



USDOT Tier 1 University Transportation Center

Semi-Annual Progress Report #2

Federal Agency: Office of the Assistant Secretary for Research and Technology

Federal Grant ID #: 69A3551747130

Project Title: Maritime Transportation Research and Education Center (MarTREC)

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Submission Date: October 30, 2019

DUNS: 1914297450000

EIN: 71-6003252

Recipient Organization: University of Arkansas

Project/Grant Period: Start Date November 30, 2016
End Date: September 30, 2022

Reporting Period Start Date: April 1, 2019
Reporting Period End Date: September 30, 2019

Report Term or Frequency: six months

Signature:

Maritime Transportation Research & Education Center (MarTREC) is a USDOT Tier 1 University Transportation Center funded through the Office of the Assistant Secretary for Research and Technology. Under the FAST Act, MarTREC is *working to preserve the Nation’s transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure*. Our vision is to be recognized as the Nation’s premier source for expertise on maritime and multimodal transportation research and education. Made up of renowned maritime transportation researchers dedicated to transferrable research and inclusive education and workforce development, the MarTREC consortium are University of Arkansas (UARK), Fayetteville, AR; Jackson State University (JSU), Jackson, MS; Louisiana State University (LSU), Baton Rouge, LA; University of New Orleans (UNO), New Orleans, LA; Texas A&M University/Texas Transportation Institute (TAMU/TTI), College Station, TX; and Vanderbilt University (VU), Nashville, TN. Maritime and related multimodal transportation research is critical to the future of our transportation system and should be a national priority. Given the link between gross domestic product and international trade, which is expected to double over the next 30 years, efficient and resilient ports are critical to the nation’s overall economy and the ability of intermodal carriers to move freight between ports of entry and inland locations. Proximity to navigable waterways makes this consortium uniquely situated to address our theme.

1. Accomplishments

1.1 Consortium-Level Accomplishments

1.1.1 Research

Goal: MarTREC will conduct research that contributes to preserve the Nation’s transportation system through efficient, resilient, and sustainable maritime and multimodal logistics and infrastructure.

Objectives:

- Conduct research projects related to MarTREC’s research goal
- Engage a diverse set of faculty and students in MarTREC research activities
- Disseminate research findings

Accomplishments:

Research Effectiveness Metrics	Progress
# of peer-reviewed journal articles (published, accepted, submitted)	19
# of conference presentations given	29
# of students participating in transportation research projects funded by UTC	34

1.1.2 Leadership

Goal: MarTREC will become the premier source for expertise on maritime transportation research, education, and workforce development.

Objectives:

- Demonstrate academic leadership towards MarTREC’s leadership goal
- Demonstrate industry leadership towards MarTREC’s leadership goal

Accomplishments:

Leadership Effectiveness Metrics	Progress
# of national and regional leadership positions held	28
# of invited talks given	6
# of leadership and research awards received	0

1.1.3 Education and Workforce Development

Goal: MarTREC will develop educational resources to elucidate scientific and engineering practices involved in maritime and multimodal transportation systems and practices.

Objectives:

- Conduct education and workforce development (EWD) projects related to the goal
- Educate college students within MarTREC theme
- Conduct workforce development related to MarTREC theme
- Conduct outreach activities related to MarTREC theme

Accomplishments:

Education and Workforce Development Effectiveness Metrics	Progress
# of transportation-related courses offered	46
# of technician certification programs offered	6
# K-12 outreach programs offered	9

1.1.4 Technology Transfer

Goal: MarTREC consortium institutions will participate in national, regional, and local education and workforce development outreach to provide state-of-the-art knowledge to private and public transportation organizations and provide a forum where government employees, academic researchers, and private sector can exchange ideas on current issues.

Objectives:

- Transfer MarTREC outcomes into practice
- Develop products in support of MarTREC technology transfer goal

Accomplishments:

Technology Transfer Effectiveness Metrics	Progress
# of project deliverables submitted	20
# of technical briefs	0
# of editorial journal positions held	10

1.1.5 Collaboration

Goal: MarTREC will continue our existing partnerships with maritime and multimodal transportation stakeholders and develop new partnerships at the consortium, institution, and project levels to facilitate our planned research, leadership, education, workforce development, and technology transfer activities.

Objectives:

- Develop external partnerships related to MarTREC's collaboration goal
- Develop collaborative products related to MarTREC's collaboration goal
- Engage faculty and students in achieving MarTREC's collaboration goal

Accomplishments:

Collaboration Effectiveness Metrics	Progress
# of existing collaborative partnerships	33
# of new collaborative partnerships formed	5

1.1.6 Opportunities for Training and Professional Development

- The Center for Training Transportation Professionals (CTTP) certified 331 individuals through 21 sessions and administered 12 workshop sessions in asphalt and storm water management
- Ten conference planning positions were held by MarTREC faculty researchers
- Six distinguished lectures were delivered by industry professionals
- Eleven students presented at professional conferences
- Fifteen leadership positions held by MarTREC faculty researchers

1.1.7 Dissemination of Results (In this reporting period)

- Two final reports and the data loaded onto Zenodo repository
- Three book chapters published
- Four peer-reviewed journal articles were published

1.1.8 Plans to Accomplish Goals and Objectives during Next Reporting Period

MarTREC has twenty-five active research projects during this reporting period. The faculty researchers will continue to engage with industry experts to ensure that these projects are making transformational contributions. We will continue to emphasize educational and technology transfer activities. MarTREC will be hosting our Annual Professional Advisory Board meeting on November 14-15, 2019. Project-level plans are discussed in 1.2.

1.2 Project-Level Accomplishments and Plans for Next Reporting Period

1.2.1 Maritime and Multimodal Logistics Management Projects

Analysis of Blockchain's Impacts on and Applicability to Maritime Industry

Jim Kruse, MBA

Texas A&M Transportation Institute

May 2019-May2020

New Project: It is unclear how relevant or critical the use of blockchain is for maritime business. A recent survey by Deloitte interviewed U.S.-based executives in the shipping sector and found that 39% of them have little or no knowledge about blockchain. Still 55% of them believe that failure to implement blockchain will put their company at a disadvantage; and 25% of them said that their companies viewed blockchain as a critical top 5 priority. Since it is new to an industry that is international, fragmented, and complex in nature, we explore several research questions arising from the application of blockchain to maritime supply chains and logistics, in particular the possible integration with existing technologies, such as automatic identification and data capture (AIDC) technologies.

Changing Trade and Transportation Patterns: NAFTA, Cuba, and the US Gulf Coast

Bethany Stich, PhD

University of New Orleans

March 2018-November 2019

Accomplishments: Since the 1969 passage of the National Environmental Protection Act, transportation planning became a complex, interdisciplinary challenge. The need for meeting environmental legislation coupled with public participation demands have revealed innumerable problems associated with the use of outdated techniques. In order to satisfy the current regulations and public policies, the transportation planning process can no longer solely rely on the basics of engineering; it is now forced to find the way in a sea of data, values and actors towards a comprehensive and integrated solution.

Project Plans: Waiting to see if Congress passes the USMCA agreement.

Combining Truck and Vessel Tracking Data to Estimate Performance and Impacts of Inland Ports

Sarah Hernandez, PhD and Chase Rainwater, PhD

University of Arkansas

January 2019-December 2020

Accomplishments: The purpose of this project is to develop a method to fuse truck and marine vessel tracking data to better estimate performance of multi-modal supply chains that use inland waterway ports. We have reviewed literature and characterization of Marine AIS and Truck GPSData.

Project Plans: We will develop fusion approaches and derivation and apply multi-modal freight fluidity measures.

Development and Application of a Methodology for Maritime-Truck Shipments Generation Analysis

Mario Monsreal, PhD and Jim Kruse, MS, MBA

Texas A&M Transportation Institute

December 2017-March 2019

Accomplishments: Truck activity is logically connected to and generated by vessel activity at a port. In turn, vessel activity is generated by truck shipments. Although one might expect a 1 to 1 relationship between the two types of shipments, that is unlikely the case. Terminal capacity is a determinant and a coupling link for vessel and truck flows. Although the current study provided a basic measure of the role that terminal operations play in vessel-truck behavior, a deeper analysis is recommended to identify more precisely the impacts of terminal operations on these multimodal flows. This study found data availability as an important constraint for a more detailed analysis. The main recommendation is to explore new data sources, and evaluate data generation techniques to produce a more complete data set for a more thorough analysis.

Completed Project: Conducted by TTI, this project was completed in March 2019. Final project report was submitted on time and distributed as per grant guidelines.

Interdisciplinary Educational Outreach with Traffic Sensor Build Kits

Sarah Hernandez, Ph.D, PE

University of Arkansas

May 2019-May 2020

New Project: This project seeks to design and implement freight oriented educational outreach activities centered on traffic sensing technologies for middle, high school, and first-year college students. The research team designed a low-cost, easily implementable LiDAR and Bluetooth sensor bundle that was capable of detecting, characterizing, and tracking freight trucks as they traveled to and from inland waterway port areas. The sensor provided data necessary to measure port performance and roadway usage by industry. The proposed work will re-design the sensor bundle as an educational outreach activity by creating sensor "build kits" and associated lesson plans for three grade levels (middle school, high school, and first year university students).

Learning from USACE Open Data for Locks

Justin Chimka, PhD

University of Arkansas

August 2018-August 2020

Accomplishments: This project plans to describe stoppages that cause downtime. This information would be a valuable addition to what has previously been available in the Lock Performance Management System data. Open Data for Locks were originally supposed to be made available but that was not the case. Furthermore, "Navigation and Civil Works Decision Support Center (NDC) is not

actively pursuing any public data dissemination services at this time. However we are continuously looking for better ways to get data to the public," according to Steven Riley, USACE.

Project Plans: Currently our focus is to analyze the NDC Key Lock Report, a monthly summary and year-to-year totals of commodity tonnages and barge traffic for key locks on the inland waterways (Institute for Water Resources Planning Assistance Library).

Modeling Dynamic Behavior of Navigable Inland Waterways

Heather Nachtmann, PhD and Justin Chimka, PhD

University of Arkansas

August 2018-August 2020

Accomplishments: This project is expanding prior MarTREC research and is utilizing our previously developed Maritime Transportation Simulator (MarTranS), which integrates agent-based modeling, discrete-event simulation, and system dynamics, to further explore the relationship between inland waterway transportation system components and regional economic impact factors. We collected current data and replicated our past scenario analyses of the McClellan-Kerr Arkansas River Navigation System (MKARNS). MarTranS was modified in order to collect and study more operational data related to lock and dam behavior. In addition, a literature search and review of prior research on and implementation of container-on-barge was completed and we have developed gap research areas and questions to explore. Results were presented in May 2019 at the Institute of Industrial and Systems Engineers annual conference. We provided economic impact data to the Arkansas Waterways Commission in support of their response to the MKARNS flooding event that occurred this fall.

Project Plans: We continue to provide new data analytics and knowledge that can guide future investment, operations, and maintenance decisions on the MKARNS. Results will be presented and published at the 2019 American Society for Engineering Management conference. We will finalize the critical research questions in this area and begin associated data collection.

Shipping Container Chassis in the US: The Legacy of Ocean Carriers

Bethany Stich, PhD

University of New Orleans

March 2018-November 2019

Accomplishments: Almost half of the chassis date from before 1997 and it is common at marine terminals to find chassis well over 20 years old. Newer chassis are safer, as they are outfitted with radial tires, antilock brakes, and LED lights. The evolution of key safety regulations related to chassis usage has placed the burden of compliance on the marine terminals and trucking companies, rather than the ocean carriers. Cultivating a few large regional pools, a national chassis pool, or possible federal public-private investment in the chassis fleet are some workable answers. One proposed solution is more competitive pricing among more international chassis lessors.

Project Plans: Final report coming soon

1.2.2 Maritime and Multimodal Infrastructure Preservation Projects

Economic Impact of the Gulf Intracoastal Waterway on the States It Serves

Brianne Glover, JD and Jim Kruse, MS, MBA

Texas A&M Transportation Institute

September 2017-August 2018

Accomplishments: This project reviewed existing literature on the economic value of the Gulf Intracoastal Waterway (GIWW), reviewed the importance of the GIWW to the energy industry, examined the overall economic impact of the GIWW to the states it serves, and estimated the increases

in transportation costs resulting from an immediate closure in the GIWW. Overall, this report estimates that the GIWW has an economic impact of \$61.5 billion annually, supports 143,000 jobs, and saves up to \$4.3 billion in transportation cost savings annually.

Completed Project: Conducted by TTI, this project was completed in August 2018. Final project report was submitted on time and distributed as per grant guidelines.

Effect of Permeability Variation of Expansive Yazoo Clay at the Maritime and Multimodal Transportation Infrastructure in Mississippi

Sadik Kahn, PhD, PE

Jackson State University

September 2018-December 2019

Accomplishments: The existence of Yazoo clay soil in Mississippi frequently causes pavement distress in multimodal transportation infrastructure. Each year, fixing the pavement requires significant maintenance budget of MS DOT. Standard soil tests were conducted on the collected soil samples, which include the moisture content test, particle size analysis. At present, the findings from this study have been presented to the senior officials of MDOT.

Project Plans: Investigate hydraulic properties of clay soil, moisture variation at different season, and effect of rainfall and duration on the subgrade moisture variation.

Engaging the Business and Tourism Industry in Visualizing Sea Level Rise Impacts to Transportation Infrastructure in Waikiki, Hawaii

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

March 2018-April 2020

Accomplishments: The goal of this research is to assess if the use of 3D virtual and augmented reality as a policy deliberation tool for improved coastal planning, engineering and design by deepening the understanding of sea level rise impacts among the business and tourism industries in Waikiki, Hawaii. During this reporting period, the post-surveys for the community meetings were developed.

Project Plans: Awaiting IRB approval.

Evaluation of Hydrogel–stabilized Expansive Soils in Mississippi for Sustainable Maritime Infrastructure Design

Yadong Li, Ph.D

Jackson State University

August 2019-August 2020

New Project: The expansive soil causes a variety maritime transportation infrastructure problem, such as cracks, damage of pipeline, and the differential settlement of foundation. In Mississippi, Yahoo clay, one type of expansive soil, causes significant concern during the maritime design and maintain. This project is proposing feasibility of using innovative hydrogel treatment as alternative expansive soil stabilization. The hydrogel treatment may provide great opportunities as cost-effective and sustainable preserving alternative approach for expansive soil stabilization in maritime infrastructure.

Fatigue Crack Control in Waterway Lock Gate Pintle Locations Subjected to Multi Modal Fracture

Gary Prinz, PhD, PE

University of Arkansas

August 2018-August 2020

Accomplishments: This research project will address multi-mode fatigue cracking within critical lock gate pintle locations. The lock gate pintle is a ball-and-socket joint that is crucial for proper gate

operation but is subject to frequent fatigue cracking. Fatigue crack repair within pintle locations is particularly challenging due to the complex multi-axial loading conditions. Detailed Sub-Modeling of the Pintle Ball and Socket during Gate Operation has been completed.

Project Plans: Parametric FEA Investigation to Develop Effective Multi-Mode Retrofit Strategies, task is currently underway and we are investigating several CFRP orientations and geometries for mitigating the crack-tip stresses. Experimental Verification task is also underway and we have been running several fatigue tests on un-retrofitted cracked plates to develop our base-line fatigue performance for later retrofit improvement comparisons.

Green Technology Approach for Capturing Pollution Washed from Transportation Infrastructures

Danuta Leszczynska, PhD

Jackson State University

March 2018-November 2019

Accomplishments: The aim of this study is to produce and investigate a carbon-based substance, namely biochar, as a new material for the in-situ adsorption of pollutants carried by the storm water runoff from the roads. Extensive literature review was completed; however, during the course of this research, we are searching for current publications available within the last 6 months. Recently, biochar as off-agricultural material is gaining a lot of interest, but there is a little info about ongoing research for direct transportation applications. Preparation of biochar was completed.

Project Plans: We have obtained preliminary results during scheduled time; however, to produce reliable results, larger quantities of biochar are needed (on-going manufacturing). In addition, we have purchased commercial biochar, and leachability tests are currently being analyzed.

A Multimodal Network Approach to the Inland and Coastal Waterway System

Bruce Wang, PhD

Texas A&M University

July 2017-January 2019

Accomplishments: The national marine highway initiative intends to position waterways in the context of multimodal transportation system. Maintenance and capacity of each element of the waterway system has implications on the multimodal network. This project has developed a multimodal freight network model that includes both waterway landside components in order to analyze the impact of waterway operations. The goal is to enhance the entire network efficiency. The tests show that the solutions are not sensitive to these parameters. Thus, the model is solved by changing the total amount of available budget into five different scenarios, each having an amount allocated to the locks and dams.

Completed Project: Conducted by TAMU, this project was completed in January 2019. Final project report was submitted on time and distributed as per grant guidelines.

Large Scale Evaluation of Erosion Resistance of Biocementation against Bridge Scour and Roadway Shoulder Erosion

Lin Li, Ph.D., P.E.

Jackson State University

March 2018-April 2019

Accomplishments: This project examined the feasibility of using biocementation through MICP as an erosion countermeasure. The results of this study bring an important conclusion that MICP-treated soil was weak to resist long-term erosion of exposing to outdoor environment. However, MICP-treated material was strong to resist rainfall induced erosion and accelerated erosion. Especially the bio-surface treatments could enhance the strength of cement-treated samples significantly and further improve the

resistance to accelerated erosion and water absorption. In addition, fiber reinforcement of MICP-treated samples improved the resistance to accelerated erosion.

Completed Project: Conducted by JSU, this project was completed in April 2019. Final project report will be submitted on time and distributed as per grant guidelines.

Liquefied Natural Gas Phase II: The Future of LNG for the US and Gulf Coast Economies

Bethany Stich, PhD

University of New Orleans

November 2017-November 2019

Accomplishments: The continued growth of Liquefied Natural Gas (LNG) production and long-distance trade has traditionally been taken as a given by global energy analysts, who have premised their positive estimates on gas being both relatively scarce and demand for it virtually unquenchable. Despite Louisiana experiencing a new cargo export potential with LNG and the subsequent construction and pending permitting of LNG Export Terminals in diverse locations along Louisiana's shorelines, the primary finding of this report, based on the state of the current energy market, precludes the utility of a focus on LNG as an export commodity. Regarding the acceleration of LNG as an industrial feedstock, as supported by the American Chemistry Council's growth projection data for the use of LNG in the petrochemical industry, our fieldwork revealed a petrochemical manufacturing boom in the parishes between New Orleans and Baton Rouge.

Project Plans: Final report coming soon

Liquefied Natural Gas III: Export Competition in a Well Supplied, Flow-Shifting Global Economy

Bethany Stich, PhD

University of New Orleans

March 2018-December 2019

Accomplishments: With trillions of cubic feet of shale reserves, the United States' (US) abundance of natural gas has prompted an increase in production of Liquefied Natural Gas (LNG) as an export commodity. UNOTI continues to urge that U.S. natural gas energy policy best practice is not to focus on export and export alone, but rather adopt a diversified and climate responsible energy policy that focuses on the Ports of South Louisiana, the Gulf Coast, and the U.S. remaining globally competitive by investing in necessary LNG fueling infrastructure, as well as continued investment in the existing petrochemical sector of Coastal Louisiana and the Gulf Coast.

Project Plans: Final report coming soon

Trade-Off Analytics for Infrastructure Preservation

Greg Parnell, PhD and Ed Pohl, PhD

University of Arkansas

August 2018-December 2019

Accomplishments: The objective of this project is to develop a course that can be taught to civil engineers, industrial engineers, and the maritime and multimodal infrastructure community on the use of trade-off analytics as a tool to assist them in their infrastructure preservation efforts. This course will be packaged into a webinar that could be delivered on-line for practicing professionals. This course will build on existing best practices defined by the International Council on Systems Engineering. We are on track with our course development.

Project Plans: We plan to offer in Fall 2019, 2nd 8 Week Session. We are working with ERDC to have the course available for U.S. Army Engineer Research and Development Center employees.

Using CSA Cement for Novel Waterway Repair Materials
Cameron Murray, PhD and Michelle Bernhardt-Barry, PhD, PE
University of Arkansas
August 2018-August 2020

Accomplishments: Calcium Sulfoaluminate-Belite (CSA) cement is a rapid setting hydraulic cement. Due to its rapid hardening characteristics and lower shrinkage and creep compared to typical portland cement, it is an ideal candidate as a repair material. The goal of this work is to develop new mixtures utilizing CSA cement that can be applied to waterway repairs.

Project Plans: A grout mixture capable of setting up rapidly underwater and a soil-cement mixture that can rapidly stabilize slopes and waterway structures will be developed. We have found the ideal water/cement ratio for an underwater BCSA cement grout. Soil cement mixtures will be developed in spring and summer 2020, to test the soil cement under moving water and determine its resistance to erosion.

1.2.3 Disaster Response and Transportation Planning for Coastal and River Valley Communities Projects

Assessment of Evacuation Network Performance under Different Evacuation Scenarios
Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
July 2019-July 2020

New Project: Several major disasters have occurred in the United States and impacted coastal and river valley communities. The economic and societal impact of such disasters have demonstrated a need for better emergency planning, response, recovery, and adaptation. Through the understanding of the behavior, characteristics of past events, much informed decisions can be made. This study will utilize data from Hurricane Irma (2017). The present research will be focusing on the evacuation process of the coastal communities in the Florida Keys.

Development and Implementation of Sustainable Transportation Resilience Indicators
Mark Abkowitz, PhD
Vanderbilt University
June 2017-March 2019

Accomplishments: This project worked to establish a protocol and method for evaluating a community's level of sustainable transportation resilience, such that if deficiencies exist, attention can be focused on mitigating those concerns. The protocol and method are being subsequently applied to a river valley community to demonstrate proof-of-concept.

Completed Project: Conducted by Vanderbilt, this project was completed in March 2019. Final project report was submitted on time and distributed as per grant guidelines.

Development of Freeway Corridor Capacity Measure to Improve Transportation Resilience
Brian Wolshon, Ph.D., P.E., PTOE
Louisiana State University
July 2019-July 2020

New Project: Natural disasters like hurricanes and floods occur throughout the world. However, coastal areas tend to be the most vulnerable to these disasters. During imminent life and death conditions, such as those posed by hurricanes, evacuations are used as a protective action. And although evacuations have a long track record of success, they can be complex, costly, and at times even risky. Capacity is one

of the most important characteristics of a freeway facility which quantifies its traffic carrying capability, and is a critical component to the resilience of transportation systems and the evacuation process. A case study will be conducted in this research to estimate the capacity of a freeway corridor consisting of multiple bottleneck sections using traffic data from a coastal area.

Exposure to STEM: Diversity in Maritime Transportation

Rick Coffman, PhD, PE

University of Arkansas

August 2018-October 2019

Accomplishments: The goal of this education and workforce development project is to develop an educational/mentoring/advising model to open doors to all students, regardless of socio-economic background, who want to pursue careers in fields related to maritime and multimodal transportation. We have identified underrepresented groups in AP classes at LRCHS. Recruited and retained students from underrepresented groups through K-12 outreach. Developed mentoring, interaction, and personal development. Demonstrated increased enrollment of underrepresented students in STEM. Six tours have been conducted.

Project Plans: Final report coming soon

Informing Post Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks

Sarah Nurre, PhD, Kelly Sullivan, PhD, and Ben Runkle, PhD

University of Arkansas

August 2018-February 2021

Accomplishments: Agriculture supply chains are of utmost importance for the function of society. Agriculture supply chains are inherently complex due to their interdependency with critical infrastructure systems including energy, water, and maritime and multimodal transportation. Our overall aim is to develop the necessary methodology to describe ag-sector and transportation-sector interdependence. We are currently in the process of modeling further interdependencies between transportation and agriculture.

Project Plans: We plan to build a geospatial dataset of interdependent agriculture and transportation infrastructure.

Informing Post-Disaster Restoration through Modeling Interdependent Agriculture and Transportation Networks - Phase II VU

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

October 2018-August 2020

New Project: Agriculture is a critical part of the U.S. economy both domestically and in terms of exports. While disruptions due to weather, etc. can affect any sector, agriculture is unique in its time sensitivity for planting, harvesting, etc. Additionally, agriculture is interdependent on other sectors, particularly transportation to get seed and fertilizers to fields at appropriate times and in getting products that may spoil to market efficiently. At present, available tools and models do not appropriately address the interdependencies and interactions that occur between agriculture and transportation infrastructure systems during times of disruption and restoration of these systems post event. This project will develop models that determine how to effectively use transportation and coordinate restoration efforts to make ag supply chains more resilient.

Interdependency of Port Clusters during Regional Disasters

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

January 2018-August 2019

Accomplishments: The research seeks to build upon the prior knowledge and expand the scientific understanding of regional disruptions to port clusters, areas of the country with multiple ports servicing the same region. The contribution of this research is to empirically show how port clusters rely upon each other during disruptive events to increase the overall resiliency of water bourn commerce during disruptive events. During this reporting period, the identification of port clusters for analysis was completed. A timeline of disruption events has also been completed.

Completed Project: Conducted by LSU, this project was completed in August 2019. Final project report was submitted on time and distributed as per grant guidelines.

Towards Integrating Resilience into Everyday Transportation Practices of Coastal and River Valley Communities

Brian Wolshon, PhD, PE, PTOE and Nelida Herrera

Louisiana State University

August 2018-December 2019

Accomplishments: Coastal and river valley communities have become increasingly vulnerable to sea level rise, hurricanes and other natural disasters. In many cases, these events force the communities to evacuate in a relatively unpredictable way. Emergency evacuations require safe and effective mobilization of the public from hazardous areas while facing uncertainty. We have completed identifying performance measurements and also developed simulation scenarios.

Project Plans: Working on the impact of different strategies and analyze simulation outputs.

Utilizing Graceful Failure as an Opportunity for Flood Mitigation Downstream to Protect Communities and Infrastructure

Janey Camp, PhD, PE, GISP, CFM

Vanderbilt University

May 2018-November 2019

Accomplishments: In 2011, we observed how “graceful failure” through planned damages to the Birds Point Levee by the US Army Corps of Engineers was enacted to alleviate extreme flooding on the Mississippi River. This action, while flooding croplands as planned in the past, actually reduced flooding and damage to waterway infrastructure and communities downstream. We completed the initial criteria selection and the screening analysis to identify sites along the inland waterway system where levees may be intentionally broken to allow for flood mitigation. We have begun doing the localized feasibility analysis of selected sites that have potential for controlled diversion and water storage during flooding events.

Project Plans: Complete analysis and feasibility study of select sites. Estimate volume of floodwaters that could be contained/diverted as well as investigate the extent of flooding in the event of a breach to ensure minimal impacts to people and infrastructure at the select locations.

Visualizing Sea Level Rise Impacts in Transportation Planning

Brian Wolshon, PhD, PE, PTOE

Louisiana State University

January 2018-November 2019

Accomplishments: The goal of this research is to test and compare new technologies in community-meeting settings in South Florida to assess the effectiveness of 3D visualization technology on improving residents' understanding of the impacts of sea level rise on their communities and the transportation infrastructure. During this reporting period, the research team completed the content for the community meetings including the 2D and 3D media, and post-surveys were tested. Pre-test and community meetings have been completed.

Project Plans: Final report near completion.

2. Participants & Collaborating Organizations

Organization Name	Location	Collaboration
US Army Corps of Engineers	Vicksburg, MS	research
Dr. John Renne, Florida Atlantic University	Boca Raton, FL	research
Port of New Orleans International Freight Forwarders & Customs Brokers Assn. World Trade Center Transportation Committee Ports Assn. of Louisiana GNO Port Safety Council Propeller Club of New Orleans New Orleans Regional Planning Commission MS Valley Trade & Transport Port of South LA Port of Plaquemines Coastal Cargo Triple G. Express Jefferson Transit Regional Innovation Alliance	New Orleans, LA	Industry networks
TN Department of Transportation TN Department of Economic and Community Development American Bureau of Shipping	TN	research collaborator
Dr. Scott Parr, Embry-Riddle Aeronautical University	FL	research
Dr. Kenneth Mitchell/ERDC - Coastal and Hydraulics Laboratory	Vicksburg MS	research
Deidre Smith, Executive Director, AR Waterways Commission,	AR	research
Dr. Jingjing Tong, Assistant Professor, Southeast Missouri State University, Cape Girardeau, MO	MO	research collaborator
Chad Johnston, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Arkansas District	AR	research collaborator
Glenn Moore, United States Department of Homeland Security, Office of Infrastructure Protection, Protective Security Advisor – Oklahoma District	OK	research collaborator
Dr. Furkan Oztanriseven, Assistant Professor, LeMoyne College	NY	research
Dr. Mohammad Barik, a researcher in University Space Research Association (USRA)	AL	research collaborator

YouthForce NOLA, New Orleans	LA	Outreach
Supply Chain Transportation Council, Baton Rouge	LA	Industry
University of Memphis, Tennessee Department of Economic and Community Development	TN	research collaborator
Dr. Shahadat Hossain, Professor, Department of Civil Engineering, UT Arlington	TX	research collaborator
Henry Liu, Professor at Civil Engineering, University of Michigan, Ann Arbor	MI	research collaborator
National Waterway Foundation	DC	resource
Travis Black, Office of Ports & Waterways Planning, MARAD	DC	stakeholder
Caren Kraska, president and chairman of the AR&MO Railroad	AR	Outreach
Rachel Ballard, Valerie Hampton, Saadia Gauthier Village of Promise, Guntersville Lock and Dam Tour Ryan Johnson and William Peoples, United States Army Corps of Engineers, Guntersville Lock and Dam Scott Fiedler and Chip Troy, Tennessee Valley Authority, Chattanooga, Tennessee, Guntersville Lock and Dam Tour	Huntsville, Alabama	Outreach Activity

3. Outputs

3.1 Publications

Peer Reviewed Journal Articles

1. Asborno, M., Hernandez, S., and Akter, T., "Multicommodity Port Throughput from Truck GPS and Lock Performance Data Fusion", under review at the Transportation Research Record, Journal of the Transportation Research Board, August 2019 (under review)
2. Baharak Sajjadi, Tetiana Zubatiuk, Danuta Leszczynska, Jerzy Leszczynski and Wei Yin Chen, "Chemical activation of biochar for energy and environmental applications: a comprehensive review" <https://doi.org/10.1515/revce-20>, Rev Chemical Engineering 2019; 35(7): 777–815
3. Khan, M. S., M. Nobahar, J. Ivoke, and F. Amini "Rainfall Variation Effect on Slope made of Expansive Yazoo Clay soil," Transportation Infrastructure Geotechnology <https://doi.org/10.1007/s40515-019-00083-w>
4. Khan M. S., J. Ivoke, and M. Nobahar, "Coupled Effect of Wet-Dry Cycles and Rainfall on Highway Slope made of Yazoo Clay," Geoscience 2019, 9 (341); doi:10.3390/geosciences9080341
5. Khan, M.S., D. Thornton, J. Ivoke, and M. Nobahar, "Numerical Investigation of Slope Stabilization using Recycled Plastic Pin on Yazoo Clay," ASCE Journal of Materials in Civil Engineering (under review)
6. Ahmed, A., Khan, M.S., Hossain, M.S., Sadigov, T. and Bhandari, P, "Safety Prediction Model for Reinforced Highway Slope Using Machine Learning Method", Journal of Transportation Research Board: Transportation research record. (under review)
7. Christopher E Anderson, Maryam Izadi, Guang Tian, Jeanette Gustat, "Assessing the Cost and Physical Activity and Transportation Associated Benefits of an Urban Trail", Journal of Transport & Health (under review)
8. Camp, J., K. Nelson, C. Philip, M. Moravec, D. Scheffler, P. Johnson, "Utilizing Agent-based Modeling to Evaluate Operational Impacts of an Incident and Possible Alternatives on U.S. Waterways", Transportation Research Record. (under review)

9. Doktycz, Charles and Mark Abkowitz, "Loss and Damage Estimation for Extreme Weather Events: State of the Practice", Sustainability (under review)
10. Gillespie-Marthaler, Leslie, K. Nelson, H. Baroud and M. Abkowitz, "Selecting Indicators for Assessing Community Sustainable Resilience", Risk Analysis (under review)
11. Johnson, P., C. Brady, C. Philip, H. Baroud, J. Camp, M. Abkowitz, "A Factor Analysis Approach to Unify Community Vulnerability and Resilience Indices for Natural Hazards", Risk Analysis, (under review)
12. Nelson, K.S. and J. Camp, "Quantifying the Benefits of Home Buyouts - Demonstration of an Approach and Local Application to an Urban Area", Anthropocene (special issue) - Urban Hydroclimatic Risks in the 21st Century: Integrating Engineering, Natural, Physical and Social Sciences to Build Resilience, (under review)
13. Whitman, M., H. Baroud, and K. Barker, "Multicriteria Risk Analysis of Commodity-Specific Dock Investments at an Inland Waterway Port", The Engineering Economist, 1-21.
14. Delgado-Hidalgo, Liliana, and Heather Nachtmann "A Heuristic Approach to Managing Inland Waterway Disruption Response," Engineering Management Journal (under review)
15. Delgado-Hidalgo, Liliana, Chase Rainwater, and Heather Nachtmann, "A Computational Comparison of Cargo Prioritization and Terminal Allocation Problem Models," Computers & Operations Research (under review)
16. Tong, Jingjing, and Heather Nachtmann, "A Tabu Search Approach to the Cargo Prioritization and Terminal Allocation Problem," International Journal of Shipping and Transport Logistics, (accepted September 2018)
17. Gedik, Ridvan, Gokhan Egilmez, Chase Rainwater, Kenneth Ned Mitchell, and Heather Nachtmann, "A Constraint Programming Approach for Scheduling Maintenance Dredging Activities of the U.S. Marine Transportation System Expert Systems With Applications," Expert Systems With Applications (under review)
18. Oztanriseven, Furkan, and Heather Nachtmann, "Modeling Dynamic Behavior of Navigable Inland Waterways Maritime Economics and Logistics (accepted May 2019).
19. Zhang, Z., B. Wolshon, P. Murray-Tuite, "A Conceptual Framework for Illustrating and Assessing Risk, Resilience, and Investment in Evacuation Transportation Systems," Transportation Research Part D: Transport and Environment (under review)

Conference Papers

1. Whalin, Robert W., "A PhD in Engineering Degree: Coastal Engineering Emphasis Area", 126th American Society for Engineering Education Annual Conference, June 2019, Tampa, FL.
2. Asborn, M., Hernandez, S., and Akter, T., "Multicommodity Port Throughput from Truck GPS and Lock Performance Data Fusion", TRB 2020 (under review)
3. Bipasha, Tarana, Jose Azucena, Basem Alkhaleel, Haitao Liao, and Heather Nachtmann, "Data Simulation to Support Interdependence Modeling of a Multimodal Transportation Network," 2019 Winter Simulation Conference (accepted - to appear December 2019).

Books/Other One-Time Publications

1. Nachtmann, Heather, "Contributions of Women to Multimodal Transportation Systems," Women in Industrial and Systems Engineering (book chapter, 1st Edition; Switzerland: Springer, published September 2019)
2. Renne, J., A. Pande, B. Wolshon, P. Murray-Tuite, and K. Kim, Creating Resilient a Transportation System: Policy, Planning and Implementation, in press, Elsevier Press, September 2019.

3. Stich, B., James Amdal, Peter Webb. Editor Olga V. Smirnova, "Chassis: The Unsung Linchpin in the Global Supply Chain In "Building a Sustainable Transportation Infrastructure for Long-Term Economic Growth", book Chapter, IGI Global 2019 (published)

Editorial Journal Positions

1. Advisory board member, Transportation research Part E: Logistics Review
2. Area Editor, The Engineering Economist
3. Area Editor, Transportation Research D, Journal of Transportation Safety System Security
4. Associate Editor, IEEE Transaction on Reliability
5. Associate Editor, Journal of Military Operations Research
6. Associate Editor, Journal of Risk and Reliability
7. Associate Editor, Operations Research Letters
8. Editorial Board, Stochastics and Quality Control
9. Editor-in-Chief, Engineering Management Journal
10. Section Editor, "Disasters & Resilience", Part D: Transport and Environment

3.2 Websites

Website Title	Web Address
MarTREC	http://martrec.uark.edu/
Institute for Multimodal Transportation	http://www.jsums.edu/imtrans/
Gulf Coast Center for Evacuation and Transportation Resiliency	http://www.evaccenter.lsu.edu/
Merritt C. Becker Jr. UNO Transportation Institute	http://transportation.uno.edu/
Texas A&M Transportation Institute	https://tti.tamu.edu/
Vanderbilt Center for Transportation and Operational Resiliency	http://www.vanderbilt.edu/vector/

3.3 New Methodologies, technologies, or techniques - Nothing to report

3.4 Inventions, patents, and/or licenses - Nothing to report

3.5 Other products - Nothing to report

4. Outcomes

4.1 Increased understanding and awareness of transportation issues

Distinguished Lectures

1. Eric C. Shen, director of the Mid-Pacific Gateway Office in the Maritime Administration of the U.S. Department of Transportation, Dan Flowers Distinguished Lecture Series, "Marine Transport and Goods Movement: Why Should You Know and Why Should you Care" April 15, 2019, University of Arkansas, 100 attendees
2. D. Leszczynska, "Sustainable Approach Toward Urban Storm Water Treatment by Biochar: From Pine Needles to In Situ Adsorber of Storm Water Contaminants", 2019 Southern Symposium on Contemporary Engineering Topics & UNO Engineering Forum, September 13, 2019, New Orleans, Louisiana, 50 attendees
3. D. Leszczynska, "Sustainability of Biochar: From Waste to Advanced Applications", University of Gdansk, Gdansk, Poland June 19, 2019, 60 attendees

4. D. Leszczynska, "Constructing Customized Non-enzymatic Sensors Based on Nano-size Carbon Material for Environmental and Medical Applications", May 6, 2019, Changzhou, China, 100 attendees
5. Jason G. Burns, Sr. , " Saving the Best for Last: A look into the complicated world of last mile logistics," September 27, 2019, University of New Orleans, 20 attendees
6. Amelia Pelegrin, Port of New Orleans; Vivek Shah, Regional Transit Authority; Courtney Young Regional Planning Commission; Dan Jatres, N.O. Mayor's Office of Transportation, September 29, 2019; University of New Orleans, 10 attendees

K-12 Programs and Pre College Events

- K-12 Target outreach – 1793 students total, 748 female, 804 underrepresented
- College Fairs – 2378 students total, 1006 female, 1000 underrepresented
- Nine Camps offered at the University of Arkansas

4.2 Passage of new policies, regulation, rulemaking, or legislation - Nothing to report

4.3 Increases in body of knowledge

Conference Presentations

1. Gallarno, George (student), "Trade-Off Analytics for Infrastructure Preservation," CELDi Spring 2019 Industrial Advisory Board Meeting and Research Symposium, April 2019
2. Gallarno, George (student), "Trade-off Analytics to Optimize USACE Civil Works Budget Allocations," IISE 2019 Annual Conference and Expo, May 2019
3. Johnson, Ashley (student), "Trade-Off Analytics to Preserve Arkansas Maritime Infrastructure," IISE 2019 Annual Conference and Expo, May 2019
4. Verkamp, Logan (student) "Development of Multi-axial Fatigue Retrofits for Waterway Lock Gate Components", SPTC Summer Symposium, August 2019 (invited)
5. Ortega, A.J. (student), Murray, C.D., "Using Calcium Sulfoaluminate Cement to Repair Waterway Transportation Structures," SPTC Summer Symposium, August 2019, Oklahoma City, OK.
6. Coffman, Rick, Murray Lock and Dam Tour, Little Rock Central High School, April 2019
7. Coffman, Rick, Lake Fayetteville Spillway: Hands on Demonstration of Hydrostatic Forces on Vertical Walls as a Corollary to Lock Walls, July 2019
8. Coffman, Rick, Locks and Dams: Little Rock Central High School, August 2019
9. Coffman, Rick, Locks and Dams: Philander Smith College, August 2019
10. Coffman, Rick, Lake Fayetteville Spillway: Hands on Demonstration of Hydrostatic Forces on Vertical Walls as a Corollary to Lock Walls. Butterfield Elementary School Science Club, September 2019
11. Coffman, Rick and Julia Loshelder(student), Guntersville Lock and Dam Tour, Village of Promise, Huntsville, AL, September 2019
12. Asborn, M., "Estimating Waterborne Port Calls from LPMS and Truck GPS data: A Multi-commodity Assignment Model", 2019 Midwestern District and MOVITE annual Meeting, St. Louis, MO, June 2019
13. Leszczynska, D. "Constructing Customized Non-enzymatic Sensors Based on Nano-size Carbon Material for Environmental and Medical Applications", May 2019, Changzhou, China (invited)
14. Leszczynska, D. "Sustainability of Biochar: From Waste to Advanced Applications", University of Gdansk, Gdansk, Poland, June 2019 (invited)
15. Stefanko, A. (student) and D. Leszczynska, "Alteration of Biomass Structure with Slow Carbonization as a Governing Factor Affecting Adsorption of Pb+2 and Other Competitive Heavy

- Metals Ions from Urban Storm Water Runoff”, 19 Southern School on Chemistry and Engineering (SSCEC), Newark, DE, August, 2019
16. Leszczynska, D. “Sustainable Approach Toward Urban Storm Water Treatment by Biochar: From Pine Needles to In Situ Adsorber of Storm Water Contaminants”, 2019 Southern Symposium on Contemporary Engineering Topics & UNO Engineering Forum, New Orleans, LA, September 2019
 17. Khan, M.S., "Highway Slopes Made of Yazoo clay: Failure Mechanism and Possible Repair", SSCET 2019, New Orleans, LA, September 2019
 18. Ivoke J., Khan M. S., and Nobahar M., "Coupled Effect of Wet-Dry Cycles and Rainfall on Highway Slope made of Yazoo Clay” Presentation at MS ASCE Section, Philadelphia, PA, September 2019
 19. Stich, B. "Autonomous Vehicles 101" Education for Louisiana Counties, Small Towns and Satellite Cities, August 2019 (invited)
 20. Webb, Peter, “A Living Laboratory Dueling Narratives- Tourism vs. Freight. Urban Planning and the built Environment”, Southeastern Conference For Public Administration, September 2019
 21. Maryam Izadi (student), “Do Bicycle Infrastructures Help to Increase Ridership?”, The Southeastern Conference for Public Administration, Baton Rouge, LA, September 2019
 22. Camp, J., M. Allen, L. Gillespie-Marthaler, M. Abkowitz. 2019. “How Critical is Access to Key Facilities in a Flood Event?” Association of State Floodplain Managers (ASFPM) National Conference, Cleveland, Ohio, May 2019
 23. Laning, Nick (student), poster presentation "Graceful Failure - Identifying Opportunities to Reduce Flood Impacts in the Mississippi River Basin”, VUSE Undergraduate Research Symposium, September 2019
 24. Abkowitz, M., "Building Resilient Communities in the Face of Extreme Weather: Inside Climate”, September 2019
 25. Nachtmann, Heather, “Wellington Lecture,” Institute of Industrial and Systems Engineers Annual Conference, Orlando, Florida, May 2019. (invited)
 26. Bu, Fan, Furkan Oztanriseven, Samareh Moradpour, Heather Nachtmann, and Justin Chimka, "Regional Economic Impacts of the McClellan-Kerr Arkansas River Navigation System," 2019 IISE Annual Conference, May 2019
 27. Moradpour, Samareh, Furkan Oztanriseven, and Heather Nachtmann, "Optimized Infrastructure Investments for the Inland Waterways." 2019 IISE Annual Conference, May 2019.
 28. Scott Parr, Resiliency Index, Supply Chain Sustainability and Transportation Resiliency Workshop, 2019, Invited Talk
 29. Amir Koleini (student) and Serena Hoermann (student) and John Renne. Visualizing Sea Level Rise Impacts in Transportation Planning. Florida Atlantic University Research Showcase. September 2019.

Conference Planning Positions

1. Board of Directors, Reliability and Maintainability Symposium
2. Board of Directors, Selects Committee INFORMS Analytics Conference
3. Co-Moderator, Ocean and Marine Division, American Society for Engineering Education 126th Annual Conference, Tampa, FL
4. Moderator, “Urban Planning and the Built Environment”, 50th Southeastern Conference for Public Administration (SECoPA) 2019 Annual Regional Conference, Baton Rouge, LA, 2019
5. Organizer, Summer Meeting for select TRB Freight and Marine committees
6. Organizing Committee, Civil, Coastal, and Environmental Engineering track, Southeast Symposium on Contemporary Engineering Topics, Entergy Corp, September 2019, University of New Orleans, New Orleans, LA.
7. Planning Track Chair, Marine Operations, World Transport Convention, Beijing

8. Rapporteur, Commodity Flow Survey Workshop
9. Session Chair, INFORMS 2019
10. Track Chair, ISERC 2019 Security Engineering

4.4 Improved processes, technologies, techniques, and skills in addressing transportation issues

Leadership Positions

1. Advisory Council for Transportation Research Member, ARDOT
2. Chair, AISC Methods of Design Committee
3. Chair, Freight Modeling Subcommittee, AT015 TRB
4. Chair, TRB Special Task Force on Climate Change
5. Co-advisor, Institute of Transportation Engineers Student Chapter at LSU
6. Committee Member, ASCE Infrastructure Resilience Division
7. Faculty advisor, U of A chapter of the Institute of Industrial and Systems Engineers
8. Group Chair, Marine Transportation Research Board
9. Member, Advisory Council for Transportation Research, ARDOT
10. Member, AISC Fatigue and Fracture Committee
11. Member, ASCE Committee for American's Infrastructure
12. Member, Lt. Gov.'s Port Advisory Board
13. Member, Marine Transportation System National Advisory Committee
14. Member, Supply Chain Transportation Council, Baton Rouge LA
15. Member, Transportation Research Board, Technical Advisory Council
16. Member, TRB Intermodal Freight Committee
17. Member, TRB Logistics of Disaster Committee
18. Membership Coordinator, TRB Inland Waterway Committee
19. Past President, American Society for Engineering Management
20. President, Society for Reliability Engineers
21. Representative, INFORMS Subdivisions Council
22. Sub-committee Chair, ABG20- Transportation Training and Education
23. Technical Member, TRB AFP 30 Soil and Rock Properties Committee
24. Treasurer, Ocean and Marine Division, American Society for Engineering Education
25. US representative, World Association for Waterborne Transport Infrastructure (PIANC) Task 193
26. Vice Chair, Engineering Infrastructure Specialty Group, Society for Risk Analysis
27. Vice Chair, Geo-Institute Soil Properties and Modeling Technical committee
28. Vice President, Geo-Institute Geophysics Committee

4.5 Enlargement of the pool of trained transportation professions

Center for Training Transportation Professionals

- Workshop/Courses
 - 5 programs, 12 sessions, 251 students
 - Asphalt Pavement Maintenance, Asphalt Paving Basics, Concrete Basics, Manual on Uniform Traffic Control Devices, Storm water Management
- Certification Courses
 - 6 programs, 21 sessions, 331 students
 - Basic Aggregates, Concrete Field Testing, Concrete Strength, Hot Mix Asphalt, National Pollutant Discharge Elimination System, Soils

4.6 Adoption of new technologies, techniques or practices - Nothing to report

5. Impacts (through project deliverables and diversity)

5.1 Effectiveness of the Transportation System

Stakeholder Citations

- ARDOT TRC1702 Truck Activity Analysis using Truck GPS Data, Final Report, September 2019.

5.2 Technology Transfer

- Six concrete videos from the Center for Training Transportation Professionals
<https://cttp.uark.edu/online-training/index.php>
- Final Report - Interdependency of port clusters during regional disasters
https://martrec.uark.edu/research/lisu_interdependency_final_report_accessible.pdf
- Final Report - Development and Implementation of Sustainable Transportation Resilience Indicators
https://martrec.uark.edu/research/vu_development_2.pdf
- “Uninterrupted Flow,” Institute of Transportation Engineers, Webinar Series

5.3 Increase in the Body of Scientific Knowledge

- Submitted two final reports
- Published three chapter sections
- Published four papers

5.4 Transfer of Results to Government/Industry Entities

- USACE is implementing the dredging project selection optimization models developed by the TAMU team.
- A series of cement mortars have been developed at varying water/cement and varying sand/cement ratios for use underwater. No other research has investigated making flowable, underwater mortars with the cement used in this project. Project ongoing.

5.5 Commercialization of Technology/Process or Adoption of New Practices - Nothing to report

5.6 Improved Performance, Skills, or Aptitudes of Underrepresented Groups

Diversity

- 36% of our research projects are led by female researchers
- 40% of our student research participation is from underrepresented populations:
 - 13 female students
 - 6 female minority students
 - 5 male minority students
- At the University of Arkansas, 40% of our k-12 participants are from underrepresented groups
- At the University of Arkansas, pre-college events, 42% from underrepresented groups

5.7 Development and Dissemination of New Educational Materials

- Trade-Off Analytics for Infrastructure Preservation developed at the University of Arkansas

6. Changes/Problems - Nothing to report

7. Special Reporting Requirements - Nothing to report