Green Infrastructure for Cities

Chicago's Stormwater Strategies for Streets

NAWCA Stormwater Management Committee Meeting

July 20, 2011, Chicago, IL

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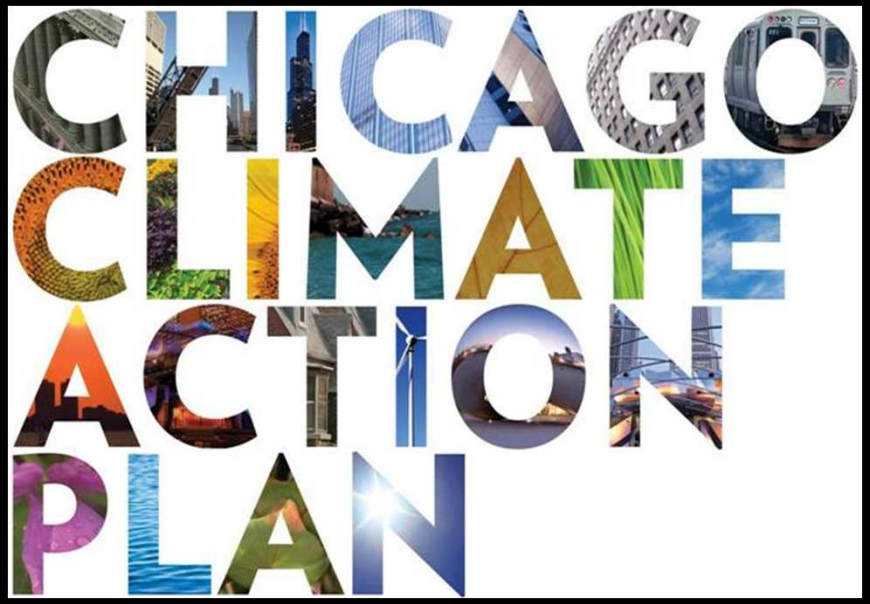


Five Strategies -

254 performance measures

ADDRESSING THE CHALLENGE OF CLIMATE CHANGE

ENERGY EFFICIENT BUILDINGS
8 ACTIONS

CLEAN & RENEWABLE ENERGY SOURCES
5 ACTIONS

IMPROVED TRANSPORTATION OPTIONS
10 ACTIONS

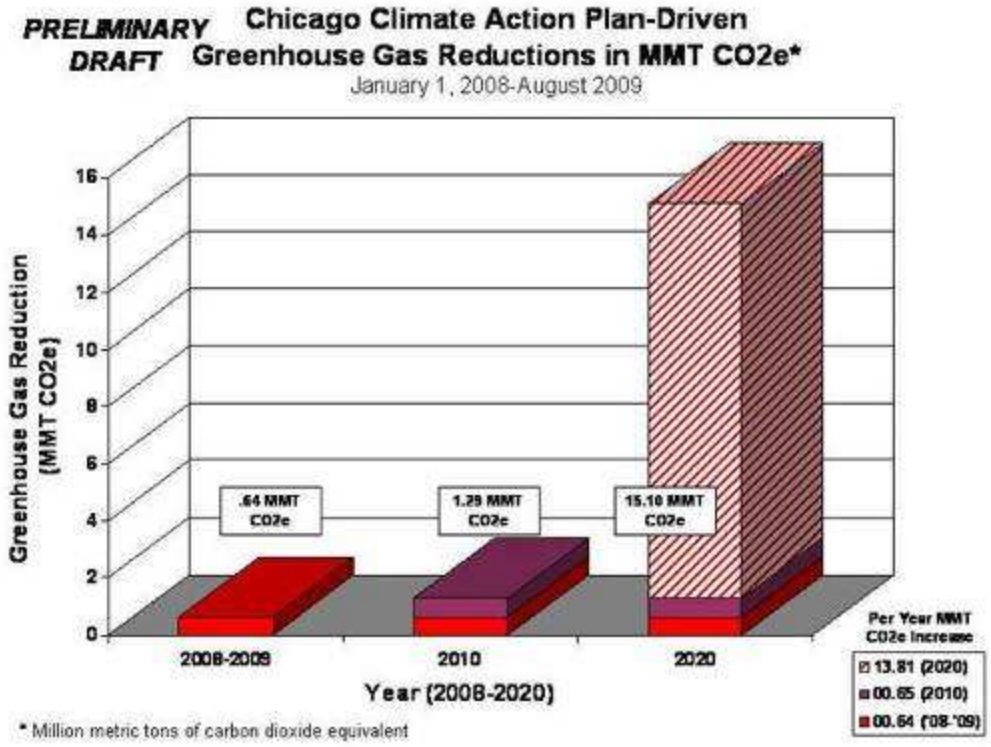
REDUCED WASTE & INDUSTRIAL POLLUTION
3 ACTIONS

PREPARATION
9 ACTIONS

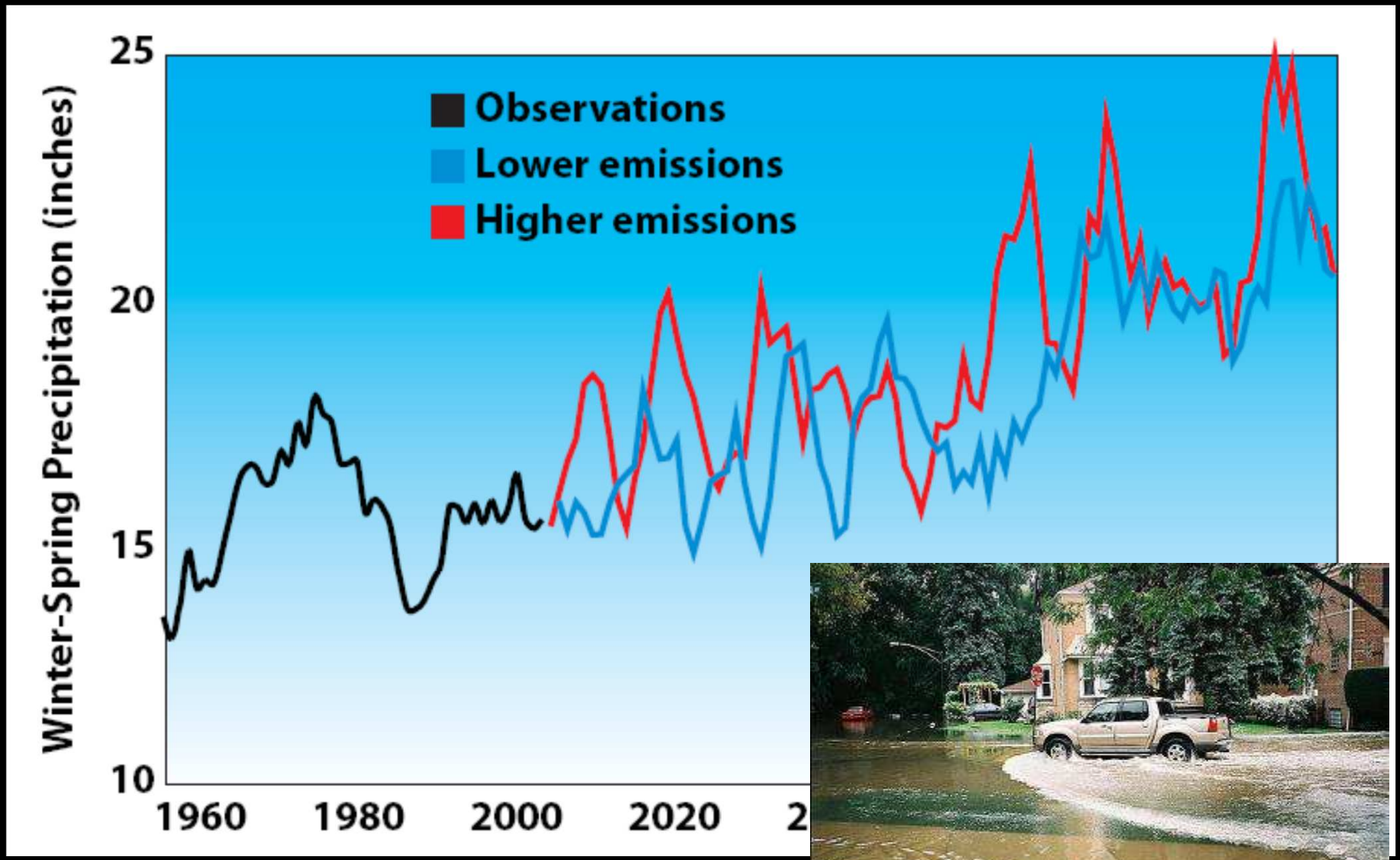
=

35 WAYS

TO ENSURE A RESILIENT CITY



Chicago Climate Action Plan: Adaptation and Mitigation



Source: CCAP

Is Water the New Oil?

20% of the Earth's fresh water is deposited in the Great Lakes

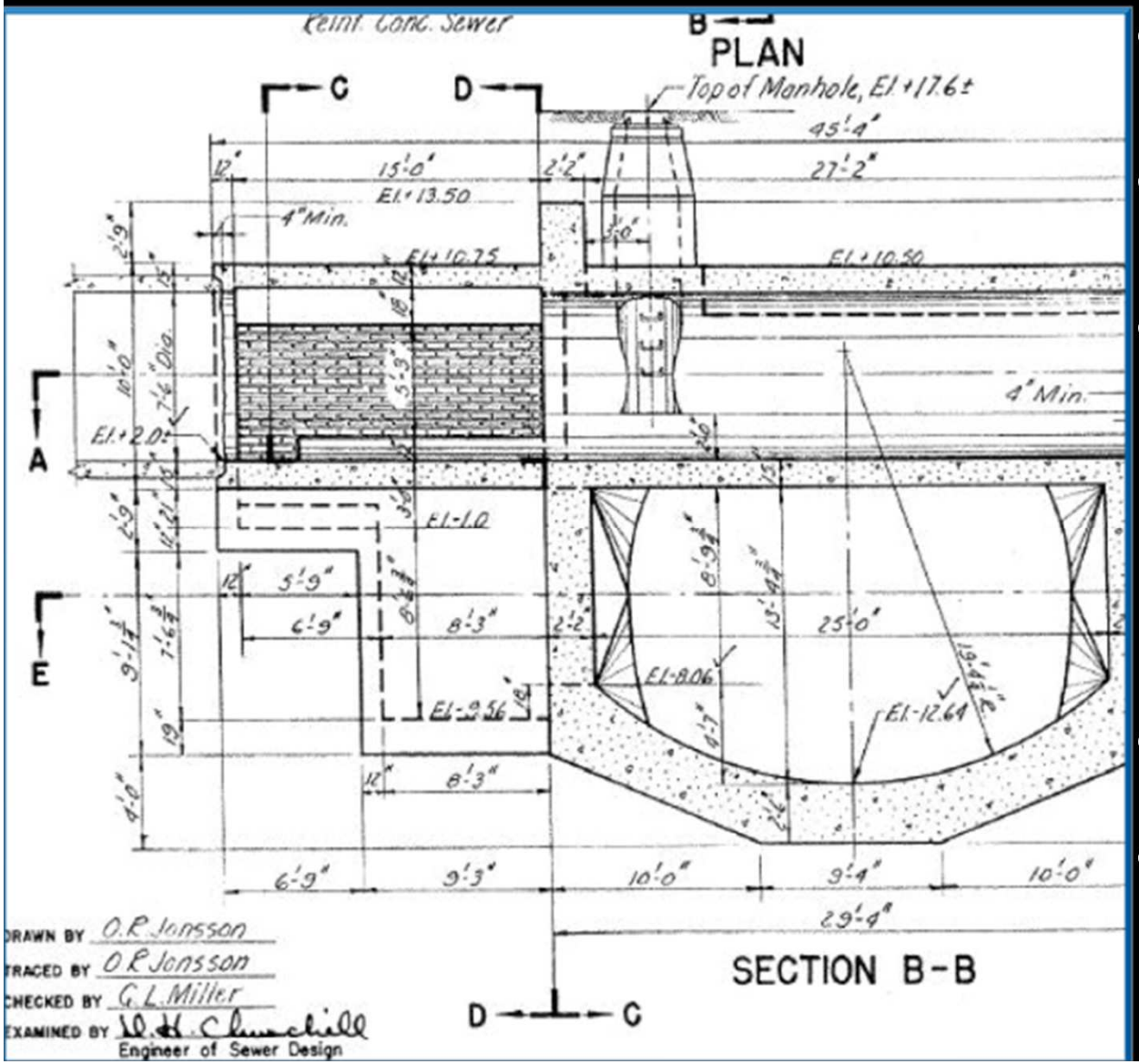
90% of the United States' fresh water is deposited in the Great Lakes

1,000,000,000 (Billion) gallons of Lake water per day are consumed by Chicagoans

<1% of drained water is renewed by Chicagoans

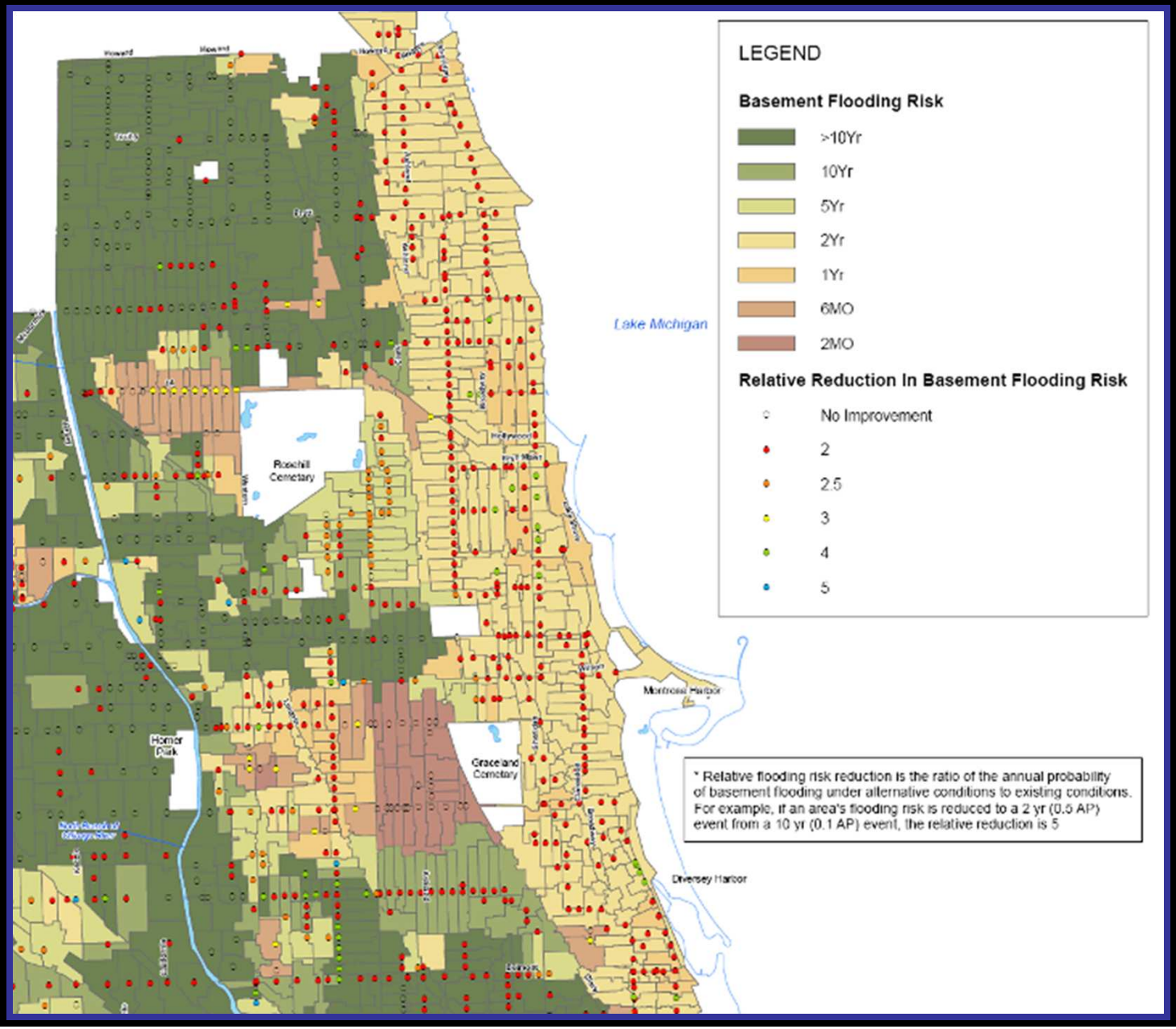
Source: Urban Lab

City Modeling Efforts - Incorporate Multiple Sources of Existing Sewer and Related Data and Produces Decision-Making Support Information

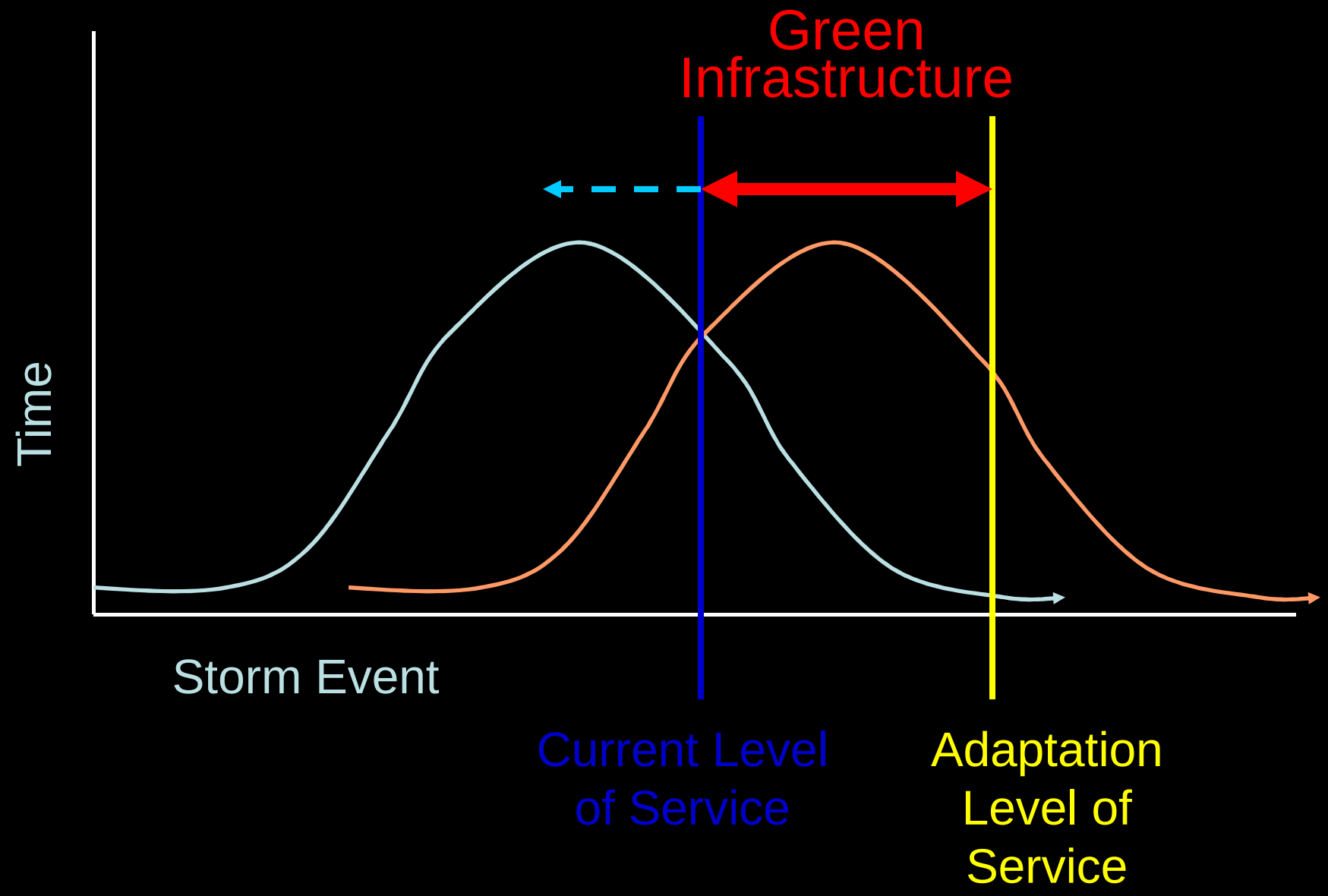


- Aerial Photography of Project Area *(2007)*
- Sewer Atlas Provides Base Network Data
- GIS layers integrated to define hydrologic model
  - Rooftops
  - Road Layer
  - Sewer GIS Data
    (updated in modeling process)
    MH, CB, loc, diam, invert
- Drainage Areas Defined
- Record Drawings Define Important Hydraulic Connections

Basement Flooding Risk Reduction - 25% Removal of Impervious Area



Climate Change and Infrastructure Adaptation



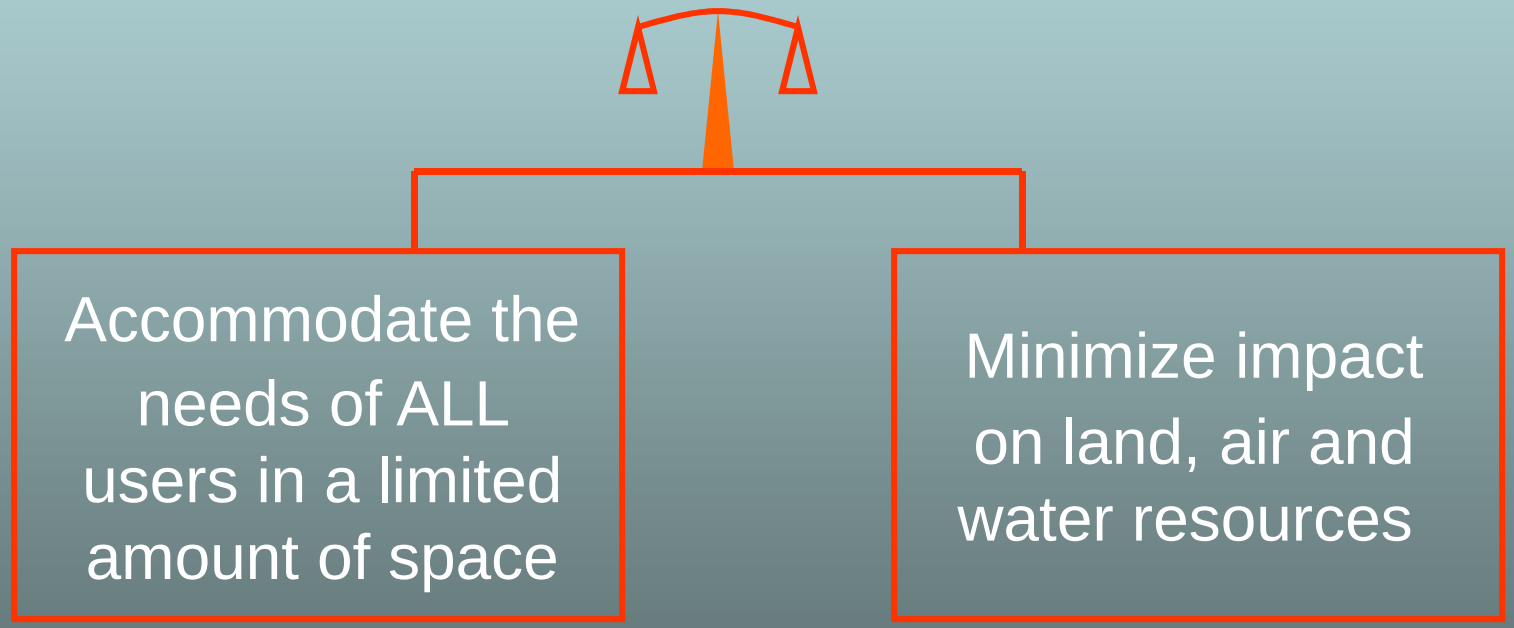
Leadership: Chicago Climate Action Plan

Permeable Pavement

Adaptation
(Infiltration)

Mitigation
(Energy use)

Old Fashioned and New Fashioned Sustainability



Green Alley Program

- Six pilot locations, and over 150 locations citywide
- Program includes use of permeable pavements, recycled materials, high-albedo pavements, and dark-sky lighting.
- Improves stormwater management and energy use through infrastructure improvements

Green Alley Program

Development of Permeable Asphalt and Concrete:

- Best Practices
- Material Testing
- Trial Batches
- Recycled Content- Slag/GTR

The Ground Tire Rubber Solution:

- Approx 600 tires recycled per alley
- Solved cohesion problem

Maintenance: Post-Construction Green Alleys

Eagle

Power Washing

Tymco

Pelican

Johnston

Little Wonder

Green Alley Maintenance Protocol

Chicago Green Alley Sweeping Procedures

1- Identify Alley by Green Alley Stamp in Apron

2- No Spray

3- Low Speed

4- Double Pass with Brushes Positioned over Permeable Pavement

Chicago Green Alley Design Types

Permeable Concrete Center Trench in Concrete or Asphalt Alley

Full Width Permeable Concrete, Asphalt, or Brick Paver Alley

Wider Implementation

Bioswales

Sidewalk Parkways

Pocket Parks

Residential Parking Lanes

Wider Implementation

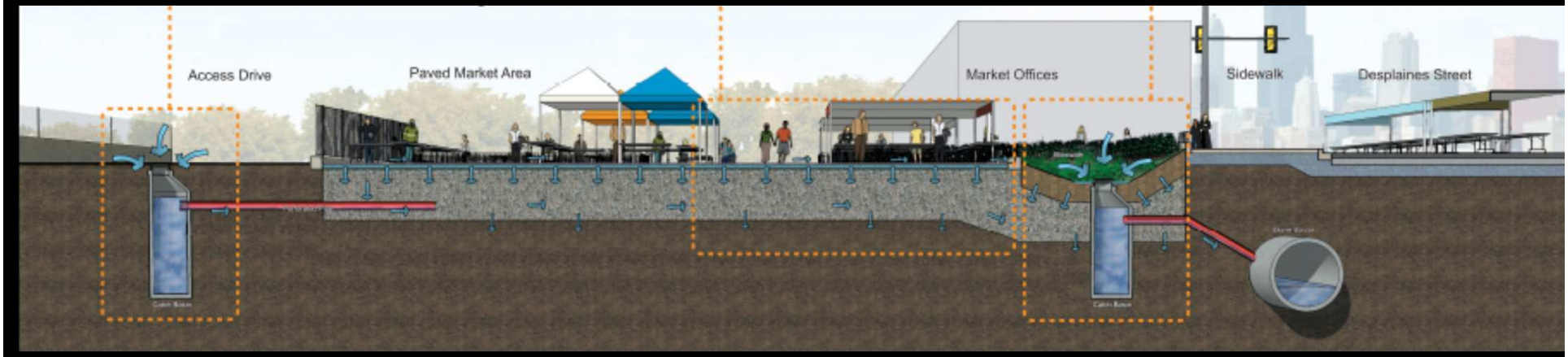
Pedestrian Way

Market Plaza

Diagonal Parking

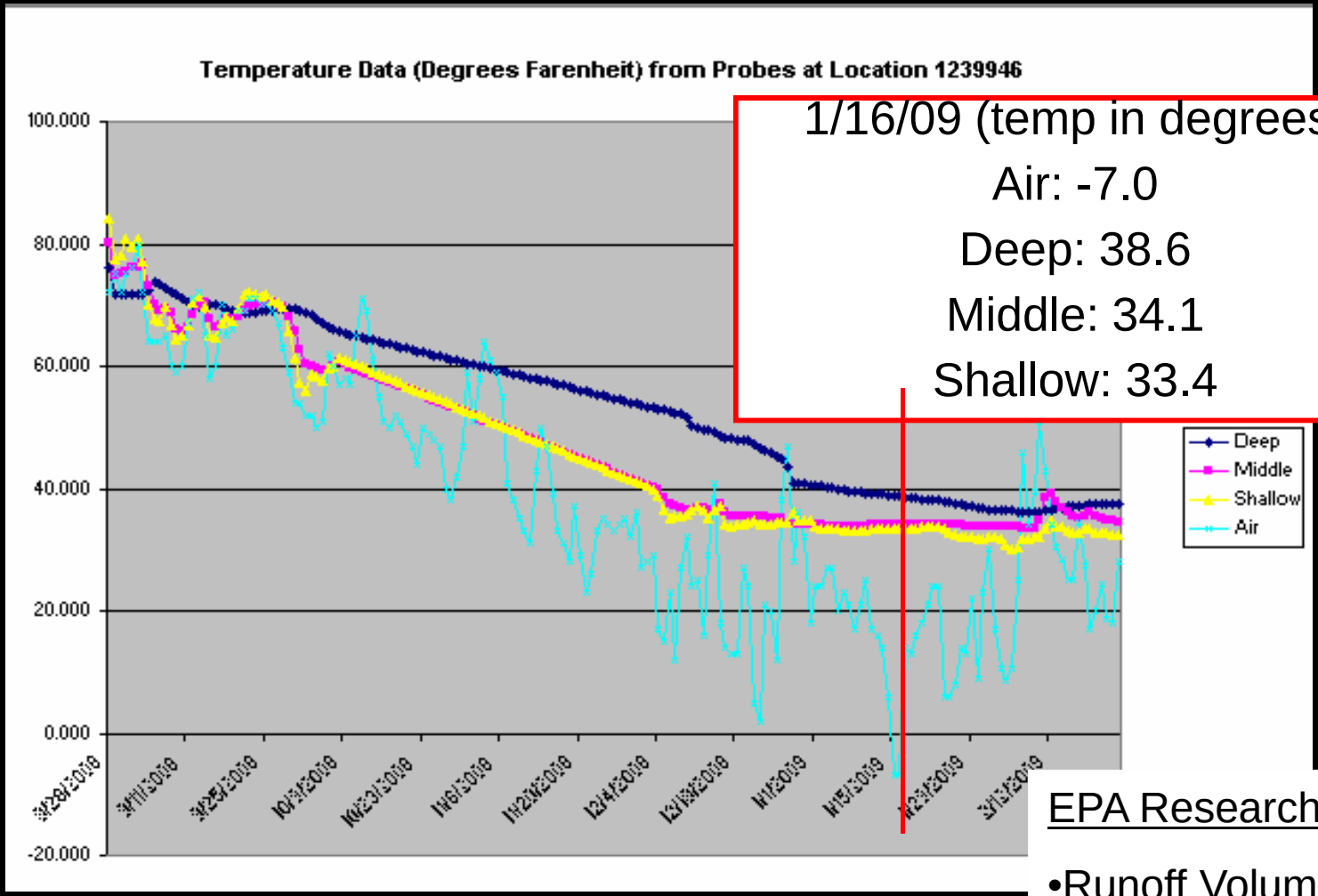
Parking/Bike Lanes

Maxwell Street Permeable Market Plaza



- .89 acres of permeable, high albedo pavers
- Pavers have initial SRI of .30 or 32%

Market Plaza: Preliminary Monitoring Results



1/16/09 (temp in degrees)

Air: -7.0

Deep: 38.6

Middle: 34.1

Shallow: 33.4

Sept 2008- Feb 2009

EPA Research Questions

- Runoff Volume and Rate
- Surface Water Quality
- Ground Water Quality
- Freeze/Thaw Performance

The Cermak / Blue Island Streetscape

CALLE SUSTENTABLE

PILSEN

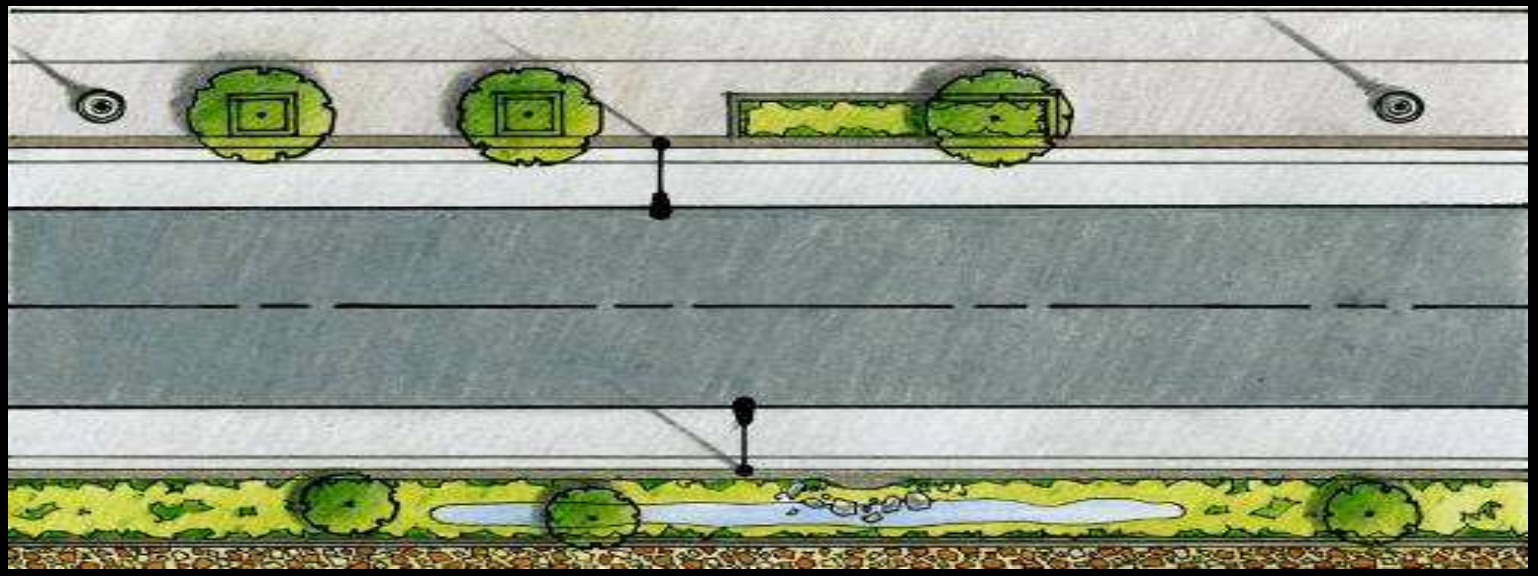
SUSTAINABLE STREET

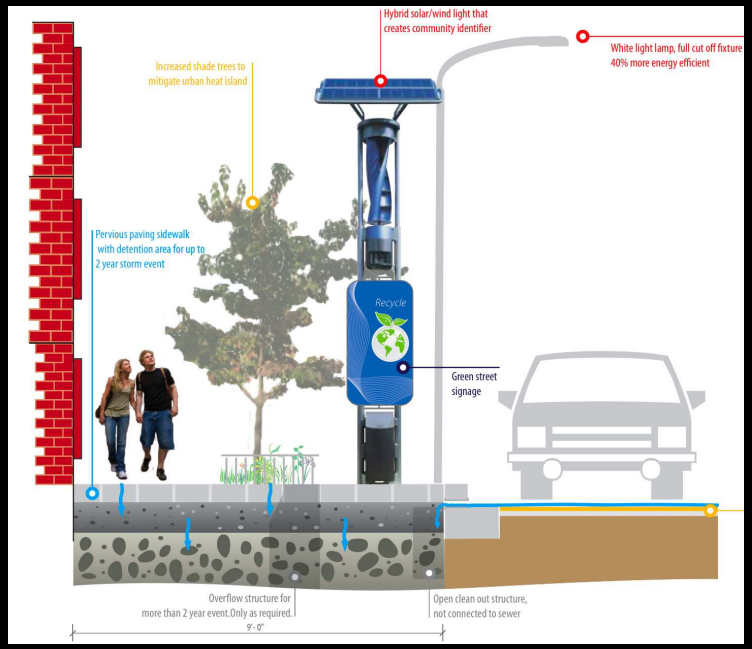
Cermak/Blue Island Sustainable Streetscape

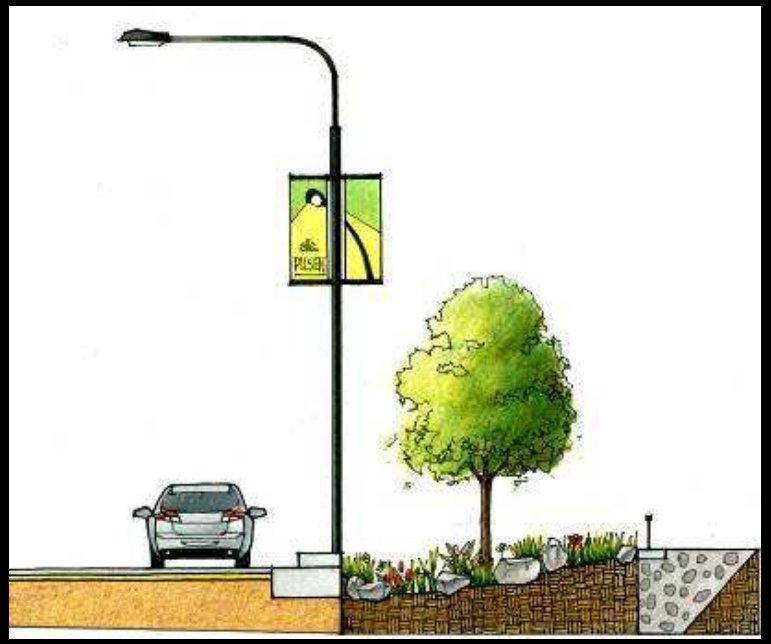
Project Sustainable Goals

Stormwater Management	Divert 80% of the typical average annual rainfall and at least 2/3 of rainwater falling within catchment area into stormwater best management practices.
Water Efficiency	Eliminate use of potable water for irrigation, specify native or climate adapted, drought tolerant plants for all landscape material.
Transportation	Improve bus stops with signage, shelters and lighting where possible, promote cycling with new bike lanes, improve pedestrian mobility with accessible sidewalks.
Energy Efficiency	Reduce energy use by min. 40% below a typical streetscape baseline, use reflective surfaces on roads/sidewalks, use dark sky-friendly fixtures. Min. 40% of total materials will be extracted, harvested, recovered, and/or manufactured within 500 miles of the project site.
Recycling	Recycle at least 90% of construction waste based on LEED NC criteria, Post/Pre- Consumer recycled content must be min. 10% of total materials value.
Urban Heat Island, Air Quality	Reduce ambient summer temperatures on streets and sidewalks through use of high albedo pavements, roadway coatings, landscaping, and permeable pavements. Require ultra low sulfur diesel and anti-idling.
Education, Beauty & Community	Provide public outreach materials/self-guided tour brochure to highlight innovative, sustainable design features of streetscape. Create places that celebrate community, provide gathering space, allow for interaction and observation of people and the natural world.
Commissioning	Model Stormwater BMP's in Infoworks to analyze and refine design. Monitor stormwater BMP's to ensure predicted performance and determine maintenance practices.

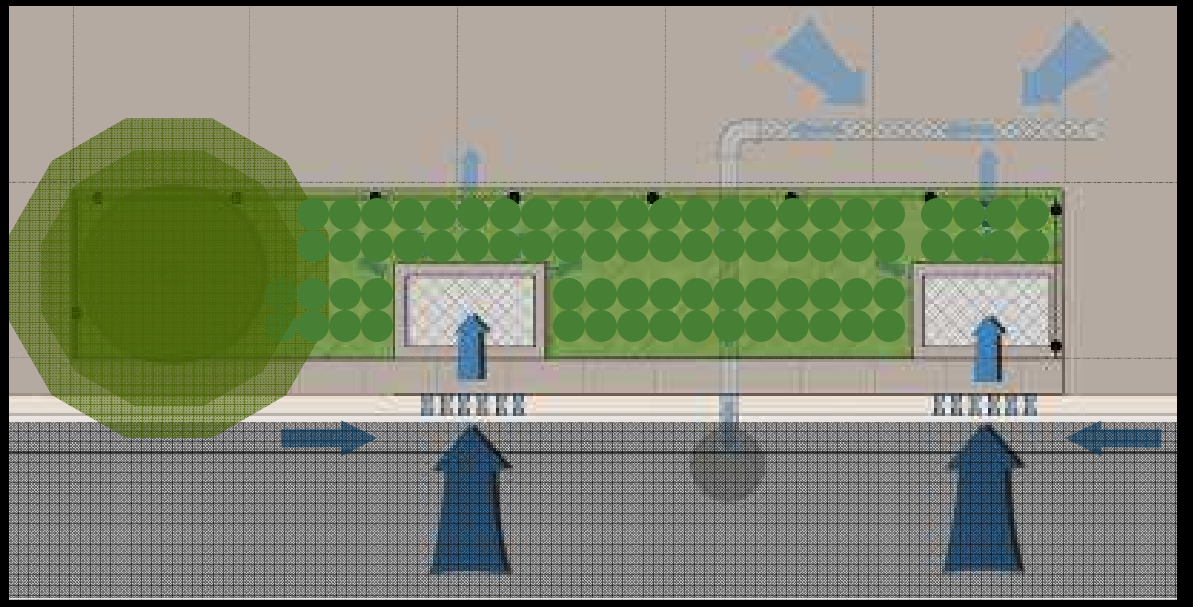
Cermak Road Plan and Section



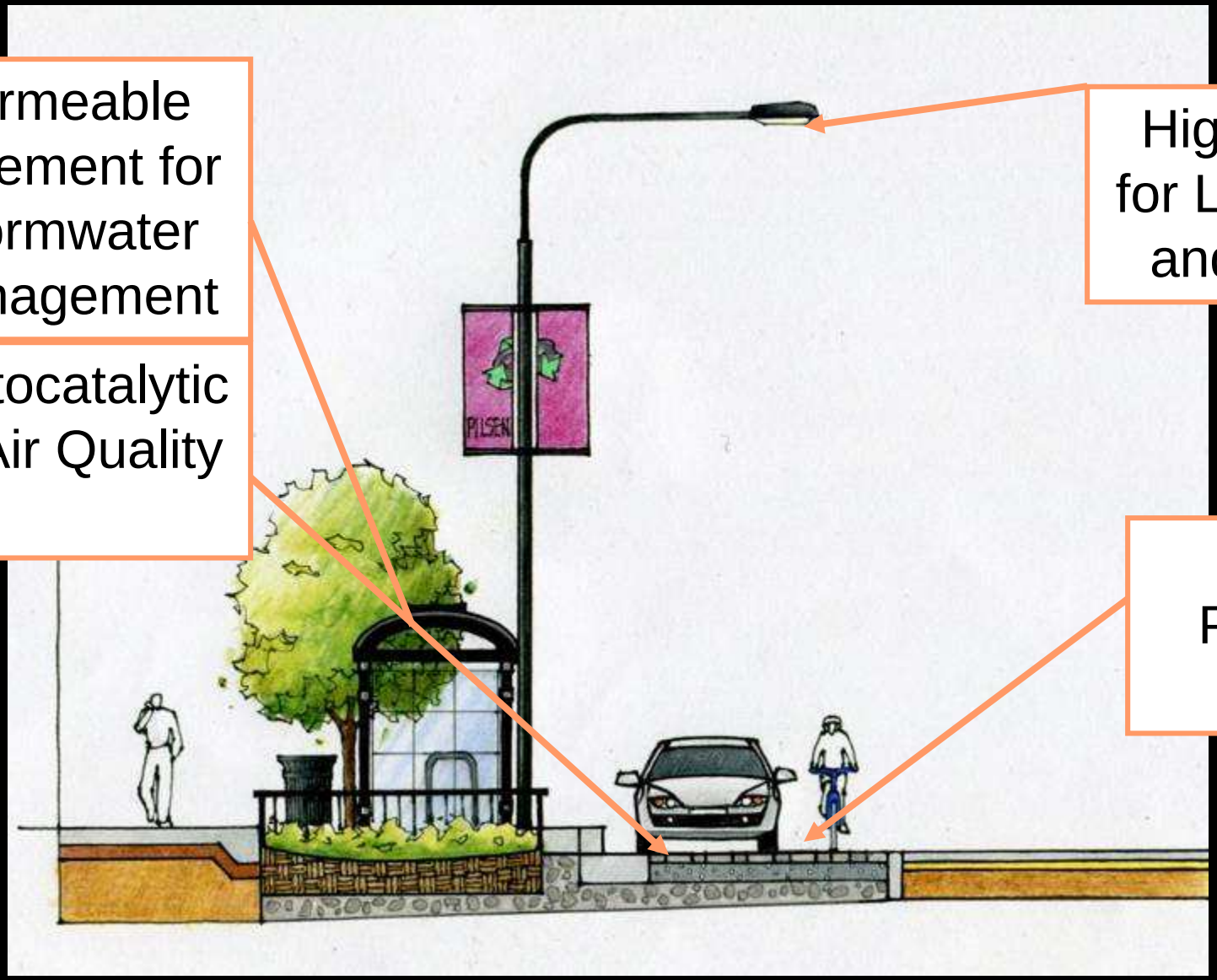




Cermak Streetscape Infiltration Planter Detail



Integrated Infrastructure Design Example: Blue Island Cross-section

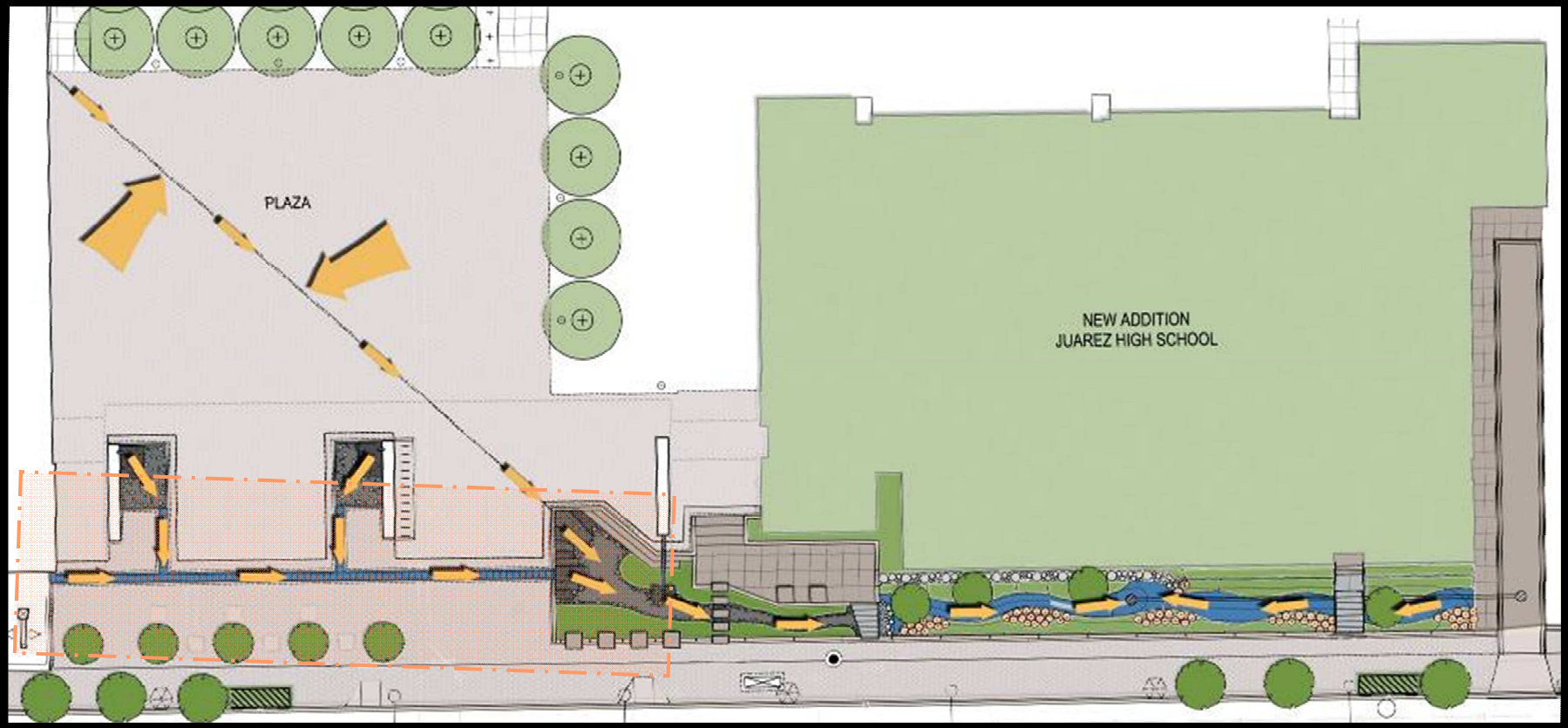


Blue Island Details

- Permeable, photocatalytic, high albedo pavers
- Infiltrating planters
- Belt and suspenders
- Landscape survival

½ Inch Paver Facemix

Juarez Community Academy Water Feature








Water Feature Details

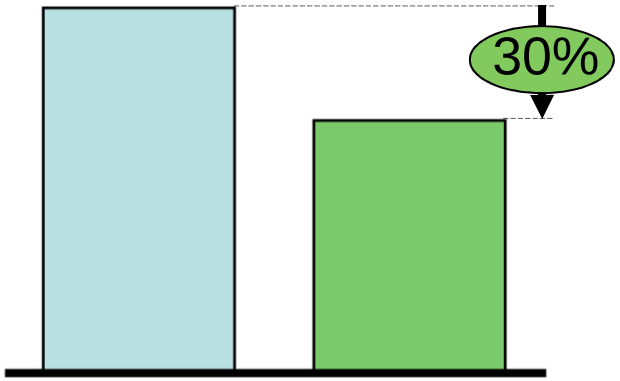
Western Ave. Stormwater Plaza

Education: Informational kiosks/identifiers with interpretive graphics

Sustainable Streets are Cost Effective

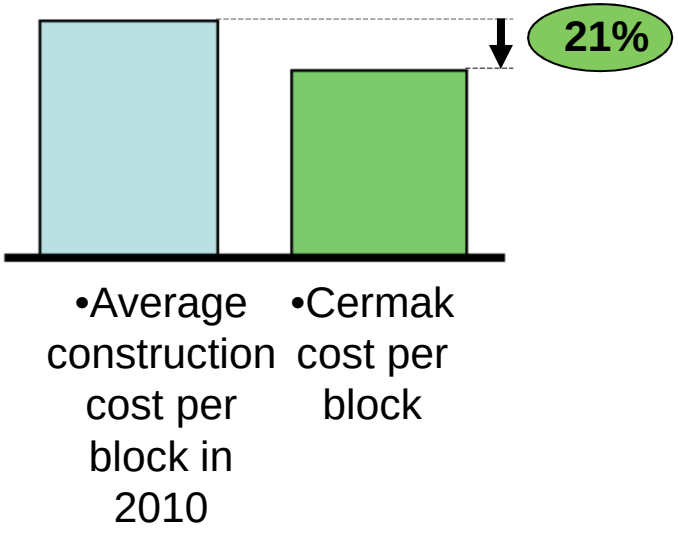
Cost is 30% less than projected…

Cermak total project cost ($)



… And is 20% less expensive than the average block in 2010

Average per block cost ($)



National and Local Rating Systems

CATEGORY	Design Strategy		Rating System			
			I-LAST Rating System (IDOT)	Green Roads Rating System	Sustainable Sites Initiative	LEED-ND
Planning	Identify Stakeholders and develop Stakeholders Involvement Plan		2	------	------	------
	Engage Stakeholders to conduct Context Audit and develop project purpose		2	------	------	------
	Involve Stakeholders to develop and evaluate alternatives		2	------	4	2
	Employ Stakeholder involvement techniques to achieve consensus for Preferred Project Alternative		2	------	------	------
	Plan for Context Sensitive Solutions (CSS)		------	5	------	------
TOTAL POINTS EARNED:			**130**	**79**	**100**	**32**
	POINTS POSSIBLE:		**228**	**118**	**250**	**100**
	Percentage % of possible points:		**57%**	**67%**	**40%**	**32%**
	Ranking:		**N/A**	**Evergreen** (>60% of total)	**One Star** (Four Star possible)	(need 8 more Points to become "Certified")

Streetscape Demonstration Project

- In 2010 CDOT began construction of the Streetscape project located on the south side of Chicago
- Installing BMPs to reduce flow and pollutant loads to local sewer system
- BMPs to capture a 2 to 5-year storm events
  - Permeable pavers in parking/bike lanes
  - Permeable pavers in sidewalks
  - Planters in or adjacent sidewalks (both concrete and permeable pavers)
    - Planter boxes
    - Runnel planters
    - Bioswales
  - Infiltration basins

QUESTIONS

- HOW WELL DOES IT WORK IN REDUCING FLOWS AND LOADS?
- DOES PERFORMANCE DECREASE OVER TIME?
- CAN THE TECHNOLOGY BE APPLIED TO A LARGER AREA AND WHAT IMPACT WILL THAT MAKE?
- SPECIAL QUESTIONS
  - EFFECT OF ZEOLITES ON SODIUM
  - INTERACTION BETWEEN SEWER AND GROUNDWATER
  - EFFECT OF SALTING RATES
  - EFFECT OF DIFFERENT GRAVEL FILL ON pH OF OVERFLOW

Background/Baseline Monitoring Locations and Equipment

- Precipitation ➔ Tipping bucket rain gauges (3)
- Combined sewer flow
  - Flow ➔ Area flow meter (3)
  - Water quality collection ➔ Autosampler (1)
- Stormwater runoff
  - Flow ➔ Pressure transducers in catch basins (3)
  - Water quality collection ➔ Autosampler (1)

Background/Baseline Monitoring Locations and Equipment (Cont.)

- Localized groundwater (4)
  - Monitoring wells and pressure transducer
- Combined sewer overflows (2)
  - Outflow into South Branch of Chicago River (just events if possible)

Study monitoring locations and equipment (Post construction)

- Rain gauges, meteorological station, combined sewer, monitoring wells, CSOs, and catch basin locations remain the same as background
- Any monitoring locations not affected by construction will remain as well
- Soil, soil water, and biomass (13)
  - Planter boxes, curb inlet planters, and bioswales
    - Soil moisture → Time Domain reflectometer
    - Soil water quality collection → lysimeter
    - Soil quality → auger samples
    - Biomass quality → Dead and living biomass
    - Water level in bioswales

Study Monitoring Locations and Equipment (Cont.)

- Three overflow structures from BMP(s) will be monitored
  - Parking lane permeable pavers along Blue Island
  - Planter boxes and infiltration basins in the sidewalks on north side of Cermak
  - Bioswales and infiltration basins on south side of Cermak
- Pressure transducer or flow meter and auto sampler at overflow points for studied BMP(s)

Media Analytical Parameters

- Water
  - Total solids, BOD, COD, Heavy Metals, TP, TN, FOG, pH, Chlorides, and polycyclic aromatic hydrocarbons (PAHs)
- Soil, Sediment, and Biomass
  - BOD, COD, Heavy Metals, TP, TN, Chlorides, PAHs, Ca, Mg, K, and Na

Data Analysis and Evaluation

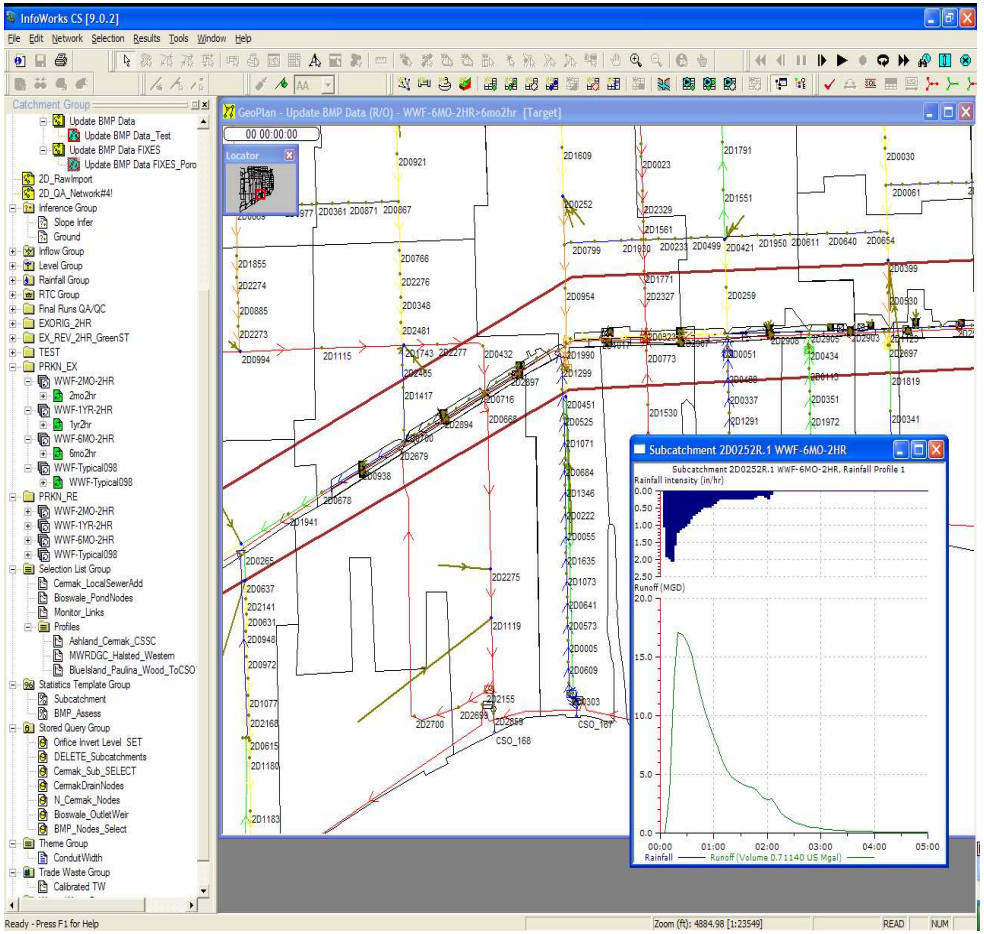
- Perform flow and load reduction analysis
  - Simple percent reductions
  - Efficiency ratios
  - Mass balance

Preliminary background monitoring results

- Little diurnal variation in sewers but stage and flow response to rainfall events
- Limited response of well levels to rainfall events
  - High conductivities during snow melts and possible exfiltration of aging sewers

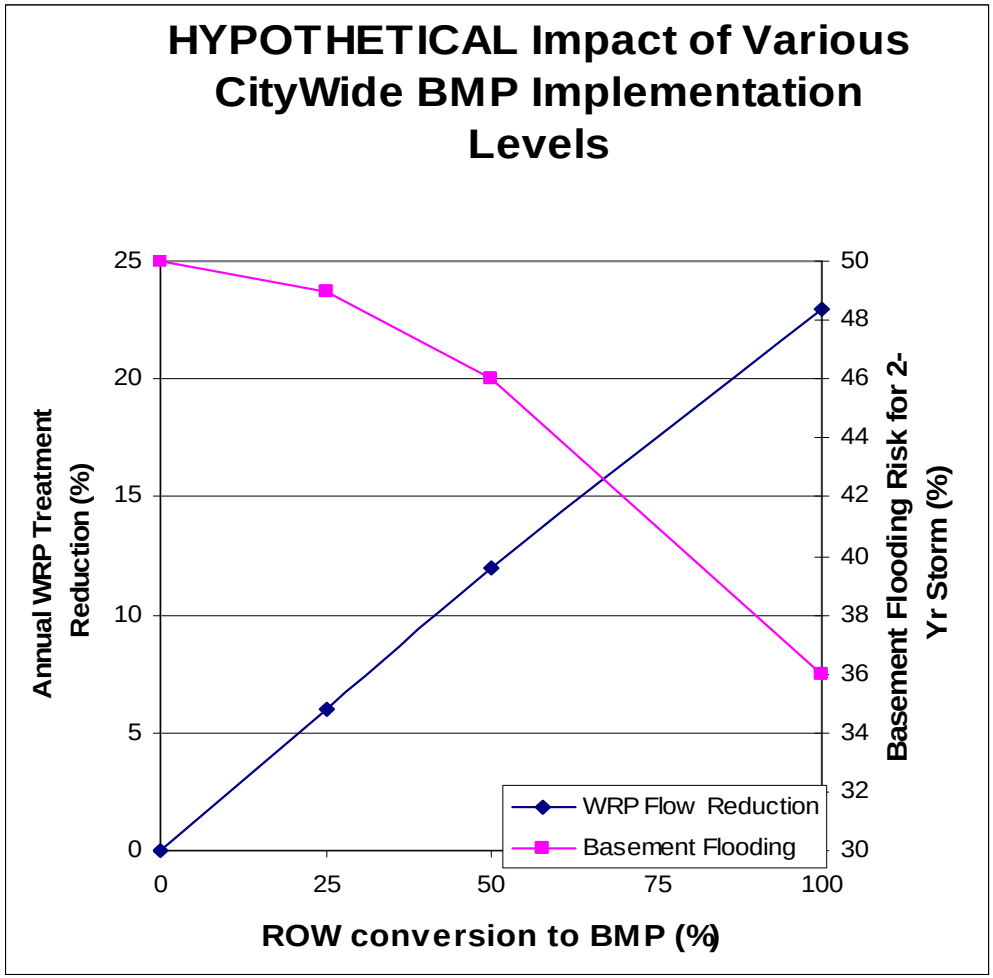
Model Development

- InfoWorks CS was used which is an effective tool with which to undertake hydrological and hydraulic modeling of the complete urban water cycle
  - Can model sewers, open channels, and complex ancillary structures
- Use the City Trunk Sewer model developed for large sewers (>42”) that includes CSOs, inlet restrictors, and interceptor connection
  - Scale this model down to Streetscape catchment area
  - Evaluate basement flooding risk, CSO events, infrastructure capacity, aging BMPs, effect of antecedent weather conditions, and Streetscape design



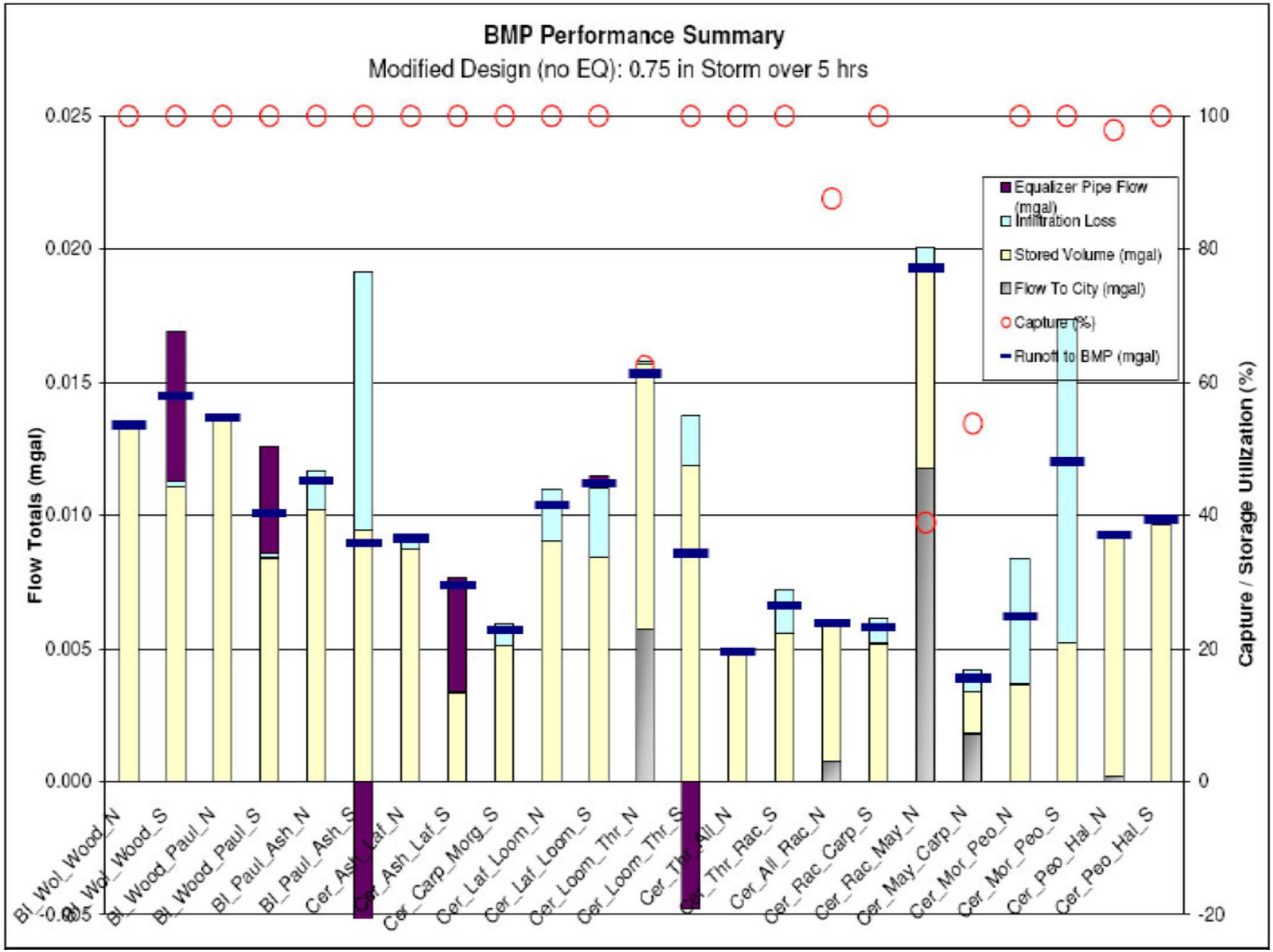
City-Wide BMP Assessment

- Translate understanding from detailed model to City scale
- Simplified – high level modeling approach
  - runoff reductions
- Evaluate various levels of City-Wide implementation
  - What areas most sensitive to more green infrastructure?
  - What is the overall reduction in loading to system and WRP?



Preliminary Modeling Results

- Examine design storm of 0.73 inches over a 5 hour period
  - Where are areas where storage capacity is being underused?
  - How can the BMPs be redesigned to maximize storage capacity?


BMP Performance Summary
Modified Design (no EQ): 0.75 in Storm over 5 hrs
Flow Totals (mgal)
Capture / Storage Utilization (%)
0.025
0.020
0.015
0.010
0.005
0.000
-0.005
100
80
60
40
20
0
-20
Equalizer Pipe Flow (mgal)
Infiltration Loss
Stored Volume (mgal)
Flow To City (mgal)
Capture (%)
Runoff to BMP (mgal)
Bl_Wol_Wood_N
Bl_Wol_Wood_S
Bl_Wood_Paul_N
Bl_Wood_Paul_S
Bl_Paul_Ash_N
Bl_Paul_Ash_S
Cer_Ash_Laf_N
Cer_Ash_Laf_S
Cer_Carp_Morg_S
Cer_Laf_Loom_N
Cer_Laf_Loom_S
Cer_Loom_Thr_N
Cer_Loom_Thr_S
Cer_Thr_All_N
Cer_Thr_Rac_S
Cer_All_Rac_N
Cer_Rac_Carp_S
Cer_Rac_May_N
Cer_May_Carp_N
Cer_Mor_Peo_N
Cer_Mor_Peo_S
Cer_Peo_Hal_N
Cer_Peo_Hal_S

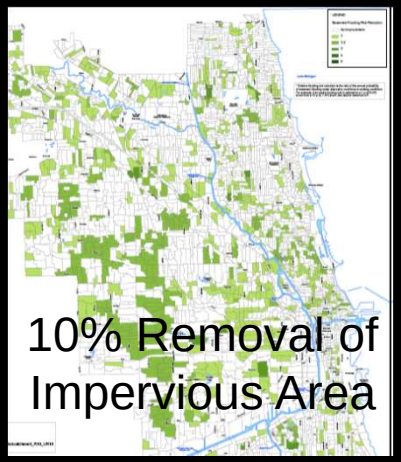
Streetscape Modeling Summary

- Current design suggests that 80% of an average design storm would be captured by the Streetscape project; 24-30% of annual precipitation would be captured if entire city underwent green reconstruction
- Citywide modeling provides opportunity to identify areas where BMP improvements are most beneficial ➔efficiently prioritize investment dollars

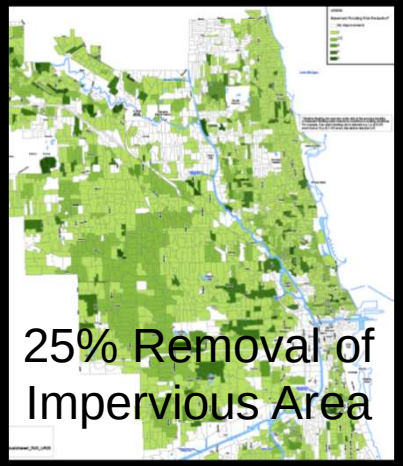
Sustainable Infrastructure Design Standards

Development and Implementation

- Nationwide Best Practices
- Public/Private Task Force
- Integration of Standards with City Policy Initiatives
- Implementation Strategy



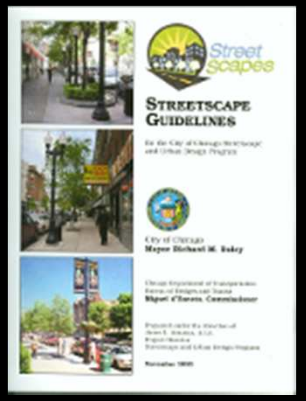
10% Removal of Impervious Area

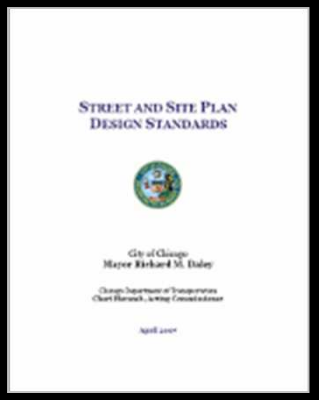


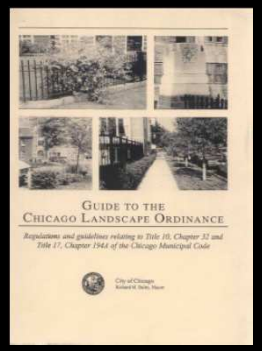
25% Removal of Impervious Area

Sustainable Infrastructure Design Manual

- Design Guidelines and Implementation Matrix
- Engineering Details and Specifications
- Project Manager Checklist
- Maintenance Requirements







So, How Complete is your Street?

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