ASCE Committee Report on Our Systemic Flood Problems

Presenter: David Fowler CFM, Senior Project Manager, Milwaukee Metropolitan Sewerage District
Great Midwest Flood 1993
Missouri River Flooding 2011
Major Floods Will Continue to Occur

- When was our last 100-year flood?
- Last Tuesday!

Cartoon by Chris Britt/SJ-R
Flooding Demographics

- Flooding is #1 natural hazard (Loss of life and property damage)
- ~17% of urban land in 100-year flood zone.
- UMRB loss of 65 m acres of wetlands = size of Illinois.
- $7.4 m in added flood damage per acre lost of wetlands (Brody, TX)
- FEMA predicts 100-year floods will grow by 40 to 45% over the next 90 years
Changing Climate

- Past century, overall precipitation up 7%
- Heaviest downpours increased 20% over last 50 years
- 1st 6 months of 2011, record breaking floods, snowstorms, droughts and wildfires
- Increased Drought & Wildfires
- Future = volatility & uncertainty

Increase in intensity of precipitation from 1958-2007

(USGCRP Global Change Impacts in U.S. 2009, updated from Groisman et al.)
- Average flood damages $10 billion per year.
- In 2011 there were 58 Federal flood disaster declarations, covering 33 different states.
- Flood damages were over $8 billion and caused 113 deaths, both exceeded the 30 – year averages ($7.82 Billion in flood damages and 94 deaths per year).
Task Committee on Flood Safety Policies and Practices

Getting Engineers Involved in the Solution is a big deal

Stop Building the Right Things in the Wrong Places
Call to Action

• Mississippi 1993, $20 Billion
• Katrina 2005, $100 Billion
• Ike 2008, $40 Billion
• Mississippi 2011, $10 Billion
• Irene 2011, $25 Billion
• Sandy 2012, >$80 Billion
• NFIP > 20 Billion Deficit
The Problem

• Have lessons been learned, or merely observed?
• Have lessons been incorporated into public policy?
• Have lessons influenced engineering practice?
• If we know what we need to do, why aren’t we doing it?
The Problem (Cont.)

• No National (Not Federal) Vision on how to reduce flood risk
• Lack of good data or sound analysis on what the potential risk is.
• The nation’s flood infrastructure (dams and levees) is in marginal or near failing condition?
• Climate change and population growth will further increase flood risk.
• The greatest task is to reverse many decades of past decisions that created these issues
ASCE Hurricane Katrina Review (2007)

- Keep safety at the forefront of public priorities
- Quantify the risks
- Communicate the risks to the public and decide how much risk is acceptable
- Re-think the whole system (Land use, Flood Management Policy + NFIP),
- Put someone in charge
- Improve interagency coordination
- Upgrade engineering design standards
- Place safety first
Challenges

• How do we manage flood risk with least harm to natural resources?
• How do we avoid the cycle of loss-and-repair?
• How do we allocate costs fairly?
• How do we account for a growing population and climate change?
• How do we achieve sustainability?
Committee Charge

• Investigate whether the lessons learned from failures during Hurricane Katrina and other flood disasters have been incorporated in the planning, design, construction and management of engineering water resource projects for the future

• Provide a basis for influencing needed change in public policy and engineering practice related to flood safety and flood management.
Committee Members

- Robert Traver, Chair, Ph.D., P.E., DWRE, M.ASCE*
- Christine Andersen, P.E., M.ASCE*
- Billy Edge, Ph.D., P.E., D.CE, Dist.M.ASCE*
- David Fowler, CFM, P.E., M.EWRI
- Gerald Galloway, Jr., Ph.D., P.E., D.CE, Dist.M.ASCE
- Robert Gilbert, Ph.D., P.E., D.GE, M.ASCE*
- Carol Haddock, P.E., M.ASCE, Former ASCE Congressional Fellow
- L. Edward Link, Ph.D., HG, M.ASCE, IPET Chair**

- John Moyle, P.E., M.ASCE
- Lawrence Roth, P.E., D.GE, F.ASCE*
- P. Kay Whitlock, P.E., D.WRE, F.ASCE
- Jessica Ludy, M.EWRI (Non-voting member)

ASCE Staff
- John Durrant, P.E., M.ASCE*
- Mike Charles, Aff.M.ASCE
- Barbara Whitten, A.M.ASCE

*Members of the Hurricane Katrina External Review Panel
**Hurricane Katrina Interagency Performance Evaluation Task Force (IPET)
Committee Work Plan

- Reviewed past recommendations and findings from several published reports
- Developed and implemented an extensive questionnaire to understand progress made and challenges ahead
- Identified 11 flood prone areas in the US and abroad as study areas
- Interviewed local experts in these areas
- Identified compelling topics in flood safety
- Hosted a Summit entitled “Building a Framework for Flood Risk Management; Goals, Roles and Responsibilities, Resources and Systems.
- Prepared Final Report
Summit on Building a Framework for Flood Risk Management

- What are our National Overarching Goals?
- What are the Roles and Responsibilities
  - For each level of government (local, state, federal)
  - Individuals and Property Owners
- What Resources are Needed?
- What Approaches are Needed?
Findings of Summit

- Flood safety continues to receive scant attention
- No common vision of how the nation should organize and coordinate to deal with flooding
- No sound analysis of the potential risk to the nation from flooding
- Flood infrastructure, primarily dams and levees, remains in near-failing condition with no plan to improve conditions
- Climate change and population growth will further stress this already difficult situation
- Limited progress has been made but more must be done
- Not enough emphasis on Non-Structural Sustainable Flood Management
Goals

- Look for opportunities to avoid development in high risk locations and include true cost/benefit for the extent and location of built resources that are needed.
- Where risks exist in developed areas, ensure that communities are prepared to properly respond to emergencies to mitigate risk to life safety.
- Preserve the basic natural resources that maintain social and environmental needs.
- Determine new economic models and markets for our natural resources that include flood risk reduction.
What resources are available, and how are the resources applied?

• Phases
  – Pre-disaster preparation—roles and responsibilities clearly defined
  – Disaster response—coordination of resources to enable efficient and effective operation
  – Post-disaster response—balance consideration of alternatives with immediate efforts to rebuild

• How do we avoid misapplication of resources?
Identified Resources

• Natural—environmental resources that are critical for sustainable ecosystems (eco services)
• Built—man-made flood reduction systems that support developed areas and land uses
• Individual—personal involvement
• Community—policy direction to achieve common goals
• Financial—capital resources to implement strategies
Implementing flood risk management requires:

1. A common definition of flood risk and a consistent means of assessing risk.
2. Effective collaboration, clear communications, and well-defined roles at all levels of government, the private sector, and the public.
4. Basing land use decisions on sustainable flood risk management principles.
5. Establishing of long-term, reliable funding mechanisms for flood risk reduction at the federal, state and local level.
6. Adapting flood risk management strategies to meet changing conditions.
National Goals

1. What are we trying to achieve for life safety and economic risk?

2. How much of our expenditures and efforts to mitigate risk should be associated with preventative versus restorative measures?

3. How do we encourage effective risk management and discourage ineffective risk management?
Committee Findings
Recommendations

1. President and Congress need to address the infrastructure maintenance
   - Shared federal/state/local funding
   - National infrastructure bank
   - Local Funding mechanisms (similar to America Fast Forward Bonds)
   - Water infrastructure Finance and Innovation Act (pilot flood focused version)
   - ASCE needs to work with President and Congress to develop funding strategy
   - Identify of “full funding” for approved water projects
Recommendations (Cont.)

2. FIFMTF working with states should develop 21\textsuperscript{st} Century unified national program for flood management.

3. Congress should provide funding to conduct the national flood vulnerability study stipulated in the 2007 WRDA Act.

4. At all levels of government balance non-structural and structural flood mitigation

5. In planning mitigation consider both long-term and short term impacts (climate change, population, and infrastructure renewal)
6. CEQ should develop guidelines to support implementation of federal principles and requirements that include public safety and ecosystem values equally in decision making. Provide incentives and create a framework that relates ecosystem benefits to other types of benefits.

7. FEMA, NOAA, USACOE, and USGS, should support the development of a coalition of nongovernment organizations to carry out a coordinated communication campaign concerning flood risk and actions to deal with the risk.
Sustainable Flood Risk Management Provides:

1. Effective and sustainable management of risks posed by floods to life safety, human health, economic activity, cultural heritage, and the environment.

2. Collaborative risk sharing and risk management at all levels of government and by all stakeholders.

3. Risk Informed policies and funding prioritization

4. Incorporate the use of natural processes to mitigate the consequences of flooding.
Future Actions

• Strengthen the Ties between the ASFPM and ASCE)

• Build on the ASCE National Flood Policy Recommendation Report

• Work on building on sustainable flood management engineering practices at the grass roots

• Get engineers to build great things in the right places (my opinion only)
Reasons for Optimism
Reasons for Optimism

• Structures in the SFHA < $250,000 will qualify for acquisition funding without a BCA Calculation
• Ecosystem Services Valuation was used in making this change (Dave Baxter, Earth Economics)
• Puts Acquisition on a level playing field for funding with Structural alternatives (i.e.: Levees)
• Working to get FEMA and ACOE to use ECO Services in BCA for structural project funding (loss of ECO Services would be a negative)
• Sustainable flood management like “Make Room for the River” is gaining momentum nation wide
Make Room for the River (RvR) began as idea in 1986, gained momentum in 1990s, US projects as inspiration
Time for Tough Questions:

“The rising waters of the Mississippi are about to test human judgment and engineering anew” John M. Barry, WSJ, 4/30/11

- Do we have an over reliance on structural approaches (dams, levees, etc.)?
- Are we incentivizing flood risk?
- What should the federal role be in reducing the nation’s flood risk?
- Will the upcoming policy opportunities provide the reforms that are so badly needed?

“...floods will occasionally come which must be allowed to spread”
- William Hammond Hall, engineer 1800
New Approach for Flood Management
Make Room for Rivers to safely accommodate floods.

Grey Strategy
- Large, expensive projects
- Economies of scale
- Proven performance
- Exposure to failures, energy markets
- Long design and construction time
- End of pipe technology bears brunt of Climate Change

Green Strategy
- Smaller, inexpensive projects
- Network requires numerous projects
- Proven on demonstration level
- Low energy inputs reduce exposure to market fluctuations
- Shorter design and construction time
- Resilient to impacts of climate change
- Allows for adaptation and flexibility
Reconnecting the River...

- **Replicate**: Implementing green infrastructure and working with nature reduces flood flows and enhances water quality.

- **Protect**: Floodplain acquisition through buyouts and relocations to restore beneficial functions of floodplains, establish greenways, parks, recreational space.

- **Restore**: Setting levees back, retiring sensitive agricultural lands, and restoring riparian vegetation increases storage.

- **Replicate**: Implementing green infrastructure and working with nature reduces flood flows and enhances water quality.
Naturally Functioning Floodplains:

**PEOPLE**
- Reliable water supplies
- Protection of health
- Safety from storms and failing infrastructure
- Quality of life – recreation, aesthetics, quiet solace
- Economic security
- Community stability

**ECOSYSTEMS**
- Diversity of habitats
- Diversity of species
- Migratory corridors
- Refuge from disturbances
- Natural, dynamic flows trigger reproductive cues
- Protection of species health – especially from toxics

Despite representing <2% of Earth's land surface area, floodplains are 2nd to estuaries in the value to society providing ~25% of all terrestrial ecosystem service benefits.

(Jeffres et al. 2008)
Areas of Progress Sustainable Green Flood Management (Make Room for the River)

Boulder, CO
Milwaukee, WI
Charlotte, NC
Otter Creek, VE
Portland, OR
Denver, CO
Napa, CA
Ottawa, IL
Pierce County, OR
Sacramento, CA
New Madrid Floodway
MMSD’s 2035 Vision
(http://v3.mmsd.com/NewsDetails.aspx)

**Integrated Watershed Management Goals:**

- Zero sanitary sewer overflows
- Zero combined sewer overflows
- Zero homes in the 100 year floodplain

- Acquire an additional 10,000 acres of river buffers through Greenseams®
- Use green infrastructure to capture the first 0.5 inch of rainfall
- Harvest the first 0.25 gallon per square foot of area of rainfall

**Energy Efficiency and Climate Mitigation & Adaptation Goals:**

- Meet 100% of MMSD's energy needs with renewable energy sources
- Meet 80% of MMSD's energy needs with internal, renewable sources
- Use the Greenseams® Program to provide for 30% sequestration of MMSD's carbon footprint
- Reduce MMSD's carbon footprint by 90% from its 2005 baseline
Hart Park
County Grounds
Kinnickinnic Concrete Removal
Menomonee River Concrete Removal
Greenseams®

2,660 Acres
Watercourse Spending

- Milwaukee River: $221.3 M
- Lake Michigan: $5.2 M
- Menomonee River: $432.6 M
- Root River: $15.9 M
- Kinnickinnic River: $165.4 M
- Oak Creek: $3.7 M
Impacts of our Work

Homes in Floodplain Removed/Remaining

<table>
<thead>
<tr>
<th>River</th>
<th>Removed/Remaining</th>
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</thead>
<tbody>
<tr>
<td>Milwaukee River</td>
<td>2,081/391</td>
</tr>
<tr>
<td>Lake Michigan</td>
<td>0/8</td>
</tr>
<tr>
<td>Menomonee River</td>
<td>264/99</td>
</tr>
<tr>
<td>Root River</td>
<td>95/16</td>
</tr>
<tr>
<td>Kinnickinnic River</td>
<td>55/597</td>
</tr>
<tr>
<td>Oak Creek</td>
<td>0/13</td>
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</tbody>
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Miles of Concrete Removed/Remaining

<table>
<thead>
<tr>
<th>River</th>
<th>Removed/Remaining</th>
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</thead>
<tbody>
<tr>
<td>Milwaukee River</td>
<td>1.9/0</td>
</tr>
<tr>
<td>Lake Michigan</td>
<td>0/0</td>
</tr>
<tr>
<td>Menomonee River</td>
<td>0.6/11.5</td>
</tr>
<tr>
<td>Root River</td>
<td>0/0</td>
</tr>
<tr>
<td>Kinnickinnic River</td>
<td>0.1/8.9</td>
</tr>
<tr>
<td>Oak Creek</td>
<td>0/0</td>
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MMSD’s Regional Green Infrastructure Plan

- Meet new discharge permit requirement
- Capture the first 0.5” that falls on impervious surfaces or an additional 740 MG
- Prioritize green infrastructure projects
What is Green Infrastructure

Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are critical components of green stormwater infrastructure. By protecting these ecologically sensitive areas, communities can improve water quality while providing wildlife habitat and opportunities for outdoor recreation. On a smaller scale, green infrastructure practices include strategies such as rain gardens, porous pavements, green roofs, infiltration planters, trees and tree boxes, and rainwater harvesting for non-potable uses such as toilet flushing and landscape irrigation.
The Mix of Green

- Bioretention / Rain Gardens: 26%
- Native Landscaping: 18%
- Porous Pavement: 21%
- Soil Amendments: 22%
- Stormwater Trees: 3%
- Green Roofs: 9%
- Rain Barrels: 1%
- Cisterns: <1%
29,300 Plants Sold Since 2006
More than 18,000 sold since 2002
Green Roofs
+10 acres since 2003
<table>
<thead>
<tr>
<th>Economic</th>
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<tbody>
<tr>
<td>Green job opportunities</td>
<td>633 O&amp;M; 161 construction jobs</td>
</tr>
<tr>
<td>Reduced infrastructure costs in the CSSA</td>
<td>$221.8 million compared to cost of GI in CSSA of $179.5 Million</td>
</tr>
<tr>
<td>Reduced pumping and treatment costs</td>
<td>Reduction in the need for deep tunnel pumping and associated treatment: $1.3 million/year</td>
</tr>
<tr>
<td>Increased property values</td>
<td>Increase in property values due to aesthetic improvements from GI: Residential: $447.8 million Commercial: $238.2 million Industrial: $19.9 million Total: $705.9 million</td>
</tr>
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## Benefits at full implementation

<table>
<thead>
<tr>
<th>Social</th>
<th>Recreational Area Increase: 275 acres</th>
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<tbody>
<tr>
<td>Improved quality of life and aesthetics</td>
<td>Reduced Crime &amp; Social Program Costs</td>
</tr>
<tr>
<td>Improved green space/recreational areas</td>
<td>Native landscaping: 8,600 acres</td>
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<tr>
<td></td>
<td>Bio-retention/rain gardens: 670 acres</td>
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<td></td>
<td>Number of trees: 738,000</td>
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## Benefits at full implementation

<table>
<thead>
<tr>
<th>Environmental</th>
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<tr>
<td>Captured stormwater runoff</td>
<td>740 MG new GI storage</td>
</tr>
<tr>
<td>Reduced pollutant loadings</td>
<td>Total suspended solids: 15.1 million pounds/year Total Phosphorus: 54,400 pounds/year</td>
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<tr>
<td>Carbon reduction</td>
<td>CO₂ sequestered plus emissions avoided due to GI-related energy savings: 73,000 tons/year</td>
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<td></td>
<td>Reduction costs due to effects on human health, property damages from increased flood risk, etc. $1.4 million/year</td>
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<td>Benefits at full implementation</td>
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<td>------------------------------------------</td>
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<tr>
<td><strong>Environmental</strong></td>
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<tr>
<td>Reduced energy use for cooling</td>
<td></td>
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<tr>
<td>Due to the insulating properties of green roofs and tree shading:</td>
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<tr>
<td>16.5 million kWh/year</td>
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<tr>
<td>Associated cost savings:</td>
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<tr>
<td>$1.5 to $2.1 million</td>
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<tr>
<td>Improved air quality</td>
<td></td>
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<tr>
<td>Criteria air pollutants removed by trees plus emissions avoided due to GI-related energy savings:</td>
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<tr>
<td>CO: 8 tons/year</td>
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<tr>
<td>NO$_2$: 103 tons/year</td>
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<td>Ozone: 403 tons/year</td>
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<td>PM$_{10}$: 190 tons/year</td>
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<tr>
<td>SO$_2$: 113 tons/year</td>
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<tr>
<td>Human health benefit costs from NO$_2$ and SO$_2$ reductions:</td>
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<tr>
<td>$6.4 million/year</td>
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Public Education

www.mmsd.com and www.freshcoast740.com
Oh, crap! Was that TODAY?