International Conference on Sustainable Infrastructure (ICSI 2021)

Technical Track Abstracts

Wednesday, December 8, 2021

Table of Contents

Track 1: Sustainable Procurement

Moderated by Theresa Harrison and Nancy Kralik

Sustainable Procurement for Infrastructure – Panel Discussion for the International Conference on Sustainable Infrastructure (ICSI) 2021

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Keywords: Sustainable Procurement, Sustainable Procurement for Infrastructure

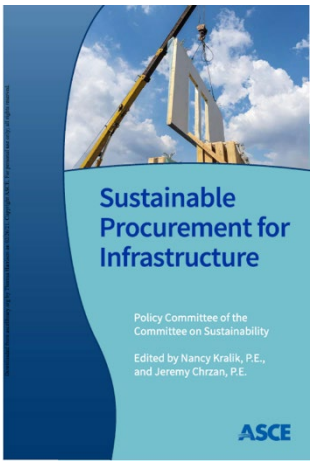
ABSTRACT

In early 2020, the ASCE Committee on Sustainability's Policy Committee published "Sustainable Procurement for Infrastructure". The Policy Committee created this Technical Report to assist personnel in the sustainable procurement of materials and design and construction services.

The panel discussion will begin with a brief overview of ASCE's "Sustainable Procurement for Infrastructure" technical report, its structure and use. The introduction will also describe how to utilize the procurement language in contracts and purchase orders and how the suggested language can serve as the basis for additional sustainability conditions. The presentation will also discuss the project owner's requirements for a Sustainability Management Plan, the contractor's interpretation of those requirements and the potential cost implications.

The introductory session will be followed by six (6) panelists from various sectors of the industry (engineers, local, state, regional, and federal governments and agencies) who will consider the technical report and provide context for procurement in their organizations. The conversation will center around how sustainable procurement can be progressed and implemented in constructing infrastructure.

The technical report: "Sustainable Procurement for Infrastructure" is available from ASCE Publications: (https://ascelibrary.org/doi/book/10.1061/9780784483107)



Track 2: Resilience (Part 2)

Moderated by Laura Patino

Planning for Climate Resilience in Coastal and Inland Wastewater Systems

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Keywords: Flooding, Planning, Resilience, Wastewater, Water, Wildfire

ABSTRACT

Impacts of climatic events to wastewater infrastructure in recent years have highlighted the importance of planning for resilience. Orange County Sanitation District and Los Angeles County Sanitation Districts have performed assessments to identify climate threats, assess vulnerabilities, and develop resilience measures to adapt existing wastewater facilities to climate change. Coastal and inland facilities were assessed, including six wastewater treatment plants, sixteen pump stations, and collection systems. Climate threats considered in the assessments included flooding, sea level rise, tsunami, wildfire, extreme heat, extreme winds, and drought. The collection of climate threats, vulnerabilities, and resilience measures have been summarized in climate resilience plans, which provide a systematic approach for adapting existing infrastructure to climate change. Comparison of resilience plans for coastal versus inland facilities identified flooding due to sea level rise as the main climate threat for coastal facilities while wildfire, localized flooding, and extreme heat posed the greatest threat to inland facilities.

Application of a Resilience Matrix Framework to Wastewater Treatment Facilities to Identify and Address Resilience Shortcomings

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Keywords: Military Installations, Organic Waste, Resilience, Wastewater Treatment

ABSTRACT

Evaluating a system's resilience is an emerging tactic currently overtaking risk analysis due to its more all-encompassing approach that can be applied to more dynamic, complex systems. One major shortcoming to resilience is that it is not yet universally defined or applied, but tools such as Dr. Igor Linkov's Resilience Matrix are attempting to bridge this gap to make evaluation of resilience more practically applicable. This Resilience Matrix evaluates both physical and non-physical stressors across four domains: physical, information, cognitive, and social. It also assesses resilience in these domains temporally, per the National Academy of Science's four phases of: plan and prepare, absorb, recover, and adapt (Linkov et al. 2013). Because the concept of resilience has only recently been applied to wastewater treatment systems (WWTS), there are many gaps hindering the detailed study of the resilience of WWTS. In their wide-ranging literature review on WWTS resilience, Juan-Garcia et al. have identified many of these deficiencies. The most prominent gaps involve the lack of identification of all the potential stressors, physical and non-physical, that can impact a system, the lack of sufficient qualitative metrics to measure resilience, and the lack of consensus in the definition of resilience and the properties that indicate resilience (Juan-Garcia et al. 2017). Applying these lessons and incorporating Linkov's Resilience Matrix and management framework (Linkov et al. 2014), we determined that WWTS are currently high risk and low resilience, and address ways to incorporate the Resilience Matrix to address resilience deficiencies across all four domains and periods.

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A Methodology for Risk Assessment to Improve the Resilience and Sustainability of Critical Infrastructure with Case Studies from the United States Army

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ABSTRACT

Reliable performance of energy and water infrastructure is central to the mission readiness of the United States Army. These systems are vulnerable to coordinated attacks from an adversary as well as disruption from natural events. In addition, the Army oversees one of the largest portfolios of built infrastructure of any organization in the world, requiring significant resources to build, operate, and maintain assets. As a result of these combined factors, delivering resilient and sustainable infrastructure is of paramount importance to reduce the economic and environmental burden of national infrastructure while ensuring the capability of the United States Army. The objectives of this work were to investigate Army installations in North America, identify best practices for improving the resilience and sustainability of critical energy and water infrastructure, and develop a framework for analyzing the resilience of an installation, while building a modeling method to study the performance of an installation under varying resilience scenarios. This work was accomplished using a multi-layered decision process to first identify unique case studies from the 117 active-duty domestic Army installations. The relevant infrastructure at each selected installation was cataloged and investigated. Best practices were identified based on historical performance. A framework for analyzing and assessing the resilience of an installation was then developed to help inform stakeholders. This framework was developed with the intention of articulating the tradeoffs between resilience goals and resource requirements to achieve those goals. Metered energy and water data from buildings across the Fort Benning, GA were curated to inform the modeling framework, including a discrete-event simulation of the supply and demand for energy and water on the installation using ProModel. This simulation was used to study the scale of solutions required to address outage events of varying frequency, duration, and magnitude, the combination of which is described as the severity of outages at a given site. Stochastic modeling techniques were then used to vary the severity of outages to study system architectures that can help harden infrastructure against historical outages. The technologies considered as possible solutions to improve system architecture included, but were not limited to, solar PV, diesel generators, natural gas combined heat and power, batteries, and portable reverse osmosis systems. This project helps provide an operational framework to help installations meet Army Directive 2020-03, which states that installations must be able to sustain mission requirements for a minimum of 14 days after a disruption has occurred.

Recommended Options for Improving the Functional Recovery of Lifeline Infrastructure Systems

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Keywords: Design Frameworks, Earthquakes, Extreme Events, Functional Recovery, Infrastructure, Lifelines

ABSTRACT

As the United States government is planning a mega investment for its aged and new infrastructure, it is essential to offer technical tools for the assessment and optimization of funding allocation from a resilience perspective. As per the ASCE Infrastructure Report Card (2021), many of the country's infrastructure elements are at a critical state with their safety - even their very operability - being questionable. Responding to a request by the Congress, the NIST SP1254 Report (FEMA-NIST, 2021) discusses "better than code" design that includes functional recovery performance goals, requiring infrastructure to be maintained to quickly provide service to the population after earthquakes – and by extension other natural hazard events. While several state-of-the-art tools and methodologies to design and build new infrastructure or to retrofit existing ones are available, the prioritization of actions and optimization of spending the allocated budget in a way that targets return to service, and thus enhancing the national security, remains a major issue requiring further guidance. We have recommended options for improving the functional recovery of lifeline infrastructure systems included in the FEMA-NIST report, and relevant efforts that support the creation of resilience and post-event frameworks, as well as decision support guides and financial tools to address some of these options. Some of the challenges in combining the various developments in this field into a consistent methodology that can be regionally adopted by communities to meet functional recovery performance goals after extreme events have also been considered.

Track 3: People: Social, Society, Stakeholders

Moderated by Tera Haramoto

Social Justice is the Major Factor for City of Los Angeles Policymaking

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Keywords: Achievement Indicators, Equity, Equity Framework, Equity Score, Social Justice

ABSTRACT

The growing social divide is a topic of much discussion these days. The U.S. is among the underachievers, in the industrial world's Social Justice Index ranked 36th of 41. The index is an effort to bring together all the indicators that reflect how fair and inclusive a nation is for its citizens, ranging from poverty levels for different age groups to environmental data. The indicators are pulled together into six major groups: poverty prevention, equitable education, labor market access, social inclusion, intergenerational justice, and health. The first three categories are given extra weight (Bershidsky 2019, Hellmann et al. 2019).

There are still limited available opportunities to participate in society in the USA. In the USA today there are hundreds of thousands of individuals and families living profoundly troubled lives marked by multiple disadvantages. In the last 10 years, the share of its population at risk of poverty remains the same at 17.8% (Statista 2021). Performance on intergenerational and interracial justice has worsened because of incoherent policies.

These are not new challenges, but they need a new approach. Centering and integrating of overlooked, vulnerable, or marginalized individuals and groups will lead to different considerations, methods, practices and resulting policies.

The New Approach

The Mayor of Los Angeles, Eric Garcetti said that he seeks to stem poverty and boost social justice in his vision for L.A.'s recovery from the pandemic in his April 2021 address to Angelinos. Mayor Garcetti offered his vision for helping Los Angeles emerge from the financial devastation of COVID-19, urging city leaders to commit to economic justice by pouring hundreds of millions of dollars into relief programs and ramping up initiatives that keep residents safe, employed and out of poverty, and creating practices and policies for integrating overlooked and vulnerable or marginalized individuals and groups. He also said he would take initial steps toward creating a pilot program for slavery reparations for Black Angelenos, by naming an advisory committee and finding an academic partner to help push the initiative.

Practices and Resulting Policies, Impacts on Engineering

In light of the staggering racial injustice shown by the George Floyd killing, Mayor Garcetti released Executive Directive 27 which speaks to the heart of the issues faced by employees of the City of Los Angeles as well as all of the City residents. The ED states that if changes are going to be made within the City they must start with the people that operate the City and each department was tasked to appoint a racial equity officer and create a report which looks at the current demographics within each department and the establishment of goals to be completed or milestones set within the fiscal year that will advance the racial awareness and practices within each department.

The evaluation of all City of Los Angeles Departments clearly shows that the concept of equality and social justice is reached to very different levels within each department and vary considerably in each department's ability to create a truly inclusive culture. A strategic framework was created with a set of indicators being established and a number of goals declared in 2020 for the Bureau of Engineering (Engineering) lasting to 2022. The implementation of the indicators is being reviewed and evaluated for effectiveness. This reference framework provides for educational policymaking with emphasis on recruiting, retaining, and promoting a workforce that emulates the diversity found within the City.

Benchmarks for social justice: assessing the fairness and the diversity of City's workplace participation - combining evidence with opinion of the civic group: To begin this work, a benchmark needed to be set to show the current demographics represented within Engineering. As shown in Figure 1 which represents all Engineering employees, the demographic makeup of the department shows a very diverse makeup at the new hire stage, however, those numbers began to shift significantly at the higher managerial positions. While Engineering is working hard to hire a diverse workforce, that diversity is not being represented in the promotional opportunities. With the formation of a diversity committee, flaws and weak areas such as the promotional gap were identified, and a set of goals were created to work on overcoming them. The goals were categorized within three benchmark groups, 1. Equitable Workforce, 2. Equitable Operations, 3. Equitable Services. The identified goals were all created with an emphasis on impacting the diversity and equitable practices within Engineering. To accomplish these goals, a civic group was formed with access to information and evidence, in line with the benchmarks (Figure 1), and its members were provided with the opportunity to express their views, which is helpful in monitoring fairness in the long run.

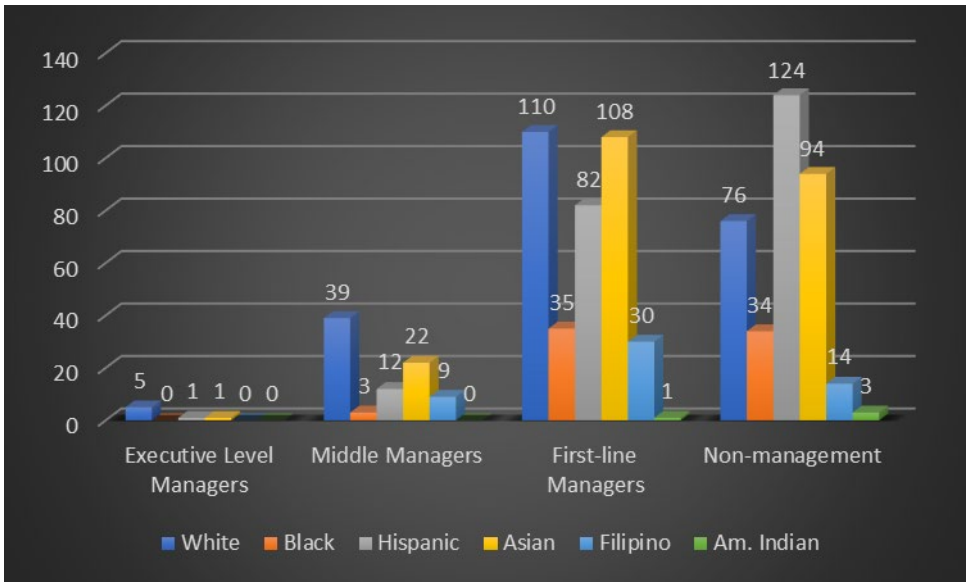

Figure 1. Engineering's Diversity Chart (City of Los Angeles BOE, 2020)

Social justice - achievement indicator for equity score card and sustainability: As there are frameworks and indicators that judge the overall sustainability of a project (i.e. LEED, Envision, etc.), Engineering is embarking on the creation of an equity framework for all projects designed and constructed within the City of Los Angeles. Inspired by Mayor Garcetti's Executive Directive No. 27 and LA's Green New Deal, Engineering hopes to spearhead a look outward, finding ways to better assess and transform the department's contribution to a more equitable built environment. The first step is to understand the existing condition by creating an Infrastructure Equity Scorecard, then use that knowledge to pinpoint areas of inequity through mapping, and, in the long run, work more closely with communities to build the

systems that best serve their needs and bring all of LA's infrastructure into the 21st century. An equity-first focus will impact the practice of hundreds of engineers and millions of residents across the City of LA. The Infrastructure Equity Scorecard and Mapping will initiate a conversation with all our contracting agencies and across public works, impacting billions of dollars of construction projects in all council districts. In the long range, the project will lead to more equitable distribution of resources by foregrounding a process that tracks infrastructure gains and losses and will give voice and agency to historically under-served residents.

With Mayor Garcetti's focus on building a more equitable City, Engineering is taking the lead in insuring that the City forces are focused on creating a more equitable workforce in addition to insuring equity is built into every project done by the City of Los Angeles.

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Do Infrastructure Deserts Exist?
Measuring and Mapping Infrastructure Equity in the City of Dallas

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Keywords: Data-Driven, Equity, Infrastructure Assessment, Mapping, Neighborhood Infrastructure, Statistical Inference

ABSTRACT

Neighborhood infrastructure, such as sidewalks, medical facilities, public transit, community gathering places, and tree canopy, provides essential support for safe, healthy, and resilient communities. However, most related studies fail to fully capture the diversity of neighborhood infrastructure and only measure a single or a few infrastructure types when assessing its condition. Taking the first step to systematically examine the presence and condition of neighborhood infrastructure, we show that "infrastructure deserts" exist, which are low-income neighborhoods suffering significantly more deficient infrastructure. A generalized data-driven framework was developed and applied at the street-level for twelve types of neighborhood infrastructure in one metropolitan area: Dallas, Texas. The results show significant infrastructure inequities across income levels for most types of infrastructure. Statistical inference with a cumulative logit model predicts (with 95% confidence) that low-income neighborhoods (census block groups) are 2.2 to 3.5 times more likely to have eight or more types (highly deficient) of deficient infrastructure than high-income neighborhoods. The paper also reveals infrastructure inequities across race-ethnicity groups. A similar statistical model predicts that predominantly Hispanic and Non-Hispanic Black neighborhoods are substantially more likely to have highly deficient infrastructure than ones without predominantly underrepresented race-ethnicity (2 to 4.6 times higher for predominantly Non-Hispanic Black neighborhoods;1.5 to 3.5 times higher for predominantly Hispanic neighborhoods). This study addresses the methodological challenge of considering multiple infrastructure types and provides an insightful framework for infrastructure investment prioritization.

Improving Walkability by Focusing on Residents' Needs and Neighborhood's Built Environment

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Keywords: Built-Environment, Pedestrian, Sidewalk, Transportation Planning, Walkability

ABSTRACT

While the benefits of walkability are clear, it could be difficult how to determine the best approach to budgeting on sidewalk development decisions in order to maximize the efficiency of the investment. This paper presents a methodology and a tool to evaluate the walkability of different areas in a city by focusing on the gap between walking needs of residents and built environment of the neighborhood. To do that, we first characterize walkability and its greatest contributing socio-demographic variables, like trip purpose, number of vehicles in the household, and the age of individuals. Next, through running Principal Component Analysis, we define a unique index for walkability, which is used to find areas with greatest demand for walkability in their neighborhood through Hotspot Analysis. Finally, using the Pedestrian Environment Index as an indicator of walkability supply for the neighborhood, we identify the most efficient places to develop sidewalks by finding the gaps between demand and supply of walkability in each neighborhood. The results suggest that in the southern and western neighborhoods of Chicago the resident's walkability desire and need does not match with the built environment characteristics. In addition to providing an informative location-based measure for policymakers, the methodology opens avenues to address some equity concerns related to walkability and prioritizing neighborhoods for improvement based on the needs of the residents.

The Nexus of Sustainable Urban Design and Human Security

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Keywords: Developing World, Environmental Security, Human Security, Sustainability, Urban Design

ABSTRACT

The nexus between urban design and human security is intuitive, and simultaneously not well understood. We inherently understand that poor urban design results in crime, unrest, and poverty. We also understand that the provision of infrastructure services (clean water, wastewater disposal, and transportation) has the potential to lift populations out of poverty and improve human security. This study uses a qualitative approach to identify those elements of urban design that provide the greatest catalyst for improvements to human security.

Human security is a subset of national and international security. A failure to meet basic human security needs has been shown to be related to national and international conflict. Threats to human security, such as drought, famine, ethnic and religious strife, and resource conflicts, have caused numerous international and national conflicts in the last 30 years. Accordingly, it is an international security imperative to find solutions to design issues caused by urbanization to prevent conflicts from occurring. In a national security context, conflict prevention is far less costly in lives lost and in national treasure than conflict resolution.

This study aims to identify the best practices for urban design in the developing world and identify urban design approaches that have been successfully implemented in the world's most challenging urban environments. Identifying these techniques provides a roadmap for the rest of the developing world to follow as global urbanization trends continue. These urban design approaches provide a springboard to improved sustainability in an urban context, and with it, improved human security.

Strategies for Increasing Resiliency and Sustainability in Public Works

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Keywords: Envision, Equity, Public Works, Resiliency, Sustainability

ABSTRACT

Within the City of Los Angeles, Public Works' Bureau of Engineering (BOE) has explored strategies to increase sustainability in infrastructure design and delivery. These strategies include, firstly, effectively assessing program-wide engineering practices and policies to measure sustainable performance using the Envision framework. Envision is a framework of sustainable, equitable and resilient indicators developed to evaluate all aspects of civil infrastructure through all project phases.

Following this assessment, the BOE is now focusing on program-wide sustainable performance strategies in three key areas, including: 1) implementing sustainability management planning as part of the project delivery process; 2) reducing embodied carbon emissions as part of material procurement practices for construction materials; and 3) understanding equitable design in infrastructure.

As public agencies look to increase sustainable and resilient project delivery, a well-developed sustainability management plan, or policy, that prioritizes setting and monitoring sustainability goals through all project phases is critical in facilitating discussions during early planning/decision-making processes. This allows engineers, project teams, and stakeholders to consider innovative solutions focused on sustainability and resiliency. Reducing embodied carbon emission from construction materials is a major step towards the fight against climate change which has a global impact. And understanding equity in infrastructure takes into consideration community engagement processes as well as organizational commitments to equity from project teams that lead to building healthy and resilient communities.

These efforts can have industry-changing impacts that promote global advances in sustainable technologies, enhance public health and build more resilient communities through infrastructure designed with equity in mind.

Track 4: Planning, Procurement, and Finance

Moderated by Eric Bill

City of San Antonio - Climate Action & Adaptation Plan - 2050 Net Carbon Neutrality - Economic Analysis to Inform Policy Trade-offs, Costs, and Public Benefits

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Keywords: Climate Action, Municipal, TBL Analysis, Texas, United States

ABSTRACT

The City of San Antonio is one of the fastest growing cities in the US - it won an American Climate Cities Challenge to implement the Paris Agreement and achieve carbon neutrality by 2050. In 2019, the City of San Antonio adopted SA Climate Ready, its first Climate Action & Adaptation Plan. In this plan, the City maps out a pathway to achieving net zero carbon emissions by 2050, while prioritizing clean air, public health, water quality and conservation, good jobs, transportation choices, clean and secure energy, and emergency preparedness. To realize the economic impacts of achieving the ambitious carbon goals, the City wished to explore broad-based outcomes from a variety of policy strategies. These mechanisms include building code changes to incentivize private action, and reinventing city buildings and open spaces as environmental and resilience generating locations. Economic analysis is a valuable approach to help draw quantitative insights towards trade-offs amongst these varied climate action policies. Six policies were identified by the Office of Sustainability as priority mitigations strategies due to their potential climate action impact:

1. Energy benchmarking for commercial and multifamily buildings
2. White roof and energy insultation building code
3. EV charger readiness building code
4. Solar PV roof readiness building code
5. Zero net energy (ZNE) municipal buildings
6. Urban agriculture

The economic analysis allowed the City to understand the long-term costs, benefits, and trade-offs of the policies across the financial, social, and environmental community impact outcomes using peer-reviewed, empirical estimations of the expected outcomes.

Innovative Economic Analysis and Triple Bottom Line Valuation of Multi-Purpose Green Infrastructure Assets and Lessons Learned for Future GI Project Planning

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Keywords: Green Infrastructure, Innovative Economic Analysis, Master Planning, Triple Bottom Line Valuation, Watershed Protection Plan Implementation, Water Quality Modeling

ABSTRACT

With climate change exacerbating natural disasters, pandemic-driven fiscal deficits, and environmental damages becoming widespread, more than ever infrastructure is needed to create job opportunities, mitigate and adapt against hazards, and improve diverse ecosystems. Prudent planning plays an important role in scoping the most effective projects – those with the greatest social, environmental and community benefits, with a lens to the highest economic value. Empirical, evidence-based data in the form of science and economic analytics can support planners, policy makers, engineers, and stakeholders in making more informed, comprehensive project designs and funding decisions that maximize public value and create benefits across multiple dimensions. Analytical tools such as life cycle cost analysis (understanding full project costs over their life cycle) and cost benefit analysis (quantifying and monetizing social and environmental co-benefits) are all important tools that can help to inform better project design, greater funding, and quicker stakeholder buy-in. A Triple Bottom Line (TBL) approach brings these tools together to holistically value the social, environmental, and financial aspects of projects. The San Antonio River Authority received a Clean Water Act 319(h) grant from the United States Environmental Protection Agency, administered by the Texas Commission on Environmental Quality, to fund Green Stormwater Infrastructure (GSI) focused Master Planning in the Upper San Antonio River Watershed that would lead to improving water quality in the San Antonio River. To determine the multi-benefits from installing GSI Best Management Practices, the River Authority utilized the comprehensive TBL approach to maximize water quality benefits, alongside other social and environmental multi-benefits, including habitat improvements, urban heat island reductions, increased access to recreation, and climate change implications. With the increasing prevalence and damages of climate change becoming more visible by the day, more than ever this approach to planning is needed to ensure the desired outcomes from infrastructure projects are maximized for every dollar spent.

Table 1. Results Summary of All Sites (1-8) Net Present Value Over 50 Years Discounted at 3%

	Impact	Site 1 (Subbasin 70)	Site 2 (Subbasin 150)	Site 3 (Subbasin 260)	Site 4 (Subbasin 270)	Site 5 (Subbasin 310)	Site 6 (Subbasin 330)	Site 7 (Subbasin 420)	Site 8 (Subbasin 560)
Financial	Capital Costs	-$318,400	-$263,700	-$754,800	-$132,700	-$155,000	-$263,800	-$181,900	-$2,481,000
	Operations & Maintenance	-$450,800	-$543,600	-$1,498,000	-$161,900	-$194,300	-$185,400	-$240,600	-$811,100
	Replacement Costs	-$223,379	-$190,590	-$530,795	-$57,342	-$68,835	-$68,624	-$89,051	-$284,379
	Residual Value	$21,100	$12,700	$35,500	$3,830	$4,600	$4,590	$5,950	$19,000
Social	Flood Risk	$850	$400	$1,156	$72	$221	$93	$221	$647
	Education	$30,915	$0	$30,915	$30,915	$30,915	$0	$0	$0
	Urban Heat Island	$6,700	$3,080	$8,610	$930	$1,120	$1,110	$1,440	$4,620
	Open Space - Recreation	$7,410	$3,250	$1,190	$190	$1,200	$0	$0	$0
	Water Quality - Induced Recreation	$2,126,544	$1,668,031	$2,731,634	$295,244	$354,365	$353,296	$458,359	$767,218
Environmental	Air Pollution from Sequestration	$880	$400	$1,130	$120	$150	$150	$190	$600
	Carbon Emissions from Sequestration	$71,100	$32,700	$91,300	$9,860	$11,800	$11,800	$15,300	$49,000
	Trash	$17,209	$7,846	$22,017	$2,278	$2,784	$2,784	$3,797	$11,895
	Water Quality - Pollutant Loading Reduction	$4,298	$4,412	$11,507	$934	$1,027	$1,363	$982	$3,194
	Pollination	$4,480	$2,062	$5,754	$622	$747	$744	$966	$3,087
Financial NPV		-$971,479	-$985,190	-$2,748,095	-$348,112	-$413,535	-$513,234	-$505,601	-$3,557,479
Social NPV		$2,172,419	$1,674,761	$2,773,505	$327,351	$387,821	$354,499	$460,020	$772,485
Environmental NPV		$97,967	$47,420	$131,708	$13,814	$16,508	$16,841	$21,235	$67,776
Triple Bottom Line-Net Present Value (TBL-NPV)		$1,298,907	$736,991	$157,118	-$6,947	-$9,206	-$141,895	-$24,346	-$2,717,218

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Public-Private Partnerships for Environmental, Social, and Governance Projects: How Private Funding for Infrastructure Can Produce Mutual Benefits for Companies and the Public

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Keywords: Climate Resiliency; Environmental Justice; Environmental, Social, Governance (ESG); Infrastructure; Public-Private Partnerships (PPP); Sustainability

ABSTRACT

The current concern for climate change and social equity in the United States, highlighted by the global COVID-19 pandemic, has increased public attention on environmental, social, and governance (ESG) issues. One of the primary challenges the country faces is the issue of infrastructure, which has a profound impact on environmental and social conditions. Private entities have an opportunity to address ESG factors and improve climate resiliency, environmental justice, and economic opportunity through public-private partnerships (PPPs) that are focused on America's aging infrastructure. It is also an opportune time to initiate infrastructure projects as they align with the Biden Administration's aggressive climate change and economic stimulus plans. This study utilized publicly available information, including sustainability reports, news sources, and research papers, to explore examples of PPPs and current ESG trends, with a focus on environmental criteria, and demonstrated how private investment in infrastructure can produce mutually beneficial results for the private entity and society.

Track 5: Sustainability in Transportation Projects

Moderated by Veronica O. Davis

The Envision® Rating System and its Impact on Transit Agency Projects

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Keywords: Design, Planning, Resilience, Sustainability, Transportation

ABSTRACT

The Institute for Sustainable Infrastructure (ISI) Envision® certification system evaluates the sustainability of infrastructure projects. Envision provides a comprehensive framework to assess how effectively a project has incorporated sustainability considerations.

While the Envision system can be applied to infrastructure projects of all types and sizes, sustainability practices within transit agency projects provide unique and challenging conditions. Agencies are incorporating Envision early in the design and planning process in order to meet their sustainability goals. This tool has proven an invaluable resource to help them communicate and validate their sustainability commitments.

Anthony Kane of the Institute for Sustainable Infrastructure provides an overview of Envision and the certification process. Thomas Abdallah, PE, LEED AP, of New York's Metropolitan Transit Authority Construction and Development (MTA C&D) discusses the evolving impact of using the rating system on recent and upcoming projects and provides specific examples of Envision in practice within the agency. James Heeren, PE, ENV SP, Senior Environmental Engineer at Dewberry, moderates this session which features an overview of the Envision certification and rating process overall, and offers insight as to how the system is being applied to specific projects.

Partially Prestressed GFRP-Reinforced Concrete Piles in a Continuous Flat-Slab Bridge Structure: Inducing Resilience of Civil Infrastructure

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Keywords: Bridge Constructability, Coiled GFRP, Flat-Slab Bridge Structure, GFRP Bridge Deck, Life Cycle Assessment [LCA], Partial Prestressed GFRP Pile

ABSTRACT

Constructability, durability, sustainability, resiliency, and Life Cycle Assessment (LCA) criteria of innovative glass-fiber reinforced polymer (GFRP) reinforcing for structurally reinforced pilings, bridge substructure, bridge superstructure, and soldier-piles bulkhead seawalls are of utmost importance for the longevity of our civil infrastructure systems, components and structural elements alike. This sentiment is echoed herein by a recently completed, first of its kind, GFRP-RC 3-span continuous flat-slab bridge and a soldier-pile bulkhead-seawall with GFRP-RC precast panels, in the State of Florida, USA.

Additional points of interest include the GFRP-RC for the CIP end-bents, intermediate bent caps, and bulkhead caps. The traditional approach includes the installation of grade-60 carbon-steel rebar with three inches or more of concrete cover and a class IV concrete with additional pozzolan material such as silica fume, metakaoline or ultrafine fly ash, especially in the splash zone. As part of this research effort and recently completed bridge project, the utilization of GFRP bars in lieu of the conventional grade-60 carbon-steel rebar in most bridge components and elements, with reduced concrete cover and eliminating the need for pozzolan material in the concrete mix design, is of great benefit. Utilization of the GFRP bars, especially within the splash zone, in South Florida's very aggressively classified marine environment provides an extended time window for required maintenance and substantial cost savings. The primary benefits are a significantly increased service life of the bridge substructure and superstructure and bulkhead-seawall. LCA criteria for unique component/element assemblies have also been investigated.

Finally, constructability and the feasibility of driving of pre-stressed GFRP piles for FDOT bridge structures were demonstrated and documented via Pile Dynamic Analysis [PDA], Pile Integrity Testing [PIT], and ground acceleration vibration monitoring during pile driving for the Ibis Waterway/23rd Avenue bridge in Broward County. Creep testing complemented the field documentation for the installed permanent tieback system at both end bents.

Partially prestressed GFRP-concrete pile constructability

Sustainability and resiliency of the built environment is of significant interest and importance in research, laboratory testing, and field-implementation of GFRP and carbon-fiber reinforced polymers (CFRP) for this Ibis Waterway/23rd Avenue bridge substructure and superstructure, as are constructability, efficiency of installation, and component durability. The overall constructability and performance characteristics of this bridge are documented further in Figure 1, which demonstrates the use of coiled GFRP bars, installation, prestressing, and constructability (including pile driving) of the 0.457m x 0.457m (18in. x 18in.) square GFRP-concrete piles. Partially prestressed GFRP-concrete piles were successfully cast at the precast yard, then constructed and driven at the bridge site, while maintaining FDOT pile driving stress limit compliance as specified by the design and plan approval teams.

(A) Coiled GFRP bar boxed delivery to site | (B) Coiled GFRP bar Casting-Bed insertion | (C) Cage-Assemblies | (D) Coiled-GFRP Prestressed in Beds | (E) Pour of GFRP Piles

(F) GFRP-Cages Crane lifted into Casting-Beds | (G) Stressed Coiled/Cage GFRP-bars | (H) Concrete Placement at GFRP-Piles | (I) GFRP at time of stress release (cut) | (J) GFRP Pile Bed Removal | (K) Pile at Driving Time

Figure 1. Coiled GFRP installation and successful partial prestressing of GFRP piles

Bridge site GFRP-RC substructure and superstructure

Constructability aspects of the bridge substructure and bridge-superstructure were detailed and documented in the field and validated via laboratory testing of the GFRP materials utilized for this project. Figure 2 shows some of the substructure's and superstructure's constructed components.

(A) GFRP-Seawall | (B) Driven GFRP Piles | (C) Tieback Grouting | (D) GFRP Bridge-Deck

Figure 2. Construction and installation of precast GFRP seawall with panel sections, driven GFRP piles, tieback-grouting, creep-monitoring and GFRP bridge-superstructure deck installation with sensor placement

To complement this research effort, LCA criteria for evaluating "green" construction were addressed, comprising the essential raw materials and resources, processing, manufacturing, distribution, usage, and end of life with final disposal stages. The realization of total life cycle impacts as determined via LCA is essential and necessary to realizing carbon-neutral construction goals and can be validated through ISO 14040 and 14044 Standards.

The use of ISO 14040 and 14044 Standards is deemed beneficial with respect to obtaining a highly desirable level of reliable, relatively unbiased data analysis and consistency of results.

In summary, "Lessons Learned" about the sustainability, constructability, and driveability of GFRP-reinforced piles in relatively loose to very dense soil conditions is showcased in this project.

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Design Ideals for Extreme Heat Resiliency: Applications in Public Transit Systems

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Keywords: Bus, Heat, Public, Rail, Resiliency, Transit

ABSTRACT

Urbanization and climate change are forcing an increasing number of people around the world to live in extreme conditions, especially extreme heat. Unaddressed, extreme heat can have profound negative impacts on the infrastructure upon which society relies. Public transit and other essential systems must be designed such that they can withstand extreme heat events, ensuring that users remain comfortable and the system is protected from degradation. Burns & McDonnell has been collaborating with a major United States county transportation authority to suggest and implement into new light rail designs features that ensure extreme heat resiliency for the system. These features can be found in all components of the light rail system including the track, overhead catenary lines, vehicles, and stations/platforms. For example, track damage can be forestalled by adding automated weather stations and track-side probes that monitor temperature data in remote areas of track, and passenger platforms can be made cooler by evaluating alternative deck section designs that reduce concrete mass and thus reduce heat absorption. Extreme heat resiliency has also been explored in the context of bus system design through the optimization of street furniture placement. Building on these examples, this study focuses on the importance of designing infrastructure systems with extreme heat resiliency, applications of how this has been done for public transit systems, and how these applications can be adapted to other projects. It is crucial that infrastructure systems be designed to withstand and recover from extreme heat events, whether they are expected or not.

Management Practices & Data Tools for Large, Multi-disciplined Infrastructure Projects Pursuing Envision Certification

Gordie Howe International Bridge:
P3 Project Leadership Vision to Enhance Sustainability Performance

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ABSTRACT

When the $5.7 billion (CAD) public-private partnership opens to the public in 2024, the Gordie Howe International Bridge project is anticipated to be one of few river crossing projects and the first international border crossing project to achieve an Envision award from the Institute for Sustainable Infrastructure.

The project's sustainability strategy includes an overall sustainability management plan and a twofold certification approach: LEED for the two Port of Entry plazas and Envision for the Main bridge and Michigan Interchange. An extensive integrated process includes the Owner (WDBA), Owner's Engineer (Parsons), Developer (BNA), and Design team (AECOM) to refine and document sustainable strategies over the course of the design-build phase.

Close collaboration led to increased Levels of Achievement for credits targets across the Envision rating system, in particular in the Quality of Life and Climate and Risk categories. Emphasis is placed on:

- Advantages of a combined prescriptive and performance approach driven by the Project Agreement, which defined sustainability objectives and mandated certification levels, while allowing the Developer to develop detailed strategies in the Sustainability Management Policy.
- Complexities of implementing multiple rating systems within a single project, e.g., defining relevant key performance indicators and associated benchmarks and targets.
- Sustainability benefits achieved due to close collaboration and relationship-building among project team members, e.g., leveraging planning phase and other Owner-driven initiatives to advance the ISI award target.
- Opportunities and challenges presented by the P3 project delivery method.

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