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Climate Change Adaptation
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Tuesday, June 16
8:30 AM – 10:00 AM
SESSION 6: Engineering and Infrastructure 2

Miami Beach Leading Solutions to Challenges from Sea Level Rise - Bruce Mowry, City of Miami Beach, Miami Beach, FL

Miami Beach Leading Solutions to Challenges from Sea Level Rise Like many coastal communities, the City of Miami Beach is experiencing rising in sea levels at a greater intensity than the global average. The fight is already under way to keep streets, businesses and residents dry on sunny days, let alone during storms. Higher tides, prolonged flooding after storms, rising groundwater, and beach erosion are among the major effects being experienced by residents, tourists and property owners. In addition, this low-lying barrier island's porous limestone geology makes it exceptionally vulnerable to salt water intrusion into infrastructure systems, surface flooding from rising groundwater and loss of vegetation due to salt water in root zones. As a member of the Southeast Florida Regional Climate Change Compact, the City is teaming with other communities to develop a regional governance approach that coordinates mitigation and adaptation activities between Broward, Miami-Dade, Monroe and Palm Beach Counties. The Compact has served to unite, organize, and assess the needs of the region through the lens of climate change and setting the stage for action. Drainage improvements have been made in areas of the City with the highest susceptibility to flooding. Initial projects have focused on flooding due to reverse flows in gravity stormwater outfalls with the installation of pumped drainage systems and Tideflex valves. The City will be looking at ways to address seawalls that are overtopped during high tides and adopting new building standards to prepare for the future. The estimated cost to implement a comprehensive pumped drainage system has been projected at $300 million. The total cost to prepare the City for higher sea levels will far exceed this amount to build seawalls to more stringent criteria, raise streets and sidewalks in low areas to higher elevations, set new building standards to new finished floor elevations, and continue to address rising ground water levels that are directly related to sea level rise. Miami Beach's response to rising sea levels focuses on implementing proven approaches, while continuing to look forward at how to best prepare for future flooding effects from climate change. Management of surface flooding from rising ground water remains one of the City's greatest challenges. The City is actively monitoring steps taken by other communities, as well as advancements in design technologies. The City Engineer oversees the program to ensure consistency of new standards in the establishment of new City design and construction criteria. A series of presentations are being held to inform the public on upcoming improvements, as well as to provide the opportunity to give feedback. Changes to the

standards that have already been adopted include: * Design for storm rainfall event increased from 6.0 to 7.5 inches in a 24-hour period * Design criteria for tailwater elevation increased from 0.67 feet to 2.7 feet NAVD As the City's program continues to evolve, industry experts, firms and the public are encouraged to share their expertise and provide input on future infrastructure improvements. A collaborative approach to adapt and mitigate the many challenges of a rising sea will benefit us all.

Case Studies on Climate Risk and Resilience Planning for Wastewater Infrastructure in Coastal Communities: Examples from FL and MA - Laurens Van Der Tak, CH2M HILL, Silver Spring, MD (co-authors: B. Goldenberg, B. McMillin, C. Jewell, P. Urich, P. Pasteris)

Communities face uncertainty related to future climate impacts on infrastructure, from extreme storms, drought, and excessive heat. Coastal communities face the added threat of sea level rise (SLR), coupled with storm surges. This paper highlights two case studies of climate vulnerability assessments and adaptation strategies focused on wastewater infrastructure in Miami-Dade FL and Boston MA. Miami-Dade County, FL In 2008, the Ocean Outfall Legislation (OOL) was passed in Florida requiring all wastewater utilities in southeast Florida utilizing ocean outfalls for disposal of treated wastewater to reduce discharges by 2018, cease using the outfalls by 2025, and reuse 60% of the wastewater flows by 2025. Incorporating climate risks is key to developing a robust facility hardening plan and designs for the Miami-Dade County Water and Sewer Department (WASD) OOL program. Understanding climate risks entails two parallel activities: * Assess projected climate change for key climate variables. A range of climate scenarios are used in hydrologic and hydraulic modeling to understand risk to critical infrastructure at each of WASD's three wastewater plants and more than 1,000 pump stations. * Define critical assets based on understanding the consequence of failure of a given asset, and definition of failure thresholds for these facilities, such as elevation of electrical systems. This case study summarizes progress in developing wastewater climate resilience and facility hardening plans under WASD's OOL program, including updating climate projections based on IPCC CMIP5 data sets, developing storm surge and inundation modeling, and definition of asset risk. Boston, MA The Boston Water and Sewer Commission is developing its Wastewater and Storm Drainage Facilities Plan with long-term service goals including climate change impact assessment and adaptation strategy development. The Commission defined the risks of climate change, assessed system vulnerabilities, and developed adaptation strategies through 2100. The framework applied IPCC projections and developed scenarios to bracket climate-related risks. The climate risk framework, data analyses, climate forecasts, modeling and mapping, risk assessment and future design standards will be presented. Historical precipitation, river response, and tide data were analyzed to establish the present-day risk envelope for flooding and inundation. Projected changes in precipitation, sea level, storm surge and river dynamics were calculated using SimCLIM and other tools for medium and high greenhouse gas emission scenario through 2100. Future design storms, river, sea level, and storm surge conditions were modeled to identify areas prone to inundation and flooding using GIS linked with hydrologic, hydraulic and 2D floodplain models. CH2M HILL's Flood Modeler Suite, calibrated to Hurricane Sandy and the FEMA 100-year base flood, was used to model Boston inundation due to sea level rise without and with a 100-year storm surge. The

Commission's storm drain and sewer system SWMM models, coupled with Flood Modeller was used to identify future flooding areas. The vulnerabilities of wastewater assets were assessed for likelihood and consequence of failure due to flooding to prioritize capital improvements for resilience in the Commission's CIP. Design storms, and design flood elevations were defined for infrastructure improvements through the year 2100. Conceptual projects were evaluated to identify future adaptation.

Rising Seas and Wastewater Infrastructure in the New York Metropolitan Area - Eric Rosenberg, Hazen and Sawyer, New York, NY (co-authors: A. Luck, L. Bendernagel ,T. Groninger, S. Mehrotra, V. Rubino, A. Cohn, P. Balci, T. Lauro, M. Coley, J. Gibney)

Among the many manifestations of climate change, it is virtually certain that sea levels will continue to rise for many centuries. Coupled with the effects of storm surge from more frequent and intense extreme events, resulting impacts are expected across a range of sectors, predominantly in densely populated coastal regions. Within the water resources sector, wastewater treatment plants are particularly vulnerable due to their placement at low-lying elevations for collection by gravity and proximity to water bodies for discharge purposes. Protection of these facilities is of vital importance to avoid disruption of public service, damage to equipment, and spillage of wastewater into nearby waterways.

The legitimacy of this risk was made crystal clear when Hurricane Sandy hit the New York Metropolitan Area in October 2012. Ensuing floods affected 10 of New York City's 14 treatment plants and 42 of its 96 pumping stations, crippled wastewater service to millions of area residents, and caused the discharge of untreated sewage into local waterways, resulting in over $95 million in damage to NYC's system alone. In response, the NYC Department of Environmental Protection (DEP) expanded a pilot vulnerability study to include its entire wastewater system, mobilizing a team of engineers on an accelerated schedule. Soon after, the Westchester County Department of Environmental Facilities (DEF) undertook a study of its own 7 treatment plants, 2 overflow retention facilities, and 31 of its 42 pumping stations.

This presentation discusses the results of these studies and their unique risk management framework encompassing the analysis of climatic data to establish site-specific design flood elevations, the assessment of flooding mechanisms and vulnerabilities for thousands of wastewater assets, and the recommendation of adaptation measures based on feasibility, costs of implementation, and levels of resiliency provided. Using this three tiered approach and a long-term cost-benefit analysis, the NYC study concluded that by investing $315 million in adaptation measures, DEP could avoid up to $2.5 billion in damages over the next 50 years. Similar conclusions resulted from the study of DEF's system, of which 4 treatment plants are addressed in this presentation.