

Infraestructura verde:  
Oportunidades de sostenibilidad socio-ecológica y  
mitigación de inundaciones en el  
Municipio de San Juan

*Arq. Psj. José Juan Terrasa Soler*

*The Office of Marvel & Marchand Architects LLP*

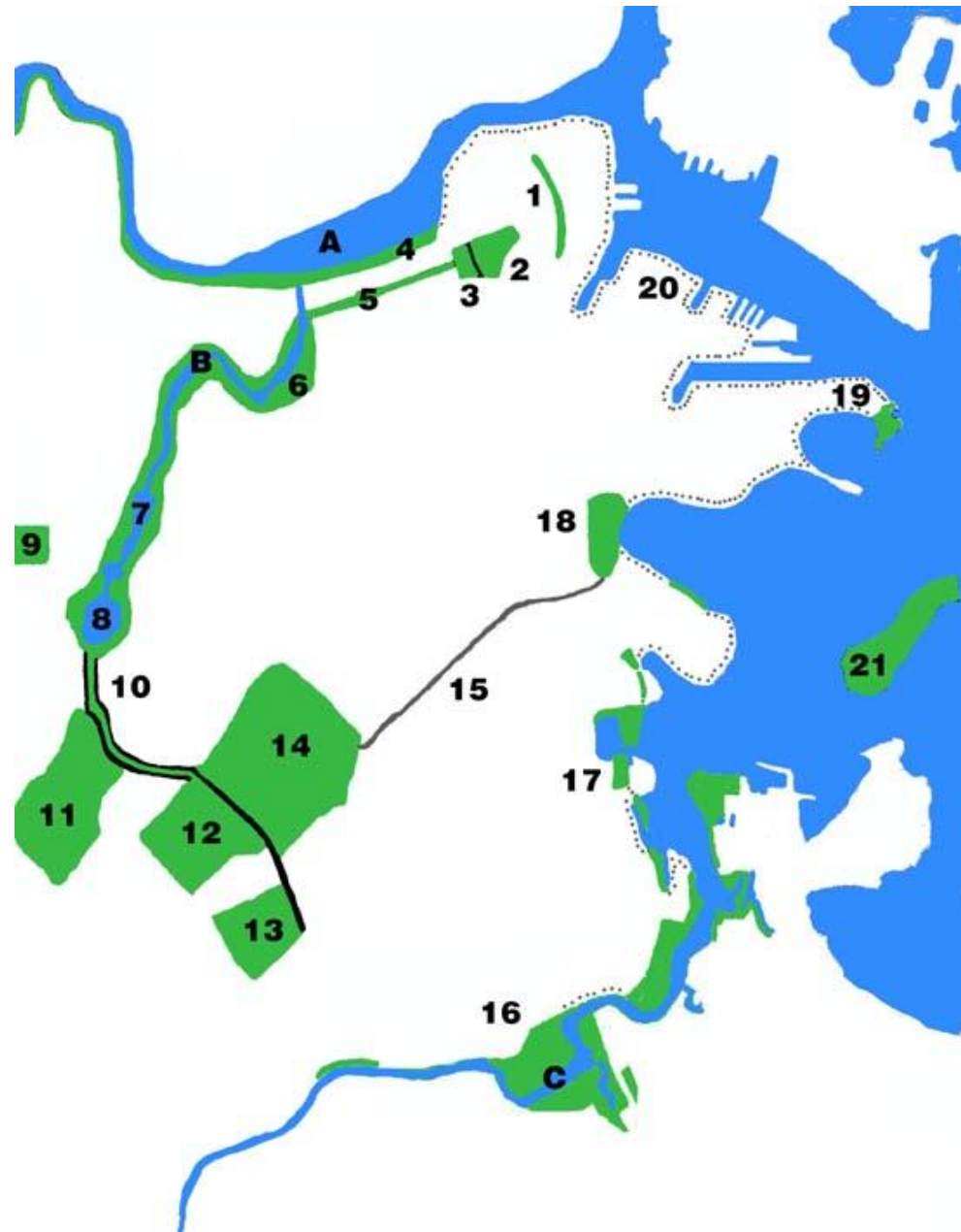
*Santurce, Puerto Rico*

“INFRAESTRUCTURA”

“GRIS” vs “VERDE”

“CYBORG”

Frederick Law Olmsted  
Emerald Necklace, Boston  
1878





# EMERALD NECKLACE *parks*

**WALKING AND RUNNING DISTANCES**  
If you would like to add physical activity to your daily life, the Emerald Necklace offers beautiful paths that are convenient to different neighborhoods. Here are a few suggestions. Distances are approximate.

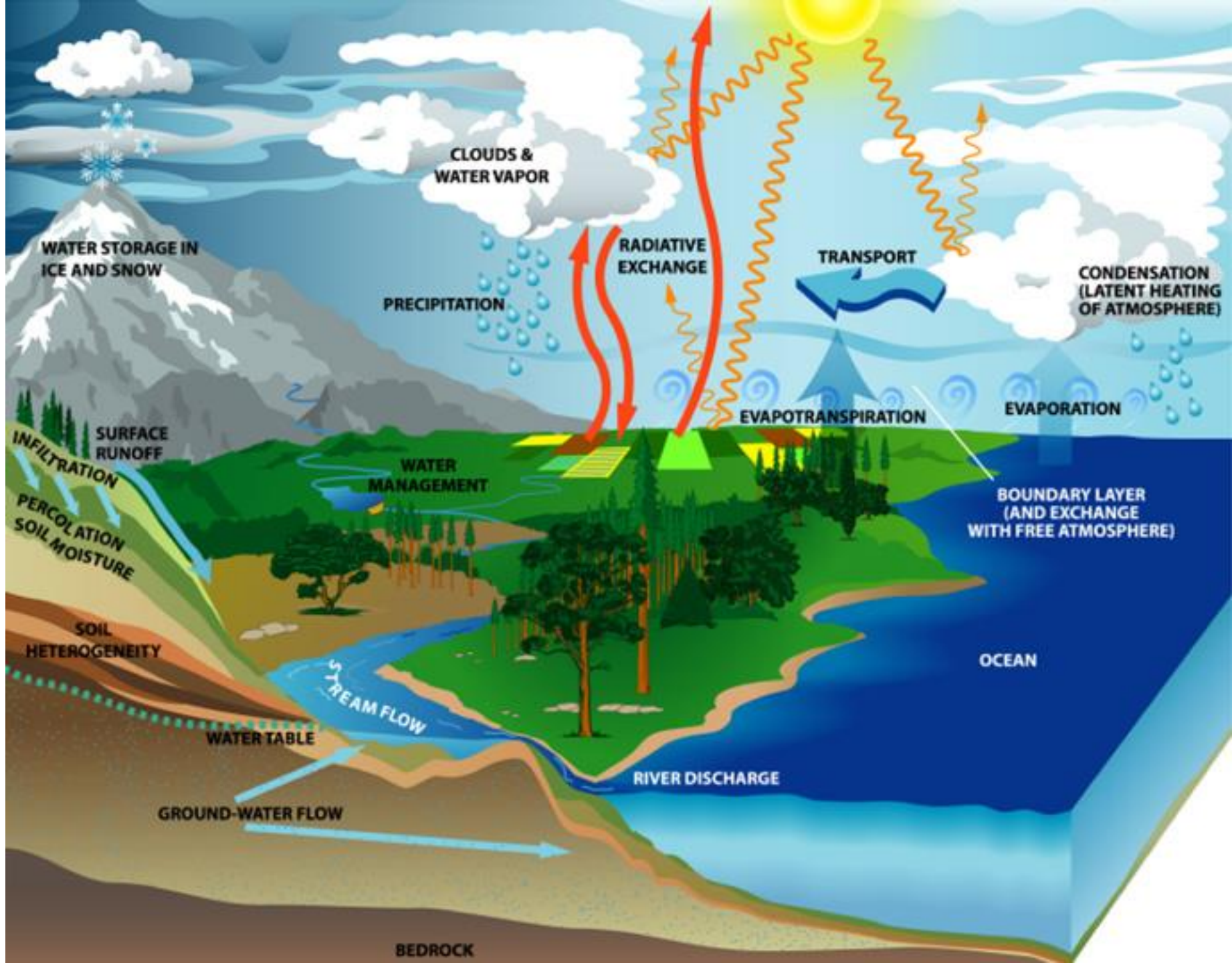
- Public Garden, at Charles St. to Charlestown East: roundtrip 2.5 miles
- Back Bay Fens Loop (Ely/Johnston Baywalk Bridge ⑪ & Ave Louis Pasteur): roundtrip 1.5 miles
- Riverway Loop (Fenway T Station to Netherlands Road): roundtrip 1.5 miles
- Leverett Pond Loop (Good for families with small children): roundtrip 2 miles
- Jamaica Pond Circumference: 1.5 miles
- Arnold Arboretum, Husewell Blvd ⑬ to Parker Hill Summit ⑩: roundtrip 2.5 miles
- Franklin Park Walking Loop: 2.5 miles

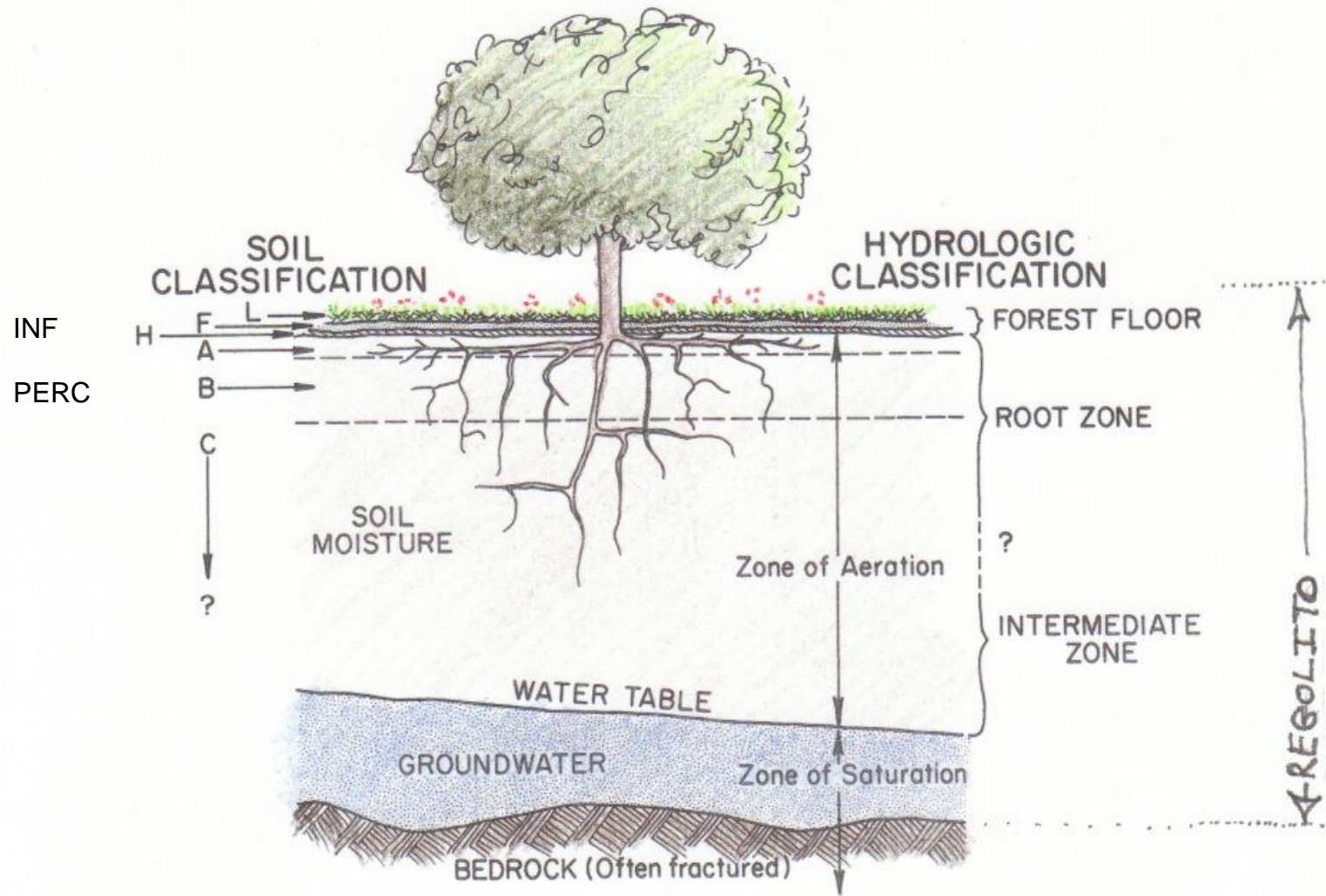


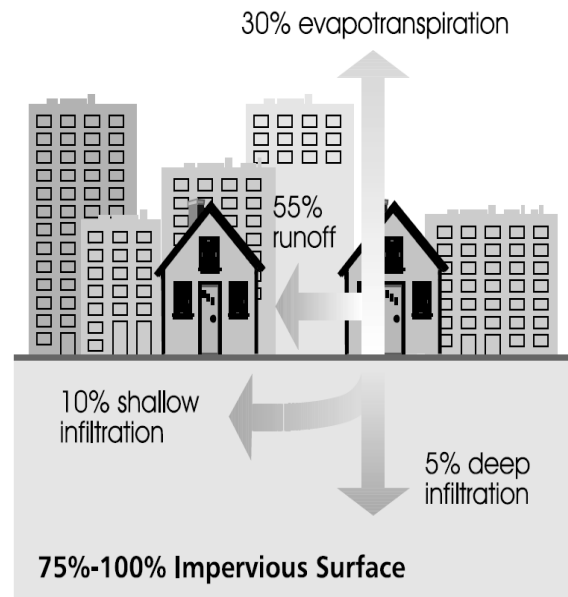
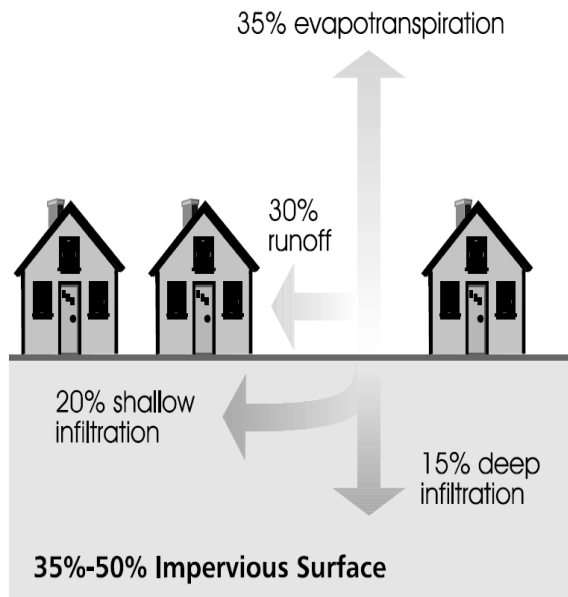
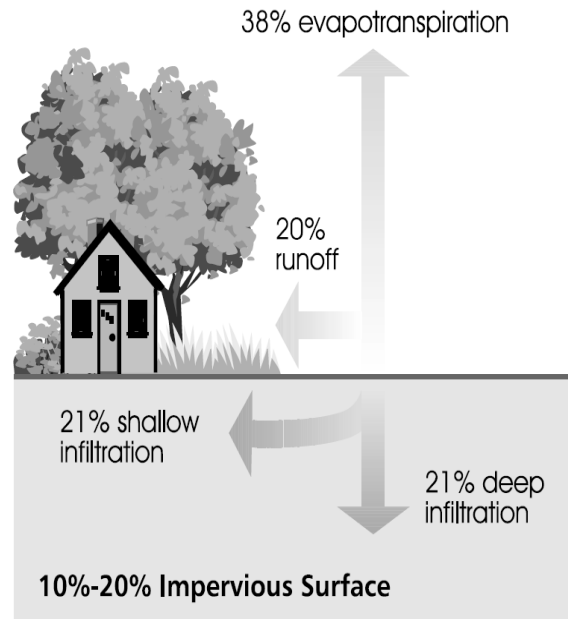
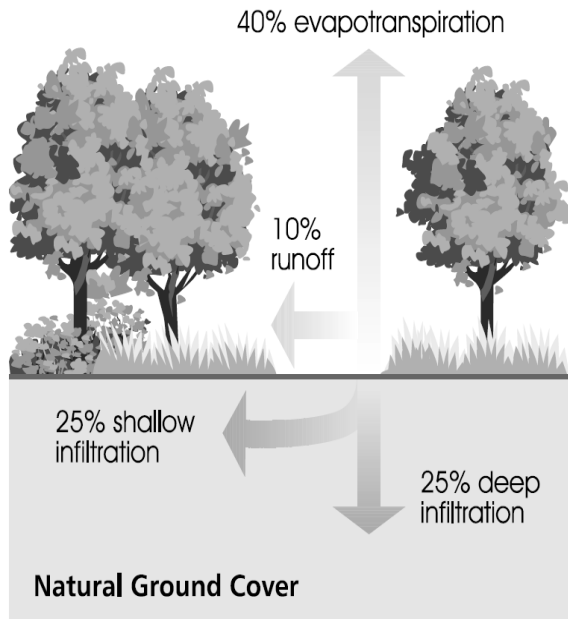
## LEGEND

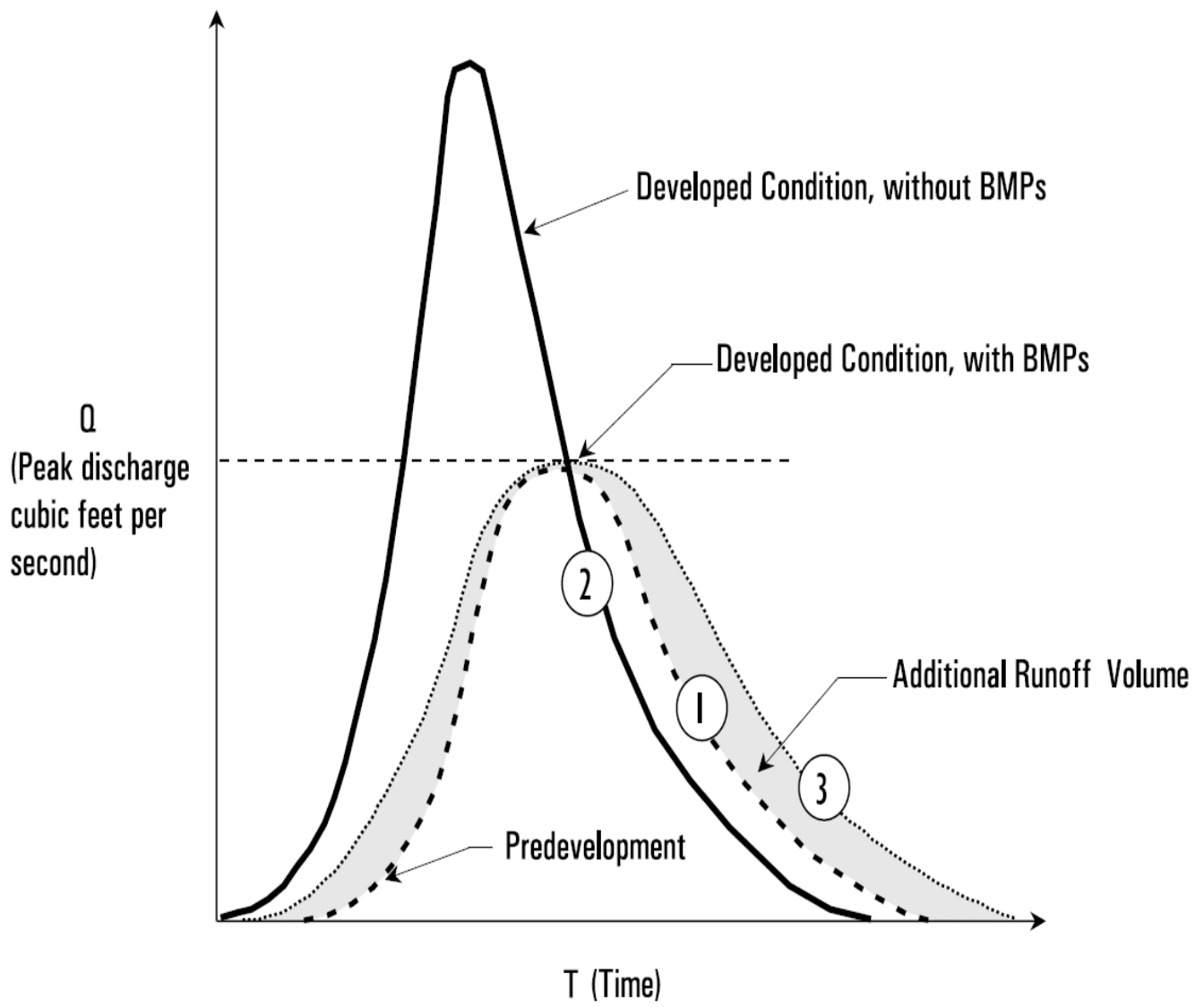
- |  |  |   |
|--|--|---|
|  |  |   |
|  |  |   |
|  |  |   |
|  |  |   |
|  |  | <small>Regulations: Please see posted regulations because they vary from park to park to ensure that the park design meets its needs.</small> |
|  |  |   |
|  |  |   |



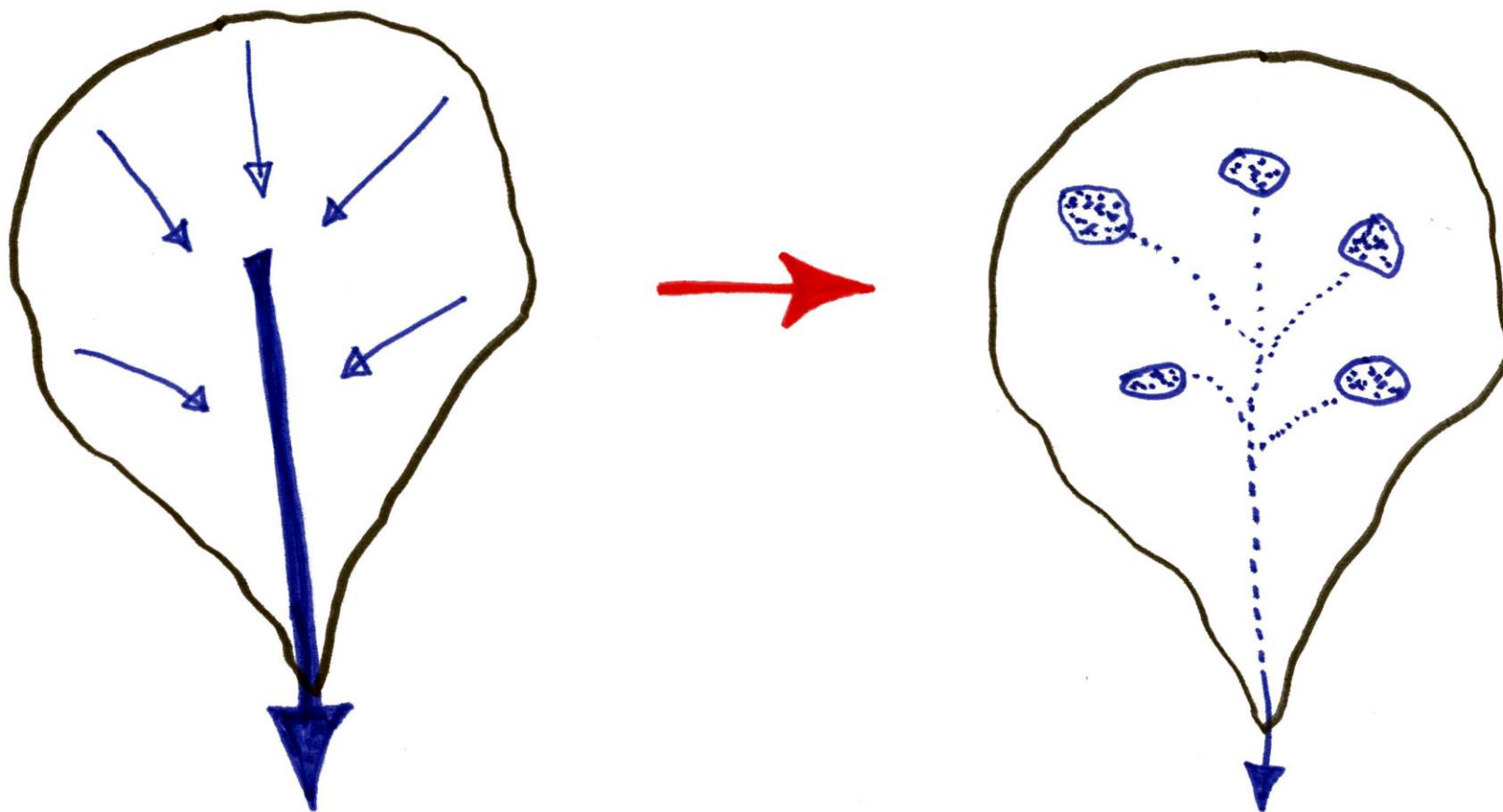






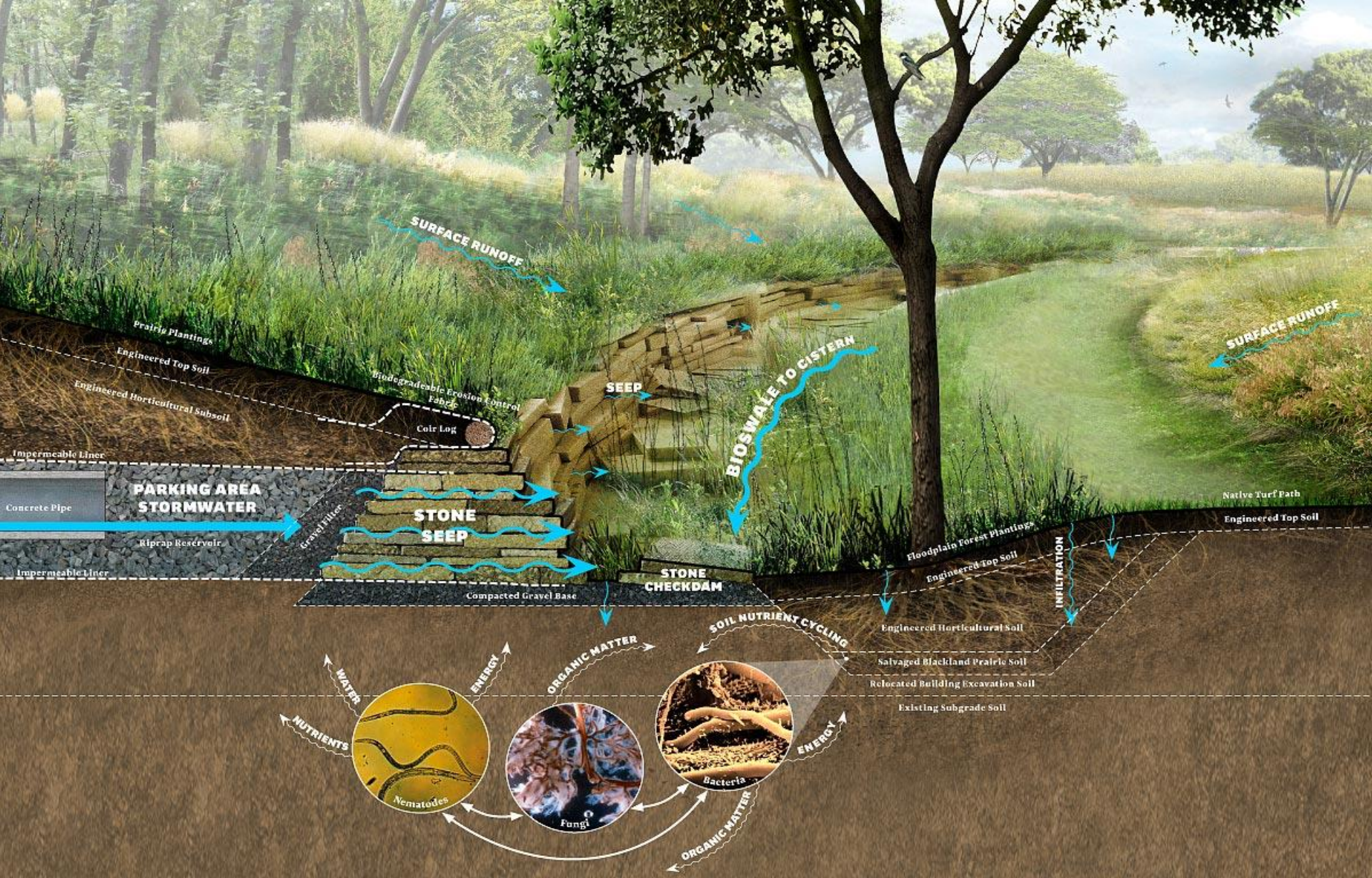




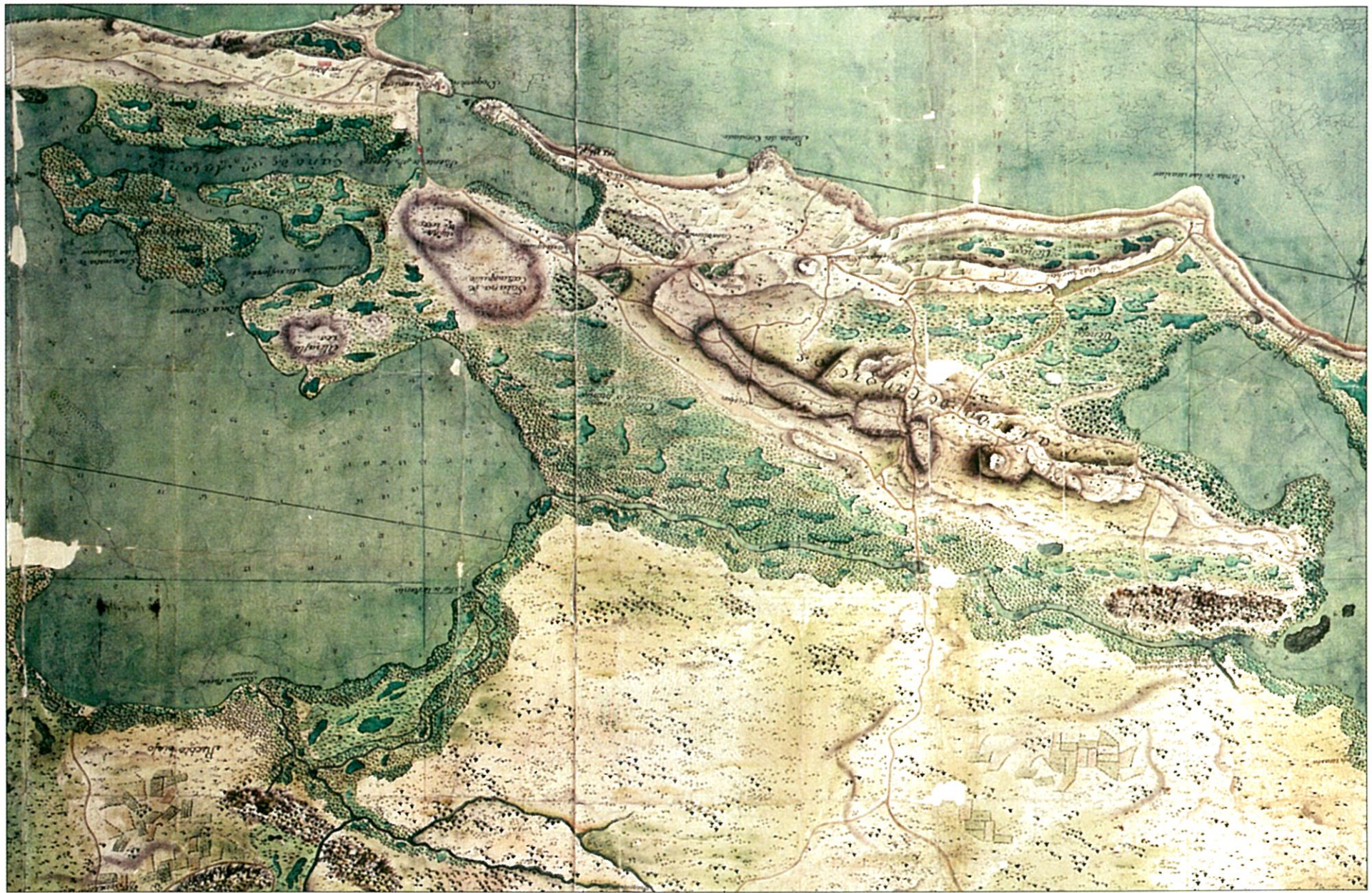


Estrategia fundamental es desagregación hidrológica

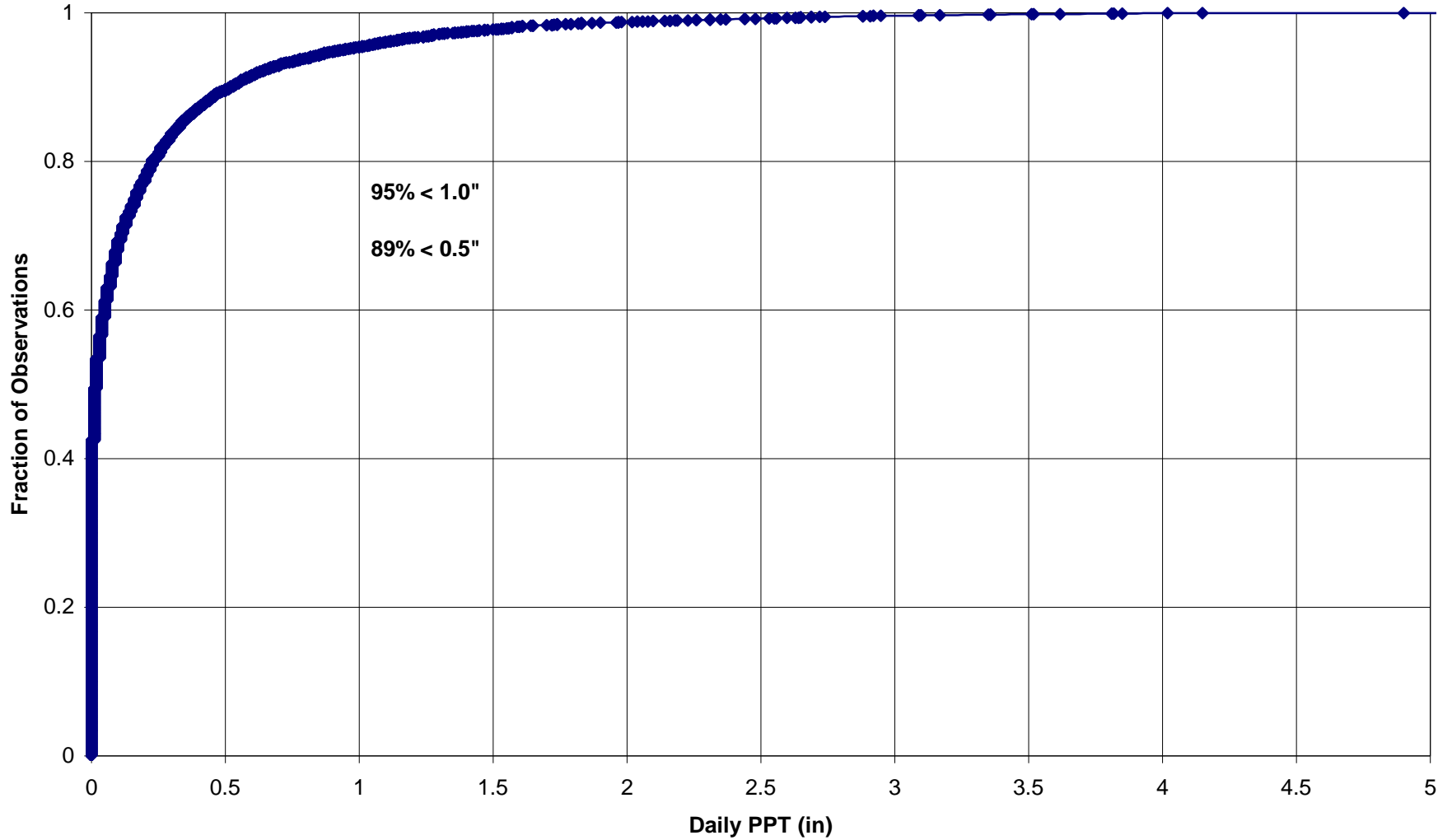
$$Q = PPT - ET \pm \Delta S$$



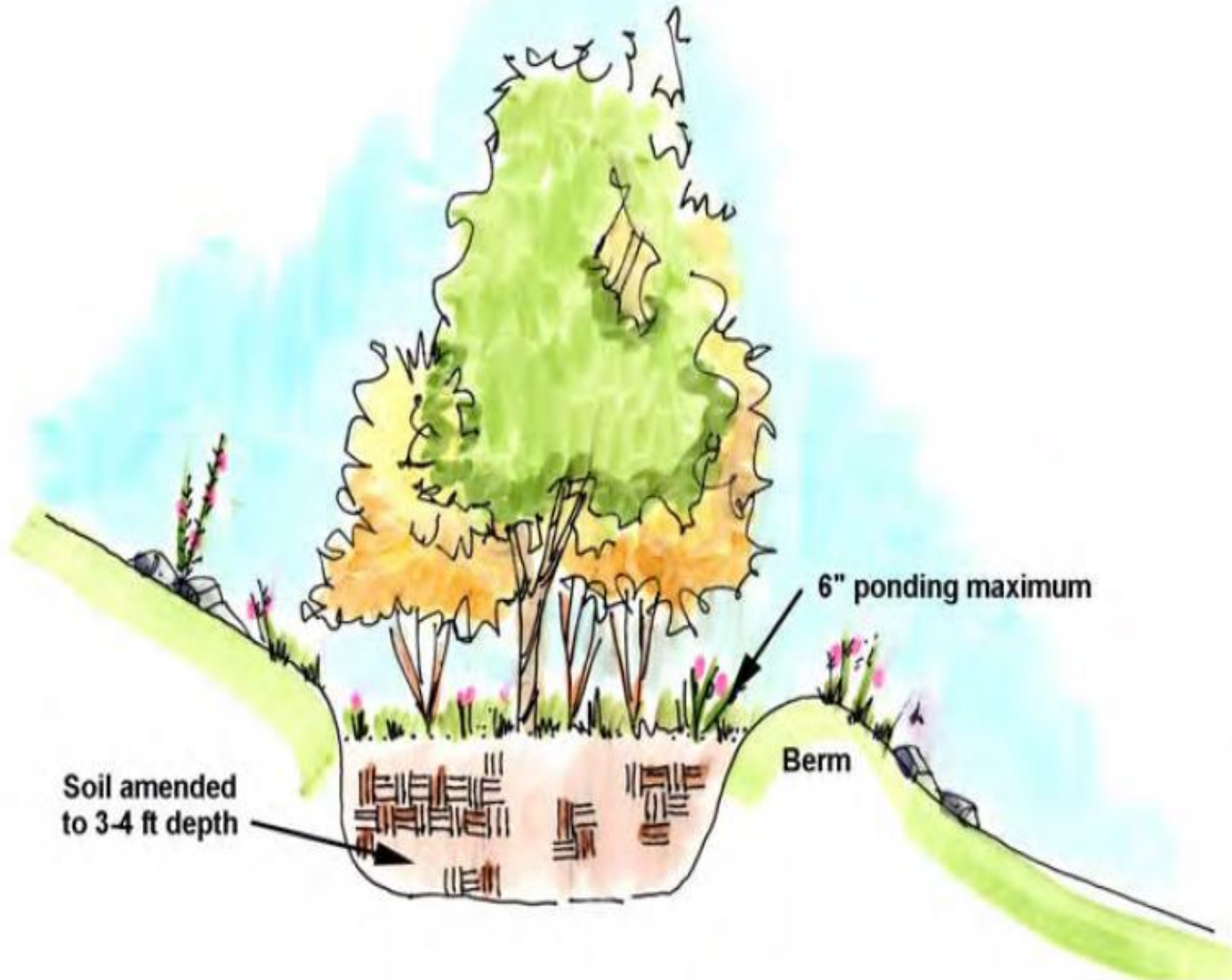
G. W. BUSH PRESIDENTIAL CENTER Dallas, TX (2008)  
 Michael Van Valkenburgh Assoc.

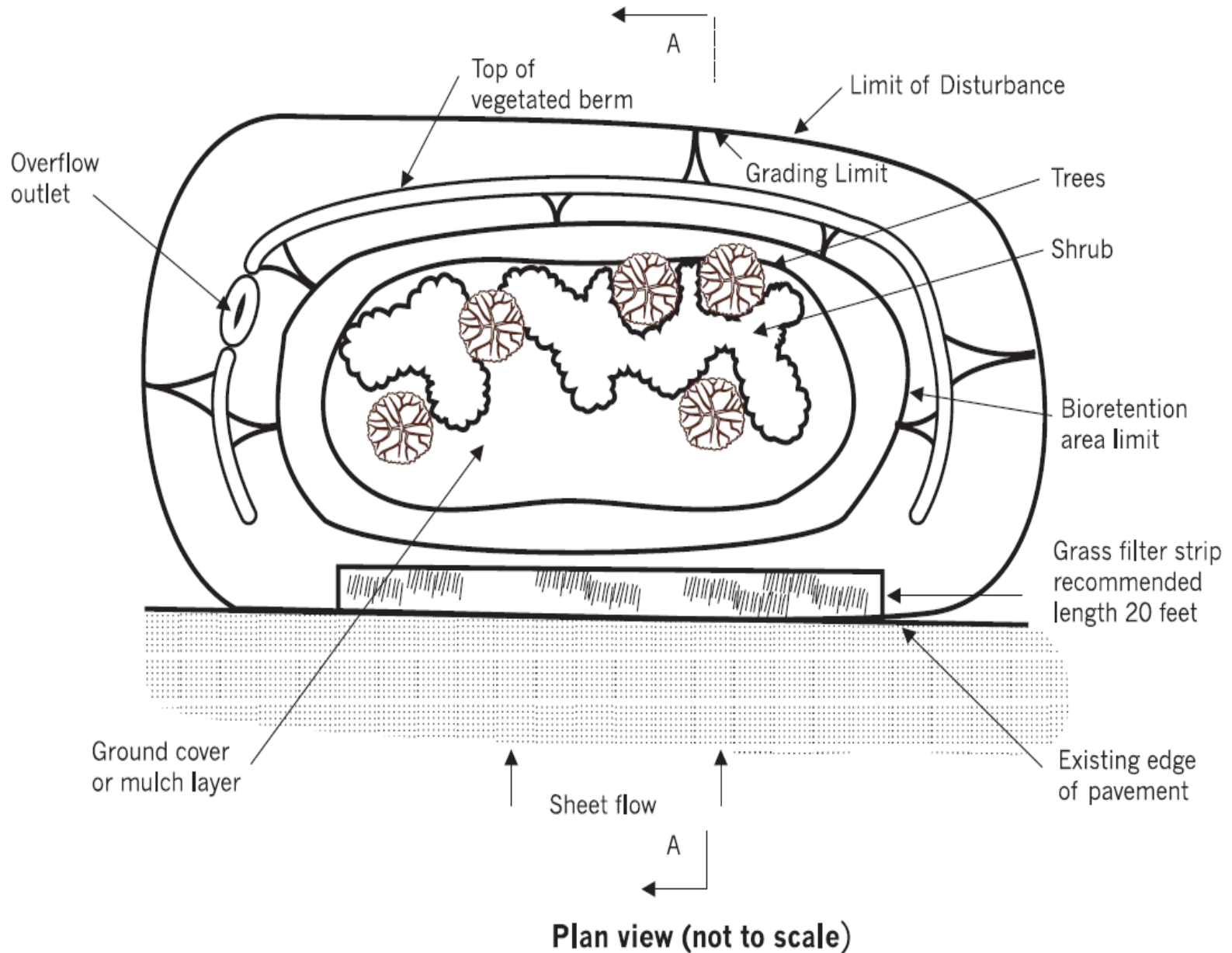


### Daily PPT Distribution in San Juan (LMM 2003-2013)

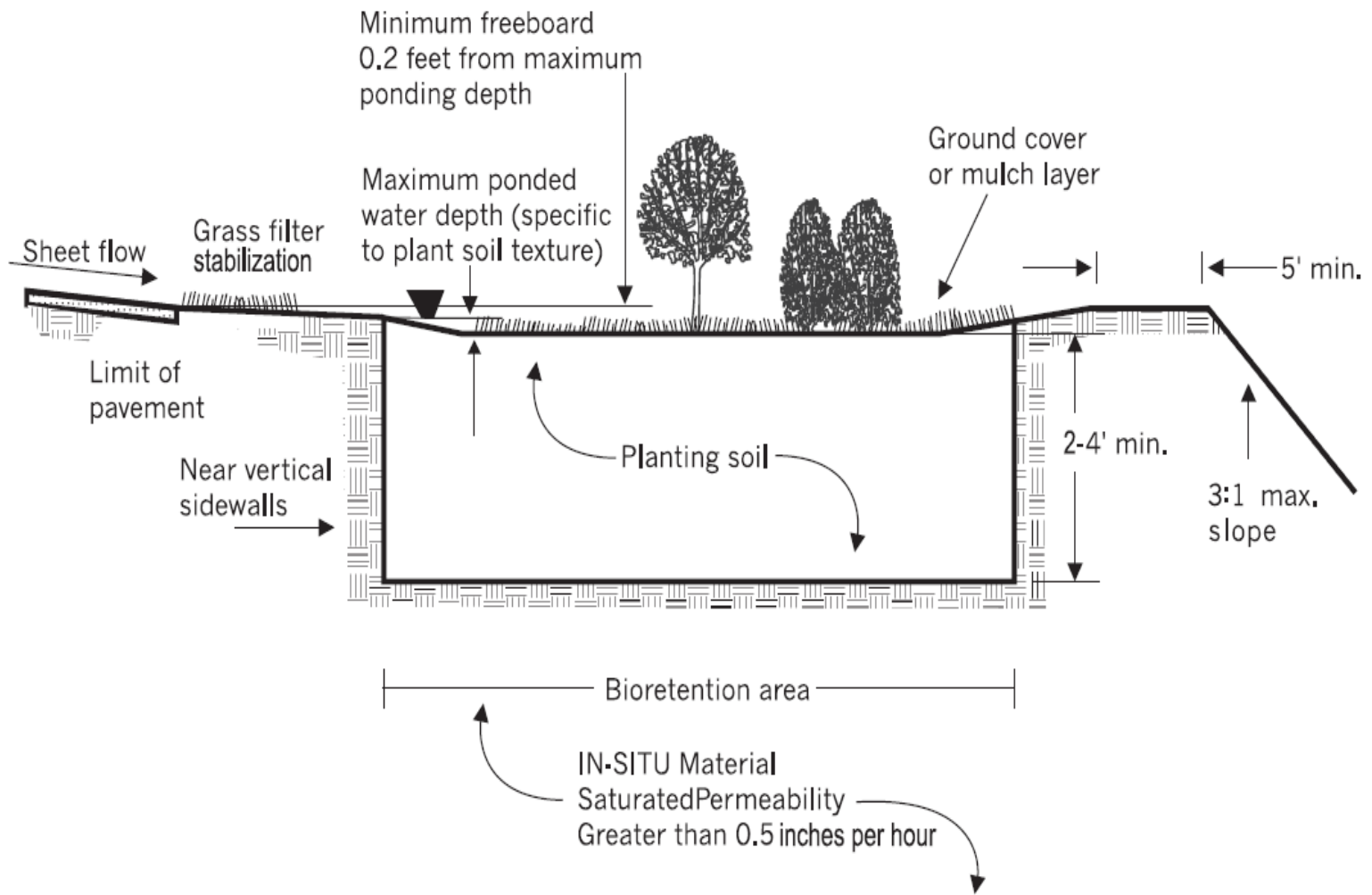


Celda de  
Bioretención





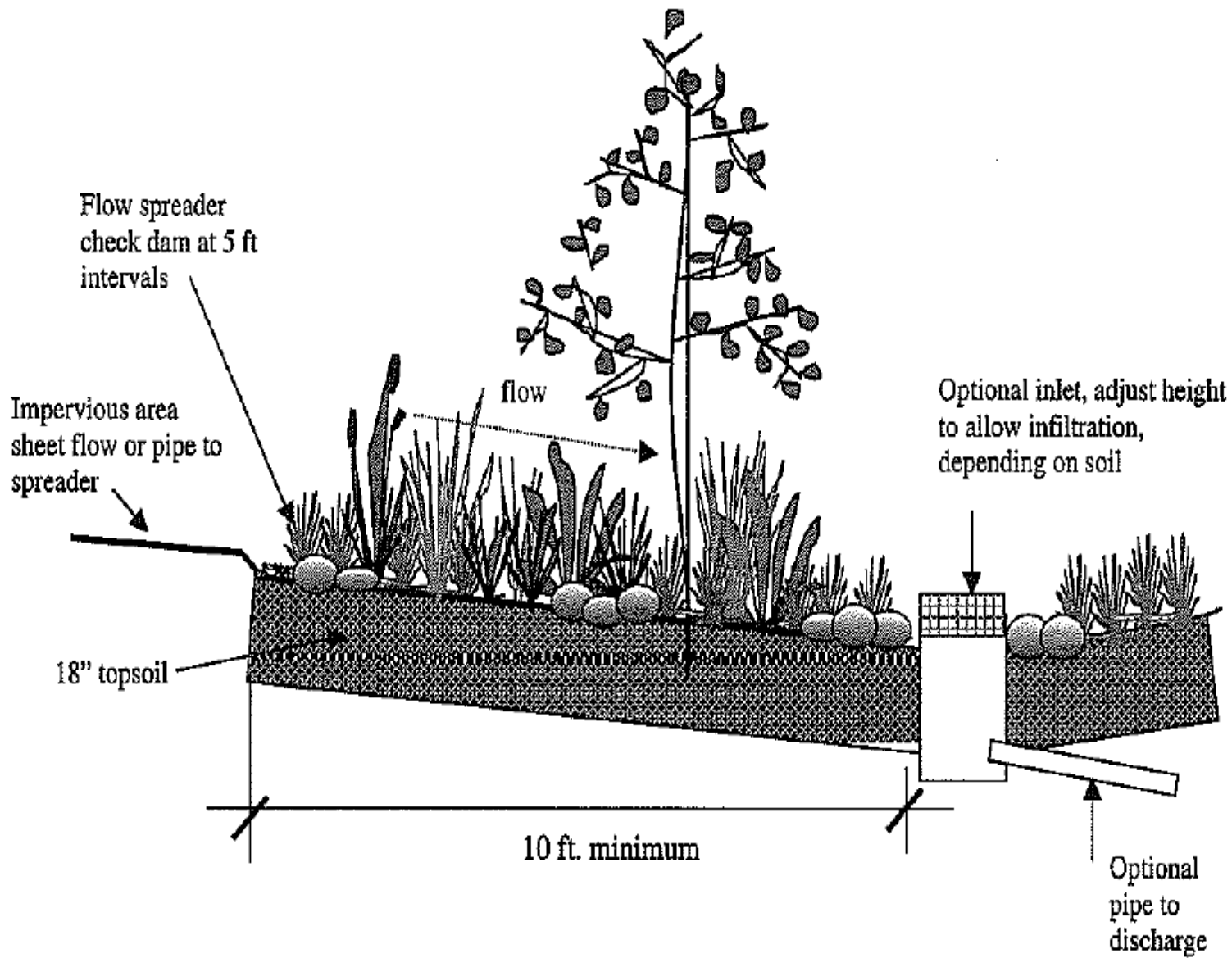
Celda de bioretención, planta típica



**Section A-A (not to scale)**

Celda de bioretención, sección típica





Franja de infiltración, sección típica

Techo Verde,  
sección típica

Vegetation

Growing Medium

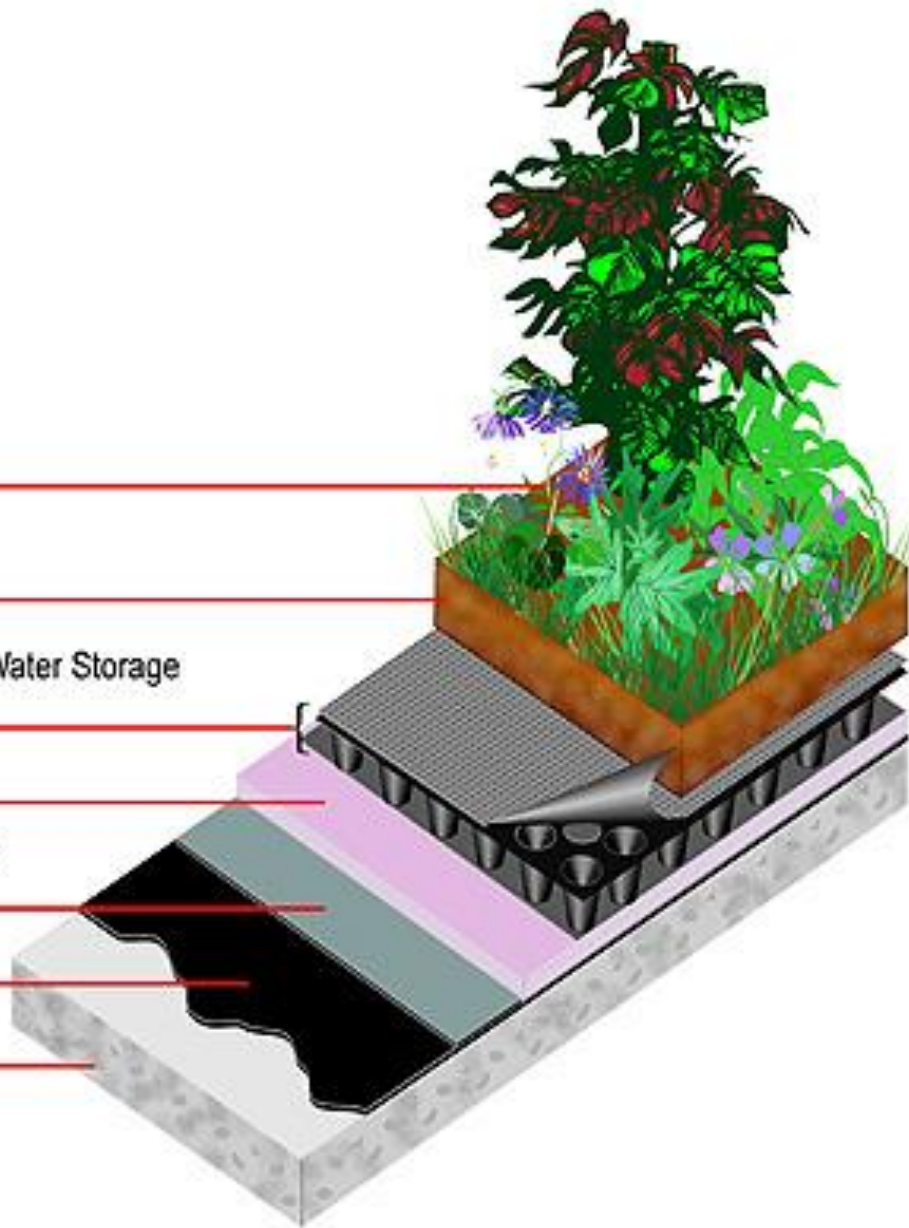
Drainage, Aeration, Water Storage  
and Root Barrier

Insulation

Membrane Protection  
and Root Barrier

Roofing Membrane

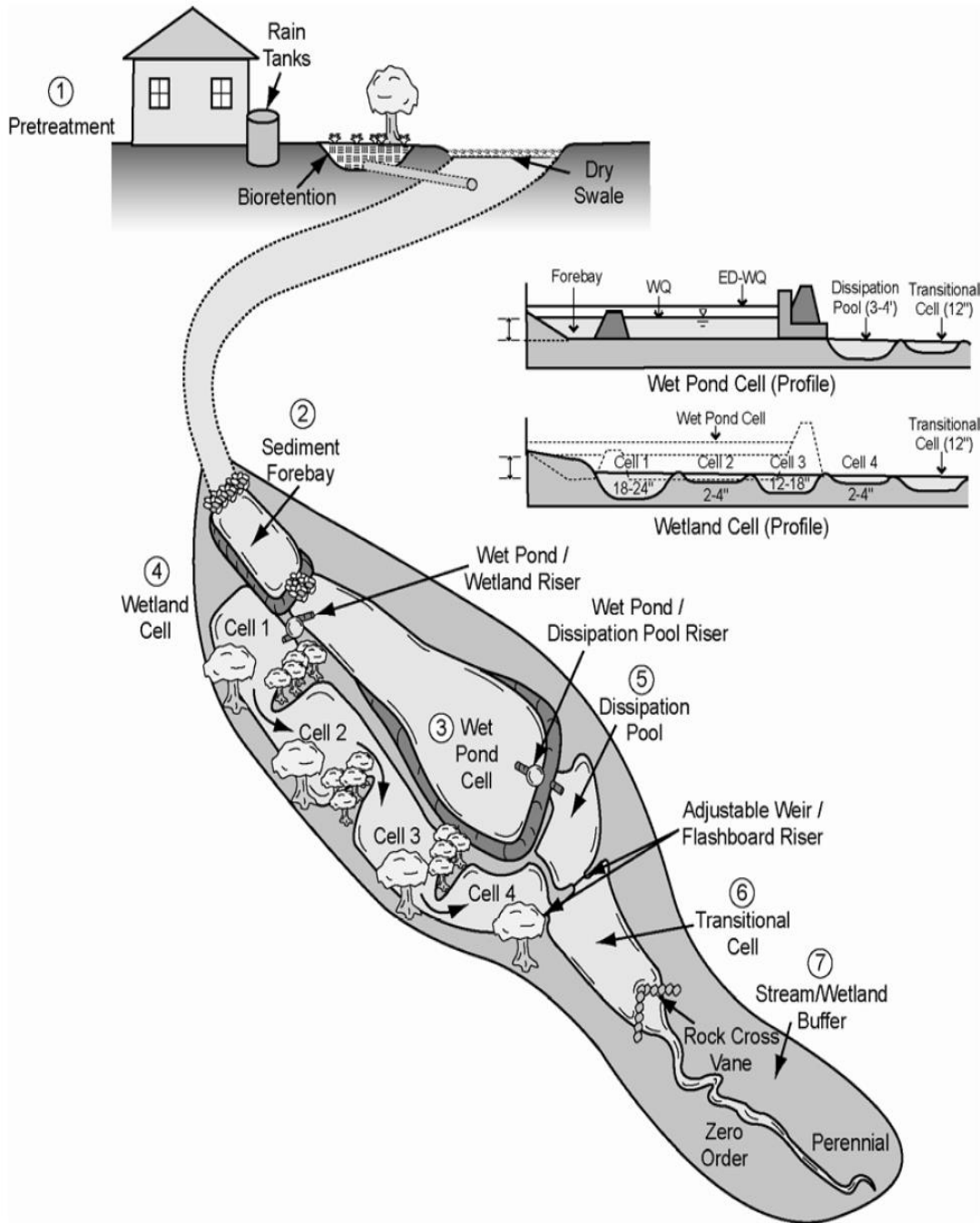
Structural Support





Pavimentos porosos

# Humedal construido

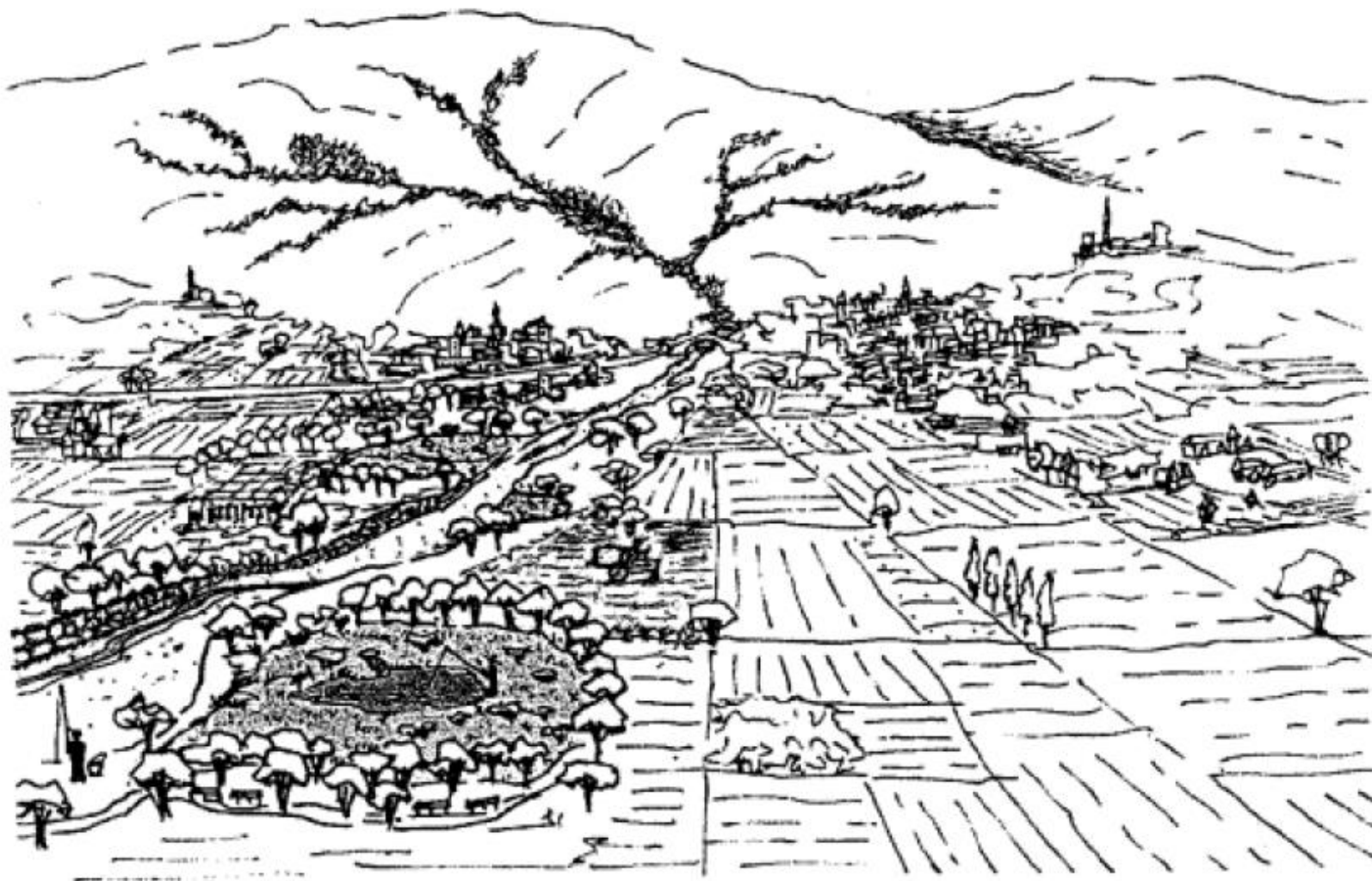




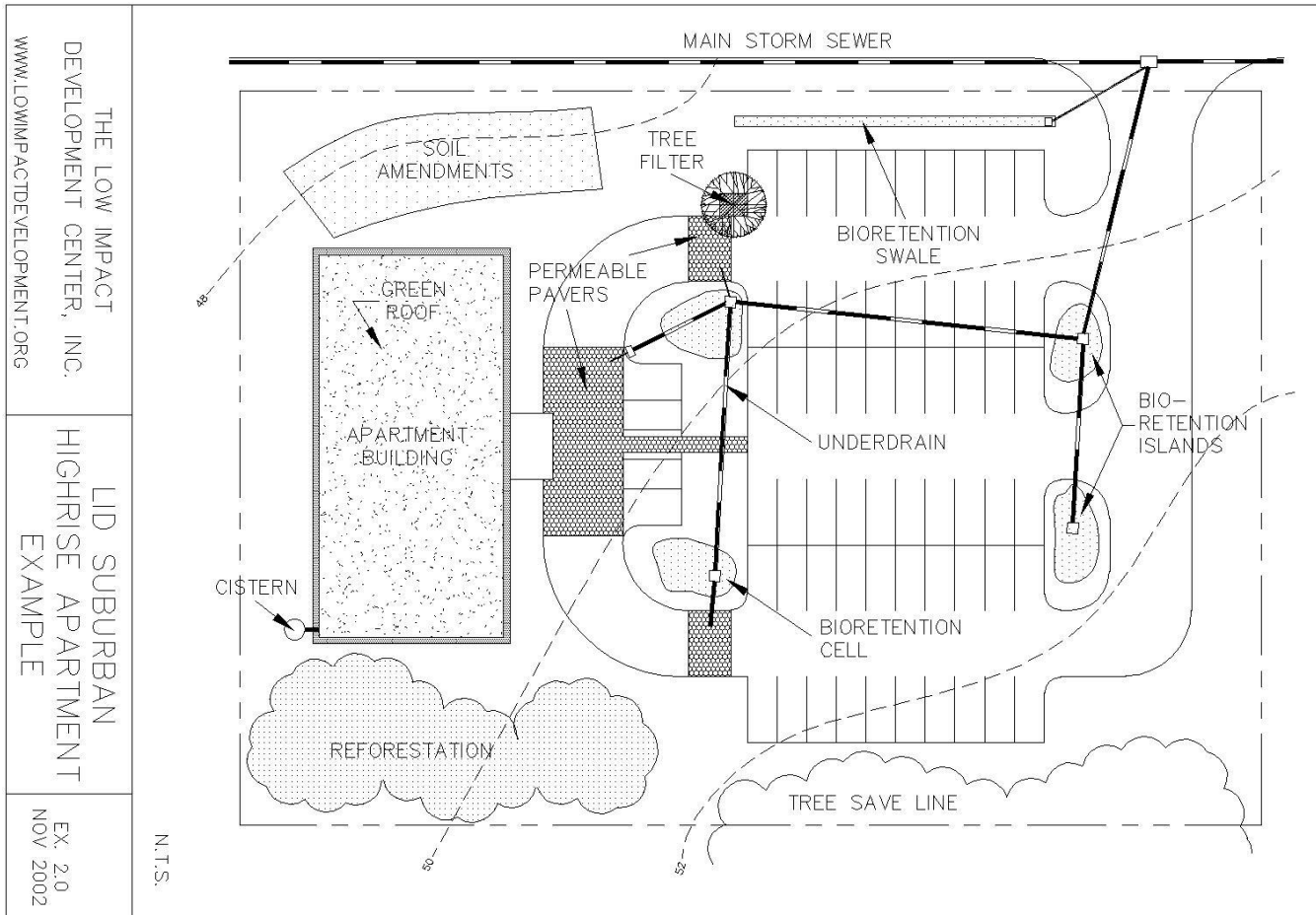


Plan de Reconstrucción de Port-au-Prince, 2010

# Contexto del paisaje regional



# Varias estrategias en conjunto...



Residencial  
de alta  
densidad







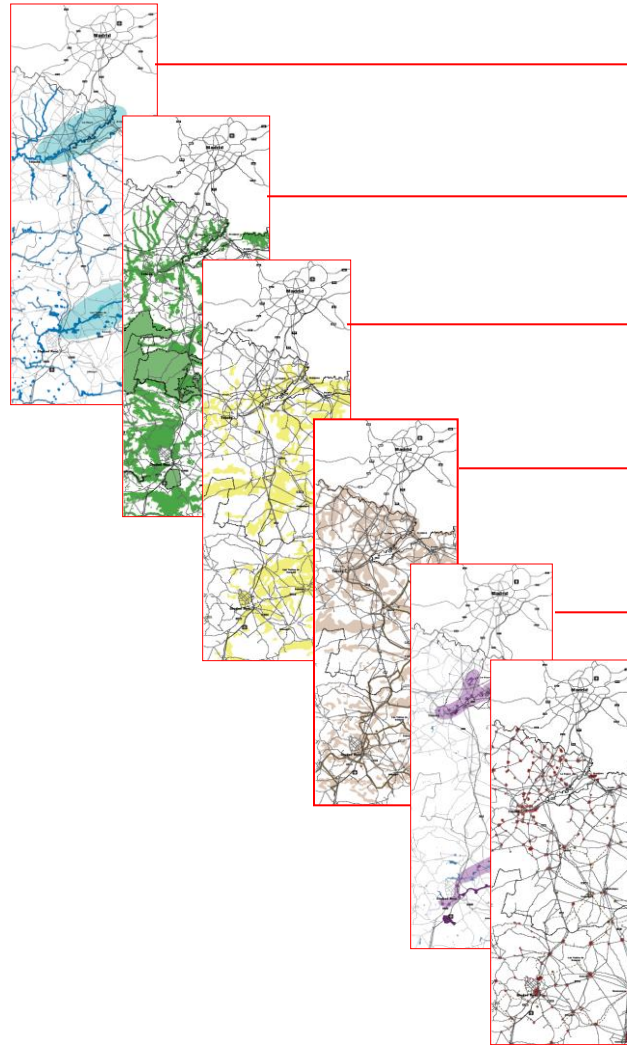
Portland, Oregon







# VISION 2025: Estrategias de Paisaje Regional



**Agua**

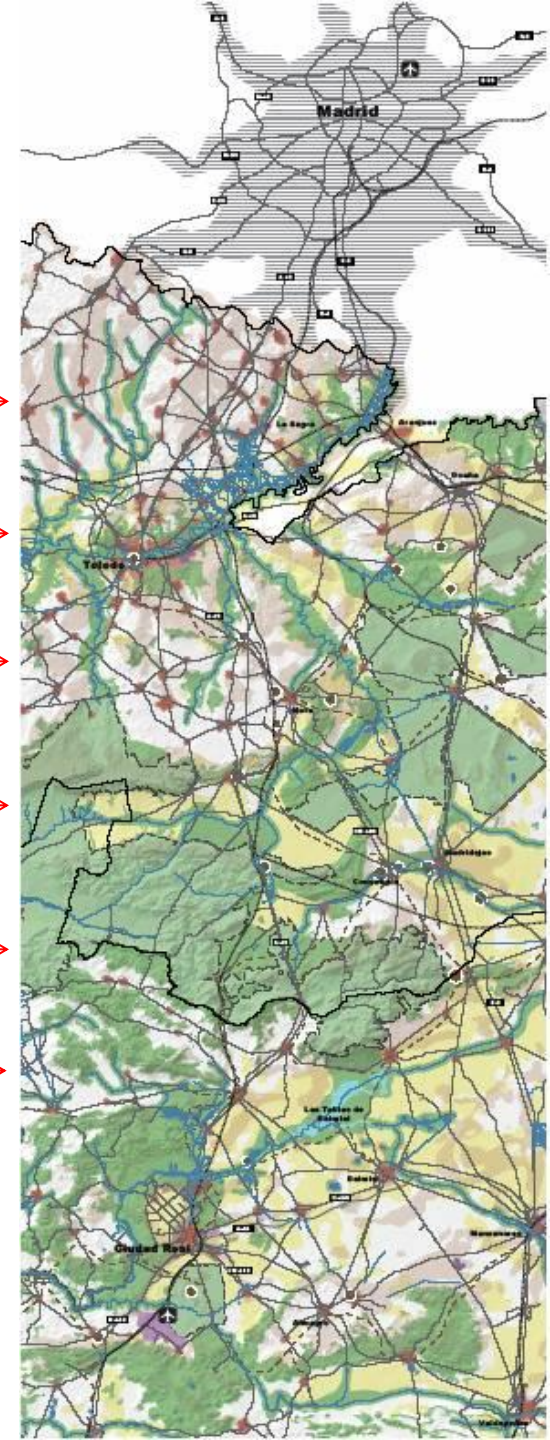
**Medioambiente**

**Agricultura**

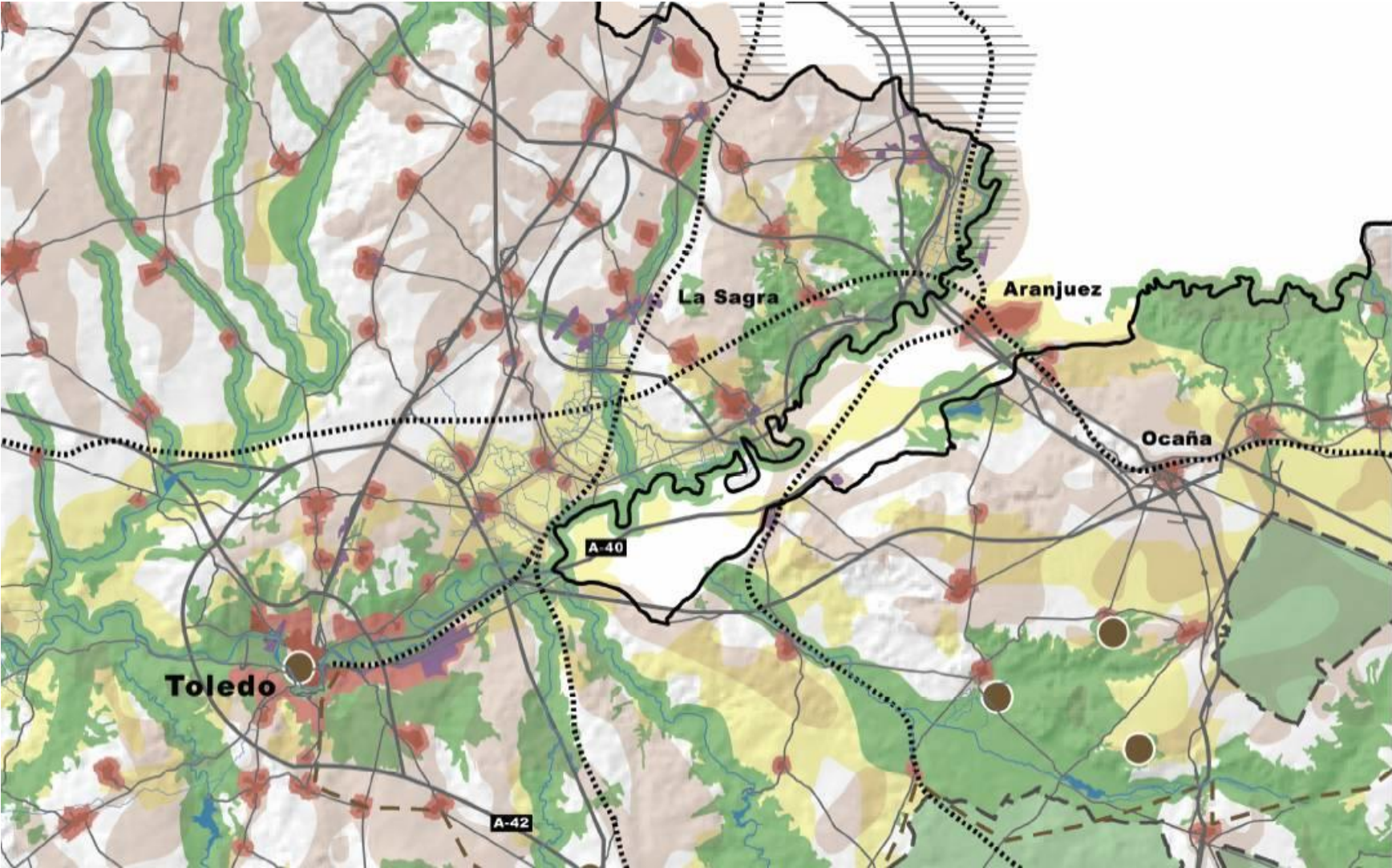
**Patrimonio**

**Infraestructuras**

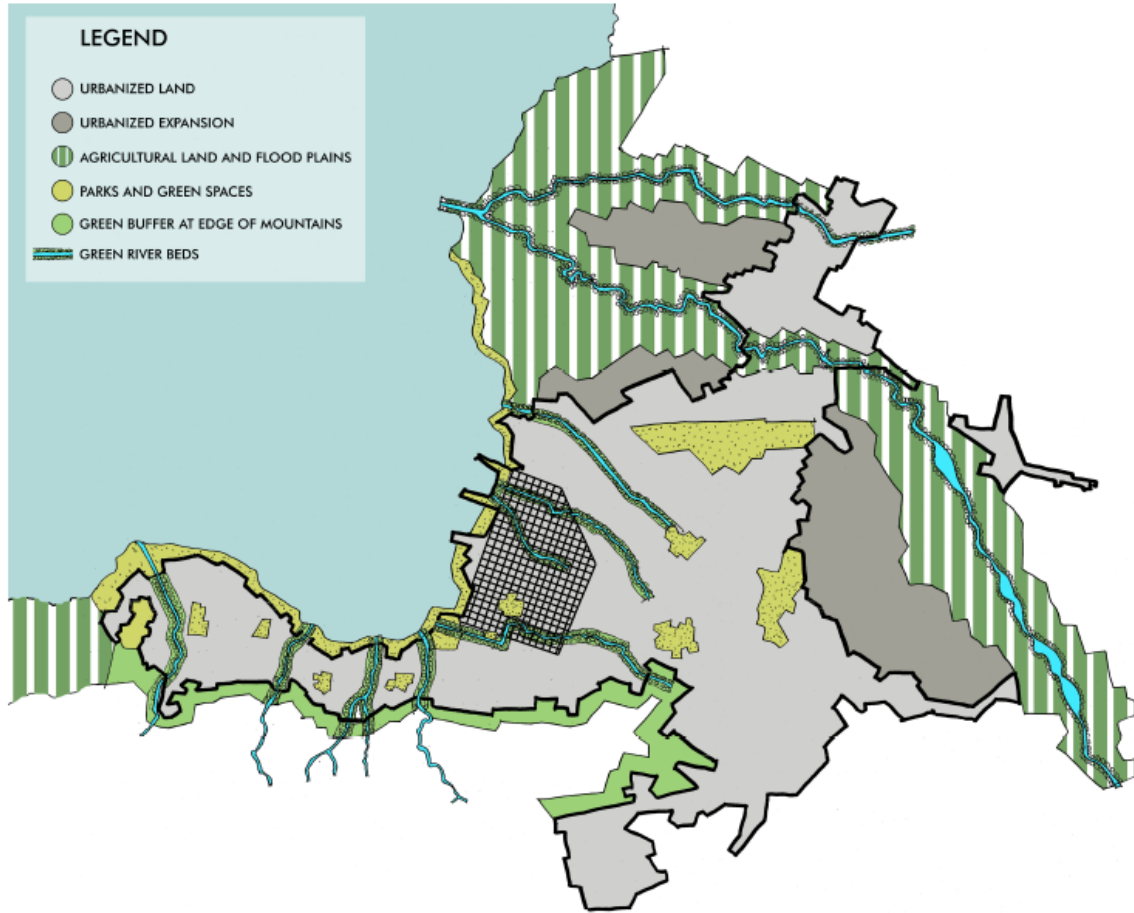
**Desarrollo  
urbanístico**



# Corredor Río Tajo: Visión 2025



ESPACE OUVERT / AGRICULTURE URBAINE / JARDINS / RÉCRÉATION  
 ESPACIOS ABIERTOS / AGRICULTURA URBANA / PARQUES / RECREACIÓN  
 OPEN SPACE / URBAN AGRICULTURE / PARKS / RECREATION



**ZONE URBANISÉE DE LA VILLE**

Port-au-Prince est une métropole en expansion. Environ 60% de la population vit dans des habitats informels dans les marécages et les communautés récupérées en pente escarpées. Ce plan vise à établir une limite à l'expansion urbaine, la préservation des terres en dehors du périmètre urbain pour l'agriculture. Elle propose également la création d'un espace vert pour piétons le long rivières et de littoral urbain de la baie. Les parcs urbains devraient être créés dans les quartiers. Dans un avenir lointain, l'aéroport devrait être déplacé, créant ainsi un grand "Central Park", parc urbain.

**ÁREA URBANIZADA DE LA CIUDAD**

Puerto Príncipe es una metrópolis de desparramiento. Aproximadamente un 60% de la población vive en asentamientos informales, terrenos pantanosos reclamados y en las laderas de las montañas. El plan propone establecer un límite a la expansión urbana preservando los terrenos en la periferia para uso agrícola. El plan también propone la creación de un área verde peatonal a lo largo de la orilla de la bahía y los ríos. Se propone la creación de parques urbanos en las comunidades y vecindarios. En un futuro puede considerarse reubicar el aeropuerto, creando la oportunidad de crear un gran "Parque Central".

**URBANIZED AREA OF THE CITY**

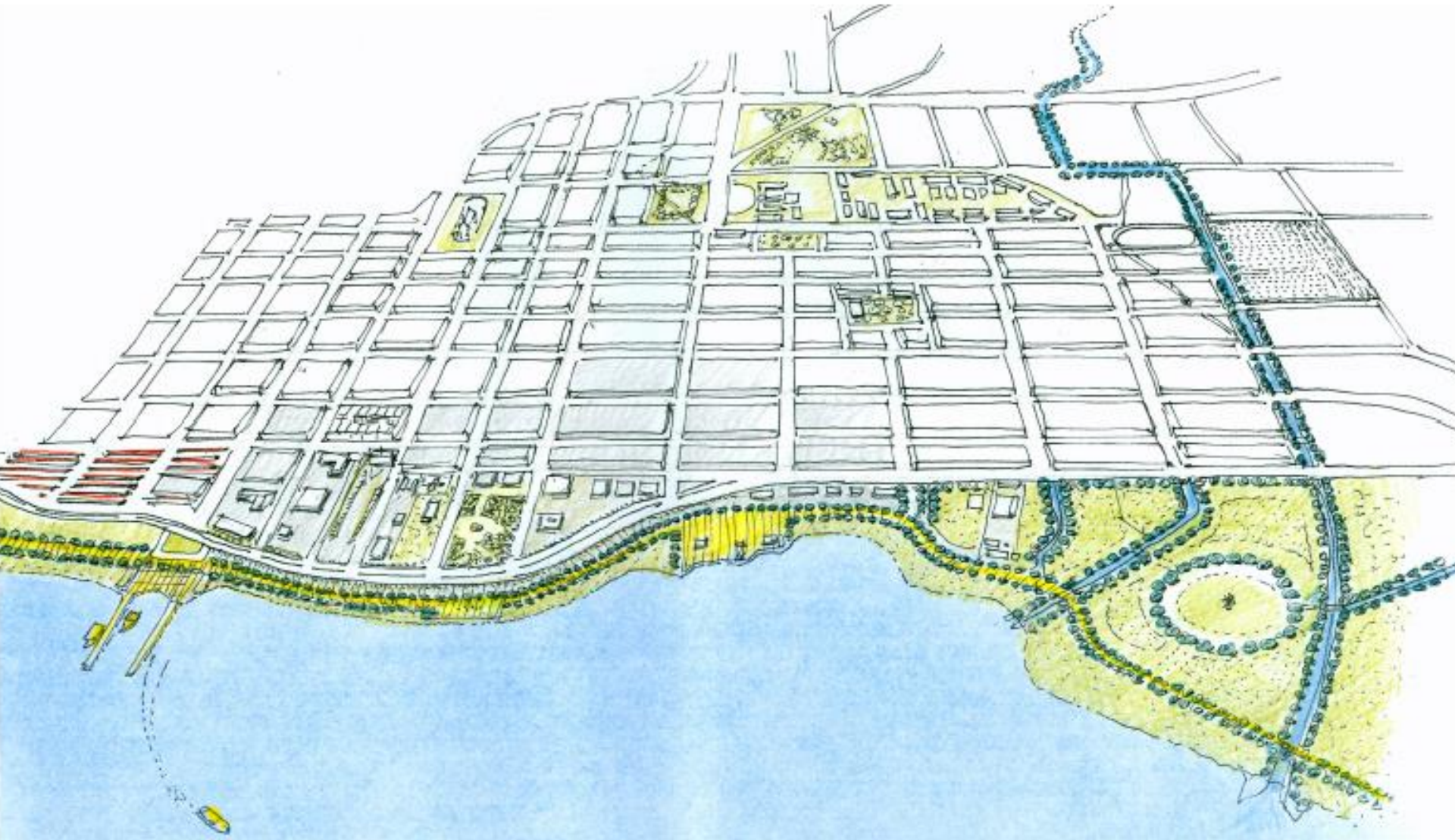
Port-au-Prince is a sprawling metropolis. Approximately 60% of the population lives in informal settlements in reclaimed swamplands and steep hillside communities. This plan attempts to draw a limit of urban expansion, preserving land outside the urban boundary for agriculture. It also proposes creating a green pedestrian area along the riverbeds and the shoreline of the bay. Urban parks should be created in neighborhoods. In the far future, consideration could be given to relocating the airport, opening the opportunity to create a large "Central Park".



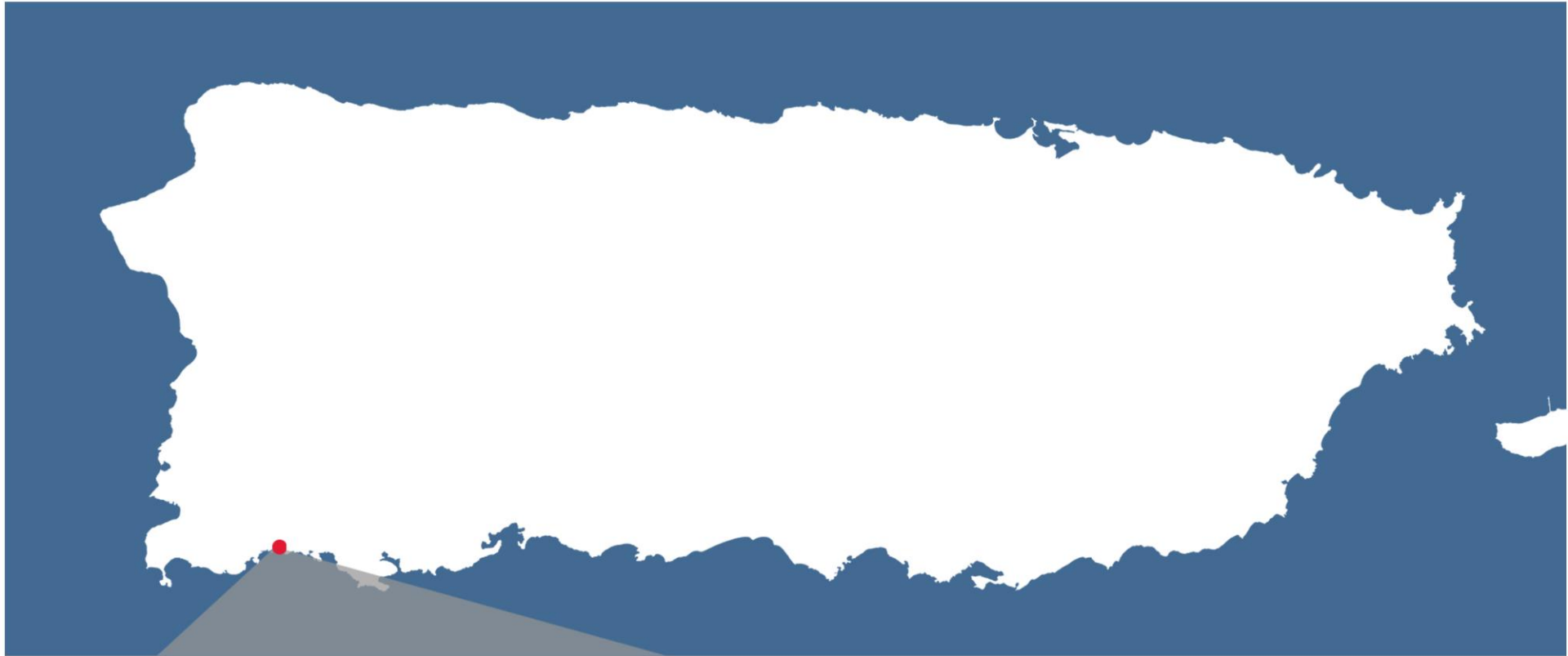




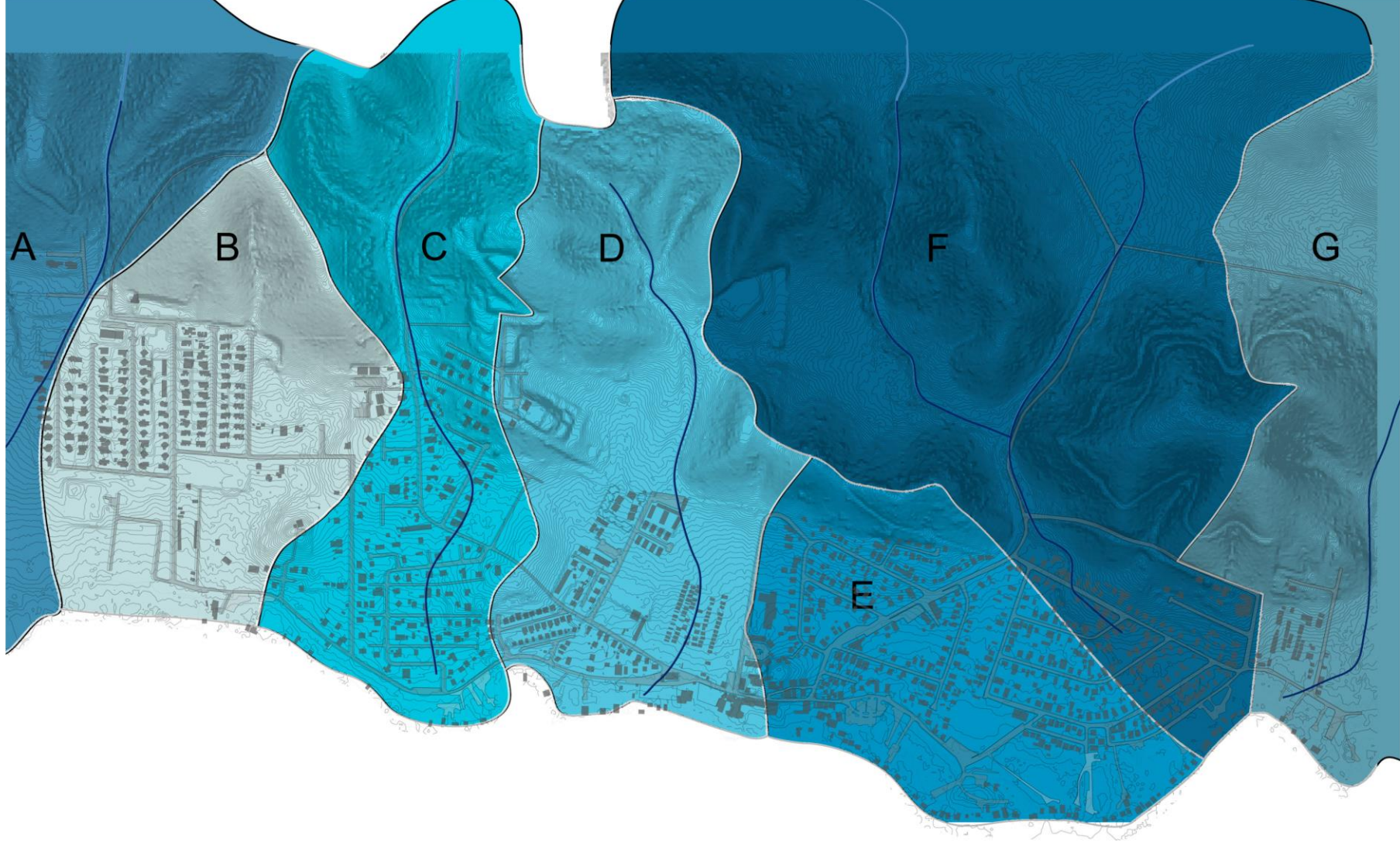






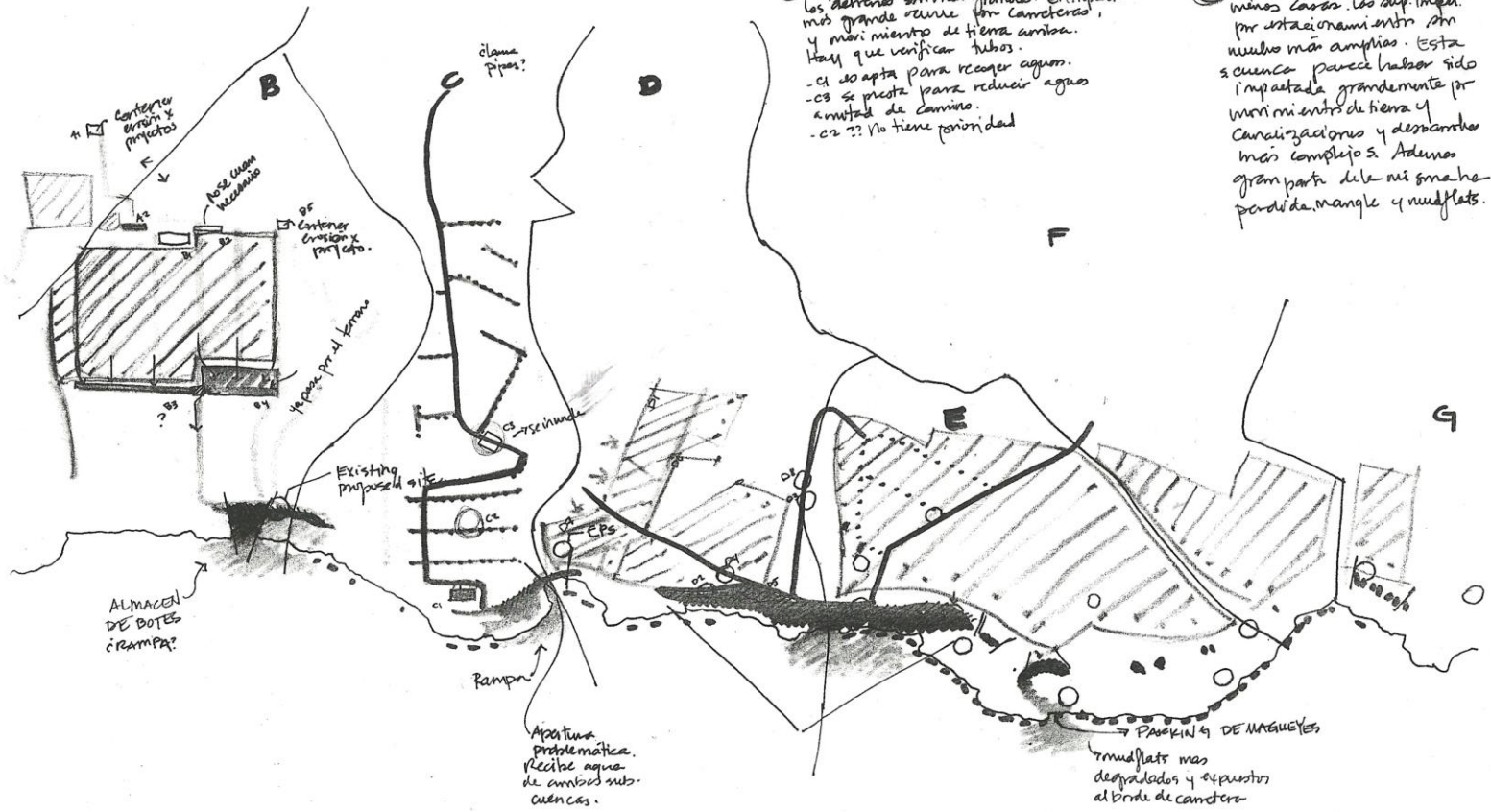












② Hay gran cantidad de casas sin embargo las drenajes son mas grande. El impacto más grande ocurre con carreteras, y movimiento de tierra arriba. Hay que verificar tubos.  
 - ca no apta para recoger aguas.  
 - ca se presta para reducir aguas  
 - amplitud de camino.  
 - ca ?? No tiene prioridad

③ a pesar de pa... tener menos casas, los sup. impen. por estacionamiento son mucho más amplios. Esta sucesión parece haber sido impactada grandemente por movimientos de tierra y canalizaciones y desarrollo más complejo. Además gran parte de la zona ha perdido mangle y mudflats.

El impacto más grande a esta cuenca proviene de las casas (techos) calles y mangüeyes de la ub. y de los movimientos de tierra de proyecto nuevos. De los 3 sites propuestos al comienzo de las casas podría considerarse 1 o 2.

para controlar erosión causada por mov. de tierra (A1 - B5)

- Intervención debe incluir reforestación

Posiblemente hay mas control de aguas usadas

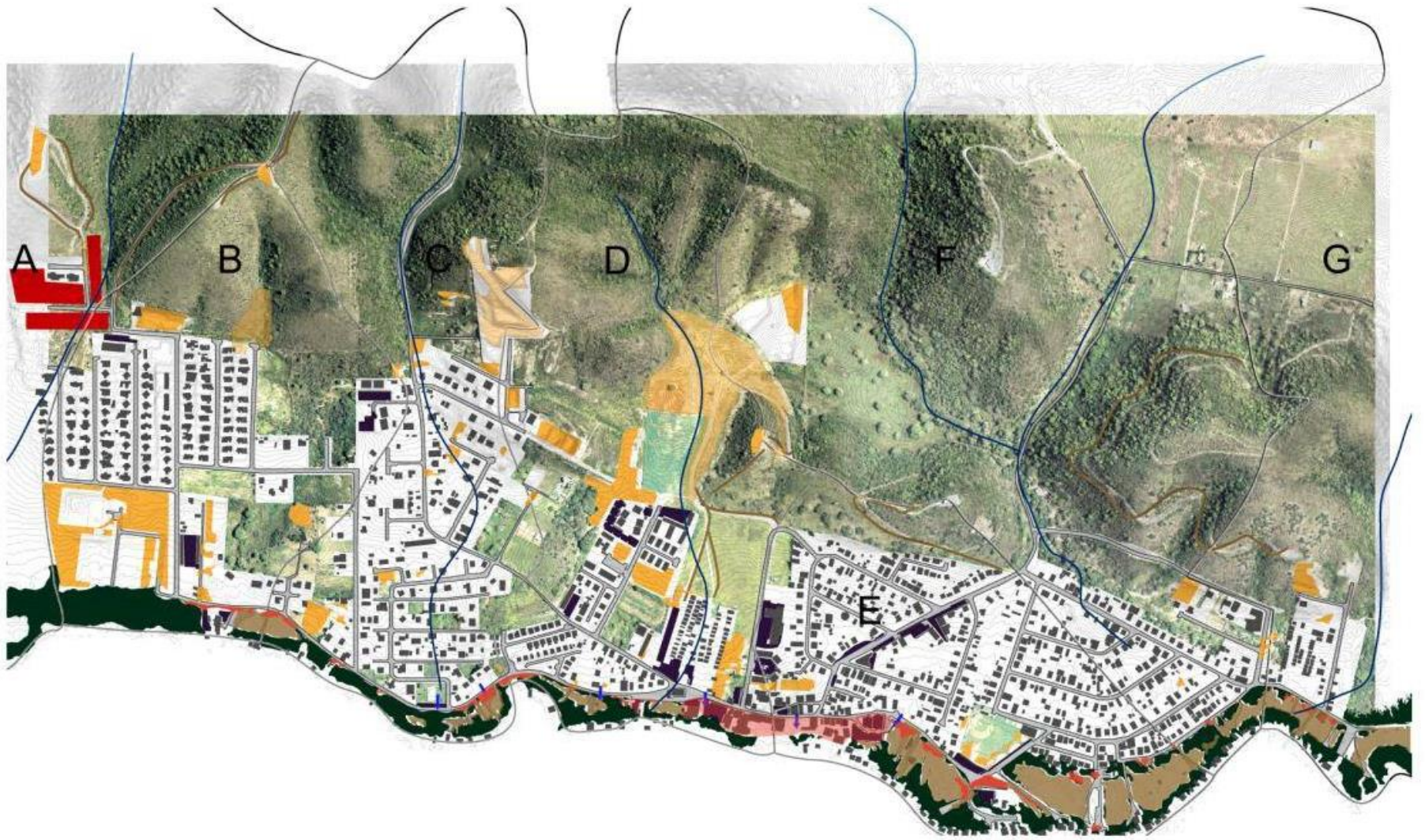
④ Muchas residencias - outfalls y mudflats más expuestos a carreteras, y estacionamientos - posiblemente menos control de aguas usadas.

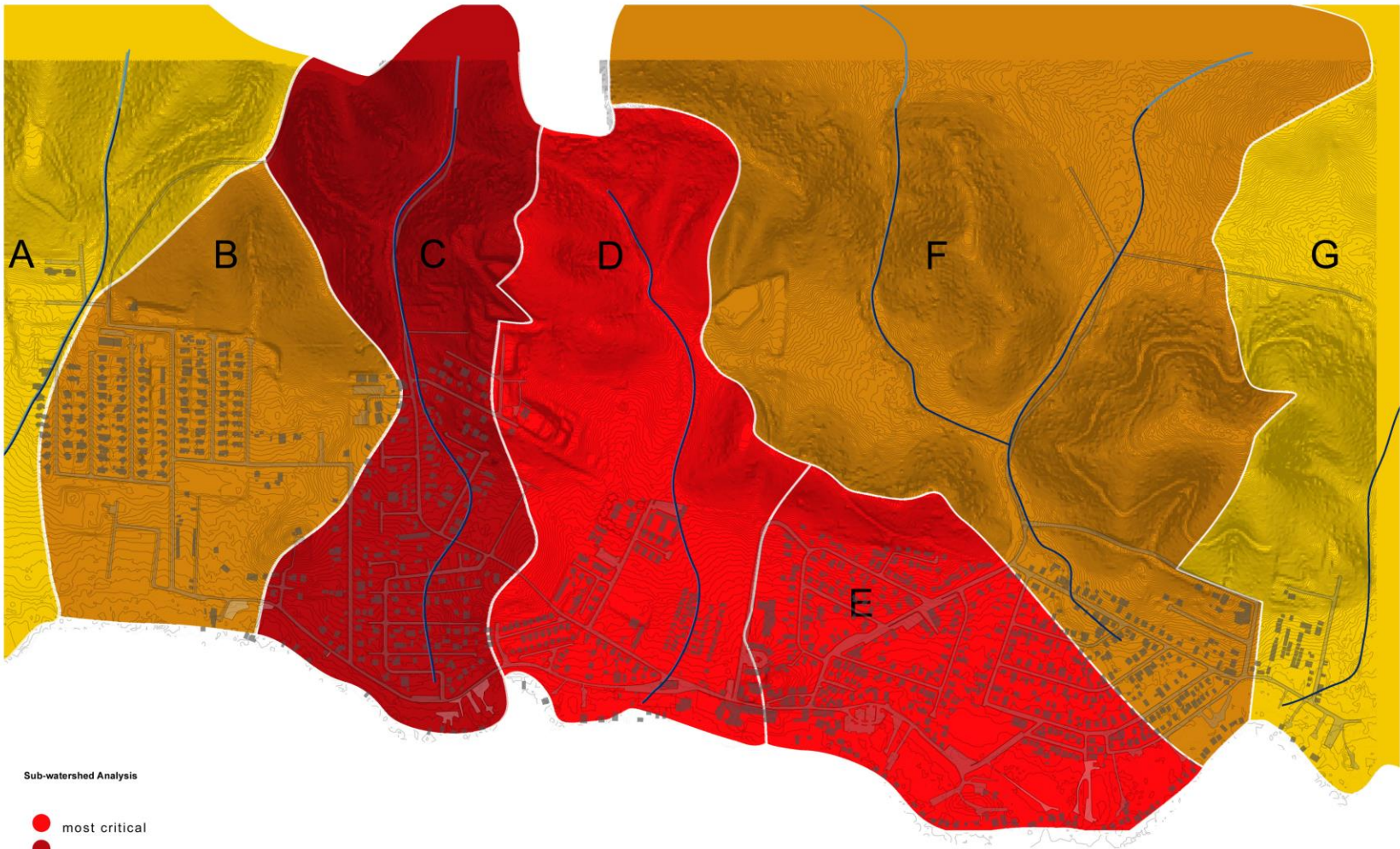
**E4F**

- Mayor cantidad de casas en el agua.
- Mayor infraestructura y accesos a través de mudflats.
- - control aguas usadas

**F y G**

Poco control de agua de excremento - drenajes y posible poco control de aguas usadas

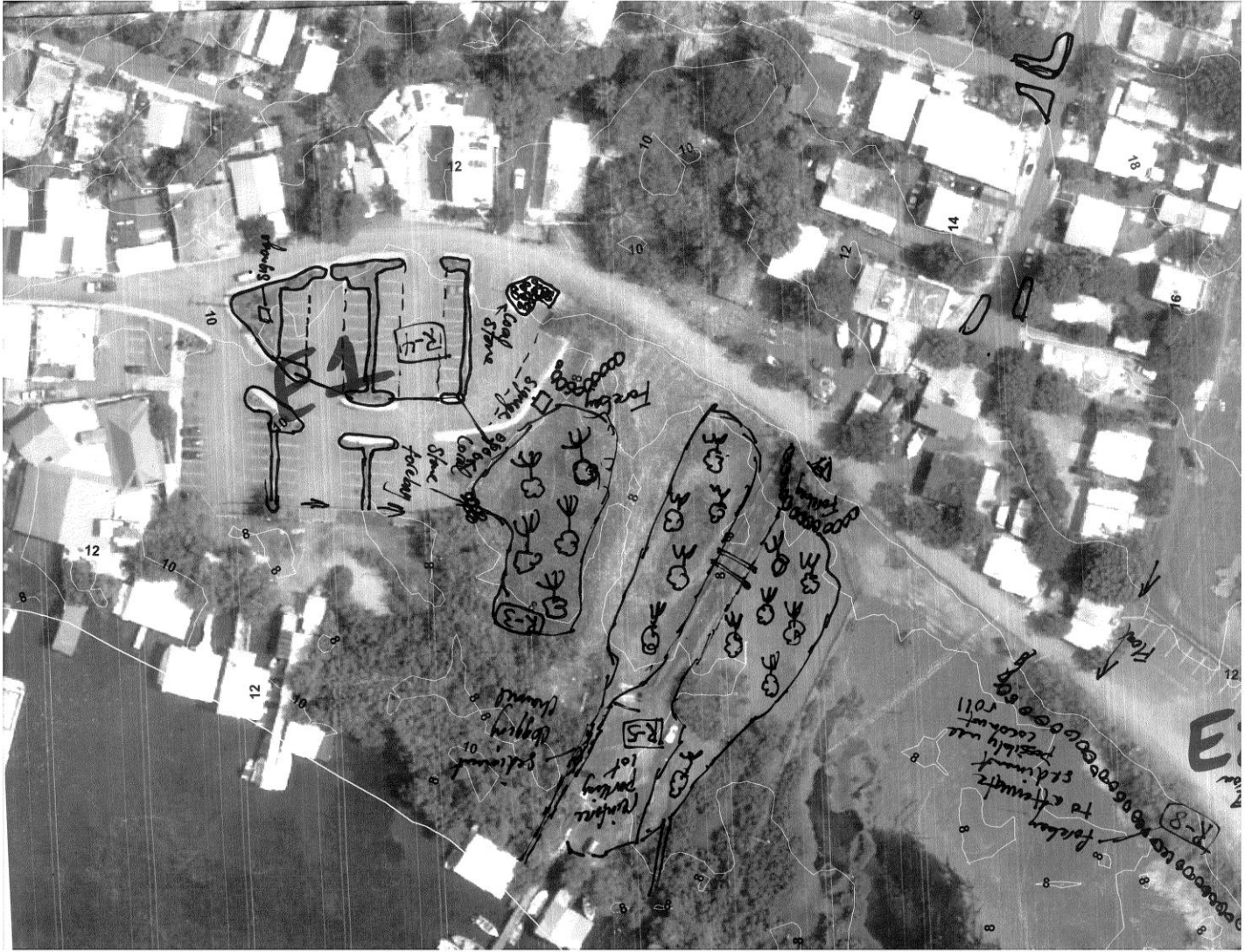




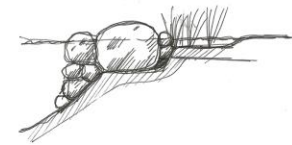
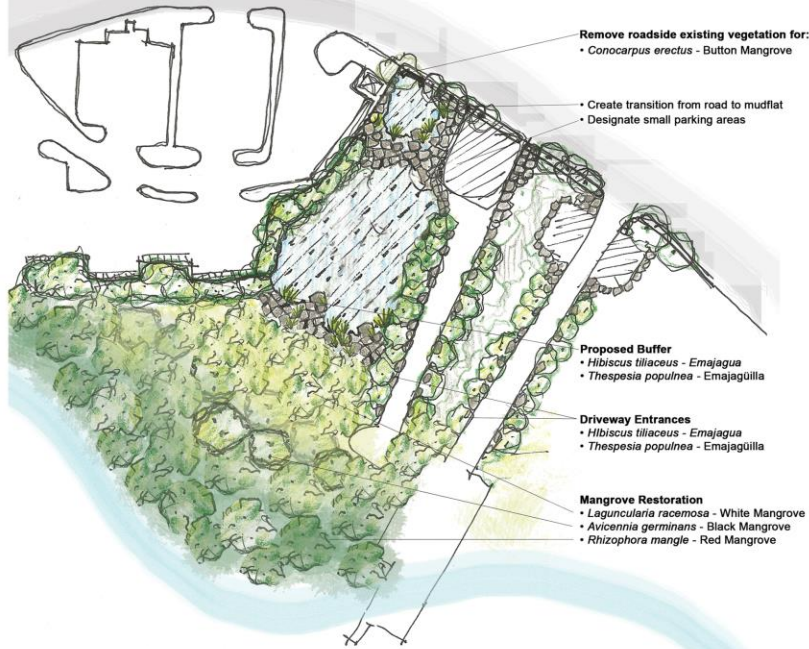
Sub-watershed Analysis

- most critical
- 
- 
- less critical

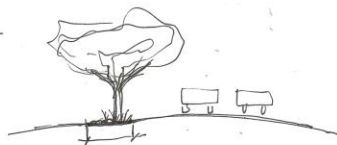




**Site E3 + E5**  
**Mangrove Restoration and Forebay General Plant Palette**



• Create transitions in depth of forebay to allow the growth of different species.



• Create transition from road to mudflat

**Mangrove Distribution According to Distance from Sea to Land**



*Rhizophora mangle* - Red mangrove  
**GROWING HABIT-** Perennial tree, Evergreen. Distinguished by its erect and aerial roots that forms a dense brush. Forms pure colonies when in direct contact with sea in quiet coasts. Reaches heights of 10 meters or more and 30 cm in diameter or more.  
**HABITAT-** Common in mangrove swamps around coastal areas, near river mouths. Provides shelter and nesting for aquatic birds. Estuarine systems.



*Avicennia germinans* - Black mangrove  
**GROWING HABIT-** Evergreen tree. Stems up to 30cm of diameter, 16 meters long. More salt tolerant than other mangrove species.  
**HABITAT-** Coastal lagoons and swamps, estuarine systems. Provides nesting and shelter of wildlife.



*Laguncularia racemosa* - White mangrove  
**GROWING HABIT-** Evergreen tree; reaches up to 20 meters high, produces pneumatophores.  
**HABITAT-** Mangrove swamps in coastal areas. Provides shelter for wildlife.



*Conocarpus erectus* - Button mangrove  
**GROWING HABIT-** Evergreen tree; generally up to 3-5 meters high but it can reach 20 meters.  
**HABITAT-** Mangrove swamp forests and sometimes on rocky and sandy shores. Estuarine systems. Provides shelter for wildlife.

**Roadside, Parking Area and Mangrove Entrance Trees**



*Thespesia populnea* - Emajaguilla (Portia tree, Spanish cork, Otaheita)  
**GROWING HABIT-** Shrub/tree of coastal woods, up to 30 feet high. Trunk of 20 cm diameter; dense crown.  
**HABITAT-** Coastal woods and



*Hibiscus perambucensis* - Emajagua  
**GROWING HABIT-** Shrub or tree, to 15 m tall.  
**HABITAT-** In brackish swamps and inner margins of mangrove, ascending to the humid mountains.



*Stahliia monosperma* - Cobana negra  
**GROWING HABIT-** Perennial tree. Evergreen. Stems up to 20 meters high.  
**HABITAT-** Coastal woodlands and borders of mangroves. Threatened with extinction.

# GREEN INFRASTRUCTURE PLAN, LA PARGUERA LAJAS PR MASTER PLAN FOR WATER MANAGEMENT AND QUALITY IMPROVEMENT

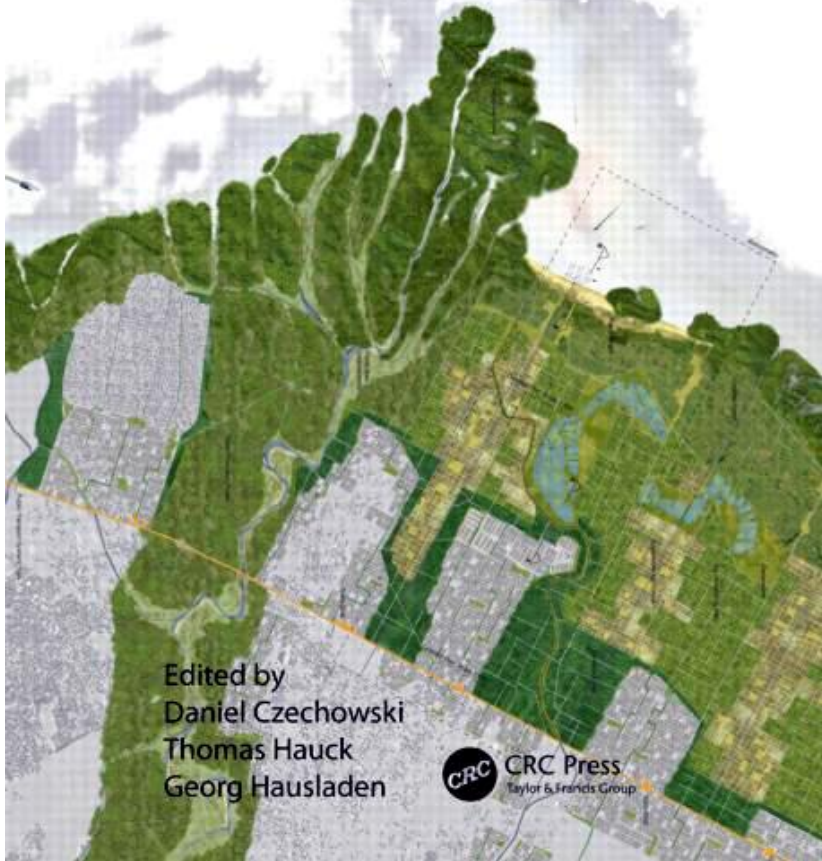


- CWP Proposed Retrofitting Practices**
- Outfall + Mangrove Restoration
  - Rainwater Harvesting + Cistern
  - Permeable Pavement
  - Raingarden
  - Bioswale
  - Green Street Bioretention
  - Road Stabilization
  - Law Enforcement
  - Sand Filters
  - Filtering Practice
  - Wetpond
  - Created Wetland / Park
  - New proposed intervention sites
  - Residential areas that could implement small scale rainwater-harvesting



# REVISING GREEN INFRASTRUCTURE

Concepts Between Nature and Design



Edited by  
Daniel Czechowski  
Thomas Hauck  
Georg Hausladen

 CRC Press  
Taylor & Francis Group

Terrasa-Soler, José Juan, Mery Bingen, and Laura Lugo-Caro. 2014.

## Chapter 20

### The Caribbean Landscape Cyborg: Designing Green Infrastructure for La Parguera, Puerto Rico

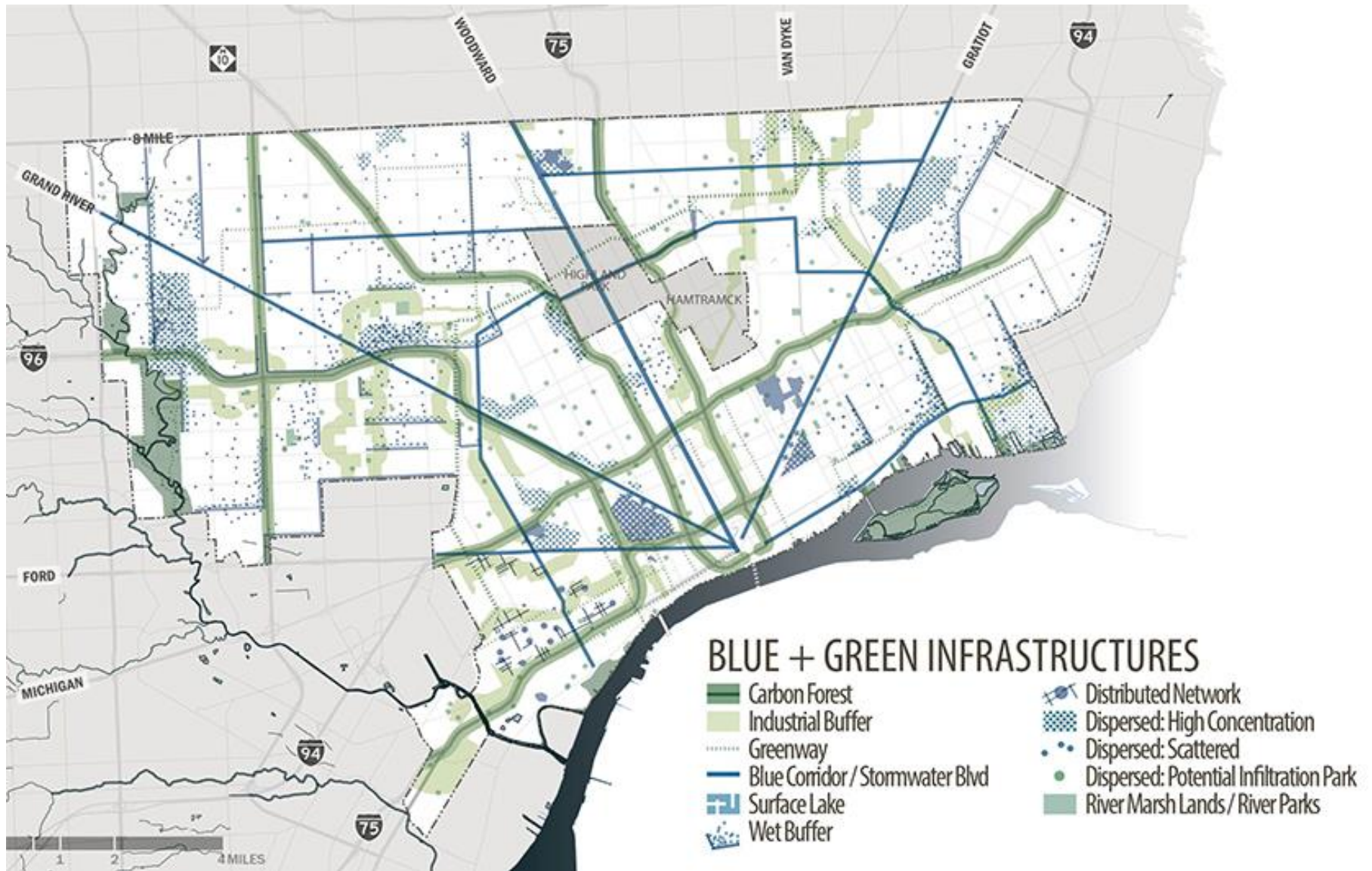
CRC Press, London

# Gracias

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jjterrasa@marvelarch.com

*The Office of Marvel & Marchand Architects LLP*  
*Santurce, Puerto Rico*





## BLUE + GREEN INFRASTRUCTURES

-  Carbon Forest
-  Industrial Buffer
-  Greenway
-  Blue Corridor / Stormwater Blvd
-  Surface Lake
-  Wet Buffer
-  Distributed Network
-  Dispersed: High Concentration
-  Dispersed: Scattered
-  Dispersed: Potential Infiltration Park
-  River Marsh Lands / River Parks



### COMMUNITY OPEN SPACES

LANDSCAPES FOR RECREATION, SOCIAL LIFE, AND SMALL-SCALE FOOD CULTIVATION

- PLAYGROUNDS
- NEIGHBORHOOD PARKS
- SPORTS FIELDS
- REGIONAL PARKS
- PLAZAS
- RECREATION CENTERS
- TRAILS / GREENWAYS
- URBAN GARDENS
- FARMERS MARKETS
- CEMETERIES (EXISTING)



### ECOLOGICAL LANDSCAPES

MEADOWS AND FORESTS THAT PROVIDE HABITAT AND OTHER ENVIRONMENTAL BENEFITS

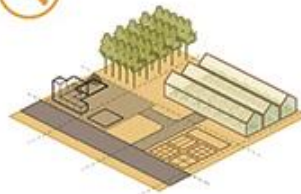
- NATURE PARKS
- INDUSTRIAL NATURE PARKS
- RAPID REFORESTATION
- SUCCESSIONAL ROAD
- ROADS TO RIVERS



### BLUE+GREEN INFRASTRUCTURES

LANDSCAPES THAT CAPTURE STORMWATER AND CLEAN AIR

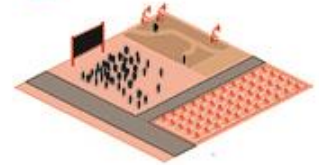
- LARGE LAKE
- SMALLER RETENTION POND
- INFILTRATION PARK
- SWALES + INFILTRATION MEDIANS
- ROAD-SIDE POND (ALONG WIDE ROADS)
- GREEN INDUSTRY BUFFER
- CARBON FOREST



### WORKING+ PRODUCTIVE LANDSCAPES

LANDSCAPES THAT GENERATE NEW KNOWLEDGE, GROW ENERGY AND FOOD, AND CREATE NEW URBAN EXPERIENCES

- RESEARCH LANDSCAPE
- URBAN FARM
- AQUACULTURE AND HYDROPONICS
- ALGAE-CULTURE
- ENERGY FIELD OR FOREST
- HOMESTEADS
- CAMPGROUNDS

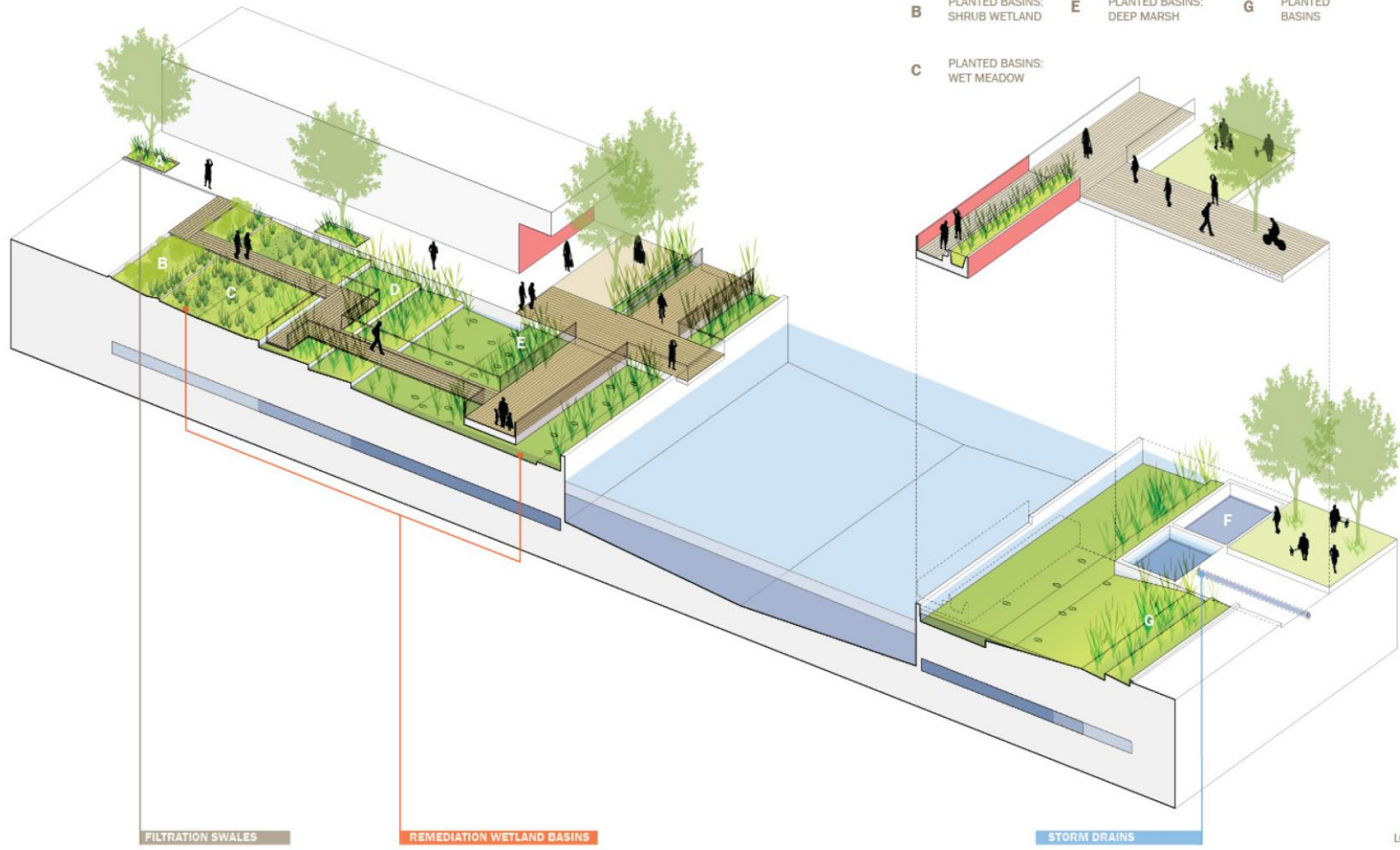


### TRANSITIONAL LANDSCAPES

TEMPORARY LANDSCAPES THAT CLEAN SOIL AND ENABLE NEW FORMS OF SOCIAL LIFE AND CREATIVE DISPLAYS

- EVENT LANDSCAPES
- REMEDATION FIELDS OR FORESTS
- ART-SCAPES
- URBAN MEADOWS

GOWANUS CANAL SPONGE PARK™  
STREET END AXONOMETRIC



- A PLANTED FILTRATION SWALES
- B PLANTED BASINS: SHRUB WETLAND
- C PLANTED BASINS: WET MEADOW
- D PLANTED BASINS: SHALLOW MARSH
- E PLANTED BASINS: DEEP MARSH
- F STORM WATER CISTERNS
- G PLANTED BASINS

WHAT YOU MAY SEE



