/LCA/GIS



The nation's largest scale environmental analysis is being integrated with the spatial capabilities of GIS to create a national scale environmental analysis.



1 OF 400 GIS MAPS (12.5M SQUARE METER RESOLUTION) [www.cmpbs.com](http://www.cmpbs.com)



1	2	3
4	5	6
7	8	9

BOUNDING BOX BETWEEN ANALYSIS - SPATIAL CORRELATION



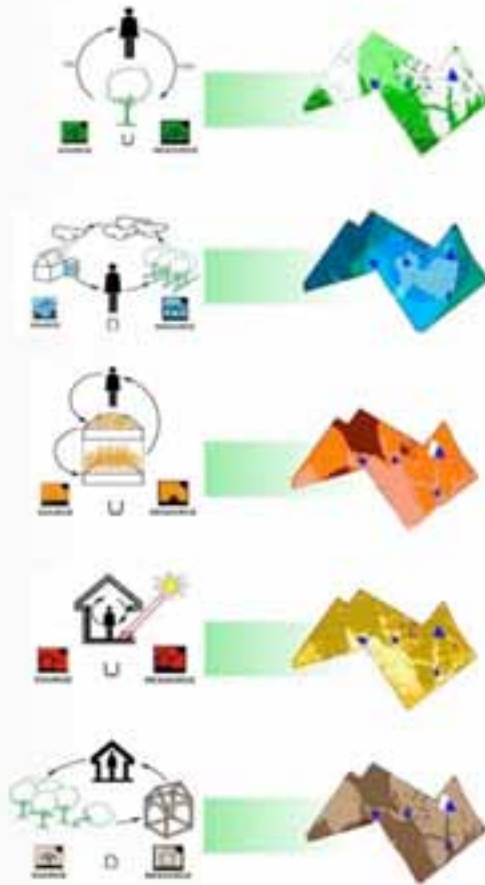
## Building Examples



Life cycle CO2 emissions for each building are shown. The carbon sink capacity of the common materials (regardless of the life cycle CO2 emissions impact) of all the materials used in the building is shown. (Estimated from a 100 year product lifetime.)



# Community Scale



# Building Scale

**Life Cycle Design**

**CroJoint**



**CroColumn**



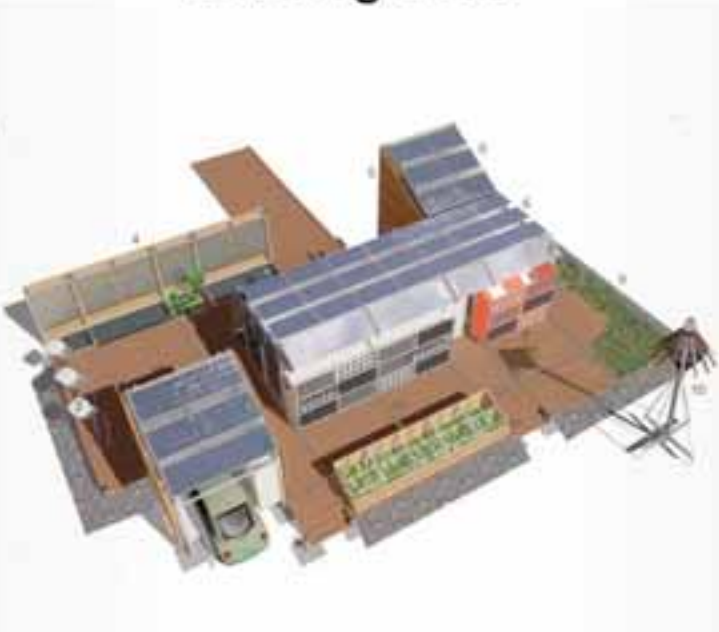
**CroWall**



**CroHome**



**CroVillage**

- 1 Solar Carport
- 2 Building Integrated Wind
- 3 Reflecting Pond
- 4 Solar Thermal Fence
- 5 Studio
- 6 High Efficiency BIPV
- 7 Light Reflecting BIPV
- 8 Light-Thru BIPV
- 9 Grassland Biome Simulation
- 10 Bat Tower
- 11 Food Garden

**Growth Plans**



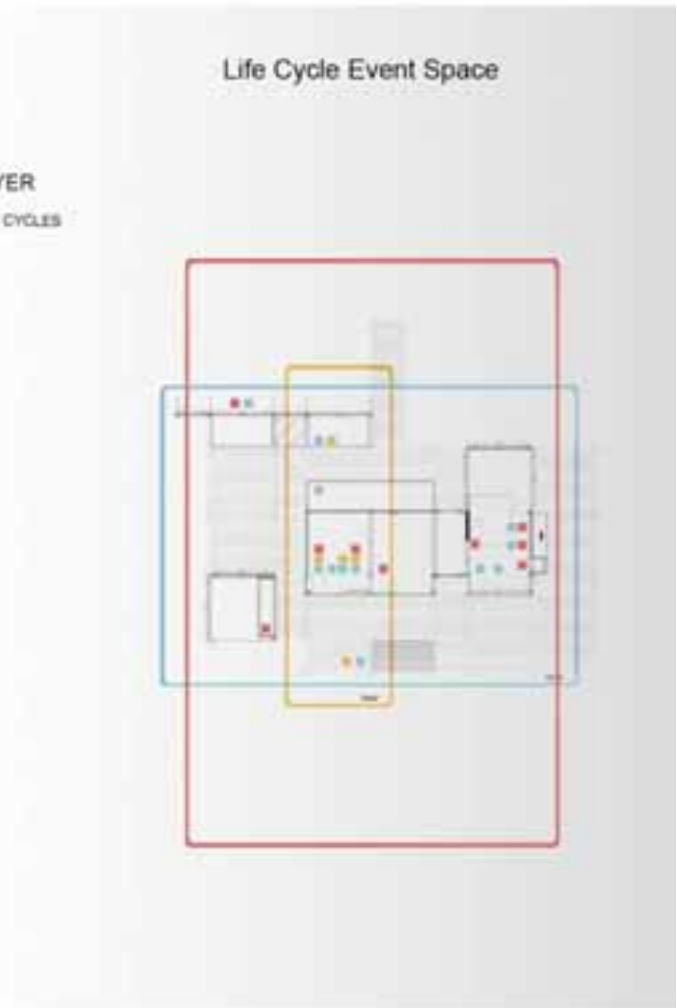
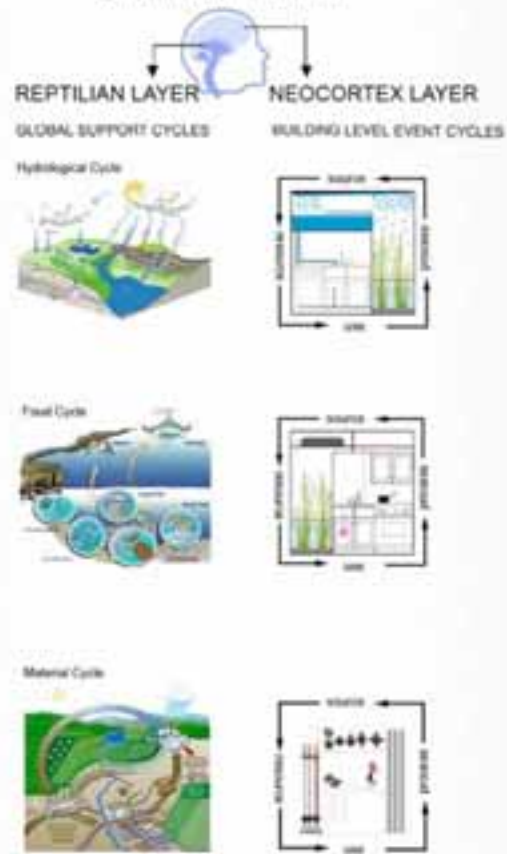
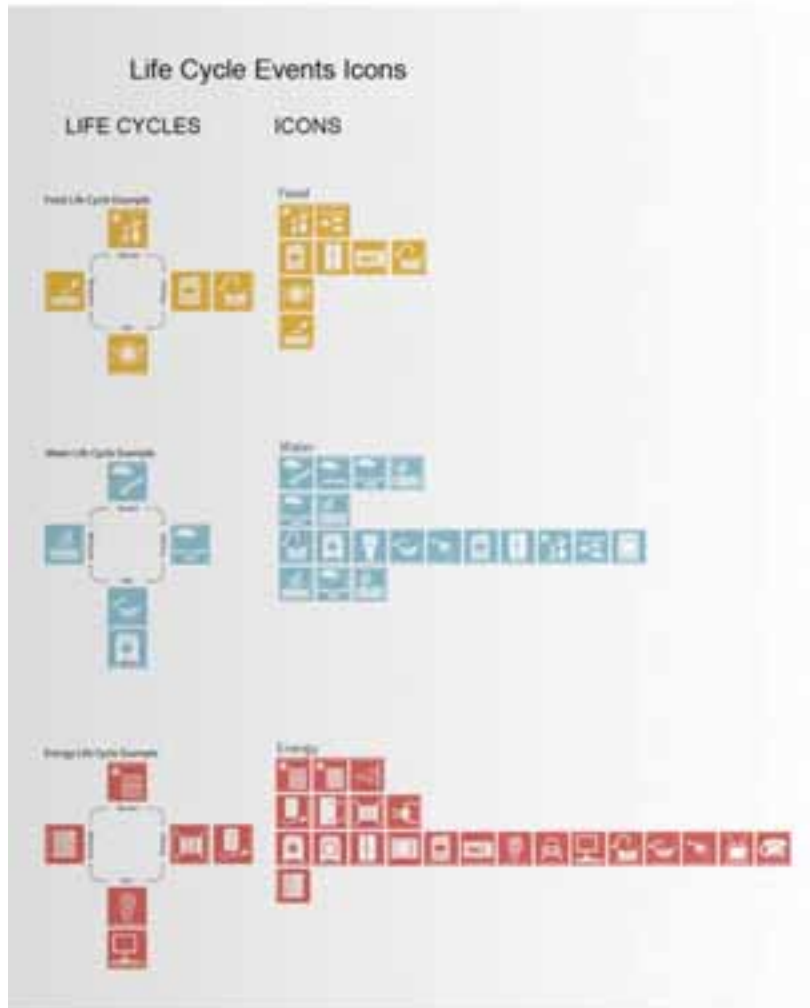
Number of Units



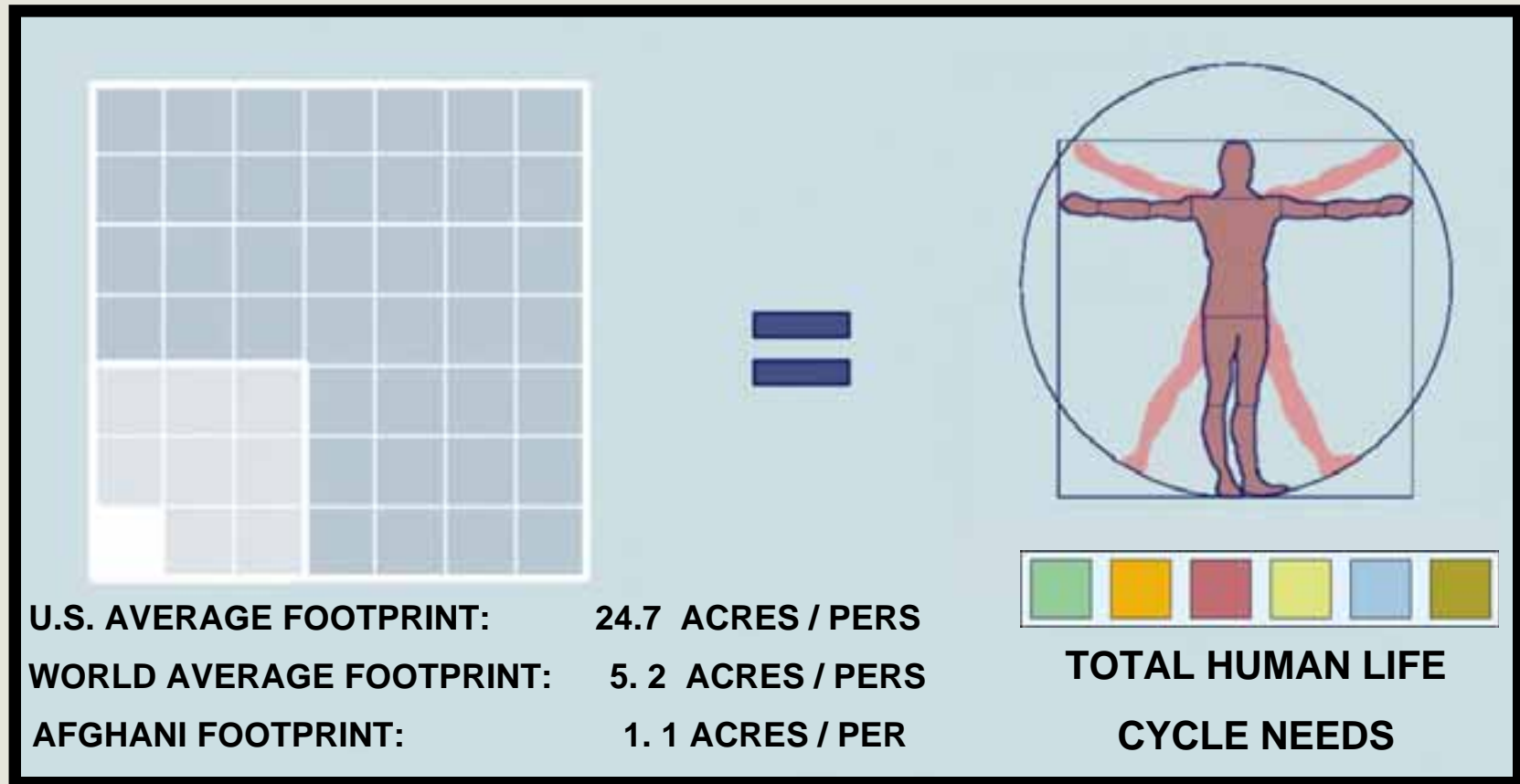


# Human Scale Greening of the Brain

Biophilic Neocortex







Life cycle footprint : **energy** (includes fossil fuels expressed in land area necessary to sequester the corresponding  $CO_2$ ), **built area** (includes degraded land), **vegetable/fruit** production land area, **grain** area, **pasture** (dairy, meat, wool production), **prime forest**.

## LIFE CYCLE FOOTPRINT

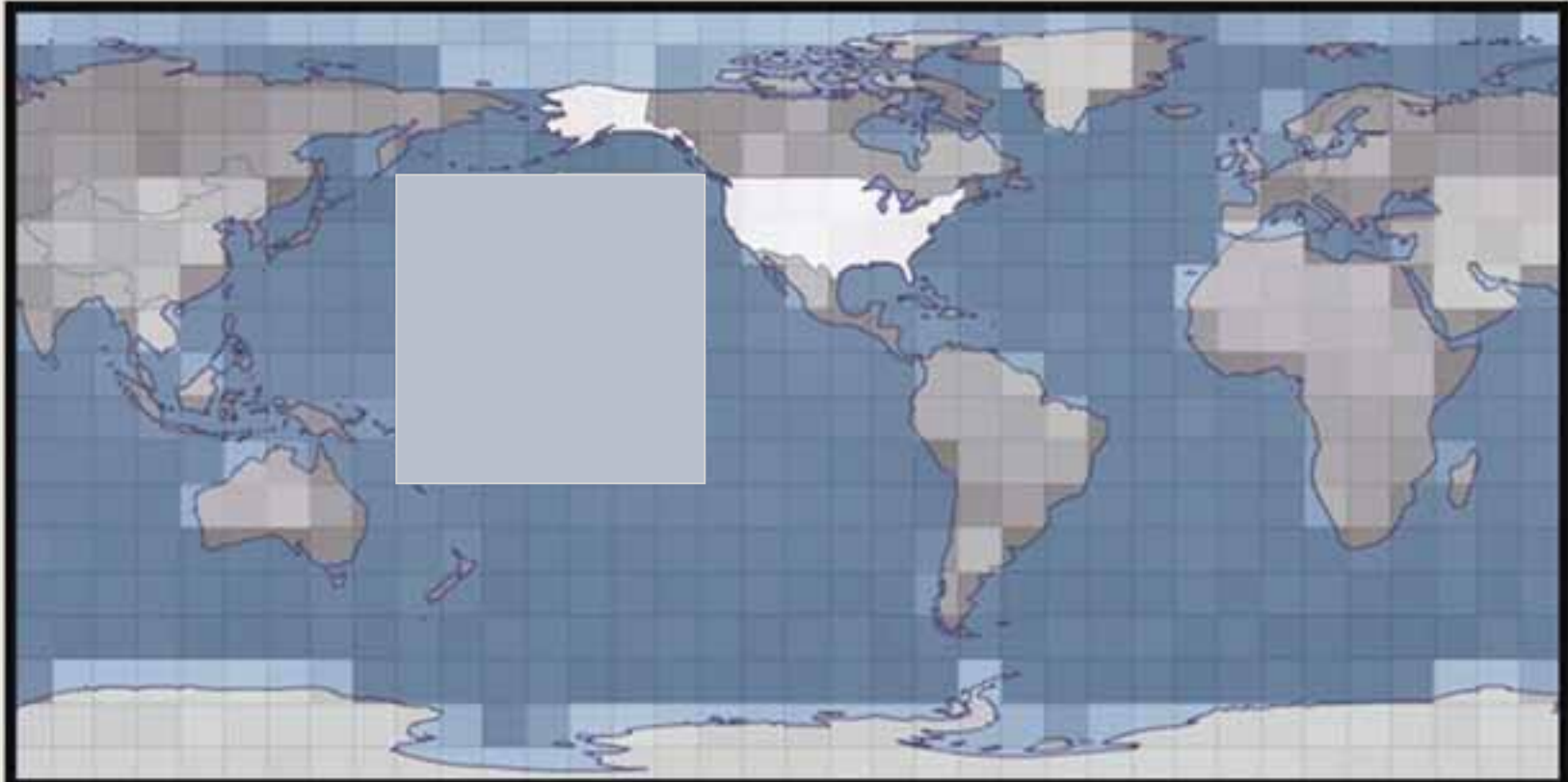


PLATE CARRE EQUAL PROJECTION : 3 190 042 ACRES PER GRID CELL.

## USA CARBON IMBALANCE

### U.S. FOOTPRINT NEEDS

INTERNAL CAPACITY

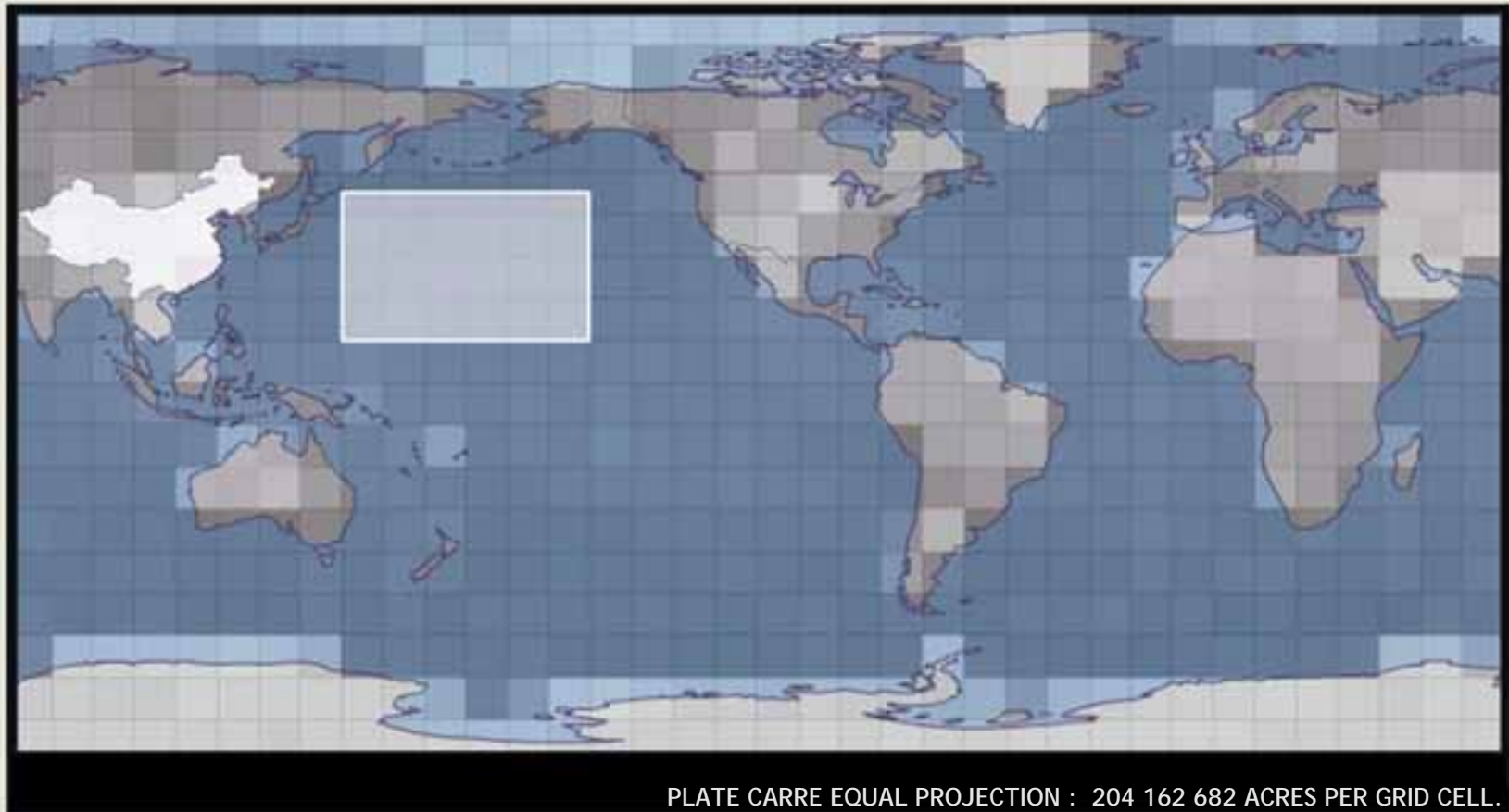
17.8 cells

DEFICIT

48 cells

© cmpbs 2008

SOURCE: LIVING PLANET REPORT



## CHINA'S FOOTPRINT NEEDS

BIO- CAPACITY

8.9 cells

DEFICIT

12 cells

© cmpbs 2008

SOURCE: LIVING PLANET REPORT

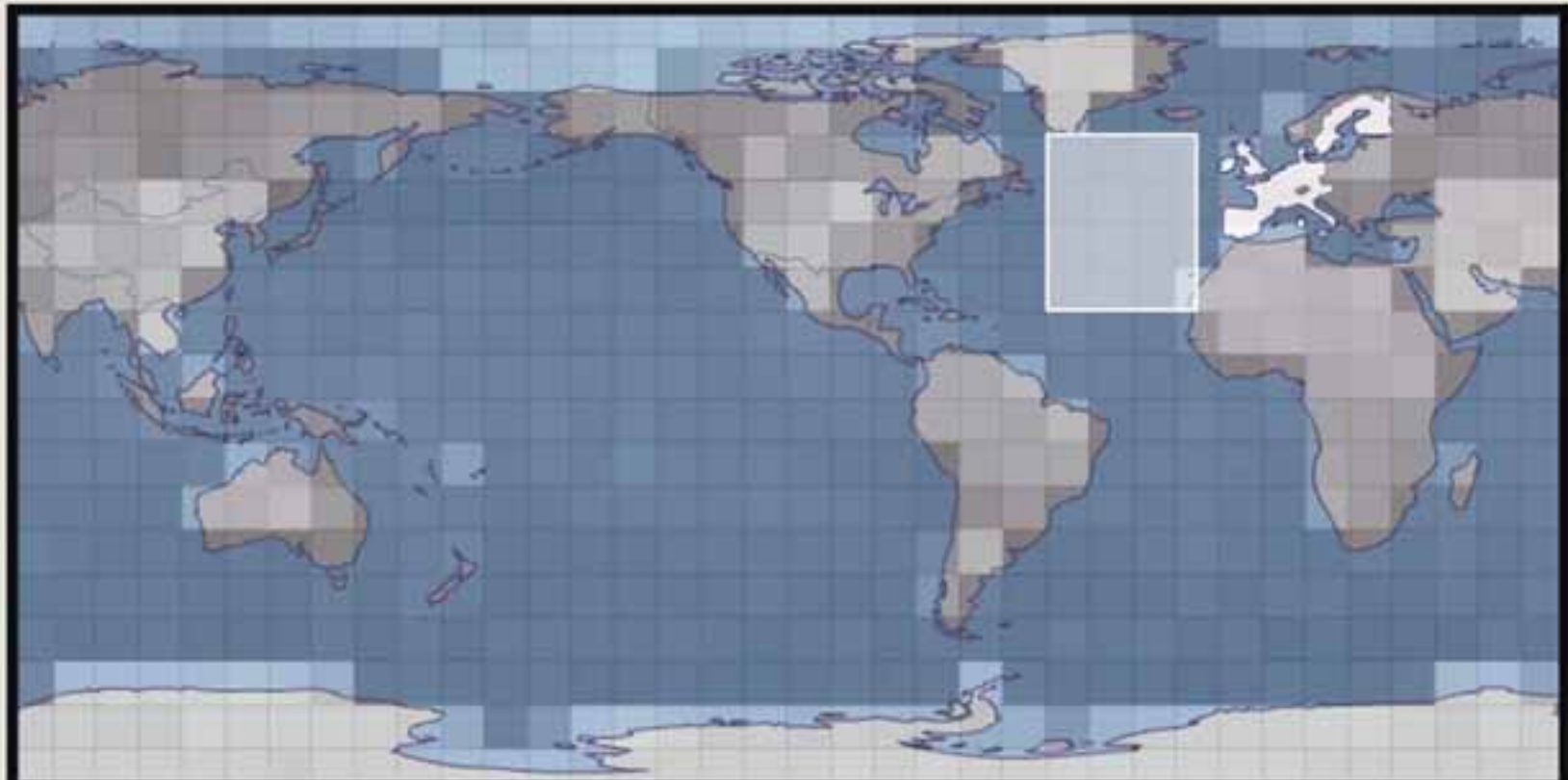


PLATE CARRE EQUAL PROJECTION : 204 162 682 ACRES PER GRID CELL.

## EUROPE'S FOOTPRINT NEEDS

BIO- CAPACITY

10.5 cells

DEFICIT

10.5 cells

© cmpbs 2008

SOURCE: LIVING PLANET REPORT



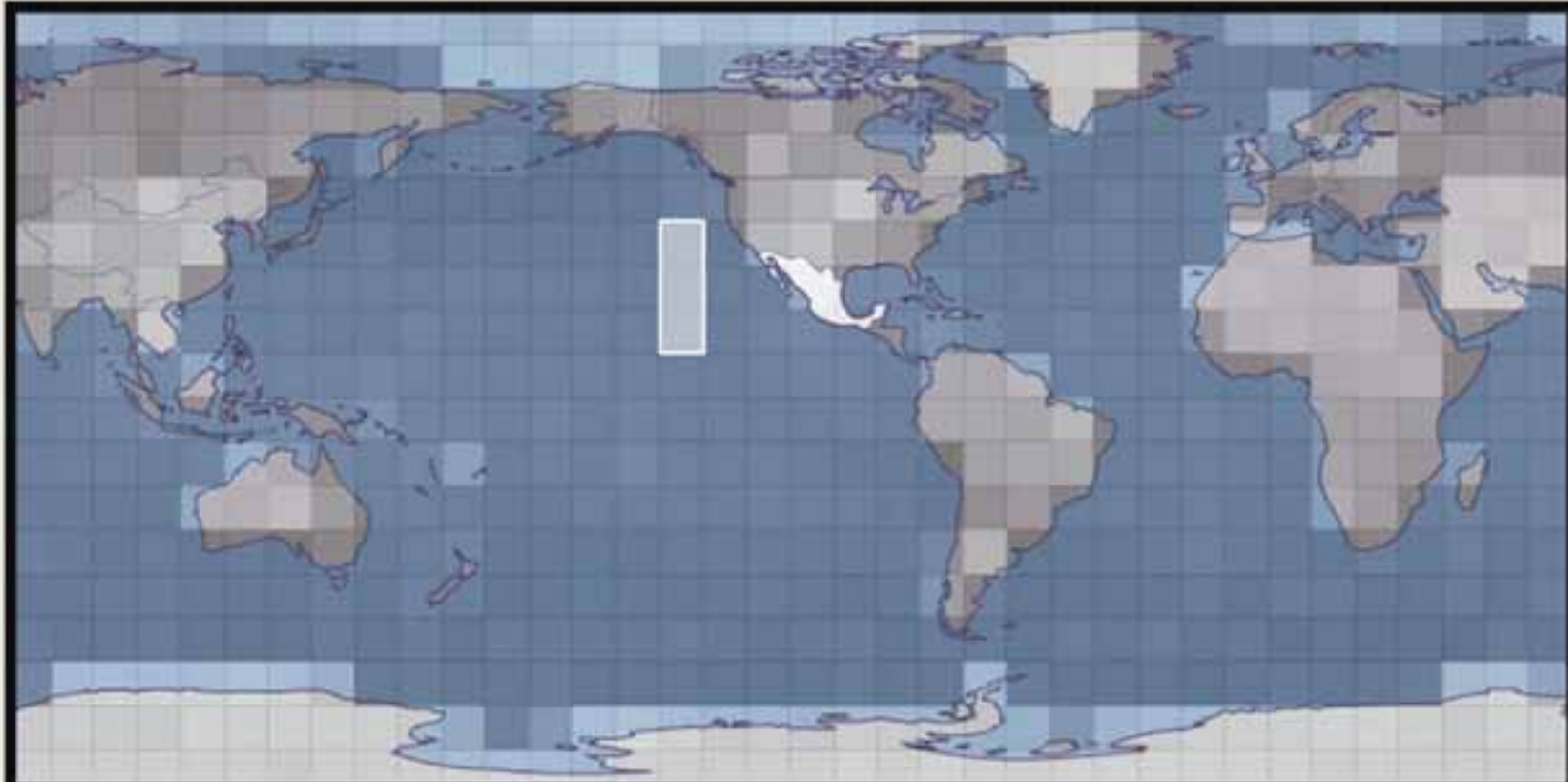


PLATE CARRE EQUAL PROJECTION : 204 162 682 ACRES PER GRID CELL.

## MEXICO'S FOOTPRINT NEEDS

BIO - CAPACITY

1.3 cells

DEFICIT

1.4 cells

© cmpbs 2008

SOURCE: LIVING PLANET REPORT

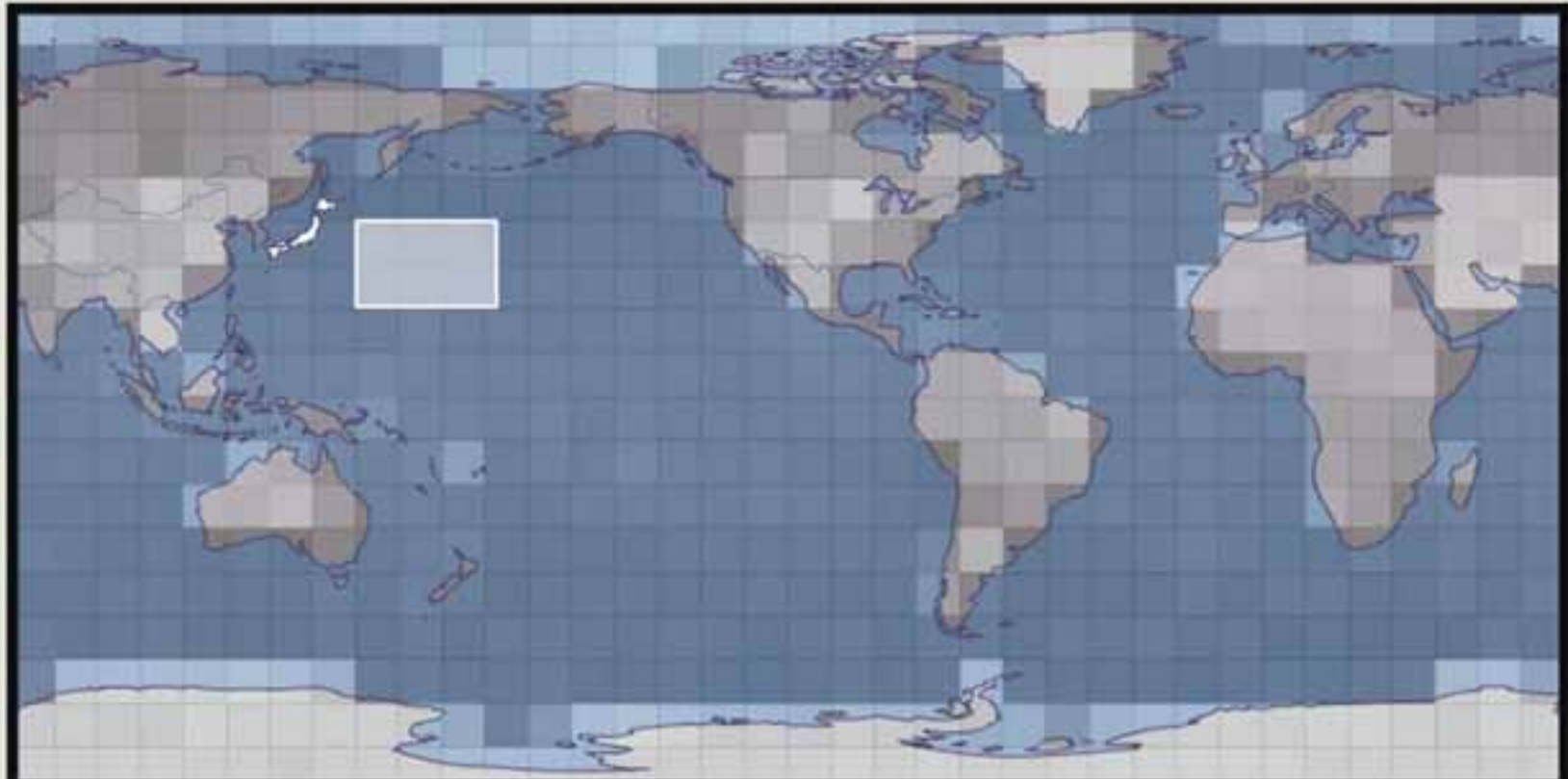


PLATE CARRE EQUAL PROJECTION : 204 162 682 ACRES PER GRID CELL.

## JAPAN'S FOOTPRINT NEEDS

BIO - CAPACITY

1 cells

DEFICIT

5.3 cells

© cmpbs 2008

SOURCE: LIVING PLANET REPORT



Plate carre equal projection : 3 190 130 acres per grid cell.

# LONDON ENGLAND'S FOOTPRINT NEEDS

Biocapacity	0.1 cells
Deficit	11.6 cells

## LONDON'S ECOLOGICAL DEFICIT FOOTPRINT



Plate carre equal projection : 40 acres per grid cell.

## UNIVERSITY CAMPUS FOOTPRINT NEEDS

Biocapacity

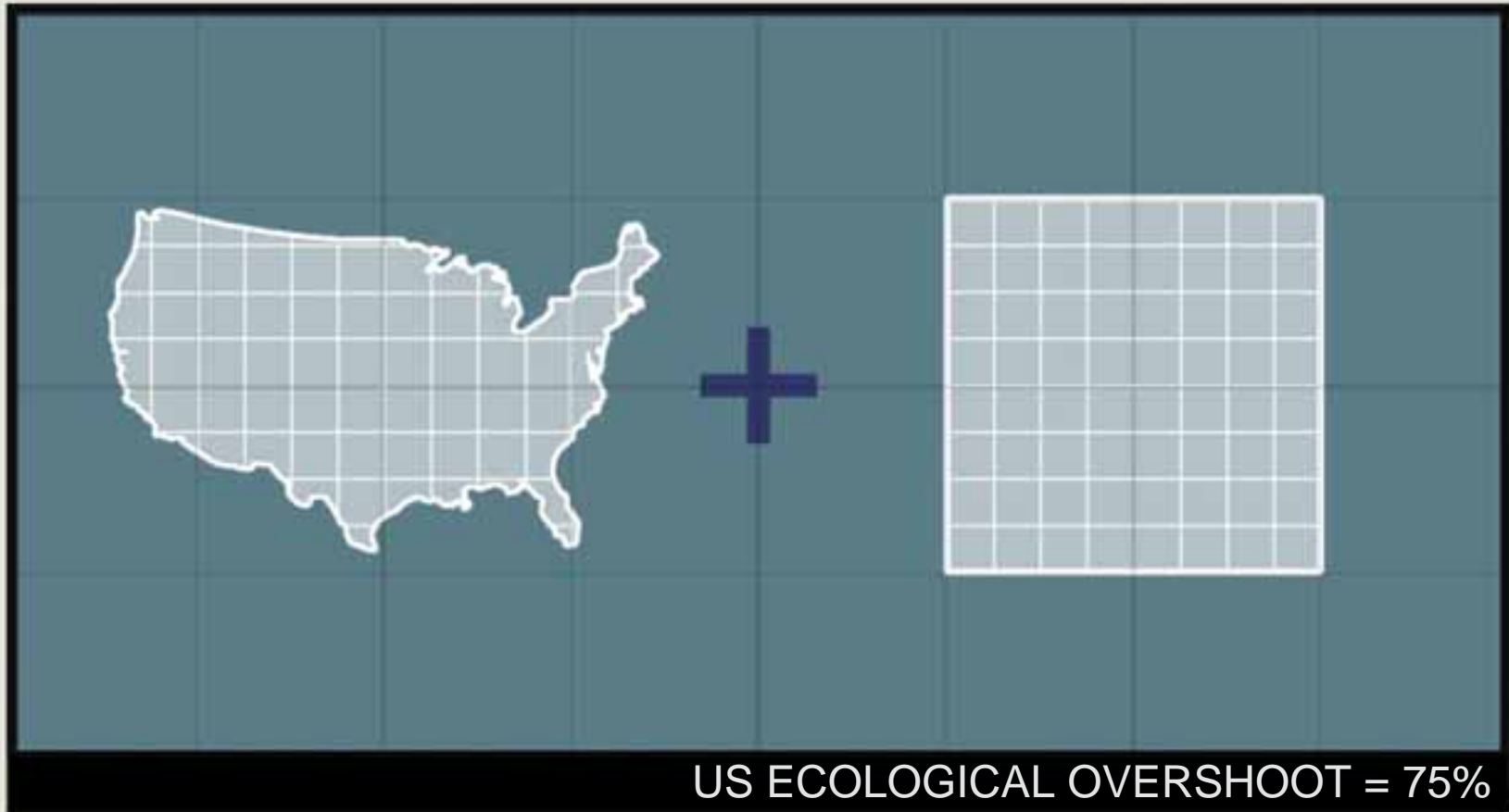
0.25 cells

Deficit

9 cells

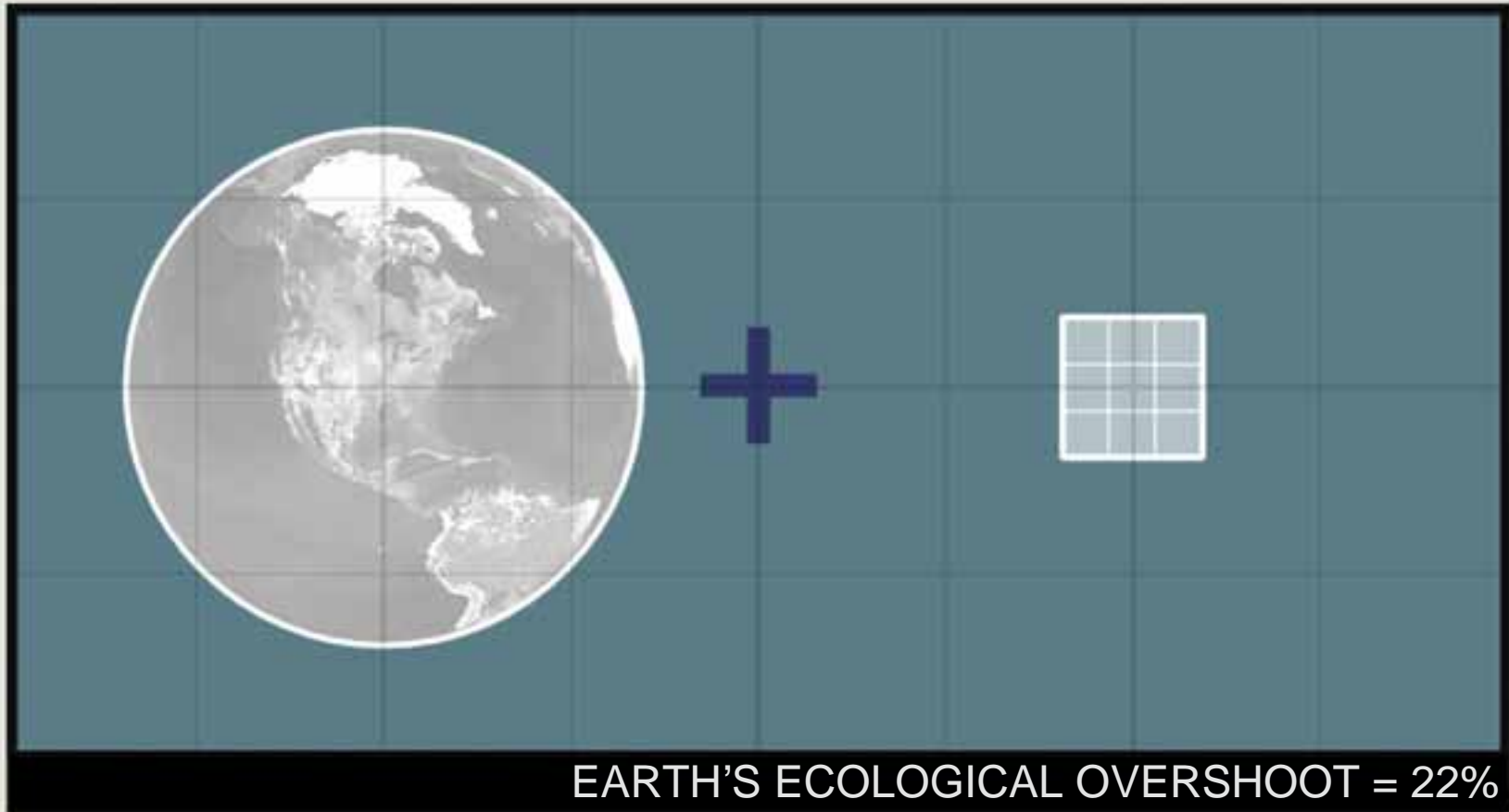
## CAMPUS' ECOLOGICAL DEFICIT FOOTPRINT





© cmpbs 2008

SOURCE: LIVING PLANET REPORT



© cmpbs 2008

SOURCE: LIVING PLANET REPORT



PLATE CARRE EQUAL PROJ : 3 190 042 ACRES PER GRID CELL.

## USA INFORMATION HIERARCHY

### AIR (CO<sup>2</sup>)

-imbalanced ( 21 times  
area of U.S. s. WWF,  
CENSUS, NASA)

### ENERGY

-Non- renewable makes up 95% of the total  
energy supply


### WATER

- Ground recharge, 0.17  
- Surface, 0.18  
(588% over balanced)

### MATERIALS

-Recycled materials only make up 6% of  
total

 Spatial

 Numeric

© cmpbs 2008

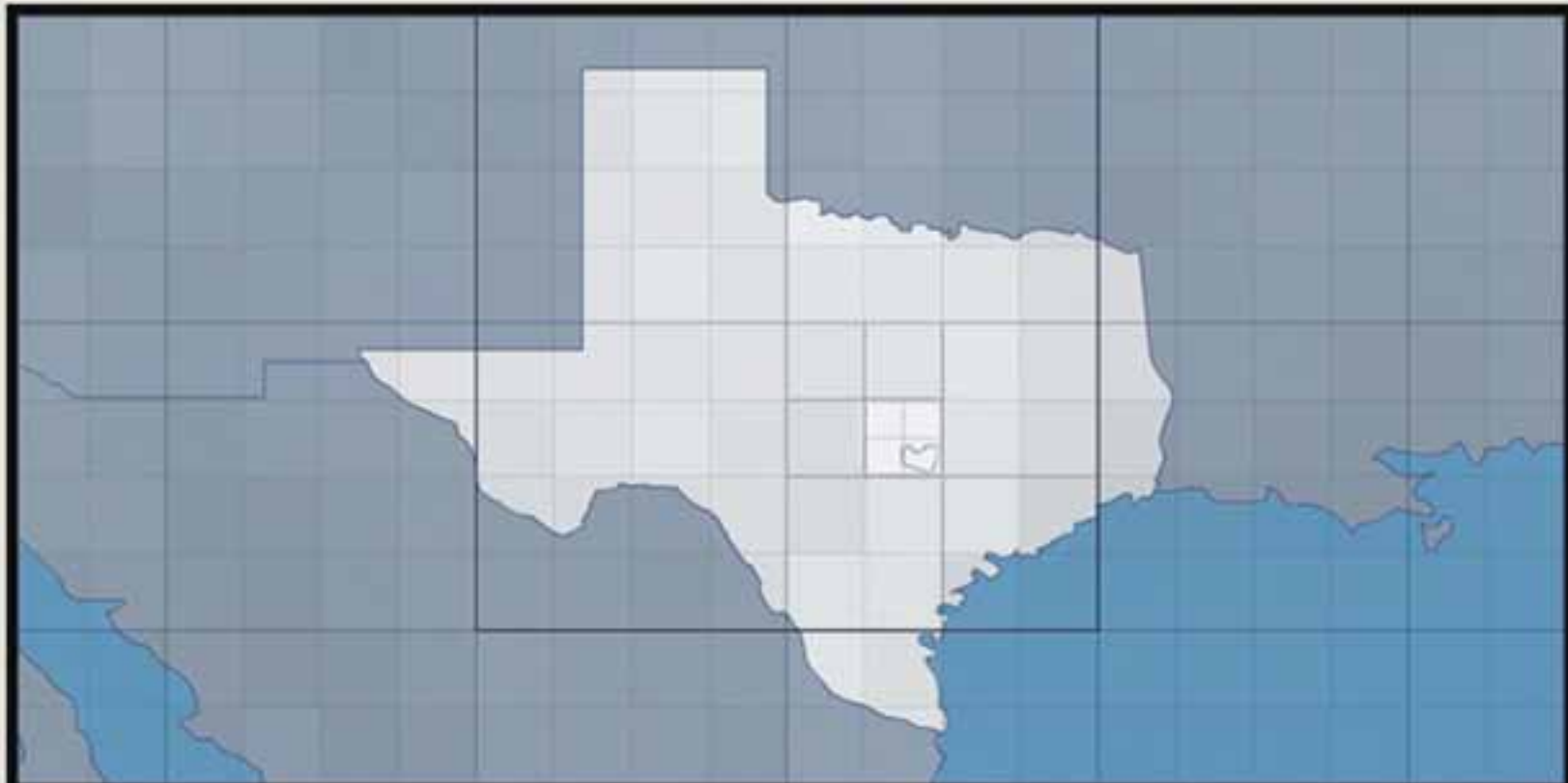



PLATE CARRE EQUAL PROJ : 3 190 042 ACRES PER GRID CELL. **TEXAS INFORMATION HIERARCHY**


**AIR (CO<sup>2</sup>)** - 8.8 times area of Texas needed

**ENERGY** - only .7% renewable (potential within state according to governors energy office could supply 25 times the present population of Texas)

**WATER** - Ground recharge, 1.67  
- Surface, 0.62  
(160% imbalanced)

**MATERIALS** - N/A

 Spatial

 Numeric



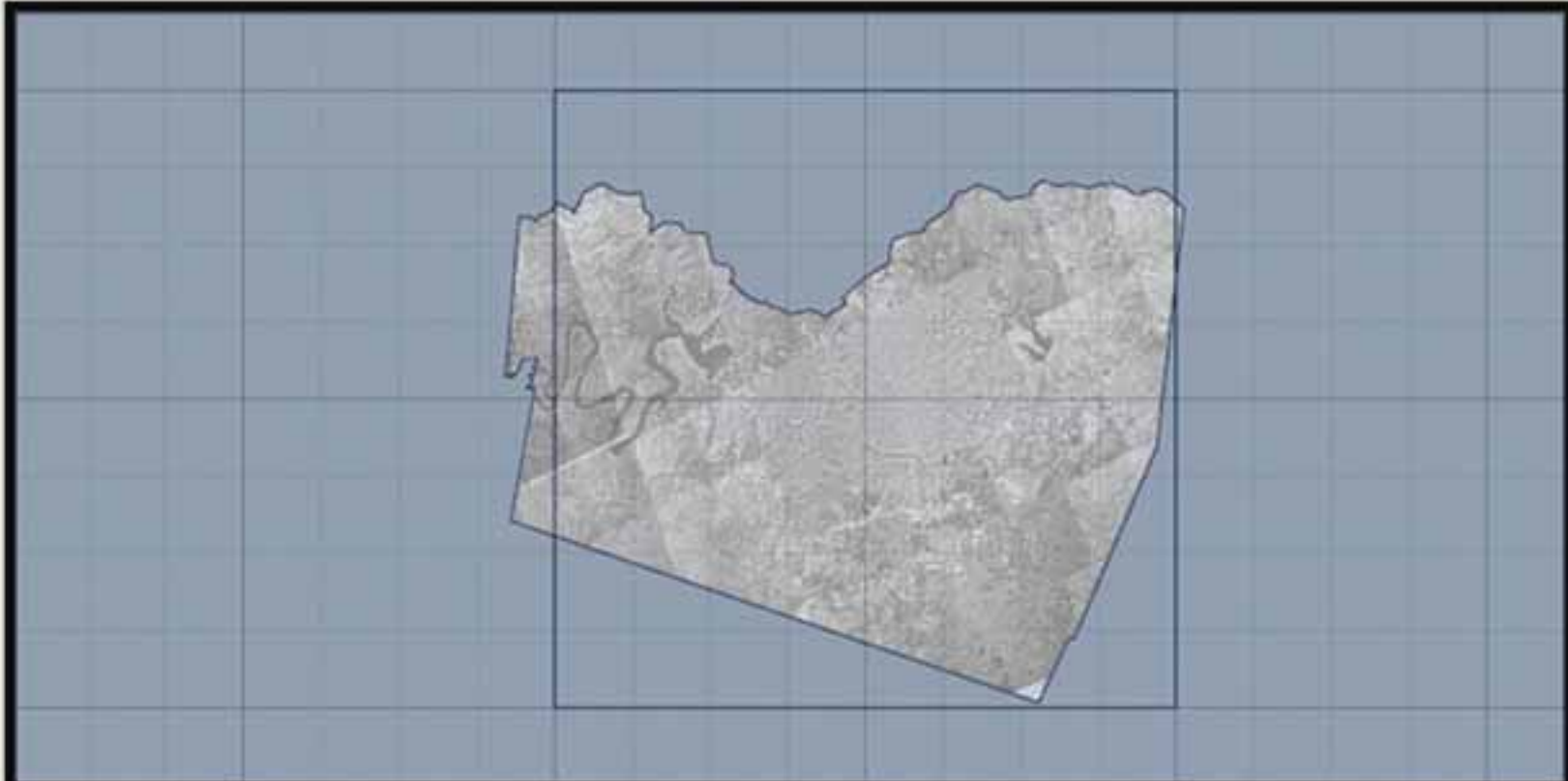


PLATE CARRE EQUAL PROJECTION : 49 844 ACRES PER GRID CELL. **AUSTIN IMBALANCE**

**AIR (CO<sup>2</sup>)**

- 62% tree cover loss\*

**ENERGY**

- Renewable 4% of total

**WATER**

- 56% worse in water use

**MATERIALS**

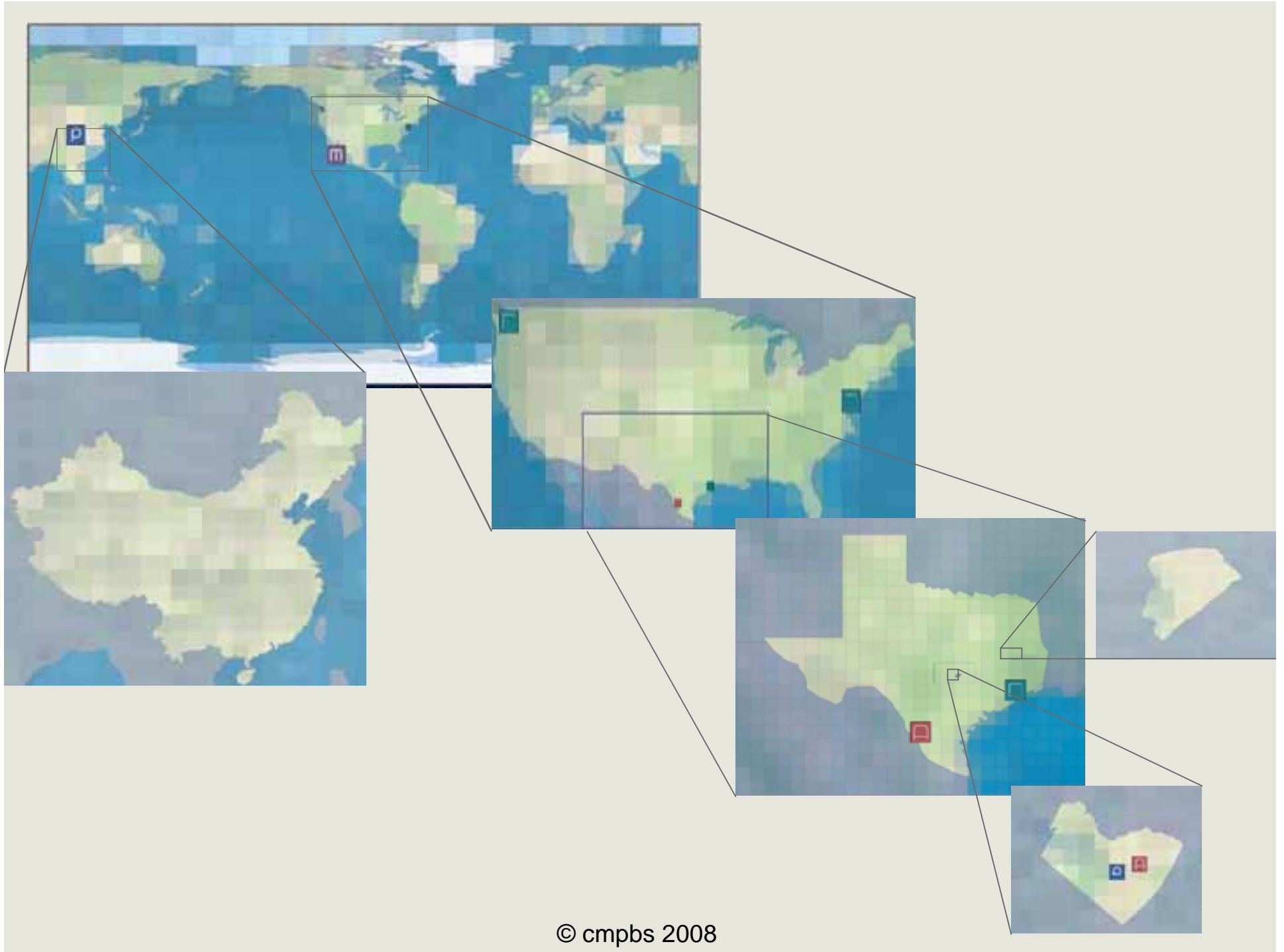
- Solid waste recycled, 14% reduction\*

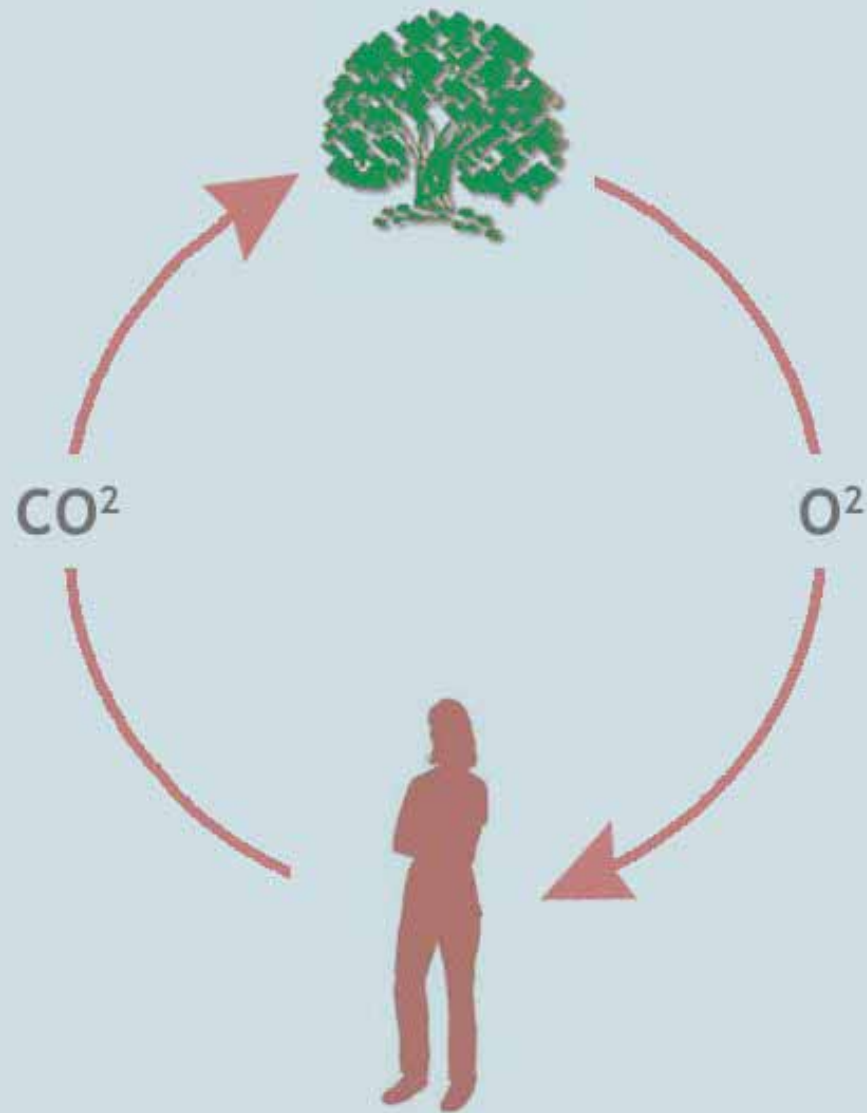
**FOOD**

- 57% of local farming reduced\*


■ All Numeric

\* All over over ten years



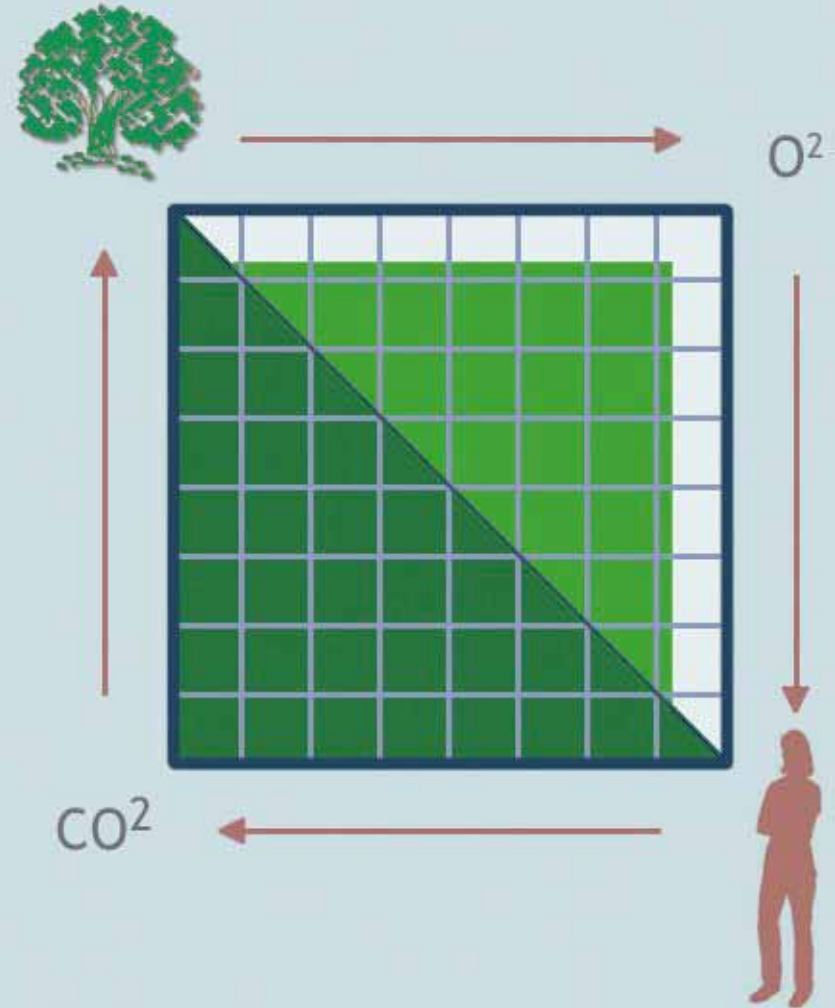


**A SIMPLE AIR LIFE CYCLE FOR BREATHING  
BETWEEN HUMANS AND PLANTS**

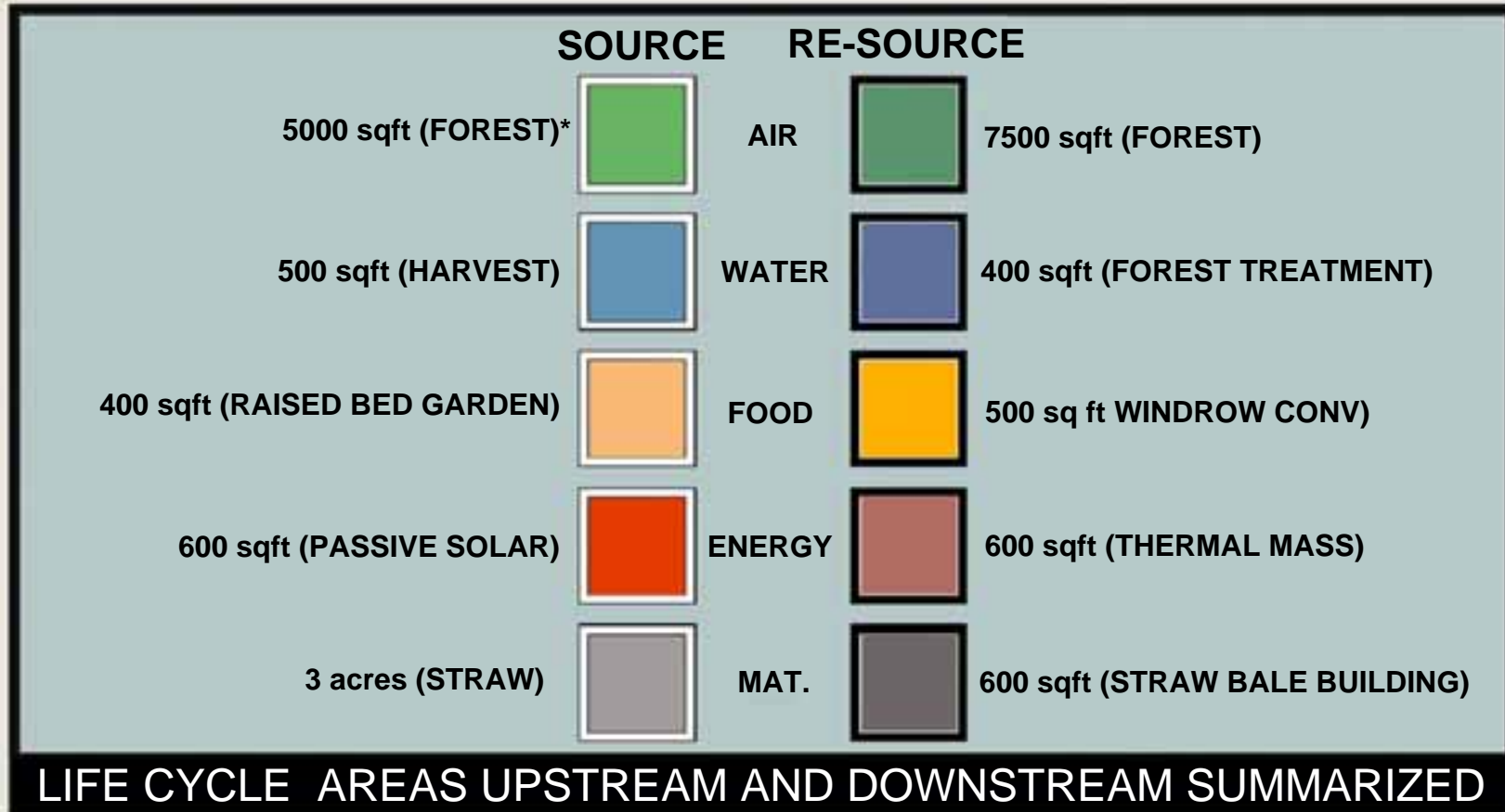
 = 240 SQ.FT.

**O<sub>2</sub> PRODUCTION :**  
**REQUIRES 5000**  
**SQ.FT OF FOREST**  
**PER PERSON**

**CO<sub>2</sub> ABSORPTION :**  
**REQUIRES 7660**  
**SQ.FT OF FOREST**  
**PER PERSON**



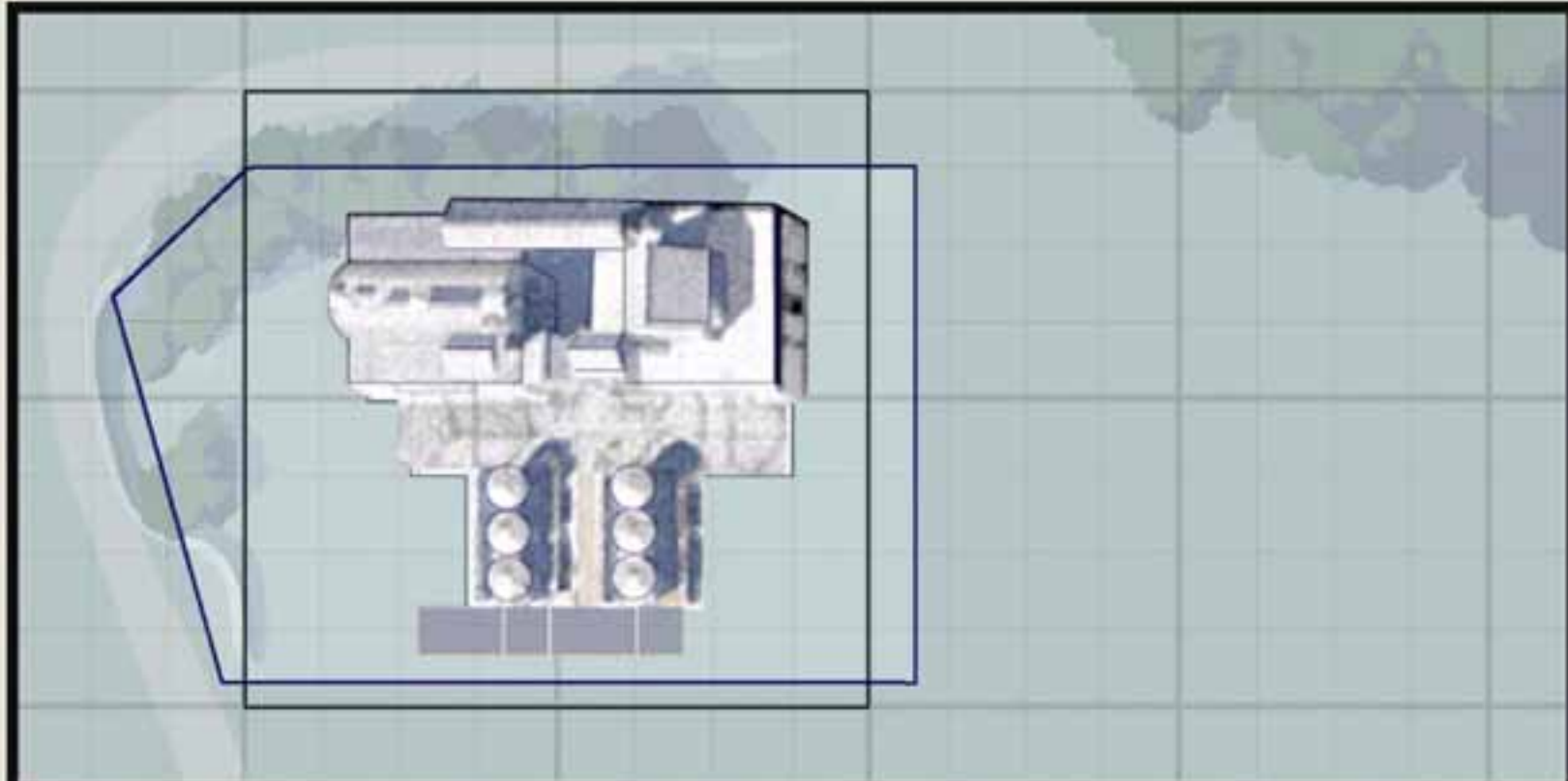
THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS



• AREA NEEDED PER PERSON  
SOURCES UPON REQUEST

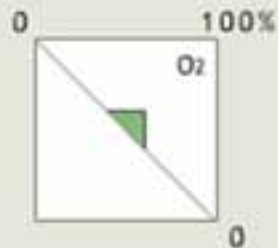
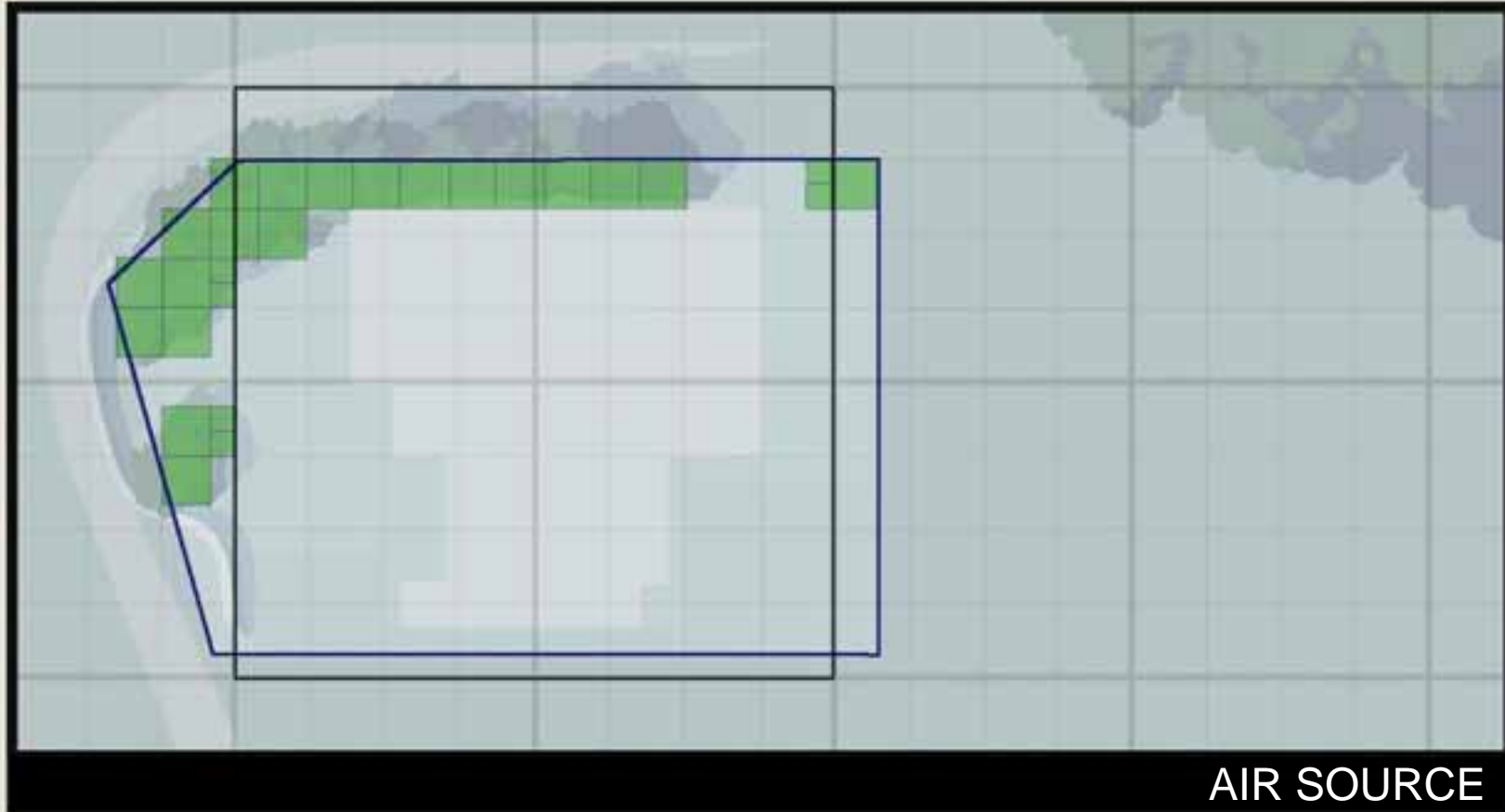


THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS



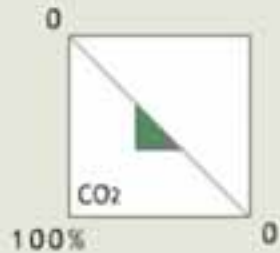
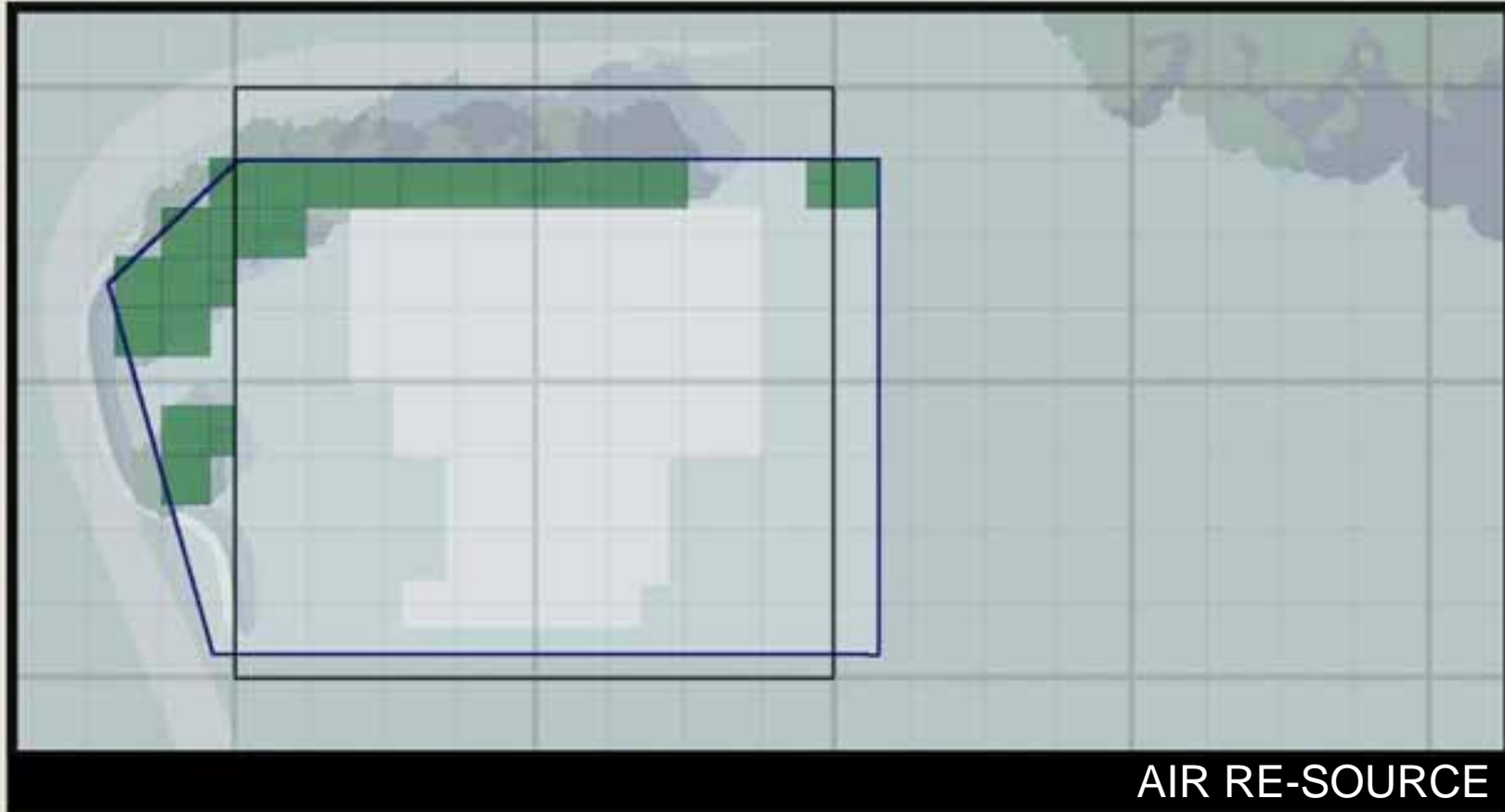
HOME SCALE SITE - QUAD GRID PLANNING UNITS

THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS



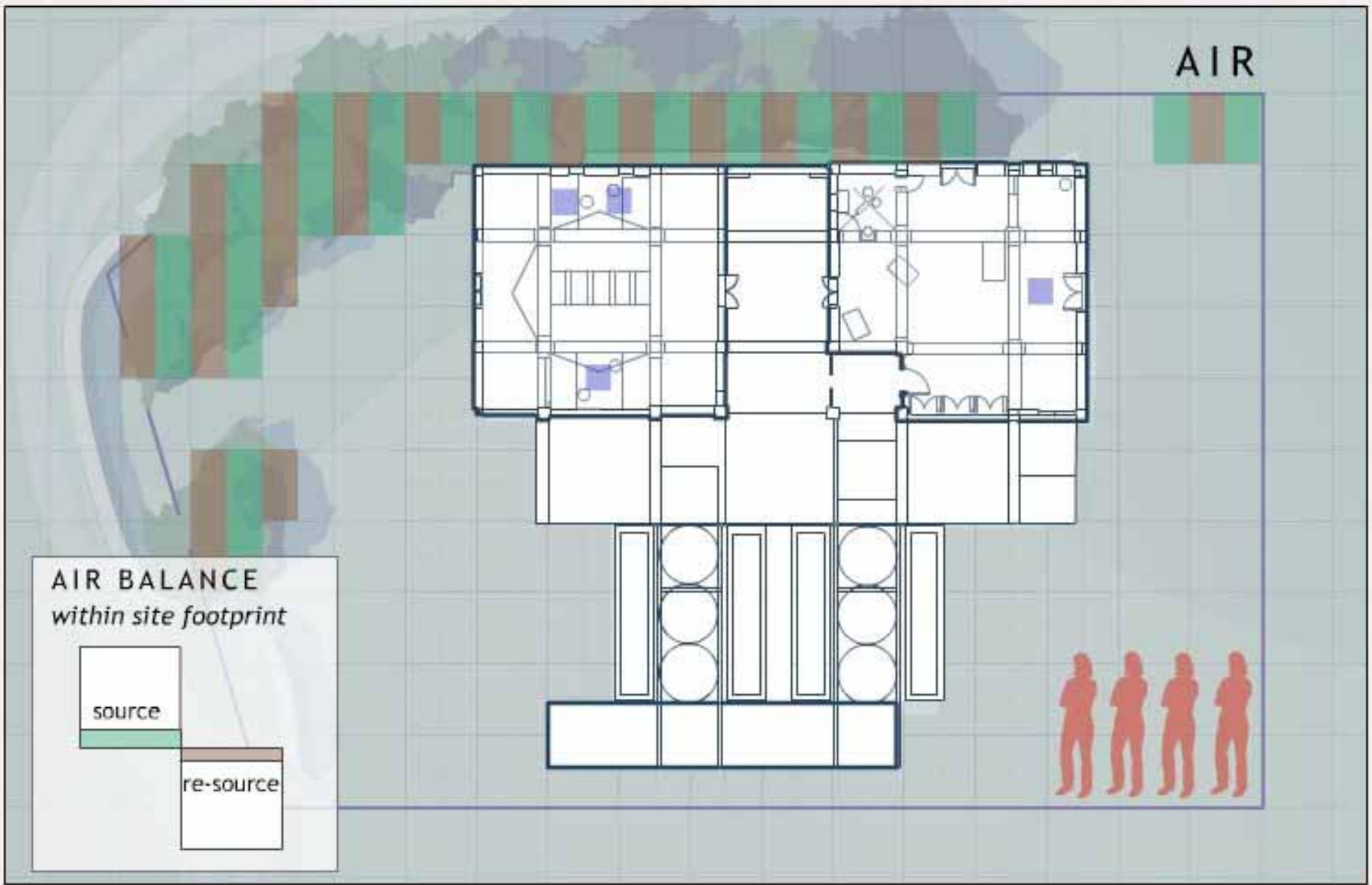
AIR (source) - 0.5% balanced

THE CENTER FOR MAXIMUM POTENTIAL BUILDING SYSTEMS



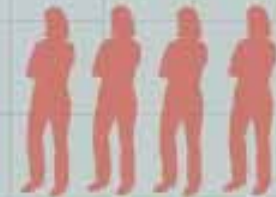
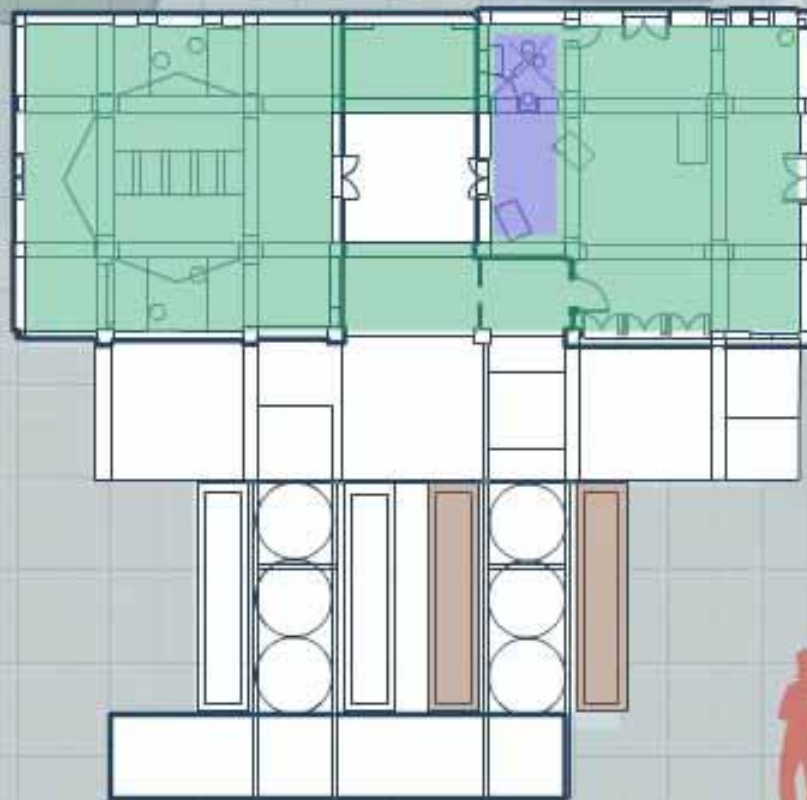
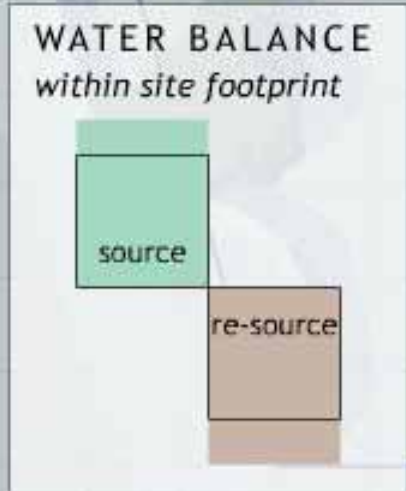
AIR (Re-source) -0.5 % balanced




ADVANCED GREEN BUILDER DEMONSTRATION



■ source O<sub>2</sub>    ■ use people    ■ re-source CO<sub>2</sub>

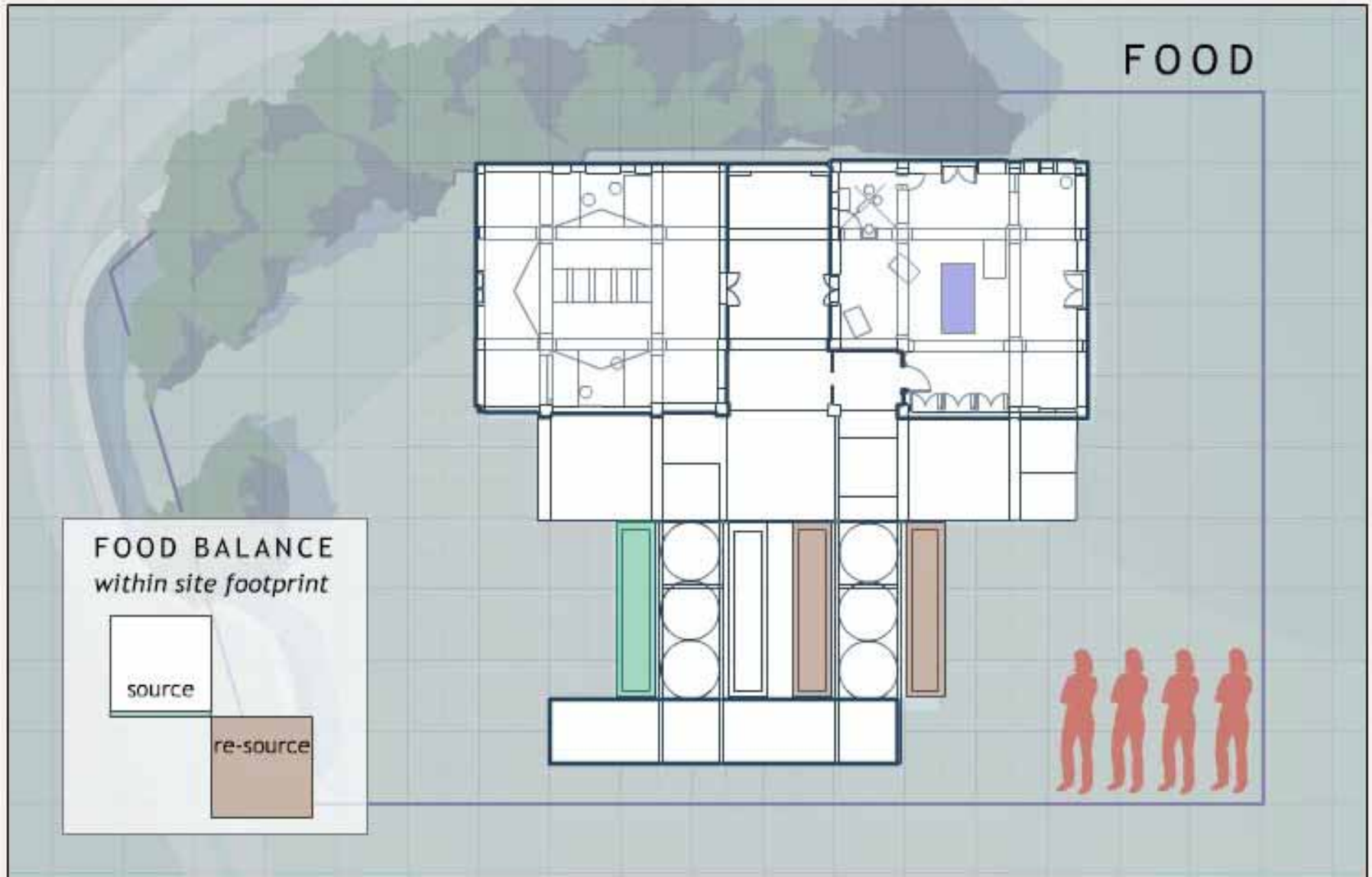
# WATER / WASTEWATER



-  source roof
-  use bath/kitchen
-  re-source wetland

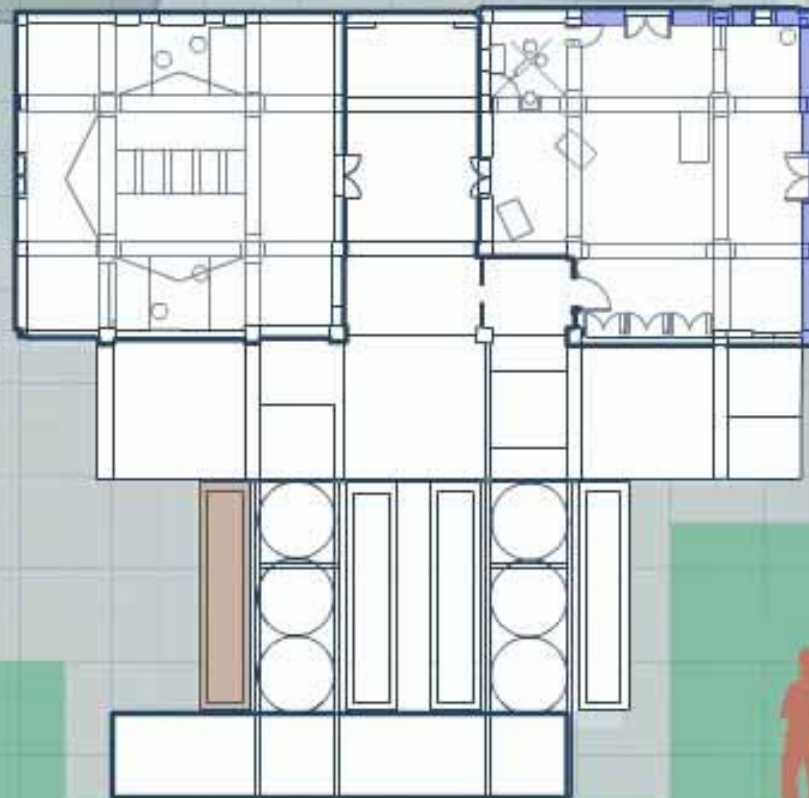
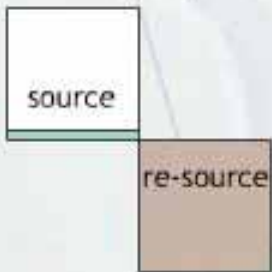





ADVANCED GREEN BUILDER DEMONSTRATION



# MATERIALS - STRAW

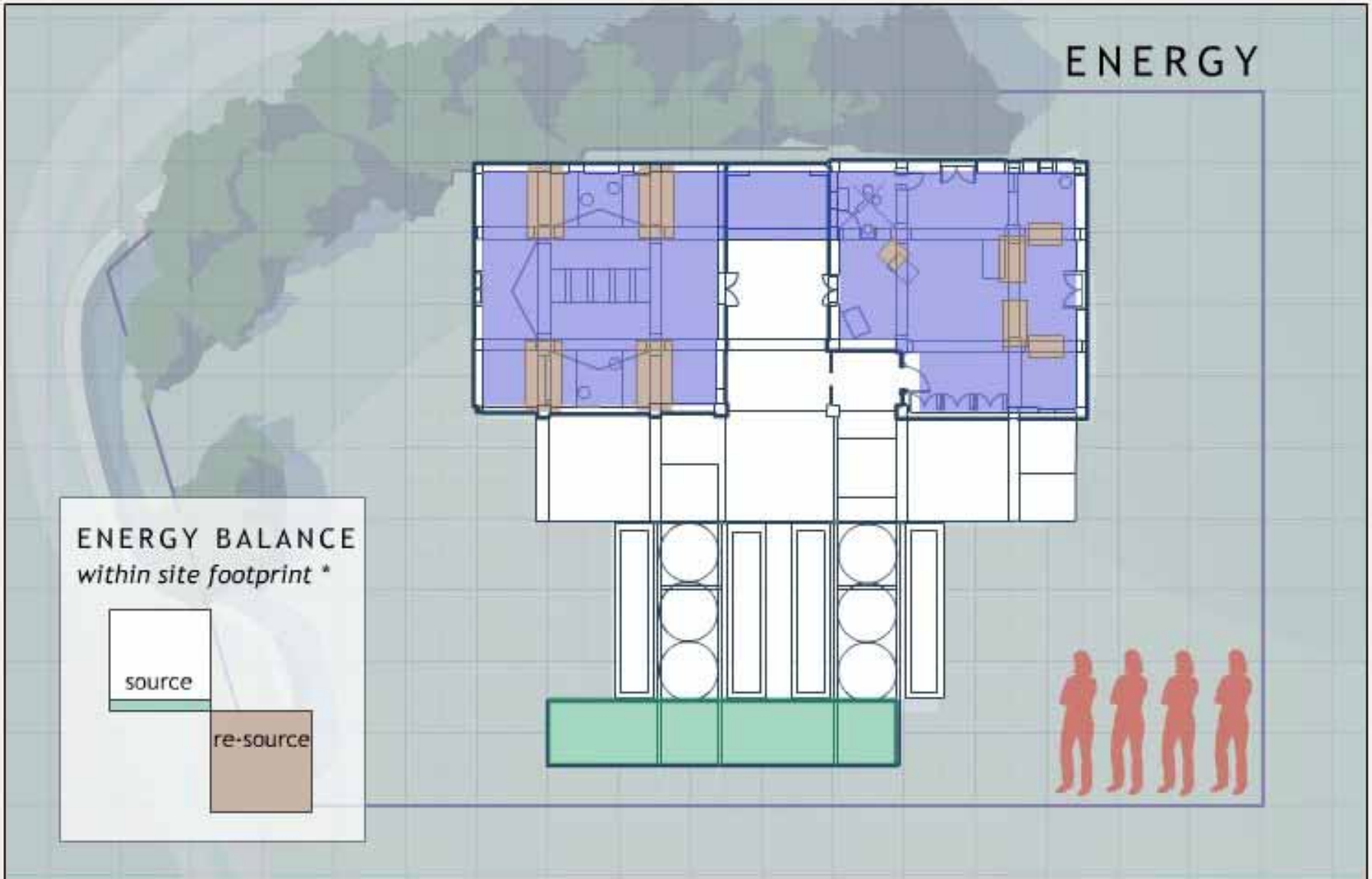
MATERIALS  
BALANCE  
*within site footprint*



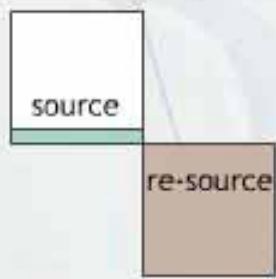
-  source straw
-  use bale walls
-  re-source garden waste

ADVANCED GREEN BUILDER DEMONSTRATION

ENERGY



ENERGY BALANCE  
within site footprint \*



\* source includes charge for electric vehicle transportation

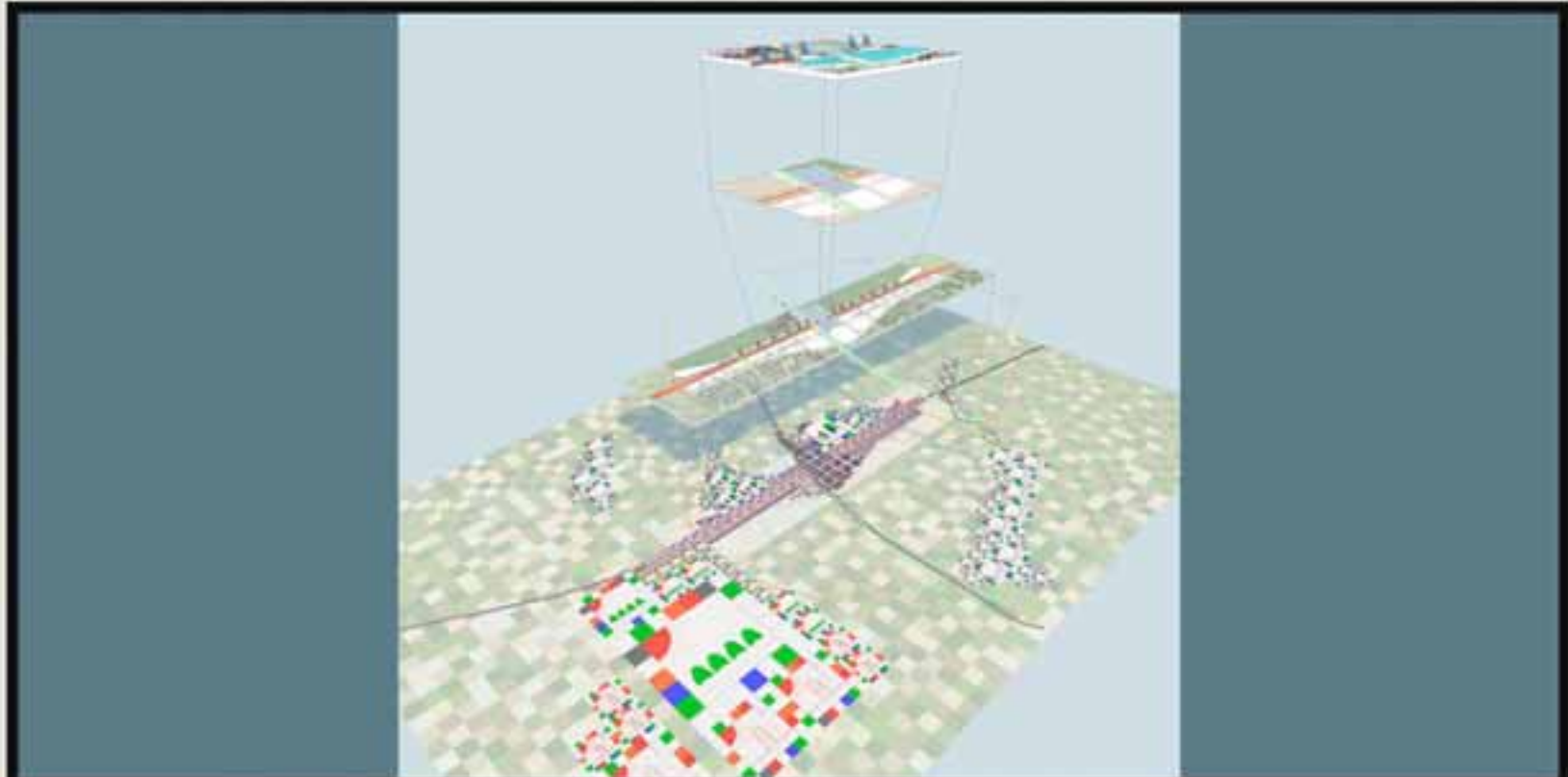
- source pv panels
- use space
- re-source conserving appliance

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MATRIX ICON AS PLANNING TOOL

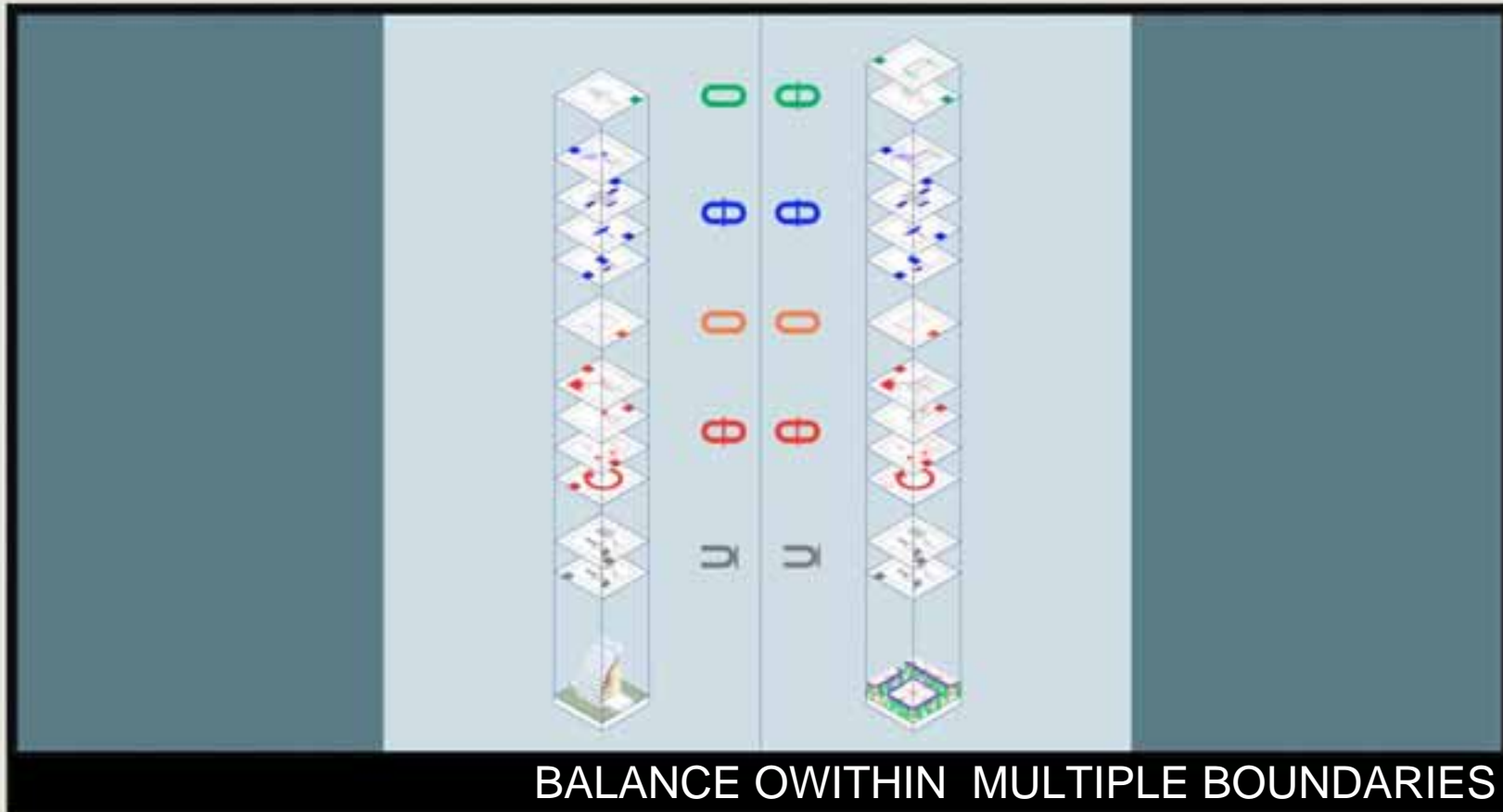
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DESIGN PROCESS



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$$\sum_{\text{Total}} = \sum_{\text{Build}} + \sum_{\text{Local}} + \sum_{\text{Urban}} + \sum_{\text{Regional}} + \sum_{\text{Country}} = [\text{Green} + \text{Blue} + \text{Orange} + \text{Red} + \text{Grey}] + \sum_{\text{Local}} + \sum_{\text{Urban}} + \sum_{\text{Regional}} + \sum_{\text{Country}} = 0$$

$$\sum_{\text{Total}} = [\sum_{\text{Urban}} + \text{Green} + \text{Red} + \text{Grey}] + [\sum_{\text{Local}} + \text{Blue}] + [\sum_{\text{regional}} + \text{Orange}] = 0$$

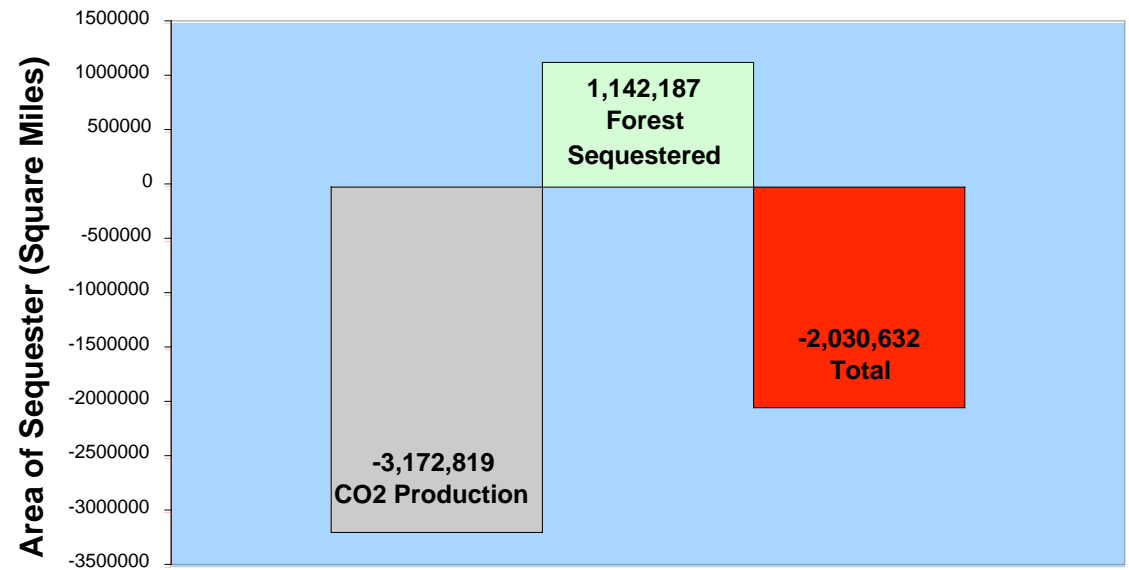
### Vegetation



### Human Activity



### U.S. CO2 BALANCE



LAND COVER :NATURE TO HUMAN = 2.7 FOLD CO2 IMBALANCE

Source: Sharing Nature's Interest, U.S. Census Bureau, USDA © cmpbs 2008

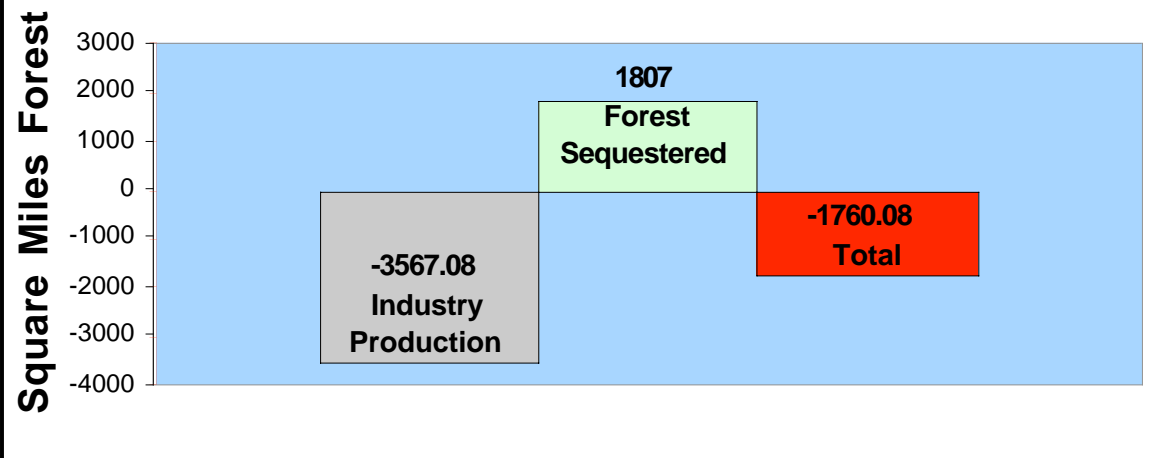
Forest Sequestered



Industry Production

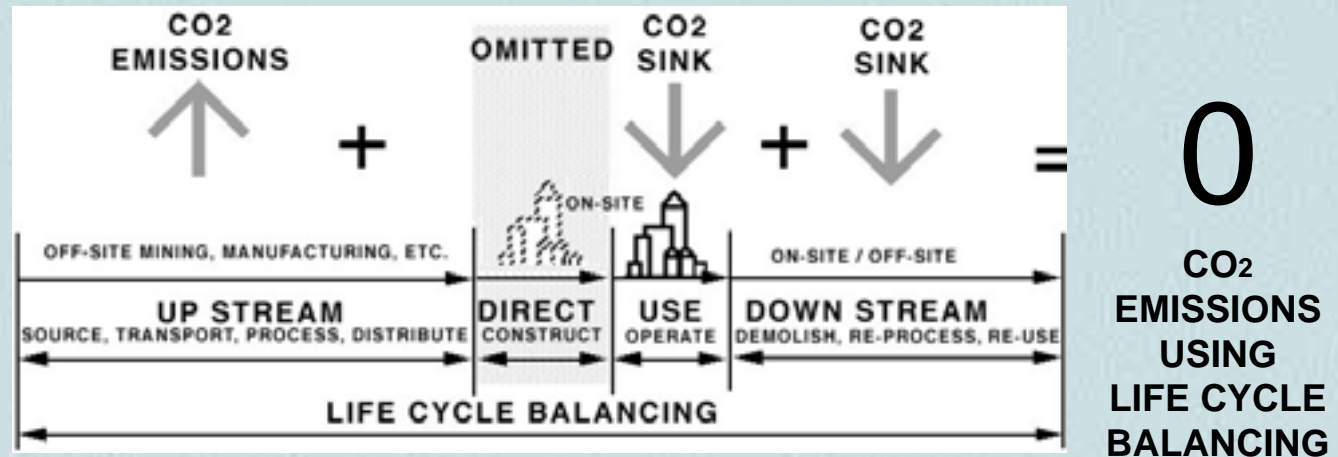
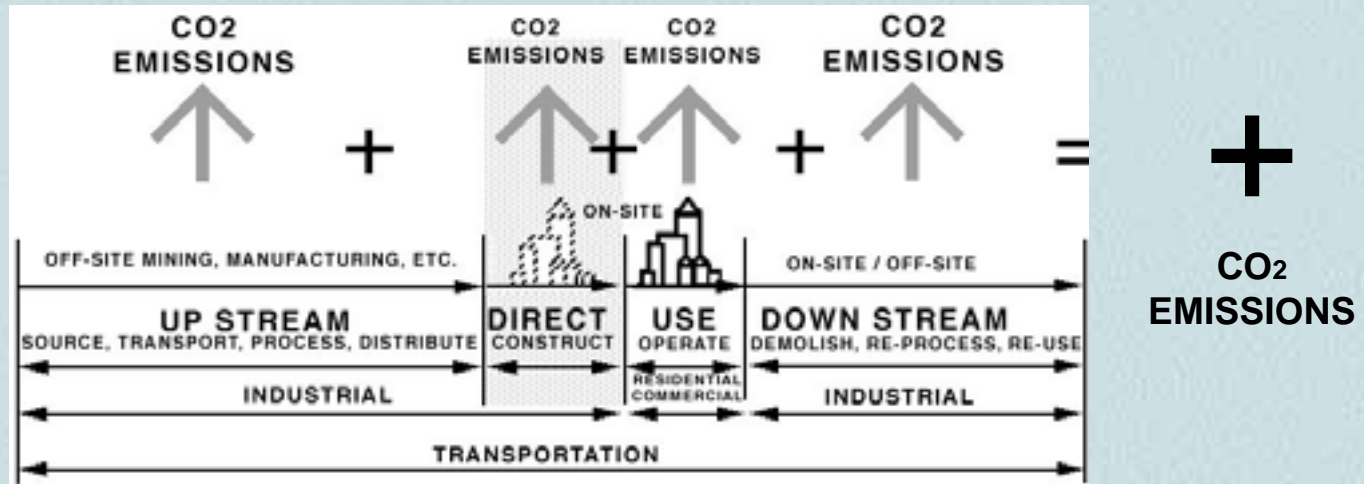


### KING COUNTY CO2 BALANCE (MANUFACTURING ONLY)



### KING COUNTY CO2 BALANCE (MANUFACTURING ONLY)

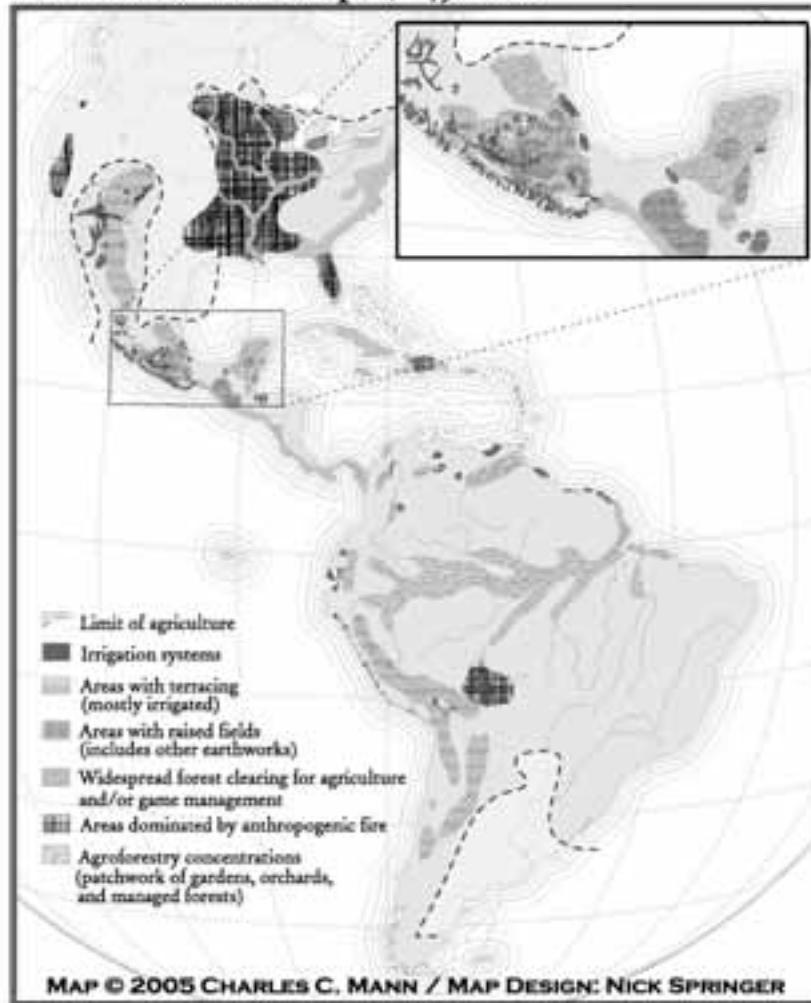
# LIFE CYCLE BALANCING - AIR EXAMPLE



CO2 emissions occur at every stage of a building's life cycle.  
 CO2 balancing may be attained by using long-lasting CO2 sink materials and products.



### Humanized Landscapes, 1491 A.D.



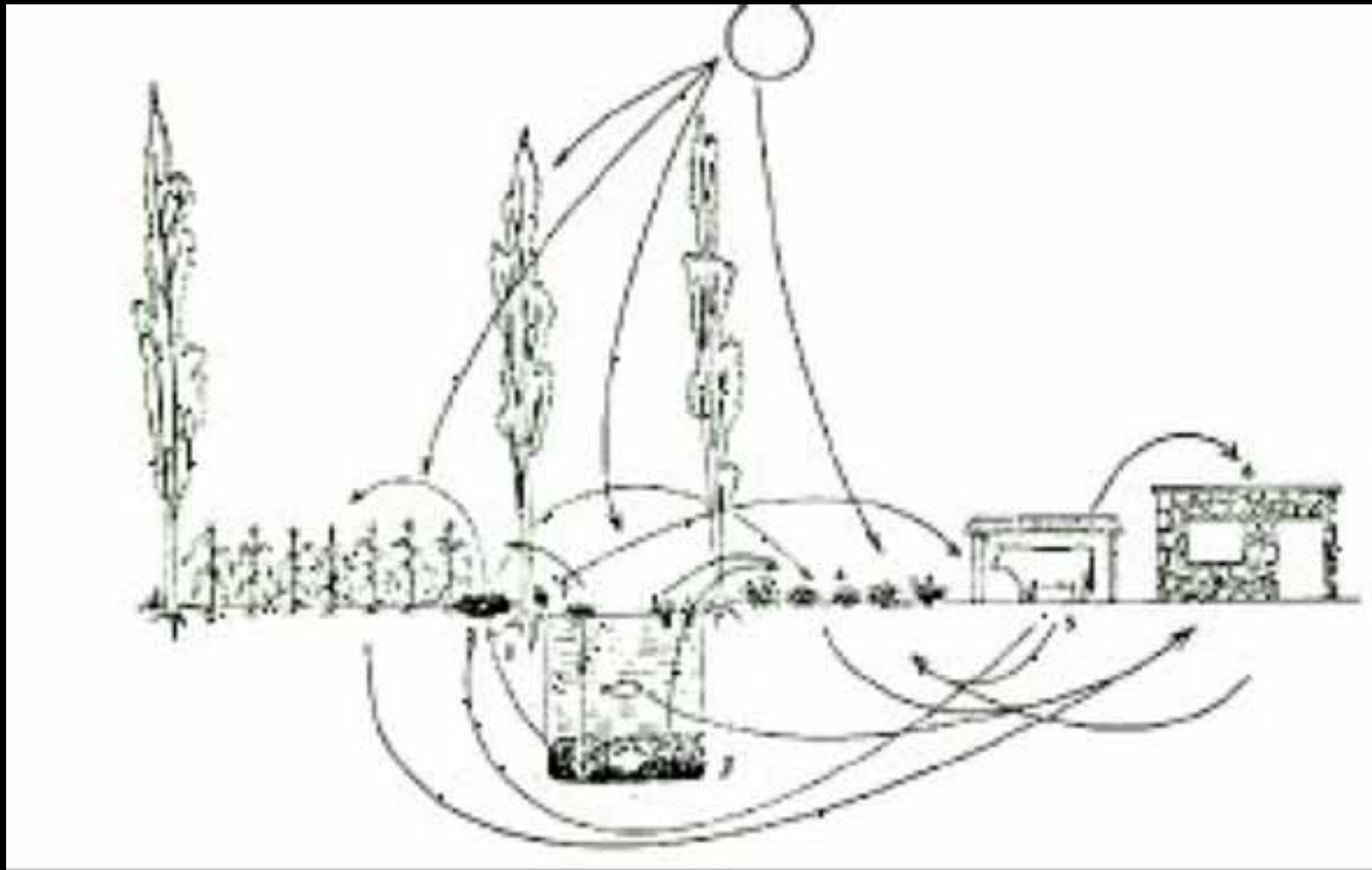
Despite its complexity, this map of Indian effects on the environment is incomplete. The most important omission is fire. I have highlighted some areas where indigenous fire effectively controlled the landscape, but Indian burning played an important ecological role throughout the hemisphere. Similarly, scattered clearing, burning and earth movement for drainage occurred in all agricultural areas—this map indicates only those areas in which these factors were especially concentrated.

“Before Columbus...the Western Hemisphere held ninety to 112 million people. Another way of saying this is that in 1491 more people lived in the Americas than in Europe.” Charles Mann, *The Atlantic Monthly*





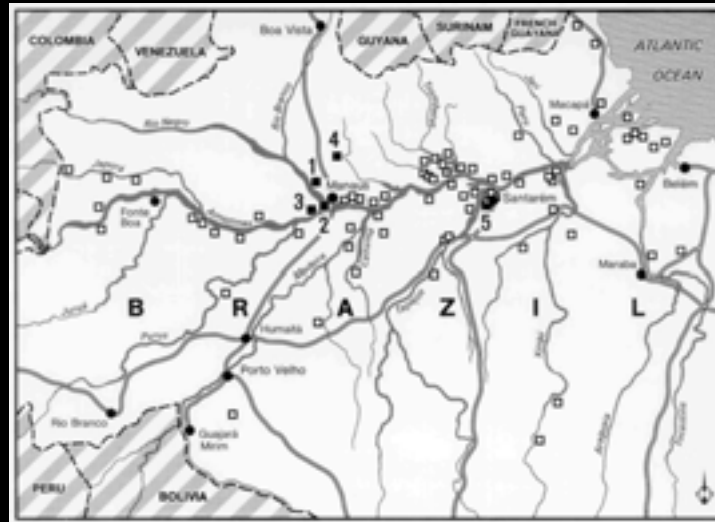
By 1519, the Mexica capital, Tenochtitlan, was the largest city in the world with a population of around 350,000 (although some estimates range as high as 500,000). By comparison, the population of London in 1519 was 80,000 people



Continuous cycling of energy and materials in the  
Chinampa systems of Tenochtitlan



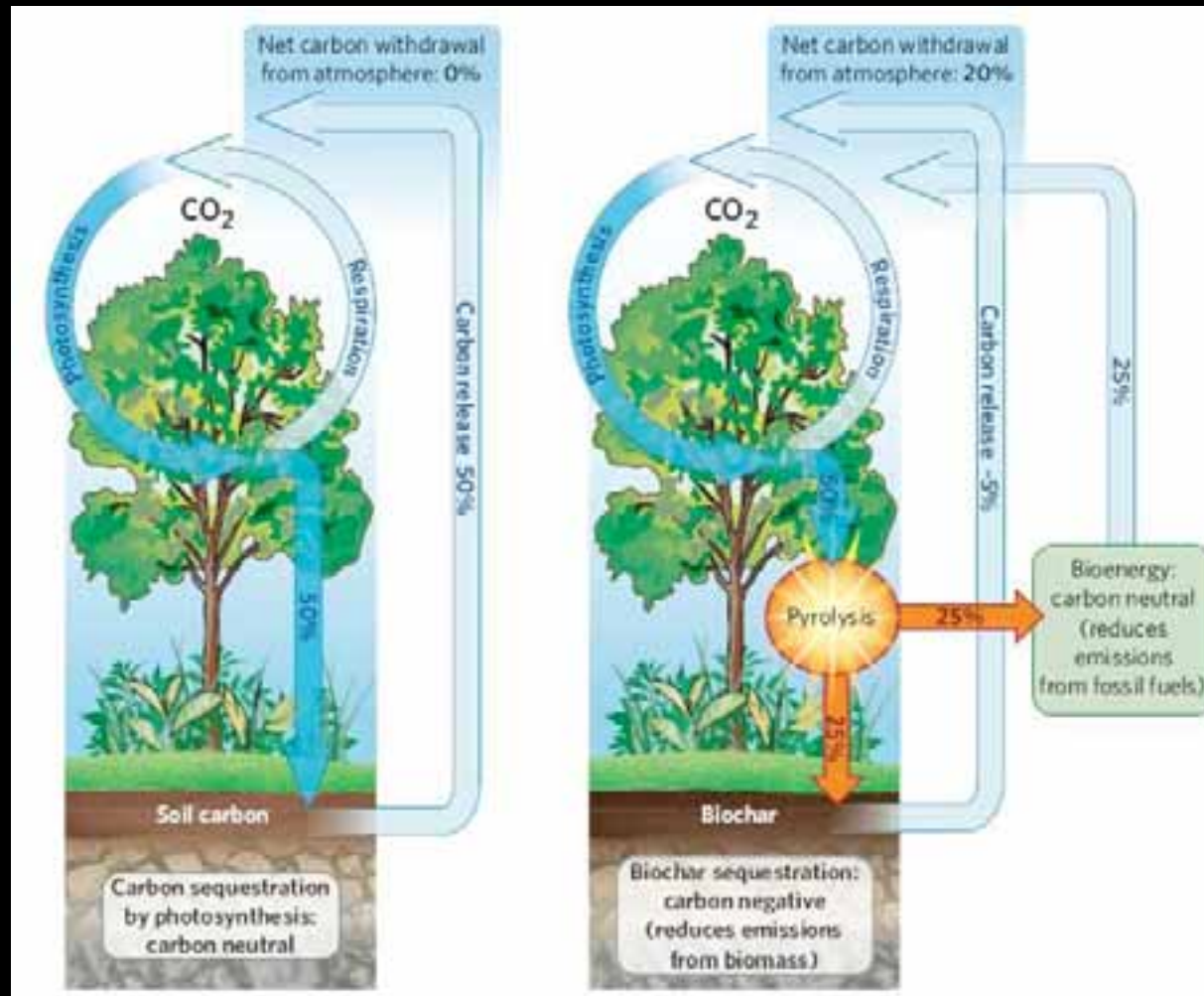
*Terra preta*, covers at least 10 percent of Amazonia, an area the size of France.



El Dorado - a large society as advanced as the Egyptians or the Incas created a soil that was several fold more nutrient rich than the the rainforest and could hold carbon 2- 3 times better than 10 times the carbon sequestering power of nutrient rich soil



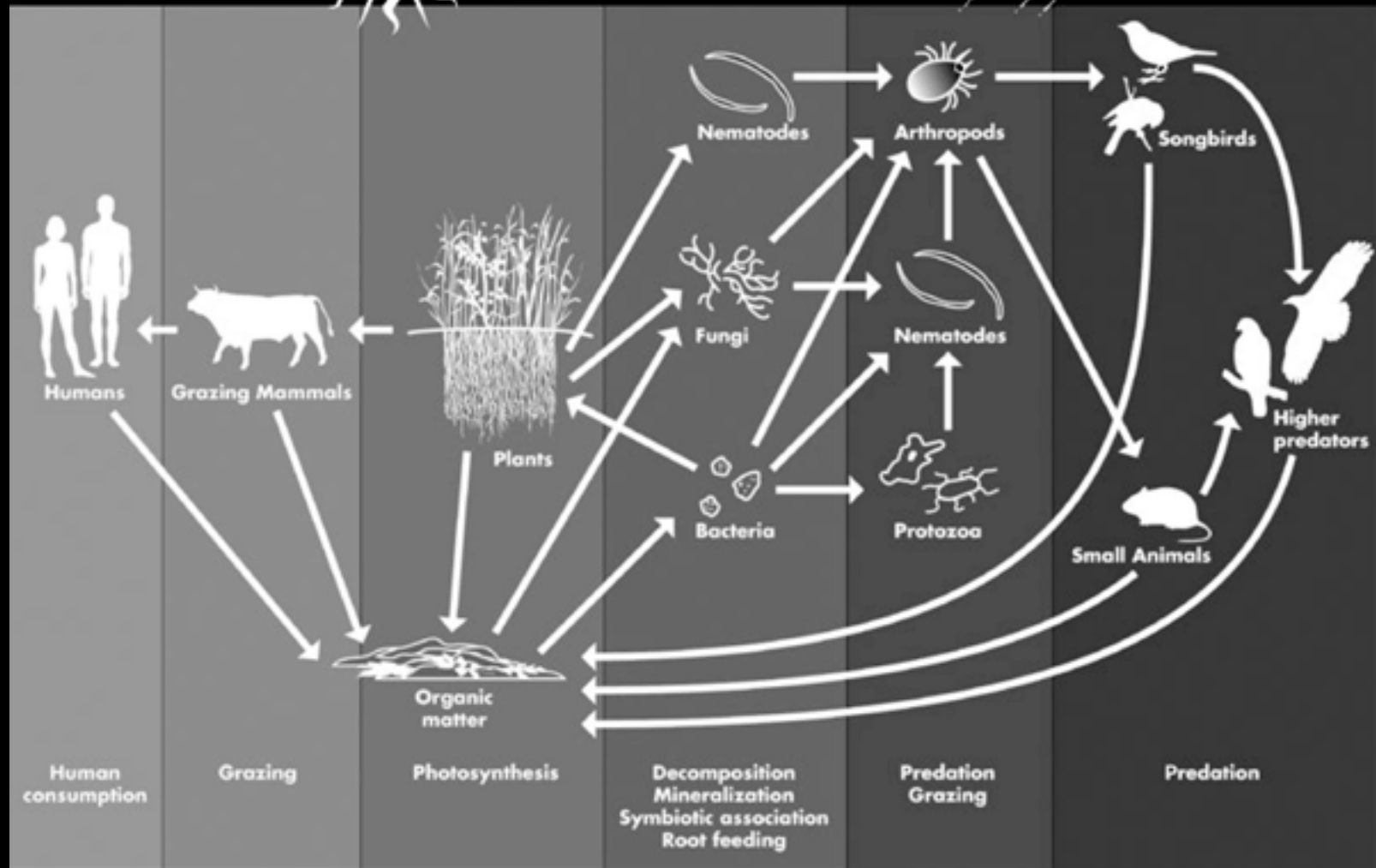
# Carbon Sequestration



Compared to afforestation (left), when biochar (right) is used as a soil amendment, it has a net 20% gain in carbon sequestration



Sunlight  **Rangeland Soil Food Web**  Rain

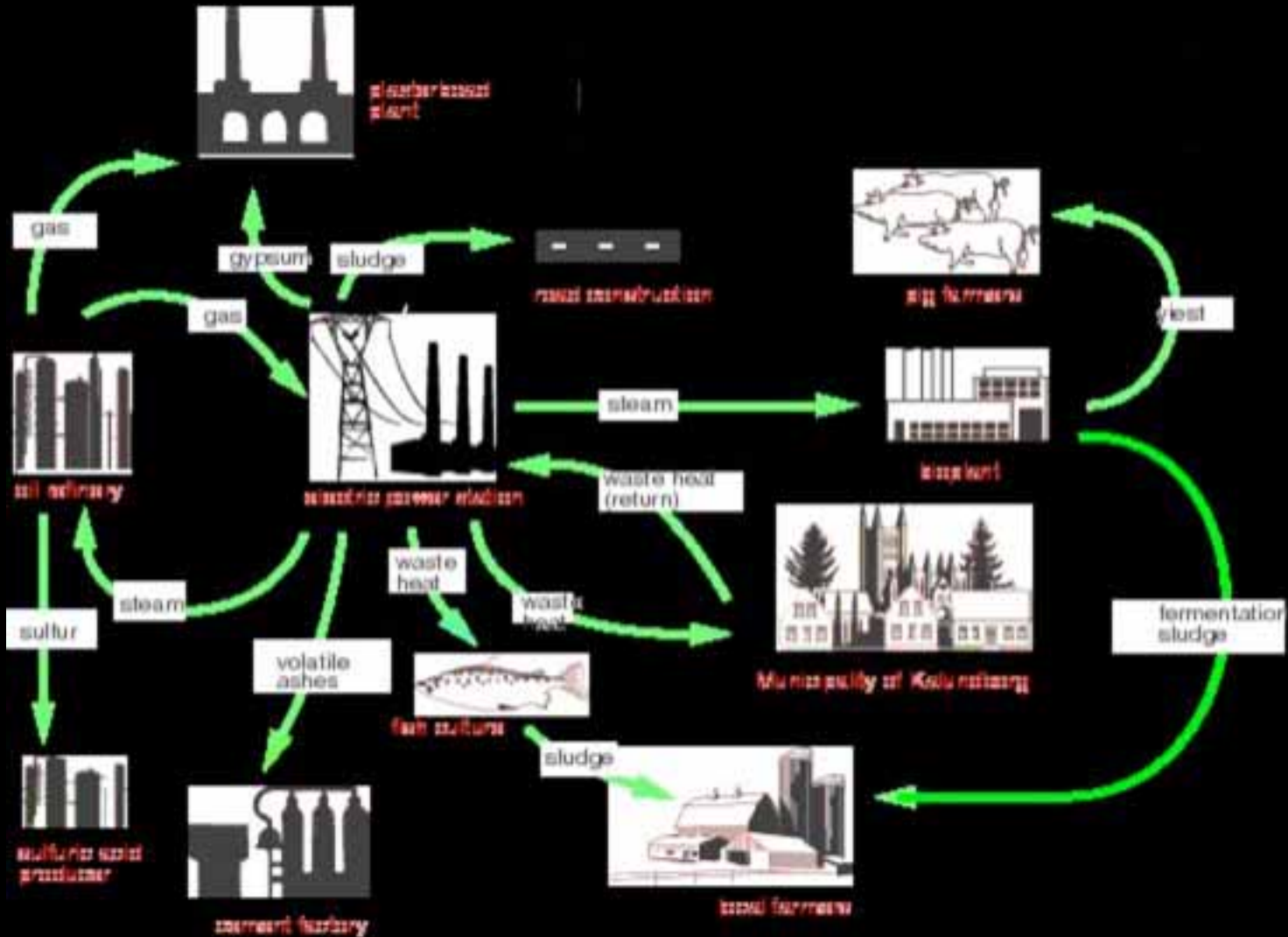


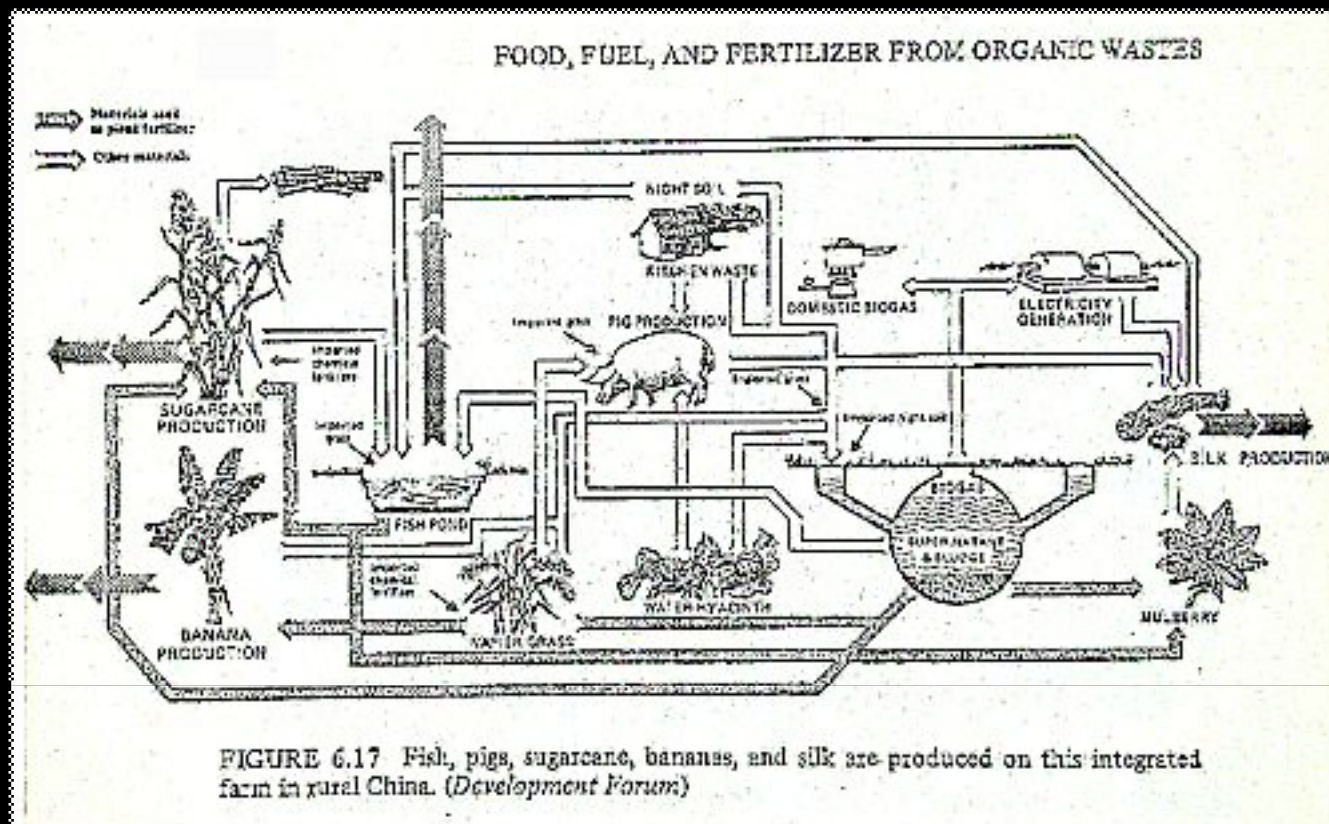
Eco-Balance Analysis for City South  
San Antonio, TX



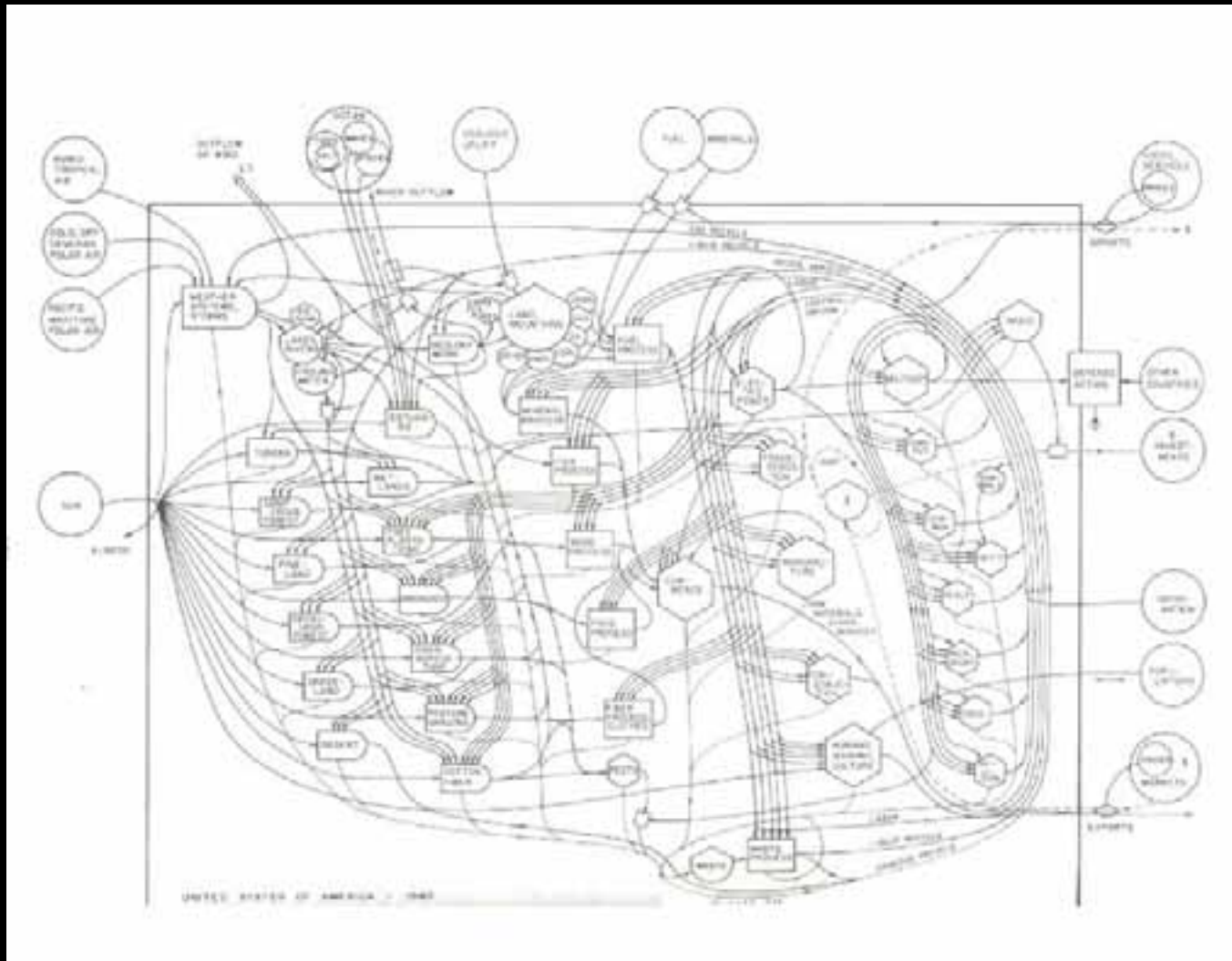


# Industrial ecosystem at Kalundborg, Denmark



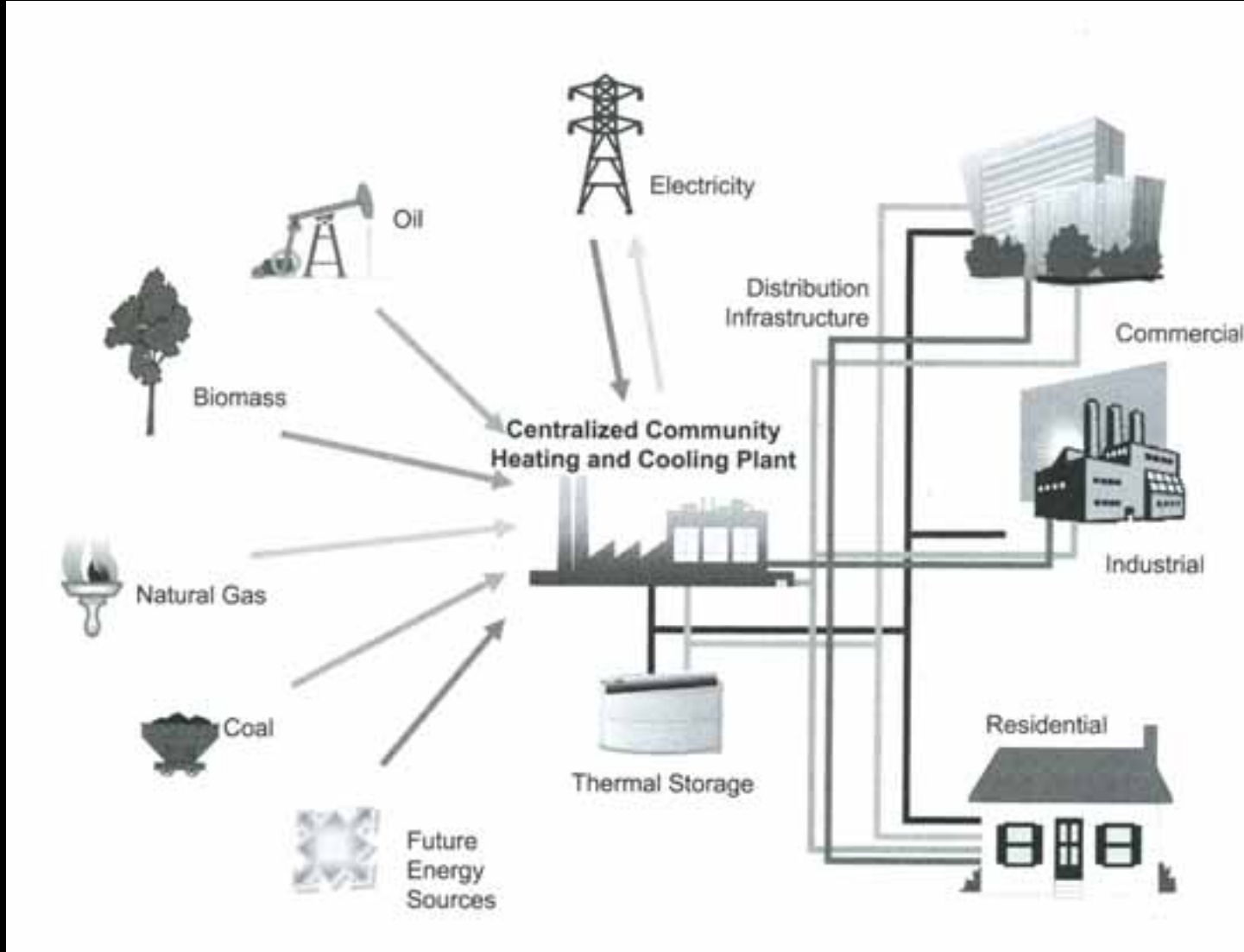


## INTEGRATED BIOSYSTEM - BEIJING, CHINA

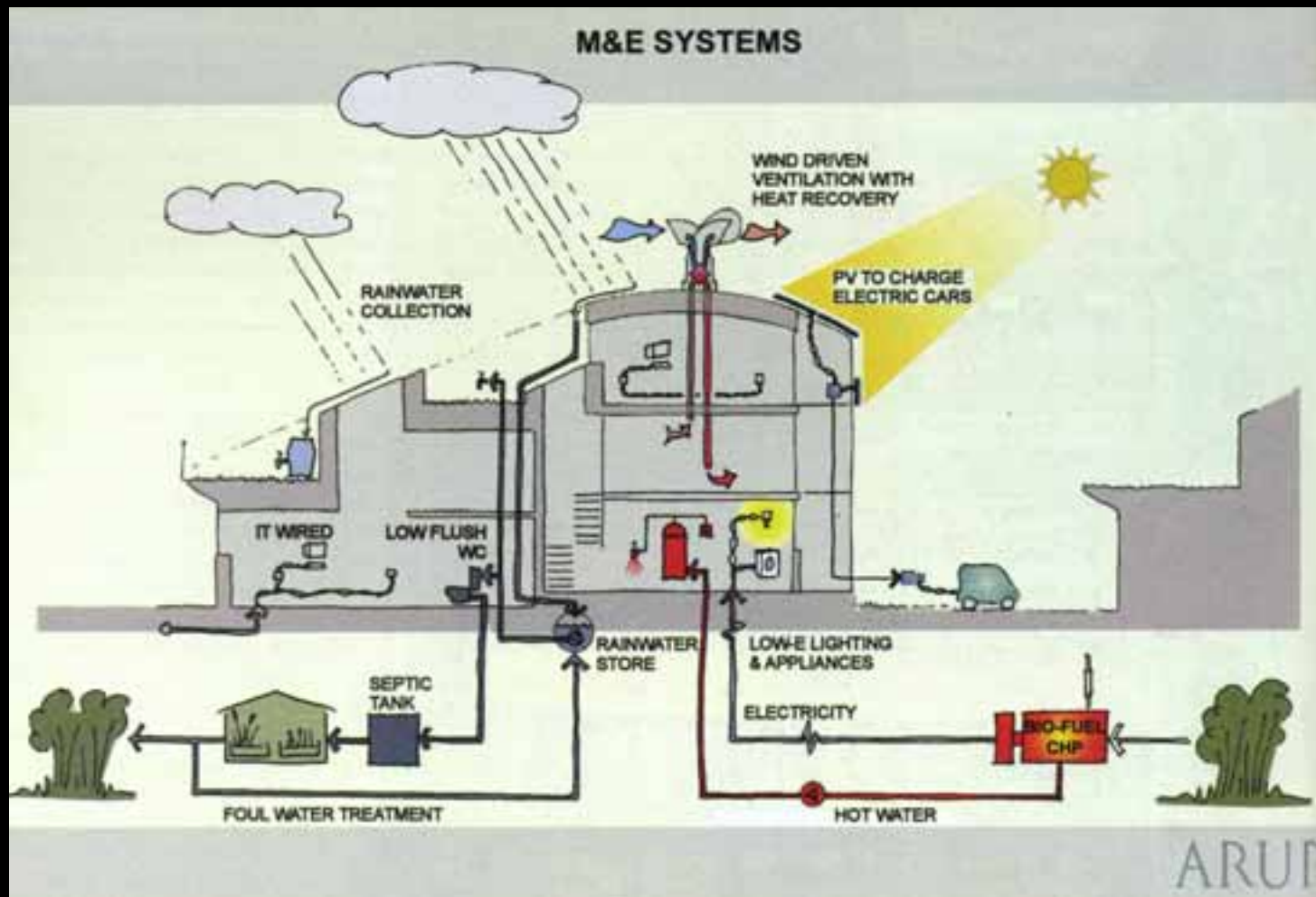


Source : systems Ecology Howard Odum

© cmpbs 2008



Douglas Farr, Sustainable Urbanism p 200 Image from District Energy St. Paul



Douglas Farr, Sustainable Urbanism p 216 Image c.Arup



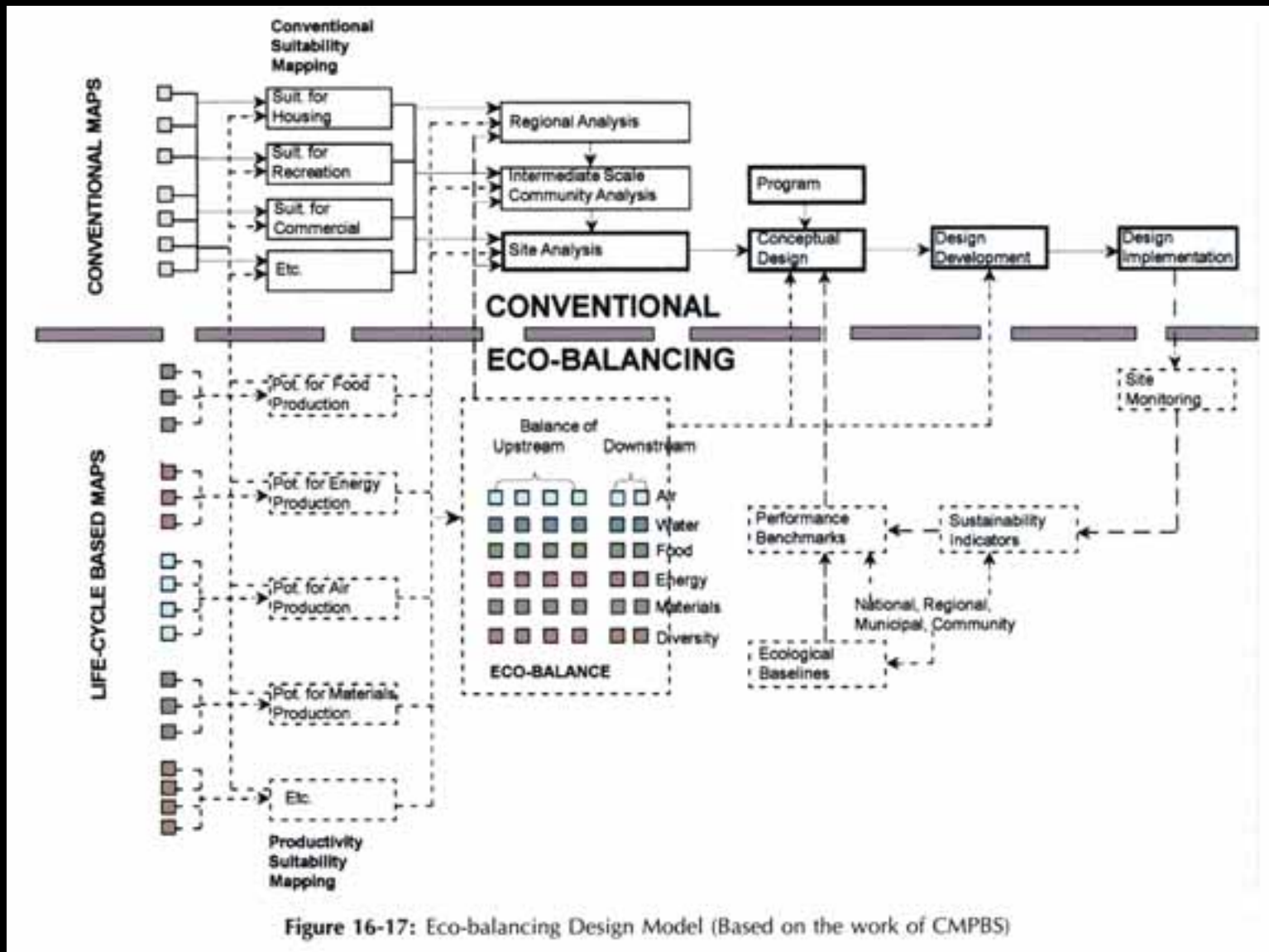


Figure 16-17: Eco-balancing Design Model (Based on the work of CMPBS)



The ecology of regenerative systems or those living systems that sustain over time are based on cyclical patterns of resource use. When these cycles ( air, water, food, energy, materials) symbiotically function with each other into a complex web of life, productivity is heightened to the extent that both nature and humans benefit beyond the capacity of either functioning unto itself

# Eco-Balance Planning

Eco-balance is a design methodology based on balancing resource use at various scales from home to community. It incorporates the life cycle structure by balancing between the sourcing and the re-sourcing of given life support needs in an ecological context. We are finding the result of multiple life cycle integration provides a potential level of productivity beyond simple balance itself.

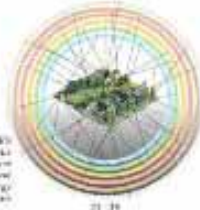
ECO BALANCE AS INTER-OPERABLE FRAMEWORK		
LIFE CYCLES	SOURCE	RE-SOURCE
Biologist	Flora	Fauna
Economist	Credit	Debit
Engineer	Heat Gain	Heat Loss
Hydrologist	Collect	Absorption
	Harvest	Treat
ICAnalyst	Upstream	Downstream
Ecologist	Producer	Consumer
Human	Opportunities	Constraints

Balance occurs in many allied disciplines whether we apply it to economics or physics or how we simplify the complex webs in ecosystems. The initial step in creation of life as we know it is the conversion of sunlight into flora that in turn supports the fauna that converts and re-sources the nutrients back to the plants. This Process of balance is shared by many of professionals that support the planning and design of the built environment

Why don't we?



### Life Cycle Balance Integrated Approach



### Smart Code Best Management Practices

**BOHANNAN WATER CODE FOR TD**

Code	Section	Best Management Practice
10.0	10.0	Stormwater Management
10.1	10.1	Stormwater Management
10.2	10.2	Stormwater Management
10.3	10.3	Stormwater Management
10.4	10.4	Stormwater Management
10.5	10.5	Stormwater Management
10.6	10.6	Stormwater Management
10.7	10.7	Stormwater Management
10.8	10.8	Stormwater Management
10.9	10.9	Stormwater Management
10.10	10.10	Stormwater Management
10.11	10.11	Stormwater Management
10.12	10.12	Stormwater Management
10.13	10.13	Stormwater Management
10.14	10.14	Stormwater Management
10.15	10.15	Stormwater Management
10.16	10.16	Stormwater Management
10.17	10.17	Stormwater Management
10.18	10.18	Stormwater Management
10.19	10.19	Stormwater Management
10.20	10.20	Stormwater Management
10.21	10.21	Stormwater Management
10.22	10.22	Stormwater Management
10.23	10.23	Stormwater Management
10.24	10.24	Stormwater Management
10.25	10.25	Stormwater Management
10.26	10.26	Stormwater Management
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10.43	10.43	Stormwater Management
10.44	10.44	Stormwater Management
10.45	10.45	Stormwater Management
10.46	10.46	Stormwater Management
10.47	10.47	Stormwater Management
10.48	10.48	Stormwater Management
10.49	10.49	Stormwater Management
10.50	10.50	Stormwater Management

MAP DATE: 2008  
 JURISDICTION: BOHANNAN  
 BEST MANAGEMENT PRACTICES

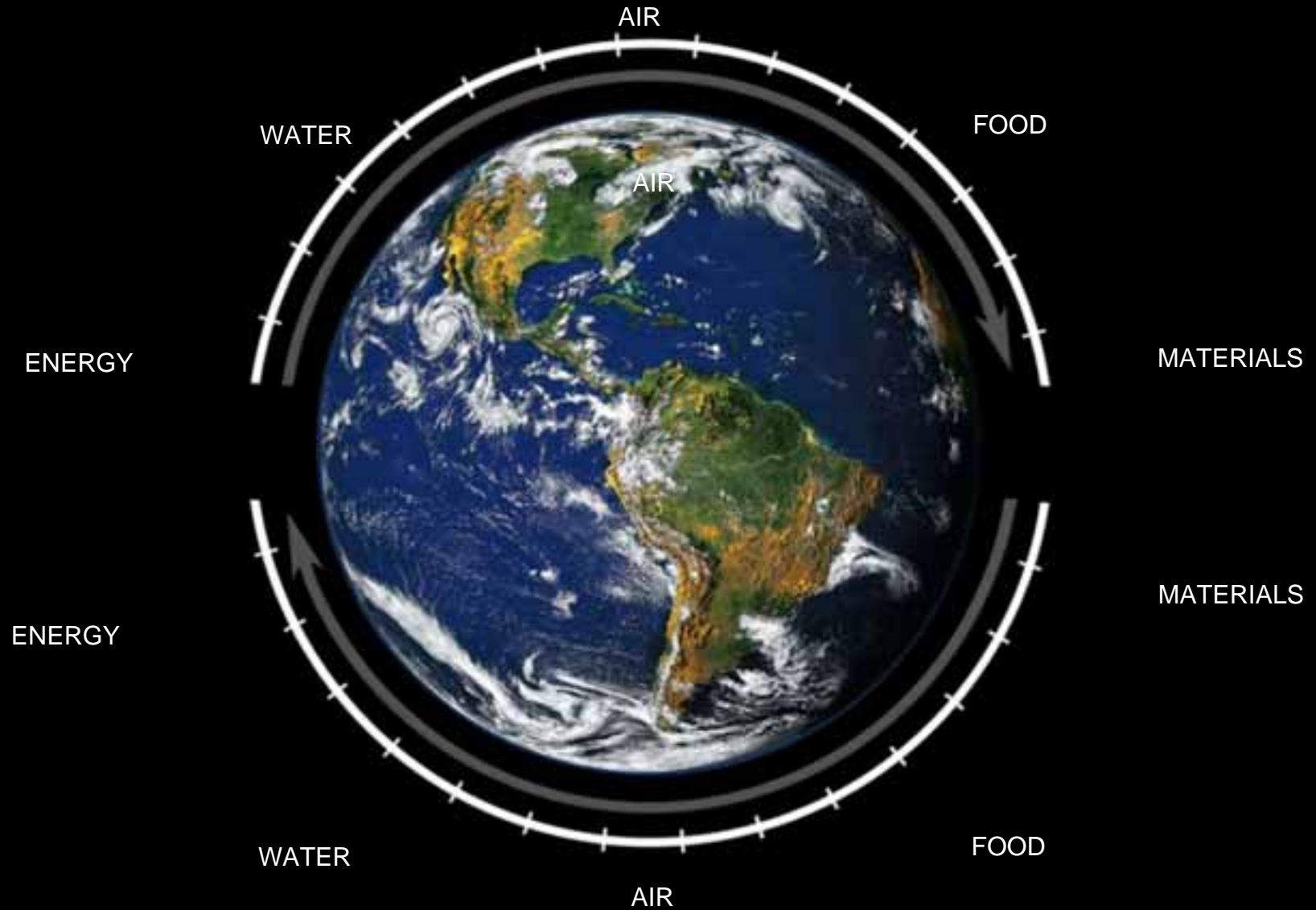
### Life Cycle Balance Single Variable Approach



### Verano Master Plan Transect Map

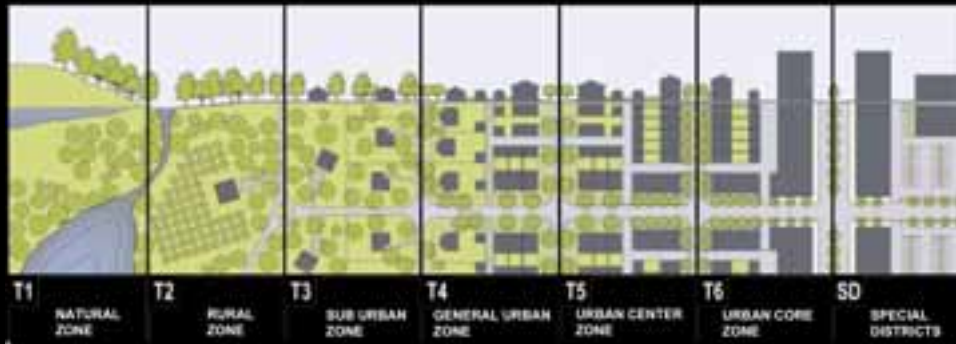


# EARTH BALANCE

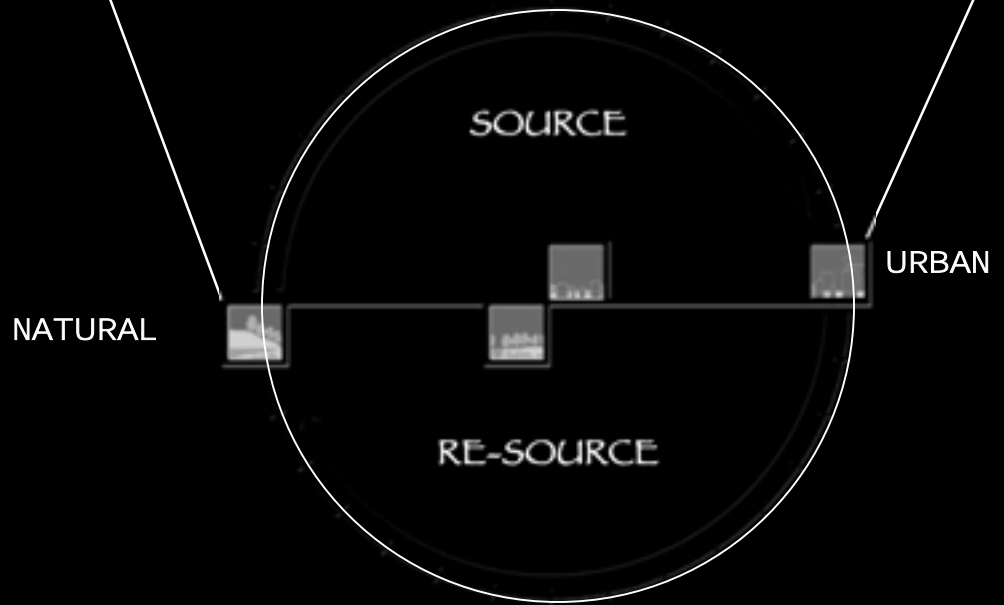


Eco-Balance Analysis for City South  
San Antonio, TX





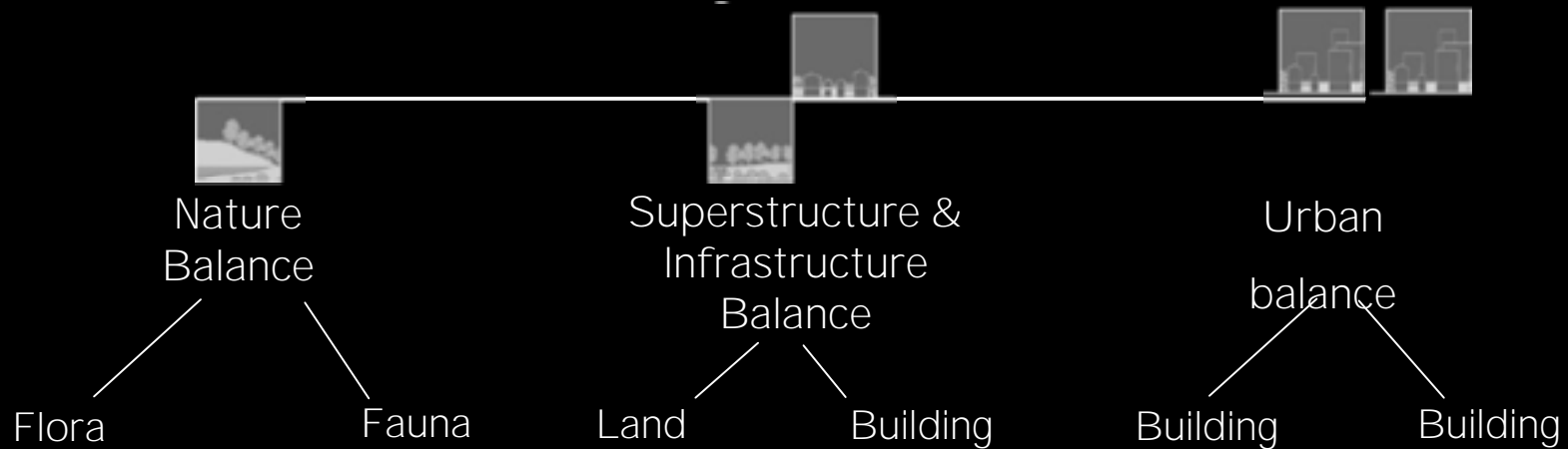
ECO - BALANCE



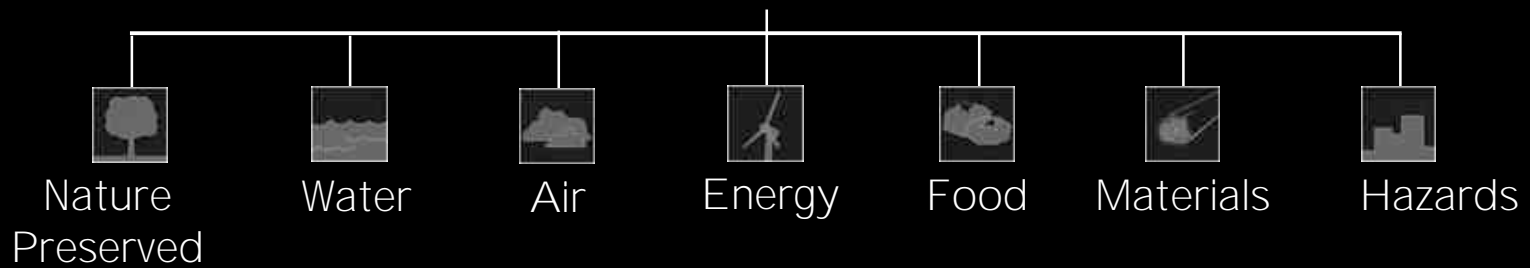


# ECO-BALANCE USING PERFORMANCE MANAGEMENT PROCEDURES

## Management Areas



## Mapping Process



## Base Maps

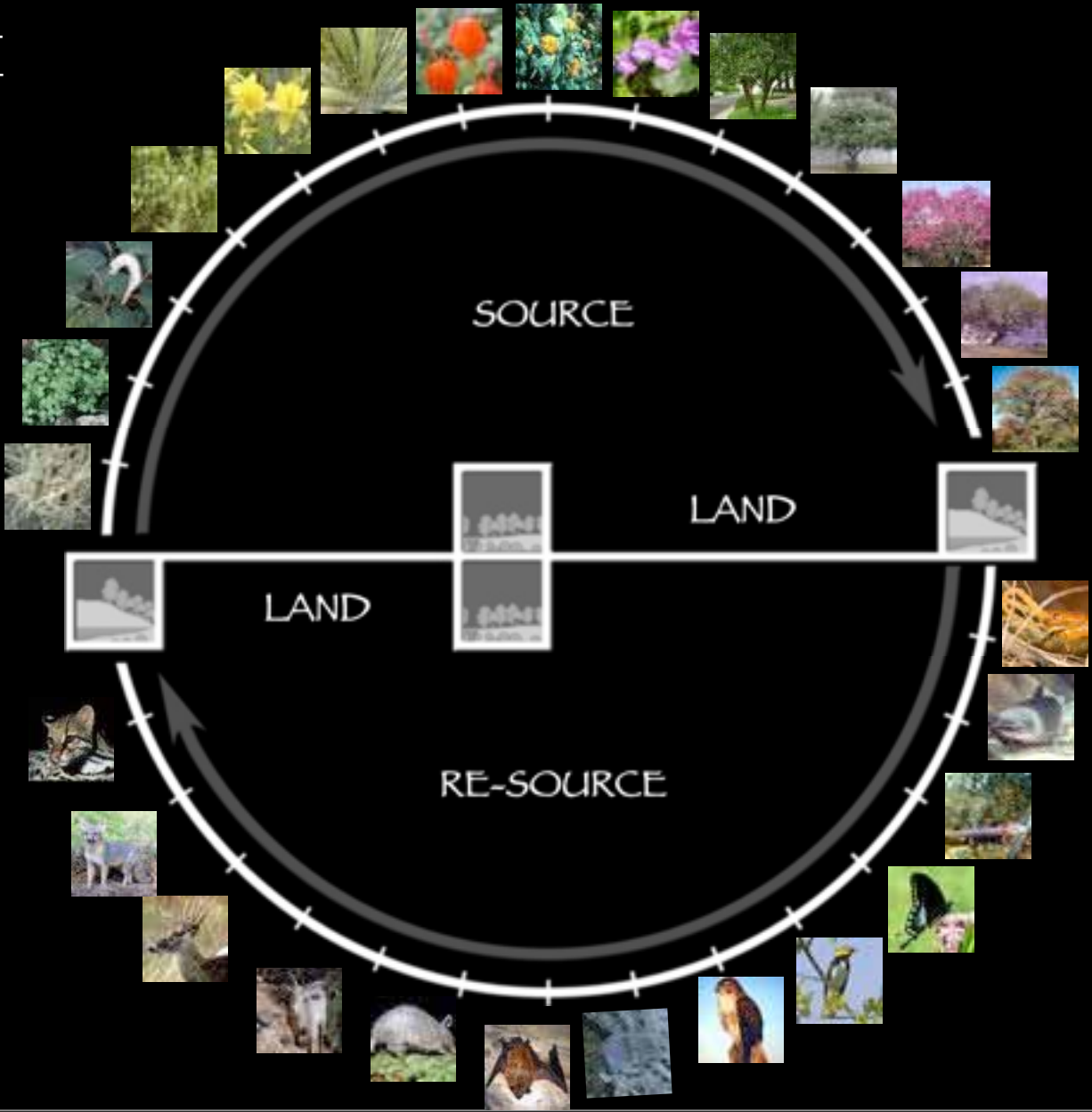


Eco-Balance Analysis  
San Antonio, TX





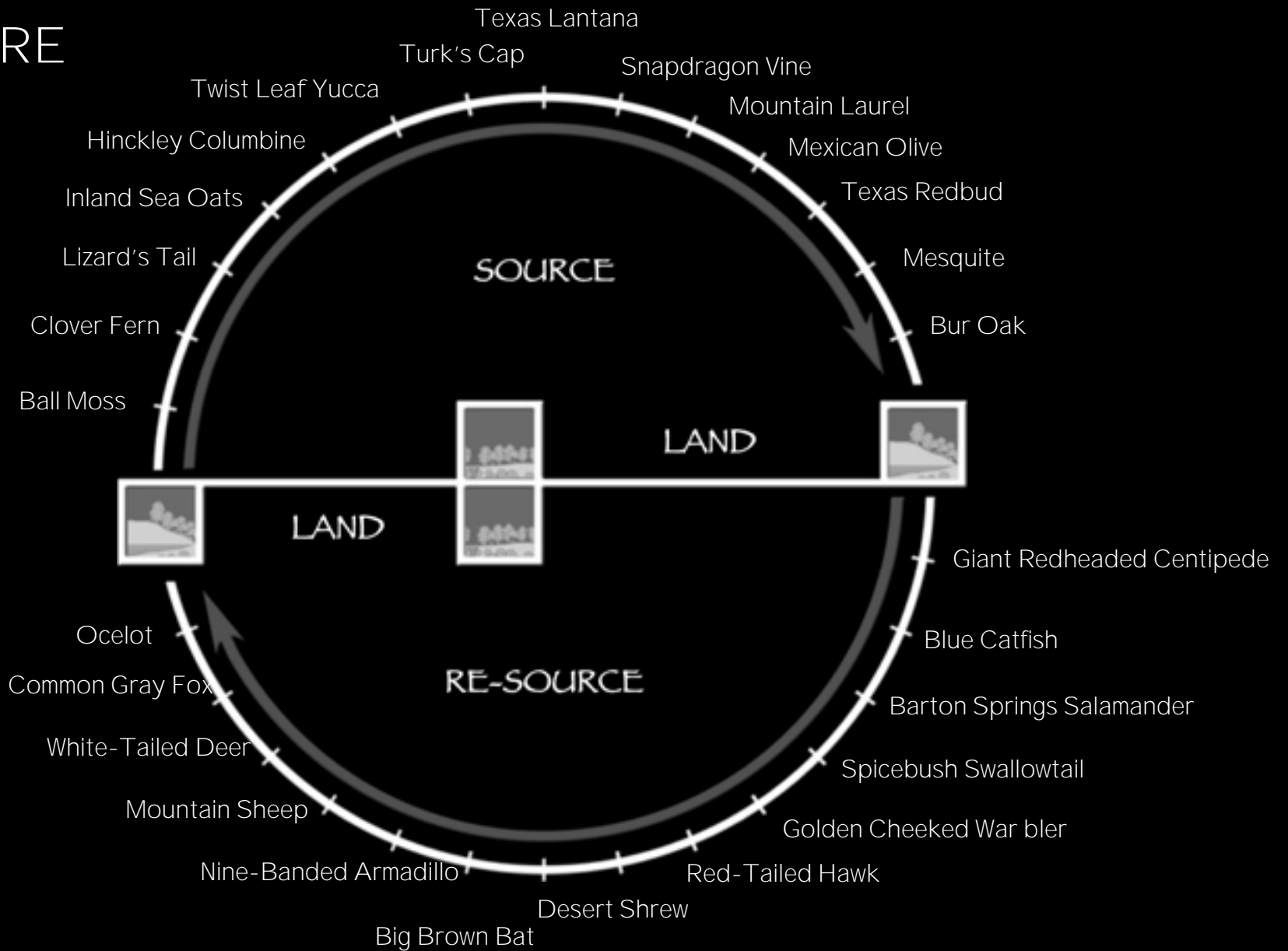
# NATURE T-1



Eco-Balance Analysis for City South  
San Antonio, TX



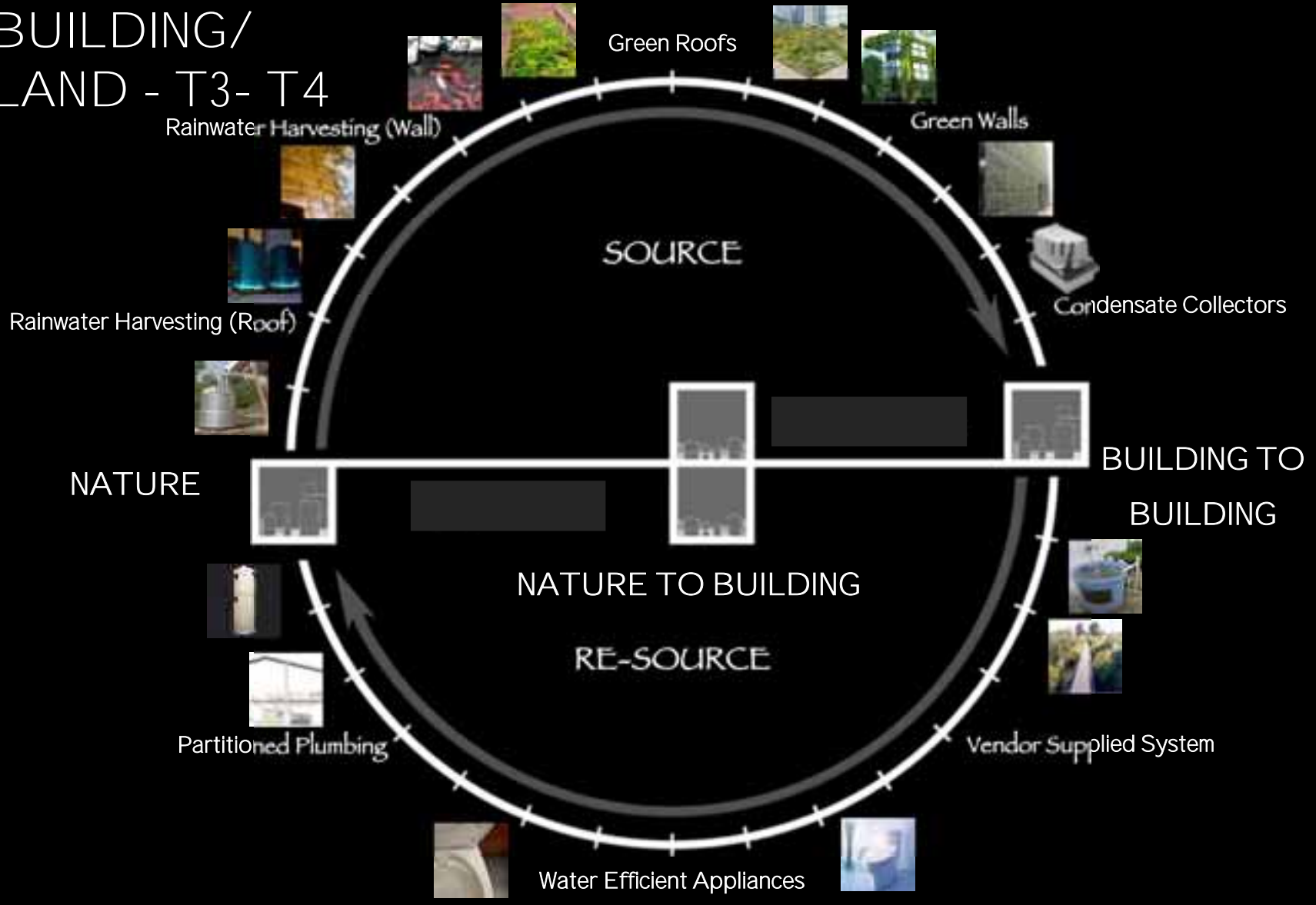
# NATURE T-1



## Eco-Balance Analysis for City South San Antonio, TX



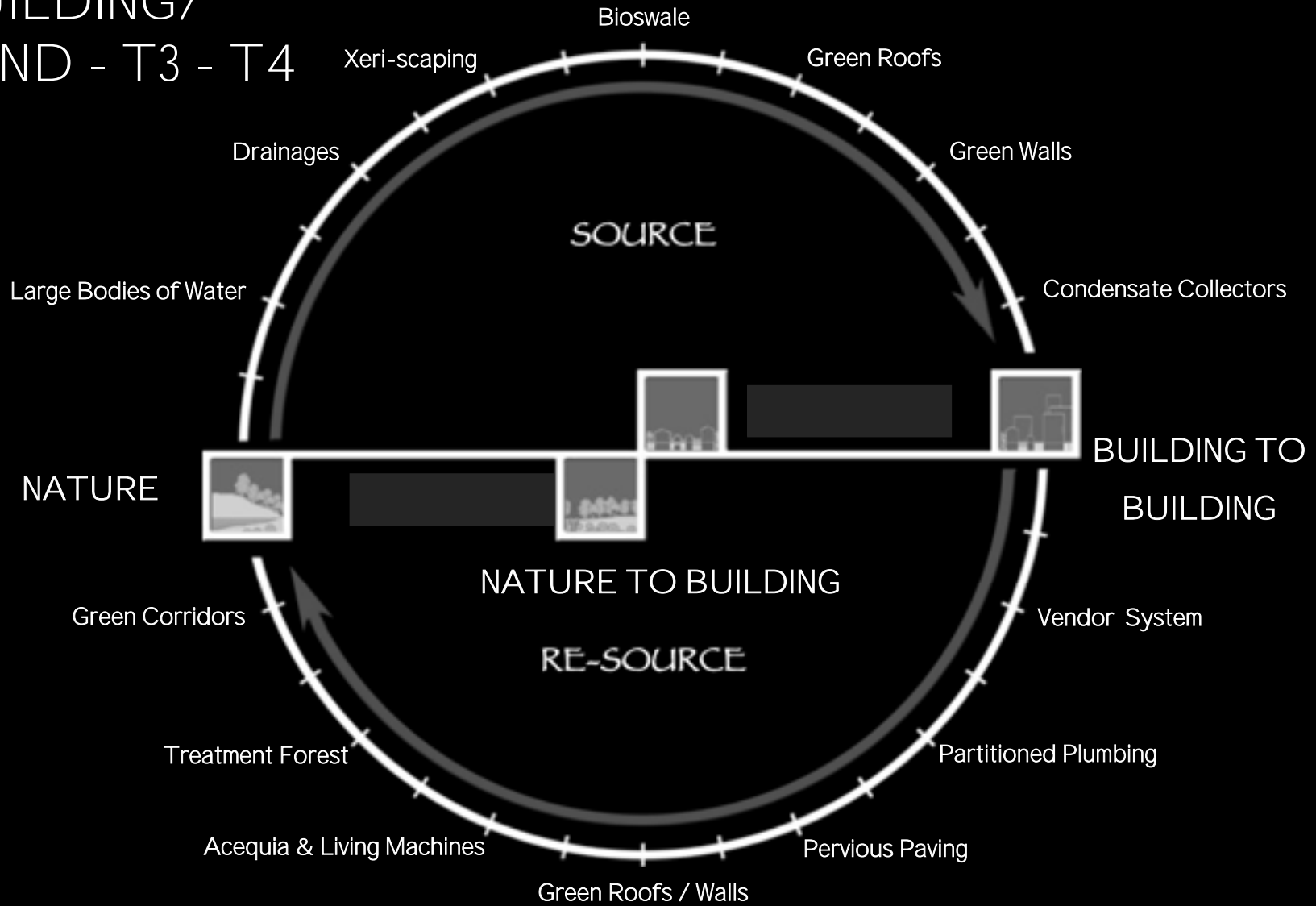
# BUILDING/ LAND - T3- T4



## Eco-Balance Analysis for City South San Antonio, TX



# BUILDING/ LAND - T3 - T4



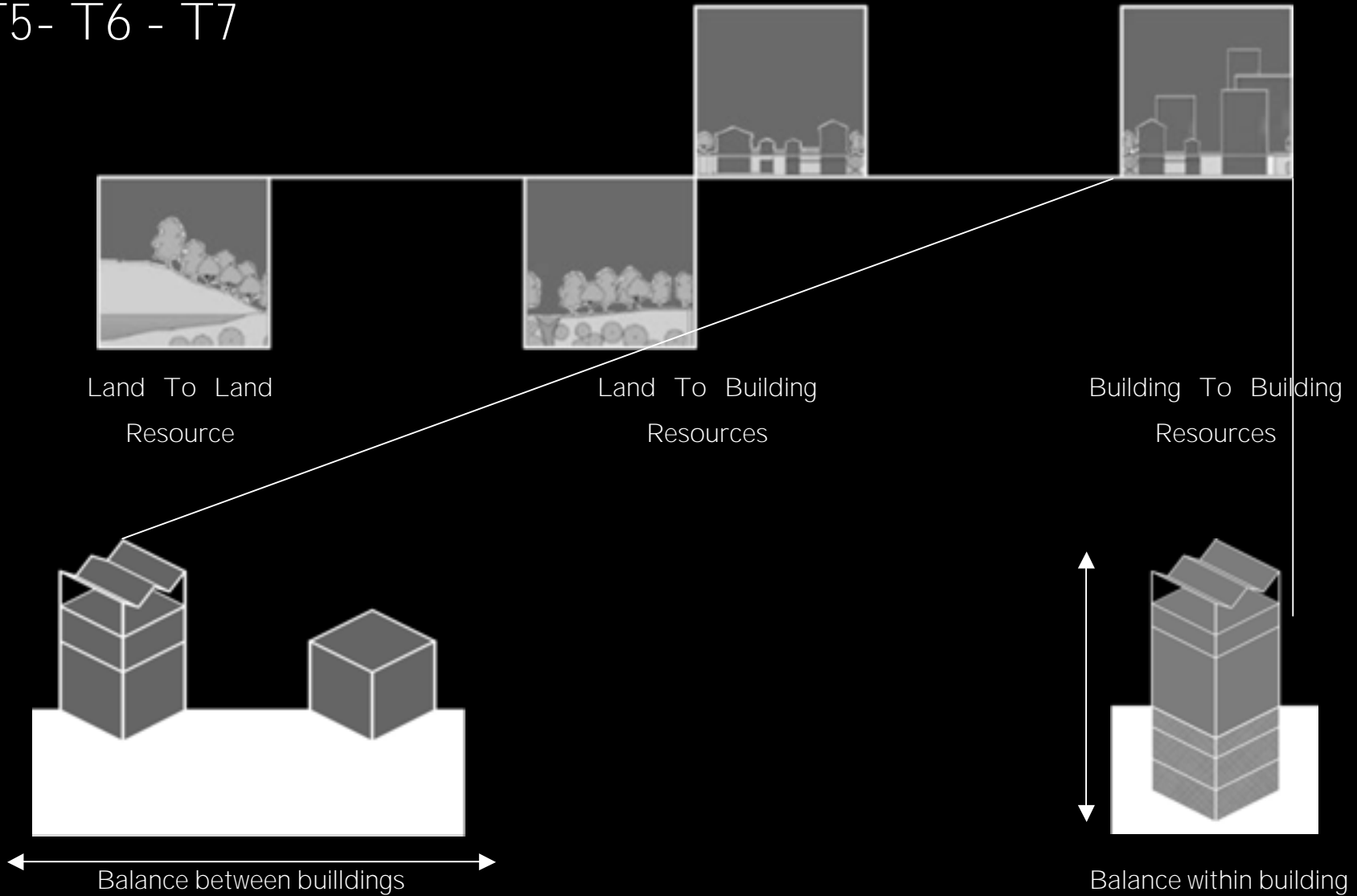
Eco-Balance Analysis for City South  
San Antonio, TX



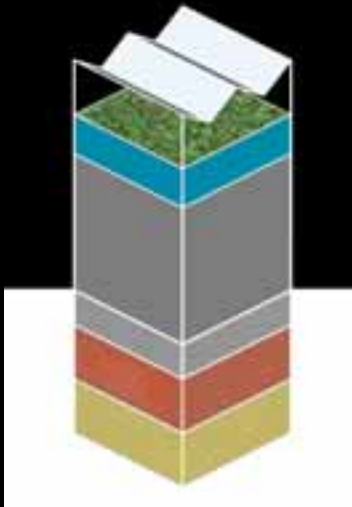


# BUILDINGS T5- T6 - T7

## Balance Type Summary

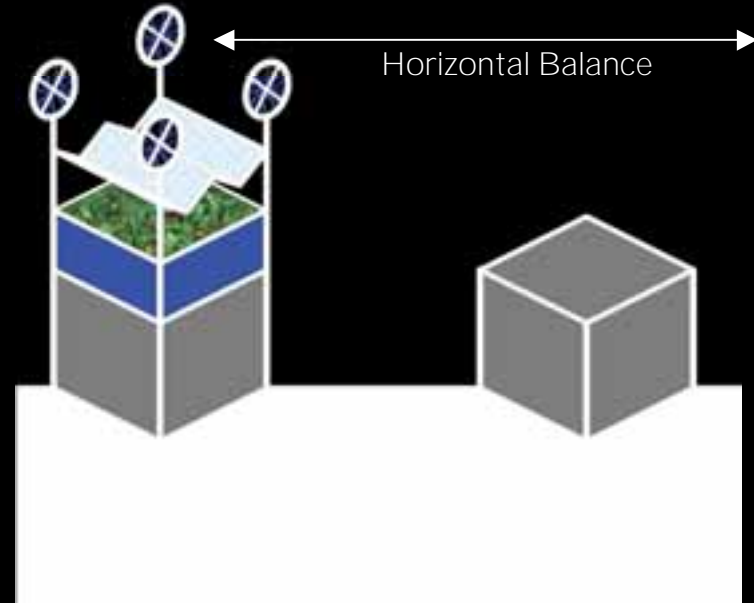


Vertical Balance



- BIPV -
- Shade
- Energy
- Green Roofs-
- Food Landscape
- WW Treatment
- Water Treatment
- Water Catchments
- Space Use
- Foundation-
- Structure
- Balance
- Energy Heat pump
- Energy Geothermal

Horizontal Balance



- |                      |                |            |
|----------------------|----------------|------------|
| Food (+)             |                | Food (-)   |
| Garden Roof          |                |            |
| Energy (+)           |                | Energy (-) |
| BIPV & Wind Sys      |                |            |
| Water (+)            |                | Water (-)  |
| Rainwater Collection |                |            |
| Building             | _____ To _____ | Building   |
| Building             | _____ To _____ | Land       |
| Land                 | _____ To _____ | Land       |



Eco-Balance Analysis  
San Antonio, TX





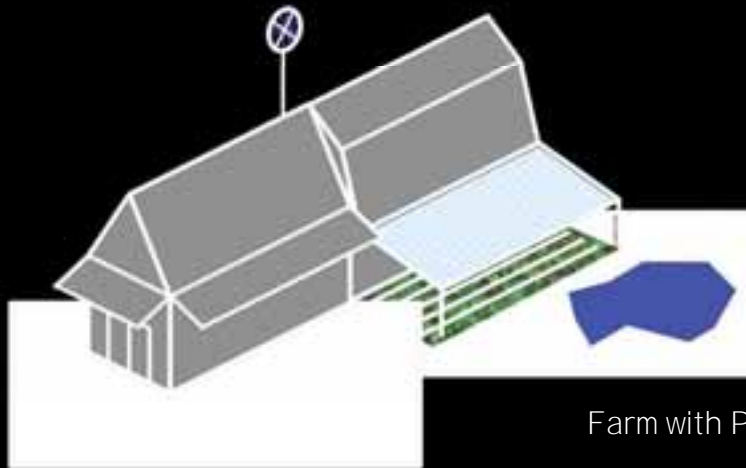
Drive-Through Bank

Energy (++)  
Water (++)



Laundromat

Energy (--)  
Water (--)



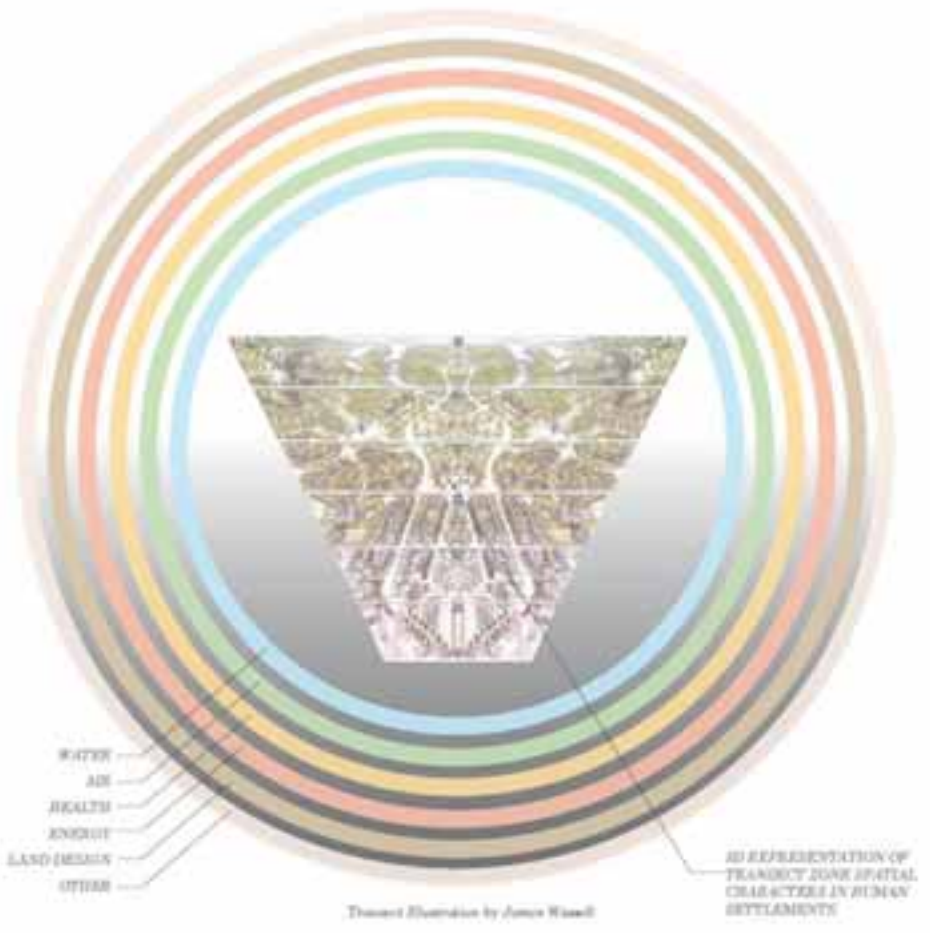
Restaurant

Food (--)  
Energy (--)  
Water (--)

Farm with Pond and Water Harvesting

Food (++)  
Energy (++)  
Water (++)

SUSTAINABLE DESIGN OPTION POINT SYSTEM				
Category	Credit Identifier	Description	Credit	Score
WATER	Nonwater Management (Water)	Reduce outdoor water use (except landscape) 1" of credit from a percentage of the project's development budget	1.0	0.0
		30% of development budget	1.0	0.2
		40% of development budget	2.0	0.4
		50% of development budget	3.0	0.6
		60% of development budget	4.0	0.8
		70% of development budget	5.0	1.0
	Nonwater Management (Energy)	Reduce 50% of the maximum electricity in the annual peak loading of both suspended loads from a percentage of the project's development budget	5.0	1.0
		30% of development budget	1.0	0.2
		40% of development budget	2.0	0.4
		50% of development budget	3.0	0.6
		60% of development budget	4.0	0.8
		70% of development budget	5.0	1.0
Nonwater Management (Materials)	Track pounds of post-consumer waste to pre-development value	2.0	0.0	
	1 lb. per 100 sq ft building floor area	1.0	0.0	
	Provide non-potable water source for irrigation for 50% of publicly owned areas	1.0	0.0	
	Provide non-potable water source for irrigation for 100% of publicly owned areas	1.0	0.0	
AIR	Urban and Wetland Conservation	Conservate 100% of all open spaces as defined by the project administrator with a buffer from the edge of the footprint of all built area by approximately 40 and 100% for conserved flowing riparian areas	1.0	0.0
	Minimize Site Disturbance	Percentage of total area left undisturbed per Development Pattern (based 100% Urban, 100% Regional Center, 10% Low-density areas permitted from development by use of a "development")	1.0	0.0
	Enhanced Vegetation	Any natural area to be 25% greater than the area requiring the maintenance and must exceed 5% of the total natural area to which it is contiguous	1.0	0.0
	Local Air Quality Protection	Provide continuous flow of the following air quality management strategies: parking lots paved with permeable pavement, 100% of air flow to open-pedestrian system	1.0	0.0
	Reduced Automobile Dependence	Locating miles of Drop & Load, Mail-In-Paid, and/or miles to customer miles of projects/units including wheelchair accessibility	4.0	0.0
		1 to 2	0.2	0.0
		3 to 4	0.4	0.0
New Concepts	Provide an outdoor bike lane at 1% above mandatory and label as an overall project average as defined by 50% for bicycle and 100% for overall project	1.0	1.0	
	Provide an outdoor bike lane to be used only for more public transit	1.0	1.0	
	Provide an outdoor bike lane to be used only for more public transit	1.0	1.0	
HEALTH	Bicycle	Locate project or a mile (part or all) that is developed as a continuous (Strategy) Cycling Program or AVIST, SPD or other VC approved Site Assessment or on a site developed as a described by a local, state, or federal agency. Use a bicycle method	4.0	0.0
		1 to 2 Acres	1.0	0.0
		3 to 4 Acres	2.0	0.0
		5 to 6 Acres	3.0	0.0
Access to Active Spaces	50% of all sites must be within 1/2 mile of general playfields, soccer, baseball, basketball, and/or sports fields	1.0	0.0	
	50% of all buildings are within 1/4 mile of public use trail or bicycle path or at least 1 mile to length in a public transit along	1.0	0.0	
HEALTH	Green Building	Reduce Development Pattern (Low- and Medium-Density) buildings to accordance with LEED Green Building (Certified), or LEED Green Building (Certified) or LEED Green Building (Certified) or LEED Green Building (Certified)	3.0	0.0
		At least 10% of all buildings in LEED Green Building (Certified) or LEED Green Building (Certified) or LEED Green Building (Certified) or LEED Green Building (Certified)	1.0	0.0
LAND USE/PLANNING	Public Open Space	Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	0.0
		Develop Open Space	1.0	0.0
	Open Network	Open and access to project or VC contiguity (including other) of project, including urban and regional connectivity	1.0	1.0
		Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0
		Open Space	1.0	1.0
	Community Growth	Provide through design along the project boundary or at least 100 feet	1.0	1.0
		Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0
Community Growth	Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0	
	Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0	
Community Growth	Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0	
	Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0	
COMMUNITY	Provision of public open space (park, sports, recreation, and/or natural) requirements	Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0
		Provision of public open space (park, sports, recreation, and/or natural) requirements	1.0	1.0
Total Points Available: 43.0			<b>TOTAL</b>	



### INTEGRATION OF LIFE CYCLE CONCERNS AND TRANSECT PLANNING

The word sustain in the most basic sense means continued availability. Nature makes things continuously available through air, water, food, energy, and material cycles. The source end of these cycles balance with the re-sourcing end, and the more productive these cycles the more humans can afford to do to fund certain needs. To accomplish this means going beyond checklists and designing so that best management practices (BMPs) contribute with other BMPs to create these cycles within nature by using human management expertise.

**PER CAPITA LAND USE FOOTPRINT**

NEED	DESCRIPTION	AREA	
		ON-SITE	OFF-SITE
AIR QUALITY	OXYGEN PRODUCTION CARBON EMISSION SEQUESTERING	300-500	88,000
WATER SUPPLY	DOMESTIC USES CISTERN FOOD PRODUCTION (Vegetarian Diet)	400-500 30- 40	33,000
FOOD SUPPLY	HOME GARDEN (Max. Maintainable By 1 Person In Spare Time) ADDITIONAL AREA FOR COMPLETE DIET (Vegetarian)	300-400	4,000
ENERGY SUPPLY	PHOTOVOLTAICS-DOMESTIC ELECTRIC PHOTOVOLTAICS-ELECTRIC VEHICLE BIOMASS FUEL-PASSENGER VEHICLE BIOMASS FUEL-SPACE HEATING	250-300 100-150	44,000 44,000
LIVING SPACE	BATHING, COOKING, EATING, SLEEPING OUTDOOR RECREATION PARKING SPACE-ELECTRIC VEHICLE	200-250 300-400 100-150	400 200
SIMPLE SUM		1,980-2,690 0.05 AC	213,600 4.85 AC
SUM WITH INTEGRATED FUNCTIONS		1,030-1,380 0.03 AC	136,000 3.1 AC

**CONCLUSION :** Rounded to the nearest unit of the infinite grid, the per capita footprint for a dwelling unit and lot in Austin, Texas is :      1,375      sqf      ON-SITE (44,000 sqf/32)  
                                          132,000      sqf      OFF-SITE (44,000 x 3)

**PER CAPITA LAND USE FOOTPRINT**



## Energy Balance - Best Management Practices In Transect Zone T3



8. Low energy landscape



11. Solar street/park lights

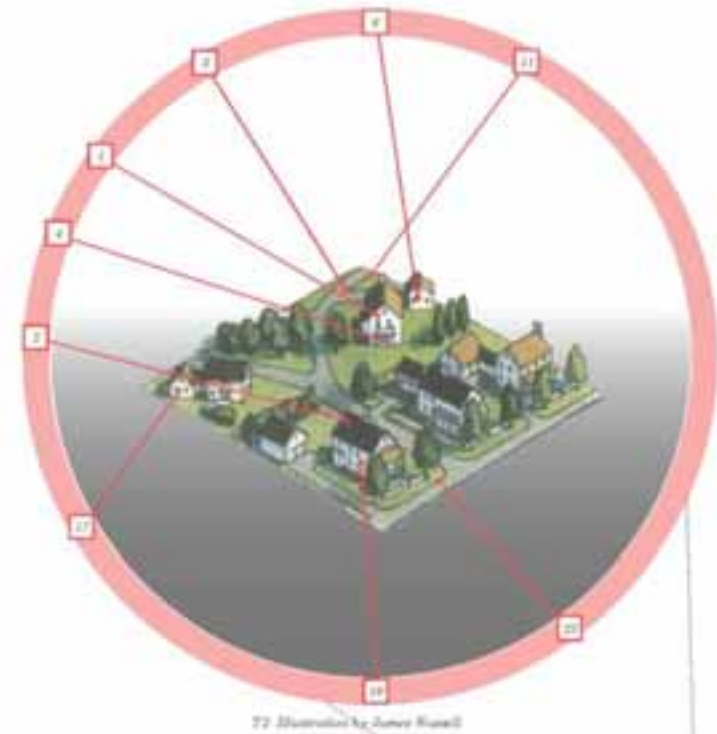


20. Smart cars



22. Bike lanes

ECO-BALANCE ENERGY CHART FOR T3			
Code	S/R	SB	Best Management Practices
1	☉	S, M	light colored exterior pavements
2	☉	S, M	ventilated roof/ventilated attic
3	☉	S	deep set/overhang eaving windows
4	☉	R, S, M	shaded porches/balconies
5	☉	M	shaded streets and alleys
6	☉	—	low embodied energy building
7	☉	M	low energy water system
8	☉	M	low energy landscape
9	☉	M	low maintenance materials
10	☉	S, M	reusable material structures
11	☉	S, M	solar street/park lights
12	☉	P	solar electric PV provision
13	☉	P	solar hot water provision
14	☉	P	daylighting provision
15	☉	S	energy conserving lights
16	☉	S	energy conserving appliances
17	☉	S	energy conserving fenestration
18	☉	—	solar oriented fenestration
19	☉	S	high R value insulation
20	☉	S, M	smart cars
21	☉	—	inter-modal cycle bus train center
22	☉	M	bike lanes
23	☉	M	walkable community



72 Illustration by James Rouse II

ENERGY



### Table Legend

- ☉ Source
- ☉ No-Source

Sustainable Businesses  
at low & transit zones

- P - Produce
- S - Sell
- M - Maintain

Energy Balance at Various: From the standpoint of the conservation end of the energy cycle the community fits the necessary LEED or other San Antonio code requirements. From the standpoint of actual Life Cycle balancing, energy follows a similar format at other life support cycles: 1) balance according to direct need (solar photovoltaics used for basic electrical use); and 2) balancing of the full energy balance cycle. At the building scale the second can be satisfied by the PV's plus passive solar architecture including shade, solar and breeze orientation, daylighting combined with all necessary re-occurring functions (window/wall insulation/ energy efficient appliances, etc). At a community scale, an example of the second involves the former plus production of enough biomass at local level from the waste generated on site through sewage treatment (scoop plants, reeds, etc) in a managed harvesting/composting process used to satisfy remaining energy needs.

2008 | ENERGY AND WATER | T3 | ECO-BALANCE





## Energy Balance - Best Management Practices In Transect Zone T6



23. Low open roof top wind systems



23. Vertical and horizontal green space

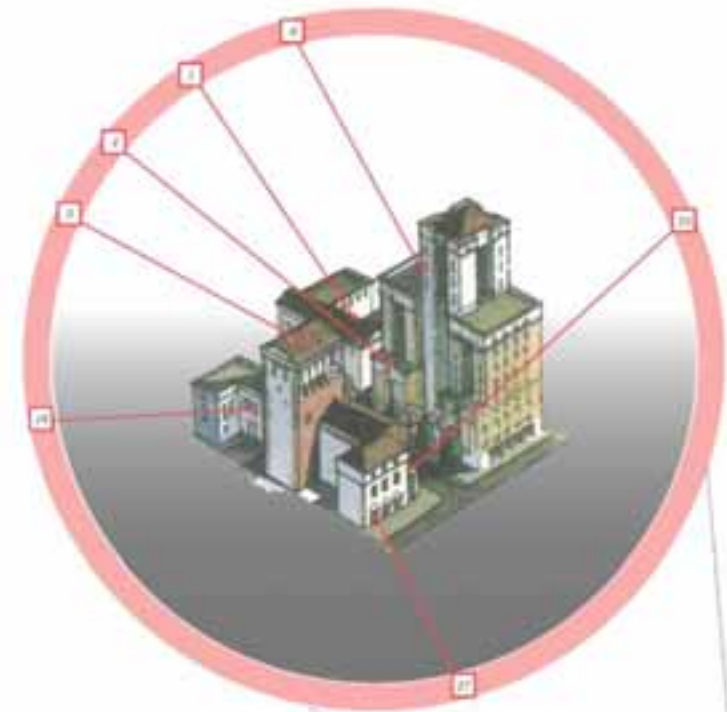


25. eVg and pV plug in parking



28. Large vertical plant-based airium humidifiers

ECO-BALANCE ENERGY CHART FOR T6			
Code	S/R	SB	Best Management Practices
1	☉	—	light colored exterior pavements
2	☉	M	operating facades
3	☉	M	PV shading facades
4	☉	—	shaded balconies
5	☉	—	shaded streets and alleys
6	☉	—	low embodied energy building
7	☉	—	low energy maintenance landscape
8	☉	—	low maintenance materials
9	☉	P, S, M	PV shades interior
10	☉	S, M	PV plants
11	☉	S, M	ice battery district cooling
12	☉	S, M	open/feasible/reusable large building systems
13	☉	P, S, M	pump storage water towers/roof tanks
14	☉	—	energy conserving lights
15	☉	—	energy conserving appliances - elevators
16	☉	—	energy conserving ventilation
17	☉	M	building to building utility sharing
18	☉	S, M	flex apdc day lighting
19	☉	S, M	Low open roof top wind systems
20	☉	—	inter modal cycle bus train center
21	☉	—	bike lanes
22	☉	S, M	wind system elevator integration
23	☉	P, S, M	vertical and horizontal green space
24	☉	M	heat pump geothermal foundations
25	☉	M	eVg and pV plug in parking garages
26	☉	P, S, M	flex rail pedestrian bridges
27	☉	—	building to building waste heat reuse
28	☉	M	fish plant waste integrated restaurants
29	☉	S, M	large vertical plant based airium humidifiers



T6 (Illustration by James Winesell)

ENERGY



### Table Legend

- ☉ Green
- ☉ No-Green

Sustainable Businesses  
at low & transit zones

- P - Produce
- S - Sell
- M - Maintain

Energy Balance of Varano: From the standpoint of the conservation and of the energy cycle the community fits the necessary LEED or other San Antonio code requirements. From the standpoint of actual Life Cycle balancing, energy follows a similar format at other life support cycles: 1) balance according to direct need (solar photovoltaics sized for basic electrical use), and 2) balancing at the full energy balance cycle. At the building scale the second can be satisfied by the PV's plus passive solar architecture including shade, solar and breeze orientation, daylighting combined with all necessary re-circulating functions (window wall insulation) energy efficient appliances, etc). At a community scale, an example of the second involves the former plus production of enough biomass of fuelwood from the waste generated on site through sewage treatment (woody plants, reeds, etc) in a managed harvesting/combustion process sized to satisfy remaining energy needs.

100001 BALCONY 000 000 00 11 ECO-BALANCE



## Water Balance - Best Management Practices In Transect Zone T3



4. Bioswales



2. Depressive surface parking driveway

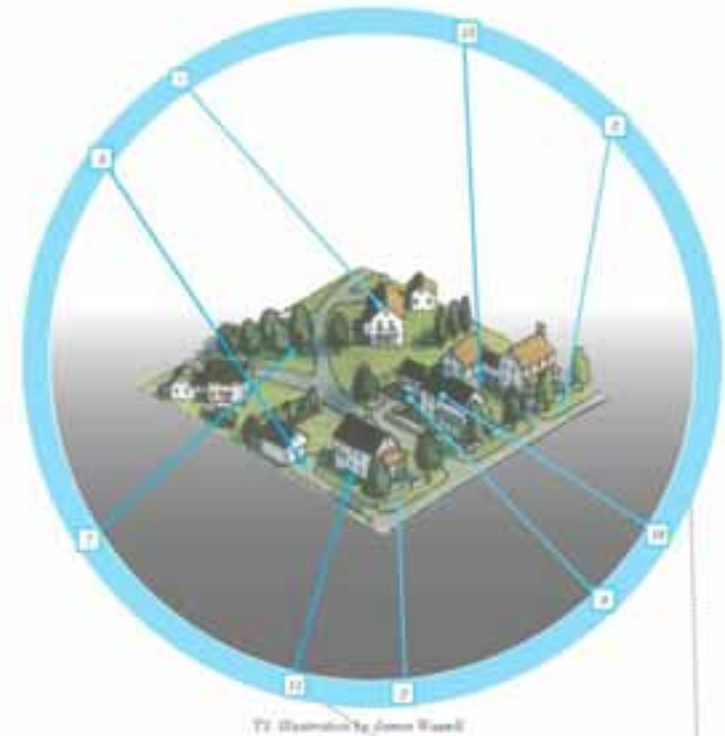


7. Tree treatment of runoff



8. Pond Treatment pond

ECO-BALANCE WATER CHART FOR T3			
Code	S/R	SB	Best Management Practices
1	☉	P, S, M	roof top-rain/AC condensate capture and storage
2	☉	P, M	create infiltration trenches
3	☉	P, M	water absorption ponds
4	☉	P, M	end of pipe bioswales
5	☉	P, M	impermeous surface parking driveway
6	☉	P, S, M	green machine fertilizer insect control
7	☉	P, S, M	tree irrigation/treatment of runoff
8	☉	P, S, M	shallow well reuse
9	☉	P, M	reed treatment pond for landscape reuse
10	☉	P, S	water conservation fixtures
11	☉	P, S, M	decorative flower microbial treatment bed
12	☉	P, S, M	fish pond collector/vector treatment system
13	☉	S, M	NOx treating pavement
14	☉	P, S	aviary vector control



T3 (Illustration by James Wazell)

WATER



### Table Legend

- ☉ Sustainable Businesses
- ☉ at level 2 Transit zones

P - Pervious  
S - Soil  
M - Maintain

- P - Pervious
- S - Soil
- M - Maintain

Water balance at Venere through most transects fits into two primary types: 1) meeting precipitation condition of a 1" rainfall, and 2) meeting extreme 100 year flash flood conditions. The first condition operates under the assumption that full balance can occur on site and the second that some can occur on site but measures will be needed to absorb significant flood waters using surface lakes and ponds on and off site to absorb these extremes. Condition one, as with other life cycle balancing, occurs according to partial balance -- matching need with collection or matching need with collector and treating that water quantity on site to a level equivalent or superior to the incoming water quality.

WATER BALANCE AND TREATMENT T3 ECO-BALANCE



# Water Balance - Best Management Practices In Transect Zone T6



3. Landscape roof



4. Disconnected driveway

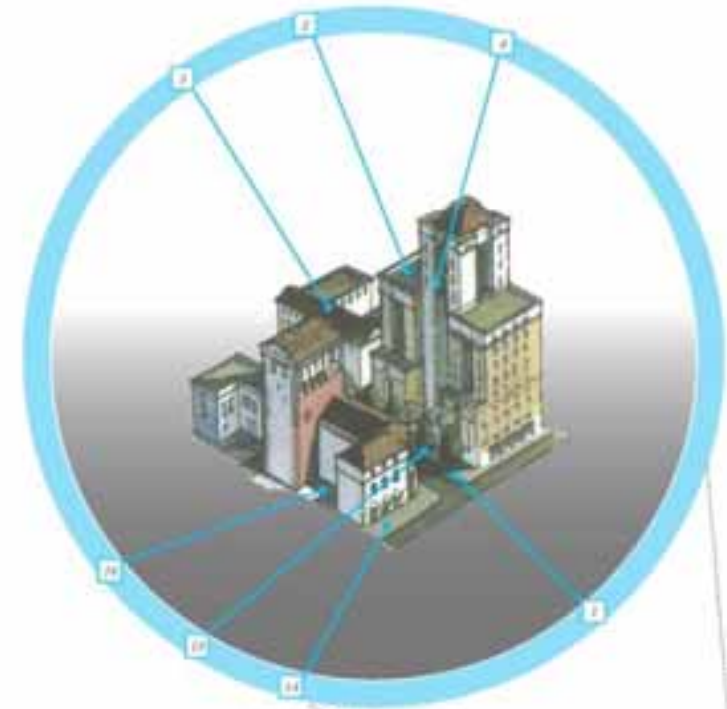


7. Micro-detention in parking lots



16. Food treatment pond

ECO-BALANCE WATER CHART FOR T6			
Code	S/R	SB	Best Management Practices
1	☉	P, S, M	site grading, high performing landscape, grade retention
2	☉	P, S, M	create berms and swales
3	☉	P, S, M	use dry-runoff construction capture and storage
4	☉	M	select downspouts that allow water to be treated
5	☉	P, S, M	provide pollution control prior to entering storm drain
6	☉	P, M	replace seal expansion to existing pipes
7	☉	P, M	use on-site sites and technologies to parking lots
8	☉	M	improved stormwater management based on site characteristics
9	☉	P, M	improve surface finish with coating
10	☉	P, M	landscape sites within parking areas before grade
11	☉	P, M	grade retention
12	☉	—	retention to filter/less drain
13	☉	M	use vegetation to prevent soil loss
14	☉	P, M	install site access erosion
15	☉	P, M	avoid wet soil erosion
16	☉	P, M	use treatment pond for landscape water
17	☉	M	water conservation fixtures
18	☉	P, M	subsurface flow treatment
19	☉	M	hard soil made treatment (landscape)
20	☉	M	detention basins attached to treatment (landscape at all sites)
21	☉	M	oil spill collection for treatment system (oil slick & landscape)
22	☉	P, M	NOx trading program (oil slick)
23	☉	M	empty water control



T6 Illustration by James Wessell

WATER



### Table Legend

- ☉ Sustain
- ☉ No-Sustain

Sustainable Businesses  
at West & Transit zones

- P - Produce
- S - Soil
- M - Maintain

Water balance at Varadero through most transects fits into two primary types: 1) meeting precipitation condition of a 1" rainfall, and 2) meeting extreme 100 year flash flood conditions. The first condition operates under the assumption that full balance can occur on site and the second that same can occur on site but measures will be needed to absorb significant flood waters using surface lakes and ponds on and off site to absorb these extremes. Condition one, as with other life cycle balancing, occurs according to partial balance - matching need with collection or matching need with collection and treating that water quality on site to a level equivalent or superior to the incoming water quality.

WATER BALANCE AND MORE BY THE ECO-BALANCE





# Health Balance - Best Management Practices In Transect Zone T3



6. Microbial based waste water treatment



10. Business Zoning



23. Community garden



22. Household composting

ECO-BALANCE HEALTH CHART FOR T3			
Code	S/R	SB	Best Management Practices
1	☉		vegetable isolation of open spaces, yards
2	☉		Noe absorption controls
3	☉	M	soil infiltration capabilities include TCD & CD
4	☉		retarded CO2 combustion type
5	☉	M	retarded evaporation to wet CO2 & CO2 (walk, cycle, bicycle)
6	☉	M	retarded based waste water treatment (best available)
7	☉	M	soil based waste water treatment (best available)
8	☉	S, M	UV in chlorine purification
9	☉	S, M	UV available in chlorine purification
10	☉	P, S, M	rain water harvesting
11	☉		avoid all PVC's
12	☉		public walkway components
13	☉		avoid petroleum products
14	☉	P, M	temporary storage for lawn care, pesticides, insecticides, herbicides
15	☉		greenway walkways
16	☉		public walkway walkways
17	☉		expanding walkway network
18	☉	M	low public walkway walkways
19	☉		accessible routes
20	☉		vegetable lawn gardens
21	☉	P, M	biogas methane
22	☉	M	water landscape
23	☉		community garden
24	☉		legible outdoor accessibility
25	☉		legible views
26	☉		recycling
27	☉	M	recovered lawn care
28	☉		life cycle cost/benefit ratio
29	☉		water recycling public areas
30	☉		vertical advertising regional look
31	☉		vertical outdoor regional patterns
32	☉	S	household composting/vermiculite
33	☉	P, S, M	leaf compost
34	☉	P, M	lawn care
35	☉	M	lawn care

### Table Legend

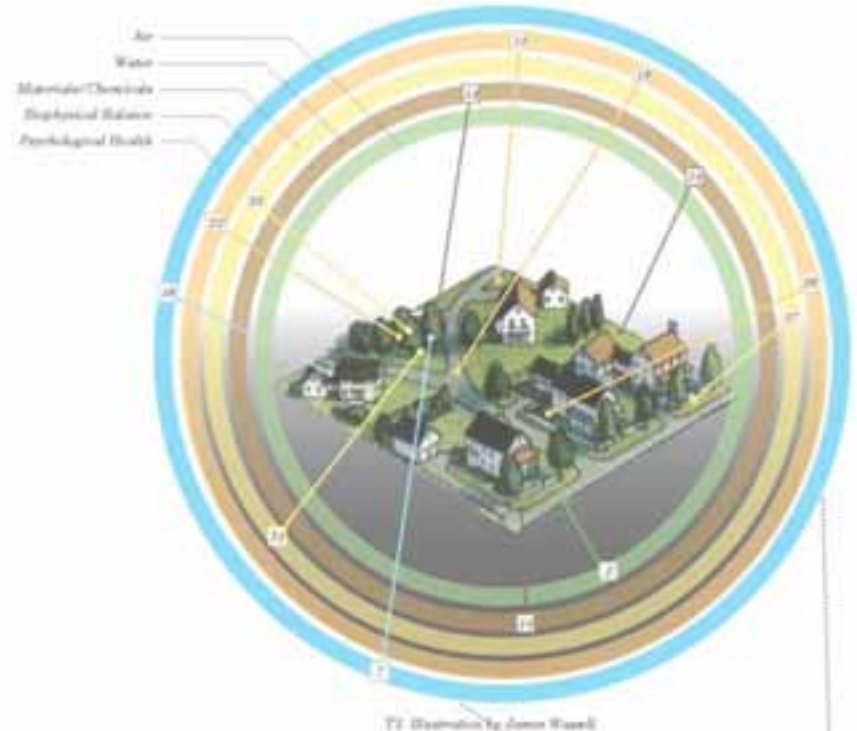


Sustainable Businesses  
at new & transit zones

P - Produce

S - Soil

M - Maintain



T3 Distribution by James Ward

HEALTH

Life Cycle Definition - In Ecobalance terminology, the health of the community relates to many different simultaneous balances such as energy balance, which reduces planetary carbon. Water balance enables a constantly improving quality and supply of water. More specifically, health balance at Verano fits three specific conditions: 1) avoidance of PBTs (persistent bio-accumulative toxic) chemicals such as mercury, cadmium, and a variety of plasticizers; 2) full cycle balancing such as easily accessible walking paths resulting in an increase of cardiovascular health; and 3) full cycle balancing such as the use of Living Machines to eradicate vectors that cause west Nile, malaria, (pesticides) while producing high quality organic fertilizers that in turn replace more chemicals in the landscape.

HEALTH BALANCE AND THE ECO-BALANCE



# Health Balance - Best Management Practices In Transect Zone T6



3 & 20 Magnolia plantations



8 Vertical greening green walls



11 Microbial based wastewater treatment



43 Outdoor meeting/public art

ECO-BALANCE HEALTH CHART FOR T6			
Code	S/R	SB	Best Management Practices
1	M		avoidance of use of gas
2	M	M	check building for maintenance issues: CO2 & CO
3	M		avoidance of PF
4	M		eliminate mercury use: CFL & CFL
5	M	P, S, M	energy flow assessment: CFL, CFL & CFL needed
6	M		low building setbacks
7	M	P	low storm & sewerage
8	M	P, S	walls of growing green walls
9	M	P, S	leached soils: lead in buildings (PVC)
10	M		walk-up library available systems
11	M		recycled liquid waste: water in building
12	M		plant treatment: water: water treatment
13	M		TV in children: public art
14	M		CO2 analysis in building: walk-up
15	M	M	low water landscaping
16	M	P, S	walls of plant wastewater treatment
17	M		avoid PF's
18	M		avoid use of building components
19	M		avoid petroleum: avoid use
20	M		avoidance: bring in trees: trees, shrubs, flowers, materials
21	M	P, S	low water: avoid excessive watering: water treatment
22	M	P, S, M	high water: avoid excessive watering: water treatment
23	M	P, S	energy flow: assessment: avoid use of materials
24	M		avoidance of building: avoid building
25	M	M	avoidance: avoid use
26	M		avoidance: avoid use
27	M	M	avoidance: avoid use
28	M	M	avoidance: avoid use
29	M	M	avoidance: avoid use
30	M	P, S, M	avoidance: avoid use
31	M	M	avoidance: avoid use
32	M	P, S, M	avoidance: avoid use
33	M	P, S, M	avoidance: avoid use
34	M		avoidance: avoid use
35	M	P, S	avoidance: avoid use
36	M	P, S	avoidance: avoid use
37	M	P, S	avoidance: avoid use
38	M		avoidance: avoid use
39	M		avoidance: avoid use
40	M		avoidance: avoid use
41	M		avoidance: avoid use
42	M		avoidance: avoid use
43	M		avoidance: avoid use
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48	M		avoidance: avoid use

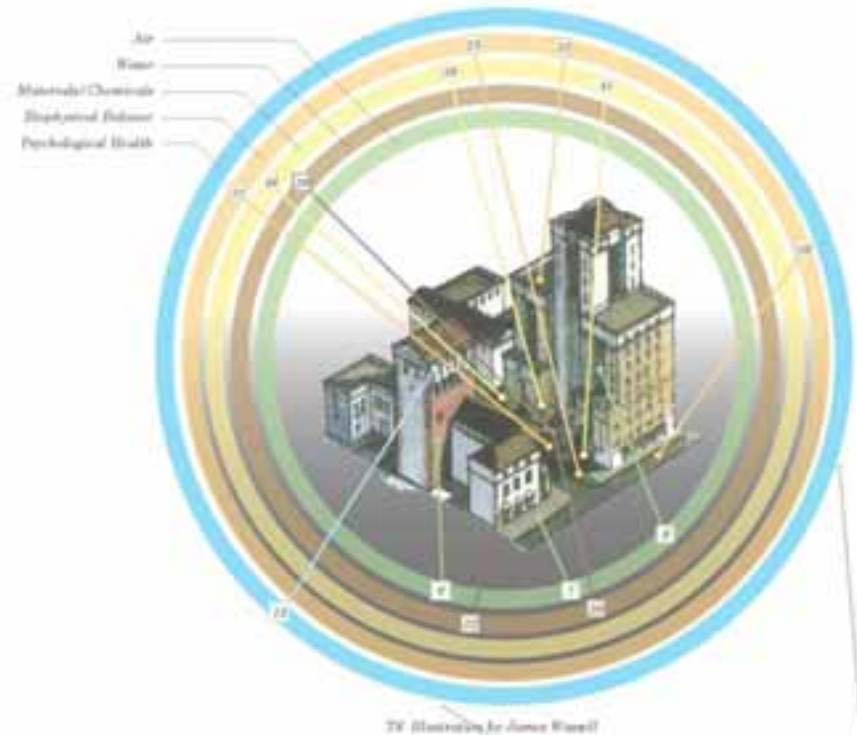
### Table Legend

- Source
- Re-Source

Sustainable Businesses at new & targeted zones

- P - Produce
- S - Sell
- M - Maintain

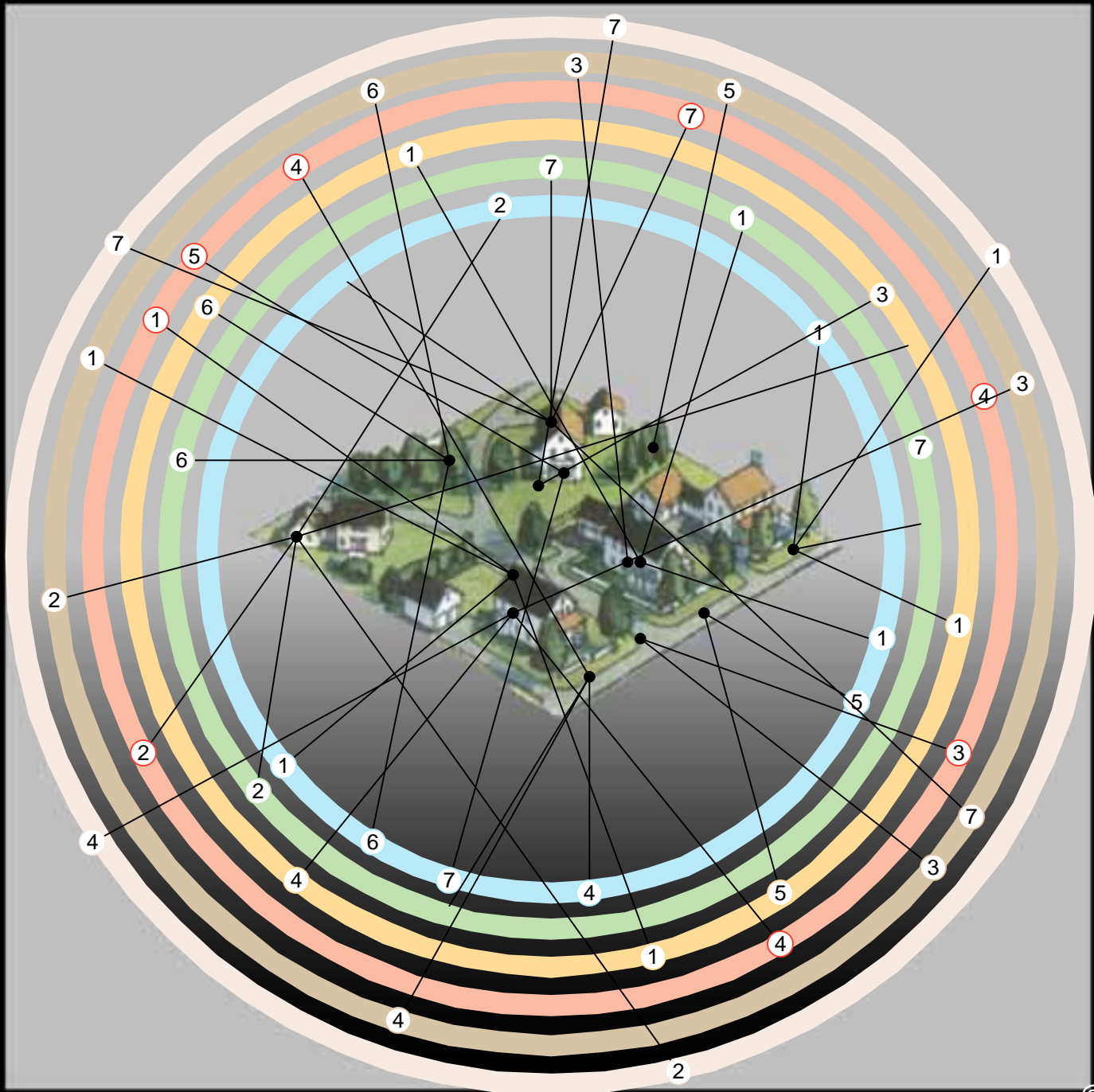
Life Cycle Definition - In Ecobalance terminology, the health of the community relates to many different simultaneous balances such as energy balance, which reduces planetary carbon. Water balance enables a constantly improving quality and supply of water. More specifically, health balance at Vireo fits three specific conditions: 1) avoidance of PF's (persistent bio-accumulative toxic) chemicals such as mercury, cadmium, and a variety of plasticizers; 2) full cycle balancing such as easily accessible walking paths resulting in an increase of cardiovascular health, and 3) full cycle balancing such as the use of Living Machines to eradicate vectors that cause west Nile, malaria, (periodic) while producing high quality organic fertilizers that in turn replace more chemicals in the landscape.



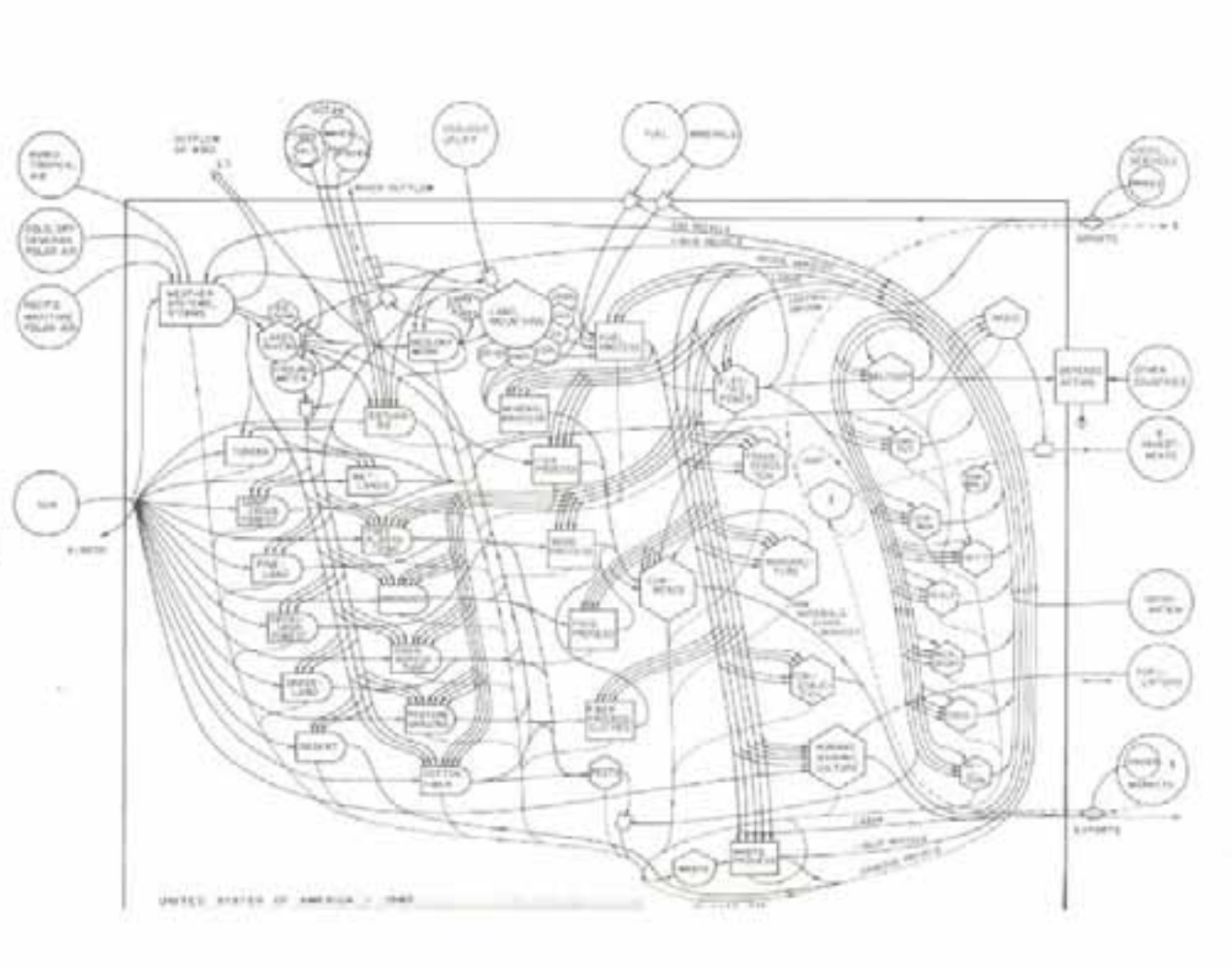
HEALTHY



ECO-BALANCE HEALTH CHART FOR T6

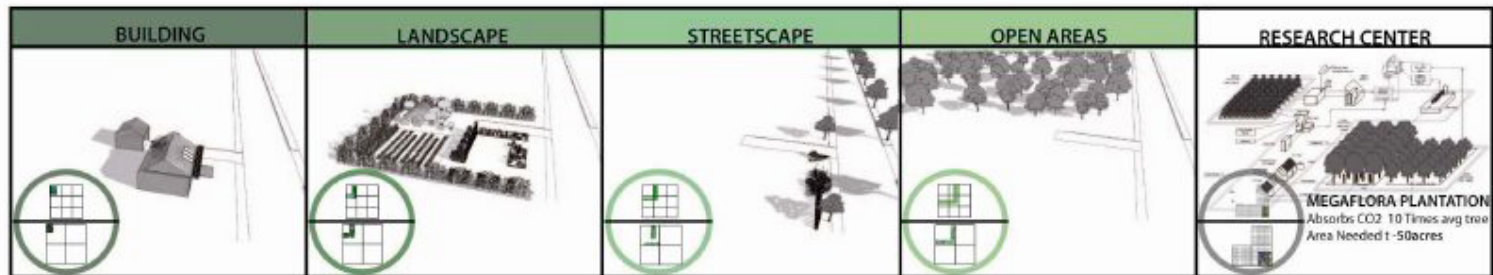
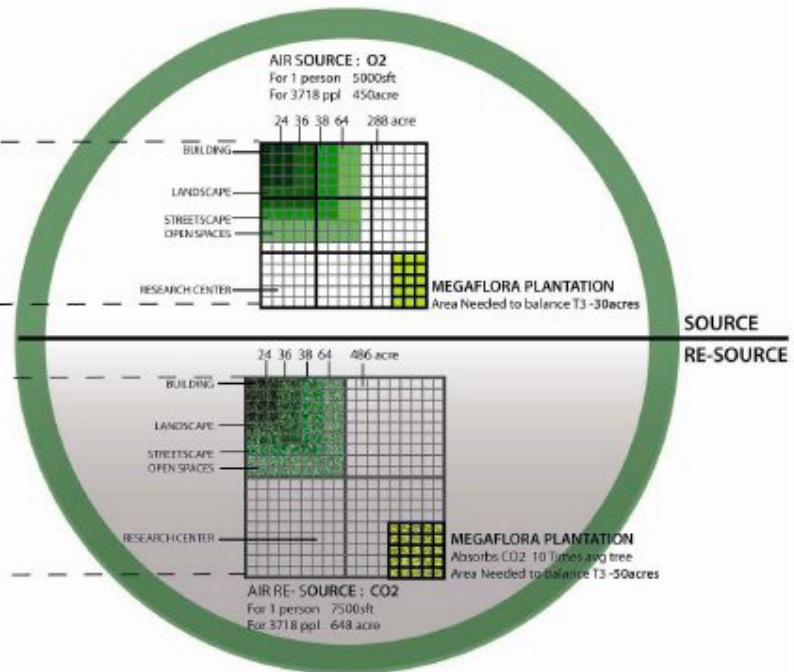
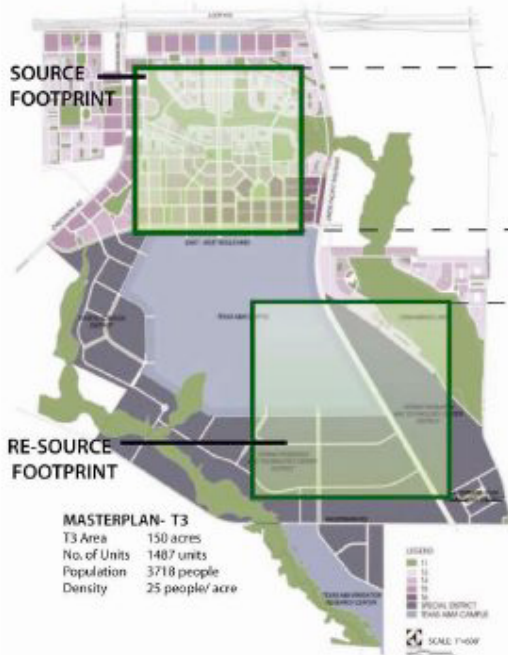






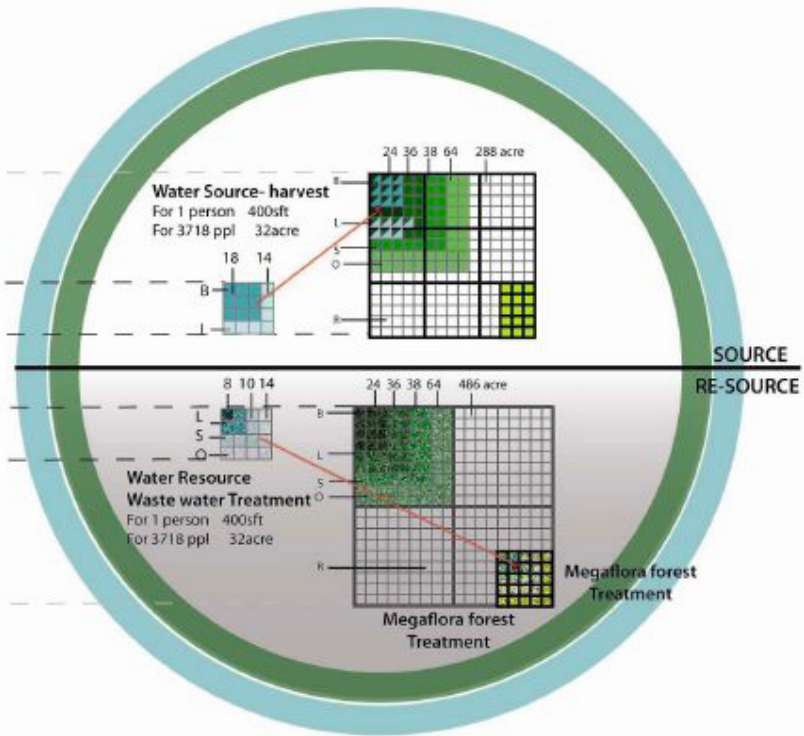
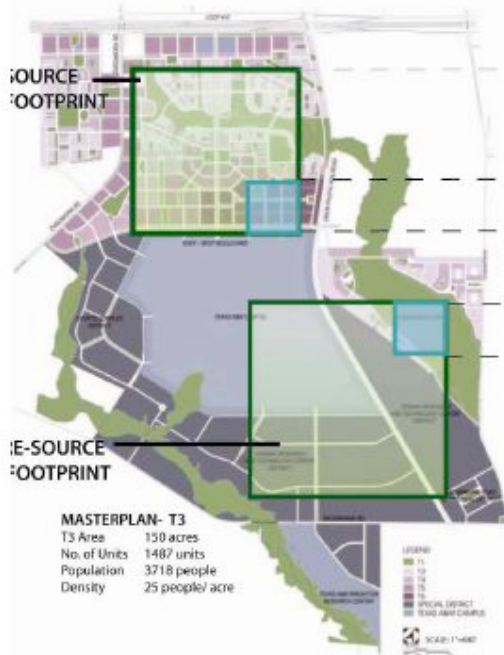
# AIR

## FOOTPRINT AREAS FOR T-3



# AIR+WATER

## FOOTPRINT AREAS FOR T-3

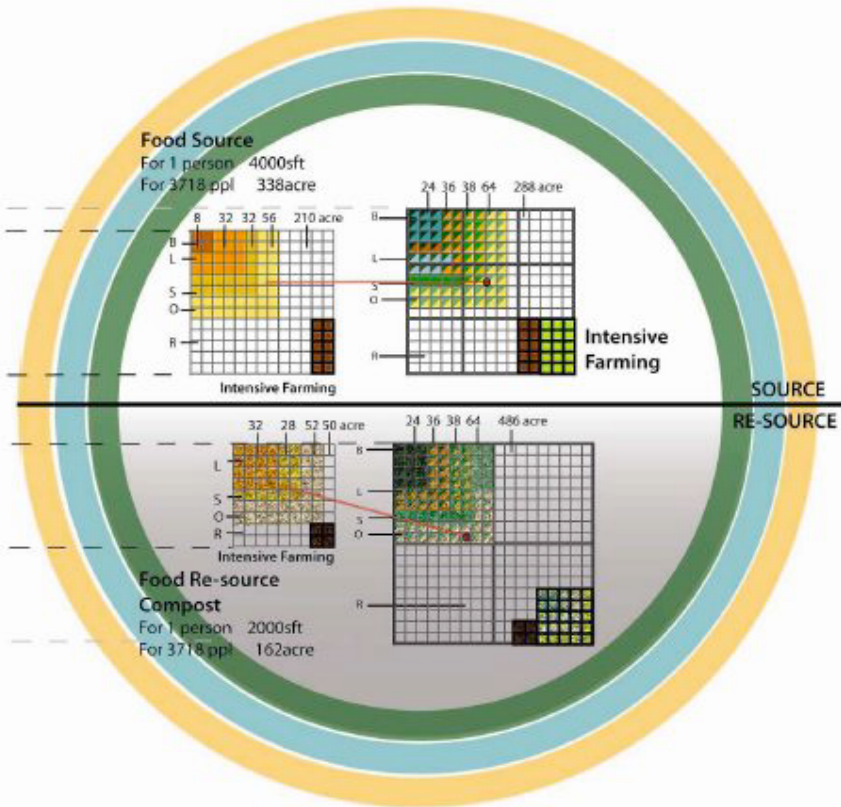
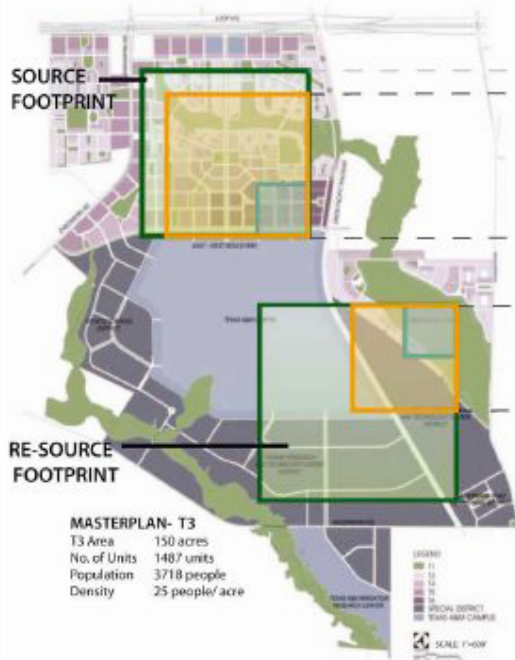


BUILDING	LANDSCAPE	STREETSCAPE	OPEN AREAS	RESEARCH CENTER



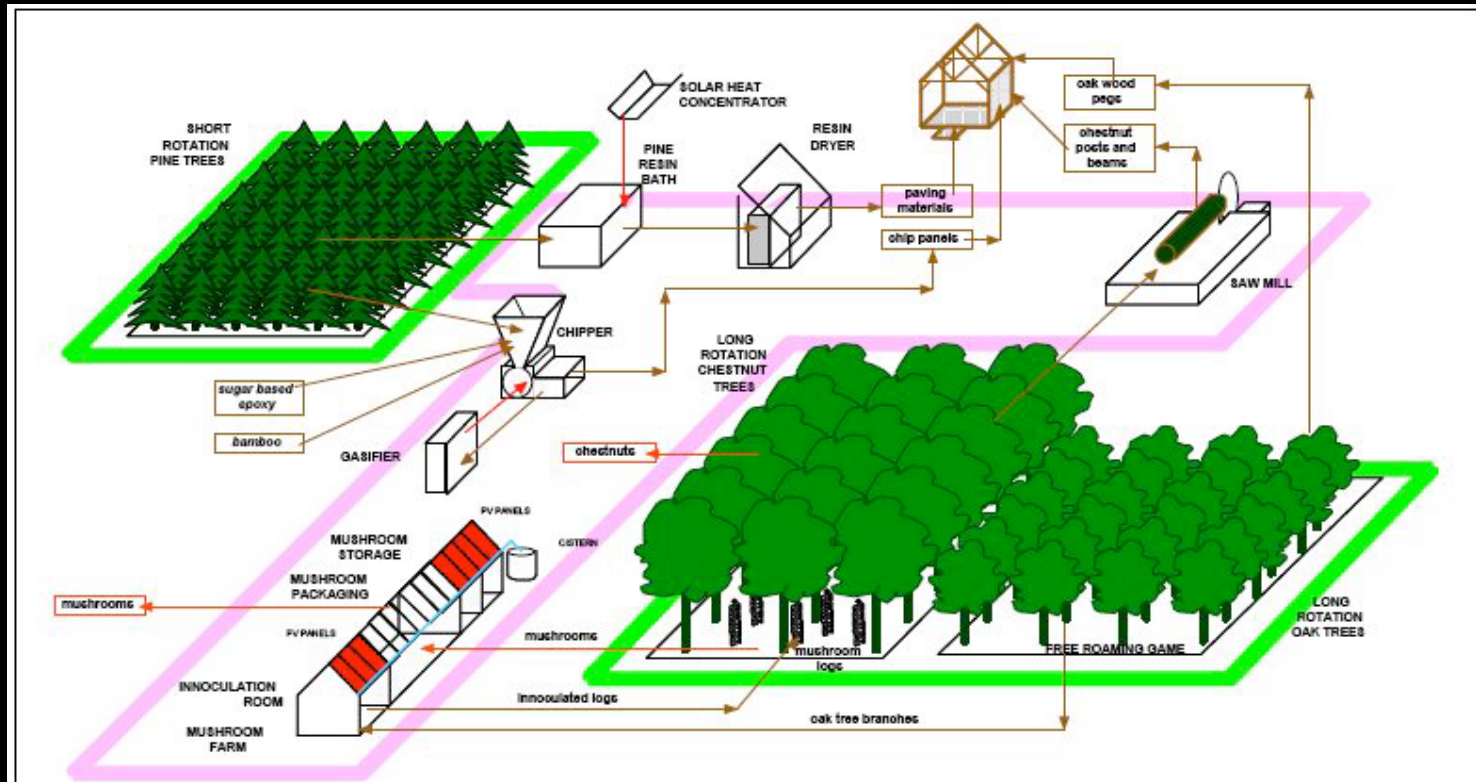
# AIR+WATER+FOOD

## FOOTPRINT AREAS FOR T-3



BUILDING	LANDSCAPE	STREETSCAPE	OPEN AREAS	RESEARCH CENTER



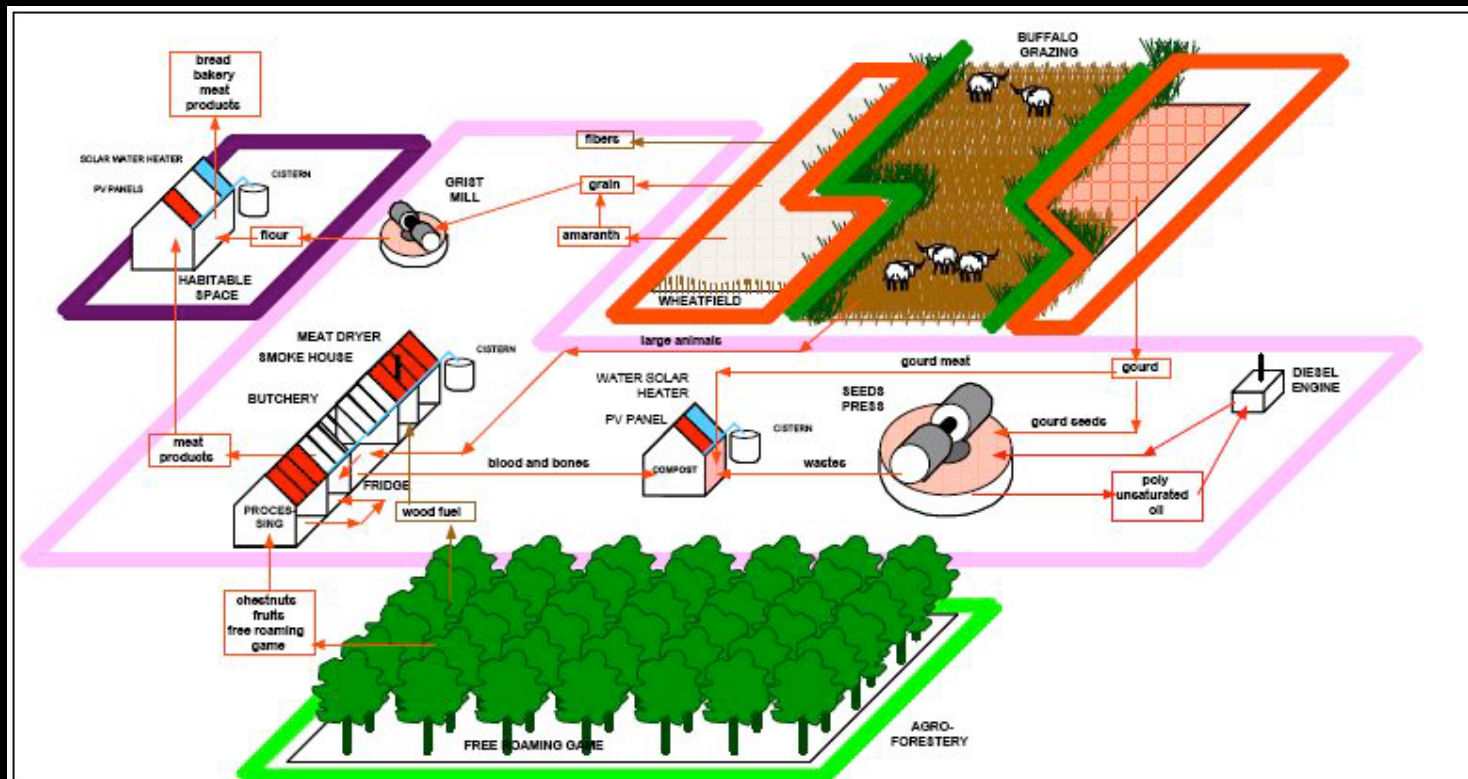


IMPORT FROM OTHER CLUSTERS	sugar based epoxy bamboo fiber	EXPORT TO OTHER CLUSTERS	chestnuts mushrooms small game building materials
IMPORT FROM OUTSIDE		EXPORT OUTSIDE	chestnuts mushrooms small game building materials

AIR/MATERIAL INTEGRATED FARM

## RESEARCH AREA

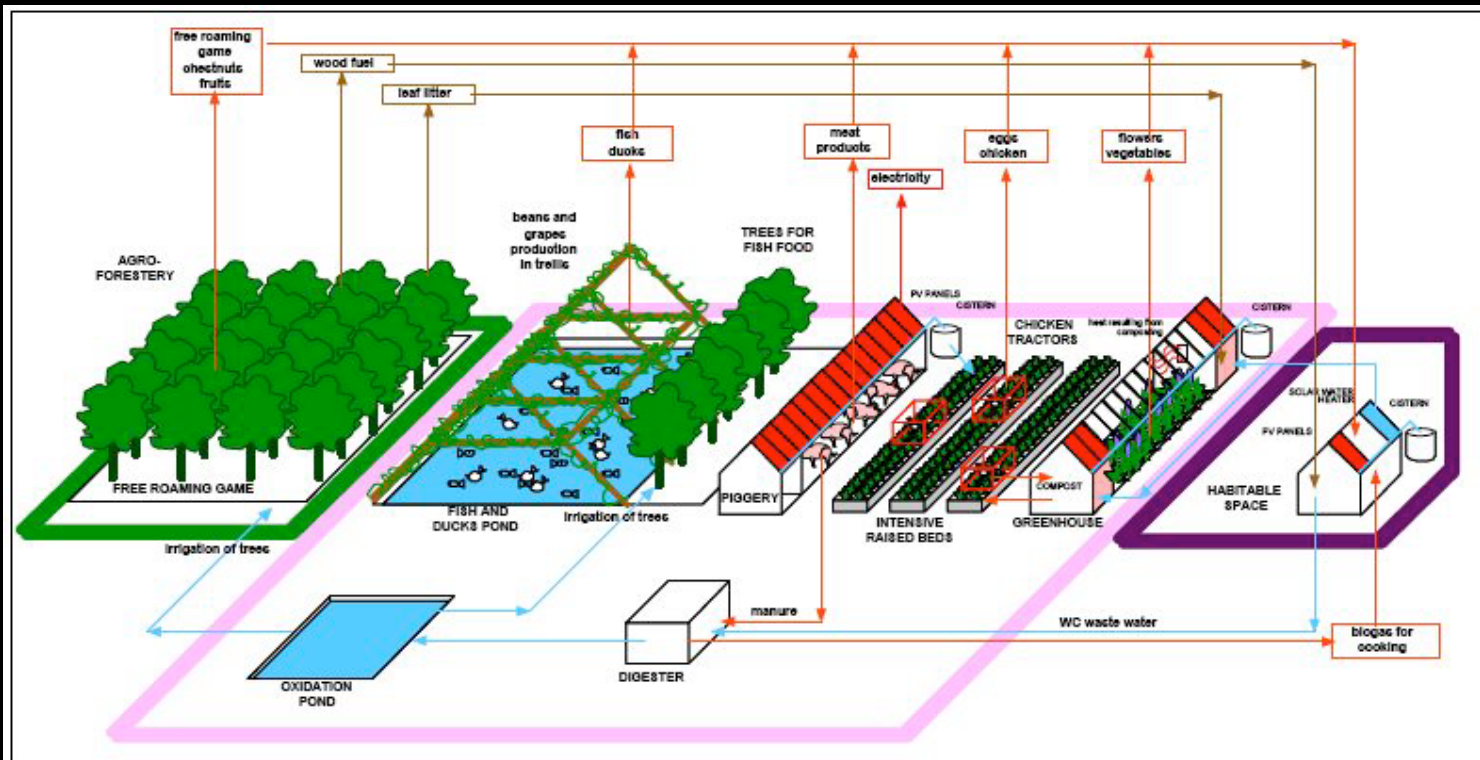




IMPORT FROM OTHER CLUSTERS	building materials eggs, poultry, ducks, small game	EXPORT TO OTHER CLUSTERS	meat products biofuel chestnuts fiber, grain, bakery
IMPORT FROM OUTSIDE		EXPORT OUTSIDE	meat products biofuel chestnuts fiber, grain, bakery

ENERGY/FOOD INTEGRATED FARM

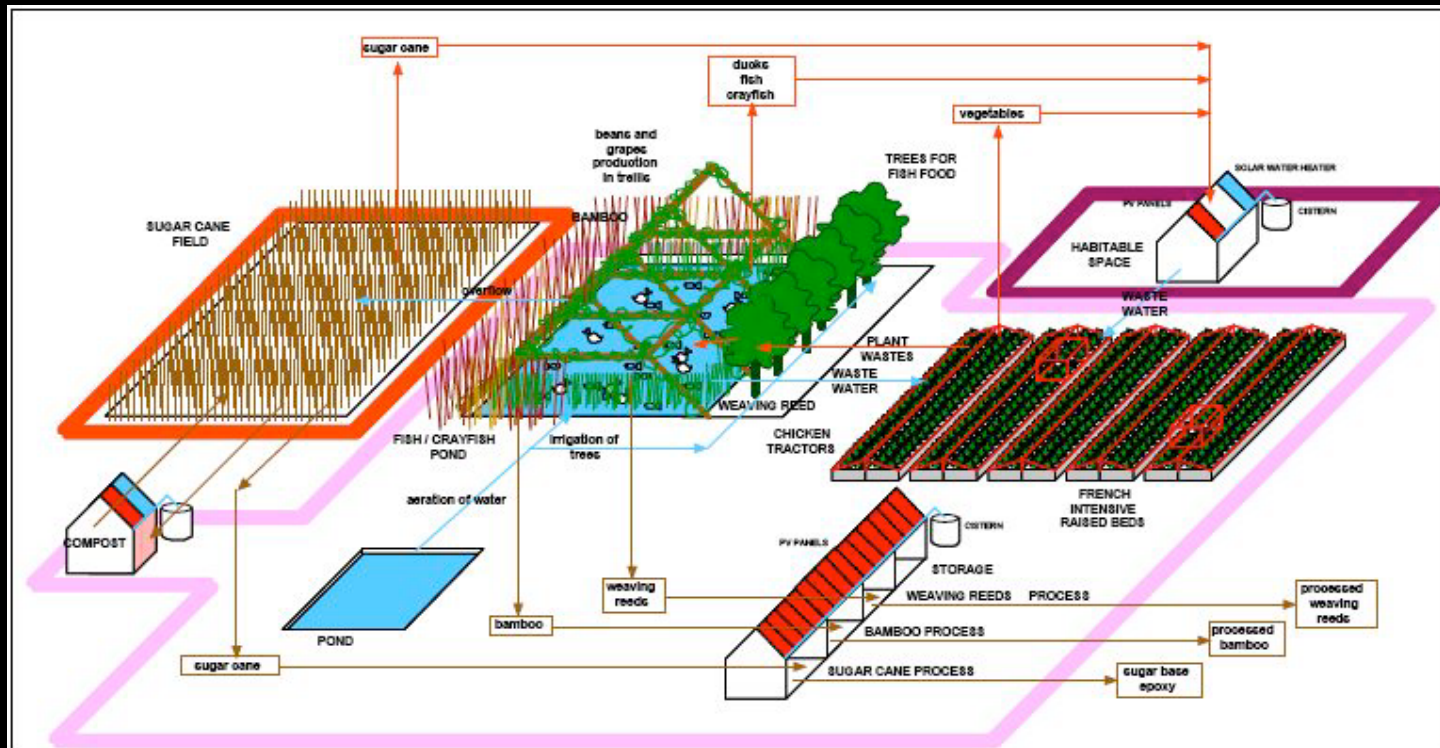
## RESEARCH AREA



IMPORT FROM OTHER CLUSTERS	building materials	EXPORT TO OTHER CLUSTERS	eggs, poultry, ducks pork biofuel, electricity fish, crayfish flowers and vegetables, chestnuts
IMPORT FROM OUTSIDE		EXPORT OUTSIDE	eggs, poultry, ducks pork biofuel, electricity fish, crayfish flowers and vegetables, chestnuts

FOOD/WATER INTEGRATED FARM

RESEARCH AREA



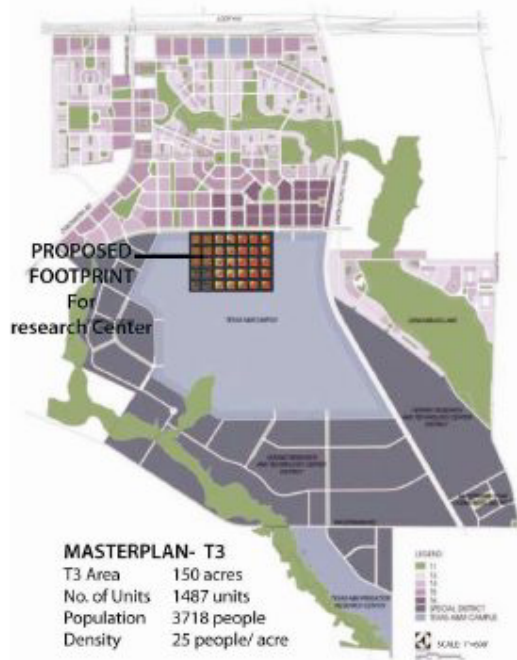
IMPORT FROM OTHER CLUSTERS	biofuel building materials	EXPORT TO OTHER CLUSTERS	eggs, poultry, ducks sugar cane, sugar based epoxy bamboo, weaving reeds fish, crayfish flowers and vegetables
IMPORT FROM OUTSIDE		EXPORT OUTSIDE	eggs, poultry, ducks sugar cane, sugar based epoxy bamboo, weaving reeds fish, crayfish flowers and vegetables

MATERIAL/FOOD INTEGRATED FARM

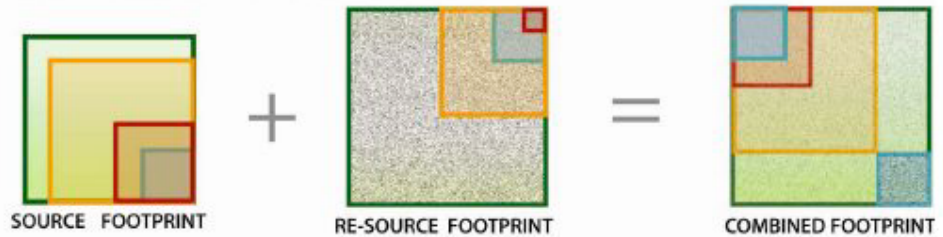
RESEARCH AREA

# AIR+WATER+FOOD+ENERGY

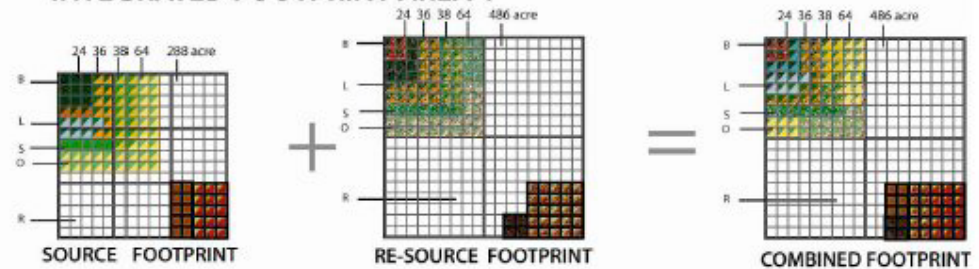
COMBINED FOOTPRINT AREA FOR T-3



## UNTEGRATED FOOTPRINT AREA :



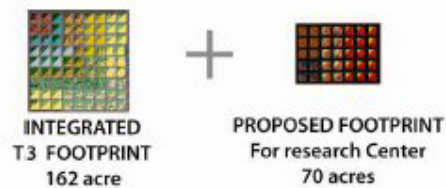
## INTEGRATED FOOTPRINT AREA :



### RESEARCH CENTER USAGE

Megaflora plantation	50acres
-O2 supply/Carbon sink	
-Waste water treatment	
-BiomassFuel / Biochar	
Intensive Farming	20acres

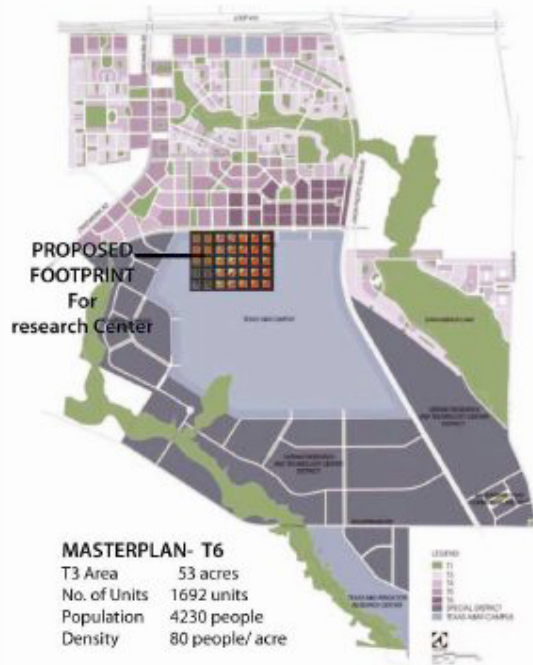
## ACTUAL FOOTPRINT REQUIRED TO BALANCE T3:



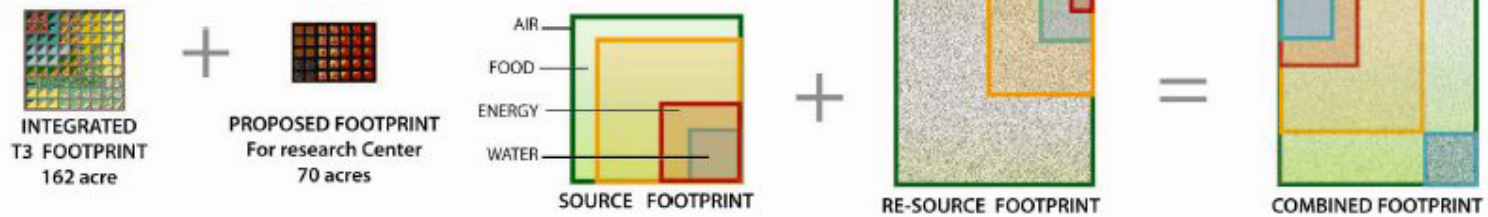


# AIR+WATER+FOOD+ENERGY

COMBINED FOOTPRINT AREA FOR T-3

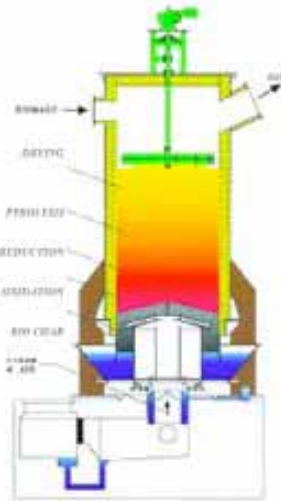


ACTUAL FOOTPRINT REQUIRED TO BALANCE T3:



# Energy bio waste material Food Conversion processes level T6

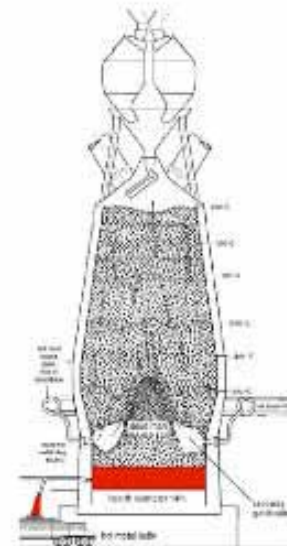
## VERTICAL BIO-SYSTEMS



BIOCHAR KLIN



ERP THOMAS  
BIODIGESTER

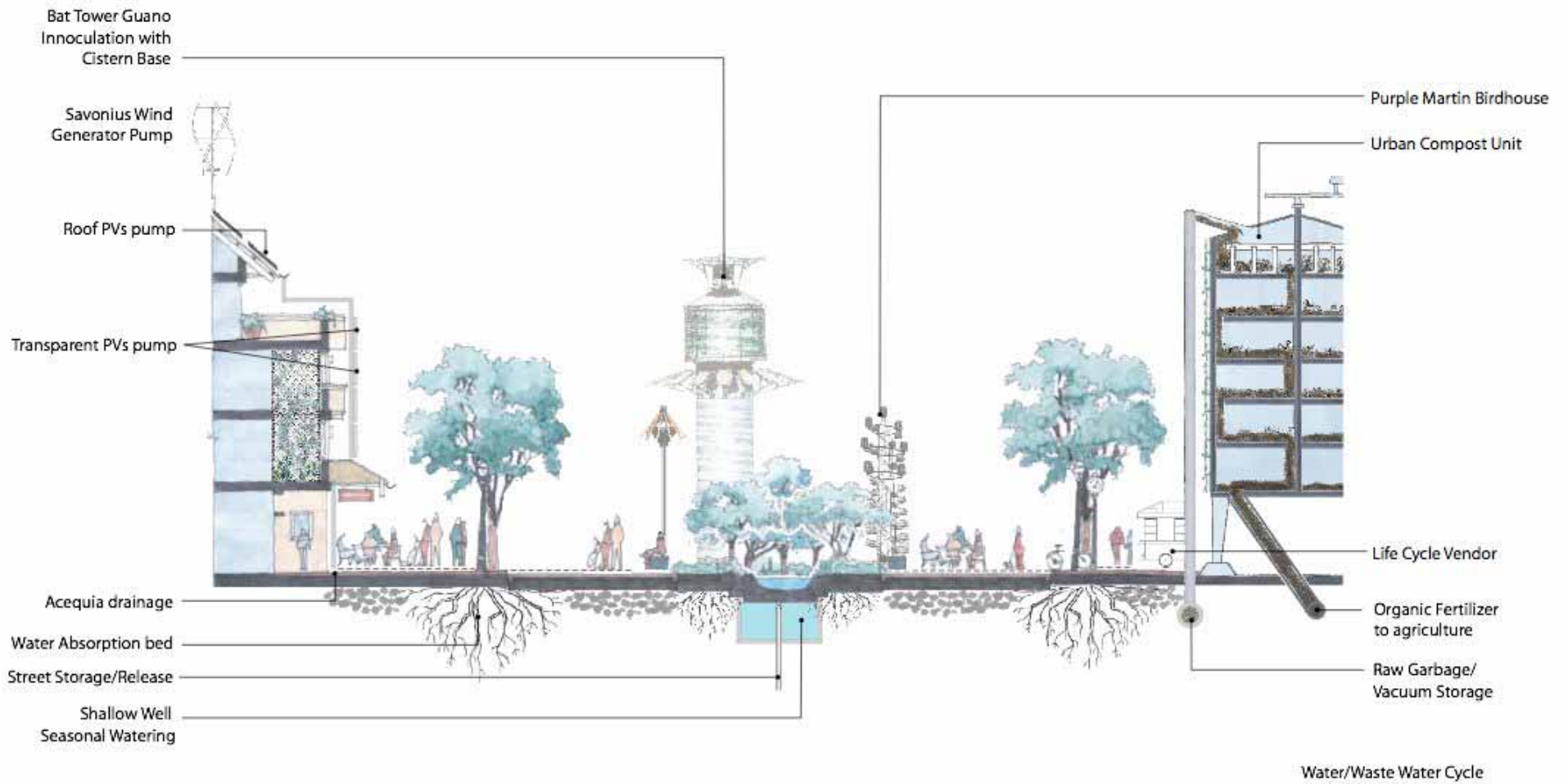


BIOSTEEL PLANT



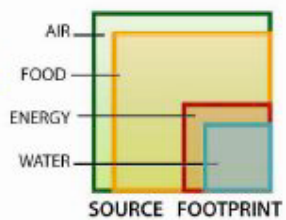
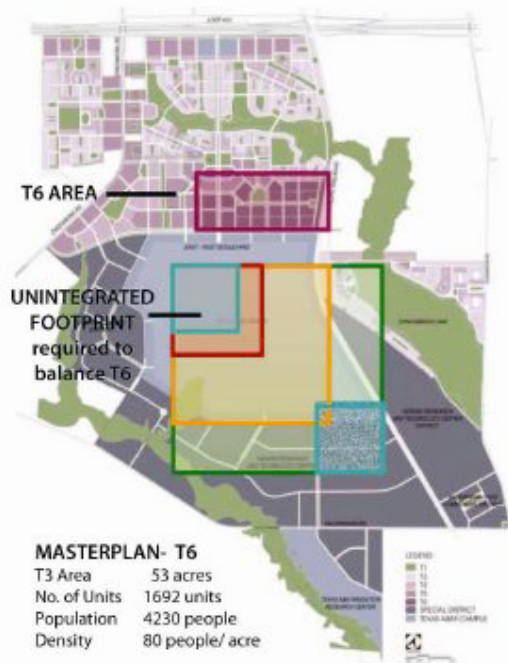
CHRIS JACOB  
VERTICAL FARMS



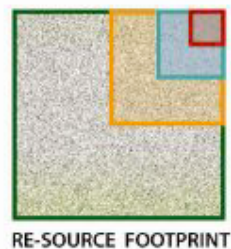


# AIR+WATER+FOOD+ENERGY

COMBINED FOOTPRINT AREA FOR T-6



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**MAIN PLAZA AND CENTRAL PARK AT TOWN CENTER**







**RAIL TRANSIT STATION**





SULPHUR SPRINGS NEIGHBORHOOD CENTER







PEDESTRIAN PROMENADE

