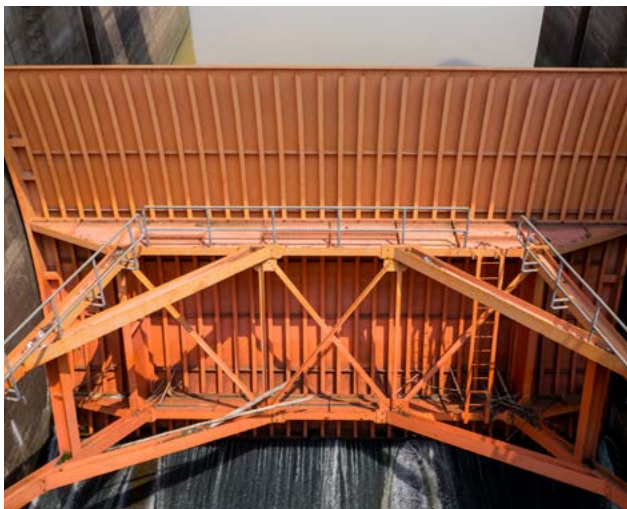
U.S. ARMY CORPS OF ENGINEERS

CIVIL WORKS RESEARCH, DEVELOPMENT & TECHNOLOGY STRATEGY

U.S. ARMY

US Army Corps of Engineers



FOREWORD

For nearly 250 years, our nation has called upon the U.S. Army Corps of Engineers (USACE) to solve many of its most pressing engineering challenges. It is a task our diverse and talented workforce has answered time and again. And yet, our mission continues to grow ever more complex. Faced with such increasing stressors as aging infrastructure, more frequent and powerful storms and new environmental concerns, we must discover new methods to overcome new challenges. Advancements such as Generative Artificial Intelligence, advanced materials, remote sensing, computational power and autonomy offer opportunities to accelerate more accurate and targeted decision support, supplementing our world-class expertise with cutting-edge scientific knowledge, engineering research and technological development.

"The Civil Works RD&T Strategy is not just a document but a blueprint for the future of USACE and the nation's natural and built infrastructure."

This Civil Works Research, Development and Technology (RD&T) Strategy is a comprehensive guide that outlines how USACE plans to tackle these challenges head-on, leveraging research and development, innovation, collaboration and practical solutions. By focusing on resilience and sustainability, the Strategy addresses both current and future challenges, ensuring that our natural and built infrastructure can withstand and adapt to various stresses. This emphasis is vital for long-term national security, economic stability and community resilience.

This strategy highlights the importance of meeting immediate operational needs, while remaining focused on long-term goals. We are guided by our six Strategic Focus Areas: Infrastructure; Water Modeling; Sediment Management; Ecosystems; Crisis Preparedness; and AI, Robotics, and Data.

Our challenges are too big to solve alone. Collaboration with government, academia and industry partners broadens the scope of our R&D efforts and ensures we remain on the cutting edge. This collaborative approach leverages external expertise and resources, enhancing the overall impact of our initiatives. We strive to engage with internal and external stakeholders from the earliest stages of a project through completion, sharing knowledge to find the best solutions together.

Along with partnering to solve challenges, another of the Strategy's core strengths is its focus on transitioning technologies from the development phase to practical application. Planning for intentional transition of technology at the initiation of R&D ensures that innovations are tested, validated and integrated into real-world projects that provide tangible benefits to the nation.

The Civil Works RD&T Strategy is not just a document, but a blueprint for the future of USACE and the nation's natural and built infrastructure. It is a call to action to work together to build a resilient, sustainable and innovative future.

Let's continue to make a difference!

Dr. Ty Wamsley
Director, Coastal & Hydraulics Laboratory
U.S. Army Engineer Research & Development Center

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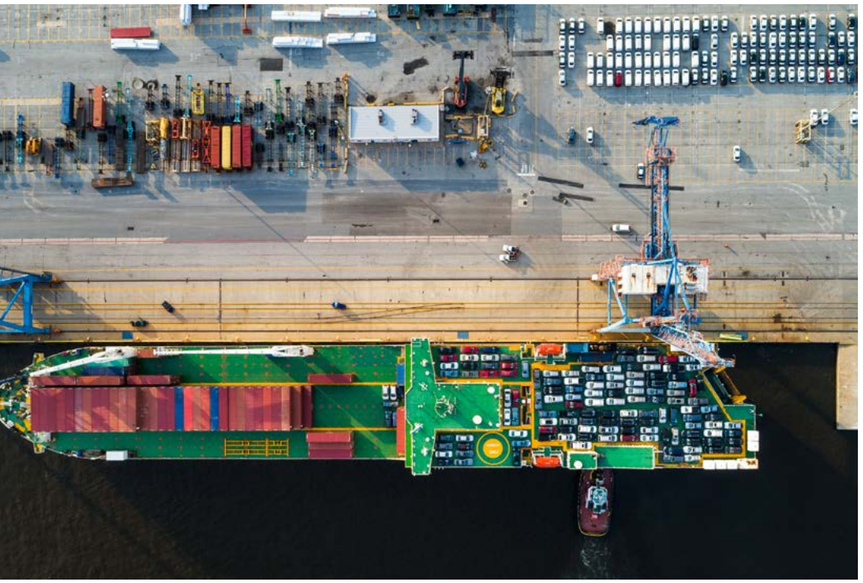


VISION

The Civil Works RD&T vision is to ensure a safer, more prosperous, and more resilient nation.

CIVIL WORKS RD&T VISION

The U.S. Army Corps of Engineers (USACE) faces critical challenges, including aging infrastructure and a changing environment. USACE solves these challenges through innovation in science, engineering and technology to ensure the resilience of the nation's infrastructure and water resources. This Strategy outlines the USACE Civil Works (CW) Research, Development and Technology (RD&T) framework, focusing on innovation, collaboration and practical solutions.

> "USACE aims to meet current needs and prepare for future challenges, enhancing the nation's water resources, enabling economic growth, and promoting public safety."

Using phases of the Technology Innovation Strategy (TIS) — Discover, Develop, Deliver, Sustain and Connect — USACE aims to meet current needs and prepare for future challenges, enhancing the nation's water resources, enabling economic growth and promoting public safety.

MISSION AND STRATEGIC PRIORITIES

The USACE Civil Works missions focus on the development and management of the nation's water resources. As the nation's engineer, USACE Civil Works missions support commercial navigation, aquatic ecosystem management, flood and coastal storm risk management and engineering services, emergency operations, recreation, hydropower, water supply and regulatory program and permitting. The Civil Works Strategic Priorities rely on innovative decision making, financing, adaptive management and state-of-the-art technology; and include upgrading waterways and ports, building resilient infrastructure, modernizing civil works programs, investing in science and R&D, and strengthening communication and relationships.

TECHNOLOGY INNOVATION STRATEGY

The USACE TIS supports these initiatives by fostering innovation across mission requirements, business processes and technology. The TIS framework ensures a balanced approach in developing and deploying near- and far-term technological capabilities.

VISION AND MISSION

The Civil Works R&D vision is to ensure a safer, more prosperous and more resilient nation. The mission addresses challenging CW problems through innovative science and engineering, achieved through the Technology Innovation Strategy Framework.

This integrated approach addresses both current and future engineering challenges, enhancing the resilience, safety and sustainability of the nation's infrastructure and environmental management practices.

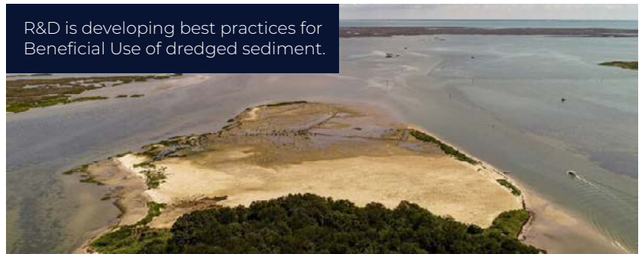
STRATEGIC FRAMEWORK

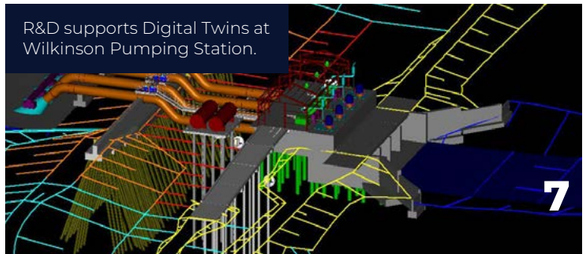
The Civil Works RD&T Strategy is implemented via the TIS framework in collaboration with USACE elements, stakeholders and partners from government, academia and industry. Partnerships are critical to increase awareness of emerging technologies, accelerate innovation and transition technology into practice. Implementation of each phase of the TIS is as follows:

- **Discover**: Matches mission requirements with current and emerging technologies by continuously scanning the global science and technology landscape to leverage opportunities.
- **Develop**: Transforms ideas into practical solutions through R&D, involving experimentation, testing and evaluation, in partnership with USACE elements and often through external partner collaboration.
- **Deliver**: Transitions technologies from development to practical use, demonstrating and validating them on actual projects and refining them based on lessons learned.
- **Sustain**: Integrates new technologies into standard practice through doctrine, training, communication and governance, ensuring they remain effective and updated.
- **Connect**: Focuses on knowledge management, fostering innovation by connecting people to knowledge and each other, and sharing lessons learned across the organization to enhance global collaboration and awareness of new technologies.

> "The USACE R&D priorities are effectively implemented through the TIS framework, ensuring that innovative technologies are discovered, developed, delivered, sustained and connected across the organization."


R&D supports mitigation controls for Invasive Carp.


R&D is developing best practices for Beneficial Use of dredged sediment.


R&D supports Digital Twins at Wilkinson Pumping Station.

PORTFOLIO OVERVIEW

The Civil Works mission is to deliver vital engineering solutions, in collaboration with our partners, to secure our nation, energize our economy and reduce disaster risk.

PORTFOLIO OVERVIEW

The USACE Civil Works (CW) program manages infrastructure to withstand hazards, enhance economic competitiveness and ensure sustainability. Facing more than $98 billion[1] in deferred construction and $2.4 billion annually[2] in potential maintenance costs, key issues include navigation outages, costly dredging and $100 billion annually[3] in water-related disaster damages since 1995. Invasive species cause $120 billion in annual costs[4]. Opportunities exist to leverage 200 million cubic yards of dredged sediment for beneficial use to increase environmental and flood risk management benefits. The CW mission, crucial for economic recovery, job creation, public health and security, focuses on delivering vital engineering solutions, in collaboration with partners, to secure our nation, energize our economy and reduce disaster risk.

ADDRESSING NEAR-TERM & GRAND NATIONAL CHALLENGES

The CW RD&T Strategy employs a dual approach: addressing immediate capability gaps and inefficiencies while focusing on long-term transformative research. This approach involves prioritizing science and technology requirements based on field needs to ensure regional requirements are met through engagement with the CW RD&T program.

By leveraging the Planning, Programming, Budgeting and Execution (PPBE) process, the Strategy aligns with long-term national challenges, promoting infrastructure resilience and economic benefits. This Strategy not only addresses short-term needs but also fosters innovation to tackle grand national challenges, ensuring the USACE CW program remains effective and efficient. Investing in innovative CW RD&T is crucial for realizing significant economic and societal gain.

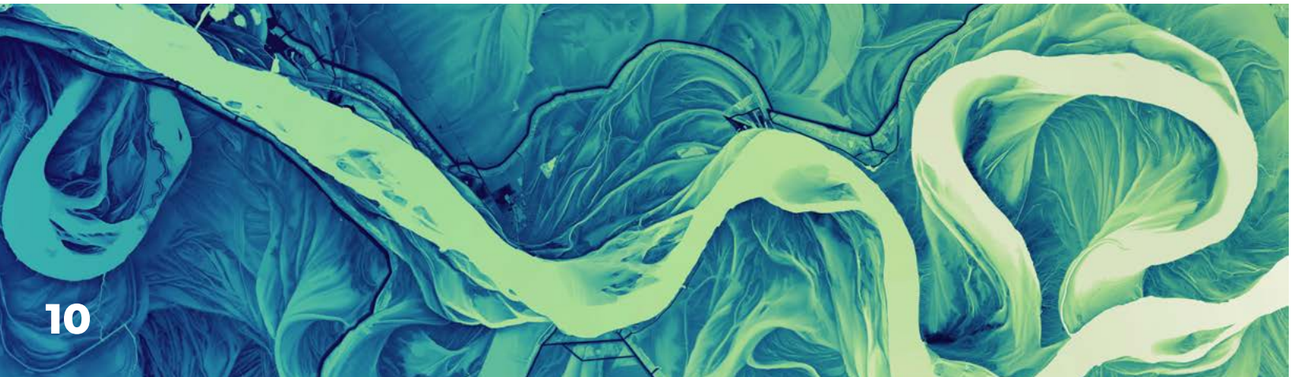
TYPES OF CIVIL WORKS RD&T

The USACE Civil Works (CW) RD&T program is multifaceted, encompassing Strategic and Tactical R&D, R&D Facilities, Data & Technology Programs, and support to USACE Division-Led innovations. This comprehensive approach ensures the program can meet both immediate operational needs and long-term strategic goals.

STRATEGIC R&D

The CW RD&T Strategy addresses grand challenges with innovation across six Strategic Focus Areas (SFAs):

- **Infrastructure**: Tackles aging infrastructure with advanced materials, corrosion prevention and resilience. Capabilities include non-destructive evaluation, asset monitoring and risk-informed decision support to modernize infrastructure and reduce downtimes.
- **Water Modeling**: Creates a continental-scale framework to integrate Earth observations and understand interactions between natural and built components of the water cycle to improve risk-informed decision support for flood risk, drought, hydropower and infrastructure performance.
- **Sediment Management**: Focuses on sustainable sediment management with forecasting, pollutant management and next-gen dredging technologies. Public-private partnerships aim to increase beneficial use of dredged sediment to 70% by 2030.
- **Ecosystems**: Enhances ecosystem restoration and invasive species management with advanced detection technologies, environmental health monitoring, and rapid response to environmental changes impacting USACE mission delivery.
- **Crisis Preparedness**: Ensures infrastructure performance under pressure by developing crisis modeling, hazard prediction, and recover-mitigation enabling technologies, aiming to break the disaster-damage-repair cycle and snsure operational continuity.
- **AI, Robotics & Data**: Leverages data science and computing, integrating Artificial Intelligence/ Machine Learning (AI/ML) capabilities, high-performance computing and data analytics into decisions. Innovations include sensor and model integration and rapid decision-support tools for optimized project delivery and data-driven decision support across CW mission areas.



Tactical R&D is improving Shoreline Evolution Modeling.

TACTICAL R&D

Tactical R&D supplements Strategic R&D by addressing near-term operational needs that require two to three years to deliver innovations to meet immediate field requirements. These needs, identified by field practitioners through Statements of Need (SONs) prioritization, emphasize rapid delivery to the field.

Tactical R&D ensures mission priorities needing rapid solutions are met quickly. This rapid response capability is crucial for addressing unforeseen challenges and ensuring the CW program can effectively adapt to immediate demands.

CW R&D Facilities measure beach conditions using the Lighter Amphibious Resupply Cargo vessel (LARC).

R&D FACILITIES

A component of the CW RD&T Strategy supports R&D facilities, such as the USACE Field Research Facility (FRF) in Duck, N.C. The FRF is an international coastal observatory with a 40-plus-year record of waves, currents, bathymetric change and documented impacts of storms and long-term climatology pertinent to the USACE Coastal Storm Risk Management, Environmental, and Navigation missions. Historical and near-real-time data are utilized to develop, refine and validate models, and emerging and cutting-edge technologies. Overall, this component of the Strategy is intended to provide critical R&D facilities required to discover, develop, test, refine and validate advanced technologies and improve delivery of innovations into practice.

DATA AND TECHNOLOGY PROGRAMS

Data and Technology Programs provide support to CW R&D activities and USACE CW practitioners via national data collection, operational support, field demonstrations of emerging technologies, and training across various CW mission areas. Integration of emerging and existing operational technology and support of implementation is essential for the Delivering and Connecting phases of the TIS.

Data and Technology programs focus on dredging, regional sediment management, water operations and navigation technical support.

SUPPORT TO USACE DIVISION-LED INNOVATIONS

This Strategy calls for deliberate engagement between CW RD&T and USACE Division Science and Technology Program Managers and others in divisions to meet national short-term needs (through Tactical R&D Statement of Nedd process and/or reimbursable studies) as well as regional mid-term innovation requirements. Divisions and RD&T will work together, using the PPBE process to address needs and leverage direct RD&T programs as appropriate. Near-term, project-specific needs requiring rapid delivery will also be met through reimbursable-supported, project-specific funds. This collaboration ensures that regional and project-specific innovations are supported effectively, enhancing the overall impact of the CW program.

R&D partners with USACE Divisions to implement Fiber Reinforced Polymers at Miter Gates.

HIGHLIGHTS

The USACE Civil Works RD&T Program is multifaceted, encompassing Strategic and Tactical R&D, R&D Facilities, and Data & Technology Programs to support implementation, operations, and cross-cutting innovative R&D.

STRATEGIC R&D HIGHLIGHTS

USACE is leading the charge in a comprehensive R&D initiative focused on addressing critical challenges in water resources management and environmental sustainability. This strategic effort is structured around six Strategic Focus Areas (SFAs) aimed at enhancing infrastructure resilience, ecological health and disaster preparedness through innovative technologies and methodologies. The following are examples highlighting strategic R&D projects that demonstrate how these initiatives are shaping the future of Civil Works, providing an example of R&D highlighted within each Strategic Focus Area..

Infrastructure: Additive Manufacturing

USACE faces significant challenges in maintaining and managing aging Civil Works infrastructure crucial for navigation and flood risk management. As these components age, the need for rapid and cost-effective manufacturing methods intensifies.

Traditionally, components were produced through casting or forging, which are efficient for mass production but less so for smaller quantities. Recent advancements in large format additive manufacturing have transformed this landscape. Arc-directed energy deposition and additive friction stir deposition techniques now allow for the creation of cost-effective, large-scale metal infrastructure components.

Additive Manufacturing supports replacement of vintage components.

A component of the Infrastructure SFA is focused on Additive Manufacturing.

USACE is leveraging these breakthroughs to meet current supply demands, especially for crafting vintage components essential to mechanical and structural systems in CW projects. By using large format additive manufacturing, USACE is accelerating manufacturing times by up to tenfold compared to traditional methods, enhancing its ability to modernize component designs and materials.

Large format additive manufacturing marks a leap in manufacturing capabilities to support rapid response needs for replacement parts and bolster infrastructure resilience. This technology addresses immediate supply challenges and positions USACE at the forefront of innovation in civil engineering, ensuring readiness to meet future infrastructure demands efficiently and effectively.

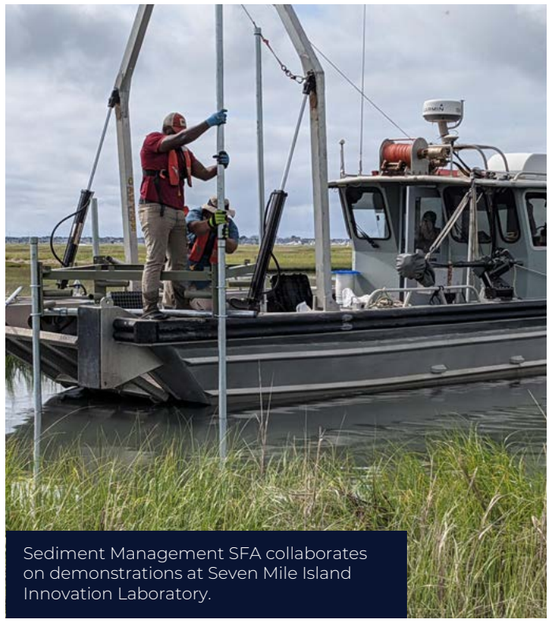
"USACE is leading the charge in a comprehensive R&D initiative focused on addressing critical challenges in water resources management and environmental sustainability."

Water Modeling: Coastal Hazards Analysis and Risk Toolkit

Coastal regions face increasing risks from storm damage and flooding. These hazards demand advanced tools to evaluate compound flooding scenarios, a challenge for current models.

Current Coastal Storm Risk Management (CSRM) studies rely on models that require substantial multidisciplinary effort to meet existing planning requirements. To address these limitations, CW R&D is developing a new tool suite to replace legacy models, promising improved capabilities, accuracy and user experience. Integrated into the Civil Works Business Intelligence cloud-based infrastructure, this suite allows seamless implementation and scalability.

The Coastal Hazards Analysis and Risk Toolkit (CHART) streamlines data preparation and analysis for CSRM studies. By improving accuracy, transparency and confidence in results, CHART supports informed decision-making and justifies USACE investments in coastal protection and environmental restoration. Investing $6.5 million over five years in this suite is expected to save $5 million annually in CSRM study costs and accelerate study timelines.



Sediment Management SFA collaborates on demonstrations at Seven Mile Island Innovation Laboratory.

The Water Modeling SFA is streamlining CSRM study applications with CHART.

Sediment Management: Dredged Material Placement on Wetlands

Coastal wetlands, marshes and tidal flats are increasingly threatened by flooding, resulting in degradation and heightened vulnerability to future flood impacts. These ecosystems support diverse wildlife and mitigate coastal storm risks.

Historically, sediment dredged from navigation channels was disposed of in confined facilities or ocean sites, removing it from the ecosystem. Recognizing the benefits of reusing dredged material, USACE now places sediment in wetlands and tidal flats, promoting sustainability by replenishing eroded habitats and enhancing natural flood protection.

In New Jersey, wetlands are particularly vulnerable to biodiversity loss and flood risks. The New Jersey Intracoastal Waterway exemplifies these challenges with shoaling issues. In response, ERDC collaborates with the USACE Philadelphia District, The Wetlands Institute, state authorities and stakeholders. The Seven Mile Island Innovation Laboratory (SMIIL) was established by this group in 2019 to test beneficial uses of dredged material within the Cape May Wildlife Management Area.

Since then, SMIIL has placed more than 100,000 cubic yards of dredged material at sites like Sturgeon and Gull Islands, mitigating the impacts of erosion. This initiative ensures coastal wetlands' sustainability and resilience, demonstrating the USACE commitment to innovative coastal management.

Ecosystems SFA developed EcoRest with certified habitat index models.

Ecosystems: Improving USACE Ecological Modeling Practices

USACE planners needed rapid analysis of ecological impacts for proposed aquatic ecosystem restoration projects. In response, researchers developed a streamlined process for creating sensitive ecological models aligned with USACE plans. These models are easy to implement within tight schedules and budgets, ensuring scientific validity.

ERDC established standardized platforms for executing habitat index-based models, ensuring consistency and comparability. The EcoRest statistical package features more than 100 certified habitat suitability index models, offering diversity and flexibility for specific project needs.

A rapid group-mediated process produces validated models in as little as three days through interactive workshops. These innovations allow USACE to quantify environmental benefits swiftly, enhancing decision-making confidence and optimizing project budgets.

USACE mandates using ecological models to forecast environmental impacts for all aquatic restoration planning studies. The EcoRest package facilitates rapid model deployment and empowers users to create new models within a robust framework, advancing consistency in modeling practices. This approach has proven successful in major projects, demonstrating substantial improvements in modeling efficiency and cost-effectiveness.

Crisis Preparedness: Wildfire Emergency Assessment & Management

Wildland fires in the U.S. are increasingly severe due to extreme weather and urban development. These fires pose significant post-fire risks, including dramatic increases in flood and debris flow intensity, impacting the USACE Flood Risk Management mission and water infrastructure.

To address these challenges, researchers developed advanced modeling and decision-support tools to predict high-risk areas for post-fire floods and debris flows. By integrating non-Newtonian physics, USACE has enhanced its ability to estimate these risks, enabling better planning and design of flood control measures.

Crisis Preparedness SFA advances post-wildfire flooding and debris flow models.

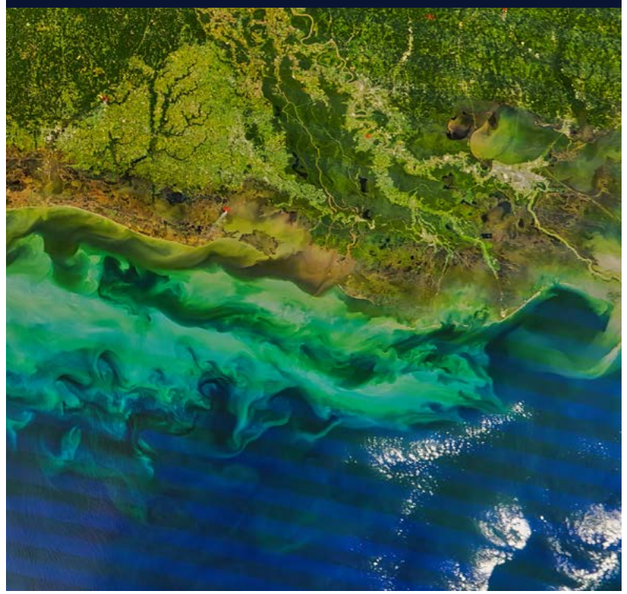
From 2019 to 2022, wildfires burned more than 29 million acres, highlighting the need for dynamic risk assessment. CW R&D efforts collaborated with 50 communities and tribal nations to identify vulnerable regions and improve emergency response strategies.

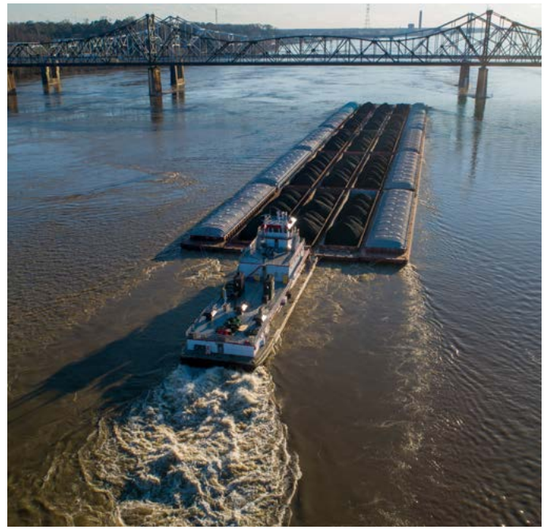
These tools offer near real-time support for water management and evacuation planning, providing an 8:1 return on investment in pre-hazard mitigation. USACE continues to mitigate post-fire flooding impacts, ensuring resilience in fire-prone regions.

AI, Robotics & Data: Numerical Model Modernization

Comprehensive water resource projects require sophisticated design, operation and decision support systems to manage water-related risks effectively. However, the complexity of current numerical models and workflows often hinders their application, leading to extended timelines and heightened costs. The Numerical Model Modernization (NMM) effort advances integrated numerical modeling technologies within a cloud computing framework, supporting missions in Flood Risk Management, Navigation and Aquatic Ecosystem Restoration.

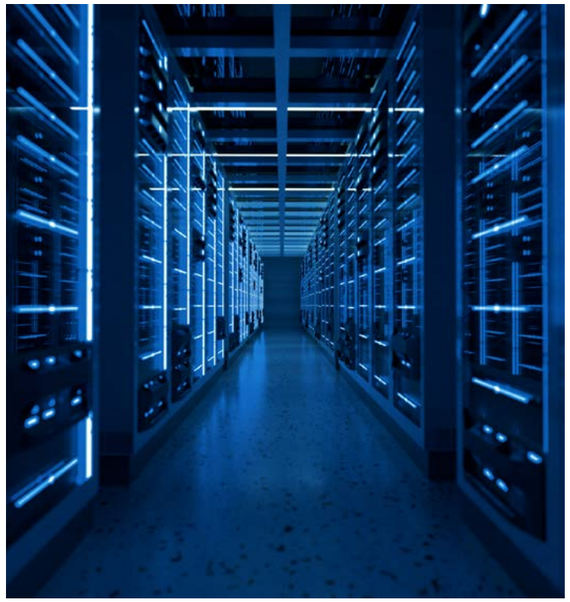
AI, Robotics & Data SFA's Numerical Model Modernization integrates technologies in cloud computing framework to integrate across large spatial regions with complex environmental forcing conditions.





Existing numerical models suffer from intricate code structures, lack of compatibility, outdated interfaces, inadequate documentation and limited accessibility. NMM addresses these challenges by restructuring models for cloud deployment, featuring modular coding, modern graphical interfaces and improved documentation.

These products streamline software maintenance, reduce development costs and offer robust, scalable numerical model codes and workflows to enhance USACE's capability to address evolving water resource challenges effectively.



Tactical R&D improves River Analysis System (HEC-RAS) modeling with 2D Bridges.

R&D Facilities supports data collection with the Coastal Research Amphibious Buggy (CRAB).

TACTICAL R&D HIGHLIGHTS

Tactical R&D includes activities aimed at addressing time-sensitive challenges impacting the CW mission that require rapid innovation through science and technology as identified through field generated requirements or other sources. Highlights herein provide examples of Tactical R&D activities.

The GenCade shoreline model, essential for planning coastal erosion protection, incorporates enhancements for cross-shore sediment transport and Monte Carlo simulations, aiding decisions on beach fills and coastal structure design. This refined model offers a comprehensive understanding of shoreline dynamics.

USACE's use of remote sensing technology in the Engineering With Nature® project approach quantifies the impact of nature-based solutions. Advanced remote sensing tools improve project design, performance and risk reduction, enabling consistent benefit quantification and transforming sustainable infrastructure practices.

Lastly, the Hydrologic Engineering Center - River Analysis System (HEC-RAS) and Adaptive Hydraulics (AdH) 2D models, crucial for simulating flow at bridges, have been enhanced to better handle pressurized flow, submerged scenarios and overtopping. This advanced 2D flow solver significantly improves hydraulic modeling capabilities.

R&D FACILITIES HIGHLIGHTS

This component of the CW RD&T Strategy supports critical R&D facilities required to discover, develop, test, refine and validate advanced technologies to improve delivery of innovations into practice presently represented by the USACE Field Research Facility (FRF), through the Coastal Field Data Collection (CFDC) program. CFDC leverages the unique capabilities of the FRF in Duck, N.C., to gather continuous in situ meteorological and oceanographic data. For more than 40 years, CFDC has collected measurements of winds, waves and currents in the nearshore, including the surf zone. These data capture storm impacts on coastal change, supporting high-resolution process studies.

Innovative instrument deployment methods enable detailed analysis of the surf zone, crucial for understanding coastal processes. The availability of this data has significantly advanced coastal research.

The beaches near the FRF are considered the most studied beaches globally, underscoring the program's impact. These data are essential for studying the vulnerability of coastal infrastructure to storms and long-term changes, addressing the challenges posed by extreme coastal forces.

DATA & TECHNOLOGY PROGRAM HIGHLIGHTS

Data & Technology programs deliver, sustain and connect R&D knowledge and technologies with USACE practitioners. These programs are a critical component of the CW RD&T Strategy, providing operational data; supporting workshops and training; providing data and analyses to validate new project designs; developing and reporting national databases; and supporting field demonstrations for project-specific applications.

The Regional Sediment Management (RSM) program supports the demonstration of sustainable RSM solutions spanning navigation, coastal and flood risk management, and ecosystem restoration missions. RSM supports project-specific demonstrations and documents best practices, technologies and approaches to assist in RSM implementation in coastal, riverine and reservoir systems. RSM supports the Beneficial Use database that leverages historical dredging data from the USACE Dredging Information System. The database facilitates viewing of dredging quantities and placement types at the local and national scale by fiscal year, USACE district and division. Beneficial use of dredged sediment provides opportunities for additional environmental, recreational, flood and coastal storm risk reduction and economic benefits.

RSM's Beneficial Use Database tracks BU across USACE Districts and Divisions.

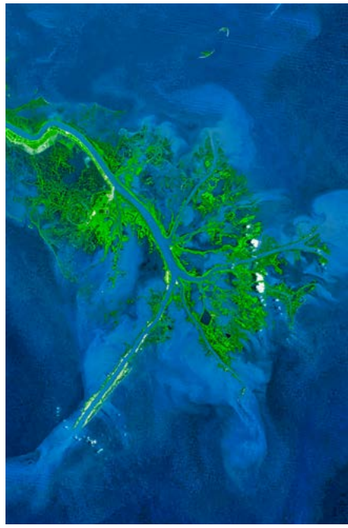
SUPPORT TO USACE DIVISION-LED INNOVATION HIGHLIGHTS

CW RD&T provides support to USACE Science and Technology Program Managers who facilitate infusion of new technologies in each Division through planning, programming, budgeting and executing new approaches, methods and technology to enhance the delivery of USACE missions.. As an example, USACE is pioneering the use of Fiber Reinforced Polymers (FRP) to repair fatigue cracks in Hydraulic Steel Structures (HSS). These structures, vital in wet and corrosive environments, face rapid deterioration from fatigue cracking, posing integrity risks and necessitating costly repairs. Traditional repair methods are time-consuming and often ineffective.

Recent studies focused on Carbon Fiber Reinforced Polymer (CFRP) and Basalt Fiber Reinforced Polymer (BFRP) patches, demonstrating their ability to halt crack propagation in harsh conditions. BFRP shows superior fatigue life compared to CFRP underwater and in sediment-laden environments.

This innovation promises extended service life for HSS, reducing repair times from months to days and minimizing disruptions to navigation and transportation. By avoiding shutdowns that reroute maritime traffic and transport logistics, FRP repairs offer an environmentally sustainable solution.

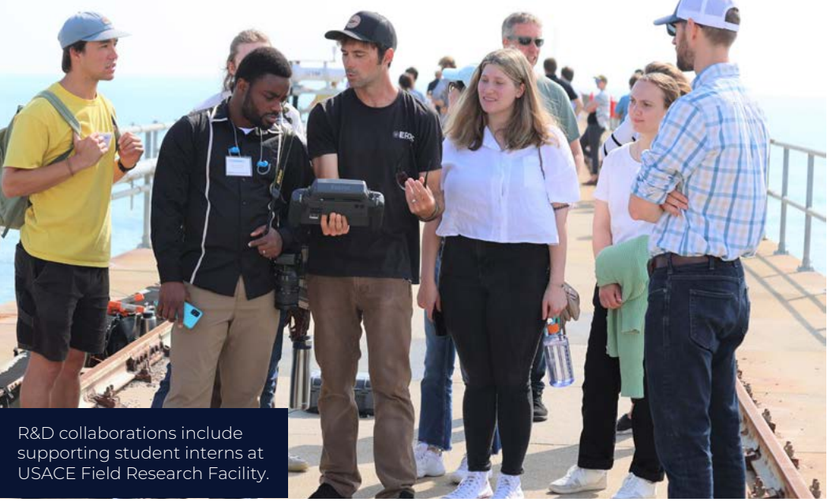
The USACE commitment to division-led innovations underscores its leadership in infrastructure resilience. By harnessing FRP technology, USACE ensures robust, cost-effective and sustainable solutions for maintaining critical waterway structures nationwide.



CW RD&T partners with USACE Districts to transition Fiber Reinforced Polymer innovations for Hydraulic Steel Structure projects.

COLLABORATION & PARTNERSHIP

The USACE Civil Works RD&T Strategy emphasizes collaboration and partnering as key enablers, both internally and externally.



R&D collaborations include supporting student interns at USACE Field Research Facility.

USACE RD&T COLLABORATIONS AND PARTNERSHIPS

The innovation landscape is evolving, shifting from a science-based approach to a network-based model. This shift underscores the importance of collaboration and partnering to advance the frontier of new knowledge and create new products. As noted by George Mason University Professor Philip Auerwald, this network-based innovation places more emphasis on the user/practitioner community to identify future technical capability needs, prioritize opportunities for innovation, shape and demonstrate new capabilities, and sustain them through training and incorporation into policy. This transformation highlights the necessity for organizations to enhance both internal and external connectivity, embracing the concept that many significant advances are as much the result of SEARCHING as they are of RESEARCHING.

Collaboration and Partnering

The USACE CW RD&T Strategy emphasizes collaboration and partnering as key enablers, both internally and externally. Collaboration broadens opportunities for new research, leverages resources and strengthens the entire CW enterprise. To stay at the forefront of innovation, USACE must engage with global R&D and technology communities, discovering new opportunities for collaboration. Early and continuous engagement with stakeholders is critical for facilitating the discovery, development and transition of knowledge, data and tools. Partnering with agencies, academia and industry on topics of joint interest leverages team excellence to develop world-class solutions transparently and openly. Moreover, partnering with universities helps build relationships, cultivate the next generation of professionals, and connect USACE to the basic research community and new ideas.

Stakeholders and Partners

Each USACE mission area has different funding sources, stakeholders, authorities and processes that enable mission accomplishment. These partners are crucial in defining requirements, assessing innovative technologies and securing necessary resources.

Each major USACE CW mission area benefits from outstanding partnerships in academia, industry, other government agencies and international allies. Innovations in technology and their applications to CW mission areas benefit greatly from these partnerships. Technologies and capabilities developed for one mission can be useful across multiple areas, providing for and leveraging additional benefits.

USACE Headquarters, Divisions and Districts

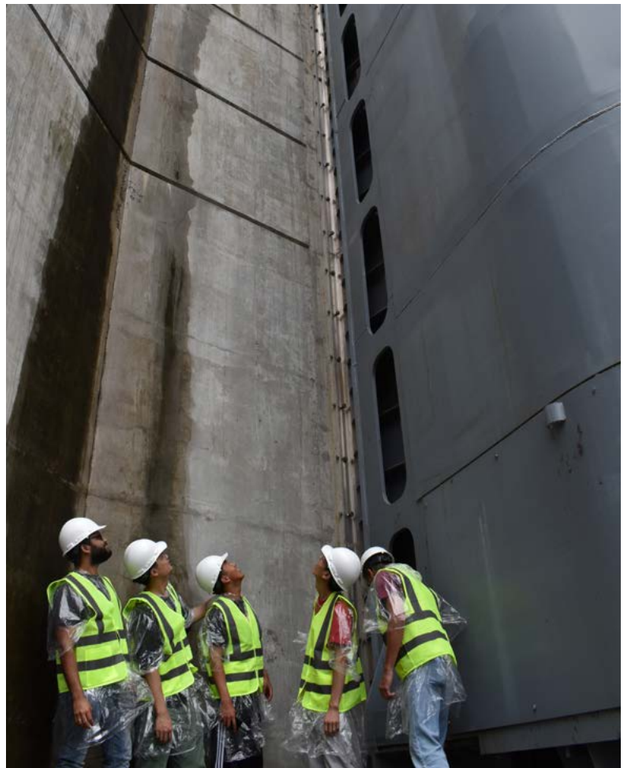
Leadership in USACE headquarters, divisions, districts and centers is important for driving the efforts necessary to achieve the Strategy's full potential. Recognizing and embracing the risks associated with transformative research and innovative technology implementation is critical.

USACE headquarters elements play a key role in identifying strategic requirements, sustaining and connecting collaborative efforts and supporting all tenets of the Technology Innovation Strategy. Headquarters will communicate strategic needs to the Directorate of Research and Development, leveraging internal and external partnerships and collaborations.

As the executors of USACE projects worldwide, divisions and districts are essential in implementing innovative technologies in project delivery. With assistance from the RD&T community, Centers of Expertise (CXs), and Communities of Practice (CoPs), they must be aware of new technologies, plan for their integration, and foster an environment where technology adoption is standard practice. Division Science and Technology Program Managers play a crucial role in identifying regional innovation needs and helping Deliver, Sustain, and Connect innovations. An innovation-focused business tenet, where prudent risk-taking in implementing new technology is accepted and expected, is essential for realizing the benefits of new capabilities and revolutionizing program delivery. Divisions and districts will be pivotal in delivering the CW RD&T Strategy and supporting all other tenets.

Centers of Expertise (CXs) and Communities of Practice (CoPs)

The role of CXs and CoPs in identifying requirements and ensuring the successful transition of technology from development to implementation is critical. They ensure the latest planning, design, construction, operation and maintenance procedures, techniques, methods and technologies are used appropriately on USACE projects. Acting as key integrators between technology development and practice, they are aware of the latest capabilities being developed and the projects being planned and executed by divisions and districts. Their deliberate and timely pursuit of new technologies drives the pace of USACE innovation. CXs and CoPs play a key role in sustaining the Technology Innovation Strategy, particularly in doctrine development and training, and in supporting all other tenets.



The USACE approach to RD&T collaboration and partnering is a comprehensive approach designed to leverage internal and external resources, ensuring the rapid and effective implementation of innovative technologies. By engaging with a range of stakeholders, including academia, industry and other government agencies, USACE can advance its mission areas. The integration of new technologies and innovative practices across the CW enterprise is crucial for addressing immediate operational needs and achieving long-term strategic goals. This approach strengthens USACE capabilities and ensures it remains at the forefront of innovation in infrastructure management and environmental sustainability.

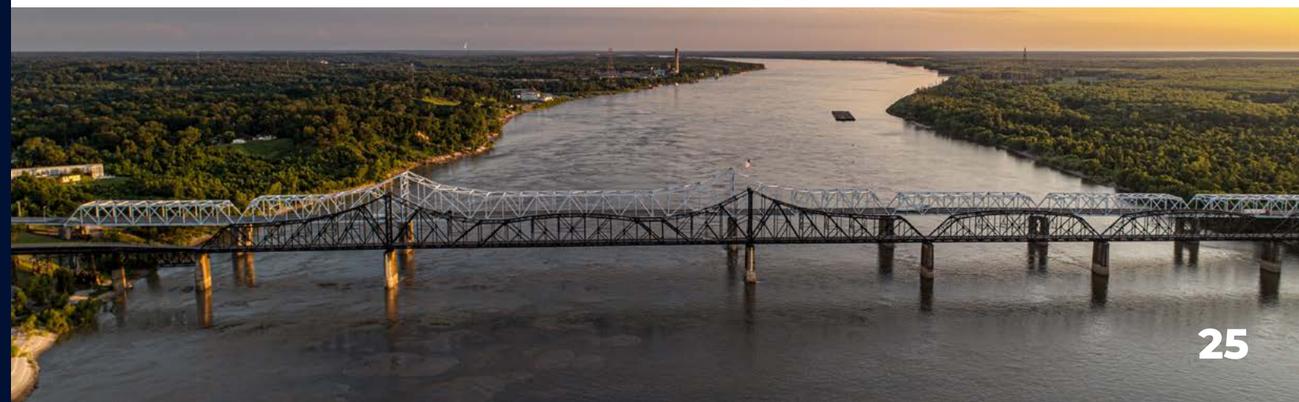
R&D collaborates with academia to test innovative methods for nearshore coastal monitoring.

R&D supports crowd-sourced community science such as CoastSnap.

USACE is tasked with addressing some of the most pressing civil engineering challenges of our time. To meet these challenges head-on, USACE leverages advances in science, engineering, and technology, preparing for future needs while addressing current ones. This forward-looking vision is essential to maintaining the resilience, safety and sustainability of the nation's infrastructure and environmental management practices.

This USACE CW RD&T Strategy is a comprehensive approach addressing both immediate operational needs and long-term strategic goals. By focusing on strategic, tactical, facility-focused, data/technology-driven, and innovative RD&T efforts, the CW program can effectively manage infrastructure challenges, enhance economic competitiveness and ensure environmental sustainability. Investment in these diverse RD&T areas will help realize significant economic and societal gains, ensuring the USACE CW program remains effective and efficient in the face of evolving challenges. This multifaceted approach addresses the current demands and positions the CW program to tackle future challenges with agility and innovation.

"This forward-looking vision is essential to maintaining the resilience, safety and sustainability of the nation's infrastructure and environmental management practices."



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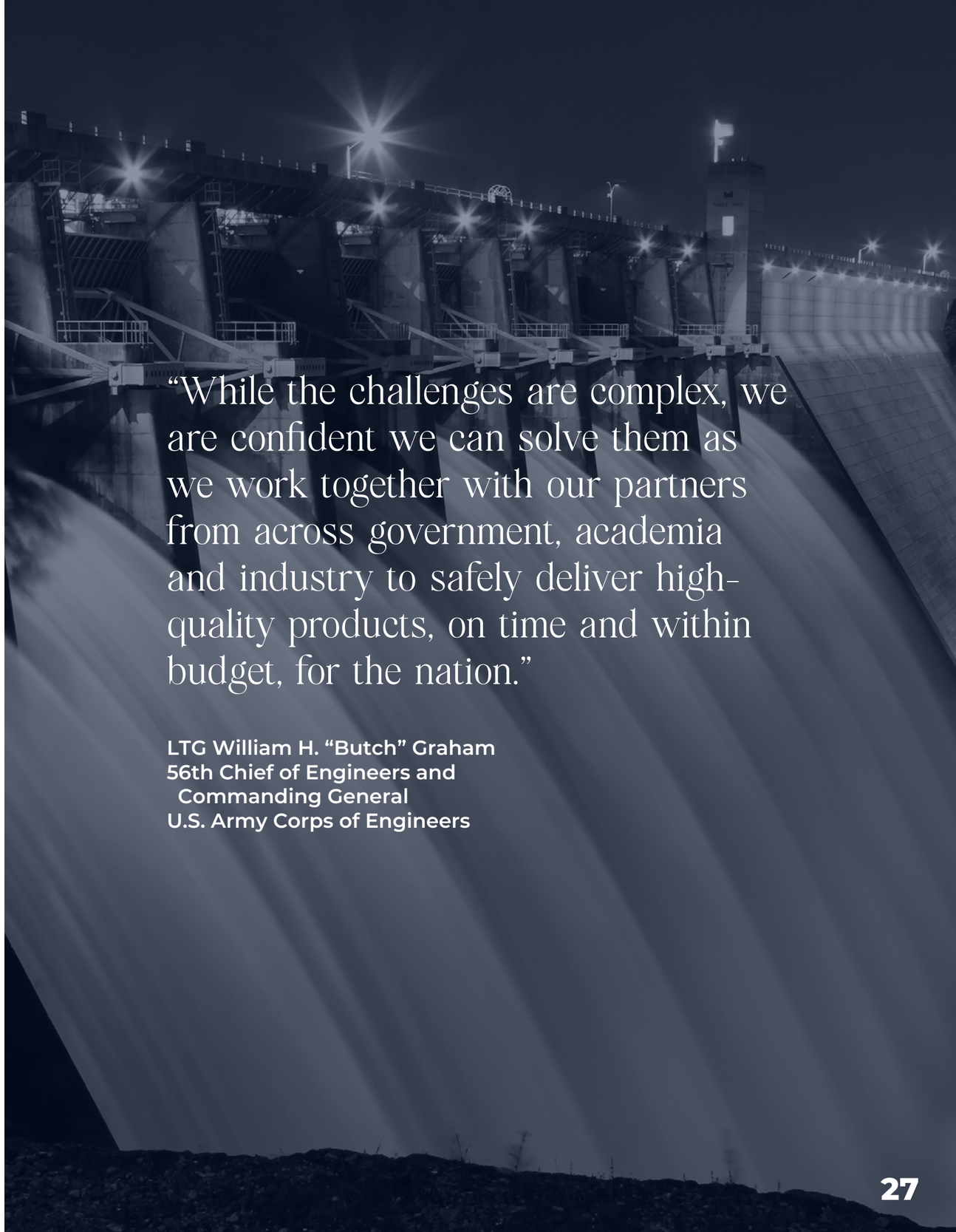

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