Session Title: Sustainable Water Systems at the Bill & Melinda Gates Foundation
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Learning Objectives:

- Learn to consider multiple opportunities and options for designing an integrated rainwater harvesting system.
- Understand how fixed and seasonal demands drive the design of a rainwater harvesting system.
- Understand policy issues concerning the right to rainwater harvesting.

Presentation Content:

Site Context and Water Systems Issues and Opportunities

The Bill & Melinda Gates Foundation is built on a project site that has a long ecological history with a more recent history of challenges common to sites on the periphery of urban development.

- The pre-developed site was a wetland located in a saddle between two hills and perched above two bodies of water
- Located in an urban setting that was once on the edge of the core city
- There was significant soil contamination due to previous uses including a streetcar service yard and later a bus barn
- The contamination was made worse by the nature of the predevelopment soils
- Downstream water systems
  - Lake Union to the east (freshwater)
Elliott Bay to the west (saltwater)
Conveyance is combined sewer

Rainwater and Site Development Approach – the project’s development strategies were guided by a set of governing principles development by the project team.

• What’s right for the environment?
  ▪ Discharge
  ▪ Reuse
• What is downstream from us that needs the water?
• Can we reuse the water?
• Do we have to store it for re-use?
• If we reuse, to what level do we need to clean the water for storage?
• If cleaning, what can be done
  ▪ Embrace and engage the challenges and make something better
  ▪ Not just about “clean up” but rather embracing the challenge to be evocative and natural, but not just on the surface
  ▪ Clean-up specific to contamination lead to a larger theme of the project’s focus on integrating functionally in the environment.
    ▪ Emphasizing connection back to a global level through natural environment
    ▪ Everything done here, has impact globally

• What if we discharge the water?
  ▪ Downstream is Lake Union and combined sewer
  ▪ Lake Union seemed like the right option to relieve pressure on the combined sewer system
  ▪ Clean cool water provided to recharge an urban lake
  ▪ However, Seattle was in the process of completing three major projects disconnecting site from lake

• With Lake Union not viable, combined sewer would receive the water, pushing the problem downstream to the treatment facility, exacerbating the potential for CSO events
• Reuse is the answer
• Reuse required the evaluation of Water Rights

• Why reuse?
  ▪ It rains in Seattle, why collect?
    ▪ Dry summers! Drought type conditions
    ▪ 2015 year has been the driest on record
  ▪ Potable water is a precious resource that needs to be used appropriately
    ▪ Takes money, energy, and mother nature cooperating to have clean potable water
    ▪ Don’t contaminate potable water
      ▪ Rainwater requires treatment, just like any other water to meet potable standards
      ▪ So - Use rainwater to do the work where it can
• Water rights: history
  - The Department of Ecology is mandated to protect water and monitor usage
  - Traditionally for irrigation rights in arid or agriculturally productive lands
    - First come is priority
    - Last to get rights, first to be cutoff
  - Water rights in the Puget Sound basin in western Washington is more focused on riparian protection
    - Endangered species within rivers that need water flow (salmon)

• Water rights: project related
  - DOE required water rights to reuse rainwater even if going to combined sewer
  - City and other developers were installing rainwater cisterns without clear legal water rights
  - Foundation wouldn’t proceed with this approach
  - Other developers were in discussions with the City on how to change the requirements
  - Foundation joining that process helped sway the momentum to get the process legally changed
    - City of Seattle now manages the water rights for the areas of the City that discharge to combined sewers
      - About 1/2 of the City falls under this classification
    - Bullitt Foundation were able to use new water law, still pushing...grey water

With the decision to collect and re-use the rainwater on-site, the rainwater harvesting system needed to be sized by demand, collection potential, and detention requirements.

• Collection
  - 140,000 square feet of non-pollutant generating surfaces
  - Rooftops
  - Plaza
  - No green roofs
    - Organics
    - Staining
    - Increased filtration/maintenance costs
  - Conveyance logistics
    - Collection systems
      - One for areas to be collected
      - One for areas to bypass collection

• Storage
  - 1,000,000 gallon tank
    - 800,000 gallons of Reuse Storage
    - 200,000 gallons of Stormwater Detention (City requirement)
• Able to do double duty with the tank by incorporating live storage above reuse volume for detention
• Overflow system is combined with detention outlet assembly
• Waterproofing
  ▪ Located within finished spaces
• Access
  ▪ From above within the plaza for ease of maintenance

• Uses – matching supply to demand to optimize the benefits of potable water use reduction
  ▪ 715,000 gallons/year for Irrigation
  ▪ 847,000 gallons/year for Toilet flushing
  ▪ 226,000 gallons/year Water Feature make-up

• Plumbing logistics
  ▪ Toilet plumbing requires two supply systems
    ▪ Sinks get potable
    ▪ Toilets get purple pipe
  ▪ Top up system from domestic supply
  ▪ Low year available water vs Reuse need)
• Mission
  ▪ The Foundation’s work

• Building a campus
  ▪ Gates family has a long history with civic work in Seattle
  ▪ Family roots
  ▪ Foundation growing fast
    ▪ 2000 started
    ▪ 2006 - 300 people
    ▪ 2015 - 1600 people (on campus)

• Consolidating temporary facilities together
• Collaboration is critical to Foundation’s work
  ▪ Within the foundation
    ▪ Individual level
    ▪ Division level
  ▪ Grantees
  ▪ Governments
  ▪ Non-governmental organizations
  ▪ Other non-profit organizations

• Building need to reflect Foundation’s character and aspirations
  ▪ Bold
  ▪ Undertaking Difficult tasks
  ▪ Mindful
  ▪ Global mindset
    ▪ Local and global community

• How to build a campus
  ▪ Mission motivating design process and people who came together to be the team
  ▪ Highly collaborative process
  ▪ Team members
    ▪ Seneca
    ▪ NBBJ
    ▪ Sellen
    ▪ GGN
    ▪ CMS
    ▪ KPFF
    ▪ Arup
    ▪ Others!!!

• Sustainability
  ▪ Even though not part of core work
  ▪ Doing the right thing and what any responsible owner would do
    ▪ Look for ways to save water
    ▪ Habitat creation
Using Natural Systems Principles to Create Sustainable Water Features

The water features were an early design program element. The goal was to recall the site's original hydrology – a boggy, low-lying area – and interpret it a way that created flexible central space – the Central Heart. However, the Foundation had a responsibility to conserve the potable water resources of the City and the region. For this reason, if the water harvesting system were not part of the program, the Central Heart pool would not have been possible.

- Natural water system pools and how the Central Heart pool is maintained
  - Design criteria for natural water system
    - Constructed entirely over structure
    - Look to nature for principles and what is possible
      - Clear water
      - Life sustaining
      - Interdependence of systems of life
      - Ecological balance
      - Periods of natural cycles vary
      - Adjust system factors in favor of the species we like
System components
- Ratio of planted to open water area is targeted at one to one
- Sanitation system
  - Ultraviolet sanitizer
  - Mechanical filtration
  - Recirculation pump flow is as low as possible
    - Save energy
    - Gentle on the plants
    - Still water
    - But enough to disrupt mosquito reproduction
- Living systems
  - GGN selected reeds and rushes
  - Plants add oxygen (good) and biomass (not-so-good) to the water
  - Algae is a non-selected part of this plant system
    - Remove decaying plant material to discourage algae
    - Reduces nutrients that would promote algae growth
- Other living system connections
  - Water borne organisms consume algae
  - Zooplankton
  - Desirable insect larvae – dragonflies
  - Aerobic bacteria – consume algae, plant, and animal biomass
    - Creates nitrates through decomposition
    - Nitrates are used by the vascular plants

This is the balanced circle of life – producers, consumers, and decomposers
- In a chemically treated pool these systems do not exist through the constant introduction of chemicals that maintain a sterile condition
- In our natural system pool we have challenges to our objectives
  - Clear water
  - Maintaining life
- Challenge number one – algae
  - Unexpected conditions exacerbated its growth and necessitated more frequent removal
    - Reflected light and heat from modern, high-performance building glazing
    - The shape of the building focuses light energy
    - Combined the building provides a constant energy input into focused areas of the pools
    - Combined with decaying plant matter, the increased light and warmth encourage algae growth
- Challenge number two – supporting beneficial life
  - The water system return screens within the pool
o Large openings
  ■ Prevent clogging
  ■ Allow dragon larvae to pass through to the main filtration system
  ■ Staff periodically collects the larvae and returns them to the pool
  ■ Dragonflies have been named mosquito hawks but it is actually in the larval stage that they consume at a higher percentage, devouring the mosquito larvae

■ Challenge number three – understanding all life that may rely on the pools
  ■ Resident
    ○ Frogs? Tadpoles are consumers of algae and the adults would provide auditory depth to the campus
    ○ Fish?
    ○ Ducks

■ Transitory
  ○ Bird habitat
  ○ Migratory waterfowl
    ■ Ducks
    ■ Heron
    ■ Gulls
    ■ Other?

■ Time for a census?

■ System design lessons
  ■ Flocculation and manual skimming as a means of removing algae is done at the Foundation
    ■ All our previous experience had been using a vacuum, like a swimming pool device. It seems flocculation may be (other than the momentary unsightliness) a more expedient method of removal
• Unsightliness to general public could be minimized by programming the process to times of less usage of the human sort
• The sanitizing equipment (UV) has lamps that can be cleaned but the fragility of the lamps causes about half of them to break in the process
  • An accessory to the device allows an internal squeegee to clean them in place.
  This is certainly an option that can be quite cost effective