



A Program of the Buckminster Fuller Institute

**THE BUCKMINSTER FULLER CHALLENGE**

Catalyzing the vanguard of a design science revolution

# **2010 FINALIST**

## **Eco- Boulevards**

“Chicagoans discard over one billion gallons of Great Lakes water per day. This “wastewater” never replenishes one of the world’s most vital resources. As a remedy, this project re-conceives the Chicago street-grid as a holistic Bio-System that captures, cleans and returns wastewater and storm-water to the Lakes via “Eco-Boulevards.”

## **Assessment Summary from the BFI Review Team**

The metabolism of the city and its relationship to larger systems is becoming a critical space of inquiry, innovation and need for systemic solutions. Eco-Boulevards thoughtfully takes this relationship on. This team may be well positioned to develop and implement aspects of their model because they operate at the confluence of non-profit, educational, public and private sectors— at a high level. The team has a strong understanding of cultural and social-economic issues and tensions. Through Eco-Boulevards, they have a vision to relate and integrate often, marginalized communities as an important aspect of the development of the model. This is done via site selection, programming and design. So the system not only mediates our relationship to the ecosystem but it begins to heal long rifts in older models of urbanization. The model is bold for taking on wastewater conditions and for the long-term vision of rendering the centralized systems obsolete. While that may be questionable the intention could elevate the innovation in solutions, so we commend the position. They had a strong understanding of best practices and the latest technologies to consider. They understood the obstacles and means to work through them and overall are a strong capable team. This model could be instrumental in how cities around one of the largest bodies of fresh water operate as mindful gatekeepers of a critical resource.

**WEBSITE:** <http://www.urbanlab.com/h2o>

**VIDEO:** <http://www.vimeo.com/7354723>

# Entry Application

## Eco-Boulevards

### **Project Team:**

UrbanLab:

Martin Felsen, Architect

Sarah Dunn, Designer

Katherine Eberly, Designer

Lee Greenberg, Designer

Jeff Macias, Designer

Paul R. Anderson, Illinois Institute of Technology, Environmental Engineer

Janet Attarian, Chicago Department of Transportation

Cathy Hudzik, Chicago Parks District, City of Chicago

Archeworks:

Giles A. Jacknain, Consultant

Kees Lokman, Landscape Architect

Mason Pritchett, Designer

Andrew Vesselinovitch, Designer

Jesse Vogler, Designer

### **Summarize your proposal in 50 words or less.**

Chicagoans discard over one billion gallons of Great Lakes water per day. This "wastewater" never replenishes one of the world's most vital resources. As a remedy, this project re-conceives the Chicago street-grid as a holistic Bio-System that captures, cleans and returns wastewater and storm-water to the Lakes via "Eco-Boulevards."

### **Describe the critical need your solution addresses. 50 words**

Chicago's environmental and economic health is directly tied to the health of the Great Lakes. Blue/green Eco-Boulevards bolster Chicago's long-term vitality by filtering/recycling water, promoting walking/biking, nourishing bio-diversity, and fostering green-jobs. Eco-Boulevards emphasize interconnectivity to support Chicago's goal of sustainable urban growth.

### **Compare and contrast your initiative with at least two leading initiatives addressing the same critical need. In comparison to these initiatives why is your proposal more likely to effect change and make a distinguishing impact? 200 words**

Seattle and Portland are implementing green infrastructure storm-water initiatives that have similar performance characteristics to the Eco-Boulevard concept. These initiatives manage storm-water runoff at the local level through the use of natural systems, or engineered systems that mimic natural systems, to treat polluted runoff, and recharge ground/surface water. Runoff is directed into landscaped catchments or through pervious surfaces to ultimately infiltrate through soils.

The problem: neither Seattle's nor Portland's green infrastructural systems treat wastewater. And neither city has developed plans for city-wide green infrastructure implementation.

Re-designing Chicago's non-sustainable water infrastructure will have a profound impact because the Great Lakes are a global resource holding 21% of the world's, and 84% of North America's fresh surface water. Water availability is becoming a key global issue as water scarcity/pollution and climate change bear down on the planet. Even in the comparatively water-rich Great Lakes region, global warming could ultimately create more urban flooding, frequent droughts and a scramble for water. Implementing blue/green infrastructure that safeguards ecosystem health and drives sustainable development is imperative. This is especially the case for cities adjacent to the Great Lakes because the Great Lakes Region is a \$2 trillion/year economic juggernaut.

**Explain your initiative in more depth and its stage of development. 200 words**

The Eco-Boulevard concept transforms existing roadways, sidewalks and parks (the "public-way"), which comprise more than a third of the land in a city such as Chicago into a holistic, distributed, passive bio-system for recycling Chicago's water. Treated water is returned to the Great Lakes, closing Chicago's water loop.

Eco-Boulevards are ecological treatment systems that make use of natural bioremediation processes to remove contaminants from storm-water and wastewater sources. In the proposal, two types of bio-systems are at work: Type A and Type B. Type A is a hydroponic bio-machine that uses aquatic and wetland ecological processes to treat wastewater naturally. These processes are carried out in reactor tanks in enclosed greenhouses. Type B is a wetland bio-system that uses constructed wetlands and prairie landscapes that use low energy processes to biologically filter storm-water naturally.

Currently, the Team is in the process of: (1) preliminarily designing a full-scale bio-system prototype to be implemented on Chicago's south side; (2) creating an Eco-Boulevard Calculator to measure the performance and benefits of blue/green infrastructure; and (3) developing a Storm-water and a Wastewater Toolbox of best management practices (BMPs), which is a catalogue of Chicago-specific multifunctional blue/green best environmental and social practices.

**How does your strategy and approach respond creatively and comprehensively to key social, cultural, economic, ecological, and technological issues which shape the condition you are seeking to transform? Why is your strategy a breakthrough and what makes it a preferred state model? 300 words**

The Eco-Boulevard concept re-conceptualizes current roadway designs on a case-by-case basis (over time) to create a preferred breed of performance-based infrastructural landscapes. Integration and connectivity between ecological and social systems is the key breakthrough toward the cultivation of a healthy ecosystem. Benefits of Eco-Boulevards include the following interdependent, multifunctional systems:

**Social**

The project evenly spreads the amenity of open green space throughout the city, stitching together historic ethnic and economic boundaries. Public space is created for diverse socialization and play such as walk/bike trails, hardscape sports fields and pocket parks. Additionally, planting beds for community members to micro-farm organic fruits, vegetables, and flowers are provided.

## Environmental

Beyond a sustainable water system, the project creates a significant city-wide reduction of urban heat island (UHI) effect; increased organic filtration of pollutants and CO<sub>2</sub> in the air; filtration of pollutants and heavy metals out of rainwater; substrate creation and soil formation; and, increased connectivity and biodiversity in the insect, invertebrate, bird and wildlife habitat.

## Energy

Reducing levels of runoff entering storm-sewers significantly reduces energy loads (and GHG emissions) because pumping and treating rainwater in a single centralized location is energy intensive. Eco-Boulevards treat storm-water and wastewater with highly distributed energy neutral systems. Harvesting energy from microbial fuel cells is also under investigation.

## Economic

On a local level, the Eco-Boulevards raise adjacent land values significantly, especially in economically depressed areas. Eco-Boulevards become social and economic attractors: high densities of compact live/work spaces will increase steadily along the Eco-Boulevards. On a city-wide level, a sustainable water supply allows the city to achieve economic growth that other less water endowed cities will be unable to sustain. Conceptual plans of Eco-Boulevards can be found here: <http://www.urbanlab.com/h2o>

## **Describe your implementation plan. What are the priority milestones you intend to achieve in years one (1) through three (3)? 200 words**

### Storm-Water Bio-System (2008-09)

The Eco-Boulevard Team has been collaborating with the Chicago Department of Transportation to integrate sustainable storm-water practices into the design and engineering of several roadways soon to be renovated throughout Chicago. Design and engineering of the roadways are ongoing and at various phases of completion prior to construction.

### Calculator (2009-10)

The Team began research phases of the Eco-Boulevard Calculator mid-2009. The calculator will assess the costs-benefits of planning/building conventional design/engineered urban infrastructure relative to the costs-benefits of planning/building comprehensive, multifunctional blue/green infrastructure. The goal of the calculator is to give policy and decision makers the validated information they require to invest in and transform the grid.

### Wastewater Bio-Machine System (2010-11)

Chicago's centralized wastewater treatment system has the largest carbon footprint in Illinois. Beginning 2010, the Team will research, design and engineer an energy-neutral distributed hydroponic bio-system that treats wastewater naturally in vertical greenhouses situated within Eco-Boulevards.

### Demonstration Site (2011-13)

Beginning 2011, the Team will work with City of Chicago officials toward designing, engineering and building a prototypical blue/green "Eco-District" containing Eco-

Boulevards. The chosen site within the city will be part of a significant community economic development initiative.

**Please provide details regarding the team and/or partners you have assembled, the team's experience and qualifications, and your ability to execute your implementation plan. If applicable, include details about external validation and/or support your strategy has received to date. 200 words**

The Eco-Boulevard Team is composed of architects, landscape architects, a biologist, an environmental engineer, an evolutionary ecologist, a lawyer, an environmental policy advocate, an interdisciplinary group of students, and City of Chicago officials from the Department of Transportation and Mayor's office. Team members are also university instructors at the Illinois Institute of Technology, University of Illinois at Chicago, University of Chicago and Archeworks (Chicago's alternative design school). The highly motivated Team of experts has been working to realize various aspects of the Eco-Boulevard initiative since early 2008.

#### Past Support (2008)

Seed funding for the Eco-Boulevard project was provided by Chicago's Environmental Fund. The funding provided support for two reports issued to City of Chicago officials titled "Growing Water: Plan of Chicago" and "Chicago Department of Transportation Storm Water Initiatives."

#### Current Support (2009-10)

The American Institute of Architects (AIA) is funding the Eco-Boulevard Calculator (see above for calculator details).

#### Validation

The Eco-Boulevard concept has been published in magazines such as The Next American City and Places (a peer reviewed journal); exhibited at the Museum of Science and Industry in Chicago; and, received multiple awards from the American Institute of Architects and The History Channel.

**What are the primary obstacles that might prevent your initiative from being realized? How do you plan to overcome them? 150 words**

Currently in Illinois, water reuse is illegal according to Illinois EPA regulations. These policies require investigation and advocacy for change. Our proposal to build a distributed system of bio-machines to clean and recycle wastewater within the Eco-Boulevards will require public policy adjustments.

Chicago's failed Olympic bid for the 2016 summer games was a setback for the implementation of Eco-Boulevards. The Team designed a system of Eco-Boulevards linking every Olympic venue with public transportation systems, walkable public spaces and parks throughout Chicago, and the Olympic Village site. The upside to Chicago's loss is that the project received extensive coverage by the local news media. The project has the support of Chicago's Mayor and the city's Department of Transportation and is still moving forward.

**What range of funding is needed to bring your project to fruition and from where do you anticipate funding will come? Explain how your initiative will financially sustain itself. 150 words**

The United States budgets \$112 billion per year for infrastructure. Our aim is for this initiative to provide the necessary metrics to qualify for large-scale public investment. Urban roadways, sidewalks and parks are built and/or reconstructed every day. This construction process is massively expensive, but we (Americans) have already decided that these expenditures will remain a continuing national priority. We believe the Eco-Boulevard and many other green infrastructure concepts should ultimately be funded with the same pool of dollars currently spent on conventional infrastructure. Blue/green infrastructure investments reduce the long term costs on the maintenance and replacement of conventional infrastructure systems, and if managed properly, investments based upon natural capital can yield high returns. A significant component of this project is the creation of designs and metrics necessary to provide public/private decision makers with the data necessary to invest in infrastructure that is financially, ecologically and culturally beneficial to all.



Bird's Eye View

# Chicago will be a model city for Growing Water

The city will become a holistic Bio-System multiplying + intensifying Chicago's "Emerald Necklace" of parks, boulevards and waterways; and saving, recycling and "growing"

## 100%

of its own water, which, in the near future, will become the world's most valuable resource.



Eco-Boulevard  
UrbanLab

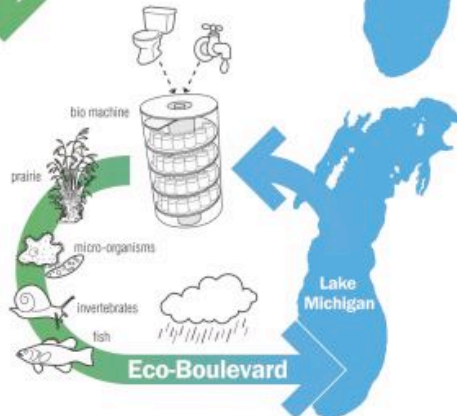
Chicago will be a model city for Growing Water

## Closed Water Loop Reverse the System

**Today**  
(Water = Waste)



**Tomorrow**  
(Eco-Boulevards)

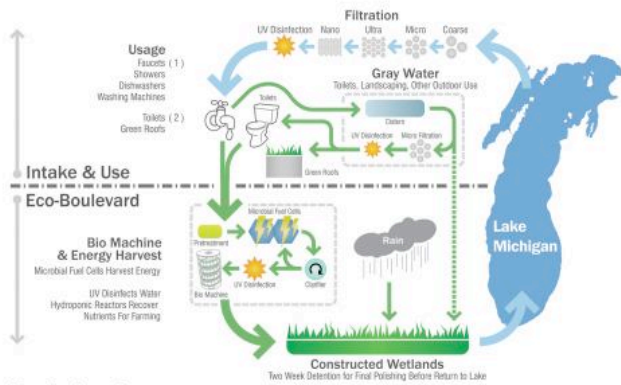


Eco-Boulevard  
UrbanLab

Closed Water Loop

## The Engineered Closed Water Loop Clean Water + Energy

A detailed look at the closed water loop exposes the inter-connectedness between the extraction, use, reuse, and cleaning of water from Lake Michigan. First, water taken from the lake undergoes a series of filtration stages. After the water is filtered, it is sent to consumers for use. "Gray" water (water from sinks, showers, etc.) is disinfected and reused for appropriate purposes in its own loop. Meanwhile, "black" water (water from toilets) is cleaned in greenhouse Bio-Machines. Microbial Fuel Cells contained in the Bio-Machines harvest naturally occurring energy produced by bacteria during the cleaning process. After being cleaned in the Bio-Machines, water is sent through a wetland flow process in the Eco-Boulevards and ultimately returned to Lake Michigan.



Eco-Boulevard  
UrbanLab

The Engineered Closed Water Loop

## Eco-Boulevards

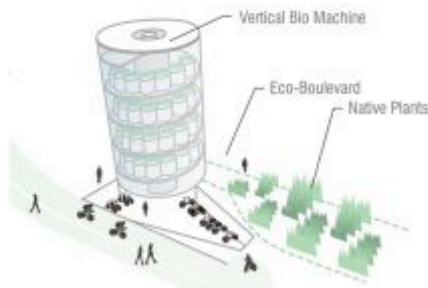
# Treat Wastewater + Stormwater on Site

### Indoor/Greenhouse Bio Machines Type A: Hydroponics

Hydroponic Bio-Machines are ecological treatment systems that use aquatic and wetland ecological processes to treat wastewater naturally.



### Vertical Bio Machine + Bike Rental



Eco-Boulevard  
UrbanLab

### Outdoor Bio Systems Type B: Wetlands

Wetland Bio-Systems are constructed landscapes such as wetlands and prairies that use low energy processes to biologically filter stormwater naturally.



### Sample Bio System



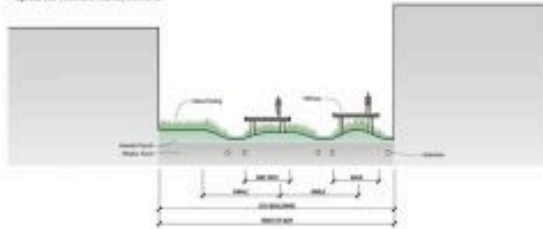
Source: Living Designs Group + OceanWells  
Jong Ho Kim, Korean Cultural Center, Los Angeles

Eco-Boulevards Treat Wastewater and Stormwater on Site

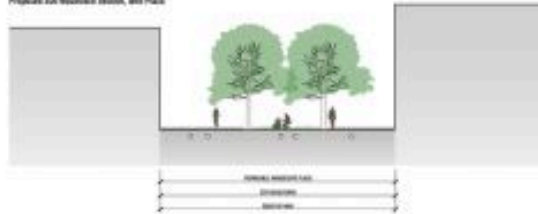
Design Analysis (For Chicago Department of Transportation)

# Roadway and Sidewalk Sections

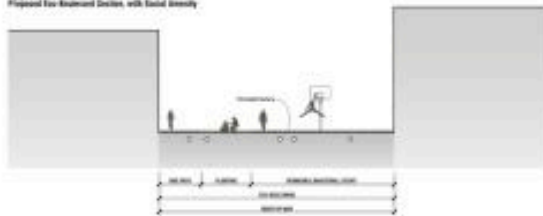
**Type A**  
Proposed Eco Boulevard Section, Suburban



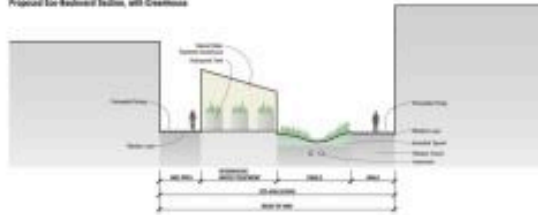
**Type B**  
Proposed Eco Boulevard Section, with Plaza



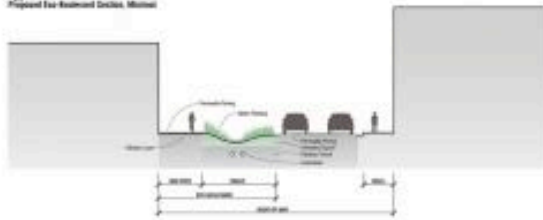
**Type C**  
Proposed Eco Boulevard Section, with Social Activity



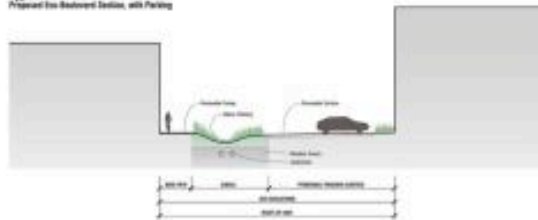
**Type D**  
Proposed Eco Boulevard Section, with Greenhouse



**Type E**  
Proposed Eco Boulevard Section, Minimal



**Type F**  
Proposed Eco Boulevard Section, with Parking



**Eco-Boulevard**  
UrbanLab

Design Analysis for Chicago Department of Transportation

# Interview

## Eco-Boulevards

### **Others are exploring similar concepts what distinguishes yours? What is the breakthrough here?**

It's has to do with the site. The idea of natural systems is out there. What we first tried to do is look at the city- Chicago specifically - to try and figure out the spatial conditions from a social equity point of view. The project started as an economic blvd first. Chicago is very segregated north/south, with a wide disparity between the have and /have-nots. Our question was initially; how can we tweak the fabric of the city to help the city economically but under the framework of a natural resources perspective? The importance of water is going to be a serious global issue, particularly with the Great Lakes representing 20% of the world's freshwater resources. We are thinking far ahead and trying to plan for the kinds of transformations that will be needed in the future. It's about the long-term planning based on social equity that goes hand in hand with resources spent.

### **Please tell us more about the status of any potential demonstration sites or actual projects.**

There are two types. The first is a storm water toolbox. We're working with the city with regard to their regular storm water maintenance practices and regulations. This tool box or storm water manual can be used with any new design and it can be applied in layers.

The second site is at 31<sup>st</sup> street that is a blvd that's never been renovated. There are a few stakeholders on that street and one of them is the Illinois Institute of Technology. They are planning to build a new student dormitory there. Our role is to develop the bio-system to support this dorm for both black water and grey water breakdown and to design the system to allow expansion for future dorms that get built. 31<sup>st</sup> street was going to be the Blvd for the Olympics and our Eco-Blvd master plan was based on this assumption. Now we need to renegotiate what will happen. So funding has become a new obstacle. I think it will happen just not the grand scale.

### **You mention that water reuse is currently illegal in Illinois. What are the legal issues you face? In this demonstration site where will the treatment waste and storm water go?**

In our design it would go to wetlands and then either get piped to the lake or work it's way down the ground and back to the lake. There has been some movement on these issues and variances have been given on a case-by-case basis, mostly private practice. We've having conversations with EPA and they may be inclined to consider some variances for a demonstration site; they will be looking closely at the engineering analysis and findings.

### **What is the relationship between the large existing centralized systems and Eco-Boulevards?**

We think that there's an enormous pressure on these grand 20<sup>th</sup> century legacy systems. They are about 100 years old and starting to fail and have high maintenance costs.. In most states, those plants have the largest energy footprint.. We'd like to try and lower the need for these systems by using natural systems to also lower the impacts

In Chicago, like in many cities the storm and sewer is combined, we'd be reducing storm-water.

**Are vertical "hydroponic bio-machines" proven, cost effective technologies suitable for treating large volumes of municipal liquid waste? Is this technology based on John Todd's Living Machines? If not, on whose prior work are you basing this treatment system and how successful has it been?**

We're definitely looking at John Todd's work. We've been concentrating also on the storm water. When we saw the Challenge we thought this could be a great way to ramp up some research into the bio-machines. We would like to integrate programming and the engineering with these kinds of systems and that's the kind of research we need to do. We're hoping to take existing technology and move it into the city to make it work in an urban environment.

**Have you seen these systems work and are they cost effective?**

Yes, the systems seem to work. We've gone to see some in Wisconsin. They have a lot of organic soluble water and they clean it with chlorine and all sorts of things. Then they bring it into a living machine. They figure out how to work very simply, it's only about 12 cells total. The maintenance is minimal with only one guy. It works well from a cost analysis perspective. They claim that it's cost effective in lots of different ways.

**What are the practical limits and obstacles you face in providing a wastewater collection system from the existing pipes to the new points of treatment?**

We're always trying to work with gravity. A lot of the infrastructures are set up to feed into the sewer system. We figured out a way to create linear systems and a point-based system. We agree that retrofitting buildings is expensive so we are framing this in terms of 50-100 years. It sounds more long term than it is. There are quite a few projects happening which could incorporate these approaches and we could begin to see transformation occurring over a 30 year time horizon.

**You talked about microbial fuel cells. Are microbial fuel cells currently an available technology at commercial scale?**

Our partner is Kimberly Grey at Northwestern. She and her students have been working on this problem. There is not an off-the-shelf product yet. But they are confident they can create something today to capture that energy.

**Is there any benefit to capturing latent energy in black water via anaerobic digestion to produce bio-gas which in the process kills 90% of the pathogens?**

One of the organizations that we are working with is Metropolitan Water Reclamation District. They are concerned about gender adjustments happening with amphibians resulting from the chemicals are in the water. We have to develop some solution to that. The bio-machine must be energy neutral. It has to be gravity fed, solar heated solar cooled.

**Have any calculations been done to determine how much domestic black water can be treated for a given area of eco-blvd?** The only quantitative models we've developed are based on storm-surge. All the global models are showing that we will get these intense storms. So we always need to find larger areas of sequestration. We want to move that water around through the eco blvd so things are not flooded. Most of the current research is around the 100 year storm.

**How much attention have you been able to give to the social dimension? The demand for recreation in Chicago and what the EcoBLVD might create for that?**

We provided a PDF for Archeworks our not for profit. The mission of Archeworks is to bring good design to underserved communities. We're really focused on green infrastructure. We're working on transforming spatial liabilities like brown fields and abandoned lots to create pocket projects and opportunities for recreation. It's all about how you leverage these spaces to increase the health base and recreational needs. That's how we're trying to address that side of the issue.

**Can you tell us what the next 12 months look like in terms of your project's development?**

The AIA commissioned us to create "The Blue and Green Infrastructure Calculator" in order to provide a metric based tool for everyone to look at and to understand that it is more cost effective to build green. We're currently in the research phase of that. We do partnership building including the Illinois EPA. We are not dealing with wastewater. We would like a parallel research project for this.