Boston Society of Civil Engineers Section
American Society of Civil Engineers

ANNUAL REPORT OF THE BOARD OF GOVERNMENT
2015 - 2016

To the Boston Society of Civil Engineers Section of the American Society of Civil Engineers:

Pursuant to the requirements of the Bylaws, the Board of Government presents its report for the year ending June 30, 2016.

A. MEMBERSHIP:

The following is statement of membership in the Section as of April 1, 2016:

Subscribing Members in:	**ASCE Members***	**BSCES (Dues Paid)****
Distinguished/Honorary*	4	0
Fellows	120	33
Members	2023	1127
Associates	991	600
Affiliates	133	64
Students	871	871
BSCES Affiliate	0	0
BSCES Life***	0	13
Totals	4142	2695
Life Members	588	20

* Includes Life Members
** Life Members are not required to pays BSCES dues
*** Of 51 active BSCES life members, only 13 are uniquely this member category. The others are already ASCE Life Members, Fellows, Members, Associates, or Affiliates.

BSCES Honorary Members:

Harl P. Aldrich, Jr.	Elected March 16, 1987
Philip Bonanno	Elected March 20, 2000
Jack Bryant	Elected May 20, 2002
Domenic T. Bua	Elected May 18, 2010
Charles Button, PE	September 30, 2015
Bruce Campbell	Elected February 17, 1994
Gonzalo V. Castro	Elected February 27, 2006
Alexander Chajes	Elected March 17, 2008
Kenneth M. Childs, Jr.	Elected February 23, 1998
John T. Christian	Elected March 21, 1988
Paul Stuart Crandall	Elected March 16, 1987
Katherine Craven	Elected, March 15, 2012
Richard A. Davey	Elected, September 23, 2013
Domenic D'Eramo	Elected May 20, 2002
Anthony J. Deluzio	Elected March 16, 2009
Albert G.H. Dietz	Elected January 19, 1981
Herbert H. Einstein	Elected April 26, 2004
Donald T. Goldberg	Elected February 22, 1993
Joe Guertin	Elected February 28, 2005
Charles L. Guild	Elected January 28, 1991
Werner Gumpertz	Elected May 19, 2003
Donald R.F. Harleman	Elected March 16, 1987
Frank J. Heger, Jr.	Elected May 21, 2001
Joseph E. Heney	Elected January 29, 1990
Ronald C. Hirschfeld	Elected January 29, 1990 (deceased)
H. Hobart Holly	Elected February 27, 1989 (deceased)
Melvin E. Jones	Elected February 27, 2006 (deceased)
Charles C. Ladd	Elected March 16, 2009
William J. LeMessurier	Elected March 21, 1988
Morris S. Levy	Elected May 26, 2011
Thomas K. Liu	Elected February 22, 1993
Robert C. Marini	Elected March 24, 1997
Lawrence J. McCluskey	Elected April 26, 2004
Carl Mellea	Elected May 19, 2003
Saul Namyet	Elected February 27, 1989
Eric O'Neil	Elected February 28, 2005 (deceased)
Luisa Paiewonsky	Elected March 15, 2012
J. Harry Parker	Elected January 29, 1990
Charles A. Parthum	Elected January 28, 1991
Deval Patrick	Elected April 13, 2009
Leo F. Peters	Elected March 20, 2000
Steve J. Poulos	Elected March 17, 2008
Maurice A. Reidy, Jr.	Elected March 21, 1988
William J. Rizzo, Jr.	Elected March 19, 2007

Cranston R. Rogers	Elected January 29, 1990
Frederick P. Salvucci	Elected May 18, 2010
Richard J. Scranton	Elected March 20, 2000
Enest T. Selig	Elected January 25, 1999
Ronald E. Sharpin	Elected September 30, 2015
Howard Simpson	Elected January 28, 1991
Robert A. Snowber	Elected February 26, 1996
Max D. Sorota	Elected February 24, 1992
John P. Sullivan	Elected September 23, 2013
Michael W. Swanson	Elected May 26, 2011
Howard Alan Thomas, Jr.	Elected May 21, 2001
Emile W.J. Troup, PE. SECB	Elected March 19, 2007
Kentaro Tsutsumi	Elected March 21, 1988
John A. Volpe	Elected January 29, 1968 (deceased)
David Weiner	Elected May 20, 2002
Nathaniel N. Wentworth	Elected February 27, 1989 (deceased)
Merit P. White	Elected February 27, 1989 (deceased)
Robert V. Whitman	Elected February 24, 1992
Lee Marc G. Wolman	Elected January 28, 1991
William S. Zoino	Elected February 27, 1995
Othar Zaldastani	Elected May 19, 2003

B. MEETINGS OF THE SECTION: TECHNICAL GROUPS AND COMMITTEES:

The Society's Technical Groups, Board and Committees sponsored over 60 events including technical presentations, jointly sponsored ASCE seminars, social/networking activities, Special Fund events, student competition/major outreach events, multi-day training courses, student chapter meetings, single day workshops, younger member group sponsored community service activities, awards dinners, student dinners, fall and spring professional engineer refresher courses, Western Massachusetts Branch event, and a government affairs activity throughout the year. Not included in this event total are the numerous student tours of Boston bridges and classroom visits undertaken by members of the BSCES Public Awareness & Outreach Committee. The details of these meetings and events are noted in the Technical Group and Committee Annual Reports.

C. MEETINGS OF THE BOARD OF GOVERNMENT:

The Board of Government met on the following dates:

July 20, 2015	Executive Committee Conference Call
August 17, 2015	Executive Committee Conference Call

September 21, 2015	Executive Committee The Engineering Center, Boston, MA
September 21, 2015	Board of Government The Engineering Center, Boston, MA
October 19, 2015	Executive Committee Louis Berger, Needham, MA
November 23, 2015	Executive Committee Massachusetts Institute of Technology, Cambridge, MA
November 23, 2015	Board of Government Massachusetts Institute of Technology, Cambridge, MA
December 14, 2015	Executive Committee The Engineering Center, Boston, MA
January 25, 2016	Executive Committee The Engineering Center, Boston, MA
January 25, 2016	Board of Government The Engineering Center, Boston, MA
February 1, 2016	Executive Committee The Engineering Center, Boston, MA
February 22, 2016	Executive Committee The Engineering Center, Boston, MA
March 21, 2016	Executive Committee The Engineering Center, Boston, MA
March 21, 2016	Board of Government The Engineering Center, Boston, MA
April 25, 2016	Executive Committee Mass. Green High Performance Computing Center, Holyoke, MA
May 23, 2016	Board of Government The Engineering Center, Boston, MA

For significant actions of the Board of Government, see Appendix A.

D. COMMITTEES:

The activities of the committees are described in the Annual Reports of the Committees.

E. AWARDS:

The Board of Government voted a number of awards during the course of the year. See the Annual Report of the Awards Committee for a listing of the 2015-2016 Awards.

F. FUNDS:

OPERATING RESERVE FUND

There is a BSCES Society Reserve Fund (formerly the Permanent Fund) which, at some point in the past received a transfer of all monies held in the Society Reserve Fund and the latter subsequently ceased to exist. Into the Society Reserve Fund is added such sums as are voted by the Board of Government including, but not restricted to, unencumbered gifts and bequests to the Section; all income from investments from the BSCES Society Reserve Fund; and transfers from the Operating checking and savings accounts. Transfer of funds from the dividends or yield or from the principal of the BSCES Society Reserve Fund may only occur upon a vote of the Board of Government as specified in Article 8, Section 2 of the Society's Bylaws.

BSCES SPECIAL FUNDS

BSCES also maintains a number of Special Funds, which were established for specific purposes. Although the monies in these funds are for the most part unrestricted, portions of these funds may be temporarily or permanently restricted. Restrictions are defined in the governing documents of each fund. Policies and procedures for the management of these funds are described in Article 8, Section 3 of the Society's Bylaws.

The Treasurer's Annual Report gives the status and details of the transactions for all the funds.

Respectfully submitted,

Ellen White, PE, President
Topher Smith, PE, Secretary

ANNUAL REPORT OF THE BOARD OF GOVERNMENT
APPENDIX A

July 20, 2015 Executive Committee

- Voted to approve payment of $615.56 in unbudgeted expenses for Outreach Committee Online Bridge Contest.

August 17, 2015 Executive Committee

- Voted to accept the meeting minutes for July 20th.

September 21, 2015 Executive Committee

- Voted to accept the meeting minutes for August 17th.

September 21, 2015 Board of Government

- Voted to approve FY 2016 Budget.
- Voted to change the name of "Student Affairs Committee" to "Student Chapter Committee"

October 19, 2015 Executive Committee

- Voted to accept the meeting minutes for September 21st.
- Voted to endorse the revised FY 2016 Budget.

November 23, 2015 Executive Committee

- Voted to accept the meeting minutes for October 19th.

November 23, 2015 Board of Government

- Voted to accept the meeting minutes for September 21st.
- Voted to put financials on record.

December 14, 2015 Executive Committee

- Voted to accept the meeting minutes for November 23rd.
- Voted to fund Student Chapter Grants, granting $1000 to Wentworth Institute of Technology, $800 to UMass Lowell, $400 to WPI, $400 to UMass Amherst, and $400 to Western New England.

January 25, 2016 Executive Committee

- Voted to accept the meeting minutes for December 14th.

January 25, 2016 Board of Government

- Voted to accept the meeting minutes for November 23rd.

February 22, 2016 Executive Committee

- Voted to accept the meeting minutes for January 25th and February 1st.

March 21, 2016 Executive Committee

- Voted to accept the meeting minutes for February 22nd.
- Voted to elect Paul Moyer to 3-year term to the TECET Board.
- Voted to elect Ali Touran to 3-year term to the TECET Board.

March 21, 2016 Board of Government

- Voted to accept the meeting minutes for January 25th.
- Voted to increase the 2017 BSCES general membership dues to $100.
- Voted to grant the 2016 Keville Scholarship award of up to $5000 to Justen Kelsey (actual value to be confirmed by Dan Cook).

April 25, 2016 Executive Committee

- Voted to accept the meeting minutes for March 21st.

May 23, 2016 Board of Government

- TBD

TREASURER'S ANNUAL REPORT
2015 – 2016

I. Treasurer and Assistant Treasurer 2015-2016

Robert L. Leger, PE, Treasurer

Gregory Mirliss, Assistant Treasurer

II. Activities:

- BSCES engaged the following firms to provide administrative support services and financial management:
  - TECET was retained to provide administrative and operational support, a director of finance and operations, an executive director, an association manager, an accountant, and other support staff.
  - Blum|Shapiro was retained to perform audit of the society accounting system and preparation and filing of the section's tax forms for the current fiscal year. Blum|Shapiro also provided reviews of the BSCES financial policies, allocation of funds, and financial oversight procedures.
  - RINET was retained to manage the organization's special fund investments. The special funds continued to be invested through Schwab. RINET provided quarterly recommendations for allocation of funds and direction relative to individual fund investment.

- The financial committee met with BSCES' financial advisor, Rinet, at the end of the Calendar Year to review the investment account performance on December 4, 2015. The Schwab investment portfolio currently aligns very closely with the society's target investment strategy. Through April 2016, the Special Funds has experienced just 3 months with an increase in market value and 7 months with a decrease in market value. The net change in investment value over this period (excluding transfers for Operating expenses) was -$85,613.11.
- TECET staff met with Blum|Shapiro representatives on November 9, 2015 to discuss the audit findings. The auditors determined that BSCES had a "clean" audit with no recommendations for changes to the current procedures. Thank you to Elizabth and Brendy and the TECET staff for their hard work in ensuring there were no flaws in the accounting practices. The completed tax forms were reviewed by the Treasurer and were filed on November 16, 2015.
- The Treasurer provided a summary of the special fund amounts based on activities through the prior fiscal year ending in June 30, 2015. This determination incorporated adjustment of the funds in consideration of the revenues and expenses relating to the funds. Blum|Shapiro assisted in reconciling the special funds and the establishment of the newly formed Charles C. Ladd fund. The Charles Ladd fund was determined to be temporarily restricted.

- The Treasurer will determine the current value of the individual Special Fund accounts for the end of FY 2016 and beginning of FY 2017 in July 2016.
- Assistant Treasurer Greg Mirliss provided extensive review of many expense requests and technical meeting pricing by committee and technical group members.
- Senior Vice President Malek Al-Khatib was assigned the task of reviewing the meeting pricing for committees and technical groups.
- To allow for adequate funds to be made available to pay monthly operating costs, $60,000 was transferred from the Schwab account in July 2014. As of March 31, 2016 the Webster account totaled $311,778.14. It is anticipated that there will not be a need for further transfer of funds to the Webster account in FY 16.
- BSCES continues to receive donations to the Charles C. Ladd fund in FY 16. Through March 31, 2016 BSCEs received $14,150 in additional donations to the Ladd fund.

III. Financial Summary through March 31, 2016:

- The BSCES total assets at the start of Fiscal Year 2016 (July 1, 2015) were $1,829,762.56.
- The current total assets (thru March 2016) were $1,878,040.09.
- The Schwab account value on July 1, 2015 was $1,632,967.73.
- The Schwab account value on March 31, 2016 was $1,470,980.47.

- BSCES' Total Revenues were $615,436.16. This amount is $24,313.84 below and 96% of the annual budgeted total revenues with 3 months remaining.
- The FY 2016 Total Expenses were $444,180.07. This amount is $386,939.93 below and 53% of the budgeted annual operating expenses.
- The current fiscal year-to-date net non-investment income is $171,256.09. This is compared to an annual projected loss of $155,537.50 through 9 months.
- While the above finances are good, it is noted that the net income during the months of April through June are typically negative by nearly $250,000. If the end-of-year losses hold true, the annual Operating loss would project to approximately $78,750 instead of $207,370.

IV. Treasurer's Team 2015-2016

Robert L. Leger, PE, CCM, Treasurer
Gregory Mirliss, Assistant Treasurer
Elizabeth Tyminski, Director of Finance and Operations
Richard F. Keenan, Association Manager
Brendy Gonzalez, Accountant

Respectfully Submitted,
Robert L. Leger, PE, CCM – BSCES Treasurer

2015-2016
ANNUAL REPORT
EXECUTIVE DIRECTOR

1. BSCES was named the Outstanding Section of the Year by ASCE National! This is the 4th time in the last 5 years that BSCES has won this award.

2. BSCES was selected for the History & Heritage Citation by ASCE National in recognition of the efforts made to celebrate the history of the civil engineering profession.

3. The Sponsorship Program recently developed (Corporate, Technical, and Outreach) resulted in over $60k raised for BSCES operations.

4. The 168th Annual Awards Dinner was held at Marriot Long Warf. The sold-out event attracted over 150 attendees.

5. BSCES presented its first Sustainability Award at the Annual Awards Dinner.

6. BSCES representatives attended ASCE's Annual Conference in New York City.

7. BSCES had several representatives that attended ASCE Leadership Conferences in Pittsburgh.

8. BSCES representatives attended the spring and fall Region 1 Assemblies.

9. BSCES had several representatives at ASCE's Fly-In program in DC.

10. BSCES provide monetary support and judges for the ASCE Student Conference featuring the Steel Bridge and Concrete Canoe contests. The event was co-hosted by Northeastern and Wentworth.

11. BSCES hosted ASCE president-elect Norma Jean Mattei; highlights included: Leadership Luncheon at the Engineering Center, key note presentation at Herzog Award dinner, and attendance at Infrastructure Day.

12. An Executive Committee meeting held in Holyoke, MA. The meeting was held in conjunction with a Western Mass Branch dinner event that attracted 80 individuals.

13. The Membership Committee formed a smaller Website Committee for the development and deployment of an updated website. The new site is more user-friendly and is supported on mobile platforms.

14. BSCES was mentioned/quoted in several media outlets, including Fox 25.

15. BSCES volunteers attended a round table discussion at the National Society of Black Engineers (NSBE) conference in Boston.

16. BSCES coordinated with ACEC and others relative to numerous legislative efforts and attended the annual Engineers and Lad Surveyors Day at the Statehouse.

17. BSCES developed and produced a document that highlighted the need to invest in our infrastructure. The brochure, *Infrastructure: Worth the Investment* was distributed at Engineers Day.

18. BSCES helped to organize, and participated in, Infrastructure Day in Holyoke, MA on May 14, 2016. The event was developed in conjunction with the City's Historical Society.

19. A new event was developed that include recognition of the Herzog Award, the numerous Outreach Awards, and new Life Members. This Spring Awards Dinner was held at Framingham State University and featured ASCE president-elect Norma Jean Mattei as the featured speaker.

20. BSCES provided $3000 in funding/grants to ASCE student chapters for local events.

21. BSCES continues to increased activity and membership on social media sites: Facebook, Twitter, and LinkedIn. A new Social Media Policy was develop to provide guidance for the use of these, and other, social media outlets.

Q:\SPONSORS\BSCES\EVENTS\FY 2016\2016-05-23 Annual Business meeting\Annual Reports\03_2016 Executive Directors Report.doc

CONSTRUCTION INSTITUTE BOSTON CHAPTER
ANNUAL REPORT
2015 – 2016

I. Summary

The ASCE Construction Institute (CI) Boston Chapter has organized technical seminars, networking sessions and site tours, and continued to grow connections with CI national, other chapters, and the Utility Contractors' Association of New England (UCANE).

II. CI Committee Officers and Members for the 2015-2016 Program (Fiscal) Year:

Active Members: (attended at least one group meeting / active email correspondence)

1. Daniel Cook – Chairman
2. Chris Hersey – Vice Chairman
3. Hans Kuebler – Secretary
4. Richard Maher – Member and Executive Board Liaison to CI
5. David Denny – Member
6. Sean Homem – Member
7. Nick Scenna - Member
8. Ali Touran – Member
9. Wayne Keefner – Member
10. Christina Cosmos – Member
11. Jim Lambrechts – Member
12. Ryan Boucher – Member
13. Robbie Burgess – Member
14. Andrew Giocondi – Member
15. Thomas Hale – Member
16. Derek Simpson – Member
17. Jeffrey Kellner – Liaison to BSCES Sustainability Group

Inactive Members:

18. Greg Imbaro – Member
19. Giuliana Zelada – Member
20. Blake LeClair - Member
21. Eoin Walsh – Member
22. Travis Mohr – Member
23. Payam Bakhshi – Member
24. Gerald Topping – Member
25. Maria Evangelista – Member
26. Kyle Davis – Member
27. Eric Salo – Member
28. George Ryan – Member
29. Jim Noone - Member
30. Jim Wheeler - Member
31. Joe Allegro – Member
32. Mike Gaa – Member
33. Steve Rusteika – Member

III. CI Member-Only Site Tours

1. December 18, 2015 Millennium Tower (Old Filenes Building), Boston, MA

Host/Tour Guide: Kathleen MacNeil, Millennium Partners - Boston

Description: Private tour of the Millennium Tower project site. Opportunity to observe various stages of construction over height of tower, and learn project details.

Attendance/Financial: 7 CI Members; No financial implications

2. TBD NewBalance Jobsite, Boston, MA

Host/Tour Guide: TBD

Description: Planned private tour of NewBalance complex, including athletic facility and adjacent commuter rail station, followed by networking at The Stockyard.

Attendance/Financial: Approximately 20 anticipated, including existing CI members and invited candidates to join CI; Expenses included in group's existing fiscal year budget

IV. CI Meetings for the 2015-2016 Program (Fiscal) Year:

Other than holding group planning meetings/conference calls and supporting the Annual Francis M. Keville Dinner on April 14, 2016 (record attendance of 332 and $882.72 profit in spite of $5,000 scholarship donation), CI focused its planning efforts this year on the following:

1. May 2016, postponed to September 2016 CI Boston Day-Summit

Planned Guest Speakers: Sam Sleiman, MassPort (Keynote); Dr. Kord Wissman, Geopier and President of ASCE Geo-Institute; Dennis Swinford, MIT; Cliff Schexnayder, Construction Consultant; Robbie Burgess, Howard Stein Hudson; Cory Brett, Simpson Gumpertz & Heger; Brendan Fitzpatrick, DurroTera; Nick Scenna, Peter Moser and Timothy McLaughlin, Stantec and SPS Construction; TBD, Skanska

Description: Full-day technical seminar, structured similarly to a day at an ASCE conference. Will include construction-specific vendors.

Attendance/Financial: Goal 50 to 100 attendees / TBD

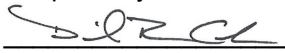
V. Other Activities/Contributions

1. Established relationship with CMAA Young Members Events subcommittee.
2. Submitted an article discussing the current state of CI and its activities (previous and planned) for the BSCES March Newsletter.
3. Six members (DC, CH, HK, RM, SH, and DD) attended the UCANE Annual Forecast Dinner Meeting and Trade Show as invited guests on March 30, 2016.

VI. CI Boston Chapter Committee Officers and Members for the 2016-2017 Program (Fiscal) Year

1. Chris Hersey – Chairman
2. Hans Kuebler – Vice Chairman
3. David Denny – Secretary
4. Additional active members listed above in Section **II**.

Respectfully submitted to the BSCES Board of Government on May 19, 2016



Daniel R. Cook, P.E., S.E., Construction Institute Boston Chapter Chairman

COPRI BOSTON ANNUAL REPORT
2015 – 2016

I. Summary

The COPRI Boston Chapter organized three technical dinner meetings. The events were attended by over 100 attendees.

II. BSCES Geo-Institute Officers and Members for 2015-2016:

1. Lauren Klonsky - Chair
2. Nasser Brahim– Vice Chairman
3. Gregory Robbins – Past Chair
4. Brian Caufield – Past Chair
5. Charlie Roberts – Past Chair
6. Frannie Bui - Secretary
7. Andrew Nilson – Member
8. Hande Caliskan – Member
9. Karen Adams – Member
10. Rebecca Skalaski - Member

III. COPRI Boston Chapter Technical Meetings

1. December 1, 2015 Preparing for a Flood: Resiliency at Massport

Guest Speaker: Robbin Peach, MPA, MA
Program Manager of Resiliency
Massport

This joint COPRI and EWRI dinner meeting was held on Tuesday December 1, 2015, at the Wyndham in Boston, MA. Ms. Peach discussed the Massport process for making its assets more resilient to flooding. She discussed the planning process for identifying threats and critical assets, architectural and engineering solutions and operational preparedness.

A total of 85 people registered and the net income from the event was $2,243.16.

2. February 9, 2016 Waterfront Facilities Inspections & Assessment Manual

Guest Speakers: Charlie Roberts, PE
Project Manager
Childs Engineering Corporation

Noah J. Elwood, PE
President
Appledore Marine Engineering

This dinner meeting was held on Tuesday, February 9, 2016 at the Chateau Restaurant in Norwood. Mr. Roberts and Mr. Elwood provided an overview of the latest ASCE Manual of Practice (MOP 130) that details the methods and techniques for the inspection and assessment of waterfront facilities. The presentation focused on different types of inspections that can be used for topside and underwater inspections. The speakers provided an overview of common defects found in various structure types, discussed how they were documented, and provided information on administrative considerations when conducting inspections.

A total of 57 people registered and the net income from the event was $1,325.16.

3. March 15, 2016 Assessing the Effects of Climate Change to the Massachusetts Central Artery and Beyond

Guest Speaker: Kirk Bosma
Project Manager and Coastal Engineer
Woods Hole Group, Inc.

This dinner meeting was held on Tuesday, March 15, 2016 at the Chateau Restaurant in Norwood. Mr. Bosma, joined us to discuss his analysis of the effects of climate change to the Massachusetts Central Artery / Tunnel Project and the Massachusetts coastline. His talk provided information on the development of the Boston Harbor Flood Risk model (BH-FRM) and discussed model output and interpretation of the results.

A total of 30 people registered and the net income from the event was $777.50.

IV. Special Events

No special events were held.

VI. Other Activities/Contributions

1. BSCES Newsletter Articles

   One article was solicited, written and submitted for the May 2016 BSCES Newsletter. The article discussed emergency preparedness.

VII. BSCES COPRI Officers and Members for 2016-2017:

1. Ryan McCoy –Chairman
2. Nasser Brahim – Vice Chair
3. Lauren Klonsky – Past Chair
4. Gregory Robbins – Past Chair
5. Brian Caufield – Past Chair
6. Charlie Roberts – Past Chair
7. Frannie Bui - Member
8. Andrew Nilson – Member
9. Hande Caliskan – Member
10. Karen Adams – Member
11. Rebecca Skalaski - Member

Respectfully submitted to the BSCES Board of Government
Lauren Klonsky, P.E., COPRI Boston Chair

2015-2016
ANNUAL REPORT
ENGINEERING MANAGEMENT GROUP

I. Summary

The goal of the Boston Society of Civil Engineering Section (BSCES) Engineering Management Group (EMG) is to organize educational and/or professional development events each season, assist our members to better understand engineering management, and to provide networking opportunities within the industry. The group holds monthly meetings to discuss current topics of interest and coordinate events. The signature event of the EMG calendar is the Joseph C. Lawler Lecture, established in March 1983, and is supported by the Joseph C. Lawler Special Fund which was established in memory of the ASCE Engineering Management Award winner through a grant from CDM Smith to BSCES. The lecture's purpose is to provide a premier event to discuss important aspects of engineering management, while reducing the financial burden of the event for BSCES members. Mr. Lawler was the first president of CDM from 1971 until his death in 1982. Through this lecture series the EMG continues his legacy of outspoken leadership and his ability to guide and influence the profession of environmental engineering.

II. BSCES Engineering Management Group Officers and Active Members and Participants for 2014-2015 include:

1. **Kevin Garvey – Chair**
2. **Michaela Bogosh – Vice Chair**
3. **Sue Gryszkiewicz – Secretary**
4. **Angela O'Donnell – Past Chair**

5. Jason Coy - Member
6. Paul Dye – Member
7. Ethan D. Field – Member
8. Lorraine Finnegan - Member
9. Mike Guidice – Member
10. Christopher Koehler – Member
11. Wayne Keefner – Member
12. Nathan Little – Member
13. Brian Morgan – Member
14. Robert Musci – Member
15. Anthony Puntin - Member
16. John Riccio – Member
17. Karla Sangrey – Member
18. Emily Schick – Member
19. Ellen White – Member
20. Mark Wixted – Member

III. Engineering Management Group Events 2015–2016 included:

1. Thursday, January 14, 2016 – Public Private Partnerships (P3): Round Table Discussion on the Funding Source to Rebuild America's Infrastructure

Guest Speaker Panel:
Moderator:
William Lyons, Jr., PE, Esq., President, Fort Hill Companies
Speakers:
Pamela Bailey-Campbell, Vice President, Jacobs Engineering,
Tom Pelnik, Managing Director of EY Infrastructure Advisors, Ernst & Young
Anatoly Darov, PE, Esq. Partner, Burns and Levinson
Javier Gutierrez, Vice President of Asset Management, Cintra

Location: The Wyndham Boston Beacon Hill, Boston, MA (dinner event)

The "Public Private Partnerships (P3): Round Table Discussion on the Funding Source to Rebuild America's Infrastructure" presentation featured William Lyons as the moderator and 4 speakers. The speakers were Pamela Bailey-Campbell of Jacobs Engineering, Tom Pelnik of Ernst & Young, Anatoly Darov of Burns and Levinson, and Javier Gutierrez of Cintra, addressed the construction, engineering, logistical and stakeholder challenges faced in utilizing P3 funding for construction projects. The speakers used many real live examples from recent P3 projects in Texas. The discussion focused on using P3 funding for transportation projects but broached the subject of using P3 funding for utility projects.

A total of 60 people were in attendance. The event resulted in a profit of $1,037.28.

2. Thursday, March 31, 2016 – Dispute Resolution Board: Alternative Dispute Resolution Process that Promotes Conflict Avoidance as well as Timey and Cost Effective Dispute Resolution.

Guest Speaker: Bob Jarnis, PE
Woodard and Curran

Location: The Wyndham Boston Beacon Hill, Boston, MA (dinner event)

The Dispute Resolution Board discussion was presented by Mr. Bob Jarnis of Woodard and Curran. Mr. Jarnis did a great job presenting on the advantages and disadvantages of utilizing the Dispute Resolution Board for larger construction projects. Mr. Jarnis was able to present on local and national projects to pique the interest of the crowd.

A total of 28 people were in attendance. The event resulted in a loss of $395.76 but had a great student representation from a few of the local colleges and universities. The student rate at BSCES events is typically cheaper than the actual cost of the meal.

3. Thursday, June 9, 2016 - Joseph C. Lawler Lecture (See Section IV)

IV. Special Fund Event

Thursday, June 9, 2016 - Joseph C. Lawler Lecture Panama Canal Supersized

Guest Speaker: Mr. Joe Adams,
President of Energy and Industry Division, MWH Global

Location: Fairmont Copley Plaza, Boston

The expansion of the Panama Canal Locks is a construction and engineering marvel. The canal expansion utilized over 10,000 workers, more concrete than the Hoover Dam, and approximately 25 times the amount of steel used to erect the Eifel Tower. Mr. Adams is the chairman of the Design Consortium for the Third Set of Locks which makes up $3.2 billion of the $5 billion dollar Panama Canal Expansion. The third lock is expected to open to boat traffic on June 26, 2016. There is a progress photo of the lock at the Pacific Ocean.

Attendance is anticipated to be greater than 65, and the event profit is not yet available.

V. Other Activities/Contributions

BSCES Newsletter Articles

One article was written and submitted this season: **"BSCES Engineering Management Group"** by Kevin Garvey, PE from CDM Smith. It appeared in the January 2016 newsletter.

VI. BSCES Engineering Management Group Officers for 2015-2016 include:

Mr. Kevin Garvey	**Chair**
Ms. Michaela Bogosh	**Vice Chair**
Ms. Sue Gryszkiewicz	**Secretary**
Ms. Angela O'Donnell	**Past Chair**

Respectfully submitted to the BSCES Board of Government on May 18, 2016 by:

Kevin Garvey, P.E. - Engineering Management Group Chair 2015-2016

ENVIRONMENTAL & WATER RESOURCES INSTITUTE
ANNUAL REPORT
2015 – 2016

I. Summary

The BSCES Environmental & Water Resources Institute (EWRI) organized one technical dinner meeting (the Camp Lecture scheduled for June 2016), one two-night technical workshop, and partnered with other BSCES Institutes for two additional technical dinner meetings. Not including the Camp Lecture, the events were attended by over 150 people and have netted approximately $ 2,800 to-date.

II. BSCES EWRI Officers and Members for 2015-2016:

1. Matt Hodge – Chairman
2. Ron Burns – Vice Chairman
3. Conrad Nuthmann – Member
4. Charlie Gore – member
5. David Roman – Member
6. Emerson Olander – Member
7. Derek Etkin – Member
8. Karen Kelley – Member
9. Karen Madsen - Member
10. Kurt Pennell – Member
11. Rishabh Iyer - Member
12. Yan Zhang – Past Chair
13. Ed Whatley – Past Chair Emeritus

III. EWRI Meetings for 2015 – 2016:

1. December 1, 2015 **Preparing for a Flood: Resiliency at Massport**

Guest Speaker: Robbin Peach, MPA, MA
Program Manager of Resiliency, Massport

This EWRI dinner meeting was a joint meeting with the Coasts Oceans, Ports, and Rivers Institute (COPRI). The meeting was held on Monday, December 1, 2015 at the Wyndham Boston Beacon Hill Hotel. Ms. Peach presented Massport's recent efforts to understand and address the threats posed to Massport by sea-level rise. She discussed the analysis that was conducted to determine just what threats Massport faced. Ms. Peach then described short-term and long-term plans that were to be enacted to protect Massport infrastructure at multiple locations.

The speaker works in Boston. The only direct cost of having Ms. Peach present was the cost of her meal at the dinner. BSCES paid the cost of the meal.

A total of 85 people were in attendance and the event netted EWRI $1,121.58 (50% of net profit for joint event).

2. December 8 & 15, 2015 **Workshops: HEC-RAS 2D & GRASS GIS Hydraulic Models**

Guest Speaker: Karen Madsen, PE Civil Engineer at AECOM
Derek Etkin, PE Water Resources Engineer at CDM Smith

This EWRI workshop occurred over two nights. Both nights of the workshop were hosted by VHB

in their Watertown Office. Each night was devoted to a different type of new software that is relevant to the practice of environmental and water resources engineering. On December 8, Karen Madsen gave a presentation about open-source GRASS GIS modeling and on December 15 Derek Etkin gave a presentation on the soon to be released HEC-RAS 2D model. Both nights included active attendees who asked a number of questions.

A total of 38 (19 per night) people were in attendance and the event netted EWRI $1,380.

3. May 4, 2016 **The History of the MWRA**

Guest Speaker: Fred Laskey
Executive Director, Massachusetts Water Resources Authority

This EWRI dinner meeting was a joint meeting with the Younger Members Group (YMG). The meeting was held on Wednesday May 4, 2016 at Nitsch Engineering in Boston. YMG organized the event including submitting the budget and determining relevant costs. EWRI's contribution to the event was publicizing the event and encouraging its members to attend. It was a great opportunity for EWRI members to interact with younger members and begin networking with younger members.

A total of 49 people were in attendance and the event netted EWR $ 310 (50% of.net profit for joint event).

4. June 2, 2016 **2016 Thomas R Camp Lecture Strategies for Managing 21st Century Water Challenges**

Guest Speaker: Curt Spalding
Administrator, US Environmental Protection Agency Region 1

This EWRI dinner meeting will be held at the Wyndham Boston Beacon Hill Hotel on June 2, 2016. Mr. Spalding will present on how challenges like climate change are impacting water management issues throughout New England. We anticipate an engaged audience and we are currently estimating an attendance of 50 BSCES members.

IV. Special Event for 2015 – 2016:

EWRI did not host any special events in 2015 – 2016.

VI. Other Activities/Contributions

1. Boston Water and Sewer Commission Design Storm Forum

Matt Hodge attended a forum hosted by the Boston Water and Sewer Commission (BWSC) on March 11, 2016. The purpose of the forum was to begin a dialogue about updating the design storm that BWSC uses in designing infrastructure for the city of Boston. The forum included a presentation from NOAA on the recently released Atlas 14 precipitation maps and the methodology used to develop these maps.

Mr. Hodge attended as a representative for BSCES and provided input and feedback to BSCES on proposed changes to design standards.

VII. BSCES EWRI Officers and Members for 2016-2017:

1. Ron Burns – Chairman
2. Currently Unknown – Vice Chairman
3. Conrad Nuthmann – Member
4. Charlie Gore – Member
5. David Roman – Member
6. Emerson Olander – Member
7. Derek Etkin – Member
8. Karen Kelley – Member
9. Karen Madsen - Member
10. Kurt Pennell – Member
11. Rishabh Iyer - Member
12. Ed Whatley - Member
13. Matt Hodge – Past Chair
14. Yan Zhang – Past Chair Emeritus

Respectfully submitted to the BSCES Board of Government on May 16, 2016
Matt Hodge, P.E., EWRI Chair

GEO-INSTITUTE ANNUAL REPORT
2015 – 2016

I. Summary

The BSCES Geo-Institute organized one technical dinner meeting, one special event, and one lunch and learn program. The events were attended by over 300 people. The technical dinner meeting and lunch and learn program netted the Geo-Institute a profit of $2,605.1. There was no charge for the special event resulting in a disbursement of $4,827.40 from the Charles C. Ladd Memorial Fund.

The Geo-Institute continued to administer the Charles C. Ladd Special Fund, which was created to honor the memory of the influential MIT Professor and past BSCES President. In 2015/16 $14,500 was donated to the Special fund bringing the total donated to over $107,000.

II. BSCES Geo-Institute Officers and Members for 2015-2016:

1. Jon Davies - Chair
2. Jennifer Jordan - Vice Chair
3. Bryan Strohman - Secretary
4. David Finocchio – Forum Chair
5. Lucy Jen - Member
6. Peter Chou - Member
7. Laurie Miller - Member
8. Michael Flynn - Member
9. Mohammad Reza Jafari - Member
10. Matthew Chartier - Member
11. Todd Dwyer - Member
12. Justin Dominguez - Past Chair
13. Derek Schipper Past Past Chair
14. Geoffrey B. Schwartz - Emeritus/BSCES Board Liaison

III. One Geo-Institute Dinner Meetings for 2015-2016:

March 10, 2016 Port of Miami Tunnel

Guest Speakers:
Peter F. Donahue, PE, ENV SP Vice President **WSP | *Parsons Brinckerhoff***
Steve Dusseault Senior Engineering Manager **WSP | *Parsons Brinckerhoff***

This Geo-Institute dinner meeting was held on March 10, 2016, at the Wyndham Boston Beacon Hill. The lecture detailed the award winning Port of Miami Tunnel which boasts a number of firsts, the first Public-Private Partnership developed in the State of Florida, the largest soft ground bored roadway tunnel completed in North America, the first use of ground freezing as temporary support in Florida and one of the most extensive ground treatment programs done in Florida. The presentation discussed the procurement method, technical challenges and management approach on this highly successful project

A total of 60 people were in attendance. The event netted the Geo-Institute $1,315.72.

IV. Special Event for 2015-2016:

November 16, 2015 . First Charles C. Ladd Memorial Lecture

Trends in Mechanically Compressed Sediment Behavior with Stress and Plasticity

Guest Speaker:
John T. Germaine, ScD Research Professor, Civil and Environmental Engineering Department, Tufts University

This Geo-Institute dinner meeting was held on November 16, 2015, at the MIT Tang Center, Wong Auditorium.

The SHANSEP concept, developed by Charles Ladd and Roger Foott, has become one of the underpinning foundations of stability evaluation in engineering practice. It is based on the principle that the strength properties of mechanically compressed fine grained sediments normalize with consolidation stress. Recent advances in experimental technology have enabled a detailed study of the compression, permeability, and shear behavior of materials over a wide range of stresses. In combination with resedimentation, we have been able to study these behaviors for a wide range of soils without dealing with the complexity of sample disturbance or specimen variability. This lecture presented results of an extensive experimental program that establishes a new understanding of the variation in behavior as a function of stress and plasticity. One very important outcome is the observation that clay rich sediments do not follow the rules of normalized behavior. This has resulted in a significant modification to the SHANSEP equation and created a need for a new generation of soil models.

A total of 218 people pre registered for the event and there were walk in's on the day. In line with the wishes of the organizing committee there was no charge for attendance. A disbursement of $4,827.40 was taken from the Charles C. Ladd Memorial Fund to offset this loss.

V. Lunch and Learn

February 25, 2016
Jet Grouting in Challenging Environments. Methods and Risk Mitigation

Guest Speakers:
Kevin Dawson, P.E., Hayward Baker, Inc
Paul Thurlow, Gtec – UK,

This Geo-Institute lunch and learn was held on, February 25, 2016, at The Engineering Center Education Trust, One Walnut Street, Boston. The topics covered included

Jet Grouting in Urban Environments

a. General Review of Jet Grouting History
b. Jet Grouting Techniques
c. Associated Risks in Urban Environments
d. Recent Boston / Cambridge Jet Grout Examples

Case History – Victoria Station, London

Victoria Station in central London is one most congested areas. Jet grouting to seal water flow over existing subway tunnels was a challenge to complete a watertight environment for mining. The work area was confined and the underground services were many. This talk shows how 4000 jet columns were completed successfully against these challenges, innovation in BIM modelling and column as builts using new instrumentation. Jet grouting under sensitive structures is feasible with the right instrumentation in place.

A total of 22 people were in attendance. The event netted the Geo-Institute $1,289.38.

VI Charles C. Ladd Memorial Fund

It was with great sadness that we saw the passing of Professor Charles C. Ladd of MIT on August 4, 2014. Professor Ladd has had a profound influence on the geotechnical community as a whole, and particularly in Boston. At MIT, he advised scores of Master's and PhD students, many of whom are amongst us as colleagues and teachers. The Geo-Institute was humbled to be approached by several of Professor Ladd's former students, Dr. Lewis Edgers of Tufts, Dr. Don DeGroot of UMass Amherst, Dr. Tom Sheahan of Northeastern, Dr. Jack Germaine of MIT, Dr. Suzanne Lacasse of the Norwegian Geotechnical Institute, and Dr. Lucy Jen of RSE Associates about being the host organization of a Charles C. Ladd Memorial Lecture. The Geo-Institute graciously accepted. The Lecture, which will be held every two years, will serve as a way to honor Professor Ladd and sustain his legacy.

The BSCES has established a Special Fund to defray costs of holding the Lecture. In 2015/16 $14,500 was donated to the Special fund bringing the total donated to over $107,000.

VII. BSCES Geo-Institute Officers and Members for 2016-2017:

1. Jennifer Jordan - Chair
2. Bryan Strohman - Vice Chair
3. David Finocchio - Secretary
4. Lucy Jen – Forum Chair
5. Peter Chou - Member
6. Laurie Miller - Member
7. Michael Flynn - Member
8. Mohammad Reza Jafari - Member
9. Matthew Chartier - Member
10. Todd Dwyer - Member
11. Jon Davies – Past Chair
12. Justin Dominguez – Past Past Chair
13. Derek Schipper - One Day Chair
14. Geoffrey B. Schwartz - Emeritus/BSCES Board Liaison

Respectfully submitted to the BSCES Board of Government on May 20, 2016
Jon Davies, P.E., Geo-Institute Chair

SEI BOSTON ANNUAL REPORT
2015 – 2016

I. SUMMARY

The BSCES/SEI Boston Chapter organized and presented our 2015 Lecture Series ("Wicked Fast Bridge Construction), a technical dinner meeting, an all-day technical workshop, and a casual social event co-hosted by BSCES YMG in the year 2015-2016. Not including the final event of the year (the social event), the events were attended by approximately 625 people and have netted approximately $16,800. In addition SEI Boston also published two articles in the November 2015 BSCES Newsletter, and engaged many structural engineers throughout the state by conducting surveys to gather information about member's desires and expectations of the group and by requesting data to be used in the Feuding Structural Engineers social event. In addition SEI Boston has lined up a potential all-day seminar for the fall of 2016. During the past year SEI has added numerous new active members while saying good-bye to two members, one who retired from the engineering practice entirely. Due to the growth in the group SEI has added an additional sub-committee so that all members remain actively engaged. The Committee is also continuing to explore better ways to communicate with members and attract new members through the use of social media.

II. BSCES/SEI BOSTON OFFICERS AND MEMBERS FOR 2015-2016:

- Peter Keeping – Chair
- Dennis Baker – Vice Chair
- Shahvir Vimadalal – Clerk
- Nathan L. Rosencranz – Member
- Mike McCall – Member
- Brent Vollenweider – Member
- Michael Cruz – Member
- Scott Bruso – Member
- Irena Svetieva – Member
- Daniel Martel – Member
- Keith Donington – Member
- Shanta Keller – Member
- Caroline Fitzgerald – Member
- Joel Lunger – Member
- Peeyush Rohela – Member
- Edward DiSalvio – Member
- Benjamin Holsapple – Member
- Christopher Kline – Member
- Jamie Mucha – Member
- Darren W. Conboy – Member, Past Chair
- Brian Brenner – Member, Past Chair
- Mark Gershman – Member, Past Chair
- Jeff Lewis – Member, Past Chair
- Ali R. Tali – Member, Past Chair
- Stephen Taylor – Member, Past Chair
- Mehrdad Sasani – Member, Past Chair
- Todd Warzecki – Immediate Past Chair

* SEI Members Hemendra Bhatt and Anil Kurian resigned from SEI during the past year.

III. SPECIAL EVENTS FOR 2015 – 2016:

2015 Fall Lecture Series – October 6, 2015 through November 3, 2015
Wicked Fast Bridge Construction

This was the main event for the year of 2015 – 2016. For the 27th time BSCES/SEI Boston held our bi-annual Fall Lecture Series. The planning for this event started back in October 2014 when the Lecture Series Sub-Committee started brain storming for a general theme for the Series. Since Rapid Bridge Construction (ABC) has recently emerged as a more popular way to minimize traffic hardships to the general public while constructing major projects SEI elected to title the Series Wicked Fast Bridge Construction and aptly have local owners and local designers give lectures on specific projects recently built in and around New England, predominantly in the Boston area.

The Lecture Series was held at Tufts University and consisted of five lectures which included a round-table discussion during the last lecture that was tabled by speakers from the previous lectures and hosted by Alexander Bardow, Massachusetts State Bridge Engineer.

Surveys received during the year clearly showed that SEI and other BSCES members prefer more casual dinner/lecture events with an emphasis on technical content so it was decided that we would serve pizza before each lecture and allow attendees to mingle while they ate. This format proved to be a big success as attendance increased noticeably from previous lecture series' while costs were quite minimal thus allowing the Series to be very profitable financially. The Committee received much feedback from lecturers and attendees that the lecture Series was very enjoyable, sufficiently technical and enabled sufficient time for networking and visiting with other local engineers.

The lectures comprising the event were as follows;

LECTURE 1 – Tuesday, October 6, 2015
The State of Wicked Fast Bridge Construction in New England
Guest Speaker: Michael P. Culmo, P.E., Vice President, CME Associates, Inc.
This presentation provided an overview of how the New England States are implementing WFBC and covered topics such as decision making process, prefabricated bridge elements, bridge system installations, accelerated project delivery and ABC tolerances. All of the New England States have constructed WFBC projects and several states have instituted Accelerated Bridge Construction (ABC) programs. The design community has adapted to these new technologies using resources made available by owner agencies, industry, and the Federal Highway Administration (FHWA). The benefits of ABC or WFBC have been well documented by FHWA and others. The primary benefits are reduced mobility impacts to the traveling public, improved safety through reduced workers and travelers to work zones, reduced impact to the environment, and higher quality.
A total of 78 people were in attendance at this lecture.

LECTURE 2 – Tuesday, October 13, 2015
Detailing of WFBC – Lessons Learned
Guest Speaker: Joseph P. Gill, P.E., President, Gill Engineering Associates, Inc.
This presentation focused on various design issues and construction details encountered on a number of accelerated bridge construction projects in Massachusetts and elsewhere. Methods of erection/placement along with development of details compatible with construction sequence and schedule as well as the lessons learned on these projects were presented. Discussions covered design approach and detailing for various bridge elements including footings, wall/column to footing connection, pier cap to wall/column connection, backwalls, approach slabs, superstructure connections to deck, barriers, waterproofing membrane and wearing surfaces. The design

approach to short term as well as long term (final design) loading along with the impact of tolerances was also discussed.
A total of 90 people were in attendance at this lecture.

LECTURE 3 – Tuesday, October 20, 2015
WFBC Local Case Study I – MassDOT Bridges
Guest Speakers:
Brian Brenner, P.E., Bridge Engineer, Stantec, Inc.
Nicholas Scenna, P.E., Bridge Engineer, Stantec, Inc.
This presentation discussed case studies of select MassDOT bridges. Topics covered included utility relocation, utility bridge, Self-Propelled Modular Transporter (SPMT) construction, MBTA commuter rail station reconstruction and lessons learned. Lessons learned discussions covered various topics including issues unique to design-bid-build procurement approach, contractor's means and methods, special specifications, precast concrete details and construction tolerances, and protection of adjacent existing structures during rapid demolition. Uses of innovative early utility relocation contract were also discussed.
A total of 85 people were in attendance at this lecture.

LECTURE 4 – Tuesday, October 27, 2015
WFBC Local Case Study II – MBTA Bridges
Guest Speakers:
Erik J. Stoothoff, P.E., Chief Engineer, MBTA
John C. Schwarz, P.E., Director of Bridge & Tunnel Projects, MBTA
The primary mission of the MBTA is to move their customers safely and on time. MBTA owns and maintains over 350 rail bridges. Advanced age and condition of these structures require several bridges to be replaced every year for foreseeable future to maintain a state of good repair. This presentation discussed past history of WFBC at the MBTA using case studies to offer lessons learned from successful implementation as well as the decision making process and future use of ABC or WFBC techniques on MBTA bridge projects. To date, MBTA has used these techniques for the construction of three bridges, and a future bridge replacement is in the final design stage. Discussion also included the use of SPMT's, which has been very successful on MBTA projects.
A total of 95 people were in attendance at this lecture.

LECTURE 5 – Tuesday, November 3, 2015
Durability of WFBC (ABC) Bridges
Guest Speaker: Bryan Busch, P.E., Director Structural Engineering, CME Associates, Inc.
CME Associates has inspected several bridges constructed with various ABC methods. This session included a discussion on what works and what does not work.
The Future of WFBC – Panel Discussion Moderated By Alexander K. Bardow, P.E., State Bridge Engineer, MassDOT
This session included a panel discussion with speakers of Lectures 1 through 4. The panel also answered questions from attendees.
A total of 90 people were in attendance at this lecture.

Throughout the Lecture Series a total of 438 people registered. The Income was $19,570, expenses were $5,146 and the net profit was $14,424.

IV. DINNER LECTURE FOR 2015 – 2016:

Kingdom Tower - A Megatall Building
Guest Speaker: Joseph G. Burns, P.E., S.E., C.Eng, F.ASCE, LEED AP, Managing Principal, Thornton Tomasetti
Wednesday, February 10, 2016
Northeastern University, Behrakis Health Center, Room 010, 30 Leon Street, Boston, MA

This event was co-sponsored by Northeastern SEI Graduate Student Chapter (Northeastern Graduate Structural Engineering Association), Northeastern ASCE Student Chapter and Northeastern Student Government.
This presentation focused on the planning and design of the Kingdom Tower and also discussed relevant aspects of other recent Megatall buildings. Megatall buildings are currently defined by the Council on Tall Buildings and Urban Habitat as those reaching the height of 600m or higher. While many such towers have been proposed over the years, it has only been within the past decade that four megatalls have finally come to fruition: Burj Khalifa (Dubai), Shanghai Tower (China), Mecca Royal Clock Tower (Saudi Arabia), and Ping An Financial Center (China). The 1-kilometer tall Kingdom Tower in Jeddah, Saudi Arabia which is currently under construction will become the world's tallest building when completed. As with all tall buildings, the most important drivers for various engineering solutions to a particular building are: performance under environmental wind and seismic lateral loads, foundations, structural materials, construction efficiencies and scheduling, and architectural shaping, internal planning, usage and aesthetics. For megatalls, however, the importance of these drivers becomes more pronounced to the point that the structural demands on the architecture and planning usually become the critical factor in the success or failure of the project.
This Lecture attracted 120 registrants. The Income was $1,130, expenses were $514 and the net profit was $616.

V. SEMINAR 2015 – 2016:

MassDOT LRFD Bridge Manual Workshop
Alexander K. Bardow, P.E.
State Bridge Engineer, Massachusetts Department of Transportation
Joseph P. Gill, P.E.
President, Gill Engineering Associates, Inc.
Bryan Busch, P.E.
Director of Structural Engineering, CME Associates, Inc.
Monday, May 16, 2016
This workshop was an encore of the Fall 2014 workshop and was geared towards younger practicing members currently designing bridges for MassDOT. It primarily focused on how to design bridge elements using Part I of the 2013 MassDOT LRFD Bridge Manual. The workshop was intended to provide an overview of the significance, and the rationale behind the changes including: new methods for dead load distribution, seismic design, bearing design, and integral abutment design. It also included discussion on certain items that may be re-evaluated and modified for inclusion in future Bridge Manual revision(s), and the reasoning for those changes. The Lecture had a net profit of approximately $1790 and there were approximately 60 registrants.

VI. Structural Engineering Feud
Based on Family Feud TV Show; but, with Structural Engineers
Wednesday, June 1, 2016

Come and join us for an evening full of networking and fun. The Structural Engineering Feud will include a Family Feud style contest with the questions based on structural engineering themes. You can choose to register as a team of five, have us assign you a team, or just come by as a spectator to meet some friends and have a few laughs!

VII. BSCES/SEI BOSTON OFFICERS AND MEMBERS FOR 2016-2017:

1. Dennis Baker – Chair
2. Shahvir Vimadalal – Vice Chair
3. Nathan L. Rosencranz – Clerk

4. Mike McCall – Member
5. Brent Vollenweider – Member
6. Michael Cruz – Member
7. Scott Bruso – Member
8. Irena Svetieva – Member
9. Daniel Martel – Member
10. Keith Donington – Member
11. Shanta Keller – Member
12. Caroline Fitzgerald – Member
13. Joel Lunger – Member
14. Peeyush Rohela – Member
15. Edward DiSalvio – Member
16. Benjamin Holsapple – Member
17. Christopher Kline – Member
18. Jamie Mucha – Member
19. Darren W. Conboy – Member, Past Chair
20. Brian Brenner – Member, Past Chair
21. Mark Gershman – Member, Past Chair
22. Jeff Lewis – Member, Past Chair
23. Ali R. Tali – Member, Past Chair
24. Stephen Taylor – Member, Past Chair
25. Mehrdad Sasani – Member, Past Chair
26. Todd Warzecki – Member, Past Chair
27. Peter Keeping – Immediate Past Chair

Respectfully submitted to the BSCES Board of Government on May 23, 2016
Peter Keeping, SEI Chair

YOUNGER MEMBER GROUP ANNUAL REPORT
2015-2016

I. Summary:

The BSCES Younger Member Group (YMG) organized several networking and volunteer events during the 2015-2016 year. These activities were some of the highest attended events in recent YMG history. In addition, the members of the YMG prepared multiple articles for the BSCES Newsletter and volunteered at Outreach events and with the Student Chapter Committee.

II. BSCES YMG Officers and Members for 2015-2016:

1. Cara Pirkey– **Chair**
2. Alyson Stuer – **Vice Chair**
3. TJ Liveston – **Past Chair**
4. Jess Yarmarkovich – **Secretary, Student Chapter Committee Chair**
5. Anthony Richardson – **Treasurer**
6. Rich Matson – Past Chair
7. Brian Paula – Member
8. Valerie Chia – Member
9. Ana Gouveia– Member
10. Kathleen Walsh – Member
11. David McVeety – Member
12. Natalie Matson - Member
13. Dale Veselsky – Member
14. Anna Dastgheib-Beheshti - Member
15. Elisa Yung – Member
16. Olivia Richards – Member
17. Ashley Sullivan – Member
18. Tyler Gilman - Member

III. YMG Events for 2015-2016:

1. August 19, 2015 **YMG Red Sox Game & Social**

   Networking Event

   The YMG hosted an evening of networking while watching the Red Sox take on the Cleveland Indians. Unlike in the past, this outing did not include food at the pregame social where the members met up to network before the game. The seats were well received as they were in the first row of the bleachers above the bullpen.

   A total of 29 people were in attendance: all professionals and the event netted YMG ~$113.

2. September 16, 2015 **Annual Bocce Tournament**

   Networking/Diversity Event

   The 9th Annual Bocce Tournament was held on a beautiful September evening in The Boston Common. The YMG invited The Young Professionals in Transportation (YPT) to participate in the event with us. This event had record breaking attendance from previous years and the weather cooperated with us as we played. Members were randomly paired

together to encourage networking. Pizza and soda was ordered from Sals Pizzeria. The two 1st place winners took home $25 restaurant giftcards and the 2nd place team received $10 giftcards to Dunkin Donuts.

38 people were in attendance: 8 YPT Members, 1 student member, and 29 YMG professionals and the event netted $208.

3. December 3, 2015 **Massport 360 Flight Simulator (Joint Event with T&DI)**

Networking/Joint Technical Event

The YMG partnered with the T&DI group to host a Technical Lunch Event at Boston Logan International Airport. Massport, generously, gave us a tour of their Air Traffic Controller (ATC) Training facilities and even demonstrated what the software can do, as well as provide the group a pizza lunch. This event was free to host.

A total of 15 people were in attendance: all professionals and the event netted the YMG $190.

4. February 23, 2016 **Annual Networking & Billiards Tournament**

Networking Event

This year's Annual Networking and Billiards Tournament was held at a new location, Scholars Bistro in Downtown Boston on February 23th, 2016. The goal of the event is to provide a fun, social event for young engineering professionals from the design and construction industries, engineering students, family and friends to network. The billiards tournament provided a great opportunity for a networking event because it encourages communication and teamwork as each team consisted of two randomly chosen entrants. Skill levels varied greatly for all the participants, but because teams are chosen randomly everyone that participated had a fair chance to win. The new location was well received. Appetizer style food was served. The 1st place team won tickets to the Annual Red Sox Game in May, 2nd place winners received $10 giftcards to Dunkin Donuts, and 3rd place winners received $5 giftcards to Dunkin Donuts.

A total of 52 people were in attendance: 42 professionals and 10 Student. The event netted the YMG ~$190.
.

5. March 6, 2016 **Downeast Cider House Tour**

Networking Event

Brewery tour and networking at the Downeast Cider House in Charlestown MA. Food and access to a cash bar were available after the tour. Downeast does not offer food, pizza and salad were ordered from Alfredo's Italian Kitchen in Somerville and delivered to the brewery.

A total of 15 people attended and netted ~$68.

6. May 4, 2016 **History of the MWRA with Fred Laskey (Joint Event with EWRI)**

Networking/Technical Event

The event was hosted by Nitsch Engineering; they provided food, beverages and event space for the event. The YMG covered the remaining food costs that were left after the $500 sponsorship from Nitsch. Fred Laskey, Executive Director of the MWRA, spoke to attendees about the proud 30 year history of the MWRA and what they have accomplished. His presentation lasted over an hour and was concluded with 30 minutes of Q&A. He brought along his two valued Engineers to answer questions.

A total of 49 people attended the event and the YMG netted ~$500.

7. May 25, 2016 **Annual Red Sox Game and Social**

Networking Event

The YMG will host the Annual Red Sox Game versus the Colorado Rockies on May 25th. 40 people are expected to attend and a pregame social will be held at The Baseball Tavern, where appetizers will be provided.

A total of 40 people attended the event and the YMG is projected to net ~$300.

8. June 1, 2016 **Structural Engineering Feud (Joint Event with SEI)**

Networking Event

The YMG joined SEI in an evening of Family Feud style fun! Teams will be formed and audiences will be laughing as the teams compete for Structural Engineering Feud title. This event has not yet happened and SEI will receive the profits.

V. Other Activities/Contributions:

1. Fall Hike at Middlesex Fells Reservation – October 18, 2015

On a beautiful fall day, 8 members took to the hills of The Fells to have a picnic lunch and enjoy the great outdoors.

2. Thanksgiving Food Drive (November 2015)

YMG hosted a food drive for Greater Boston Food Bank. Thanks to the generosity of YMG members more than 275 meals were provided. We raised over $1100 with 40 donors.

3. Holiday Party/Toys-For-Tots - December 10, 2015

The December monthly meeting was held at Sacco's Bowl Haven and Flatbread Company. After a quick meeting, attendees were treated to bowling and pizza. As part of the holiday party, the YMG participated in Toys-for-Tots where the entrance fee for this event was to bring at least 1 toy to donate. More than 3 dozen toys were donated.

A total of 23 people attended.

4. YMG/BSSC Ski Trip to Stowe – January 30, 2016

Once again, this year YMG teamed up with BSSC to host a Ski/Ride Trip to a local Mountain. This year we piled in the charter busses up to Stowe Mountain in Northern Vermont. 18 Younger Members attended the day long trip, at the end of the day we all met fro a drink at the lodge before heading back in the busses.

5. Middlesex Fells Reservation Clean Up Day – April 30, 2016

On one of the first beautiful spring days of the year, YMG met up with DCR (who runs the Middlesex Fells Reservation), to help clear out invasive bushes along Spot Pond. 11 younger members helped out for over 3 hours to pull out and cut down the buckthorn that was blocking the views of the pond.

6. Volunteer Night - Friday Night Supper Program – June 10, 2016

During this volunteer night, Younger Members will serve a 3 course meal to guests who attend this free program. This event has not taken place prior to submitting this report, but 8 spots are available for the evening.

VI. BSCES YMG Officers and Members for 2016-2017:

1. Alyson Stuer – **Chair**
2. Jessica Yarmarkovich – **Vice Chair**
3. Cara Pirkey– **Past Chair**
4. Ana Gouveia – **Secretary**
5. Anthony Richardson – **Treasurer**
6. TJ Liveston – Past Chair
7. Valerie Chia – Member
8. Tyler DeRuiter – Member
9. Rich Matson – Past Chair
10. Bill Sterrit – Member
11. Peter Sun – Member
12. Elisa Yung – Member
13. Anna Dastgheib-Beheshti - Member
14. Brian Paula – Member
15. Grant Lella – Member
16. Dana Wolkiewicz – Member
17. Zuki Mahmuljin – Member
18. Ashley Sullivan – Member
19. Tyler Gilman - Member

Respectfully submitted to the BSCES Board of Government on May 18, 2016.
Cara Pirkey, E.I.T, Younger Member Group Chair.

The Awards Committee has received the following nominations for BSCES Individual Awards

Award	Nominee
Citizen Engineer Award	Robert Schreiber, P.E., BCEE, D.WRE, CDM-Smith
Lester Gaynor Award	(none received)
Government Civil Engineer Award	Richard M. Bessom, P.E., CCM, Massachusetts Port Authority
Clemens Herschel Award	Mehrdad Sasani and Leila Keyvani-Someh, Northeastern University Paul Kirshen, U. Mass. Boston; Lauren Caputo, ESS Group; Richard M. Vogel, Tufts U.; Paul Mathisen, WPI; Ana Rosner, USGS; Tom Renaud, Vertex Environmental Services
Ralph Horne Award	(none received)
Journalism Award	Rosabeth M. Kanter, Harvard Business School
Pre-College Educator Award	Kathleen Malone, Derby Academy
Technical Group Award	(none received)
Younger Member Award	Alyson Stuer, C&C Consulting Engineers

We have also received the following nominations for the BSCES Employer Recognition Awards.

Award	Nominee
Small Employer Recognition Award	(none received)
Large Employer Recognition Award	Green International Affiliates, Inc.

2016 INDIVIDUAL SECTION AWARDS

Boston Society of Civil Engineers Section
American Society of Civil Engineers

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Robert Schreiber, PE, BCEE, D.WRE For the:

XX CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

____ GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

____ CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

____ JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

____ PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

____ YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

CDM - Smith
75 State Street, No. 701
Boston, MA 02109

Is this a re-nomination? Yes ____ No X

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Bruce Jacobs Daytime Telephone: 617-308-7074 Email: bjacobs@enviroinsite.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

Robert Schreiber, of CDM-Smith, has been a tireless advocate for a national groundwater monitoring network program for the United States. Schreiber was recently ASCE's alternate representative to the Federal Advisory Committee on Water Information, and is co-chair of its Subcommittee on Ground Water, focusing on implementation of the National Ground-Water Monitoring Network. This advisory committee serves an important role in advising the U.S. Geological Survey on coordination of Federal water information programs. The efforts of the committee ultimately led to the development of a data portal (cida.usgs.gov/ngwmn/index.jsp) and funding of the National Groundwater Monitoring Network with initial funding of $2.6 million in 2015 and $4 million in 2016.

Robert writes that "Design and testing of the National Groundwater Monitoring Network reflects a wonderful collaboration of volunteers from all sectors, and the web portal developed by the USGS represents a significant step forward for efficient delivery of groundwater data. The efforts of many volunteers have produced a Network that will eventually fill important data gaps and provide the basis for significantly improved tracking of groundwater 'health' on a nationwide basis."

In addition to his efforts on behalf of the monitoring network, Schreiber has served in numerous positions within the National Ground Water Assocation (NGWA) including chair of its Divisional Board of Directors, the national NGWA Board of Directors, and Government Affairs Committee. He has also served on several BSCES committees including Government Affairs and a long-time member of the Freeman Fund.

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

2016 INDIVIDUAL SECTION AWARDS

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Richard M. Bessom, P.E, CCM For the:

_____ CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

_____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

X GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

_____ CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

_____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

_____ JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

_____ YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

Massachusetts Port Authority
One Harborside Drive
East Boston, MA 02128

Is this a re-nomination? Yes _____ No X

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Robert Leger Daytime Telephone: 617-568-3532 Email: rleger@massport.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

Nomination of Richard M. Bessom, P.E., CCM for BSCES Government Civil Engineer Award

Rick Bessom is Massport's most senior Program Manager for Horizontal Projects within the Capital Programs and Environmental Affairs department. He has worked as a Civil Engineer at Massport for more than 30 years and oversees a variety of airside, waterside and landside projects that include runway construction, fuel supply, FAA navigation aids, roadways, bridges, tunnels, drainage, parking structures, maritime projects, pier rehabilitation, utility relocation, and other projects necessary to keep the airport operational and in a state of good repair during the current period of burgeoning airport passenger service. His jurisdiction extends not only to Logan Airport, but to Worcester Airport, Hanscom Field, Conley Terminal, Moran Terminal, the World Trade Center, and other Massport properties in South Boston, East Boston and Chelsea.

Rick is well-known for his attention to detail and unprecedented knowledge of engineering design and construction. During his career at Massport he has gained extensive knowledge of airport and airfield operational requirements and has imparted this knowledge to many engineers that have worked under his direction.

As a part of his duties as program manager, he is responsible for planning and budgeting for new projects that enhance the customer experience with Massport and also ensures that ongoing repairs are made to existing airport properties that will prolong their use. With thorough recordkeeping for past projects he is able to anticipate repairs that will be necessary based on the age of prior construction and budget accordingly.

BSCES 2016 INDIVIDUAL SECTION AWARDS

Boston Society of Civil Engineers Section
American Society of Civil Engineers

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Ed Hunter **For the:**

_____ **CITIZEN ENGINEER AWARD:** This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

_____ **LESTER GAYNOR AWARD:** This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

X **GOVERNMENT CIVIL ENGINEER AWARD:** This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

_____ **CLEMENS HERSCHEL AWARD:** This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

_____ **RALPH HORNE AWARD:** This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

_____ **JOURNALISM AWARD:** This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ **PRE-COLLEGE EDUCATOR AWARD:** This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ **TECHNICAL GROUP AWARD:** This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

_____ **YOUNGER MEMBER AWARD:** This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:
Ed Hunter, Assistant General Manager
for Design and Construction, MBTA
100 Summer Street, Suite 1200 Boston MA 02110

Is this a re-nomination? Yes _____ No ✓

Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.

Your Name: Rob Brunetti Daytime Telephone: (630) 816-5160 Email: rbrunetti@patrickco.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

Nomination of Edward Hunter for Government Civil Engineer Award

Ed Hunter has made a significant and lasting impact on eastern Massachusetts through his decade long service to the MBTA. Originally hired as the Director of Construction, Ed has ascended to the position of Assistant General Manager for Design and Construction. Ed has brought to the MBTA more than 25 years of experience from the private sector, with past experiences working in construction and for fabrication firms, and later in construction management on behalf of the Massachusetts Turnpike Authority and MassDOT on the Central Artery/Tunnel Project. Ed made the transition from the private sector to the public sector in 2006, and the public has been the beneficiary.

During Ed's tenure at the MBTA, he has helped execute a multitude of upgrades to transit stations to improve ADA accessibility, with the latest accomplishment occurring in March of this year with the reopening of the Government Center Station. He has also managed the MBTA's 5 year rolling Capital Investment Program, managing up to 100 or more projects at any one time. Throughout his tenure, Ed was deeply involved with multiple process improvements across the design and construction departments, including embracing progressive reforms to project controls, risk analysis and independent cost and schedule assessments. Ed has bridged the gap between the MBTA, the consulting community and the construction community – engaging a broader set of participants in the MBTA's processes and seeking new and innovative ideas. He has supported multiple grand initiatives such as the prospect of delivering commuter rail service to the South Coast communities of Massachusetts including New Bedford and Fall River, with thorough evaluations of the risks and the realistic budget that would be needed. He understands the importance of the MBTA as the sole means of transportation for many and is focused on enhancing the commuting experience and supporting economic growth in the greater Boston area. Ed is not one to mince words or to skirt difficult issues, and he is committed to finding solutions and developing workable plans to achieve success.

Ed's biggest contributions to Massachusetts may have occurred over the past year, when Ed had the courage to address some difficult issues head-on. In the winter of 2014, when Mother Nature exposed the fragility of the MBTA's aging infrastructure and equipment, Ed teamed up with his counterparts on the Operations side of the MBTA to launch the Winter Resiliency Infrastructure Program (WRIP). The WRIP response team broke through typical barriers and process hurdles at the MBTA, and is implementing more than $80M of upgrades, repairs, and reinforcement work in record time. This program actually completed more work than planned in 2015, and continues to complete work within the time and budget constraints set for the program.

Also in 2014, the MBTA became aware that the Green Line Extension Project was trending toward a significantly higher cost than anticipated, putting the entire program at risk. Ed had the courage to recommend hitting the stop button, and working with members of various task forces established by the Governor, Secretary of Transportation, and the MBTA's General Manager, he helped guide many of the activities that re-scoped the project and revised the delivery method from a CM/GC delivery to a Design-Build delivery. A new budget and schedule has been developed for the Green Line Extension program and is being reviewed by the FTA for approval.

Consistent in all of Ed's accomplishments is the willingness to look at the hard questions, willingness to collaborate with other internal functions within the MBTA, and the ability to leverage the knowledge and contributions available from the broader professional community including being a presenter at several BSCES events. Although there is much work yet to be done on our transit system, Ed has made a positive and lasting impact, and thus is nominated for the 2016 Government Civil Engineer Award.

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

2016 INDIVIDUAL SECTION AWARDS

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Mehrdad Sasani and Leila Keyvani-Someh For the:

_____ CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

_____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

_____ GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

x CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

_____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

_____ JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

_____ YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

Mehrdad Sasani, Associate Professor, and Leila Keyvani-Someh, Department of Civil and Environmental Engineering, 400 Snell Engineering Center, 360 Huntington Avenue, Northeastern University, Boston, MA 02115

Is this a re-nomination? Yes _____ No x

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Jerome F. Hajjar Daytime Telephone: 617-373-3242 Email: jf.hajjar@neu.edu

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

Northeastern

May 13, 2016

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

To the BSCES Awards Committee:

I am pleased to write a letter in strong support for Prof. Mehrdad Sasani and his former Ph.D. student, Dr. Leila Keyvani, to receive the 2016 Clemens Herschel Award for their paper entitled "Analytical and Experimental Evaluation of Progressive Collapse Resistance of a Flat-Slab Posttensioned Parking Garage," published in the *Journal of Structural Engineering*, ASCE, in November 2015. This paper highlights important behavior related to resisting progressive collapse of post-tensioned concrete structures that had previously not been identified. While this parking garage slab had no bottom reinforcement that would normally be thought vital to redistribute forces if a column were removed (e.g., due to a blast), this paper highlights why this forces could be redistributed through after undergoing permanent displacement. This discovery was shown through a unique set of experiments in the field. In this paper, the authors demonstrate that in order for the structural response to capture the effects of the tendency of the slabs to grow in length as flexural cracking occurs after loss of a column, two important modeling requirements are needed in a nonlinear analysis of the structure.

This paper builds on the knowledge the authors have gained in conducting seminal field experiments and analytical evaluation of progressive collapse resistance of several actual reinforced concrete (RC) and post-tensioned (PT) structures slated for demolition. This paper presents and discusses important aspects related to: 1) developing reliable computational models for evaluating response of PT structures following loss of a column; 2) documenting important collapse resisting mechanisms in PT slabs; and 3) documenting the mechanics of gravity load redistribution necessary to resist progressive collapse.

Prof. Sasani is a leading authority on progressive collapse of RC and prestressed structures. During the last eight years he has published 17 journal papers on this topic. He is currently a member of the SEI Standards Committee on Disproportionate Collapse Mitigation, the SEI Technical Committee on Disproportionate Collapse and the SEI Technical Committee on Blast, Shock, and Impact. He also chairs Committee 377 on Performance Based Structural Integrity and Resilience of Concrete Structures of the American Concrete Institute. Within Massachusetts, he has chaired the SEI Boston Chapter, he is one of the founding members and the current chair of the Structural Engineers Emergency Response program, and he is the chair of the Massachusetts Engineers and Architects Emergency Response Committee. Prof. Sasani is also bringing this work to practice through his extensive activities on SEI committees. Prof. Sasani has dedicated his research program to these topics and, together with his students such as Dr. Keyvani, he has made major contributions to our understanding of how to resist progressive collapse of RC and PT structures.

For all of these reasons, I strongly endorse Drs. Sasani and Keyvani to receive the 2016 Clemens Herschel Award.

Sincerely,

Jerome F. Hajjar

Jerome F. Hajjar, Ph.D., P.E., F.ASCE, F.SEI
CDM Smith Professor and Department Chair

Department of Civil and Environmental Engineering
400 Snell Engineering Ctr.
360 Huntington Ave.
Boston, MA 02115
617.373.2444
f 617.373.4419

Analytical and Experimental Evaluation of Progressive Collapse Resistance of a Flat-Slab Posttensioned Parking Garage

Leila Keyvani, A.M.ASCE[1]; and Mehrdad Sasani, M.ASCE[2]

Abstract: Despite the popularity of posttensioned (PT) floors for parking garages and the likelihood of a column loss, due to blast or vehicle impact, there is a lack of research on the progressive collapse potential of this structural system subsequent to initial damage. In this paper, progressive collapse resistance of an actual posttensioned parking garage is evaluated experimentally and analytically. An interior column was removed by explosion and the structure resisted progressive collapse with a permanent maximum vertical displacement of about 61 mm (2.4 in.). Analytical models of the garage are developed using computer software and nonlinear dynamic analyses are performed. The interaction between the tendon and the slab is modeled explicitly. The analytical results show that despite the fact that the slab around the removed column had no bottom reinforcement and the tendons were placed close to the top of the slab, pushing the slab down, the compressive membrane forces developed in the slab helped increase the flexural strength of the slab sections. The gravity load redistribution is discussed and characterized. **DOI: 10.1061/(ASCE)ST.1943-541X.0001279.**

Author keywords: Concrete slabs; Progressive collapse; Posttensioning; Full-scale tests; Concrete and masonry structures.

Introduction

Posttensioned (PT) slabs have been widely used as a floor system in the United States. About 1 billion m^2 (10 billion ft^2) of PT slabs are in service (Bondy 2012). Parking garages have increased the use of PT floor systems due to its efficiency in providing long spans with a rather shallow slab thickness. Despite the popularity of PT slabs, there is a lack of experimental and analytical research on nonlinear and dynamic response of PT structures to extreme events such as loss of a primary element due to an impact or a terrorist attack, and their progressive collapse resistance.

Progressive collapse resistance of structural systems has been investigated in the past in element and system level (Sasani et al. 2007, 2011; Kokot et al. 2012; Qian and Li 2015, 2013b). Progressive collapse is defined as the spread of an initial local failure from element to element, which eventually results in the collapse of an entire structure or a disproportionately large part of it [ASCE/SEI-7 (ASCE 2010)]. The direct design method, which explicitly investigates the ability of the structure to arrest the initial damage propagation, is used in the research reported in this paper [Department of Defense (DoD) 2010]. In this threat-independent method, some of the primary structural elements, commonly a column, are eliminated and the capability of the structure to bridge over the initial damage is investigated.

Previous incidents and studies have shown flat plates to be susceptible to progressive collapse subsequent to a column removal and/or punching failure. Hawkins and Mitchell (1979) evaluated factors that can initiate and trigger progressive collapse in flat plate structures. Salim and Sebastian (2003), Jahangir Alam et al. (2009), and Habibi et al. (2012) experimentally evaluated the punching strength of flat plate panels due to monotonic loading. Qian and Li (2013a) experimentally investigated progressive collapse resistance of a subassemblage flat plate floor due to a corner column removal. Polak (1998), Megally and Ghali (2000), and Wang and Teng (2008) developed and used layered shell elements to capture localized punching in flat plate structures. Mirzaei and Sasani (2011) and Keyvani et al. (2014) analytically evaluated the progressive collapse resistance of flat plate floors after a sudden column removal in a system level.

A review of previous studies on PT slabs shows that there are limited experimental studies on the topic. There are some experiments on small-scale flat plate systems (one-way or two-way) for evaluating elastic and ultimate responses under fire conditions, gravity, and cyclic loading (Scordelis et al. 1959; Burns and Hemakom 1977; Kosut et al. 1985; Kang and Wallace 2006; Ellobody and Bailey 2009; Zhang et al. 2011; Kim et al. 2012). Experiments are also conducted on small-scale PT slab-column connection specimens for evaluating flexural and shear failure, under gravity and pseudostatic loading (Foutch et al. 1990; Han et al. 2006a, b, 2012). Ratay (2007) conducted an experiment on an actual 2-story unbonded PT flat plate by evaluating the response to loss of posttensioning force. They removed the effect of posttensioning by gradual saw-cutting of the tendons.

Similar to the experimental studies, analytical models on PT flat plate floors have not been developed adequately to date. There are limited studies on modeling of posttensioning. Han et al. (2012) analytically evaluated the seismic performance of three PT flat plate frames. The posttensioning was modeled implicitly at the level of slab-column connections only. Huang et al. (2010) studied two explicit modeling approaches for posttensioned beams and slab-column connections, as follows: (1) detailed modeling of the physical condition of the tendons in the concrete, and (2) using springs to model the connection between the tendon and slab. The latter was validated with experimental results by Huang et al. (2010) and

[1]Ph.D. Candidate, 400 SN, Dept. of Civil and Environmental Engineering, Northeastern Univ., Boston, MA 02115. E-mail: l.keyvani@neu.edu

[2]Associate Professor, 400 SN, Dept. of Civil and Environmental Engineering, Northeastern Univ., Boston, MA 02115 (corresponding author). E-mail: sasani@neu.edu

Note. This manuscript was submitted on August 11, 2014; approved on January 7, 2015; published online on February 20, 2015. Discussion period open until July 20, 2015; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Structural Engineering***, © ASCE, ISSN 0733-9445/04015030(8)/$25.00.

found to be more efficient. In the research reported in this paper, an actual PT parking garage surrounding the Crowne Plaza Hotel in Houston, Texas, was evaluated against progressive collapse. An interior column was removed by explosion and the response was recorded using sensors. Explicit Finite Element (FE) analytical models are developed in the research reported in this paper to evaluate the results. The interaction between the tendon and the slab is modeled explicitly using link elements (Huang et al. 2010). A nonlinear dynamic FE analysis is performed which accounts for both material and geometric nonlinearities using *SAP2000*. The analytical results are in good agreement with the experimental results. In addition, the effect of different parameters on the global response of the structure is evaluated.

Parking Garage Characteristics

The parking garage of the Crowne Plaza Hotel was located in Houston, Texas, and constructed in 1973. The hotel and the garage were demolished by implosion after the experiment was concluded. Fig. 1 shows the plan of a portion of the parking garage located on the north side of the hotel. The 216-mm (8.5-in.) thick garage floor was made of posttensioned concrete. Button-headed wire tendons were used in the garage floor, which was common in the industry in the 1960s and early 1970s (Krauser 2006). The button-headed system involved the use of parallel, 6-mm (0.25-in.) diameter wires. The wires were bundled together in groups of seven to form tendons. The average effective posttensioning force in both directions was 36 kN/m (27 kip/ft). The material properties are discussed subsequently in this paper. The initial damage was imposed by exploding Column D5 (Figs. 1 and 2). The slab vertical displacement at the top of removed Column D5 is obtained using the average recording of two diagonal potentiometers as described in Sasani et al. (2007).

Explicit Modeling of Unbonded PT Parking Garage

The building was symmetric about Line 5 (Fig. 1) and extended beyond Line G. The symmetric floor plan is utilized in the model.

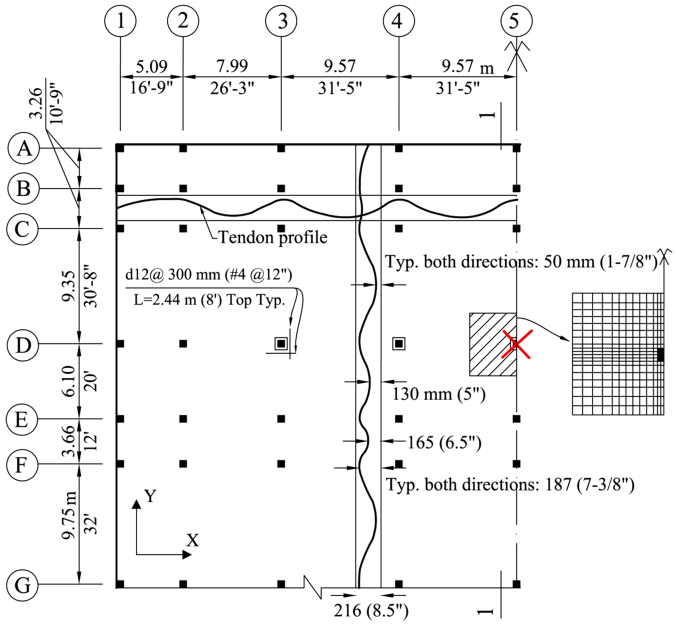


Fig. 1. Plan view of posttensioned parking garage

Fig. 2. Column D5 with shear cap (before removal; image by M. Sasani)

The floor beyond Line G is not modeled since the extended portion of the building beyond that line was not considerably affecting the response after column removal. In order to reduce the analysis time, the floor is divided into regions with linear and nonlinear material behavior. The linear regions are modeled by four-node shell elements while the nonlinear regions are modeled by beam elements. This is due to the fact that the nonlinearity is modeled using localized fiber plastic hinges (FPHs) which can only be assigned to beam-column elements in the computer program *SAP2000*. The surroundings of the removed column as well as the neighboring columns are the main nonlinear regions. Through an iterative process, the regions that remain linear elastic are identified and modeled as such. Fig. 1 shows a zoomed-in view of the mesh layout around the removed column. The portion of the slab directly above the column is modeled using rigid beam elements and the columns are modeled using Bernoulli beam elements. Because the analytical results demonstrate that punching in the neighboring columns was not expected, detailed modeling to account for punching is not needed. The geometric nonlinearity is also accounted for in the analysis.

The beams are modeled using Bernoulli beam elements with localized nonlinear FPHs at the center of the elements. The hinges account for the interaction between the moment and axial forces, and the corresponding deformations in the section. Given the refined model and the short lengths of the beams with respect to the floor spans, the plastic hinge length is set equal to the element length. In this computer program *SAP2000* the force-deformation relationship of a FPH is not rigid-plastic but rather elastic-plastic. This leads to an error of double counting the flexibility of the beam element. Therefore, the portion of the beam elements represented by FPH is considered axially and flexurally rigid (Sasani et al. 2011). Ten integration points are used over the depth of the section. The shear areas of the beam elements are set equal to the slab cross-section but the torsional stiffness is half of the slab cross-section because of the change in shear flow in the continuous slab as compared with that of beams (Hambly 1991). The torsional stiffness of

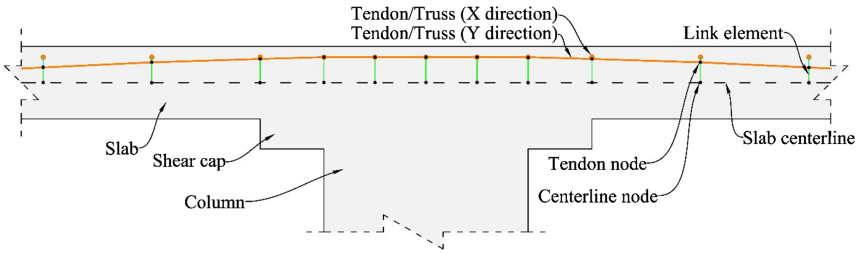


Fig. 3. Two-dimensional view of PT slab showing tendons connectted to slab axis by link elements

the beam elements are calculated based on Roark's formulation (Young and Budynas 2002).

The posttensioning tendons are modeled explicitly. The model can be used for both unbonded and bonded slabs. Unbonded tendons are modeled such that they are free to slide horizontally with respect to the slab. That is, the relative vertical displacement of the tendon with respect to the slab is neglected. The tendons are modeled as truss elements which are connected to the slab (beam and shell) elements (Fig. 3). The connection between the truss and slab elements is through link elements (Wilson and Habibullah 2000). A link element constrains the displacement of a node on the truss to the corresponding node of the slab element (beam or shell). For unbonded tendons, all degrees of freedoms except the horizontal component of the link elements, which is parallel to the tendon line, are rigid. The modeling technique presented in this paper for unbonded posttensioned slabs has been examined and verified by Huang et al. (2010) against experimental results of Foutch et al. (1990) and has been shown to be reasonably accurate and computationally efficient. The posttensioning force for the truss elements are then calculated and applied by reducing the temperature of the truss elements. Since the tendons were constrained horizontally to the slab at the ends (location of the anchors) the temperature reduction leads to formation of tension in the tendons and compression in the slab.

The top portion of the exploded column was not damaged after column removal [Fig. 4(a)]. In addition, the reinforcing bars of the lower half of the column survived the explosion with some residual lateral deformation. To account for the resistance from the remaining column rebars after explosion, they are explicitly modeled. Fig. 4(b) shows the analytical model for the rebars and the top portion of the column. Two perpendicular rigid elements constrain the displacement of the top of the rebars to the bottom of the remained column [Fig. 4(b); Sasani and Sagiroglu 2010]. Due to the symmetry of the plan in the x-direction (Fig. 1) only half of the model shown in Fig. 4(b) is used. The longitudinal reinforcement of the column was eight D25-mm (No. 8) bars. These bars are modeled as four lumped nonlinear beam elements.

In order to remove the column dynamically, first its reactions under gravity loads and posttensioning effects are found. Then the column is removed from the model and replaced with its reactions. The results of analysis under the gravity loads and posttensioning effects are identical for the two models, with and without the column. Then, forces opposite to the reactions are applied in 2 ms (Sasani and Sagiroglu 2008) and a nonlinear dynamic analysis is performed.

The average damping ratio in the first mode of vibration based on the recorded vertical motion of the floor is found (Chopra 2000), which is about 0.03. A mass-proportional damping is used in the model. In addition, numerical damping is used to dissipate the effects of higher modes of vibration and improve numerical convergence.

Material Properties

Due to some issues with concrete sampling from the parking garage floor, the compressive strength of concrete is not known experimentally. A concrete sample obtained from the first floor of the main structure surrounded by the garage suggested a concrete compressive strength of 32 MPa (4.6 ksi), which is used in the research reported in this paper. This uncertainty is discussed subsequently in the paper. A linear postpeak compressive softening is considered up to a strain of 0.006, with no residual strength beyond this point. The modulus of rupture calculated based on the ACI 318-11 (ACI 2011) recommendation of $0.62\sqrt{f'_c}$ MPa ($7.5\sqrt{f'_c}$ psi; f_c = maximum compressive strength of concrete) is found to be 3.5 MPa (0.5 ksi). A linear tensile postpeak softening is considered up to maximum tensile strain of $3\varepsilon_{cr}$ (Sinha et al. 1964; Bahn and Hsu 1998) with no residual tensile strength beyond it; ε_{cr} is the strain at the peak tensile strength. This is used for 152-mm (6-in.) long beam elements, representing fracture energy of 104 N/m (7.1 lb/ft), which is in the range of values reported by Yankelevsky and Reinhardt (1987). The Takeda model is adopted for the hysteretic behavior of the concrete material. The tendons and the reinforcing bars had respective yield strengths of 1,700 and 480 MPa (250 and 70 ksi, respectively), and modulus of elasticity of about 200 GPa (29,000 ksi).

Initial Upward Force

The removed column was supporting only one floor. The column explosion caused an upward motion, with a peak value of 3.7 mm (0.14 in.) at 0.019 s after the column removal (Fig. 5). In order to account for the upward motion soon after column removal, a dynamic upward force is applied to the structure. Due to the unknown

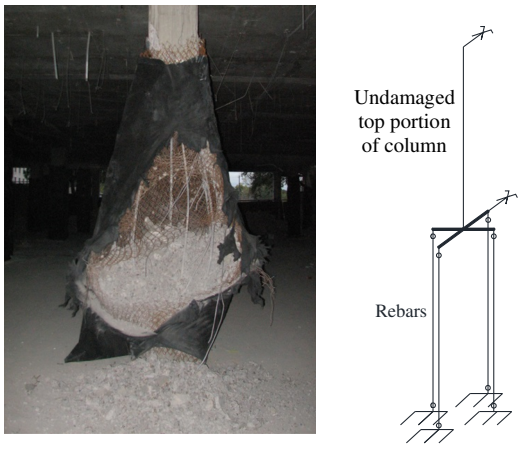


Fig. 4. (a) Exploded column; (b) analytical model

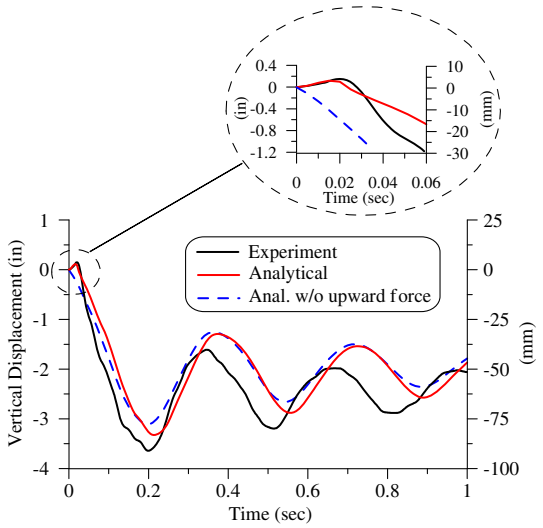


Fig. 5. Analytical and experimental vertical displacement of unbonded PT at top of removed column (zoomed-in view of initial upward motion is shown)

magnitude and variation over time of the upward dynamic force over time, as a result of explosion, this force was found by an iterative approach such that the floor displacement would be consistent with the recorded field data. Consistent with the experimental data, in the analytical model and during the upward motion, it was assumed that the bars were deformed outwards, due to the blast effects inside the column. The results show that the building response is not, however, sensitive to the maximum value of the outward deformation of the longitudinal rebars of exploded column, which is consistent with the results obtain by Sasani and Sagiroglu (2010).

At the peak upward motion, explicitly modeled column rebars apply about 1,245 kN (280 kip) of downward force to the slab at the location of the removed column. This was expected to help match the sharper slope of the recorded downward motion from about 0.02–0.04 s. However, as can be seen in the close-up plot in Fig. 5, the analytical results deviate from the field data. After this initial discrepancy, the downward displacements obtained from the analysis and the experiment show rather parallel curves, with the analytical results shifted by about 0.015 s.

After Column Removal

The results obtained show that the building resisted progressive collapse with the maximum vertical displacements of 92 and 84 mm (3.6 and 3.3 in., respectively) from the field test and the analytical study, respectively. The permanent vertical displacements of about 61 and 49 mm (2.4 and 1.9 in., respectively) were found experimentally and analytically, respectively. The period of vibration of the analytical model is about 9% larger than that of the field data, which can be primarily attributed to the discrepancy in estimating the stiffness of the structure.

Slab Tendency to Grow

Based on the analytical results after column removal, with the increase of the vertical downward displacement, the tensile stress at the bottom of the slab at the vicinity of the removed column reaches the concrete modulus of rupture in the weakest sections under positive moments. Before column removal and under the gravity loads, this region was under negative moment. Since the slab around the

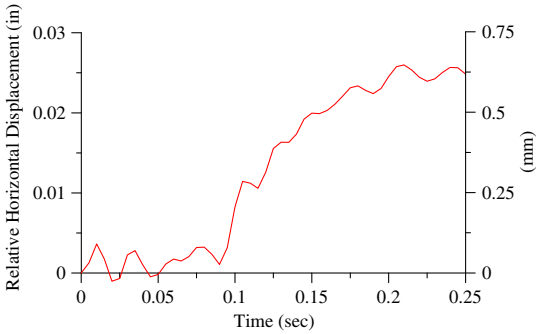


Fig. 6. Relative displacement between Columns B5 and D5 (slab elongation) along Line 5 after column removal

removed column had tendons and reinforcing bars located at the top of the slab sections, after column removal, a larger portion of the sections including the centerline of the slab (midheight) experiences (smeared) tensile strains. Due to this tensile strain at the midheight of the slab, the slab tends to elongate or grow horizontally (Fenwick and Megget 1993; Kim et al. 2004; Sasani et al. 2011; Keyvani et al. 2014). One indication of the slab in-plane growth is the relative horizontal movement of columns adjacent to the removed column. The growth pushes the surrounding columns away from each other. Based on the analytical results and as shown in Fig. 6, the total maximum horizontal elongation of the slab along Line 5 after column removal is about 0.64 mm (0.025 in.). The effects of the slab growth tendency are described in a subsequent paragraph.

Slab Membrane Forces

The tendency of slab around the removed column to grow is primarily constrained by the membrane action of the surrounding slab (including tendons) and the lateral stiffness of the columns. As a result of these constraints, compressive membrane forces develop in this region, which amplify the posttensioning compressive forces. The elongation of the slab increases the surrounding column shear forces. On average, the surrounding columns resist 24% of the additional compressive force developed in the slab. The remaining 76% of the additional compressive force developed as a result of growth is resisted by the membrane action of the slab itself (Fig. 7).

Fig. 7 shows the formation of the additional compressive membrane force normal to Section 1-1, shown in Fig. 2, at the peak vertical displacement. The axial compressive force in the slab around the removed column increases due to the slab tendency

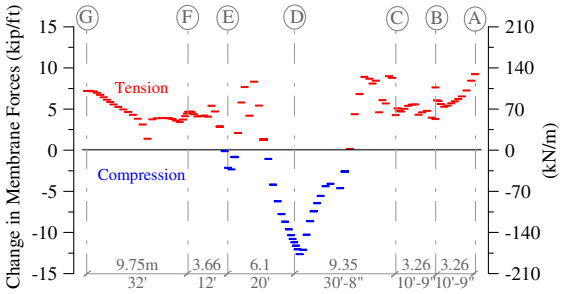


Fig. 7. Change in membrane force of slab after column removal at peak displacement normal to Section 1-1

Table 1. Percentage of Axial Force of Removed Column Transferred to Adjacent Columns after Column Removal at Peak Vertical Displacement

Lines	4	5
C	3%	27%
D	17%	—
E	−4%	52%

to grow and the imposed constraint by the structure (primarily the slab in the surrounding region). In order for the structure to be in equilibrium horizontally, tensile membrane forces develop in the rest of the slab to resist the additional compressive force (Dat and Hai 2013). The enhancement in compressive membrane forces is in general higher at the locations with higher flexural demands such as the location of the removed column where the growth tendency is higher compared to the rest of the slab.

Analytical results show a 10% increase in the tendon tensile force on column Lines 5 and D at the peak displacement. This is due to the combined effects of geometric nonlinearity and the slab tendency to grow. Kim et al. (2012) tested three simply supported two-way slabs with two-way posttensioning loaded to develop extensive cracks. With the increase of the vertical displacement and formation of cracks, they also observed an increase in tendon axial forces. Since the tendons are unbonded, the tendon force depends on its total elongation. That is, the increase in the tendon force in unbonded tendons is not localized. Thus, a local failure of an unbonded tendon is less likely in the case of large deformations (Kim et al. 2012).

Gravity Load Redistribution

After column removal, the slab moment reverses from negative to positive (tension at the bottom) around the removed column, while the negative moments around the adjacent columns increase. At the peak displacement, more than half of the gravity load previously supported by the removed column is transferred in the direction of the shorter adjacent span to Column E5. The percentages of axial force of the removed column that is transferred to the adjacent columns at the peak vertical displacement after column removal is given in Table 1. Due in part to the dynamic nature of the response, at the peak displacement, the total increase in the axial force of the neighboring column is larger than the removed column axial force.

Figs. 8(a and b) show the moment diagrams about the global Axis X along Line 5 (Fig. 2) at the peak and permanent vertical displacements directly obtained from the computer program *SAP2000*, the so-called total moments. The total moment in a PT slab is composed of three parts, as follows: (1) the primary moment which is generated due to tendon eccentricity, (2) the secondary moment which is generated because of the tendons in indeterminate structures, and (3) the moment due to gravity (external) loads (Khan and Williams 1995).

In the vicinity of all columns, as expected, both the tendons and the reinforcing bars are located close to the top of the slab sections. As can be seen in Fig. 8(b), the slab in the vicinity of the neighboring columns of the removed column is under a negative moment (consistent with the locations of the tendons and reinforcement) of about 84.5 kN-m/m (19.0 kip-ft/ft) at permanent displacement. The slab around the removed column, however, is under a positive moment of about 44.5 kN-m/m (10.0 kip-ft/ft) at the left face of the shear cap, causing compressive stress at the top of the slab, where the tendons and reinforcing bars are placed. That is, the gravity loads and the tendons develop moments in the same direction (both positive) in the vicinity of the removed column and in opposite directions (negative and positive, respectively) in the vicinity of the adjacent columns. Despite the significant difference between the contribution of the reinforcement and tendons in developing the moments of these two sections, the negative moment at the far end is only about 2 times the positive moment. This ratio is even smaller if the positive moment at the right side of the shear cap is considered. Therefore, the total moment does not seem to correctly represent the contribution of different sections of the slab in developing moments and in turn shear forces to resist the gravity loads.

In order to better understand the gravity load redistribution in the slab after column removal, the moment due to the gravity loads at the permanent displacement is of interest. Due to the nonlinearity of the system, a method for estimating the secondary moments is not readily available. One can, however, calculate the primary moment for each section, subtract it from the total moment, and find the sum of the secondary moment and the moment due to gravity loads. This is shown in Fig. 8 as gravity + secondary.

The gravity + secondary moment at the permanent displacement is about 16 kN-m/m (3.6 kip-ft/ft) in the slab section at the left face of the shear cap of the removed column. The negative gravity + secondary moments at the faces of Columns E5 and C5 are (respectively) about 122 and 127 kN-m/m [27.5 and 28.6 kip-ft/ft, respectively; Fig. 8(b)]. In order to compare the relative contribution of the positive and negative moments in resisting the gravity loads, the response of the slab can be analogous to that

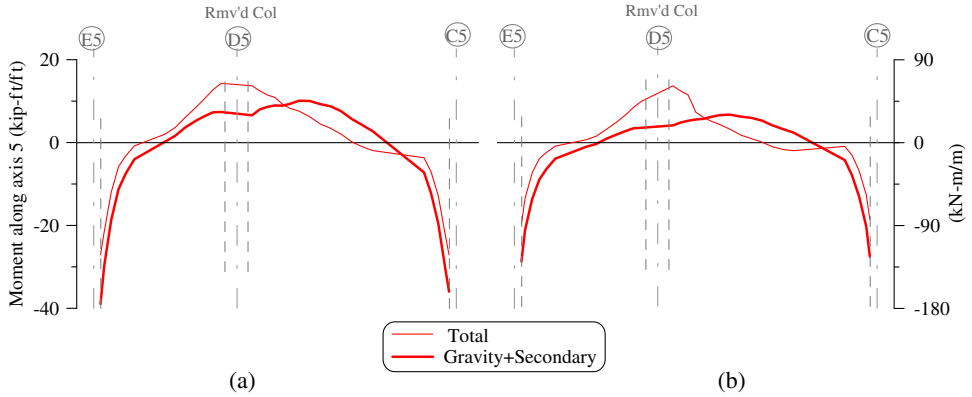


Fig. 8. Moment about global axis X, along line 5 per unit width of slab at (a) peak and (b) permanent displacements for unbonded PT (dashed lines represent faces of columns E5 and C5 and shear cap of column D5

J. Struct. Eng., 2015, 141(11): 04015030

of a fixed end beam under gravity loads. Having this analogy in mind, the contribution of the negative moment in resisting the gravity loads is in fact about 8 times larger than that of the positive moment. The positive gravity + secondary moment resistance in the vicinity of the shear cap (where there is no bottom rebars or tendons) is due to the axial compressive force developed by the compressive membrane forces caused by the slab tendency to grow, which was discussed previously.

Column Removal without Initial Upward Force

As was explained in the Introduction, one of the scenarios suggested in the alternate load path (ALP) method by guidelines such as DoD (2010) and GSA (2013) to evaluated progressive collapse response of the structures is the instantaneous removal of an entire column. Therefore, another analysis is carried out in which no upward force (pressure due to the column explosion) is applied during column removal. The vertical displacement is shown in Fig. 5. The results show that the initial upward force due to the explosion did not have a significant effect on the maximum response of the structure.

Explicit Bonded PT Modeling

In order to compare the effects of unbonded versus bonded tendons in PT slabs, in this section the response of the building to a column removal under the assumption of bonded tendons is analytically evaluated. To model the floor with bonded tendon, link elements described before, are fully rigid in all degrees of freedom at all nodes. Fig. 9 shows the vertical displacement history at the location of the removed column. The results show insignificant differences between the two bonded and unbonded analytical models. Unlike the unbonded model in which the change in tendon axial force is uniform along the slab and depends on the total elongation of the slab between the anchored ends only, for the bonded model, the variation of the tendon axial force along the slab is not uniform and show localized increase in the tendon forces. At the locations where yielding of tendons is likely, to account for the material nonlinearity in these regions, localized axial plastic hinges are defined with bilinear force-deformation relationship according to the material properties. Unlike FPHs, the elastic deformation occurs over the member length and the plastic behavior occurs in the hinge. Fig. 10 shows the change in tendon axial force after column removal at the peak displacement. The analytical results show that the tendon yields axially at the locations with larger flexural demands.

Compared to the unbonded model, in the bonded model due to the localization of the deformation and forces, the tendons are

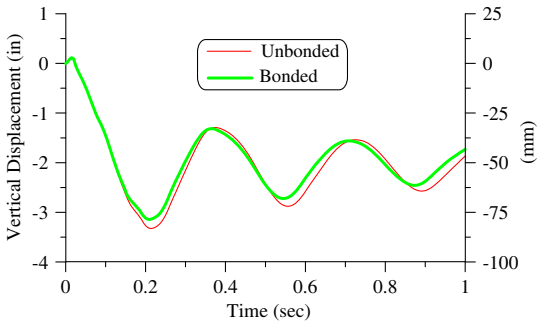


Fig. 9. Comparison of vertical displacement history of analytical bonded and unbonded PT model

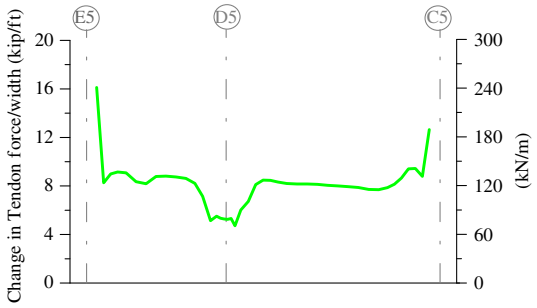


Fig. 10. Change in bonded tendon axial force per unit width of slab along Line 5 after column removal at peak displacement

subjected to higher strain at the critical section. This could potentially lead to tendon fracture and eventually to partial progressive collapse of the structure. Unlike the local responses, the global responses of the two models are not significantly different.

Parametric Study of Explicit Unbonded PT Slab

In this section the sensitivity of the unbonded PT model to different modeling parameters such as the torsional stiffness of the grillage, mesh size, presence of live load, and material properties is evaluated.

Mesh Size

The analysis was started with a maximum mesh size of about 915 mm (36 in.) and achieved peak vertical displacement of about 76 mm (3 in.). The mesh size was reduced to the smallest reasonable size and the final mesh layout is shown in Fig. 2 which has been used throughout this paper. The mesh layout is finer around the columns with layout of 152 mm (6 in.) and coarser farther away with maximum shell element size of 432 mm (17 in.). The peak vertical displacement increased to 84 mm (3.3 in.).

Effect of Modulus of Rupture of Concrete

The modulus of rupture used in the previous sections was based on ACI 318-11 (ACI 2011) recommendation of $0.62\sqrt{f'_c}$ MPa ($7.5\sqrt{f'_c}$ ksi); however, other studies show that modulus of rupture for the normal weight concrete can vary between $0.66\sqrt{f'_c}$ and $\sqrt{f'_c}$ MPa (8 and $12\sqrt{f'_c}$ ksi; Nilson et al. 2010). The maximum value of $1\sqrt{f'_c}$ MPa ($12\sqrt{f'_c}$ ksi) is used in this paper to examine its effects. Fig. 11 shows the effect of tensile properties of concrete on the global response of the structure after column removal compared with the unbonded model and experimental results. In this model, an increase of about 66% in modulus of rupture results in 7% reduction in the maximum vertical displacement of the structure (Fig. 11).

Torsional Stiffness of Grillage

As mentioned previously, the torsional stiffness that is used for the grid of beam elements is set equal to one half of the normal cross section of the slab (Hambly 1991). Using full torsional stiffness for the beam elements, shown in Fig. 11, results in about 15% decrease in vertical displacements at the location of the removed column.

Effect of Live Load

The load combination DoD (2010) and GSA (2013) is used in this subsection to study the structural response in the presence of live

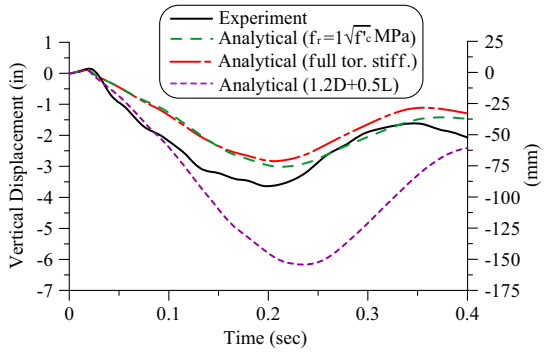


Fig. 11. Vertical displacement history at location of removed column for explicit unbonded PT model with different parameters compared to experiment ($f'_c = 32$ MPa $= 4.6$ ksi)

load and additional dead load for the explicit unbonded PT model. This load combination is $1.2(\text{dead load}) + 0.5(\text{live load})$. The live load of parking garages is 1.9 kN/m^2 (40 lb/ft^2) according to ASCE/SEI-7 (ASCE 2010). The results show about 90% increase in vertical displacement as a result of 40% increase in the gravity loads (Fig. 11), which is due to the nonlinearity of the system. However, the time to peak displacement is increased only by 14%.

Effect of Compressive Strength of Concrete

The results reported so far were based on using the concrete compressive strength of a sample obtained from the first floor of the main structure surrounded by the garage. A second concrete sample obtained from the main structure suggested a concrete compressive strength of 24 MPa (3.5 ksi). In order to evaluate the floor response with $f'_c = 24$ MPa (3.5 ksi) and its corresponding modulus of elasticity, the explicit unbonded model of the parking garage is analyzed with the smaller concrete compressive strength. The analytical model was further modified by increasing the modulus of rupture to $1\sqrt{f'_c}$ MPa ($12\sqrt{f'_c}$ ksi), which is the upper range according to Nilson et al. (2010). The results of these two analyses are shown in Fig. 12. The results suggest that lower concrete compressive strength and modulus of elasticity with or without a high tensile strength could also capture the vertical displacement response of the slab with 4 and 12% error, respectively.

Posttensioned Computer Software Models

The posttensioning in *SAP2000* can be modeled using template models with linear behavior as well, which can be used either

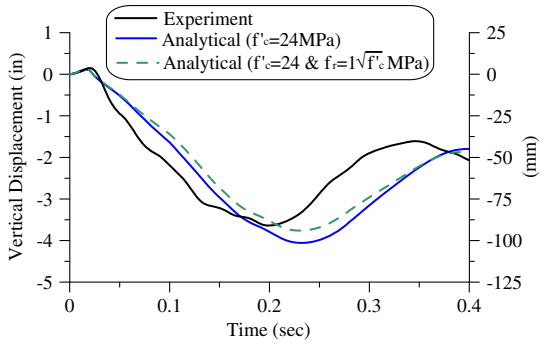


Fig. 12. Vertical displacement history at location of removed column for explicit unbonded PT model compared to experiment ($f'_c = 24$ MPa $= 3.5$ ksi)

as equivalent constant force acting on the structure along the tendon profile or as structural elements. The tendon profile for both cases is modeled using linear segments, to be consistent with the explicit model discussed previously.

For the equivalent constant force method, the posttensioning effects of the tendon are replaced with the horizontal and vertical components of the tendon axial force as constant forces, acting at the boundaries of the beam or shell elements. This method is mainly meant for models having linear response (Wilson and Habibullah 2000). The peak vertical displacement at the location of the removed column modeled using this method is 114 mm (4.5 in.) compared to 92 mm (3.6 in.) of the experimental results. In the explicit model, the tendons are modeled as elements and therefore increase the degree of indeterminacy of the structure, which is ignored in the case of model with constant force. Furthermore, since the force exerted from tendon to the structure is constant in the equivalent constant force method, the increase in tendon force, which was discussed previously, is not accounted for.

Conclusions

Analytical models are developed in the research reported in this paper to evaluate the response of a posttensioned flat slab to a column removal scenario, accounting for both material and geometric nonlinearity. The model using readily available techniques in *SAP2000* did not properly capture the nonlinear response of the structure to a column removal. However the explicit (unbonded) model developed in this paper was able to more closely simulate the recorded vertical displacement of the floor.

The slab had no bottom reinforcement, and around the removed column the tendons (located close to the top of the slab) were adding to the demand and pushing the floor down, yet the structural system was able to redistribute the gravity loads with a permanent vertical displacement of about 61 mm (2.4 in.) based on experiment. The gravity load carrying capacity of slab is in part attributed to an increase in the flexural capacity of slab sections due to the formation of compressive membrane forces in the slab. The membrane force is developed as a result of the slab tendency to grow, while being partially constrained by the structural system. The compressive membrane forces are resisted mainly by the slab in-plane action and to a smaller degree by the column shear forces.

It is demonstrated that the use of total moments developed in slab sections are misleading in identifying the contribution of different portions of the slab in collapse resistance subsequent to column removal. Around the removed column, the primary moment is in the same direction as the moment due to the gravity loads, therefore the total moment overestimates the contribution of this region in redistributing gravity loads. It is also concluded that compared to unbonded PT systems, bonded PT floors are more susceptible to failure after column removal, due to the localization of tendon strains.

Acknowledgments

This paper is based upon research supported by the National Science Foundation (NSF) Award No. CMMI-0547503. The help provided by Dr. Marlon Bazan, Dr. Serkan Sagiroglu, and Scott Forest in the research reported in this paper is acknowledged. The reviews and valuable comments made by Dr. Mohammad Jonaidi, Justin Murray, and Dr. Serkan Sagiroglu are acknowledged and appreciated. The writers greatly appreciate the support provided by James Redyke (Dykon Explosive Demolition Corporation), without the help of whom the research reported in this paper

would not have been possible to complete. The help provided by Leonard Cherry (Cherry Demolition), site manager Michael Dokell, and assistant Jaime Castaneda is also appreciated.

References

ACI (American Concrete Institute). (2011). "Building code requirements for structural concrete and commentary." *ACI 318-11*, Farmington Hills, MI.

ASCE. (2010). "Minimum design loads for buildings and other structures." *ASCE/Structural Engineering Institute (SEI)-7*, Reston, VA.

Bahn, B. Y., and Hsu, C. T. T. (1998). "Stress-strain behavior of concrete under cyclic loading." *ACI Mater. J.*, 95(2), 178–193.

Bondy, K. B. (2012). "Two-way post-tensioned slab with bonded tendons." *PTI J.*, 8(2), 43–48.

Burns, N. H., and Hemakom, R. (1977). "Test of scale model post-tensioned flat plate." *J. Struct. Div.*, 103(6), 1237–1255.

Chopra, A. K. (2000). *Dynamics of structures*, 2nd Ed., Prentice Hall, Upper Saddle River, NJ.

Dat, P. X., and Hai, T. K., (2013). "Membrane actions of RC slabs in mitigating progressive collapse of building structures." *Eng. Struct.*, 55, 107–115.

DoD (Department of Defense). (2010). "Design of buildings to resist progressive collapse." *UFC 4-023-03*, United Facilities Criteria (UFC), Washington, DC.

Ellobody, E., and Bailey, C. G. (2009). "Modelling of unbonded post-tensioned concrete slabs under fire conditions." *Fire Saf. J.*, 44(2), 159–167.

Fenwick, R., and Megget, L. (1993). "Elongation and load deflection characteristics of reinforced concrete members containing plastic hinges." *Bull. New Zealand Natl. Soc. Earthq. Eng.*, 26(1), 28–41.

Foutch, D. A., Gamble, W. L., and Sunidja, H. (1990). "Tests of post-tensioned concrete slab-edge column connections." *ACI Struct. J.*, 87(2), 167–179.

GSA (General Services Administration). (2013). Progressive collapse analysis and design guidelines for new federal office buildings and major modernization projects.

Habibi, F., Redl, E., Egberts, M., Cook, W. D., and Mitchell, D. (2012). "Assessment of CSA A23. 3. Structural integrity requirements for two-way slabs." *Can. J. Civil Eng.*, 39(4), 351–361.

Hambly, E. C. (1991). *Bridge deck behavior*, CRC, Boca Raton, FL.

Han, S. W., Kee, S.-H., Kang, T. H.-K. (2006a). "Cyclic behaviour of interior post-tensioned flat plate connections." *Mag. Concrete Res.*, 58(10), 699–711.

Han, S. W., Kee, S.-H., Park, Y.-M., Lee, L.-H., and Kang, T. H.-K. (2006b). "Hysteretic behavior of exterior post-tensioned flat plate connections." *Eng. Struct.*, 28(14), 1983–1996.

Han, S. W., Moon, K. H., and Park, Y. (2012). "Effect of slab bottom reinforcement on seismic performance of post-tensioned flat plate frames." *Mag. Concrete Res.*, 64(4), 317–334.

Hawkins, N. M., and Mitchell, D. (1979). "Progressive collapse of flat plate structures." *ACI J. Proc.*, 76(7), 775–808.

Huang, Y., Kang, T. H., Ramseyer, C., and Rha, C. (2010). "Background to multi-scale modelling of unbonded post-tensioned concrete structures." *Int. J. Theor. Appl. Multiscale Mech.*, 1(3), 219–235.

Jahangir Alam, A. K. M., Amanat, K. M., and Seraj, S. M. (2009). "Experimental investigation of edge restraint on punching shear behaviour of RC slabs." *IES J. Civ. Struct. Eng.*, 2(1), 35–46.

Kang, T. H.-K., and Wallace, J. W. (2006). "Punching of reinforced and post-tensioned concrete slab-column connections." *Struct. J.*, 103(4), 531–540.

Keyvani, L., Sasani, M., and Mirzaei, Y. (2014). "Compressive membrane action in progressive collapse resistance of RC flat plates." *Eng. Struct.*, 59, 554–564.

Khan, S., and Williams, M. (1995). *Post-tensioned concrete floors*, Butterworth-Heinemann, Oxford, U.K.

Kim, J., Stanton, J., and MacRae, G. (2004). "Effect of beam growth on reinforced concrete frames." *J. Struct. Eng.*, 10.1061/(ASCE)0733-9445(2004)130:9(1333), 1333–1342.

Kim, U., Kang, T. H. K., and Chakrabarti, P. R., (2012). "Rehabilitation of unbonded post-tensioned slabs with different boundary conditions." *PTI J.*, 8(2), 5–19.

Kokot, S., Anthoine, A., Negro, P., and Solomos, G. (2012). "Static and dynamic analysis of a reinforced concrete flat slab frame building for progressive collapse." *Eng. Struct.*, 40, 205–217.

Kosut, G. M., Burns, N. H., and Winter, C. V. (1985). "Test of four-panel post-tensioned flat plate." *J. Struct. Eng.*, 10.1061/(ASCE)0733-9445(1985)111:9(1916), 1916–1929.

Krauser, L. (2006). "Repairs, modifications, and strengthening with post-tensioning." *PTI J.*, 4(1), 24–40.

Megally, S., and Ghali, A. (2000). "Punching of concrete slabs due to column moment transfer." *J. Struct. Eng.*, 10.1061/(ASCE)0733-9445(2000)126:2(180), 180–189.

Mirzaei, Y., and Sasani, M. (2011). "Punching shear failure in progressive collapse analysis." *Proc., Structures Congress*, 2941–2950, ASCE, Reston, VA.

Nilson, A., Darwin, D., and Dolan, C. (2010). *Design of concrete structures*, 14th Ed., McGraw-Hill, New York.

Polak, M. A. (1998). "Modeling punching shear of reinforced concrete slabs using layered finite elements." *ACI Struct. J.*, 95(1), 71–80.

Qian, K., and Li, B. (2013a). "Experimental study of drop panel effects on the response of reinforced concrete flat slabs after the loss of a corner column." *ACI Struct. J.*, 110(2), 319–330.

Qian, K., and Li, B. (2013b). "Performance of three-dimensional reinforced concrete beam-column substructures under loss of a corner column scenario." *J. Struct. Eng.*, 10.1061/(ASCE)ST.1943-541X.0000630, 584–594.

Qian, K., and Li, B. (2015). "Analytical evaluation of the vulnerability of RC frames for progressive collapse caused by the loss of a corner column." *J. Perform. Constr. Facil.*, 10.1061/(ASCE)CF.1943-5509.0000493, 04014025.

Ratay, C. R. (2007). "Progressive weakening to failure of an unbonded post-tensioned flat plate." *PTI J.*, 5(1), 23–35.

Salim, W., and Sebastian, W. (2003). "Punching shear failure in reinforced concrete slabs with compressive membrane action." *ACI Struct. J.*, 100(4), 471–479.

SAP2000 14 [Computer software]. Berkeley, CA, Computers and Structures.

Sasani, M., Bazan, M., and Sagiroglu, S., (2007). "Experimental and analytical progressive collapse evaluation of actual reinforced concrete structure." *ACI Struct. J.*, 104(6), 731–739.

Sasani, M., Kazemi, A., Sagiroglu, S., and Forest, S., (2011). "Progressive collapse resistance of an actual 11-story structure subjected to severe initial damage." *J. Struct. Eng.*, 10.1061/(ASCE)ST.1943-541X.0000418, 893–902.

Sasani, M., and Sagiroglu, S. (2008). "Progressive collapse resistance of Hotel San Diego." *J. Struct. Eng.*, 10.1061/(ASCE)0733-9445(2008)134:3(478), 478–488.

Sasani, M., and Sagiroglu, S. (2010). "Gravity load redistribution and progressive collapse resistance of 20-story reinforced concrete structure following loss of interior column." *ACI Struct. J.*, 107(6), 636–644.

Scordelis, A., Lin, T., and Itaya, R. (1959). *Behavior of a continuous slab prestressed in two directions*, California Dept. of Public Works, Sacramento, CA.

Sinha, B., Gerstle, K. H., and Tulin, L. G. (1964). "Stress-strain relations for concrete under cyclic loading." *ACI J. Proc.*, 61(2), 195–212.

Wang, W., and Teng, S. (2008). "Finite-element analysis of reinforced concrete flat plate structures by layered shell element." *J. Struct. Eng.*, 10.1061/(ASCE)0733-9445(2008)134:12(1862), 1862–1872.

Wilson, E., and Habibullah, A., (2000). *Structural analysis program SAP2000*, Univ. of California, Berkeley, CA.

Yankelevsky, D. Z., and Reinhardt, H. W. (1987). "Response of plain concrete to cyclic tension." *ACI Mater. J.*, 84(5), 365–373.

Young, W. C., and Budynas, R. G., (2002). *Roark's formulas for stress and strain*, 7th Ed., McGraw-Hill, New York.

Zhang, N., Fu, C. C., and Che, H. (2011). "Experiment and numerical modeling of prestressed concrete curved slab with spatial unbonded tendons." *Eng. Struct.*, 33(3), 747–756.

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

2016 INDIVIDUAL SECTION AWARDS

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Paul Kirshen, Lauren Caputo, Richard M. Vogel, Paul Mathisen, Ana Rosner, Tom Renaud For the:

____ CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

____ GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

XX CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

____ JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

____ PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

____ YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

Paul Kirshen, U. Massachusetts Boston, Lauren Caputo, ESS Group, Waltham (lauren.r.caputo@gmail.com); Paul Mathisen, Worcester Polytechnic Institute (mathisen@wpi.edu); Rich Vogel, Tufts University (richard.vogel@tufts.edu) ~~Ana Rosner, USGS Conte Fish Research Center, Turner Falls, MA (arosner@usgs.gov); Tom Renaud, Vertex Environmental Services,~~ Boston, MA (trenaud@vertexeng.com)

Is this a re-nomination? Yes ____ No XX

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Bruce Jacobs Daytime Telephone: 617-308-7074 Email: bjacobs@enviroinsite.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

Adapting Urban Infrastructure to Climate Change: A Drainage Case Study

by Paul Kirshen, Lauren Caputo, Richard M. Vogel, Paul Mathisen, Ana Rosner, and Tom Renaud

Journal of Water Resources Planning and Management
Volume 141, Issue 4, April 2015

Adapting Urban Infrastructure to Climate Change: A Drainage Case Study

Paul Kirshen, M.ASCE[1]; Lauren Caputo, A.M.ASCE[2]; Richard M. Vogel, M.ASCE[3]; Paul Mathisen, M.ASCE[4]; Ana Rosner[5]; and Tom Renaud, A.M.ASCE[6]

Abstract: Attributes of an effective infrastructure adaptation planning process as well as methods for choosing among adaptation strategies are described. The major attributes include: (1) a vulnerability assessment, (2) proactive adaptation strategies that are implemented over time and space, (3) climate change scenario analysis including climate surprises to handle the uncertainty of the future climate, (4) actions that are robust and/or flexible and adjustable, (5) a planned, progressive approach that ties implementation to critical thresholds of actual climate changes and preserves options for future actions, (6) evaluation with multiple social, economic and environmental criteria, and (7) integration of local stakeholders into the planning process. Multiple methods can be used to generate and evaluate adaptation strategies. A subset of the key attributes is then used in a case study of urban drainage management, which was designed and implemented to illustrate these attributes. It is shown that multicriteria scenario analysis can be effectively used to generate and evaluate alternative adaptation strategies. The identification of when critical thresholds are reached under conditions of climate variability and change is a major research need. **DOI: 10.1061/(ASCE)WR.1943-5452.0000443.**

Introduction

It is generally agreed that the volumes of precipitation in extreme events will increase under conditions of a changing climate (IPCC 2012; Interagency Climate Change Adaptation Task Force 2011). Kharin et al. (2013) used frequency analysis of daily data from general circulation models (GCM) to determine changes in the amount of precipitation for the 20-year, 24-h storm. The multimodel median showed 5–10% increases by midcentury, and 10% to more than 20% increases by end of century over the continental United States under moderate climate change. With these increases in precipitation magnitude and intensity, associated increases in runoff, storm water discharges, and flooding are expected. These concerns are particularly acute in urban areas due to the extensive development and high population densities that exist in these areas. Thus, for example, it can expected that urban drainage networks designed for the conditions of the past or present climate will not function as effectively in the future as they do now. Municipalities and other stakeholders must have effective plans or processes in place to ensure that infrastructure services will be not be adversely affected by these changes, the process of adaptation.

Given the ever-increasing attention given to societal responses to climate change, there is a rapidly burgeoning literature on the development and evaluation of methods for effective adaptation planning under a variety of forms of uncertainty. This paper begins by summarizing that literature in an effort to synthesize the critical elements of an effective infrastructure adaptation planning process as well as those methods that have been advanced for developing and choosing among strategies. Next, a subset of key attributes of those approaches is selected and used in a case study. This case study is designed and implemented in such a way as to reflect many of the attributes of an effective adaptation planning process for infrastructure using drainage as an example. The paper concludes with a summary of further research needs in infrastructure adaptation planning.

Adaptation Planning

The adaptation planning process normally includes two major components: (1) completion of a vulnerability assessment, and (2) development of an adaption strategy. The vulnerability assessment provides an estimate of the degree to which a system is susceptible to and unable to cope with the effects of climate change. The vulnerability assessment typically includes an analysis of climate change exposure and sensitivity, and an evaluation of adaptive capacity, which represents the extent to which the effects of climate change can be mitigated with adaptation (Snover et al. 2007). The adaptation strategy represents a set of actions to be employed to adjust the natural or human systems to mitigate the damage or harm that would result from the anticipated changes in climate (Kiparsky et al. 2012). The remainder of this section concentrates on considerations and factors that are important in the development of an effective adaptation strategy.

It is recognized that a major challenge of proactive adaptation planning is the uncertainty of the future climate (Milly et al. 2008).

[1]Research Professor, Environmental Research Group, Dept. of Civil Engineering, Institute for the Study of Earth, Oceans and Space, Univ. of New Hampshire, Durham, NH 03824 (corresponding author). E-mail: paul.kirshen@unh.edu

[2]Water Resources Engineer, ESS Group, Waltham, MA 02451. E-mail: lauren.r.caputo@gmail.com

[3]Professor, Dept. of Civil and Environmental Engineering, Tufts Univ., Medford, MA 02155. E-mail: richard.vogel@tufts.edu

[4]Associate Professor, Dept. of Civil and Environmental Engineering, Worcester Polytechnic Institute, Worcester, MA 01609. E-mail: mathisen@wpi.edu

[5]Research Associate, U.S. Geological Survey Conte Anadromous Fish Research Center, 1 Migratory Way, Turners Falls, MA 01301. E-mail: arosner@usgs.gov

[6]Environmental Engineer, Vertex Environmental Services, 1 Congress St., Boston, MA 02114. E-mail: trenaud@vertexeng.com

Note. This manuscript was submitted on June 28, 2013; approved on February 11, 2014; published online on July 21, 2014. Discussion period open until December 21, 2014; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Water Resources Planning and Management***, © ASCE, ISSN 0733-9496/04014064(11)/$25.00.

The uncertainty arises from the unknown possible future emissions of greenhouse gases (GHG) combined with additional uncertainty in the response of the climate system to the emissions. To address the range of conditions that could potentially arise given this high degree of uncertainty, a scenario approach to adaptation planning is normally undertaken (Titus et al. 2009; Dessai and Hulme 2004; Water Utility Climate Alliance 2009; Brown et al. 2011). Scenarios are internally consistent narratives of plausible future states that may evolve from present conditions, given various driving forces (Groves and Lempert 2007). Scenarios are used when reliable projections of future conditions are not available, as is recognized to be the case for climate change. The scenarios attempt to constrain the range of plausible future conditions and can be based not only on climate variables, but also on socioeconomic conditions. The scenarios can be integrated into an adaptation plan using either a top-down or bottom-up approach. The top-down approach uses scenarios of future climates with system modeling to determine the range of possible impacts at a particular site; with an understanding of these impacts, the effectiveness of individual adaptation actions are subsequently tested (USEPA 2010). In contrast, the bottom-up approach determines the critical climate sensitivities of a system and then focuses upon the possibilities of them occurring (USEPA 2010; Cromwell and McGuckin 2010; Brown et al. 2011).

Adaptation Strategies and Actions

An adaptation strategy includes a set of local and regional proactive actions that are implemented by public and private organizations over time and space to manage systems that are vulnerable to future climate and other forms of change. Three general classes of proactive adaptation strategies for urban areas or other built environments (Kirshen et al. 2008a) include:

1. Protection: construction of a barrier to lessen the impacts of the climate changes, such as a seawall to protect against more coastal flooding;
2. Accommodation: allowing the impacts to occur but attempting to lessen them by taking specific actions. Examples of accommodation actions are flood proofing, developing evacuation plans, building cooling shelters, and purchasing insurance; and
3. Retreat: moving away from the impact. Examples of retreat actions include leaving floodplains and moving to cooler climates.

Because ecosystem services are important for the functioning of some infrastructure services, analogous proactive adaptation strategies for ecosystems include (Millar et al. 2007):

- Resistance: forestalling impacts and protecting highly valued resources;
- Resilience: improving the capacity of ecosystems to return to desired conditions after disturbance; and
- Response: facilitating transition of ecosystems from current to new conditions.

The various infrastructure adaptation strategies can be classified into two categories: *here and now* actions, and *prepare and monitor* actions. *Here and now* actions are normally designed for new projects or for presently threatened areas. Such projects should be designed for climate change adaptation. The incremental costs for new projects are relatively low compared to capital costs under the present climate. *Prepare and monitor* actions are for areas where present threats are low. A planned, progressive approach is developed in an adaptation plan that is not implemented immediately; rather, options are preserved for future adaptation implementation. The actions are undertaken when designated trigger points or thresholds, which are also determined as part of the adaptation planning process, are reached (Reeder and Ranger 2011; Brekke et al. 2011; Ray et al. 2012; Rosner et al. 2014; Douglas et al. 2013; Haasnoot et al. 2012). The *prepare and monitor* approach is similar to the *real options* approach, for which planning is carried out now at some price to preserve the possibility of taking actions in the future (L. Dobes, "Notes on applying 'real options' to climate change adaptation measures, with examples from Vietnam," CCEP working paper 7.10, Centre for Climate Economics & Policy, Crawford School of Economics and Government, The Australian National University, Canberra).

Designation of trigger points or thresholds normally requires the development of the monitoring system to support the determination of the threshold values. The monitoring system could include local and global data such as from in situ sensors, remote sensing instruments, monitoring networks, and local assessor reports. Examples of relevant datasets include meteorological variables, tide measurements, socioeconomic conditions, demographics, and stakeholder values (Reeder and Ranger 2011).

An effective adaptation strategy developed for a particular site should consist of actions that are robust (meaning that they function acceptably well under most future uncertainties and risks), and/or flexible and adjustable such that they can be implemented successfully as biophysical and socioeconomic conditions change. Yohe and Leichenko (2010) refer to the latter approach as *Flexible Adaptation Pathways*.

In addition, an effective adaptation strategy includes:

- No-regret (i.e., valuable even without climate change) and cobenefit (i.e., valuable to multiple sectors) actions,
- Actions that effectively integrate with sustainability planning to respond to other pressures on the region such as population and land use changes and GHG mitigation, and
- A portfolio of approaches for multiple levels of safety.

An effective strategy is evaluated with multiple social, economic, and environmental criteria and respects equity and adaptive capacity needs. It is also responsive to climate surprises, and employs adaptive management as needed. Additionally, because adaptation is often implemented at the local level, local stakeholders must be integrated into the planning process (Kousky et al. 2009; Stakhiv 2010; Brekke et al. 2011; Lempert and Groves 2010; Ray et al. 2012; National Research Council 2009; Matthews et al. 2011; Hallegatte et al. 2011; Douglas et al. 2013).

Development of Adaptation Plans

Development of a particular adaptation strategy can range from a trial-and-error approach based on comparing the performance of several adaptation strategies under a small set of scenarios and criteria (e.g., Kirshen et al. 2012) to sophisticated methods such as decision scaling (Brown et al. 2011) and robust decision making (RDM, Hall et al. 2012). For example, Brown et al. (2011) developed the decision-scaling approach for application to bottom-up adaptation planning. Here, the sets of climate change conditions for which an adaptation plan decision is most sensitive are determined. Then, efforts are focused on determining the plausibility of these climate change conditions occurring. Once the plausibility is known, this additional information on future possible climates can be used to evaluate plans in general.

RDM provides a very powerful method to evaluate a possible adaptation strategy. The process systematically examines the performance of a plan over thousands of possible biophysical and socioeconomic scenarios, and then determines the sets of scenarios to which the performance is most sensitive. The results can then be iteratively used by decision makers to develop improved plans.

Adaptation strategies can also be developed from the output of complex optimization models such as the model developed

by Ray et al. (2012) using robust optimization or using real options as discussed by Gersonius et al. (2013) and Wang and de Neufville (2006). Both the approaches of Ray et al. (2012) and Gersonius et al. (2013) require assigning probabilities to future streamflow or precipitation conditions over time. However, as illustrated by Ray et al. (2012), by analyzing the results from many possible probability distributions it is possible to find adaptation strategies that function reasonably well over a range of conditions. In theory, if designed and used properly, optimization techniques can help sort through a myriad of possible alternative strategies to generate a much smaller and more reasonable set of adaptation strategies. The advantage of using an optimization model to generate alternatives is that they can theoretically examine the entire planning horizon and all the linkages among the components of a strategy.

Urban Drainage Case Study: Somerville, Massachusetts

Methodology Summary

This case study is designed and implemented to reflect many of the attributes of an effective adaptation planning process for infrastructure using an urban drainage system in the northeastern United States as an example. The vulnerability assessment includes development of possible climate change scenarios, definition of a set of indicators to assess impacts, evaluation of sensitivities of the system to the scenarios, and a review of the adaptive capacity of the system. Adaptation planning includes development and testing of several sets of alternative, integrated adaptation actions over time and space that may manage the impacts. Two different decision-making approaches are used to quantify the economic results: a design storm least-cost approach and a risk-based approach where performance is evaluated over all possible precipitation conditions. Present expected value costs to meet design criteria for the design storms are compared for each climate change scenario over time to identify the least costly adaptation strategy. Similarly, present expected value net benefits over time are compared to identify the most effective adaptation strategy in this approach.

Recent literature has assessed the drainage vulnerabilities of urban areas to potential changes in extreme rainfall. The Water Environmental Research Foundation (WERF 2009) presents general flow charts of vulnerability networks and possible resulting drainage stresses in urban areas under climate change. Rosenberg et al. (2010) cites previous research completed in U.S. and Canadian cities prior to 2009. For three major urban areas in the state of Washington, Rosenberg et al. (2010) found that drainage impacts varied by GCM. Zhou et al. (2012) summarize some of the recent literature on urban drainage and climate change and concluded that a process is needed for adaptation planning for urban drainage. They present a method based upon determining the impacts of climate change on two adaptation options and choosing the option that maximizes the expected value benefit/cost ratio over time. They do not, however, include multiple climate change scenarios. Similarly, Olsson et al. (2013) evaluate the performance of several drainage management strategies under climate change but only consider costs of the adaptation options for one composite climate change scenario.

Researchers are also stressing the possibilities of using flexible, decentralized approaches to adapt to the increased drainage flooding and associated water quality impacts under climate change (Auld et al. 2006; WERF 2009; Roseen et al. 2011). This is in contrast to large-scale solutions such as sewer separation, which might be effective and robust, but also can be expensive and inflexible. One of the most flexible and decentralized approaches is low-impact development (LID), in which, even without climate change, there is currently much interest. Some, such as Heaney and Sansalone (2009), view LID as one of the best approaches for the future management of urban drainage. Thus LID is a no-regrets policy. LID is "an approach to land development (or re-development) that works with nature to manage storm water as close to its source as possible" (http://www.epa.gov/region1/topics/water/lid.html, accessed June 16, 2013). The LID approach employs principles such as preserving and recreating natural landscape features, minimizing effective imperviousness to create functional and appealing site drainage that treat storm water as a resource rather than a waste product. LID techniques include decentralized approaches such as porous pavement, preservation of buffers, bioretention, distributed storage, and rain gardens. As WERF (2009, p. 62) states "As more and more green infrastructure is added . . . .year after year, it may be capable of keeping up with the gradually increasing rainfall intensity phenomenon over the course of time." Another approach to storm water management is to combine it with the holistic management of storm water, flood waters, water supply, and wastewater management, an approach advocated by many (Novotny and Brown 2007; Zoltay et al. 2010; Daigger 2009).

Case Study Area

With a 2010 population of 75,754 over an area of approximately 11 sq km, Somerville, Massachusetts (Fig. 1), is "the most densely populated municipality in New England" (City of Somerville 2011). The city is highly urbanized, almost completely built out, and has limited open space.

The case study site is the Winter Hill neighborhood and the commercial Assembly Square area, which are serviced by the combined sewer system of the Somerville-Medford Branch Sewer (S-MBS). This site was chosen because the Somerville city engineer identified this as an area that was already experiencing negative impacts because of climate, i.e., local drainage flooding and combined sewer overflows into the Mystic River. For example, the system has the capacity to handle the wastewater flow but is "only sufficient to handle storm flows resulting from about a one-year storm" (CDM 1974). A storm that occurred on July 10, 2010 in

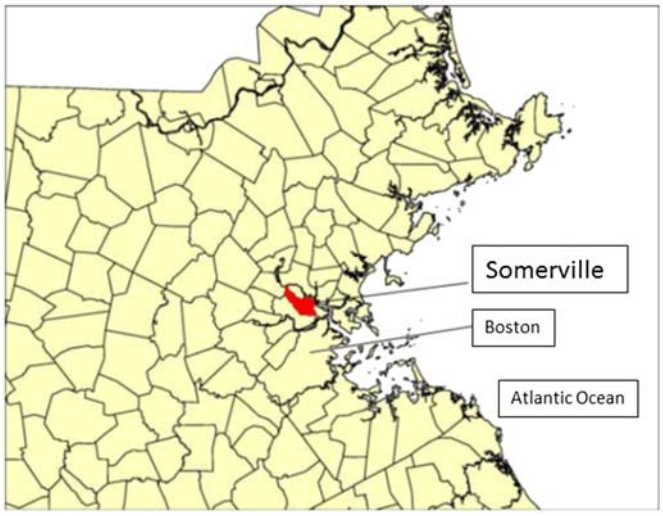


Fig. 1. Location of Somerville, Massachusetts (the polygons represent municipal boundaries) [data from Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division]

Somerville dropped approximately 9 cm of rain in an hour, causing combined sewage to surcharge into the streets. One woman needed to be rescued from a highway underpass near Assembly Square because the water rose too quickly for her to drive out of the tunnel (TheBostonChannel.com 2010).

In addition to the wastewater and storm water generated in the Winter Hill area, sanitary flow and storm water also enters the S-MBS from several other neighborhoods bordering the area. The Winter Hill and Assembly Square watersheds draining to the S-MBS cover a total area of 2.7 sq km and are shown in Fig. 2. A number of the watersheds have separate infrastructure for storm water and sanitary sewage; however, all separated storm water in the watershed drain into the S-MBS. A separate storm water outfall was never built due to financial constraints.

Under low flow conditions, S-MBS storm water and combined sewage flow to the Chelsea Creek headworks and subsequently the Deer Island wastewater treatment plant through the DeLauri pump station (Fig. 3). Under high flow conditions, excess flow is diverted through the Somerville Marginal Combined Sewer Overflow (CSO) facility, triggering an overflow into the Mystic River. The Somerville marginal facility is gravity-operated, unmanned and has a capacity of 11 m^3/s (245 million gallons per day). Water flowing through the facility is screened and chlorinated and then is discharged into the Mystic River via one of two outfalls depending on the tidal elevation. During low tide, flow discharges through Outfall 205 (located downstream of the Amelia Earhart Dam) and, during high tide, flow discharges through Outfall 205A (located upstream of the dam).

The Winter Hill area is comprised of multiresidential neighborhoods (54%), followed by much smaller areas of industrial (14.5%), commercial (11.4%), transportation (7.7%), and urban public/institutional (6.8%) land use. There are smaller areas of recreation, open land, forest, marina, and water. The watershed is 73% impervious, a very high percentage even for an urban city.

There are few existing storm water controls within the watershed that either promote infiltration or retain runoff before entering the combined sewer system. Most rooftop drains are directly connected to catch basins. The high impervious area in Somerville makes it almost impossible for storm water to recharge into soils to replenish groundwater. Many homeowners pave their front yards to create more parking for residents (Carlson et al. 2014). The highly urbanized watershed forces Somerville to rely heavily on its storm water infrastructure to prevent flooding.

At the time of the preparation of this paper, Assembly Square is currently under construction with new office space, retailers, and residential units. When complete, the Assembly Square storm water management network will drain into the system downstream of the Somerville CSO facility. Thus it will not affect volume of flow through the Somerville CSO facility. The finished storm water management network in Assembly Square includes some LID features.

Vulnerability Assessment

The first step was a vulnerability assessment to determine the impacts without any adaptation, referred to in the figures below as the No Action plan. The 3-month, 10-year, and 100-year design storms were chosen to serve as a basis for evaluation. The 3-month storm was chosen specifically to evaluate system performance against the US EPA CSO policy that states there should be no more than an average of four overflow events per year under the presumption approach (USEPA 1995). The 10-year and 100-year storms

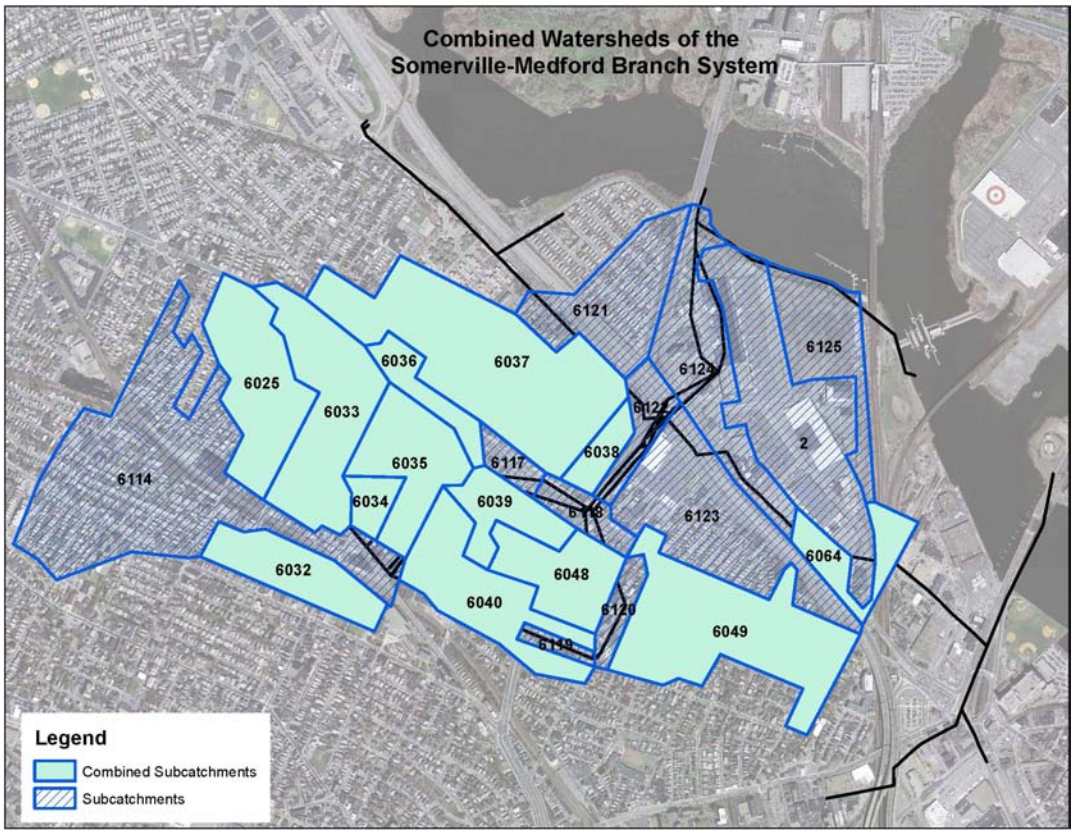


Fig. 2. Separate and combined watersheds of the S-MBS [base layer from Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division]

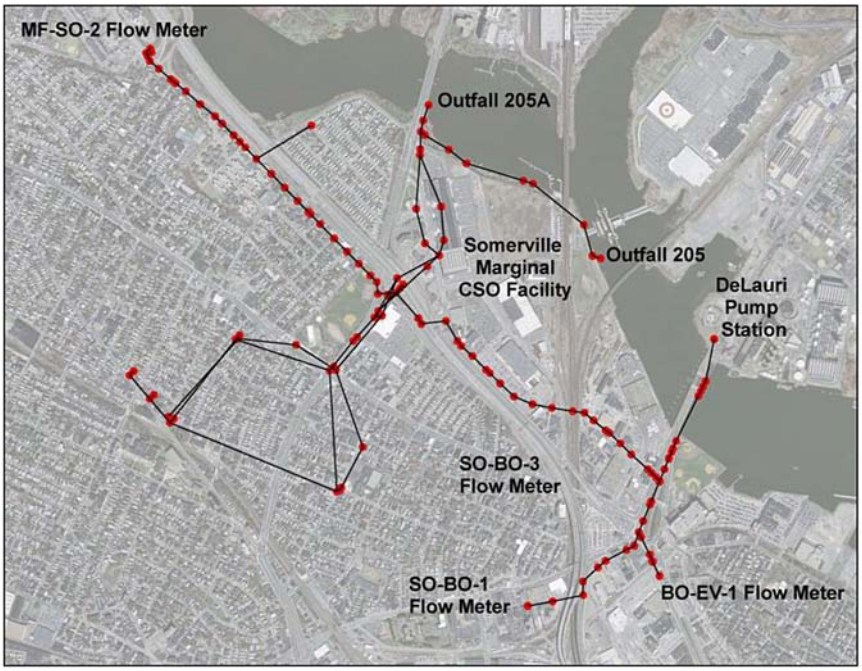


Fig. 3. Layout of Somerville-Medford Branch Sewer (S-MBS) [base layer from Office of Geographic Information (MassGIS), Commonwealth of Massachusetts, Information Technology Division]

were chosen for evaluation according to Standard 2 of the Massachusetts Stormwater Rules for storm water management design (MassDEP 2008).

Plausible scenarios of the future ranges of the extreme design precipitation for the area were developed by Powell (2008) based upon the Special Report on Emission Scenarios (SRES, Nakicenovic and Swart 2000). For each SRES scenario of B1, A1b, and A2 and each 20-year time period around 2010, 2050, and 2100, an extreme value statistical distributions was fit to the daily values of each of 20 general circulation models for the GCM grid cell closest to Somerville. The future extreme values for the various frequencies of interest from each GCM and for each scenario were then scaled by the ratios of the present design values derived from measured historical data to the present values from the GCM. The results are displayed as box and whisker plots to show the variability in percent changes for precipitation. The analysis

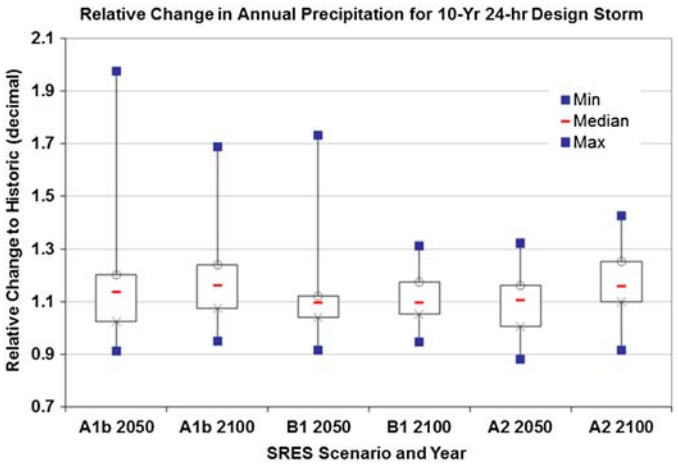


Fig. 4. Example of extreme event analysis in Somerville, Massachusetts

was completed for 2, 10, and 100-year storms. Fig. 4 is an example of the output.

Scenarios for changes in sanitary and storm water flows entering the system upstream and downstream of the area were not developed; it was assumed that they would remain the same because system managers there would take actions in the future to ensure the flows would not increase. Because the case-study area was already built out, the authors assumed no changes in sanitary flows. Thus, their low-impact and high-impact scenarios only included precipitation changes.

For the analysis, three scenarios were selected to represent high, moderate, and low climate change impacts. The selection of low and high impact scenarios was intended to provide an envelope that covers a wide range of plausible scenarios. The moderate scenario provides a basis for understanding how the costs and impacts may vary with the extent of climate changes.

The authors chose as the low-impact scenario the value of the change that was exceeded by 75% of the values (bottom of the box in Fig. 4) in the SRES scenario with the lowest 75 exceedance value. The high value was that exceeded by 25% of the values (the top of the box in Fig. 4) for the SRES scenario that had the largest increase. The moderate scenario was defined as the median value of the median values of each SRES scenario. In some instances, the scenario of the high or low scenario value in 2100 was different than the scenario of the high or low scenario value in 2050. In these cases, the SRES scenario chosen for 2100 was chosen as the scenario for 2050 to ensure consistency.

The overall planning horizon was selected to be the year 2070, with an interim evaluation point set at the year 2040. Because the precipitation results were available for 2050 and 2100, interpolation was used to determine climate scenarios values for 2040 and 2070. The planning window of the years 2040 through 2070 was selected because it provides (1) reasonable correspondence with the typical design life of many urban storm water facilities, (2) a time frame for which significant changes in climate are expected to have measureable and (potentially significant) impacts,

Table 1. Storm Total for Each Climate Change Scenario in Somerville, Massachusetts

		Storm total for each climate change scenario (mm)					
		2040			2070		
24-h design storm	2010	Low	Moderate	High	Low	Moderate	High
3-month	42.93	44.70 (1.05%)	45.72 (1.08%)	47.75 (1.14%)	46.23 (1.08%)	48.01 (1.12%)	50.55 (1.18%)
10-year	123.95	127.76 (1.04%)	133.60 (1.09%)	138.94 (1.14%)	129.54 (1.05%)	139.45 (1.13%)	148.34 (1.20%)
100-year	224.54	231.14 (1.04%)	247.40 (1.14%)	272.80 (1.27%)	230.63 (1.03%)	254.76 (1.14%)	296.16 (1.32%)

and (3) a realistic planning window that could be tenable for many communities and cities. The three-month storm volume was derived from the two-year volume. Results are shown in Table 1.

In addition to precipitation, the surface water elevations of the Mystic River needed to be adjusted for climate change because they control the elevation heads at the CSO outfalls. Low, moderate, and high scenarios were defined for water surface elevations and applied in conjunction with the same climate change scenarios defined for precipitation in the models. At the upstream outfall above the Amelia Earhart Dam, it was assumed that dam operations would change to accommodate future upstream flooding and the water surface level would remain constant behind the dam at the present elevation of 32 m above the Metropolitan District Commission (MDC) datum. At the downstream outfall below the Amelia Earhart Dam, the elevations of a typical 24-h tidal cycle data were increased by scenarios of expected global sea level rise (SLR) for 2040 and 2070 from Vermeer and Rahmstorf (2009).

The peak of the tide was set to occur one hour after the rainfall peak for each precipitation condition to create a worst-case scenario for drainage in the S-MBS. The small amount of subsidence in the region of approximately 19.8 cm/100 years (Kirshen 2008b) was ignored.

To evaluate the impacts of climate change, a set of metrics was required. The three performance metrics for this study were the volume of hazardous flooding in streets, volume of combined sewage discharged from the Somerville Marginal CSO facility, and the peak flows in the main trunk line at the intersection of the S-MBS with the Cambridge branch. These metrics were selected because they (1) are parameters that would be directly affected by increased runoff associated with climate change, (2) are quantifiable in terms of flow, volume, and cost, (3) would likely have impacts on the environment and public health, and (4) were concerns of the City of Somerville.

Hazardous flooding is defined as flooding volume in the streets minus *nuisance* flooding. Nuisance flooding is the volume of water that can flow through the streets of Somerville without overtopping the curb; in other words, this type of flooding is a nuisance but causes no harm or damage. A value for nuisance flooding was calculated for each junction in the S-MBS as the product of pipe length, average road width, and average curb height. Values for nuisance flooding were found to be very small compared to total flooding during model simulations, so nuisance flooding was ignored when determining hazardous flooding.

The design standard for flow through the CSO facility was to have no increase in volume beyond the present volume for each future design storm. The design standard for the hazardous street flooding was to tolerate only a minimal total volume (1,900 m^3) under all design storms and for all climates. It was also required that the peak flows in the main trunk line at the intersection of the S-MBS with the Cambridge branch be equal to or less than existing peak flows. Since the analysis found that the peak flows were reduced under all adaptation strategies in all future scenarios of climate when the other metrics and conditions were met, peak flows are no longer included in discussions for the remainder of this paper. They were reduced because lower flows were entering the sewer system.

The drainage and the sewer system flows were modeled with the US EPA Stormwater Management Model (SWMM, http://www.epa.gov/nrmrl/wswrd/wq/models/swmm/). The modeled sewer system started at meters MF-SO2, SO-BO1 and BO-EV-1 in Fig. 3. It included these watersheds as well as the watersheds in the S-MBS system. Downstream boundary conditions were set at the DeLauri pump station, and at the CSO outfalls above and below the Amelia Earhart Dam. As stated earlier, the *above* outfall was set to a fixed water surface elevation and the *below* outfall varied tidally. Upstream sanitary flows entering the system remained unchanged. The drainage catchments were modeled above the three upstream boundary conditions but, as stated earlier, it was assumed that adaptation activities were undertaken in these catchments such that there would be no increases in runoff in the future as a result of climate change (i.e., no changes in precipitation were ever applied to these subcatchments).

The model was calibrated and verified with the measured discharge and elevation data at meter SO-BO-3 from several precipitations events and the corresponding meter data at the upstream boundaries. It was also calibrated and verified with some limited data on CSO releases. Those calibration and verification runs may be seen in Caputo (2011). The model was run with one previous day of dry weather before the storm simulation to ensure that the antecedent conditions at the beginning of wet weather events would be appropriately simulated. Because the Assembly Square drainage network was not connected to the network below the CSO facility during the period of time of the calibration and verification data, its drainage network was not included during calibration and validation of the model.

The vulnerability of the current drainage network to present and future climate scenarios was the first analysis completed with the SWMM model. Fig. 5 illustrates that in all time periods and for all climate change scenarios (even the case of the 100-year, low climate change scenario in 2070), the CSO release exceeded present volumes, a violation of the design metric. Fig. 6 shows that there are also hazardous volumes under all present and future conditions except for the three-month storm—again a violation of design conditions. Given these assumptions, the system is in violation now, and some actions are needed to manage both present and future climate conditions.

Somerville Adaptation Planning

With the system vulnerability established, the next step was adaptation planning. Strategies for controlling combined sewer overflows in urban areas were identified through review of literature, correspondence with engineers at municipal agencies, and experience of the authors in regards to long-term CSO planning. The authors searched for strategies that might meet the design goals with the lowest possible present value cost. Some common strategies for

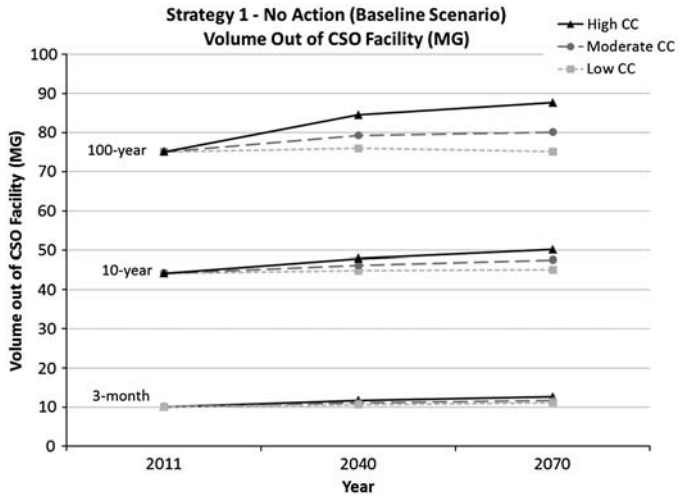


Fig. 5. Volume discharged from the CSO facility for the no action (baseline) strategy (1 mg = 3,790 m^3)

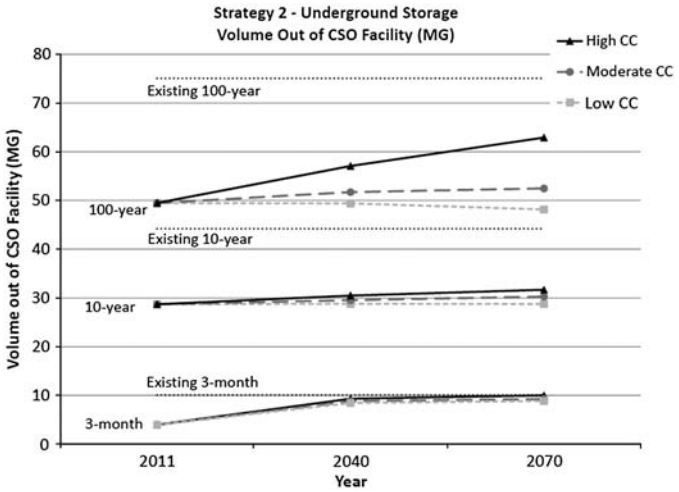


Fig. 7. Volume discharged from the CSO facility for the underground storage strategy (1 mg = 3,790 m^3)

urban CSO control include sewer separation, underground storage, and more recently, green infrastructure or low-impact development controls. For the purposes of this analysis, the selected adaptation strategies included underground storage, LID applied throughout the watershed, sewer separation, and a combination of sewer separation and LID. These strategies could be classified as protection adaptation actions because they are attempting to keep the threat away from stakeholders.

Underground storage incorporates retention basin storage throughout the S-MBS as a flexible, distributed design. The vulnerability assessment indicated that under all climate scenario conditions for the periods 2011, 2040, and 2070, the majority of hazardous flooding occurred at approximately the same 20 nodes. Therefore, 20 retention basins were incorporated in the S-MBS in SWMM and the storage needed to manage the hazardous flooding in 2070 under the high precipitation scenario was determined. This mimics the goal of flexibility in design and preserving options for later action. Then, depending upon the climate scenario for each time period (2011, 2040, 2070), the necessary amount of storage was added to meet the design conditions. As shown in Figs. 7 and 8, this strategy managed the conditions over all time periods and scenarios.

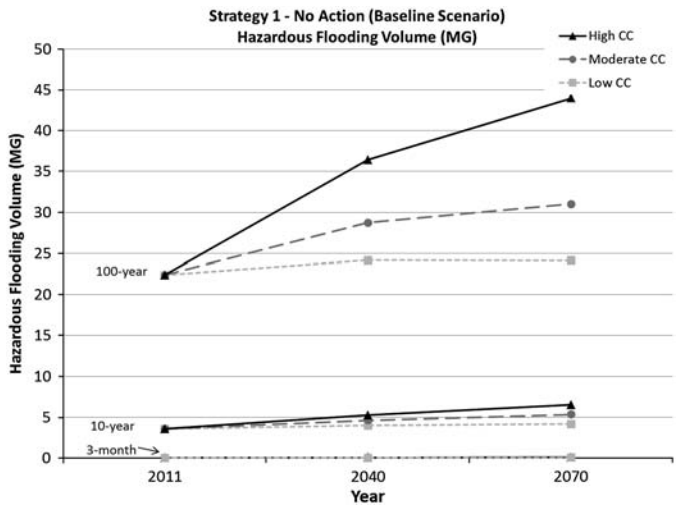


Fig. 6. Hazardous flooding volume for the no action (baseline) strategy (1 mg = 3,790 m^3)

The LID adaptation strategy employed LID throughout the watershed draining to the S-MBS. Through discussion at research meetings with municipal officials, LID techniques that were considered viable include infiltration trenches/dry wells, porous pavement, rain barrels, blue roofs, green roofs, and bioretention.

In residential areas, impervious areas were broken down into two categories: rooftops and driveways/pathways. LID techniques that homeowners may install to store storm water from rooftops include drywells, rain barrels, green roofs, and blue roofs. Porous pavement was selected as the technique that homeowners would install to store storm water from driveways/pathways. Maximum feasible amounts of LID by type are below:

Rooftop

- 60% of roofs drain to on-site drywells,
- 10% of roofs drain to rain barrels,
- 10% of roofs are converted to green roofs,
- 10% of roofs are converted to blue roofs, and
- 10% of roofs make no changes in existing drainage.

Driveways/pathways

- 25% of area is converted to porous pavement.

Design of each LID approach was determined using the Massachusetts DEP Stormwater Handbook (MassDEP 2008). Not all the LID techniques modeled were directly available in SWMM; in these cases the most representative element in SWMM was used for the modeling.

LID options for commercial, business, and industrial areas to store storm water from rooftops include drywells, rain barrels, and blue roofs. LID techniques that may be installed to store storm water from parking lots/sidewalks/pathways include only porous pavement. LID that may be installed to store storm water from grass and shrub areas include bioretention. Maximum feasible amounts of LID are below.

Rooftop

- 50% of roofs drain to on-site drywells,
- 20% of roofs are converted to green roofs, and
- 20% of roofs are converted to blue roofs.

Parking lots/sidewalks/pathways

- 75% of impervious area is converted to porous pavement grass/shrubs, and
- 15% of pervious area is converted to bioretention.

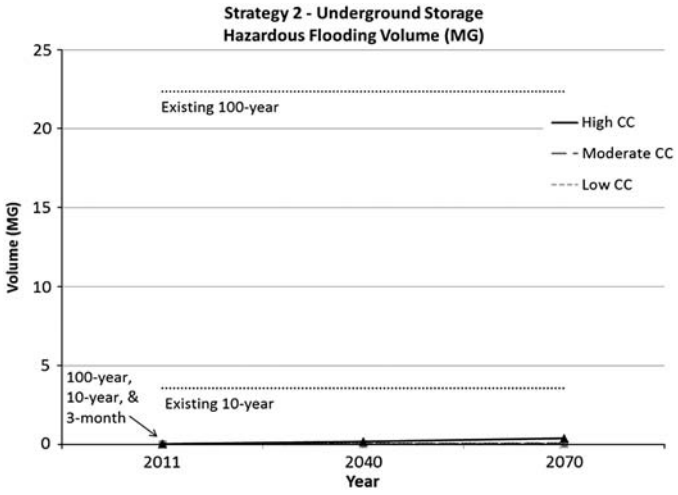


Fig. 8. Hazardous flooding volume for the underground storage strategy (1 mg = 3,790 m^3)

It was assumed that LID would be installed with the following schedule:

- 2011: Install 30% of the maximum amount of LID planned to be installed;
- 2040: Install additional 50% of the maximum amount of LID; and
- 2070: Install remaining 20% of LID.

The performance of the LID strategy was then simulated under the climate change scenarios. This strategy met design conditions for the CSO volume being discharged out of the treatment facility under all the scenarios. As shown in Fig. 9, however, the LID strategy did not meet the performance metrics for hazardous flooding under the moderate and high scenarios for all the times and therefore did not meet design conditions. The LID techniques used in this study cannot contain more than a 5.1-cm storm, and therefore, cannot alone manage even the present 10-year or 100-year storms.

Sewer separation was the next strategy investigated. To meet the performance targets for hazardous flooding and reduction in CSO volumes, it was necessary to perform sewer separation in all subcatchments that drained to the main trunk of the S-MBS and the Winter Hill sewer system. Sewer separation resulted in meeting design conditions for all the scenarios over all time periods.

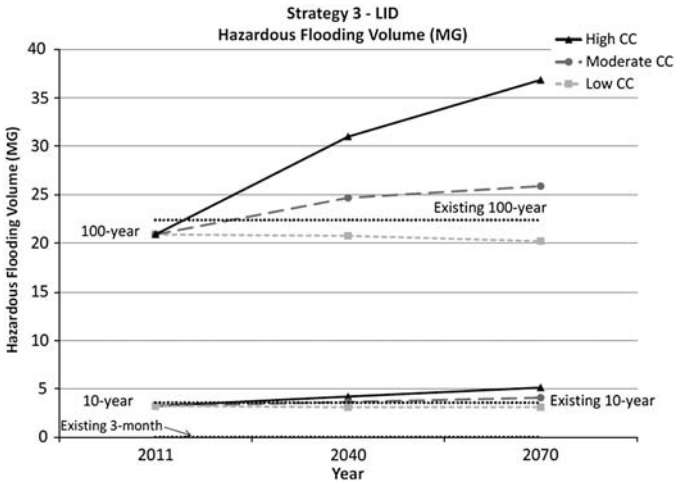


Fig. 9. Hazardous flooding volume for the LID strategy (1 mg = 3,790 m^3)

Because the Winter Hill system was not meeting design conditions under the present climate, it was assumed that this alternative would be built over the next decade.

The final adaptation strategy employed a combination of sewer separation and LID. LID techniques were eliminated if they were deemed costly and did not provide much storage/retention. Thus the LID techniques considered included the following: blue roofs, dry wells, and porous pavement. With a trial and error iteration of two to three steps, the authors found a strategy that worked reasonably well. Under this strategy, staged actions would be carried out as follows:

- 2011: Perform sewer separation in all but five subcatchments, install 100% of possible LID in 4 subcatchments;
- 2040: Separate another subcatchment; and
- 2070: No action necessary.

This staged strategy was found to be effective for all scenarios over all time periods.

Cost Analysis

To evaluate the adaptation scenarios, the expected present value costs of each alternative were determined. Here, capital costs include construction, design and engineering (D&E) costs. Variable costs include costs associated with operations and maintenance (O&M), the treatment of water flowing to Deer Island WWTP, and treatment of water flowing through the Somerville Marginal CSO facility. Future costs were discounted by a real discount rate of 2.3%.

Expected values of variable costs for each management alternative were calculated as follows. For each climate change scenario and each planning year (2011, 2030, 2070), the variable costs for meeting each design event (e.g., the 100-year storm) were plotted against the probability of each event and then the area under the curve determined. Next, the expected values of the variable costs for each planning year for each climate change scenario were plotted over the 60-year time frame. The total expected value variable cost over all the years for that scenario and management alternative was then calculated by determining the area underneath this curve.

The total expected present value costs of the strategies meeting the design conditions were determined by added the discounted present value capital costs to the expected present value variables costs and are summarized in Table 2. Because Strategy 3 (LID) did not satisfy the design goals, it was not included. The costs are very large compared to actual investments in similar cities in drainage management because of the very high degree of service being provided under present and future climates. The authors realize that the actual planning process may result in trade-offs being made between costs and level of drainage management.

The difference of the costs in Table 2 for an adaptation strategy is low primarily because of the high capital costs to meet conditions in the present. For example, the costs of underground storage to meet design conditions under one climate change scenario were approximately $310 million in 2010, then $65 million in 2040, and $25 million in 2070. Results show that Strategy 4, sewer separation, is the most cost-effective strategy for all climate change

Table 2. Comparison of Strategy Costs for 100-Year Storm Design Conditions under Various Climate Change Scenarios

	CC scenario		
Strategy	Low	Moderate	High
2	$485,000,000	$486,200,000	$487,600,000
4	$191,200,000	$191,200,000	$191,200,000
5	$217,240,000	$217,360,000	$217,450,000

Note: 2 = storage; 4 = separation; 5 = LID and separation.

Table 3. Net Benefits and Costs for the Underground Storage Strategy

CC scenario	Benefits	Costs	Net Benefits
Low	$721,500,000	$536,600,000	$184,900,000
Moderate	$731,300,000	$540,200,000	$191,200,000
High	$744,000,000	$543,900,000	$200,100,000

scenarios because it is the least expensive for each scenario and meets the performance standards for each scenario. The results may have been different if other criteria such as flexibility, cobenefits, and no-regrets were considered.

Net Benefits Approach

Another evaluation approach is to select the alternative that maximizes the expected value of the net benefits of adaptation. Benefits are defined as the costs of the damages that would be avoided as compared to the No Action plan. Costs include the same costs as in the design storm approach as well as the costs of the residual damages. A similar analysis as for the design storm approach was employed for each adaptation alternative strategy; the benefits and costs associated with the frequency of each event and each scenario were determined and then integrated for each scenario.

Damages avoided include any reductions in volumes flowing through the CSO facility and to Deer Island WWTP, and any reductions in hazardous flooding. The costs and hence values of flows through the CSO facility and the WWTP have been described above. Hazardous flooding damages cover all expenses incurred due to building structural damage, damage to contents in basements, and costs to pump out combined sewage and clean and disinfect basements. Costs for structural and content damage are based on the Army Corps of Engineers relationship tables (U.S. Army Corps of Engineers 2003). Pump-out, cleaning, and disinfection costs are based on costs from commercial services (Caputo 2011). Assumptions were made to estimate the number of houses affected by flooding and how much flooding occurred by estimating the number of buildings flooded by the 100-year and 10-year storms. No hazardous flooding occurred under the 3-month storm. Then, given an assumed footprint of each building, the average depth of flooding in each building was determined assuming all the hazardous flooding flowed into basements.

As an example, the expected value and discounted benefits and costs for the Underground Storage strategy are in Table 3. The costs for Underground Storage are greater than those of the design storm approach because they include the residual damages as well as the capital and operation and maintenance costs. The results in Table 3 exhibit benefit-cost ratios of approximately 1.3 for all the climate change scenarios. Table 4 compares the net benefits of all the alternatives and the costs of the system vulnerability.

Table 4 illustrates that Strategy 4, sewer separation, is the most beneficial strategy when analyzed using the net benefits approach because this strategy has the highest net benefits for all climate change scenarios. This result is consistent with the result obtained from the design storm approach. Again, the results may have been different if other criteria such as flexibility, cobenefits, and no-regrets were considered.

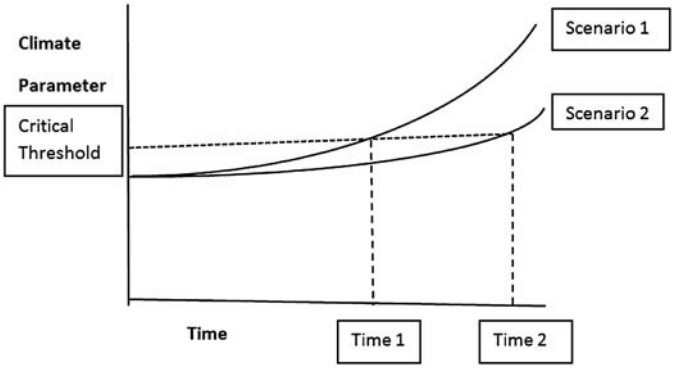


Fig. 10. Range of time for obtaining critical threshold given two climate change scenarios

Conclusions and Recommendations for Further Research

This paper has presented and illustrated a vulnerability assessment and an evaluation of adaptation strategies for the impacts of climate change upon urban drainage flooding and CSOs. The vulnerability assessment showed that the design metrics for hazardous flood volumes and CSO discharges are exceeded under present climate conditions and an envelope of future climate change scenarios. Thus, adaptation actions are required. Four adaptation strategies were defined, and the performance of each of these strategies over each climate change scenario was evaluated using least cost and risk-based net-benefits approaches. For this particular case study, sewer separation over the next decade was found to be the most favorable adaptation strategy. Using both evaluation approaches, it performed the best over all the climate change scenarios compared to the other strategies.

The case study illustrates aspects of vulnerability and adaptation planning for managing drainage and CSO infrastructure. Because the approach used in this paper is limited to the direct economic damages of the flooding, it does not explicitly include other criteria such as flexibility, cobenefits, or resilience. It also does not consider other associated impacts, such as disease, lost economic activity due to temporary lack of access to commercial and industrial facilities, and decrease in response of emergency services due to street flooding. Impacts such as these and other socioeconomic and biophysical factors can also be considered in a similar manner if suitable metrics are quantified. If quantification is not possible, then qualitative descriptions can be used. Climate surprises were also not considered. This could have been done by evaluating the strategies for the higher extremes in Fig. 4.

Evaluation of the adaptation strategies in the case study assumes that the adaptation actions are implemented in preselected times in the future. This is not the case with *prepare and monitor* adaptation

Table 4. Comparison of Net Benefits for All Strategies

	CC scenario		
Strategy	Low CC	Moderate CC	High CC
1. No action	−$746,200,000	−$756,200,000	−$769,100,000
2. Underground storage	$184,900,000	$191,200,000	$200,100,000
3. LID	−$944,300,000	−$954,300,000	−$959,700,000
4. Sewer separation	$549,000,000	$559,200,000	$572,300,000
5. Sewer separation and LID	$519,500,000	$529,300,000	$542,000,000

strategies in which adaptation options are preserved and actions are taken when designated climate change trigger points or thresholds are reached. Examples of such strategies for coastal flooding protection in Boston Harbor under rising sea levels are given by Douglas et al. (2013). Because the present evaluation uses climate change scenarios, only the possible range of time over which an adaptation action should be taken can be obtained from such an analysis. This is conceptually shown in Fig. 10. The authors are currently testing an adaptation planning approach where the evaluation of a *prepare and monitor* strategy is applied to the time period when a critical threshold is reached under a climate change scenario.

Of course, implementation of adaptation strategies which are dependent upon reaching thresholds related to climate change assumes that it is possible to define and identify when the climate change has occurred, e.g., when has the 10-year storm increased by 5 cm. Implementing an adaptation strategy too soon can result in an inefficient investment; implementing it too late can result in extra damages. Vogel et al. (2013) describe a more complete statistical analysis that outlines the importance of considering the likelihood of both underpreparation and overpreparation, and Rosner et al. (2014) introduce a combined statistical and decision analysis approach that begins to address adaptation decisions in this setting. Research is also continuing on this approach.

Acknowledgments

This research was supported by U.S. National Oceanic and Atmospheric Administration (NOAA) Sectoral Applications Research Program Grant Number NA07OAR4310373, Guidance Tools for Planning and Management of Urban Drainage Systems under a Changing Climate. The first author was also partially supported by the U.S. Army Corps of Engineers Institute for Water Resources. We appreciate the information provided for the case study by Vithal Deshpande, the Massachusetts Water Resources Authority, Robert King, William Pisano, and Owen O'Riordan. The four anonymous reviewers and the editors provided extremely helpful comments.

References

Auld, H., MacIver, D., and Klassen, J. (2006). "Adaptation options for infrastructure under changing climate conditions." Adaptation and Impacts Research Division (AIRD) Environment, Canada.

Brekke, L., White, K., Olsen, R., Townsley, E., Williams, D., and Hanbali, F. (2011). "Addressing climate change in long-term water resources planning and management." U.S. Army Corps of Engineers and U.S. Dept. of the Interior, Washington, DC.

Brown, C., Werick, W., Leger, W., and Fay, D. (2011). "A decision-analytic approach to managing climate risks: Application to the upper great lakes." *J. Am. Water Resour. Assoc.*, 47(3), 524–534.

Caputo, L. (2011). "Robust stormwater management strategies under climate change: A case study in Somerville, Massachusetts." M.Sc. thesis, Tufts Univ., Medford, MA.

Carlson, C., Barreteau, O., Kirshen, P., and Foltz, K. (2014). "Stormwater as a public good provision problem: A new perspective of low impact development (LID) for urban stormwater management practices under climate change." *J. Water Resour. Plann. Manage.*, in press.

CDM. (1974). "Report on improvements to the sewer system." Somerville, MA, 140.

City of Somerville. (2011). "About Somerville." ⟨http://www.somervillema.gov/about-somerville⟩ (Aug. 21, 2011).

Cromwell, J., and McGuckin, R. (2010). "Implications of climate change for adaptation by wastewater and stormwater agencies." *Climate Change Impacts on Water and Research Needs Workshop*, Denver, CO.

Daigger, G. (2009). "Urban water and wastewater management in 2050." *Proc., ASCE World Environmental and Water Resources Congress*, Kansas City, MO.

Dessai, S., and Hulme, M. (2004). "Does climate adaptation policy need probabilities?" *Clim. Pol.*, 4(2), 107–128.

Douglas, E., Kirshen, P., Watson, C., and Wormser, J. (2013). "Preparing for the rising tide." The Boston Harbor Association, Boston, MA.

Gersonius, B., Ashley, R., Pathirana, A., and Zevenbergen, C. (2013). "Climate change uncertainty: Building flexibility into water and flood risk infrastructure." *Clim. Change*, 116(2), 411–423.

Groves, D. G., and Lempert, R. J. (2007). "A new analytic method for finding policy-relevant scenarios." *Global Environ. Change*, 17(1), 73–85.

Haasnoot, M., Middelkoop, H., Offermans, A., van Beek, E., and van Deursen, W. (2012). "Exploring pathways for sustainable water management in river deltas in a changing environment." *Clim. Change*, 115(3–4), 795–819.

Hall, J., Lempert, R., Keller, K., Hackbarth, A., Mijere, C., and McInerney, D. (2012). "Robust climate policies under uncertainty: A comparison of robust decision making and info-gap methods." *Risk Analysis*, 32(10), 1657–1672.

Hallegatte, S., Henriet, F., and Corfee-Morlot, J. (2011). "The economics of climate change impacts and policy benefits at city scale: A conceptual framework." *Clim. Change*, 104(1), 51–87.

Heaney, J., and Sansalone, J. (2009). "Urban stormwater management in 2050." *ASCE Proc., World Environmental and Water Resources Congress*, ASCE, Reston, VA.

Interagency Climate Change Adaptation Task Force. (2011). "Federal actions for a climate resilient nation." *Progress Rep.*, Washington, DC.

Intergovernmental Panel on Climate Change. (2012). "Managing the risks of extreme events and disasters to advance climate change adaptation." *A Special Rep. of WG I and II*, C. Field, et al., eds., Cambridge University Press, Cambridge, U.K.

Kharin, V., Zwiers, F., Zhang, X., and Wehner, M. (2013). "Changes in temperature and precipitation extremes in the CMIP5 ensemble." *Clim. Change*, 119(2), 345–357.

Kiparsky, M., Milman, A., and Vicuna, S. (2012). "Climate and water: Knowledge of impacts to action on adaptation." *Ann. Rev. Environ. Resour.*, 37(1), 163–194.

Kirshen, P., Knee, K., and Ruth, M. (2008a). "Adaptation to sea level rise in metro Boston." *Clim. Change*, 90(4), 453–473.

Kirshen, P., Merrill, S., Slovinsky, P., and Richardson, N. (2012). "Simplified method for scenario-based risk assessment adaptation planning in the coastal zone." *Clim. Change*, 113(3–4), 919–931.

Kirshen, P., Watson, C., Douglas, E., Gontz, A., Lee, J., and Tian, Y. (2008b). "Coastal flooding in the northeastern USA due to climate change." *Mitigation Adaptation Strategies Global Change*, 13(5–6), 437–451.

Kousky, C., Rostapshova, O., Toman, M., and Zeckhauser, R. (2009). "Responding to threats of climate change mega-catastrophes." Resources for the Future Faculty Research Working Paper Series, ⟨http://www.rff.org/RFF/Documents/RFF-DP-09-45.pdf⟩.

Lempert, R., and Groves, D. (2010). "Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American West." *Technol. Forecasting Social Change*, 77(6), 960–974.

Massachusetts Dept. of Environmental Protection (MassDEP). (2008). "Structural BMP specifications for the Massachusetts stormwater handbook." Chapter 2, *Massachusetts stormwater handbook*, Vol. 2, Commonwealth of Massachusetts, Boston, MA, 133.

Matthews, J., Wickel, B., and Freeman, S. (2011). "Converging currents in climate-relevant conservation: Water, infrastructure, and institutions." *PLoS Biol.*, 9(9), e1001159.

Millar, C., Stephenson, N., and Stephens, S. (2007). "Climate change and forests of the future: Managing in the face of uncertainty." *Ecol. Appl.*, 17(8), 2145–2151.

Milly, P., Betancourt, J., Falkenmark, M., Hirsch, R., Kundzewicz, Z., Lettenmaier, D., and Stouffer, R. (2008). "Stationarity is dead: Whither water management?" *Science*, 319(5863), 573–574.

Nakicenovic, N., and Swart, R., eds., (2000). *Special Rep. on Emission Scenarios*, Cambridge University Press, U.K., 570.

National Research Council. (2009). "Informing decisions in a changing climate." National Academies Press, Washington, DC.
Novotny, V., and Brown, P. (2007). "Cities of the future: Towards integrated sustainable water and landscape." *Proc., Int. Workshop*, IWA Publishing, London.
Olsson, J., Amaguchi, H., Alsterhag, E., Dåverhög, M., Adrian, P., and Kawamura, A. (2013). "Adaptation to climate change impacts on urban storm water: A case study in Arvika, Sweden." *Clim. Change*, 116(2), 231–247.
Powell, A. (2008). "An analysis of the change of design storms due to future climate predictions." M.S. thesis, Univ. of Colorado, Boulder, CO, 95.
Ray, P., Kirshen, P., and Watkins, D. (2012). "Staged climate change adaptation planning for water supply in Amman, Jordan." *J. Water Resour. Plann. Manage*, 10.1061/(ASCE)WR.1943-5452.0000172, 403–411.
Reeder, T., and Ranger, N. (2011). "How do you adapt in an uncertain world? Lessons from the Thames Estuary 2100 Project." *World Resources Rep.*, Washington, DC, ⟨http://www.worldresourcesreport.org⟩.
Roseen, R., Janeski, T., Houle, J., Simpson, M., and Gunderson, J. (2011). "Forging the link, linking the economic benefits of low-impact development and community decisions." The UNH Stormwater Center, Univ. of New Hampshire, Durham, NH.
Rosenberg, E., et al. (2010). "Precipitation extremes and the impacts of climate change on stormwater infrastructure in Washington State." *Clim. Change*, 102(1–2), 319–349.
Rosner, A., Vogel, R., and Kirshen, P. (2014). "A risk-based approach to flood management decisions in a nonstationary world." *Water Resour. Res.*, 50(3), 1928–1942.
Snover, A., et al. (2007). "Preparing for climate change: A guidebook for local, regional, state governments." ICLEI, Oakland, CA.
Stakhiv, E. (2010). "Practical approaches to water management under climate change uncertainty." *Workshop on nonstationarity, hydrologic frequency analysis, and water management*, R. Olsen, J. Kiang, and R. Waskom, eds., Colorado Water Institute, Fort Collins, CO.
TheBostonChannel.com. (2010). "Floods trap cars in rising waters; Police headquarters evacuated." ⟨http://www.thebostonchannel.com/weather/24209833/detail.html⟩ (Sep. 3, 2011).
Titus, J., et al. (2009). "Coastal sensitivity to sea-level rise: A focus on the mid-Atlantic region." *Synthesis and analysis product 4.1*, U.S. Climate Change Science Program and the Subcommittee on Global Change Research, Washington, DC.
U.S. Army Corps of Engineers. (2003). "Economic guidance memorandum (EGM) 04-01, generic depth-damage relationships for residential structures with basements." *CECW-PG 10*, Washington, DC.
U.S. Environmental Protection Agency (USEPA). (1995). "Combined sewer overflows: Guidance for long-term control plan." *EPA/832-B-95-002*, Office of Wastewater Management, Washington, DC.
U.S. Environmental Protection Agency (USEPA). (2010). "Climate change vulnerability assessments: A review of water utility practices." *EPA 800-R-10-001*, Office of Water.
Vermeer, M., and Rahmstorf, S. (2009). "Global sea level linked to global temperature." *Proc. Natl. Acad. Sci.*, 106, 21527–21532.
Vogel, R. M., Rosner, A., and Kirshen, P. (2013). "Brief communication: Likelihood of societal preparedness for global change." *Nat. Hazards Earth Syst. Sci. Discuss.*, 1(1), 1–13.
Wang, T., and de Neufville, R. (2006). "Identification of real options 'in' projects." *16th Annual Int. Symp. of the Int. Council on Systems Engineering (INCOSE)*, International Council on Systems Engineering, San Diego, CA.
Water Environment Research Foundation (WERF). (2009). "Implications of climate change for adaptation by wastewater and stormwater agencies." *CC2R08*, Stratus Consulting and MWH Global, Alexandria, VA.
Water Utility Climate Alliance. (2009). "Options for improving climate modeling to assist water utility planning for climate change." ⟨http://www.wucaonline.org/html⟩ (Dec. 30, 2012).
Yohe, G., and Leichenko, R. (2010). "Chapter 2: Adopting a risk-based approach." Vol. 1196, Annals of the New York Academy of Sciences, New York, 29–40.
Zhou, Q., Mikkelsen, P., Halsnæs, K., and Arnbjerg-Nielsen, K. (2012). "Framework for economic pluvial flood risk assessment considering climate change effects and adaptation benefits." *J. Hydrol.*, 414–415, 539–549.
Zoltay, V., Vogel, R., Kirshen, P., and Westphal, K. (2010). "Integrated watershed management modeling: A generic optimization model applied to the Ipswich river basin." *J. Water Resour. Plann. Manage*, 10.1061/(ASCE)WR.1943-5452.0000083, 566–575.

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

2016 INDIVIDUAL SECTION AWARDS

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Rosabeth Moss Kanter For the:

_____ CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

_____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

_____ GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

_____ CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

_____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

XXX JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

_____ YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

Harvard Business School, Soldiers Field, Boston, MA 02163

Is this a re-nomination? Yes _____ No X

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Bruce Jacobs Daytime Telephone: 617-308-7074 Email: bjacobs@enviroinsite.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

Dr. Rosabeth Moss Kanter's recently published *Move: Putting America's Infrastructure Back in the Lead* lays out the sad state of today's transportation infrastructure and provides a vision for its restoration. America, she notes "has neglected or underinvested in some critical aspects of transportation and infrastructure." With numerous examples, she describes a country where commuters, manufacturers, and clients of public transportation face innumerable delays with consequent negative effects on the quality of life and the country's economic viability. Kanter provides a vision for addressing our infrastructure woes that includes regional and local initiatives, public-private partnerships, and implementation of innovative technology and practices. Achieving this vision, she says will require both courageous leadership ready to do the right thing and an informed and empowered citizenry. Dr. Kanter has used her considerable persuasive powers to attract the public's attention as noted by an appearance with John Stewart on the Daily Show and reviews of her book in the Boston Globe, New Yorker, the New York Times, and the Wall Street Journal.

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

2016 INDIVIDUAL SECTION AWARDS

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Kathleen Malone For the:

_____ CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

_____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

_____ GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

_____ CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

_____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

_____ JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

X PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

_____ YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

Derby Academy, 56 Burditt Ave, Hingham, MA 02043

Is this a re-nomination? Yes _____ No X

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Kayla Arruda Daytime Telephone: 774-451-1722 Email: kayla.arruda@stantec.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

BSCES 2016 INDIVIDUAL SECTION AWARD NOMINATION
PRE-COLLEGE EDUCATOR AWARD – KATHLEEN MALONE

In early December, I was put in contact with Kathleen Malone through the BSCES Outreach Committee when I volunteered to be a Model Bridge Competition mentor. Kathleen is the Math Enrichment Coordinator at the Derby Academy in Hingham, and her entire fifth grade class participates in the Model Bridge Competition. I joined 5B, one of the three sections of fifth grade students, 5B, for their engineering class each Friday around lunchtime. I immediately found it hard to believe that Kathleen's students were only in fifth grade. She sets high standards for her kids and empowers them to reach those standards through engaging lessons and productive group work sessions. She has successfully mimicked the engineering process in her classroom by placing an emphasis on teamwork, defining and identifying problems, and also having the flexibility to refine solutions as the design is tested. She stresses to her students that they must follow the blueprints that they created, but that things don't always go according to plan and that engineers must learn from their mistakes and adapt.

Kathleen is resourceful. As her mentor, I felt like she fully utilized the opportunity to have an engineer in her classroom as I was very involved in the kids' bridge designs. She would often put me on the spot in front of the entire class and say, "Well, Kayla, you're an engineer – what do you think? Have you ever solved a problem like this before?" In addition to moments like that, Kathleen and I coordinated a field trip in February to a nearby bridge, the Fore River Bridge. She facilitated the trip, ensuring that the students knew what to expect and that they would be attentive listeners. We used the concept of a moving classroom and spoke about the bridge while we were on the bus, so the students had to focus in a setting that they're used to singing/goofing around in. The field trip was a success and all of the teachers and students found it to be tremendously valuable. The others teachers that I met from Derby also spoke of Kathleen with such esteem and appreciation for how she has embraced teaching STEM at the school.

Kathleen also has her entire sixth grade class participate in the Future Cities Competition, so she has her hands full with engineering projects. I think that all of Kathleen's students will find themselves at an advantage when they (hopefully) decide to pursue engineering due to the experiences that they have in her classroom. Kathleen Malone is an excellent educator and deserves the BSCES Pre-College Educator Award.

Please feel free to contact me with any questions by email at kayla.arruda@stantec.com or by phone at (774)451-1722.

Sincerely,

Kayla Arruda

Kayla Arruda

Stantec

2016 INDIVIDUAL SECTION AWARDS

Boston Society of Civil Engineers Section
American Society of Civil Engineers

Each year, BSCES presents awards to deserving individuals in the Section or in the community who are nominated by their peers in recognition of their service. **Here is your opportunity to nominate a co-worker, friend, or someone who you think deserves special recognition.** To submit a nomination, complete this form and return it to:

BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE,
The Engineering Center, One Walnut Street, Boston, MA 02108-3616

The Nominations Deadline is **Monday, May 16, 2016**. The Awards Committee will review all nominations and present a list of candidates for selection by the Board of Government at their May meeting. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall.

I would like to nominate Alyson Stuer, EIT For the:

_____ CITIZEN ENGINEER AWARD: This award is presented to a BSCES member or registered professional engineer for outstanding public involvement in local or national legislation, education (at any level), non-profit volunteer organizations, community activities, or similar activities improving the image of ASCE, BSCES and the civil engineering profession.

_____ LESTER GAYNOR AWARD: This award is presented to a BSCES member or registered professional engineer for part-time elected or appointed service as a city or town official, whose reimbursement for this service has not been more than an honorarium.

_____ GOVERNMENT CIVIL ENGINEER AWARD: This award is presented to a BSCES member who is serving as a paid public sector engineer at a federal, state, or municipal agency, department, or authority in Massachusetts.

_____ CLEMENS HERSCHEL AWARD: This award recognizes those individuals who have published papers, not necessarily published in the BSCES Journal, that have been useful, commendable, and worthy of grateful acknowledgment. If nominating for the Clemens Herschel Award, please attach the name of the paper and names of all authors, if co-authored.

_____ RALPH HORNE AWARD: This award is presented to a BSCES member or registered professional engineer for unpaid public service in a municipal, state or federal-elected or appointed post for philanthropic activities in the public interest.

_____ JOURNALISM AWARD: This award is to be presented to a member of the media who reports on engineering topics, particularly civil engineering, in a manner that benefits the profession. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ PRE-COLLEGE EDUCATOR AWARD: This award is to be presented to a member of the K-12 educational community who integrates engineering topics, particularly civil engineering, in a manner that benefits the profession and may promote students to pursue an engineering career. The Public Awareness and Outreach Committee reviews these nominations and recommends the recipient to the Board.

_____ TECHNICAL GROUP AWARD: This award is given for papers which have been presented at a Technical Group meeting or for papers that were submitted to a Technical Group for review and recommended for publication by its Executive Committee. Each paper should be original (i.e., not contributed or published elsewhere). This award is open to all BSCES members.

X YOUNGER MEMBER AWARD: This award is intended to recognize a member, 35 years of age or younger on February 1 in the year of the award, who has made an outstanding contribution to BSCES.

Name and Company Address of Nominee(s)*:

Alyson Stuer, C&C Consulting Engineers, 214 Lincoln St, Boston MA, 02134

Is this a re-nomination? Yes _____ No X

**Please attach a brief (no more than one page) explanation of the candidate's qualifications for nomination.*

Your Name: Cara Pirkey Daytime Telephone: 617-532-2257 Email: cpirkey@hntb.com

NOTE: *If you nominated someone last year who was not selected, you may re-nominate the individual(s).*

QUESTIONS: *Contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.*

May 11, 2016

BSCES Awards Committee,
The Engineering Center
1 Walnut Street
Boston, MA 02108

Dear Mr. Jacobs,

It is my extreme pleasure to nominate Alyson Stuer, E.I.T for the 2016 Boston Society of Civil Engineers Section Younger Member of the Year Award. Ms. Stuer received her Bachelors Degree from Worchester Polytechnic Institute (WPI) in 2009 and her Masters from Northeastern University in 2013. She became involved with the ASCE Student Chapter during her time at Northeastern, focusing her efforts on outreach and STEM activities. Her passion for helping the youth learn about STEM transferred to her professional life, where she has participated in Girl Scout Day at WPI, Cambridge Science Festival, Future City, conducts bridge tours, and multiple other events.

For the FY 2015- 2016, Ms. Stuer was elected Vice Chair of the Younger Member Group (YMG). While working closely with her this past year as Chair of the Younger Member Group, I can personally say that her passion for the Civil Engineering Profession is contagious and she truly enjoys participating in this organization. During this Fiscal Year, the YMG applied (and won) a Student Transition Activity (STAY) Grant, in which Ms. Stuer volunteered to organize. This involved getting the local college students and professionals together for a night of networking and mentoring, she formed a small committee and even created a Resource Handbook for the students, which comprised of "what I wished I knew before I entered the professional world" type information, licensures, office etiquette, and ASCE/BSCES information. The evening was a huge success with many students signing up for ASCE/BSCES memberships and bonding between the students and professionals.

As you can see, Ms. Stuer shines greatly when it comes to outreach and the civil engineering society, she is accountable and always ready to help and deserves to be recognized for her efforts. I appreciate your time in reviewing this nomination, Ms. Stuer comes highly recommended from all of her peers. If you have any questions, feel free to email me at CPirkey@HNTB.com

Sincerely,
Cara Pirkey, EIT
2015-2016 BSCES YMG Chair

Boston Society of Civil Engineers Section
American Society of Civil Engineers

2016 EMPLOYER RECOGNITION AWARDS

To Publicly Reward Employers for Exemplary Employee Support

The Boston Society of Civil Engineers Section of the American Society of Civil Engineers Awards Committee invites you to nominate an organization to receive the* Small Employer Recognition Award *or the* Large Employer Recognition Award*. Please see the following awards description and page 2 of this form for nomination instructions. To be eligible to receive this award your award nomination must be received by the BSCES Awards Committee no later than Monday, May 16, 2016.

As a means of fostering participation in Society activities, the Boston Society of Civil Engineers Section/ASCE has established an award to recognize those employers who encourage their engineers to actively participate in ASCE and BSCES. Special recognition will go to those organizations who exhibit exemplary support as evidenced by:

- **Providing a model for involvement through organization-wide participation in local, regional, and national ASCE and BSCES activities.**
- **Allowing engineers time off to attend ASCE and BSCES meetings and seminars.**
- **Being sponsors of ASCE and BSCES meetings/ seminars or being sponsors of the BSCES Newsletter.**
- **Supporting and encouraging technical and professional growth.**
- **Encouraging engineers to prepare articles for publication in the BSCES Newsletter or ASCE and BSCES professional and technical journals.**
- **Assisting in the payment of ASCE and BSCES dues.**

Members who want their organization to be considered for recognition should fill out the attached nomination form which describes their organization's level of support to ASCE and BSCES. The awards committee will review the nominations and select an exemplary small employer and a large employer in the Section. Organizations with less than 50 employees are eligible for the Small Employer Award. Awards will be presented at the 168th BSCES Annual Awards Dinner in the fall. Successful recipients will be considered for endorsement as potential (future) applicants for the ASCE Employer Recognition Award. No organization will be eligible to receive the award in consecutive years.

NAME OF EMPLOYER: Green International Affiliates, Inc.

Boston Society of Civil Engineers Section/ASCE

2016 EMPLOYER RECOGNITION AWARDS

Complete and return this nomination form and attachment to the BSCES Awards Committee no later than Monday, May 16, 2016 to be eligible for the award.

Nominator/Title:	Peter A. Richardson, P.E., Vice President		
Address:	239 Littleton Road, Suite 3, Westford, MA 01886		
Telephone:	978-923-0400	**Email:**	prichardson@greenintl.com
Signature:	Peter A. Richardson	**Date:**	May 11, 2016
Employer:	Green International Affiliates, Inc.		
Contact Person:	Peter A. Richardson, P.E.		
Title:	Vice President		
Office Address:	239 Littleton Road, Suite 3, Westford, MA 01886	**Website:**	www.greenintl.com
Telephone:	978-923-0400	**Email:**	prichardson@greenintl.com

Please answer the following questions:

How many employees do you have?	84	
How many are civil engineers?	42	
How many civil engineers are members of ASCE? **BSCES?**	18	16
How many times in the last year have you provided sponsorship of BSCES meetings/seminars or sponsorship of the BSCES Newsletter?	2	
Please attach a list of ASCE and BSCES Members in your organization.		

For those engineers who are ASCE and BSCES Members, please answer the following questions:

What percentage of ASCE and BSCES dues are paid by the employer?	100%
Does the employer pay for subscriptions to ASCE and BSCES technical or professional journals?	Yes
On average, how many Technical/Professional seminars (one day or longer) does each of your engineers attend annually?	1
Does the employer allow time for members to attend ASCE and BSCES activities?	Yes
How many technical/professional articles were published by your engineers within the last two years?	6

How many of your engineers are active on an:

BSCES Board of Government	0
BSCES Technical Group or Committee	4
ASCE Regional (District) Council	0
ASCE National Committee	1

Please attach one 8.5 x 11 inch sheet (double sided) and describe any specific activities or policies which demonstrate your organization's support for involvement in ASCE and BSCES.

Please return this completed form and the additional page if needed no later than Monday, May 11, 2015 to: BSCES Awards Committee, Boston Society of Civil Engineers Section/ASCE, The Engineering Center, One Walnut Street, Boston, MA 02108-3616. For questions contact BSCES Awards Committee Chair Bruce Jacobs at (617) 879-0253 or bjacobs@hydroanalysisinc.com.

Thank you for your continued support of ASCE and BSCES.

Current ASCE and BSCES Members
Green International Affiliates, Inc.

Prefix	First Name	Last Name	Credentials	Member Grade
Mr.	Erik	Atkins	P.E., M.ASCE	MEMBER
Mr.	Stephen	Bibinski	EIT, A.M.ASCE	ASSOCIATE
Ms.	Tiffany	Card	EIT, A.M.ASCE	ASSOCIATE
Mr.	Marc	Caufield	P.E., M.ASCE	MEMBER
Mr.	Michael	Cruz	P.E., M.ASCE	MEMBER
Mr.	Gabe	Gabrielli	P.E., M.ASCE	MEMBER
Mr.	Ko	Ishikura	P.E., M.ASCE	MEMBER
Mr.	Aniket	Mahajan	EIT, A.M.ASCE	ASSOCIATE
Mr.	Marvin	Miller	P.E., F.ASCE	FELLOW
Ms.	Cindy	Noret	EIT, A.M.ASCE	ASSOCIATE
Ms.	Kamila	O'Neill	EIT, M.ASCE	MEMBER
Mr.	Tony	Qu	EIT, M.ASCE	MEMBER
Mr.	Peter	Richardson	P.E., M.ASCE	MEMBER
Mr.	William	Scully	P.E., M.ASCE	MEMBER
Mr.	Ripal	Shah	P.E., M.ASCE	MEMBER
Mrs.	Danielle	Spicer	P.E., M.ASCE	MEMBER
Mr.	Frank	Tramontozzi	P.E., M.ASCE	MEMBER
Ms.	Olga	Vershinina	S.M.ASCE	STUDENT

ASCE and BSCES Member
ASCE Member only
Note: Aniket Mahajan has not yet paid 2016 Dues

Green's Involvement and Support of ASCE and BSCES

Green International Affiliates, Inc. (Green) supports its employees' involvement in professional societies and our senior management strongly encourages staff members at all levels to get involved with business organizations relevant to their respective disciplines. In particular, dues are reimbursed and time and expenses for attendance at meetings are fully compensated.

Green has been especially supportive of BSCES and the important work it does. We have on staff a number of individuals who actively participate in BSCES, including two past presidents, Peter A. Richardson (2012 to 2013) and Danielle Spicer (2010 to 2011). Peter served in this role while at Green and we fully supported the work he did for the organization and assisted him as needed in carrying out his responsibilities. With a staff of 84, including 42 civil engineers, this level of participation is exceptional. Below is a listing of our current personnel who have been involved in BSCES over the past year and the activities in which they have participated:

Peter Richardson

- Serve on ASCE's Committee for Sustainability Committee's Strategic Communications Subcommittee developing criteria for a Section and Branches level Sustainability Award.
- Serve on the BSCES Government Affairs and Professional Practice Committee: attended Engineers and Land Surveyors Day; helped develop Comprehensive Adaptation Management Plan briefing sheet; helped develop Infrastructure Investment brochure; and presented ASCE report card at State House briefing for Massachusetts Legislators and staff.
- Serve on BSCES Newsletter Committee and contributed several newsletter articles this past year (3 or 4).
- Served as Chair of the Nominating Committee.
- Serve on the BSCES Committee for Sustainability and helped develop criteria for BSCES Award.
- Member of the Programs Committee.
- Attended several BSCES Dinner Meetings.

Bill Scully

- Participate on the Transportation & Development Institute group.
- Chaired the subcommittee the past few years to plan/conduct the annual "Legislative Update" meeting. Worked with group to plan the Berger Seminar.
- Worked with group the past year in initiating several webinars sponsored by the T&DI.
- Attend monthly committee meetings and approximately 5 to 6 events (lunch or dinner meetings) per year.
- Attended Engineers and Land Surveyors Day at State House every year during the past 4 or 5 years.

Danielle Spicer

- Chair of the BSCES Membership committee with over 8 different meetings (all conference calls).
- Attended approximately 2 or 3 dinner events this past year.
- Participated last year and this year in Engineers and Land Surveyors Day at the State House.

Michael Cruz

- Participated in BSCES Structural Engineering Institute Boston Chapter
- Served on the Membership Subcommittee for SEI, participating in 12 monthly meetings and creating a membership survey.
- Attended all six of the 2015 Fall Lecture Series: Wicked Fast Bridge Construction
- Attended 2 or 3 dinner events.

Green's Involvement and Support of ASCE and BSCES

Elisa Yung

- Have attended monthly YMG meetings starting in January 2016.
- Will be Social Co-Chair starting in July 2016.
- Volunteered as Judge at Future Cities.
- Helped plan and participated in BSCES Senior Night and helped create a Student Resource Guide Booklet.
- Volunteered at ASCE Steel Bridge and Concrete Canoe Competitions.
- Attended 2016 John Freeman Lecture.
- Attended The History of the MWRA Presentation.

Kamila O'Neill

- Volunteered in January for the Model Bridge Competition
- Volunteered in April for the Girl Scouts STEM conference with the Outreach committee
- Signed up to volunteer for the Infrastructure Day in Holyoke coming up in a little over a week
- Attended two of the SEI 2015 Fall Lecture Series: Wicked Fast Bridge Construction
- Volunteered as judged for the Mead Paper Presentation at Northeastern as part of the ASCE Student Conference

Marvin Miller

- Attended at least five luncheon and dinner meetings: Bertram Berger, Keville, etc.
- Served on the T&DI committee and co-chaired the last Bertram Berger Seminar.

Marc Caufield

- Attended the USING BRAIN BASICS webinar that was streamed here at Green on 10/21/15.

Olga Vershinina

- Attended 2 dinner meetings, and also volunteered once for the BSCES events.

Tony Qu

- Attended dinner meeting: Beyond the MassDOT Accelerated Bridge Program: Successfully Implementing Innovation
- Attended five of the 2015 Fall Lecture Series: Wicked Fast Bridge Construction
- Participated in BSCES-sponsored training course: FHWA-NHI-130-055 Safety Inspection of In-Service Bridges

John R. Freeman Fund Committee Annual Report for 2015-2016

Committee Members, 2016-2016:

E. Eric Adams (MIT)
Dominique N. Brocard (AECOM, Chair)
Stuart Caine (Alden Research Laboratory)
Steven Estes Smargiassi (MWRA)
Ferdi Hellweger (Northeastern University)
Karen Kelley (CDM)
Peter Shanahan (MIT)

Grants

No grants were awarded this year.

2016 Freeman Lecture

This year's Freeman Lecture, sponsored by BSCES' Environmental and Water Resources Institute was held on April 11, 2016. The topic was: **"Desalination for Water Supply, Is Energy Consumption Manageable?"** presented by Professor John Lienhard of MIT's Department of Mechanical Engineering. The lecture was attended by about 50 and its cost was approximately $ 7,000 (final bill not in yet).

A table with BSCE registration material was set up to encourage Lecture attendees to join BSCE.

Committee Meetings

The Committee met on several occasions via conference calls to discuss the Freeman Lecture and other matters.

A meeting attended by several Freeman Committee members was held with the BSCES Leadership on February 22, where Freeman Fund practices were discussed relative to BSCES Policies.

Respectfully submitted,

Dominique N. Brocard, Chair

Freeman Fund Budget – FY 16-18

Average value of Fund over past 3 years:		$310,000 (est)
Expense guideline:	4.5% of past 3 year average value of Fund:	$13, 950
Anticipated Expenses:	Freeman Lecture	$8,000
	Grants	$5,000
	Total	$13,000

LEGISLATIVE FELLOW COMMITTEE ANNUAL REPORT 2015 – 2016

I. Committee Members 2015-2016

David Westerling, PE, PLS, (Chair)
Dom D'Eramo, PE
William Lyons, PE
Anatoly Darov, PE,
Heather Ford, PE
Sudhir Murthy, PE,
Richard Keenan, TEC, BSCES Association Manager

II. Committee Meetings:

Several telcom meetings were held during the year to discuss webpage material other issues.

- A list of frequently asked questions about the Legislative Fellow process was composed and reviewed by the Committee.
- Our current BSCES Legislative Fellow, Mike Sullivan, will be stepping down at the end of this Legislative Session
- Applications for the next Legislative Fellow will be accepted in the Fall and a new Legislative Fellow will start at the beginning of the Legislative Session in January. 2017.

III. Seminars or Lecture Series:
None

IV. List of Members 2016-2017
David Westerling, PE, PLS, (Chair)
Dom D'Eramo, PE
William Lyons, PE
Anatoly Darov, PE,
Heather Ford, PE
Sudhir Murthy, PE,
Mike Sullivan, PE
Richard Keenan, TEC, BSCES Association Manager

Respectfully Submitted,
David Westerling, PE, PLS, Chair

Attach: Frequently Asked Questions LF

LEGISLATIVE FELLOW – FREQUENTLY ASKED QUESTIONS (FAQs)

1. **Q: What is a Legislative fellow?**
   A: A Legislative Fellow (LF) is a representative of the BSCES membership and functions as a technical resource at the Statehouse. The LF works at the Mass Statehouse, usually with the staff of the Joint Committee on Transportation and comments on current issues relating to the engineering profession that the legislature has identified. This can be a very wide net of issues; to date, most of the LF's attention has been on legislation in the transportation arena with lessor support on environmental project impacts. However, every session of the legislature is different and the issues vary greatly from session to session. The LF job is a cool job with great visibility within BSCES and the Statehouse! The prior LF's love to talk about their experiences and would welcome questions

2. **Q: Why should I apply and become an LF?**
   A: You get to go to the statehouse as often as you want and have an email address that allows you access to the Statehouse news – you are always in the know! Seriously, an LF can make a real difference by helping solve real world problems that the state is wrestling with. While serving as an LF, you come to really understand how state legislation is developed as well as have a definite impact on the shape of that legislation with your comments/expertise – you can affect the outcome. The LF is automatically the "expert" on many topics and your comments/input are sought after. It also provides an opportunity at public service and means to give back to the BSCES and the transportation profession.

3. **Q: How much time is involved in being an LF?**
   A: On average, 2 days a week should be spent actually working at the Statehouse. Some commitments, such as intermittent night meetings, committee meetings on an alternate day, or a critical time schedule, are beyond those two days, so we tell the LF to assume 20 hours per week.

   Further, BSCES asks that you prepare an article every quarter describing your experiences for the membership; and there is often a request to be part of a panel or make a presentation to a BSCES board. This "PR" allows others to understand the value of the position and allows the LF to let others know of the interesting work he/she is doing on behalf of BSCES.

4. **Q: How do I get work?**
   A: You will be located in the area of the House Chairman of the Joint Committee on Transportation. Upon your arrival, and sometimes in between, you will send out an "all statehouse" announcement that you have arrived, who you are, and that you are available for assignments. The response will be sufficient to keep you busy. In addition, some LF's have seen pending legislation, attended committees meeting and sought out those involved to offer expertise. You may also help the committee staff in preparing for and during public meetings of pending legislation. Some time is spent writing articles for the BSCES newsletter.

5. ***Q: I am not a transportation expert or an environmental expert – can I still be effective?***
   A: Yes, you are still most likely the most knowledgeable person in the room even if not within your area of expertise. However, the beauty of BSCES is that you can call on other members to provide specific expertise in an area that you may not have strong knowledge in. This network of other available engineers allows the LF to be a technical resource to the legislators, provide the broad services that the position needs and gives the LF a "sounding board" for proposed ideas.

6. **Q: Why should my company agree to let me work a reduced schedule? What's in it for them?**
   A: The overall experience of being an LF is so much richer than attending a training course or commenting on legislation after publication as a member of a specialty technical group. To actually review and comment on materials in real time is an amazing growth experience. You get a "ring-side seat" during transportation funding legislations and get a better understanding of the transportation priorities of both the Executive and Legislative branches of government. This experience will stick with the employee and cause them to view the engineering profession (and current employer) as a more motivated employee – the upshot is that an employee will most likely stay with its employer longer. Even with the LF time commitment, you will still be able to provide at least 2 to 3 days of work with your current employer.

   From the company's perspective, a commitment to keep critical work flowing with your reduced schedule would be important to emphasize. Also, you will need to have a discussion about the number of hours you will plan to work during this term period. Will there be any impact on your benefits, projects/work assigned, etc. Your employer is required to submit a statement as part of your application to indicate their support of this endeavor.

7. **Q: Do I have to be an active BSCES Member?**
   A: Yes, your dues and membership must be current. Further, you must be a Registered Engineer in the Commonwealth.

8. **Q: Do I get paid?**
   A: Yes, the position comes with a $15,000 stipend for 12 to 18 months of service – the exact number of months is a bit dependent on the legislative schedule as well as assignments given. For example, some LF's have served beyond their paid term to complete review of a report. BSCES asks that you divide the invoice for the stipend into 2 to 4 invoices to allow payment over the working period and not as a single lump sum amount.

9. **Q: What are other reasons to become an LF?**
   A: As an LF, you will make a difference! The work you will perform really matters and your expertise (in any engineering related matter) is a sought after skill by those in the Statehouse. In addition to an office space and availability of the statehouse news service, you will be able to take advantage of statehouse tours/orientation session, go to legislative conferences on a wide variety of current topics, sit in the Legislative Chamber, and meet the actual legislators and their

staff in person or just roaming the halls. You will have a renewed appreciation for the backdrop of how this Commonwealth's rules and regulations are prepared.

BSCES MEMBERSHIP COMMITTEE ANNUAL REPORT 2015 – 2016

I. Committee Officers 2015-2016

Danielle Spicer, P.E., Chair	Brian Morgan, P.E., member
Ellen White, PE, Vice Chair	Ali Touran, P.E., member
Anthony Richardson, PE, Secretary	Anni Autio, P.E., member
Bruce Jacobs, P.E., member	Reed Brockman, P.E., member
Chris Broyles, P.E., member	John Schoenfeld, P.E., member
Rob Musci, P.E., member	

Rich Keenan, member from TECET Staff	
Tony Puntin,P.E., member from TECET Staff	

II. Committee Meetings:

The Membership committee didn't begin its activity until December of 2015. We started out with 9 members and grew to 11. Since then, the committee has held eight (8) conference calls. The major achievements and initiatives of the committee include:

- Sent out two surveys (BSCES member survey and BSCES Non-Members. The surveys were sent out to better understand what our members value as a BSCES member as well as to gather info from ASCE members who are not BSCES members as to why they aren't members.
- Reviewed Results from survey in order to strategize how best to improve membership within BSCES
- Put together a presentation highlighting ASCE and BSCES membership benefits as well as what BSCES does for people to present to firms to further increase membership and potential activity within BSCES.
- Purchased merchandise (BSCES personalized pens) to use to give to presenters at all BSCES events.
- Continue strategizing different ways to increase membership and increase active involvement by volunteers.

IV. List of Officers 2016-2017

Danielle Spicer, P.E., Chair	Brian Morgan, P.E., member
, Vice Chair	Ali Touran, P.E., member
Anthony Richardson, PE, Secretary	Anni Autio, P.E., member
Bruce Jacobs, P.E., member	Reed Brockman, P.E., member
Chris Broyles, P.E., member	John Schoenfeld, P.E., member
Rob Musci, P.E., member	Ellen White, PE, member

Rich Keenan, member from TECET Staff	
Tony Puntin,P.E., member from TECET Staff	

Respectfully Submitted,
Danielle Spicer, P.E., Chair

NEWSLETTER ANNUAL REPORT
2015 - 2016

I. Summary

The BSCES Newsletter Editorial Board had a successful year achieving its goals of publishing engaging issues of *BSCESNews* each month that include content from each of its targeted monthly contributors, within budget.

II. BSCES Newsletter Editorial Board for the 2015 - 2016 Program (Fiscal) Year

1. Chair: Michael R. Cunningham, PE
2. Bonnie Ashworth
3. Ronald Burns, PE, LSP, LEED AP
4. John C. Cavanaro, PE
5. Richard F. Keenan
6. David M. Manugian, PE
7. Angus J. O'Leary, PE
8. Anthony M. Puntin, PE
9. Peter A. Richardson, PE, LEED AP, ENV SP, CFM
10. Matthew I. Shuman, PE
11. Christopher "Topher" Smith, PE
12. Ellen P. White, PE

III. Newsletter Board of Editors Meetings/Activities for the 2015-2016 Program (Fiscal) Year

The Newsletter Editorial Board met monthly during the year, typically on the first Wednesday of the month to determine the content of the monthly newsletters. All meetings were held by conference call. A total of ten newsletters were issued in September 2015, October 2015, November 2015, December 2015, January 2016, February 2016, March 2016, April 2016, May 2016, and June 2016. Well over 100 articles and news items were published during the course of the year.

Each issue of the *BSCESNews* was sponsored by a firm, focused loosely on a Special Theme for that month and highlighted a different BSCES Featured Group. The following table provides a summary of these elements for each issue:

Issue	Sponsoring Firm	Special Theme	Featured Group
September 2015	TranSystems Corporation	Transportation	Transportation & Development Institute Boston Chapter
October 2015	VHB	Sustainability	Committee on Sustainability
November 2015	Louis Berger	Structures	Structural Engineering Institute Boston Chapter
December 2015	McMillen Jacobs Associates	Energy	Geo-Institute Boston Chapter
January 2016	Jacobs	Project Delivery	Engineering Management Group
February 2016	Kleinfelder	Water Infrastructure	Environmental & Water Resources Institute Boston Chapter

Issue	Sponsoring Firm	Special Theme	Featured Group
March 2016	Stantec	Economic Outlook	Construction Institute Boston Chapter
April 2016	AECOM	Outreach & Volunteerism	Younger Member Group
May 2016	GZA GeoEnvironmental	Emergency Preparedness	Coasts, Oceans, Ports and Rivers Institute Boston Chapter
June 2016	Green International Affiliates, Inc.	State of Infrastructure	Government Affairs & Professional Practice Committee

This year we made changes to two monthly themes to better align with current industry trends and areas of focus. Transportation and State of Infrastructure were added in replacement of Transit Oriented Development and Financing Infrastructure.

The BSCES Executive Committee continues to discuss changing the newsletter from its current format consisting of an email containing a hyperlink to a PDF file located on the BSCES website to a more dynamic hypertext-based menu of articles. There is no consensus on this change, in part because the PDF format gives recipients the option to save and print out the newsletter and it consists of a traditional publication method.

The newsletter remained within budget. The success of the newsletter is due to the articles provided by members, the article solicitation and editing by the editorial board, and the support of The Engineering Center Education Trust.

III. BSCES Newsletter Editorial Board for the 2015 - 2016 Program (Fiscal) Year

1. Chair: Michael R. Cunningham, PE
2. Bonnie Ashworth
3. Ronald Burns, PE, LSP, LEED AP
4. John C. Cavanaro, PE
5. Richard F. Keenan
6. David M. Manugian, PE
7. Angus J. O'Leary, PE
8. Anthony M. Puntin, PE
9. Peter A. Richardson, PE, LEED AP, ENV SP, CFM
10. Matthew I. Shuman, PE
11. Charles W. Roberts, PE
12. Brian A. Morgan, Esq., LEED AP

Respectfully submitted to the BSCES Board of Government on May 6, 2016
Michael R. Cunningham, PE, Newsletter Board Chair

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

BSCES Nominating Committee Report
May 19, 2016

To: Ellen White, P.E., President, BSCES Board of Government

From: BSCES Nominating Committee:

Peter A. Richardson, P.E. (Chair)	Melissa Carter, P.E	Angela O'Donnell, P.E.
Reed Brockman, P.E	Michelle Cheung, P.E.	Chris Broyles, P.E.
Ali Touran, PhD, P.E.	Mathew Shuman, P.E.	Alyssa Marino Medina, P.E.

cc: Tony Puntin, P.E., BSCES Executive Director
Richard Keenan, BSCES Association Manager

The Nominating Committee nominates the following candidates to the 2016-2017 BSCES Board of Government. All nominated candidates are *subscribing members in good standing* with BSCES and ASCE and eligible to serve and fulfill all responsibilities as outlined by our Constitution and By-Laws. The consent of all nominees has been obtained.

1) Candidates for next year's Board of Government (Balloted or Continuing Term)

The Nominating Committee nominates the following candidates for the Board of Government.

Position	Current 2015-2016 Board of Governors	Recommended 2016-2017 Board of Governors Slate
Past President	Ali Touran, PhD, P.E., F. ASCE Northeastern University	**Ellen P. White, P.E.** **Patrick Engineering Group**
President	Ellen P. White, P.E. Patrick Engineering	**Brian A. Morgan, Esq., LEED AP** **CDM Smith Inc.**
President-Elect	Brian A. Morgan, Esq., LEED AP CDM Smith Inc.	**Malek A. Al-Khatib, P.E.** **Louis Berger Group**
Senior Vice President	Malek A. Al-Khatib, P.E. Louis Berger Group	**Geoffrey B. Schwartz, P.E.** **GZA GeoEnvironmental, Inc.**
Senior Vice President	Geoffrey B. Schwartz, P.E. GZA GeoEnvironmental, Inc.	**Richard D. Maher, P.E., PMP, LEED AP** **Perry Associates, LLC**
Vice President	Richard D. Maher, P.E., PMP, LEED AP Perry Associates, LLC	**Bruce L. Jacobs, PhD, P.E.,** **HydroAnalysis, Inc.**
Vice President	Bruce L. Jacobs, PhD, P.E., HydroAnalysis, Inc.	**Christopher "Topher" Smith, P.E.** **CDM Smith**
Secretary	Christopher "Topher" Smith, P.E. CDM Smith	**Charles Roberts, P.E.** **Childs Engineering**
Treasurer	Robert L. Leger, P.E. Massachusetts Port Authority *Note: Second Year of Two Year Term*	**Robert L. Leger, P.E.** **Massachusetts Port Authority** *Note: First Year of Two Year Term*
Assistant Treasurer *by board only; not on ballot*	Gregory L. Mirliss, P.E. AECOM USA, Inc.	**Gregory L. Mirliss, P.E.** **AECOM USA, Inc.**

BSCES
Boston Society of Civil Engineers Section
American Society of Civil Engineers

2) Candidates for next year's Technical Group Chairs (Balloted)

The Nominating Committee nominates the following candidates as Technical Committee Chairs.

Technical Group/Institute Chapter	Current 2015-2016 Chairs	Recommended 2016-2017 Chairs
Coasts, Oceans, Ports and Rivers Institute Boston Chapter	Lauren S. Klonsky, PE CDM Smith Inc.	**Ryan M. McCoy, PE** **Pare Corporation**
Construction Institute Boston Chapter	Daniel R. Cook, PE Simpson Gumpertz & Heger, Inc.	**Christopher P. Hersey** **Skanska**
Engineering Management Group	Kevin Garvey, PE CDM Smith, Inc.	**Michaela Bogosh, PE** **CDM Smith**
Environmental & Water Resources Institute Boston Chapter	Matt Hodge, PE Hodge.WaterResources, LLC	**Ron K. Burns, PE** **CHA**
Geo-Institute	John Davies, PE Hatch Mott McDonald	**Jennifer A. Jordan, PE** **JCK Underground, Inc.**
Structural Institute Boston Chapter	Peter M Keeping, PE HNTB Corporation	**Dennis J. Baker, PE** **HNTB Corporation**
Younger Members Group	Cara Pirkey, EIT HNTB Corporation	**Alyson Stuer** **C&C Consulting Engineers**
Transportation & Development Institute Boston Chapter	Todd M. Clark, PE Hoyle Tanner and Associates	**Bryan Zimolka, PE** **Howard/Stein-Hudson Associates**

3) Candidates for next year's Nominating Committee (Balloted)

The Nominating Committee nominates the following six candidates for three elected positions on next year's Nominating Committee (two year term).

Cara Pirkey, EIT HNTB Corporation	Alicia DiCecca Stantec
Todd M. Clark, PE Hoyle Tanner and Associates	Michael R. Cunningham, PE, Kleinfelder
Olivia Richards Gill Engineering	Gregory G. Robbins, P.E. GZA GeoEnvironmental, Inc.

The three most recent past presidents of BSCES also serve on the Nominating Committee in addition to the BSCES members who will be serving their final year in 2015-2016. These members are:

Past Presidents	***Members at Large & Year of Term***
Reed M. Brockman, PE (3rd Year)	Angela O'Donnell, P.E. (2nd Year)
Ali Touran, PhD, PE, F. ASCE (2nd Year)	Chris Broyles, P.E. (2nd Year)
Ellen White, P.E. (1st Year)	Alyssa Marino Medina, P.E. (2nd Year)

4) Candidates for BSCES Honorary Members (Board Approval Only)

This award is to go to "Persons of Eminent Engineering Attainment." Per Article 5, Section 1 of the BSCES By-Laws, the Nominating Committee may nominate one name for every 1,500 members of BSCES. Based on this criterion, the Nominating Committee may select up to two candidates based on membership for the 2015-2016 year.

The nominating committee recommends the following candidates for BSCES Honorary Members:

Former Governor Michael S. Dukakis: (Retired)
Judith Nitsch, PE, LEED AP BD+C: BSCES Past President and Founding Principal and Member, Board of Directors for Nitsch Engineering

Brief biographic information for both Governor Michael Dukakis and Judith Nitsch follows.

Michael Stanley Dukakis Dukakis graduated from Brookline High School (1951), Swarthmore College (1955), and Harvard Law School (1960). He served for two years in the United States Army, sixteen months of which he spent with the Support Group to the UN Delegation to the Military Armistice commission in Munsan, Korea. Dukakis began his political career as an elected Town Meeting Member in the town of Brookline. He was elected chairman of his town's Democratic organization in 1960 and won a seat in the Massachusetts legislature in 1962. He served four terms as a legislator, winning re-election by an increasing margin each time he ran. Dukakis won his party's nomination for governor in 1974, became Governor and is credited with digging Massachusetts out of one of its worst financial and economic crises in history. Dukakis was defeated in the Democratic Primary in 1978 by Edward King, but came back to defeat King in 1982 and was re-elected to an unprecedented third four-year term in 1986. In 1986 his colleagues in the National Governors Association voted him the most effective governor in the Nation. Dukakis won the Democratic nomination for the Presidency in 1988 but was defeated by George Bush. He served his final two years as governor at a time of increasing financial and economic distress in Massachusetts and the Northeast. After leaving office in January 1991, Dukakis and his wife, Kitty, spent three months at the University of Hawaii where Dukakis was a visiting professor in the political science department and at the School of Public Health. Since June of 1991, Dukakis has been a visiting professor at Northeastern University's political science department and has also taught in the senior executive program for State and Local managers at the John F. Kennedy School of Government at Harvard University. He has also taught for the past three years at Florida Atlantic University. His research has focused on national health care policy reform and the lessons that national policy makers can learn from state reform efforts. He has authored articles on the subject for the Journal of American Health Policy (1992); the Yale Law and Policy Review (1992); the New England Journal of Medicine (1992); and Compensation and Benefits Management (1993). In addition, he co-taught with Professor Rochefort a graduate seminar in national health policy reform that included a series of public forums and an all-day conference that culminated in the publication of Insuring American Health for the Year 2000, a Northeastern University publication that has been distributed widely to health policy makers, legislators and others. Kitty and Mike Dukakis have three children, John, Andrea, and Kara, and are the proud grandparents of Alexandra Jane Dukakis (Excerpt taken from Hellenic Resources Network)

Judy Nitsch is the founding principal of Nitsch Engineering. Her work over the past 40 years in the civil engineering field has focused on the design and management of site development and infrastructure-related projects. A graduate of Worcester Polytechnic Institute (WPI), Judy is a Registered Professional Engineer in 11 states. She received an Honorary Doctor of Engineering Degree from WPI in 2015, and an Honorary Doctor of Science Degree from the Massachusetts Maritime Academy in 2010.

Judy served on the Board of Directors of CREW Network (Commercial Real Estate Women) for five years and was the 2014 President of this national organization. Watch an interview with Judy about her involvement with CREW Network and its value for the industry here. She has also served as President of the American Council of Engineering Companies of Massachusetts and President of the Boston Society of Civil Engineers Section/ASCE.

In 1989, Judy was elected the first alumna member to WPI's Board of Trustees; she served as Chair of the Facilities and Campus Infrastructure Committee for 16 years. Judy serves on the board of the Greater Boston Chamber of Commerce and is co-chair of its Real Estate Development Committee. She is a Trustee of Eastern Bank, a member of the ULI Boston Advisory Board, and a Fellow of ACEC, ASCE, SWE, and SMPS. (Excerpt from www.nitscheng.com)

PAST PRESIDENTS COMMITTEE ANNUAL REPORT
2015-2016

I. Committee Officers and Members 2015-2016

Carlos Peña (Chair)	Dom D'Eramo	Emile Troupe
Alexander Bardow	Joel Lunger	Peter Richardson
Anatoly Darov	John Sullivan	Rick Scranton
Anni Autio	Judy Nitsch	Robert Stephens
Paul Moyer	Lew Edgers	Rob Dill
Charlie Kalauskas	Linda Hager	Rodney Plourde
Danielle Spicer	Mark Hasso	Steve Bernstein
David Bohn	Mike Swanson	Steve Rusteika
David Westerling	Nick Mariani	Terese Kwiatkowski
Ellen White	Ali Touran	Reed Brockman

II. Committee Meetings:

Following direction given by the Board of Direction, the focus of the Past Presidents Committee this year was to evaluate current and projected budget shortfalls and make recommendations for improvements. PPC held six (6) meetings for that purpose. In a series of brainstorming sessions, the PPC developed the following recommendations:

Past President Committee Recommendations Presented to BSCES Board on 4/25/2016

Short Term Recommendations - FY 2017

- Eliminate Executive Director Position, reassign duties: some duties taken over by TECET staff, some duties taken over by BSCES volunteers, some duties eliminated
- Increase dues: from $85 to $100 (Board already voted to do this)
- Increase membership, with a focus on ASCE-only members
- Increase Sponsorship Revenue
    - At membership renewal time, encourage making Optional Voluntary Section Donations via the renewal form
    - Ask members for donations through well-timed mailings, with a one-page appeal letter, perhaps with a fact sheet
    - Implement a formal long-range giving program – previously recommended by the PPC as the “1848 Club”
- Increase profitability of BSCES Events and Institute/Technical Groups Events
    - Hold dinner meetings at lower cost alternative venues outside of Boston
    - Look at alternatives to dinner meetings
    - Reduce number of dinner meetings – currently numbering 50 per year, BSCES should hold the line at 20

Long-Term Recommendations - 2018 and beyond

- Rethink/Retool BSCES mission to meet current membership needs.
- Redefine relationship with TECET - review BSCES goals, review and refine TECET scope of work to align with budgetary constraints.

III. Seminars, Lecture Series & Events:

In addition to the above noted BOG request, the PPC initiated and helped organize the next Infrastructure Day for 2016. The yearly events are intended to increase public appreciation of notable infrastructure in their communities.

Our first (1st) event was held on May 15, 2015 for the Choate Bridge (circa 1764) in Ipswich, MA and celebrated the oldest 2-span stone arch bridge in the country and as a National Historic Civil Engineering Landmark by ASCE. The plague dedication ceremonies were officiated by local and state public officials and ASCE President-Elect Brian Brenner. The event featured a parade across the bridge lead by a Girl Scouts Troop and day-long community events at a nearby park. (see attached flyer)

Our second (2nd) event was held on May 14, 2016 at Heritage State Park in Holyoke, MA. The event celebrated the significance of the Holyoke Dam and Canals and their contribution to the development of the city as an industrial leader in 1800's and its current status as an off-the-grid "green" community deriving their electricity solely from a dam generated power plant. The event also recognized Clemens Herschel (1842-1930) made for development of the venturi meter as the first large-scale, accurate device for measuring water flow and contributions to the civil engineering profession and the City of Holyoke. The event was officiated by Mayor Alex Morse, ASCE President-Elect Norma-Jean Mattei and other local and state officials. The event featured displays at Heritage State Park, a Canal Walk, Holyoke Dam fish tours, and other events at the South Hadley Canal Park, the Massachusetts Green High Performance Computing Center (MGHPCC), the Holyoke Carousal and the Children's Museum. Event sponsors, contributors and organizers include the firm of Fuss & O'Neill, Tighe & Bond, O'Connell Construction, the Holyoke Historical Society and other local groups and societies. (see attached flyer)

Future events may include additional Public Infrastructure Appreciation Days (PIAD) throughout the Commonwealth and New England, a world premier of a new IMAX movie the "Dream Big – Engineering Wonders of the World next February 2017 and a possible INFRASTUCTURE DAY event in Boston (yet to be developed, but mentioned often).

IV. List of Officers 2014-2016

Carlos Peña, Chair

Respectfully Submitted,
Carlos G. Peña, PE, Chair

PROGRAM COMMITTEE ANNUAL REPORT
2015 – 2016

I. Committee Officers & Members 2015-2016

Jeff Lewis, PE, Chair
Tony Puntin , PE
Ali Touran, PE
Peter Richardson, PE,
Malek Al-Khatib, PE
Richard Keenan
Reed Brockman, PE
Ali Tali, PE
Rich Maher, PE
Geoffrey Schwartz, PE

II. Committee Meetings:

Meetings were held on a monthly basis during the year. The major initiative of the committee is to identify, develop and host training courses to benefit BSCE members and the Engineering community. Courses with a duration from half a day to two days are typically the focus of the committee with the exception of NHI and PE Refresher courses. Courses held during this year (July 1, 2015 to June 30 2016) are listed below. The Committee

III. Seminars or Lecture Series:

9-10-15 thru 10-27-15 – Fall Professional Engineer Refresher Course

2-2-16 thru 2-4-16 – NHI Bridge Inspection Refresher Training

2-23-16 thru 4-12-16 – Spring Professional Engineer Refresher Course

3-1-16 thru 3-2-16 – NHI Inspection and Maintenance of Ancillary Highway Structures

4-4-16 thru 4-15-16 – NHI Safety Inspection of In-Service Bridges

4-18-16 thru 4-22-16– NHI Tunnel Safety Inspection

6-20-16 thru 6-24-16– NHI Tunnel Safety Inspection

IV. List of Officers 2016-2017

Jeff Lewis, PE, Chair
Vice Chair, TBD

Respectfully Submitted,
Jeff E. Lewis, PE, Chair

PUBLIC AWARENESS & OUTREACH COMMITTEE
ANNUAL REPORT
2015 – 2016

I. Committee Officers 2015-2016 (alphabetical order by first name)

- Alex Bonnar, Ralph Salvucci Online Bridge Design Contest Coordinator
- Alicia DiCecca, Future City Competition Judging Coordinator
- Alyssa Marino Medina, Technical Group Liaison; Future City Judging Coordinator
- AnaCristina Fragoso, *Civil Engineering Today* Co-host; Media Coordinator
- Benjamin Mall, Secretary
- Bruce Jacobs, Liaison to BSCES Executive Committee
- Greg Mirliss, Treasurer
- Olivia Richards, Committee Chair, Model Bridge Coordinator, Future City Co-coordinator
- Reed Brockman, Past Chair; *Civil Engineering Today* Co-host; Future City Co-coordinator
- Sarah de Orlando, Future City Co-coordinator
- Sofia Puerto, Committee Member
- T.J. Liveston, Liaison to Younger Member Group

II. Events and Contests:

We held our annual Ralph Salvucci Online Bridge Design Contest, Model Bridge Competition, Future City Competition, and Spring Awards Banquet this year. Overall, each program continued to grow this year through participation of students from all over the New England area.

A. Ralph Salvucci Online Bridge Design Contest (January 12, 2016 – April 22, 2016; Spring Awards Banquet on May 10)

- Eight schools were represented by 105 teams of 1 or 2 students.
- Three teams (two from Malden Catholic High School and one from Carver Middle High School) will compete in the national finals on May 26, 2016.
- The top five teams were invited to be honored at the Spring Awards Banquet. Each team member was alloted one free guest (parent/guardian). In addition to the banquet invitation, the top 5 teams were awarded cash prizes in the form of Amazon gift cards.

B. Model Bridge Competition

- Total of 33 schools competed this year. Winning team came from Swampscott Library after-school program.
- Materials for this year were all shapes and sizes of pasta.
- Judges for the event consisted of Mike McGrath, Tony Ricci, Terri McCarthy, Erik Stoothoff, Ellen White, and Bill Egan

C. Future City Competition (New England Region)

- Total of 36 teams from New England area participated. Winning team came from Farmington, CT.
- This year the competition was held at MassDOT, 10 Park Plaza.
- Roughly 30 engineers showed up on competition day to volunteer as judges.
- This year was the last year the $75,000 grant was offered as part of Massachusetts' @Scale Project Initiative from the Massachusetts Department of Education. The @Scale grant, aimed to support

enhancement projects proven effective in advancing the goals of the state's STEM plan, enabled implementation of the Future City program for ten cities outside of Boston. The @Scale grant allowed the New England Future City program to grow and build relationships with more schools and educators and ensures continued growth for the Future City New England Region.

D. Spring Awards Banquet
- The Spring Awards Banquet was a new event this year, replacing the "The Ralph Salvucci Online Bridge Contest Awards Celebration and Ernest Herzog Technical Paper Award Presentation". The Banquet honored multiple groups of people including
- Two local winners of ASCE's 2016 New Faces of Civil Engineering
- Gabriel Gerardo Rojas Perez, S.M.ASCE, University of Massachusetts Lowell
- Micah Strauss, S.M.ASCE, University of Massachusetts Lowell
- Professional engineers who have achieved excellence with ASCE Life Members
- Ralph Savucci Online Bridge winners
- Model Bridge winners
- Future City winners
- Herzog Award winner
- The winner of the Herzog Award presented their paper on using high tech field inspections and computer modeling to revise bridge loadings on several bridges located in Rhode Island. As required, the presentation was geared towards a non-technical audience so the students and parents could see and understand an example of what civil engineers do.
- The keynote address was given by ASCE President-Elect Norma Jean Mattei.

III. Civil Engineering Today TV Show:

Through the Boston Neighborhood Network, we have a monthly TV show (since July 2006) of which the focus is the profession of Civil Engineering. Guests and a variety of topics are covered on the show. This year, we continued the show, hosted by Reed and AnaCristina.

IV. Other Programs and Endeavors

In addition to the above, other programs and engagements this past year include:

A. Boston Bridges Tour
- Tour requests have increased this year; some requests for as early as late February (weather still a little cold).
- Tours have been held not only for young student groups, but also to the general public (through the Cambridge Science Festival) and professional groups (American Association of Mechanical Engineers).

B. Infrastructure Day – Holyoke Dam
- Outreach attended the event with activities such as the Zakim Bridge model and the shake table. The public enjoyed the activities and the event was a success.

C. Arch Bridge
- The Outreach Committee purchased a cushion Arch Bridge with available funds within the budget. This cushion arch bridge will be used at all Outreach STEM booths at events. We also plan to purchase a BSCES Outreach banner and pop-up banner to improve our image at events.

V. Involvement in other Science, Technology, Engineering, and Math (STEM) events:

Through the popularity of our programs and the reputation we have established among other STEM advocates, we have been invited to and have helped at numerous events all over Massachusetts. A few of the events are listed below.

- Girl Scouts of Eastern Massachusetts STEM Expo
- Cambridge Science Festival
- Jr. Tech "Girls STEM Summit"

VI. List of Officers 2016-2017 (alphabetical order by first name)

- Alex Bonnar, Ralph Salvucci Online Bridge Design Contest Coordinator
- Alicia DiCecca, Future City Competition Judging Coordinator
- Alyssa Marino Medina, Technical Group Liaison; Future City Judging Coordinator
- AnaCristina Fragoso, *Civil Engineering Today* Co-host; Media Coordinator
- Benjamin Mall, Secretary, Model Bridge Coordinator
- Bruce Jacobs, Liaison to BSCES Executive Committee
- Greg Mirliss, Treasurer
- Olivia Richards, Committee Chair,
- Reed Brockman, Past Chair; *Civil Engineering Today* Co-host; Future City Competition Co-coordinator
- Sarah de Orlando, Future City Competition Co-coordinator
- Sofia Puerto, Committee Member
- T.J. Liveston, Committee Member

Respectfully,
Olivia Richards, EIT, Chair

SOUTHEASTERN MASS COMMITTEE ANNUAL REPORT
2015-2016

Committee Officers & Members (2015-2016):

Azu O. C. Etoniru, P.E., P.L.S., Chair
Charles H. Gross, P.E., Vice Chair
John Cavanaro, P.E., Clerk
Nicholas A. Lanney, P.E.
Doug Hartnett, P.E.
Eric Cederholm, P.E.
Patrick Brennan, P.E.
Brian Dunn
James Pavlik, P.E.
George Collins, P.E.
John Chessia, P.E.
Gary McNaughton, PTOE, P.E.

Liaison to BSCES Board of Government – None at this time (formerly B. Clay Schofield, P.E.)

Committee Meetings:

The Committee held monthly meetings at the Abington Alehouse in Abington, MA.

Outreach Activities:

Members of the Committee attended career day events at local and Regional High Schools: promoting and encouraging students to pursue careers in civil engineering; used models and plans to build activities for students and demonstrate how civil engineers build infrastructures and improve quality of lives for the citizenry. Members of the Committee serve on Advisory Committees and Panels on Technology and Career at local and Regional High Schools; and also serve on municipal Planning Boards, Conservation Commissions and Boards of Appeal.

Seminars or Workshops:

The Committee sponsored a half day seminar on **Aggregate Ground Improvement** on **November 19, 2015** in Abington at an expense of $2,342.97 and a revenue of $3,905.00, with 80 attendees. The Committee also sponsored a half day seminar on **Enforceable Contract Clauses for Engineers** on May 20, 2016 in Abington, with 21 people in attendance; the final expense and income figures for this seminar are not yet available, albeit it is estimated the event would net a modest income.

Future Events and Activities:

The Committee hopes to hold increased membership drive events during the 2016-2017 fiscal year; and continue with its monthly meetings on the third Friday of each month, except during the months of July and December 2016. The Committee is planning a traffic/transportation event for the month November 2016 on the 18th of the month; and a second event on April 21st 2017, on environmental impact assessment.

List of Officers and Members for 2016-2017:

Azu O. C. Etoniru, P.E., P.L.S., Chair
Charles H. Gross, P.E., Vice Chair
John Cavanaro, P.E., Clerk
Nicholas A. Lanney, P.E.
Doug Hartnett, P.E.
Eric Cederholm, P.E.
Patrick Brennan, P.E.
Brian Dunn
James Pavlik, P.E.
George Collins, P.E.
John Chessia, P.E.
Gary McNaughton, PTOE, P.E.

Respectfully Submitted,

Azu O. C. Etoniru, P.E., P.L.S., Chair

Student Chapter Committee
2015 – 2016

I. Committee Officers & Members 2015 - 2016

Jessica Yarmarkovich, EIT, Committee Chair, MIT Liaison

Richard Matson, Merrimack College Liaison
Cara Pirkey, Northeastern University Liaison
Natalie Matson, Tufts University Liaison
Tyler Deruiter, University of Massachusetts Amherst Liaison
Dale Valesky, University of Massachusetts Amherst Liaison
Tyler Gilman, University of Massachusetts Dartmouth Liaison
Ana Gouveia, University of Massachusetts Lowell Liaison
Valeria Chia, Wentworth Institute of Technology
Ashley Sullivan, Western New England University Liaison
Greg Fitch, Western New England University Liaison
Olivia Richards, Worcester Polytechnic Liaison

II. Committee Meetings and Events:

During the monthly Younger Members Group meetings, liaisons discuss updates regarding their respective student chapters.

Student Chapter related events throughout the year are listed below.

Student Chapter Caucus
October 19, 2015
Louis Berger Group, Needham

The Younger Members Group (YMG) and BSCES Student Chapter Committee hosted the annual Student Caucus event at Louis Berger Group's impeccable office in Needham. Eight Student Chapters attended the event, contributing to over 30 students. The evening began with a social gathering, in which students met members of the BSCES Executive Committee, Younger Members Group and students from other school chapters. Cara Pirkey, the YMG Chair introduced the group followed by Ellen White, BSCES President, who gave a presidential address, focusing on the history and importance of BSCES. BSCES members enjoyed a delicious buffet style Italian dinner from Comella's.

The remainder of the night focused on round table discussions hosted by members of YMG and BSCES. Topics that were covered included 'Industry Talk', in which Ellen White discussed what it takes to be a successful professional in the industry; 'Interview and Resume Skills'; 'Becoming a Young Professional' in which Alyson Stuer focused on transitioning from being a student to an employee; 'ASCE Activities, Awards & Scholarships' in which Anthony Puntin represented ASCE National; 'Younger Members Group' in which Cara Pirkey focused on the YMG mission and events; and 'Outreach Activities'.

Total Attendance: 33

Senior Night & STAY Grant
March 1, 2016
Bertucci's Alewife

The Younger Members Group (YMG) and the Student Chapter Committee hosted the first YMG Senior Night at Bertucci's in Alewife.

The event was funded by the ASCE 2015 Student Transition Activity (STAY) Grant for $1,500 that YMG and Student Chapter Committee applied for and was awarded. The purpose of the Grant is to aid in creating a program which; forges lasting relationships between organizational entities, strengthens relationships with individual student members, educates students about the value of Society membership, and helps building students' desire for continue affinity to ASCE.

The event registration was open to senior undergraduate students studying Civil Engineering at the ASCE Student Chapters. The purpose of the event was allow the students to meet and connect with young and experienced professionals in the field and to learn more about BSCES and ASCE membership opportunities. Each student was provided with a BSCES Student Resource Guide, which was created for the event using the ASCE STAY Grant funding.

49 Total attendees:23 Students, 21 BSCES Members, 5 Non-members.

Student Conference

The Younger Members Group volunteered at the 2016 Student Conference, hosted by Northeastern University and Wentworth Institute of Technology. Volunteers assisted with judging of the competitions, providing encouragement and a cookie break. Day one was the steel bridge competitions hosted at Northeastern University's Mattwew's Arena, won by the Universite Laval. Day two was the concrete canoe competition, which took place at Lake Cochituate, also won by Universite Laval.

III. Special Funds Meetings and Events:

104th BSCES Student Night
Designing for Tornados: A Paradigm Shift
April 6th, 2016
Tuft University, Alumnae Hall

The 104th annual BSCES Student Night was hosted at Tufts University with special guest speaker Doctor Long T. Phan, PhD, PE, F.ACI. The keynote presentation focused on current research and investigations into damage to the built environment caused by natural or man-made disasters.

The event included the presentation of the 2016 Howe-Walk, Desmond Fitzgerald and Willliam P. Morse special funds winners.

Howe-Walker Fund
Katrina DiGloria, Western New England University
Tracy Donohue, University of Massachusetts Amherst
Jared Peterson, Merrimack College
Evan Hayes, Northeastern University
Christine Lai, Northeastern University
Amanda Perry, MIT
Katrina Martel, University of Massachusetts Dartmouth
Adam Brooks, Tufts University
Tyler Valila, University of Massachusetts Lowell
Jamie Grome, Wentworth Institute of Technology
Rachel Kennedy, Worcester Polytechnic Liaison

Desmond Fitzgerald Fund:
Steven Hock, Northeastern University

William P. Morse Fund

Miranda Seeley, Tufts University

Total Attendance: 57

IV. List of Officers 2016-2017

Valeria Chia, Committee Chair, Wentworth Institute of Technology

Zuki Mahmuljin, MIT Liaison
Richard Matson, Merrimack College Liaison
Cara Pirkey, Northeastern University Liaison
William Steritt, Tufts University Liaison
Tyler Deruiter, University of Massachusetts Amherst Liaison
Tyler Gilman, University of Massachusetts Dartmouth Liaison
Ana Gouveia, University of Massachusetts Lowell Liaison
Ashley Sullivan, Western New England University Liaison
Greg Fitch, Western New England University Liaison
Dana Wolkieicz, Worcester Polytechnic Liaison

Respectfully Submitted,
Jessica Yarmarkovich, EIT, Chair

Q:\SPONSORS\BSCES\EVENTS\FY 2016\2016-05-23 Annual Business meeting\Annual Reports\34_SAC Committee Report_Yarmarkovich.doc

COMMITTEE ON SUSTAINABILITY ANNUAL REPORT 2015 – 2016

I. Committee Members 2015-2016

Melissa Carter, Chair
Ronald Burns, Member
Richard Costa, Member
Stephen Farr, Member
Jeff Goldberg, Member
Jeffrey Kellner, Member
Susan Kremer, Member
Teresa Vangeli, Member

II. Committee Meetings:

Nine meetings were held during the year and there is one remaining meeting in June. The major initiatives of the committee included:

- Committee members authored/submitted two articles for the BSCES October newsletter titled *"2015 BSCES Sustainability in Civil Engineering Award Winner: Alewife Stormwater Wetland*", and "*We Need a Plan to be More Resilient to Natural Disasters and Climate Change*".
- The committee issued a call for nominations for the second annual BSCES Sustainability in Civil Engineering Award. Related activities included publishing promotional ads in BSCES newsletters, creating one page flyers for distribution to BSCES members, and posting nomination forms on the BSCES web site. No submissions have been received and the deadline was extended to June 10, 2016. If a submission is received, the committee will assemble the panel of judges and facilitate the judging process during the months of June and July 2016. The award will be announced at the BSCES annual awards dinner in the Fall of 2016.
- Committee members Peter Richardson and Melissa Carter continued to be engaged with the Zofnass Program for Sustainable Infrastructure at the Harvard Graduate School of Design. This was part of an ongoing effort by the committee to stay engaged with other local sustainable infrastructure events and organizations.

III. Seminars or Lecture Series:

None

IV. List of Members 2015-2016

Melissa Carter, Chair
Ronald Burns, Member
Richard Costa, Member
Stephen Farr, Member
Jeff Goldberg, Member
Jeffrey Kellner, Member
Susan Kremer, Member
Teresa Vangeli, Member

Respectfully Submitted,
Melissa Carter, PE, Chair