

Water Resilient Cities Conference



“Future-proofing” Infrastructure for the Anthropocene

Hillary Brown, FAIA

Maxine Goodman Levin College of Urban Affairs
Cleveland State University
April 21, 2016 Cleveland, OH

Water Resilient Cities Conference

FOREWORD BY DAVID W. ORR

NEXT GENERATION INFRASTRUCTURE

Principles for Post-Industrial Public Works

HILLARY BROWN



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Crisis creates opportunity

Level of investments needed:

- “D+” from the American Society of Civil Engineers, 2013 (Drinking & Wastewater)
- 11% bridges structurally deficient
- 240,000 water main breaks
- \$ 3.6 trillion over 6 years to get to ‘good repair’
- US: < 1% GDP
- Europe: 4% GDP
- India : 8% GDP
- China: 9% GDP



Infrastructure renewal as national imperative



Water Resilient Cities Conference | Levin College | Future-Proofing Infrastructure

April 21, 2016 Hillary Brown FAIA

Infrastructure renewal as national imperative



Challenges to conventional infrastructure design?

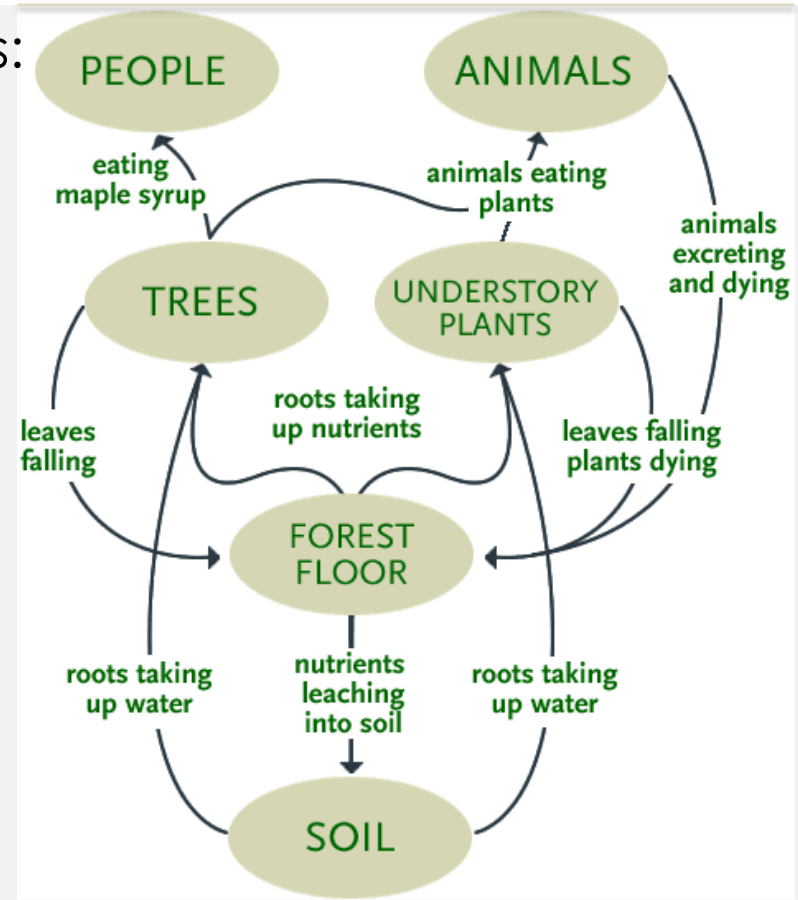
- low carbon imperatives
- NIMBYISM
- climate instability

New habits of mind

- From “silo” separation (fragmentation) to integration
- Recognize vital interdependencies of energy, water, waste, agriculture
- Capitalize on system synergies

“Infrastructural ecologies”

- Consider opportunistic relationships: technologies can be aligned and integrated synergistically
- Reflect the self-organized ‘ecosystems services’
 - water purification, waste digestion, biomass production, etc.
- Organized collectively and cooperatively, i.e. ecologically

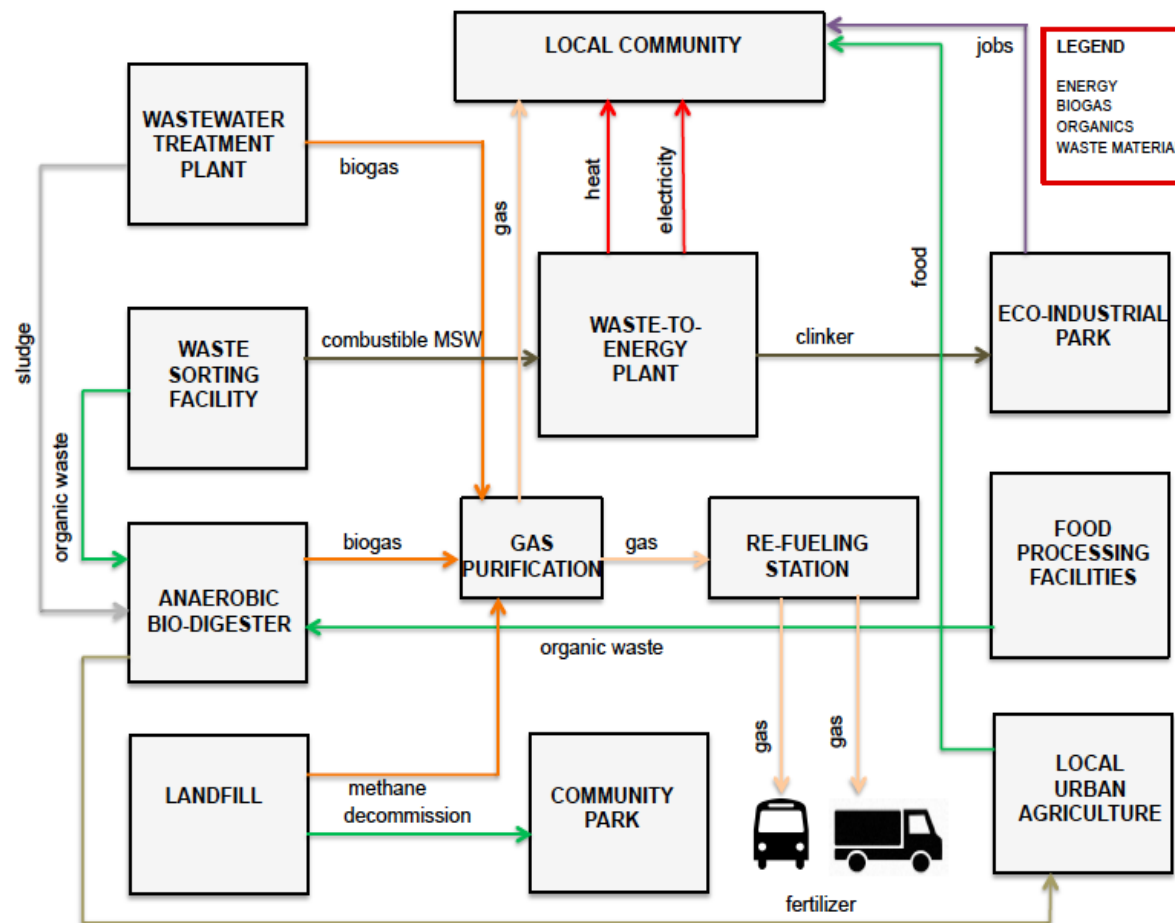


Forest eco-system

“Infrastructural ecologies”

A holistic system of beneficial exchanges across multiple sectors to reduce costs, improve performance and reduce impacts.

Fosters inter-system synergies by proactive colocation, capitalizing on adjacent or local land-uses, natural systems or resources



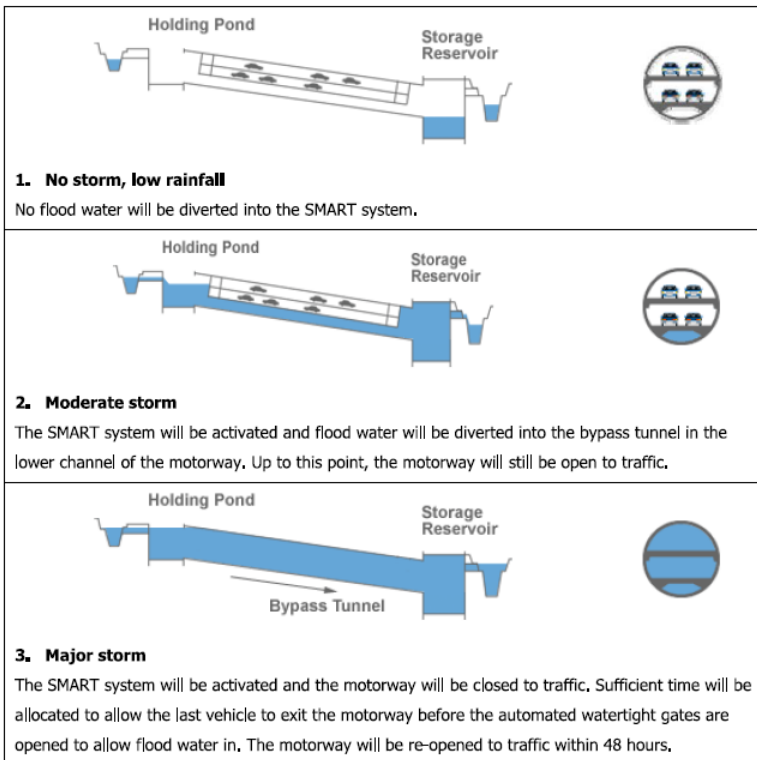
Public works and utilities that are ...

1. **MULTIFACETED:** multipurpose, interconnected and synergistic
2. **SOFT PATH:** work with passive, natural processes
3. **COMMUNITY-FRIENDLY:** improve social contexts and serve local constituencies
4. **LOW CARBON:** reduce global warming
5. **ADAPTED:** resilient and responsive to dynamic conditions of a changing world

1. Multipurpose interconnected synergistic

Tunnel & Stormwater Storage

Kuala Lumpur, Malaysia



Images © Michael Singer Studio, photo: David Stansbury

1. Multipurpose interconnected synergistic

civic plaza + sewage treatment plant

Forum/Besos Wastewater Treatment Plant, Barcelona, Spain



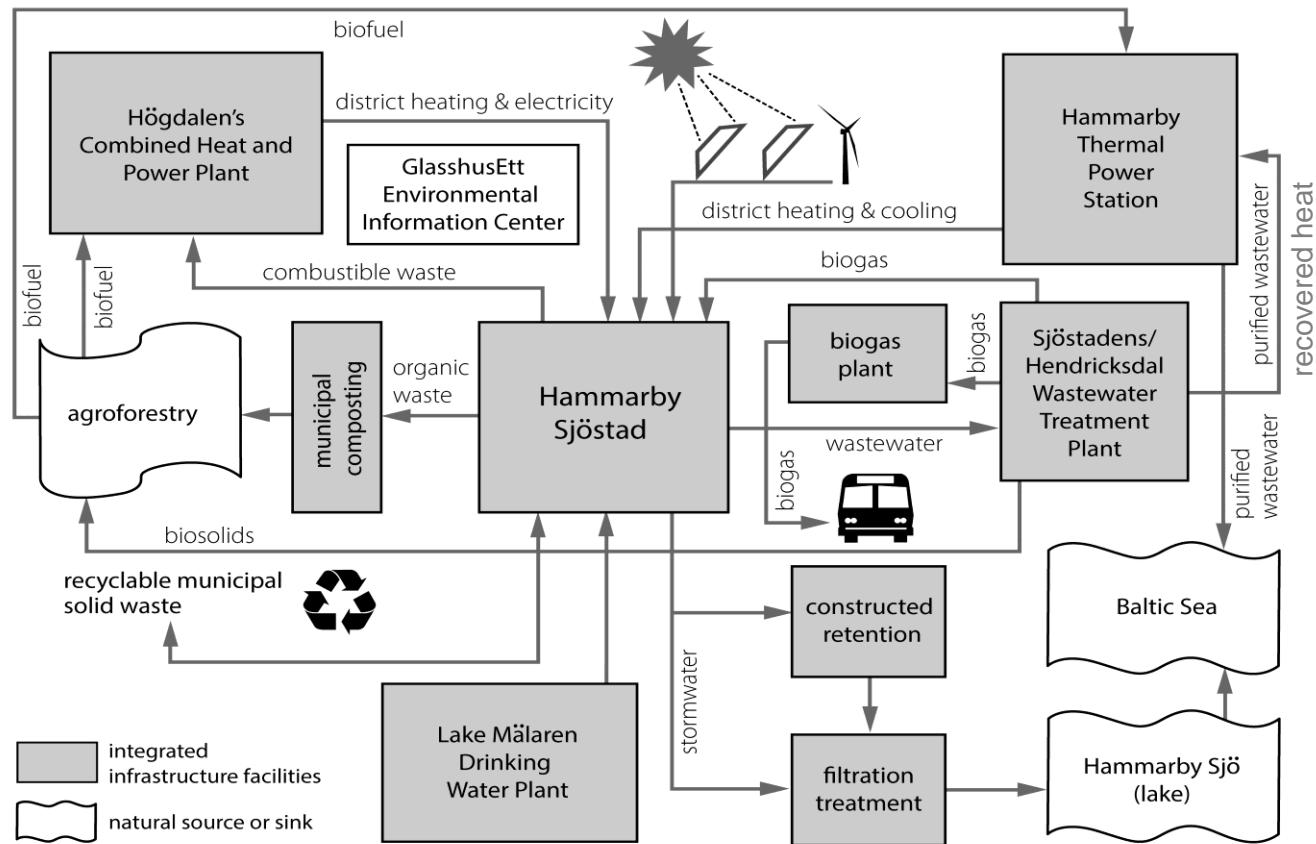
reservoir + power production

Yamkura Dam, Japan



1. Multipurpose, interconnected synergistic

Networked utilities: closed loop cycling of water, energy and matter *Hammarby Sjöstad, Stockholm, Sweden*



1. Multipurpose, interconnected, synergistic infrastructure

Justification for infrastructure ecology

Benefits/Cost savings

- Optimized land use \$
- Economies of scale \$
- Eliminated redundancies in maintenance and operations \$
- Synergistic cascading of energy and/or resources \$
- Reduced environmental impact/resource conservation
- Reduced construction disruption
- Community benefits
- Job creation and new tax revenue
- Increase resiliency

METRICS

- SO** Site optimization
- ES** Economies of scale
- OS** Operational savings
- RC** Resource Conservation
- RE** Reduced environmental impact
- RD** Reduced disruption
- PA** Public amenity /community benefit
- EB** Job creation/new revenue
- RE** Resiliency

$$\Sigma = \text{SO} + \text{ES} + \text{OS} + \text{RC} + \text{RE} + \text{RD} + \text{PA} + \text{EB} + \text{RE}$$

2,3. "Soft-path" solution/community friendly

ecologically reflexive: increasing reliance on natural systems

conventional infrastructure

hard, industrially engineered systems

focus on "Inputs & Outputs"

*large centralized treatment plants
and rapid conveyance*

single purpose land use (industrial)

'progressive' infrastructure

incorporating reliance on passive or
'soft systems' (natural processes)

attention to whole systems:
'upstream' and 'downstream' and
immediate context

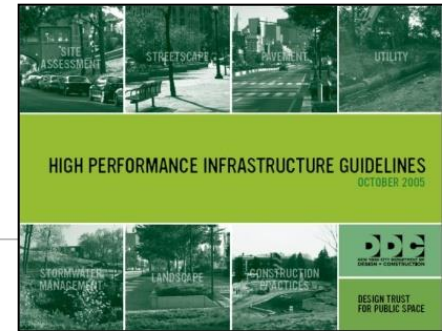
partly or wholly decentralized.
aspects of water sources/ use/
treatment/ disposal kept local

multiple use real estate – parks,
recreation and civic use

(adapted from Valerie Nelson 2007)

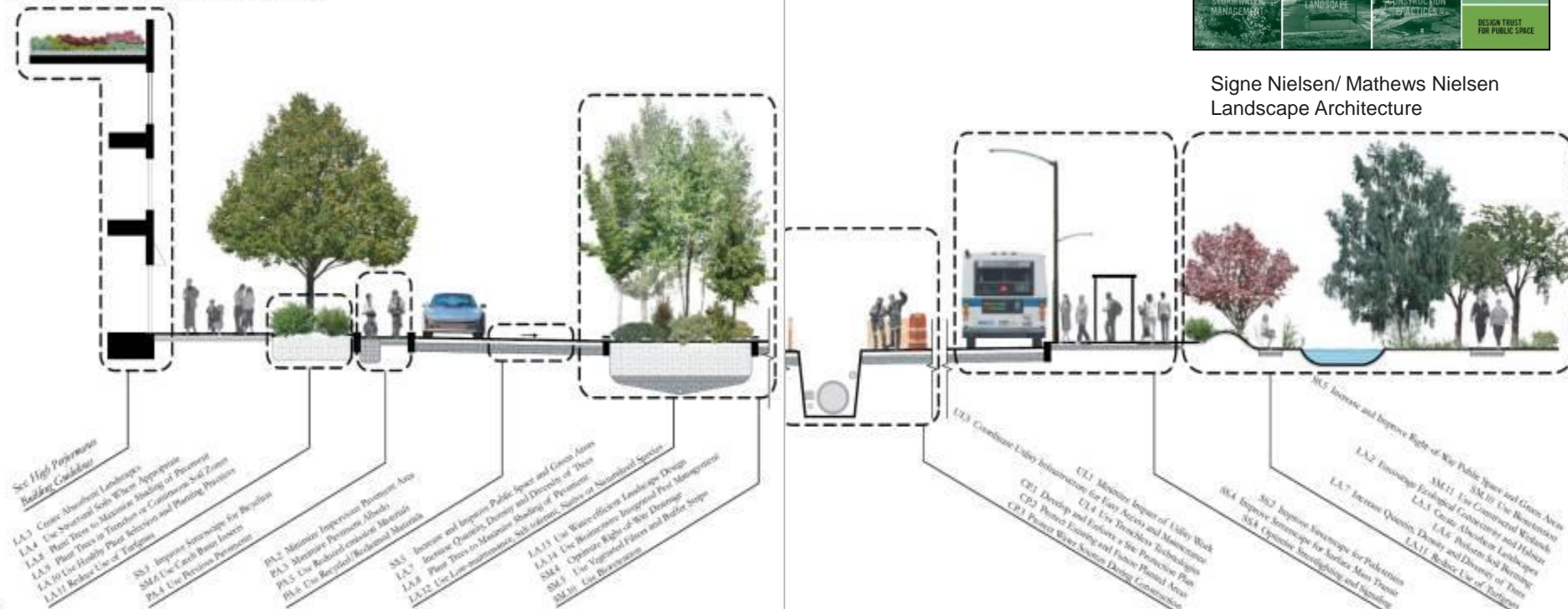
2,3. "Soft-path" solution/ community-friendly

City of New York High Performance Infrastructure Guidelines, 2005 integrating sustainable 'best practices' into the public right-of-way



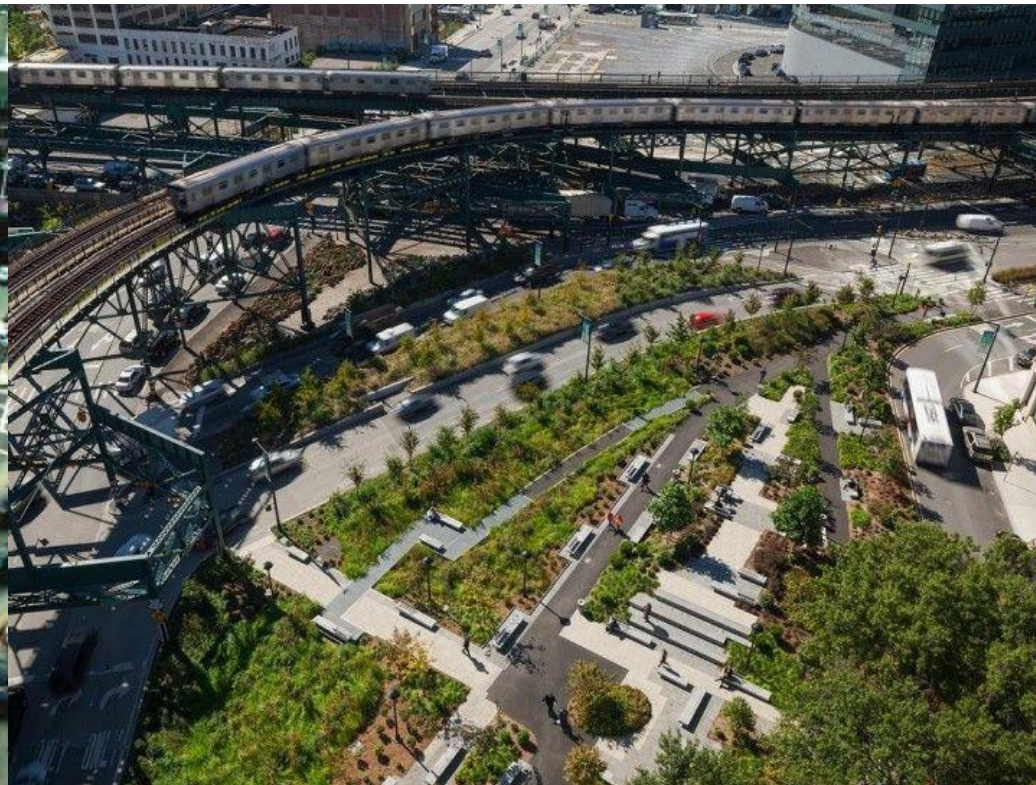
Signe Nielsen/ Mathews Nielsen
Landscape Architecture

INTEGRATION OF BEST MANAGEMENT PRACTICES



2,3. "Soft-path" solution/ community-friendly

City of New York High Performance Infrastructure Guidelines *Dutchkills Green, Queens, New York*



2,3. "Soft-path" solution/ community-friendly

Multiuse public waterfront park+ wastewater treatment plant

Sherbourne Common, Toronto Waterfront, Toronto Canada



Shai Gil, Courtesy Teeple Architects

2,3. "Soft-path" solution/community -friendly

water filtration plant + park/interpretive center + shared
conference facility

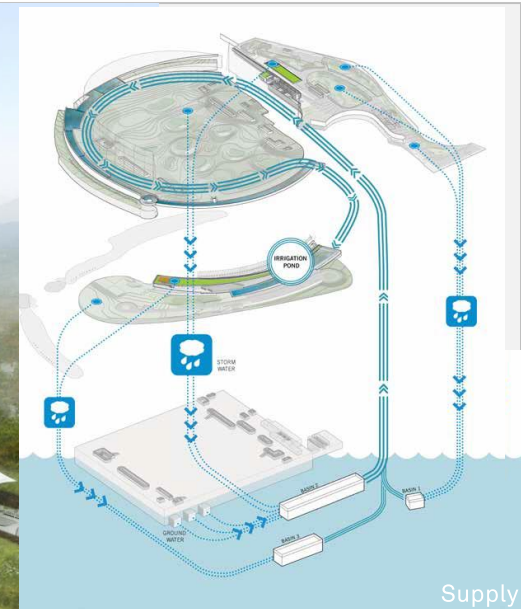
Willamette River Water Treatment Plant Wilsonville, Oregon



© Nic Lehoux, Courtesy Miller Hull Architects

2,3. "Soft-path" solution/ community friendly

Driving range/public facilities/ water filtration treatment plant Croton Water Filtration Plant Bronx, New York



2,3. "Soft-path" solution/ community friendly

Multiple purpose roofscapes

Rotterdam, The Netherlands

Neighborhoods + Distinct Opportunities



HARBOUR

POST-WAR DISTRICT

COMPACT CITY

19TH CENTURY DISTRICT

SUBURBS



Types of Sustainable Roofs



Green
Vegetation
Extensive or Intensive



Blue
Buffer Extra Rainwater
Collection Under Vegetation



Red
Active Use
Sports, Parties, Meetings, Etc



Yellow
Energy Collection
Solar Panels or Wind Turbines

Image: <http://www.urbanisten.nl/wp/?portfolio=rotterdam-roofscapes>

2,3. "Soft-path" solution/ community-friendly

Urban river water bioremediation for reuse + public park

Wadi Hanifah Bioremediation Facility Riyadh, Saudi Arabia



Courtesy Arriyadh Development Authority | Moriyama & Teshima | Buro Happold

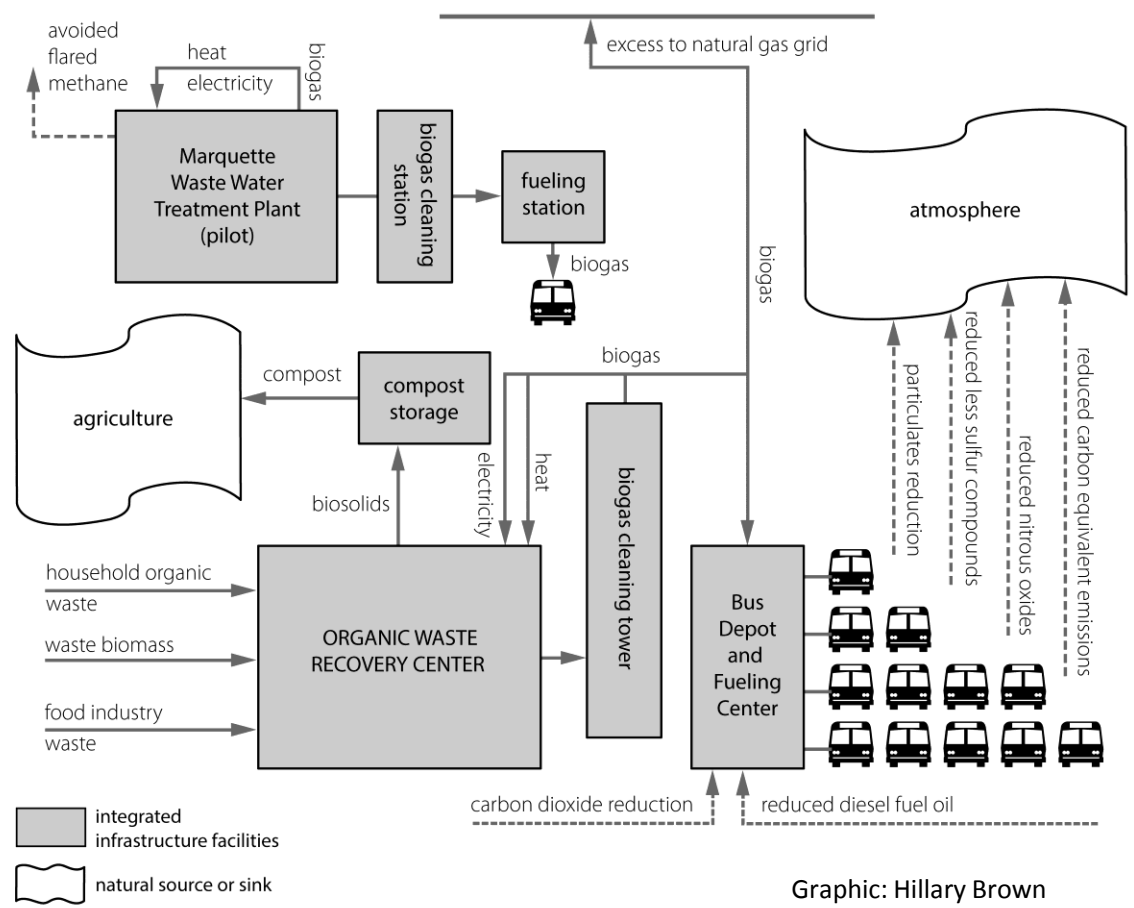
4. Carbon-reducing (green heat and power)

Biogas recovered from wastewater and organic waste

Lille Métropole Organic Waste Recovery Center and Transfer Center, Lille, France



Courtesy ADEME & Vous



Graphic: Hillary Brown

4. Carbon-reducing (green heat and power)

East Bay Municipal Utility District WWTP

Oakland, CA

WWTP Biodigestion program

- Sewerage plus restaurant food scraps, waste streams from wineries and poultry farms
- \$ 2.5 m savings in on-site electricity
- \$ 500,000 in selling excess to the grid



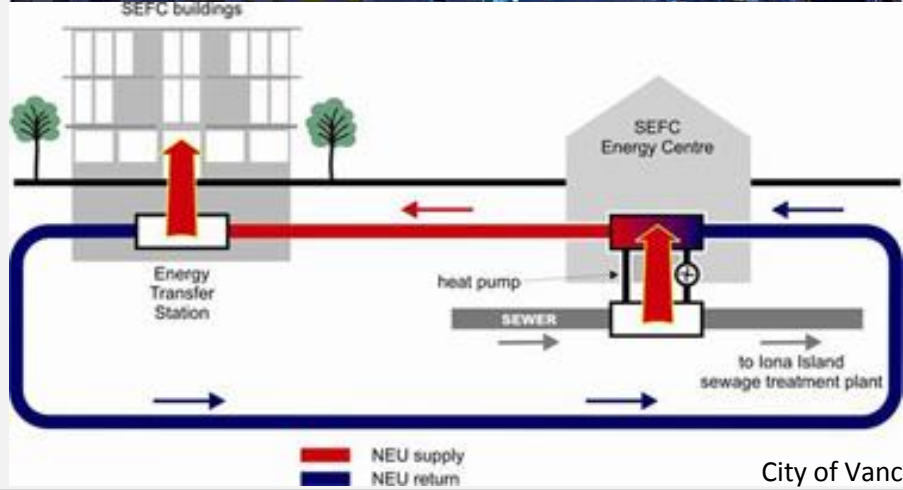
EBMUD

4. Carbon-reducing (green heat and power)

Southeast False Creek Neighborhood Energy Utility

City of Vancouver, British Columbia CA

- Thermal energy recovery from sewage supplies 3.2 MW of district heating and hot water to Southeast False Creek neighborhood
- 60% GHG reductions

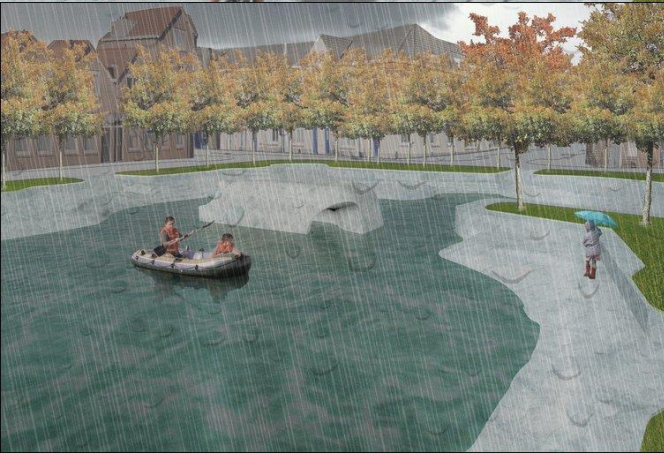


City of Vancouver.

5. Climate-adapted: responses to rising water levels

Hard Solutions: Water Squares (multi-use)

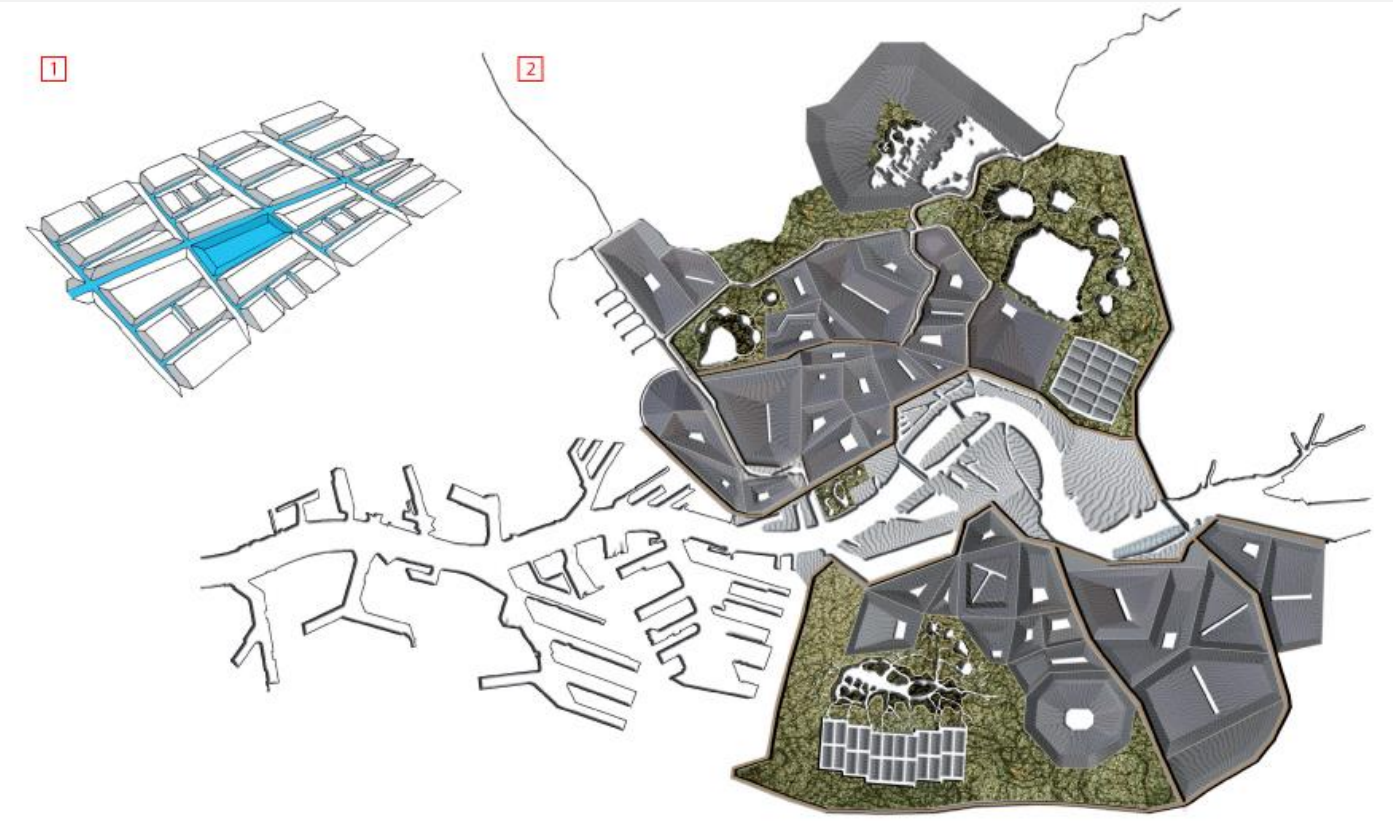
Rotterdam, The Netherlands



5. Climate-adapted: responses to rising water levels

Hard Solutions: Water Squares (multi-use)

Rotterdam, The Netherlands



Images © Michael Singer Studio, photo: David Stansbury

5. Climate-adapted: responses to rising water levels

Hard Solutions: Garage & Stormwater Storage

Rotterdam, The Netherlands

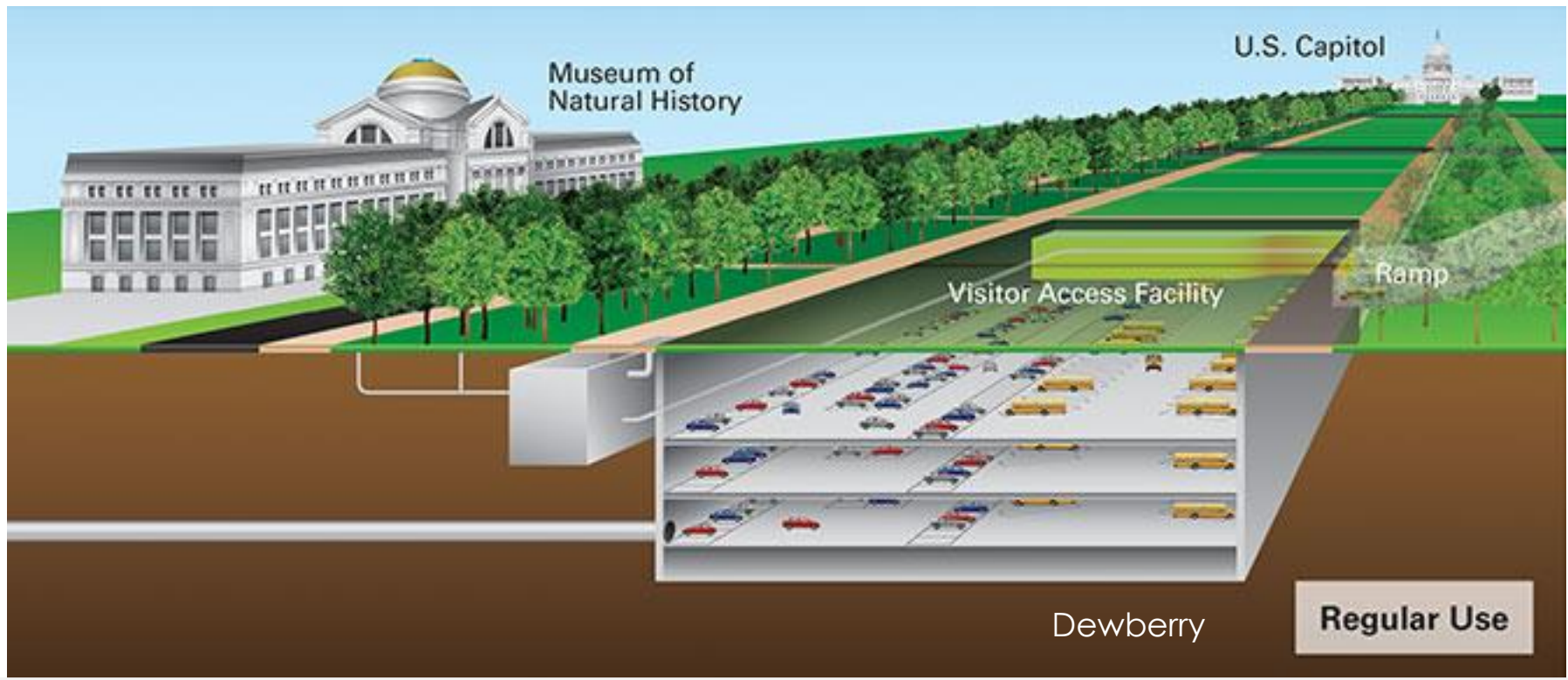


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5. Climate-adapted: responses to rising water levels

Parking & Stormwater Storage

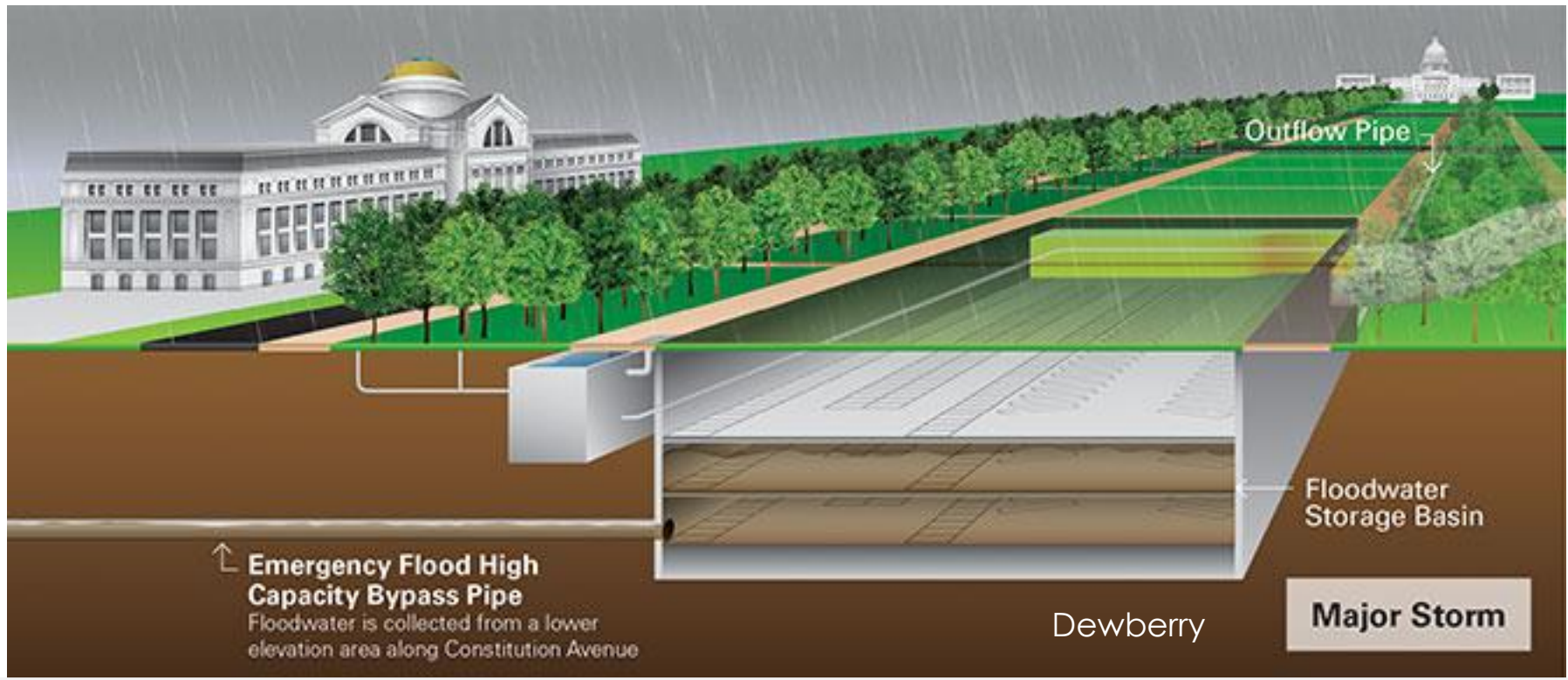
National Mall, Washington D.C.



5. Climate-adapted: responses to rising water levels

Parking & Stormwater Storage

National Mall, Washington D.C.




5. Climate-adapted: responses sea level rise, water shortage

Tidal Barrage + tidal power plant + visitors center + highway

Sihwa Lake, Banwol Bay, Korea

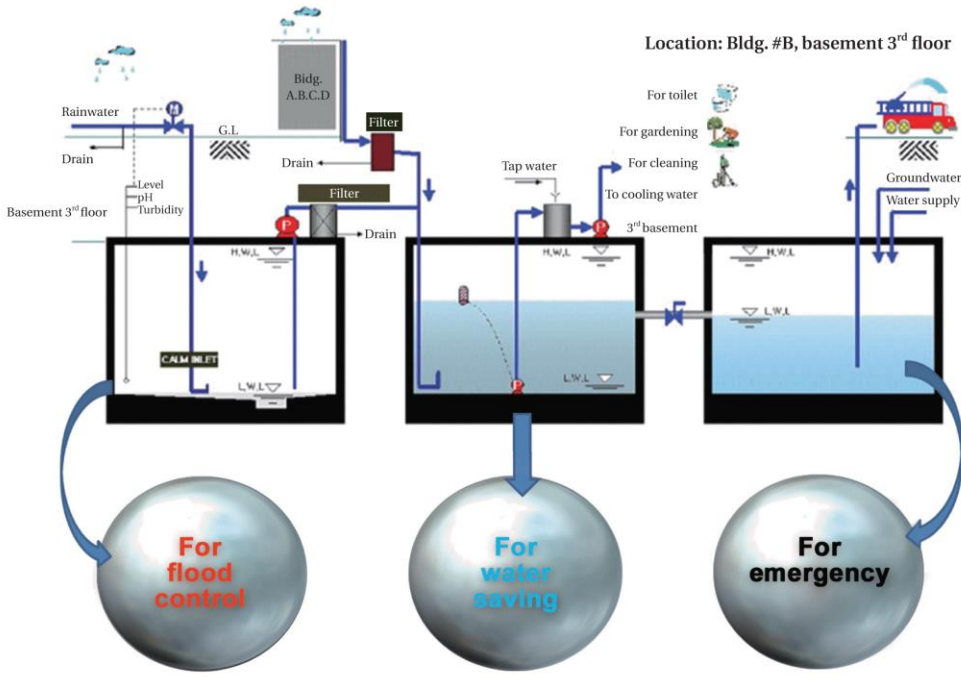


 한국수자원공사
Courtesy: Korea Water Resources

5. Climate-adapted: responses to water scarcity/stress

Urban rainwater harvesting and storage for multiple use

Seoul, Korea



5. Climate-adapted: responses to water scarcity/stress

Wastewater reuse: for energy production and industry

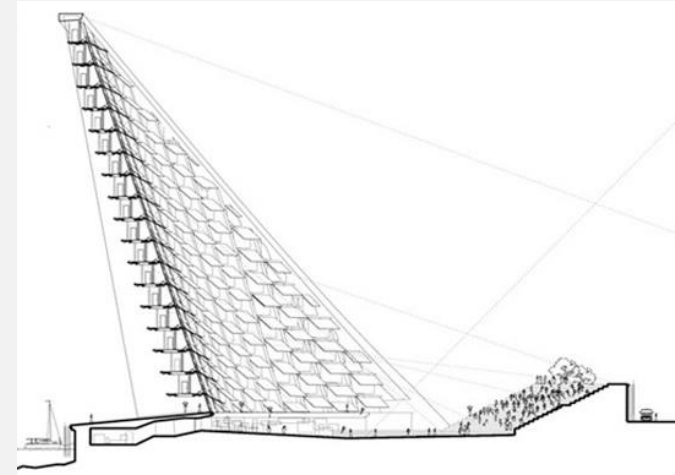
Mankato, MN



5. Climate-adapted: responses to water scarcity/stress

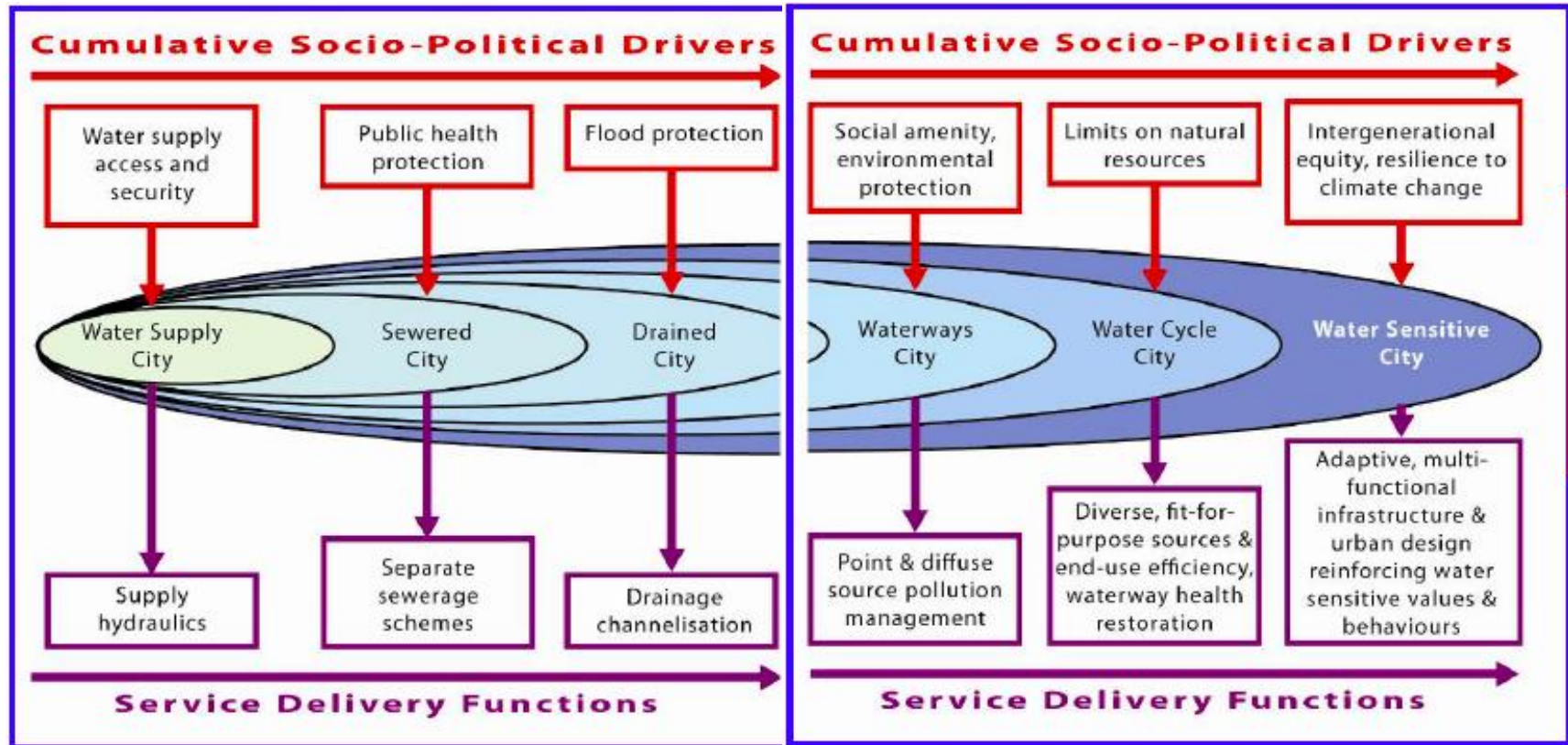
Solar desalination plant + civic amphitheater

“Teatro del Agua” – Tenerife, Canary Islands, Spain



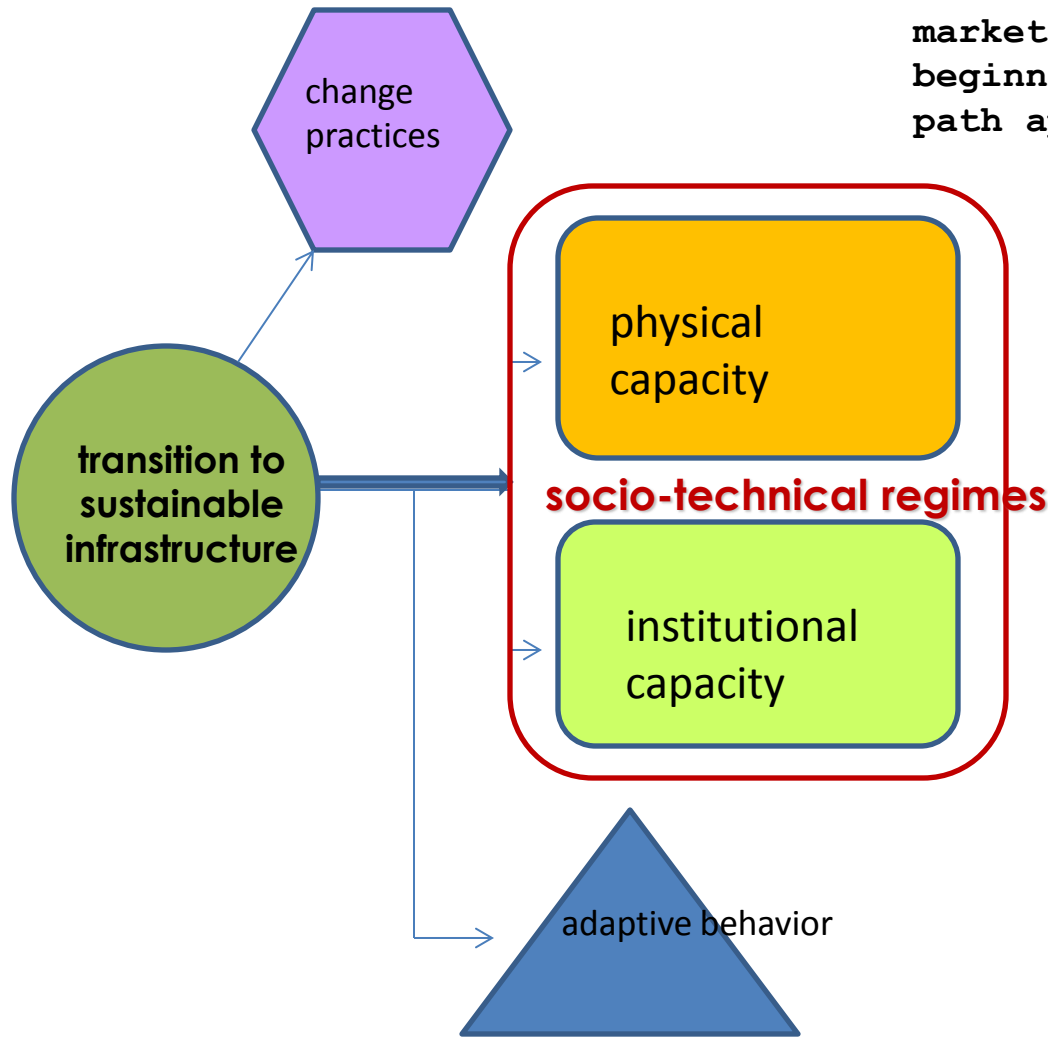
Trending towards the “soft path”

Sustainable urban water management – a framework



Brown, Keath & Wong 2009

" host of institutional and market rigidities and barriers to beginning a long-term shift to a soft path approach" - V.Nelson



challenges

- technology is easy part
- change to systemic ‘socio-technical’ regimes more challenging
- requires co-evolution of technologies and regimes

❖ planning, financing, operating, regulating

adapted from Bergman, Haxeltine et al 2008

“Think systematically; experiment locally”

- Oklahoma City sales tax : \$ 750 M for parks , bike trails, streetcar system and transit hub
- The Chicago Infrastructure Trust- private investment for cross-sector urban projects
- California I-Bank
- West Coast Infrastructure Exchange (WCX) regional energy, water and transport

State-developed alternative investment vehicles

- State revolving funds (SRFs)
- State Infrastructure banks (SIBs)
- “Green” banks

Federal level

- Water Infrastructure Finance Innovations Authority
- Federal Water Infrastructure Trust Fund

Financing entities adopt outcome-oriented, threshold, or supplementary criteria along lines of 5 principles

Award formulas aligned with 5 principles

prioritize projects that:

Support Mixed Land Use:

- Mixed-use by two or more sectors of of under-utilized, degraded or brownfield property
- Shared use of roads, operation, and maintenance facilities and utilities

Mitigate CO₂ Production

- operational energy efficiency coupled with on-site production of, or purchase of green power
- Interlinked facilities that reduce energy demand and environmental impacts through the recovery and exchange of waste, wastewater, or waste heat or other useful matter.

Award formulas aligned with 5 principles

prioritize projects that:

Incorporate green infrastructure

- Systems planned in accordance with integrated water-resource management programs
- On-site water harvesting, retention, and/or treatment for non-potable reuse or for direct infiltration, and to eliminate stormwater runoff

Integrate social and/or economic benefits

- Improved quality of life, and economic competitiveness for the community through inclusion of community amenities

Include climate adaptation measures

- place-based measures to achieve resilience against extreme weather events, or sited in climate-sensitive areas, with priority given to soft infrastructure
- Inclusion of safeguards (e.g., redundancy) to reduce cross-sectoral cascading failures.

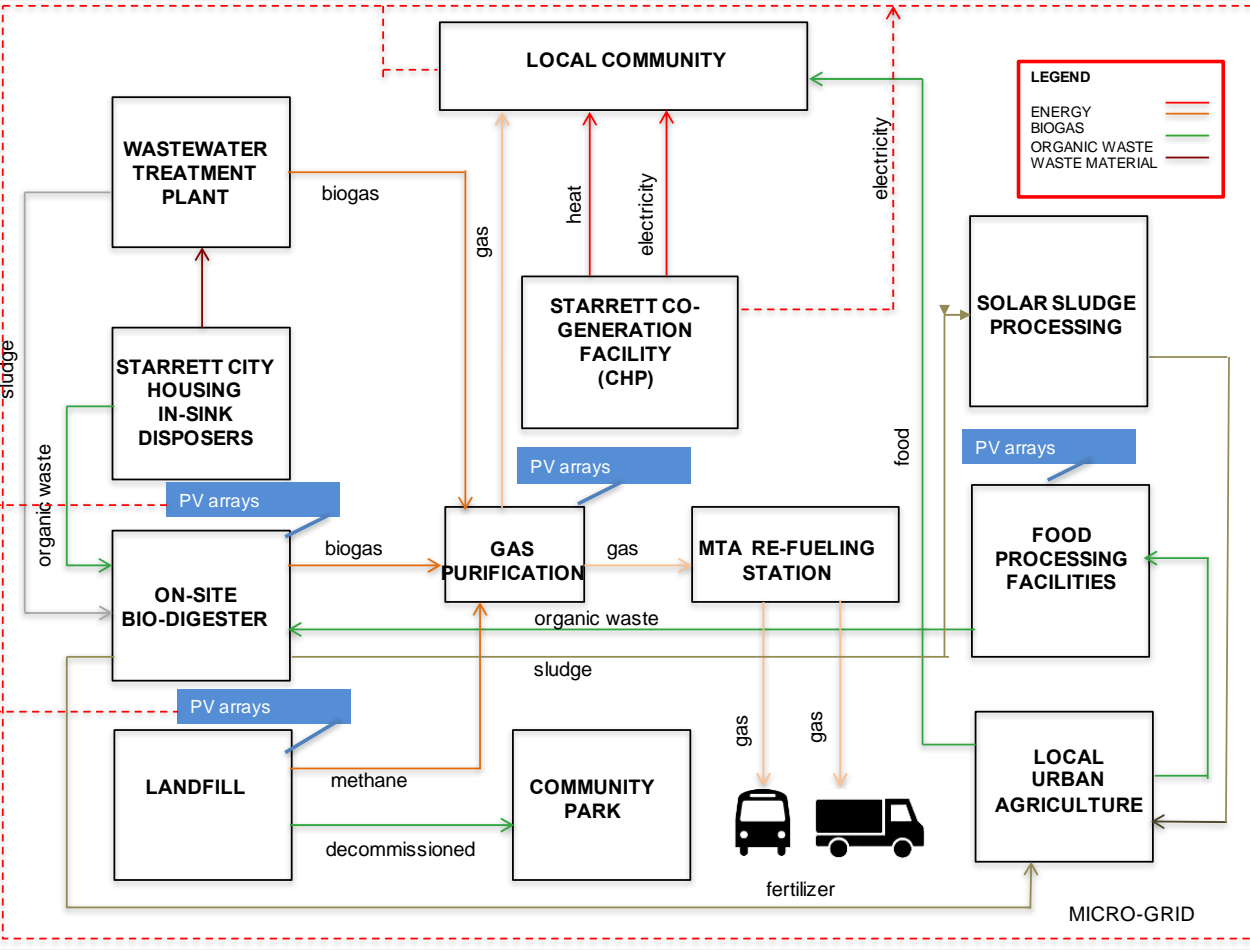
Commission Roles and Responsibilities

Advocate for cross-sector infrastructural improvements

- Promote integrated infrastructure development through advocacy, outreach and advisory technical support
- Broker between state and local authorities, service providers, and other stakeholders as well as private investors and equity owners
- Encourage blending of state (or city) funds from across multiple capital programs

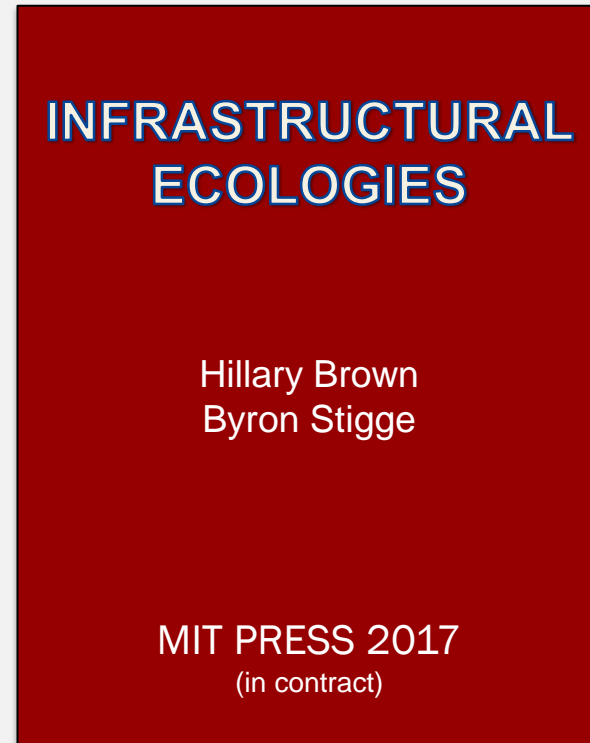
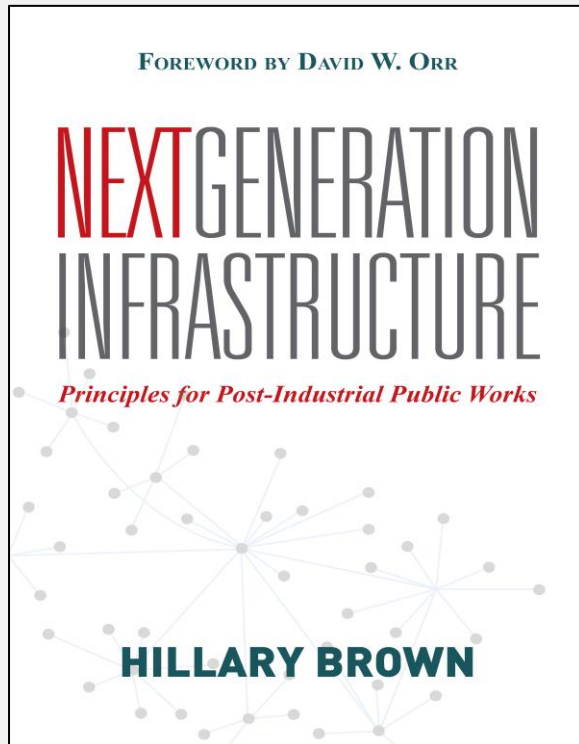
Infrastructural ecology

Jamaica Bay, New York



Thanks for your attention

QUESTIONS AND COMMENTS!



www.hillarybrown.net