



STATE OF NORTH CAROLINA
DEPARTMENT OF TRANSPORTATION

ROY COOPER
GOVERNOR

J. ERIC BOYETTE
SECRETARY

September 17, 2020

MEMORANDUM

TO: Researchers and University Officials

FROM: Neil Mastin, PE 
Research and Development Manager

RE: NCDOT FY2022 Research Request for Proposals

In this document, please find the official Request for Proposals summarizing NCDOT generated research needs for the Fiscal Year 2022 Research Program. This package contains internally generated NCDOT Ideas. **If you submitted a research idea or ideas directly, you will receive direct communication regarding those ideas.** We are not accepting new ideas at this time, only proposals.

The RFP is being distributed to central research/sponsored program offices and directly to faculty and research staff. Please share this email with any university associates or departments that may be interested in participating.

All proposals should be submitted electronically through the NCDOT R&D website.
Note that if already have an account for the Research Ideas site, those credentials will continue to work for the Proposal site.

Instructions on setting up an account and submittal links can be found at the link below.
<https://connect.ncdot.gov/projects/research/Pages/research-dev-ideas.aspx>

The deadline is Friday, November 6, 2020, @ 4:00 PM.

Detailed instructions for writing NCDOT Research Proposals can be found on the R&D website:

[Click here for proposal instructions and templates.](#)

If you have any questions or comments, please contact me or one of our [NCDOT Research Engineers](#) or send queries to research@ncdot.gov.

We look forward to seeing your submissions!

A Few Notes:

Contacting NCDOT Idea Generators

Should you choose to respond to one or more NCDOT research ideas, we strongly encourage you to communicate with the NCDOT professionals who generated the research idea. This will allow you to understand the full intent and desired scope of the research need and prepare the best possible proposal.

If you received this as a forwarded message, and you wish to be added to our database for future communications, please reply with the subject line: **ADD TO NCDOT RESEARCH ROSTER**. Please provide your full contact information including title, university, department, email, phone, fax and address.

Should you wish to be removed from future notifications, please reply with the subject line: **REMOVE FROM NCDOT RESEARCH ROSTER**.

CC: George Hoops, FHWA



RESEARCH & DEVELOPMENT

**NCDOT Research and Development
Request for Proposals
Fiscal Year 2022**

September 17, 2020

FY 2022

REQUEST FOR PROPOSALS

ENVIRONMENT

AND

HYDRAULICS

Research Idea Title:

Modeling the Effects Of Rail Noise Propagation on Pedestrians In North Carolina Railroad Environments

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-019	2022	7/6/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Smock	Roger	Safety and Outreach Consultant	rdsmock1@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Smock	Roger	Safety and Outreach Consultant	rdsmock1@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Improved Models Performance/Traffic/Financial etc.;New or Improved Specifications;Improved Worker or Public Safety;Permitting or Regulatory Compliance;Other (Specify below)

Explain Anticipated Benefits:

Highway and rail design engineers' pedestrian mitigation design efforts

What is the problem or issue needing investigation?

Over the last decade, the incidence of pedestrian strikes by train has increased in the United States resulting in injury, loss of life, as well as costly disruptions in sensitive transportation and logistics systems. Though trespass strike events are well documented, little research to date has investigated the relationship between sound propagation and its effect on rail trespass strikes. The history of efforts to control rail noise in the United States dates back to the early 1960s, and technological improvements in noise abatement have continued to enable trains to operate more quietly, thus avoiding immediate detection by individuals in the vicinity. Research has shown that roughness on the running surfaces of wheels and rails, is the root cause of rolling noise, and a variety of technological improvements such as dampening devices attached to the webs of wheels and the rails have been implemented to reduce this noise. Similarly, train rolling friction coefficients (friction coefficients are a key measurement of noise from vehicles) have fallen substantially with improvements in train wheel and track technology and are currently less than those of highway vehicles. For example, the coefficients for railroad steel wheels on steel rails is between 0.001-0.002, whereas the friction coefficient for car tires on asphalt is 0.02.

Since 2015 I have watched approximately 60 video recordings from in-cab locomotive cameras of pedestrians struck by NCDOT Piedmont trains and various Amtrak trains operating in NC. In addition, I conducted follow-up investigations, reviewed local law enforcement investigative reports, interviewed local investigators, railroad police agents and other rail industry stakeholders in keeping with the NCDOT BeRailSafe mission of mitigating rail tragedies in NC. The one recurring theme from investigators and the rare anecdotal feedback from victims' families is the universal belief that people walking on the tracks should hear or feel the train with adequate advance warning to avoid being struck.

A small minority of people enter the railroad to cause intentional harm to themselves. The vast majority do not. Most people use the railroad to walk to a pre-determined destination.

The video camera system onboard train locomotives display the train speed and the train horn status. After observing numerous videos of incidents while the train horn is sounding at 105 decibels and approach speeds between 50 and 79 M.P.H, the same or similar human behavior occurs. Most of the humans I observed were never aware of the train approach or made a realization far too late to take lifesaving action. Local law enforcement investigations indicate that most of the victims are not wearing earbuds or headphones. The video verifies the same human reaction regardless of the presence of earbuds: no awareness of a train approach or insufficient notice to react.

Even with the technological improvements that have been made, emergency response units, local enforcement agencies, elected officials, and the general public are largely unaware that walking on the railroad often involves individuals who are caught unaware, and are unable to hear an impending train before a strike occurs. In addition to noise reduction technologies that are being implemented, other external factors (i.e. topographic conditions, horn frequencies, train type, policy measure such as Federal Railroad Administration regulated No-Train Horn Highway Crossings i.e. 'quiet zones', etc.) may also play a role in why individuals are unable to hear approaching trains. Today, individuals have unlimited access to music, podcasts, and radio via cell phones and earbuds. Thus, individuals in the rail right-of-way who are listening to media through their earbuds may not be able to hear train horns or the sound of train rolling stock itself over the sound of these media.

Background:

Pedestrian trespass events often involve individuals who are caught off-guard and are unable to hear a train before a strike event occurs. Today, individuals have constant access to music, podcasts, and radio via cell phones and earbuds that may “drown out” the sound of trains as they approach. Additionally, technological improvements and policy measures that result in noise mitigation also play a role in trains being undetected by individuals on the railway. Research needs to be conducted to model how train noise propagates in various environments and how train noise is heard by individuals on the railroad right of way. Sounds produced by train horns, wheels, track, and other sound emitters need to be studied to determine how these noises may interact with pedestrians in rail environments as subject to external factors in the localized environment.

Research Tasks:

The objective of this applied research is the development of a model that demonstrates the decomposition of sound subject to a variety of factors including: (1) geographic and topographic conditions, (2) difference in horn frequencies by freight and commuter rail engines, (3) train type and its influence on noise propagation, (4) impact of policy, such as “quiet zones”, among other factors. The following research tasks are anticipated, although other and alternative proposed tasks are welcome for consideration:

1. Literature review of types of train noises propagated and factors that would influence the decomposition of noises emitted
2. Identification of a comprehensive set of factors that may affect train noise propagation that will be evaluated in this research
3. Development of a methodology for modeling noise propagation and decomposition subject to the localized environmental and other factors (identified in Task 2)
4. Creation of a model or simulation that demonstrates how propagated train noises are heard by individuals on the rail right-of-way subject to factors identified in Task 2 (see first sentence in this “Research Objectives and Tasks” box)
5. Production of a list of conditions that create high-risk environments for noise propagation to go undetected by individuals on the railroad right-of-way, based on the findings from the model or Simulation
6. Produce a report of the study’s findings

Products of the Research:

- A model that demonstrates how propagated train noises interact with external factors, such as vegetation/brush, buildings, etc., in the localized environment
- A prioritized list of high-risk environments resulting from the conditions that enable noise propagation to go undetected by individuals on the railroad right-of-way
- Scientific evidence to explain why individuals, who trespass on the railroad right-of-way, are caught “off-guard” by trains approaching
- Awareness, knowledge and guidance for highway and rail design engineers to ‘design out’ pedestrian ease of access to rail environments

Possible IT Components:

Modern, high-speed computers have enabled the development of microphone arrays that can pinpoint the sources of noise on trains as they pass by on a track. This technology is especially valuable for locating and modeling sources of noise propagation caused by trains. This study should employ state-of-the-art technology (i.e. decibel meters, video cameras etc.) and a data-driven approach to demonstrate how train noise propagation is dependent on a variety of factors (enumerated in “Research Objectives and Tasks”.

Implementation:

Based on the findings from this study, NCDOT will be able to pinpoint high-risk areas of train noise-detection. This information can be used to demonstrate where noise-related safety countermeasures can be implemented to obviate rail trespass strikes related to individuals being caught off-guard. BeRailSafe will implement the findings with public and public safety stakeholders through local, state, and national rail safety awareness networks. In addition, the research findings will be shared with highway and rail design engineers to 'design out' ease of access by pedestrians to rail environments.

Additional Comments and Information:**Subcommittee Comments:**

Research Idea Title:

Vessel Electrification Investigation for the NCDOT Ferry Division Fleet

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-024	2022	7/7/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Peele	Catherine	Environmental Officer	cdpeele@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Peele	Catherine	Environmental Officer	cdpeele@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Other (Specify below)

Explain Anticipated Benefits:

The potential for modifying existing ferries and/or constructing new all electric ferries will equate to emissions reductions output by a NCDOT system, increase the environmental responsibility, potential for preventative maintenance repairs

What is the problem or issue needing investigation?

The Ferry Divisions long range plan “Ferry Forward 2050” was completed in the summer of 2020 and is considered the guide in identifying opportunities and challenges as well as recommending approaches to solutions for terminals, vessels, workforce needs, funding and operations through 2050. One of the recommendations presented in the plan is to initiate a feasibility study to investigate the associated construction costs and benefits of a converted diesel fleet to fully-electric or diesel-hybrid. Replacing diesel engines has the potential to save fuel and reduce the Ferry Division's carbon footprint dramatically, in line with North Carolina's Executive Order 80. The Ferry Division does not have a diesel-electric hybrid vessel in operation but, two are under construction. Passenger ferry operations across the United States, and internationally, are actively pursuing alternative clean energy sources for their operations. Washington State Ferries recently passed legislation and identified funding to pursue a diesel electric hybrid option for several vessels in its fleet and announced construction on a new vessel that will be diesel electric. Other operators around the country, such as Casco Bay Lines, have initiated research efforts into alternative energy sources for propulsion.

This goal of this research project will be to investigate the associated construction costs and benefits of a converted diesel fleet to fully-electric along identified short haul routes. Short-haul routes are the best candidates as a test case given the smaller size of the vessels and shorter crossing times. A brief research effort into other electrification efforts elsewhere in the country has revealed that battery technology does not yet allow for a pure electric vessel on crossings greater than 20 minutes depending on the size and payload of the vessel. Similarly, some experts note that diesel electric technology has not yet proven to reduce emissions or significantly improve efficiency on long-haul routes. These are some of the factors that would need to be studied and considered for the Ferry Divisions fleet as the project develops.

Background:

The North Carolina Department of Transportation's Ferry Division and the North Carolina Ferry System have served North Carolina's coastal region for more than 70 years. This Ferry System is the second largest state-run passenger ferry system in the United States carrying nearly 2 million passengers and 800,000 vehicles in the 2018/2019 fiscal year. Service is provided across a broad spectrum of geographies, from inland river crossings to long-haul crossings over the Pamlico Sound, and an equally wide array of demographics in the communities it serves. There are seven regularly operated routes: Knotts Island-Currituck, Cape Hatteras-Ocracoke (Southdock), Swan Quarter-Ocracoke (Silver Lake Terminal), Cedar Island-Ocracoke (Silver Lake Terminal), Bayview-Aurora, Minnesott Beach-Cherry Branch, and Southport-Fort Fisher. The Ferry Division is lags behind compared to other ferry operators in making advancements toward cleaner or renewable energy propulsion. This research would assist the Division in making progress toward those technologies, identify maintenance cost savings, and be a steward of the environment.

Research Tasks:

Research Tasks Include:

- Literature review
- Peer exchange with other ferry operators with electric fleets
- Discussions with electric ferry builders on requirements, needs, feasibility

The research project will identify the equipment and costs associated with performing the required modifications to identified vessels to allow for electric power operation.

Items to note include but are not limited to:

- Cost estimates of performing modification projects
- Options for potential equipment (to include addition or reduction of weight)
- Time required to modify vessels
- Recommended changes to crew complement (number +-, type license,)

The research will also detail and outline associated shoreside infrastructure improvements and costs that will be needed to power or charge the vessel.

Items to note include but are not limited to:

- Power grid capabilities and needed improvements along with costs estimates at identified terminals
- Charging port options and costs at identified terminals,

The research will also compare the construction costs of diesel, diesel hybrid powered ferries to all electric powered ferry.

Vessel crew operation and maintenance education and training needs will be identified along with resources to obtain specified training and cost estimate of completion

If different options for other equipment or shoreside infrastructure are available, those options should be presented in the final report for comparison.

Emissions savings data will be quantified using provided system data or by using existing Ferry Division studies and reports.

Cost benefit analysis of operating current vessels with diesel engines, slowly replacing existing vessels with diesel-hybrid electric compared to systematically retrofitting identified vessels to all electric and performing needed infrastructure construction. Ideally identifying a possible savings in lifetime operating costs if present.

Short haul routes and associated vessels to be researched include: Bayview – Aurora, Southport – Fort Fisher, Cherry Branch – Minnesott Beach, Currituck – Knotts Island.

Products of the Research:

A final report will include:

- Feasibility of electrification for vessels along the identified routes
- Costs associated with shore side improvements
- Cost and time estimates of performing modification projects
- Options for equipment
- Changes to crew complements
- Advantages and disadvantages and cost benefit analysis of constructing diesel ferries vs. diesel hybrid vs. all electric
- Suggestions on funding or potential grants
- Implementation schedule for modification of existing vessels

Possible IT Components:

No IT components will be needed for the research except for possible survey tools

Implementation:

The results of the report will allow the Ferry Division to establish goals for modification to vessels and shore side components to use electric vessels. Implementation will also include securing grants for future projects and meeting with community and industry leaders to identify barriers and how to move forward.

Additional Comments and Information:**Subcommittee Comments:**

Research Idea Title:

Genetic study, comparative fitness examination, and establishment of quantitative targets for the conservation of freshwater mussels in the Complete 540 Project Area.

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-043	2022	7/9/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Burroughs	Anne		amburroughs@ncdot.gov v

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Gray	Jared	Aquatic Team Lead	jgray@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;New or Improved Specifications;Permitting or Regulatory Compliance;Other (Specify below)

Explain Anticipated Benefits:

Near term results of this research will improve the ecological status of listed mussel species known to exist in the Complete 540 Project area. This benefit will help NCDOT with permitting and regulatory compliance. Potential long-term benefits to NCDOT include future time and cost saving, and improved specifications in required permitting and regulatory compliance needed for federally protected mussel species located in Neuse River and Tar River basins.

What is the problem or issue needing investigation?

Threat of extirpation of rare freshwater mussels from the Complete 540 Project study area.

Background:

The imperiled mussel species in the Complete 540 Project area are at risk of extinction. The development of a restoration plan is desired to prevent this. Success of this plan will require a multidisciplinary approach with highly coordinated and expert guidance. Years of declining mussel populations have likely limited the local gene pool for these target species. The importance of genetic diversity is linked to ability to adapt to changing environments. Therefore, a detailed genetic study of the target freshwater mussel species would be critical to inform recovery plan management efforts to magnify the conservation efforts for these mussels.

Although laboratory propagation of mussels can produce great quantities of mussels, laboratory raised mussels tend to be slow growing (compared to natural grown mussels) and less resilient to environmental stressors. If propagation is to be employed for successful re-introductions the disparity of fitness must be understood so it can be mitigated.

The intent of this research is help conserve and restore imperiled mussels known to exist within the Complete 540 Project area. Ecological restoration is a task full of logistical complexities and high costs, both biological and financial (Donaldson et al. 2019). In order to guide and gauge the effect of this effort quantitative and qualitative goals must be established for all key parameters. Potential goals include but are not limited to: genetic diversity, changes in abundance of populations, and distribution in the wild (Donaldson et al. 2019).

Objective of the research is to efficiently and effectively elevate the state of the science in genetics, propagation and ecological species restoration in order to improve conservation outcomes for all imperiled freshwater mussels of the complete 540 Project study area.

Research Tasks:

- Genetic study of imperiled freshwater mussel species in the Project area to ensure effective reintroduction and/or augmentation efforts to best conserve and enhance genetic diversity among these freshwater mussel populations.
- Imperiled freshwater mussel fitness experiments for propagated versus wild individuals to inform propagation and management for enhanced recovery of the species.
- Study to set quantitative conservation (i.e. reintroduction and/or augmentation) targets for imperiled freshwater mussel populations based on demographic and genetic models.

Products of the Research:

- Quarterly progress reports (QPR), at the completion of each quarter for each study.
- Draft final report at the completion of the study.
- Final report based on reviews of the draft final report by a Project Steering & Implementation Committee.
 - Expert literature review and analysis of the state of science in mussel genetics, propagation and restoration and ecological conservation.
- Improved understanding of current genetic diversity in target mussels and plan to maximize success of propagation.
- Improved understanding of the comparative fitness of wild and propagated mussels that informs freshwater mussel propagation and rearing techniques to provide robust mussel stock which can contribute to recovery of mussel species.
- Clear goals for restoration of imperiled mussels in the Complete 540 Project study area

Possible IT Components:

None

Implementation:

All research will be employed to improve the conservation and restoration techniques employed at the Yates Mill Aquatic Conservation Center (YMACC). This information is needed to ensure the conservation investment in propagation, restoration, and key management guidelines will result in ecological benefit of the target protected species.

Additional Comments and Information:

The research applicant or team should possess an Endangered Species permit from the North Carolina Wildlife Resources Commission and section 10 permits from the US Fish and Wildlife Service prior to submitting a proposal.

Subcommittee Comments:

Research Idea Title:

Management and propagation of the Magnificent Ramshorn (*Planorbella magnifica*) for reintroduction.

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-044	2022	7/9/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Burroughs	Anne		amburroughs@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Gray	Jared	Aquatic Team Lead	jgray@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;New or Improved Specifications;Permitting or Regulatory Compliance;Other (Specify below)

Explain Anticipated Benefits:

Near term results of this research will improve the ecological status of Magnificent Ramshorn. This benefit could help NCDOT with permitting and regulatory compliance. Potential long-term benefits to NCDOT include future time and cost saving, and improved specifications in required permitting and regulatory compliance needed for protected aquatic species.

What is the problem or issue needing investigation?

Propagation techniques for the Magnificent Ramshorn (*Planorbella magnifica*) snail need refinement to efficiently scale up production to prevent extinction in captivity and to produce enough snails for reintroduction into the wild. Reliable data on biotic and abiotic micro- and macro-habitat requirements are also needed to insure long-term survival both in captivity and in the wild. Research on propagation techniques along with establishment of water quality and habitat requirements will help identify key impediments to short- and long-term species survival in laboratory populations. In turn this knowledge can be used to propose mediation of threats to wild habitat to support reintroductions.

Background:

The Magnificent Ramshorn is an air breathing, aquatic dwelling snail limited to the southeastern Coastal Plain of North Carolina. This species is presumed extinct in the wild. Multiple collections occurred prior to extirpation. Two captive populations exist from these collections and have been propagated separately.

Research Tasks:

- Improve upon and refine existing propagation techniques to sustain captive (ark) populations.
- Using refined techniques, scale up capacity and production of Magnificent Ramshorn snails such that reintroduction is possible.
- Determine water quality and habitat requirements needed in laboratory conditions and wild habitats and determine suitability of possible reintroduction sites in the Magnificent Ramshorn's historic range.
- Synthesize results of previous objectives to inform reintroduction and recovery of the species.

Products of the Research:

- Quarterly progress reports (QPR), at the completion of each quarter.
- Draft final report at the completion of the study.
- Final report based on review of the draft final report by a Project Steering & Implementation Committee.
- Expert literature review and analysis of the state of science in Magnificent Ramshorn propagation, restoration and conservation.
- Determined biotic and abiotic habitat and resource requirements for species persistence.
- Increased understanding of the threats to Magnificent Ramshorn survival in captivity and in the wild.
- Refined propagation procedures to support re-establishment of wild populations.
- Actionable plan for successful reintroduction of Magnificent Ramshorn into the wild.

Possible IT Components:

None

Implementation:

NCDOT will use the research to improve the conservation and restoration techniques employed at the Yates Mill Aquatic Conservation Center (YMACC). This information is needed to ensure the conservation investment in propagation, restoration, and key management guidelines will result in ecological benefit of the Magnificent Ramshorn.

Additional Comments and Information:

The research applicant or team should possess an Endangered Species permit from the North Carolina Wildlife Resources Commission prior to submitting a proposal and demonstrate experience working with the species, including propagation and captive rearing.

Subcommittee Comments:

Research Idea Title:

Research and Development of in-vitro propagation of North Carolina freshwater mussels (Unionidae).

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-045	2022	7/9/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Burroughs	Anne		amburroughs@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Gray	Jared	Aquatic Team Lead	jgray@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;New or Improved Specifications;Permitting or Regulatory Compliance;Other (Specify below)

Explain Anticipated Benefits:

Near term results of this research will improve the ecological status of listed mussel species known to exist in the Complete 540 Project area. This benefit will help NCDOT with permitting and regulatory compliance. Potential long-term benefits to NCDOT include future time and cost saving, and improved specifications in required permitting and regulatory compliance needed for federally protected mussel species located in Neuse River and Tar River basins.

What is the problem or issue needing investigation?

Several protected mussel species near extinction from the North Carolina's rivers. Release of laboratory propagated mussels could either support or re-establish some of these imperiled populations. Establishment of populations takes high quantities of high quality, mussel stock. Improvement of in-vitro propagation techniques to increase mussel stock vigor should be explored to replace or complement host reared mussel propagation and reduce costs.

Background:

Many mussel species are declining worldwide. Some watersheds are experiencing environmental rebounding and could once again support mussel populations. Propagation of mussels for release has been used to augment declining populations and/or reintroduce extirpated mussels in recovered systems.

The mussel life cycle is a complex process, reliant on host fish species. Host-dependent propagation can produce healthy progeny; however the technique requires capture and care of host fish species, which compounds the difficulties of mussel propagation. In-vitro propagation offers a reduction in complexity by removing the challenges, logistics, and costs associated with fish capture and care, and it allows for more intense focus on mussel propagation. However current in-vitro methods produce mussel stock with reduced vigor as compared to host reared stock.

Research Tasks:

- Identify technique variables that affect unionid mussel productivity and vigor as targets for scientific analysis, with an emphasis on improving propagation of federally listed and at-risk species to support recovery.
- Conduct controlled studies, develop improved techniques, and report results with analysis of implications for conservation and recovery imperiled mussel species in eastern North Carolina.

Products of the Research:

- Quarterly progress reports (QPR), at the completion of each quarter.
- Draft final report at the completion of the study.
- Final report based on review of the draft final report, by a Project Steering & Implementation Committee.
- Expert literature review and analysis of state of the science of existing in-vitro mussel propagation techniques with analysis.
- Improved in-vitro propagation technique resulting in increased quantities of quality mussel stock available for re-introduction projects to support mussel conservation efforts for rare species.

Possible IT Components:

None

Implementation:

Research will be employed to improve the conservation and restoration techniques employed at the Yates Mill Aquatic Conservation Center (YMACC). This information is needed to ensure the conservation investment in propagation, restoration, and key management guidelines will result in ecological benefit of the target protected species.

Additional Comments and Information:

The research applicant or team should possess an Endangered Species permit from the North Carolina Wildlife Resources Commission and section 10 permits from the US Fish and Wildlife Service prior to submitting a proposal.

Subcommittee Comments:

Research Idea Title:

Water quality testing program for re-introduction sites for Dwarf Wedgemussel (Alasmidonta heterodon), Yellow Lance (Elliptio lanceolata), Atlantic Pigtoe (Fusconaia masoni), Carolina Madtom (Noturus furiosus) and Neuse River Waterdog (Necturus lewisi) in

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-050	2022	7/9/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
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Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Gray	Jared	Aquatic Team Lead	jgray@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;New or Improved Specifications;Permitting or Regulatory Compliance;Other (Specify below)

Explain Anticipated Benefits:

Near term results of this research will improve the ecological status of rare aquatic species known to exist in the Complete 540 Project area. This benefit will help NCDOT with permitting and regulatory compliance. Potential long-term benefits to NCDOT include future time and cost saving, and improved specifications in required permitting and regulatory compliance needed for federally protected aquatic species located in Neuse River and Tar River basins.

What is the problem or issue needing investigation?

Successful reintroductions and/or augmentation of aquatic species populations requires a better understanding of the water quality variables these species need for survival, successful reproduction, and population persistence.

Background:

Several freshwater aquatic species near extinction from the Neuse and Tar river systems. Stabilization of past development may allow some streams within these watersheds to once again support these rare species. Re-introduction and augmentations have been used to conserve the species. However successful re-introductions are dependent on correct site selection. Proper site selection requires an improved understanding of the factors that caused the decline of these species in the wild, as well as refined understanding of the water quality factors required to support fully these species.

Research Tasks:

- Perform detailed literature review of water quality parameters associated with the target aquatic freshwater species.
- Identify (quantify and qualify) water quality parameters and ranges that affect target species survival, growth, and productivity. Results should include water quality factors critical to survival and persistence of rare species (e.g., optimal physico-chemical profiles) and those for which evidence of negative effects are known (e.g., pollutants, tolerance limits for physico-chemical parameters)
- Locate sites in the Tar River and Neuse River basins that provide suitable water quality and physical habitat. Future suitability and viability of these sites also should be modeled and compared to extant and historic range/NHP occurrence records.
- Develop a reintroduction plan based on a synthesis of the water quality factors critical to target species survivorship, growth, and reproduction rates that would facilitate conservation and recovery of populations, and sites within the Neuse River and Tar River basins deemed suitable for population augmentation or reintroduction.

Products of the Research:

- Quarterly progress reports (QPR), at the completion of each quarter.
- Draft final report at the completion of the study.
- Final report, based on review of the draft final report by a Project Steering & Implementation Committee.
- Expert literature review of existing water quality testing and freshwater mussel re-introduction projects
- Reintroduction program to identify the ideal release sites based on established list of factors that impact aquatic species health, with the required ranges of factors to support target species survivorship, growth and reproduction in the laboratory and the wild.
- Based on analysis of findings develop a series of scientific testing to isolate and identify lead factors for target species. These tests are followed by refined testing to quantify the ranges of these factors.
- Results used from iterative testing and analysis used to develop parameters for successful re-introduction.

Possible IT Components:

None

Implementation:

Research will be employed to improve the conservation and restoration techniques employed at the Yates Mill Aquatic Conservation Center (YMACC). This information is needed to ensure the conservation investment in propagation, restoration, and key management guidelines will result in ecological benefit of the target protected species.

Additional Comments and Information:

The research applicant or team should possess an Endangered Species permit from the North Carolina Wildlife Resources Commission and section 10 permits from the US Fish and Wildlife Service prior to submitting a proposal.

Subcommittee Comments:

FY 2022

**REQUEST FOR
PROPOSALS**

TRAFFIC SAFETY

AND

ROADWAY DESIGN

Research Idea Title:

Developing a Crash Modification Factor for Converting from an At-Grade Intersection to a Diamond Interchange

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
TR	2022-007	2022	6/22/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Hummer	Joseph	State Traffic Management Engineer	jehummer@ncdot.gov

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Sponsor/Champion:

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Hummer	Joseph	State Traffic Management Engineer	jehummer@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Cost Savings;Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety

Explain Anticipated Benefits:

A CMF for the conversion of a conventional signalized intersection to a standard diamond interchange will help in at least two ways. The CMF can be used directly during projects that compare at-grade and interchange alternatives. Also, the CMF will serve as a bridge so that many at-grade alternatives can be compared to interchanges alternatives. A high-quality CMF allowing quantitative safety comparisons of design alternatives will be a major step forward for large projects, likely resulting in safer roadways and less-costly projects.

What is the problem or issue needing investigation?

In recent years NCDOT has funded a number of projects to improve large at-grade intersections. At many of these places the project team also considers grade-separated intersection and/or interchange alternatives. Unfortunately, there is no good way to judge the safety of the competing design concepts in such cases. The crash reduction

factor (CRF) list maintained by the Traffic Safety Unit has a factor for the conversion of an intersection to a diamond interchange, but the factor is based on a 2007 meta-analysis performed mostly on European designs of unknown type and quality so it is of only marginal help. The Crash Modification Factor (CMF) Clearinghouse maintained for the FHWA at the Highway Safety Research Center contains only that 2007 meta-analysis and two factors that examined the conversion of at-grade intersections to diverging diamond interchanges, and again those factors offer only marginal help. It is remarkable that for projects that could cost well over \$10 million, in which the difference between alternatives could be well over \$5 million, in the dimension that the NCDOT website says is most important (safety), project teams have almost no useful information to use in making a decision on a design concept.

The objective of the project is to develop a high-quality CMF for the conversion of a conventional signalized intersection into a signalized standard diamond interchange. At a standard diamond interchange the ramp terminals are spaced far enough apart—600 feet or so—to allow storage between the signals.

Besides helping during projects converting from a conventional signal to a standard diamond, the CMF that is the object of this research can also serve as a bridge to other intersection and interchange designs. We already have good CMFs for the conversion of a conventional signalized intersection into many alternative designs such as median u-turns, continuous flow intersections (CFIs), and reduced conflict intersections. Hopefully in the future we will have new CMFs for the conversion of standard diamond interchanges into other grade-separated intersection designs and into other interchange designs such as double roundabouts, partial cloverleaves, and single-points. Thus, with the proposed CMF in hand project teams will be able to compare a very large number of different designs on the basis of safety.

Background:

A recent project on which this proposed CMF could have been applied was U-5744, US-70 at Timber Drive in Garner. The project team compared a conventional signal, a CFI, and a diamond interchange. A quantitative safety comparison of the alternatives would have helped.

Research Tasks:

The tasks of this proposed research should include:

- 1) Insure that the research team has recent publications in this area and any on-going work in other agencies
- 2) Develop experiment plan
- 3) Collect crash and other needed data
- 4) Conduct statistical analysis
- 5) Write final report

Products of the Research:

The main product of the research would be a report containing the data sets, the analyses, and the conclusions from the CMF development exercise.

Possible IT Components:

IT might have to approve the researchers for access to NCDOT databases that contain exposure or crash information. Otherwise, IT would seem to have a minimal role in the research.

Implementation:

The Traffic Safety and Traffic Management Units would be able to implement the findings throughout the NCDOT through webinars. The Traffic Safety Unit would be able to update their CMF list to include this result. The researchers would be expected to publish and present the findings in high-quality outlets to reach the international market outside NC. The CMF Clearinghouse would hopefully add this new CMF to its database.

Additional Comments and Information:

A responding research team should demonstrate previous experience conducting before-and-after safety analyses.

The researchers will almost surely have to collect data from outside NC to insure an adequate sample size. The proposal should discuss the sam

Subcommittee Comments:

Please ensure the proposal is reviewed prior to submittal by Joe Hummer (jehummer@ncdot.gov) of the Mobility and Safety Division.

Research Idea Title:

Validating the NCHRP 7-25 Pedestrian and Bicyclist Quality of Service "20-Flags" Method with Crash Data

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
TR	2022-008A	2022	6/24/2020 12:00:00 AM

Research Idea Generator:

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Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety

Explain Anticipated Benefits:

A validated 20 flags method would be a great boost to many NCDOT project teams struggling with whether their plans and designs are good for pedestrians and bicyclists and how those plans and designs could be improved. The 20 flags method is logical and relatively easy to apply, so if it is also valid it could see application on most NCDOT projects.

What is the problem or issue needing investigation?

NCHRP Project 7-25 is wrapping up in 2020 with the publication of the final report in September or so. The main achievement of the research was to develop a procedure to evaluate the quality of service provided to crossing pedestrians or bicyclists at any intersection or interchange. The so-called "20 flags" method looks at many aspects of the crossing experience and produces an objective, quantitative score that project teams can use to compare alternative design concepts or to improve a particular design. The 20 flags method was developed using literature, focus groups, on-line surveys, and expert input. However, the 20 flags method has not been validated against crash data.

In other words, the new method looks logical and helpful, but we have no empirical evidence that reducing the number of aspects flagged will result in a reduction in pedestrian or bicyclist crashes once the intersection or interchange is built. The objective of this project is to validate the NCHRP 7-25 20 flags method against pedestrian and bicyclist crash data. The validation must be with a sufficiently large sample of intersections and interchanges to see a relationship between flags if one really exists. The validation exercise must account for the pedestrian and bicyclist volumes appropriately. Having a validated relationship would be a great step forward in the ability of project teams to plan and design for good pedestrian and bicyclist facilities, but if the relationship is not validated that would be OK as a signal to project teams not to trust the 20 flags method too much.

Background:

Prior to development of the 20 flags method in NCHRP 7-25, there was not a good way for project teams to objectively evaluate the pedestrian and bicyclist quality of crossing experience at intersections and interchanges. High-quality crash models or crash modification factors do not exist, level of service is very limited, other indexes or checklists are subjective, and microscopic simulation is too expensive at early stages of project development. Most of the literature on pedestrians and bicyclists at intersections and interchanges is focused on remedial treatments for existing locations rather than the optimum design of new or rebuilt locations.

Research Tasks:

The tasks of this proposed research include:

- 1) Develop experiment plan
- 2) Identify intersections and interchange sites to use in validation
- 3) Collect exposure data or surrogates
- 4) Collect crash data
- 5) Collect intersection and crossing characteristics for 20 flags method
- 6) Run 20 flags method for sampled intersections and interchanges
- 7) Conduct statistical analysis
- 8) Write final report

Products of the Research:

The main product of the research would be a report containing the data sets, the analyses, and the conclusions from the validation exercise.

Possible IT Components:

IT might have to approve the researchers for access to NCDOT databases that contain exposure or crash information. Otherwise, IT would seem to have a minimal role in the research.

Implementation:

The Traffic Safety and Traffic Management Units would be able to implement the findings throughout the NCDOT and NC cities and towns through webinars. The researchers would be expected to publish and present the findings in high-quality outlets to reach the international market outside NC.

Additional Comments and Information:

A responding research team should demonstrate previous professional experience with pedestrian and bicyclist crash and exposure data. Knowing how to efficiently mine the existing exposure data sources will be a key skill for the research team.

Subcommittee Comments:

The NCHRP Project 7-25 report should be available in September for integration into this proposal. Please ensure the proposal is reviewed prior to submittal by Daniel Carter (dlcarter4@ncdot.gov), Joe Hummer (jehummer@ncdot.gov) and Brian Mayhew (bmayhew@ncdot.gov) of the Mobility and Safety Division as well as John Vine-Hodge (javinehodge@ncdot.gov) and Heather Hildebrandt (jhildebrandt@ncdot.gov) of Integrated Mobility, Lisa Penny (lepenny@ncdot.gov) from Research and Development is glad to coordinate any preliminary conversations and review of the proposal prior to submittal with these individuals.

Research Idea Title:

Groundwork for the Second Edition of the Alternative Intersection and Interchange Informational Report

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
TR	2022-011	2022	6/29/2020 12:00:00 AM

Research Idea Generator:

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Sponsor/Champion:

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Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety

Explain Anticipated Benefits:

Accomplishing the objectives of this research will mean that NCDOT will, after FHWA and its author team finishes their work, have a newly revised AIIIR for use by our project teams. As NC is the world's leader in reduced conflict intersections, and is either first or second among the states in roundabout installations, we should have a leadership role in this project, and it benefits us to have national-level guidance based in large part by our thoughts and designs. A new AIIIR should lead to even more and even better alternative designs saving our motorists time and crashes, helping our pedestrians and bicyclists, and saving our taxpayers money.

What is the problem or issue needing investigation?

The Alternative Intersection and Interchange Informational Report (AIIIR) First Edition was published in 2010 by the FHWA. It was the first national, public-sector, comprehensive guidebook on the alternative designs which were starting to be built in many states and some other countries. The AIIIR brought together in one document in a standardized format useful information on a half-dozen designs, plus variations, so

that they could be compared. The AIIR contained original results as well, especially operational data from simulation experiments. The AIIR also contained a suggested methodology for planners and engineers to evaluate alternative designs during project processes.

The AIIR was a valuable resource for many years, but is now considered out of date by many. Since 2010 in the area of alternative designs we have seen new designs emerge like the diverging diamond interchange (DDI), a new category of designs emerge in grade-separated intersections, new variations like reverse RCIs and partial median u-turns, a whole set of new crash modification factors (CMFs) to evaluate the safety of alternative designs, a new method to evaluate the pedestrian and bicycle quality of service at alternative designs from NCHRP 7-25, a huge new set of public relations materials, new guidance on the constructability of designs, and other advances. Alternative designs can reduce crashes, reduce delay, enhance pedestrian and bicycle experiences, and reduce costs, but planners and designers need a single volume from which to start their search for the optimum design for a particular spot.

The objective of this research would be to start the process of compiling the AIIR Second Edition. This would include a fresh literature review, expert interviews, an annotated outline for the second edition, a fresh set of simulation runs, and other quantitative work as needed.

Background:

Jeff Shaw of the FHWA Office of Safety agrees that the Second Edition of the AIIR is the next biggest document priority for FHWA in the area of alternative design. Jeff has pledged that if NCDOT completes this first phase of the research he will have the resources to hire a consultant to complete the writing and to finish the publication process. A very similar arrangement between NCDOT and FHWA led to the publication of the Quadrant Roadway Guidebook by FHWA in April 2020. If Jeff and FHWA cannot uphold their end of the bargain upon completion of this research, NCDOT can always seek funding to finish the document on our own and release it as an NCDOT publication, which would still be helpful to us but not as impactful nationwide.

Research Tasks:

The tasks of this proposed research should include:

- 1) Literature review,
- 2) Interviews of experts on alternative designs or convening of an expert panel,
- 3) Draft outline,
- 4) Design of microscopic simulation experiments,
- 5) Conduct microscopic simulation experiments,
- 6) Analyze simulation experiment data,
- 7) Plan and complete other necessary quantitative work,
- 8) Complete annotated outline, and
- 9) Assemble materials for handoff to FHWA author team.

Products of the Research:

The main product of the research would be a package of materials ready to handoff to the AIIR second edition author team, including a revised and complete annotated outline, an up-to-date literature review, and all desired quantitative analyses.

Possible IT Components:

IT might have to approve the researchers for access to certain useful NCDOT databases. Otherwise, IT would seem to have a minimal role in the research.

Implementation:

The Mobility and Safety Division would be able to implement the findings throughout the NCDOT through webinars. Key documents like the Roadway Design Manual might have to be revised to include new information from the research. Of course publication of the second edition AIIIR by the FHWA would be accompanied by national webinars and many other outreach efforts at that level.

Additional Comments and Information:

In their proposal the researchers should provide their thoughts on which new designs should be included in the second edition, how the simulation experiments should be crafted, and which other quantitative analyses should be conducted to add value to the

Subcommittee Comments:

The project proposal should be 1 year or less in duration. Please ensure the proposal is reviewed prior to submittal by Joe Hummer (jehummer@ncdot.gov) of the Mobility and Safety Division.

Research Idea Title:

Determining the Best Intersection Concepts and Design Features for Connected and Automated Vehicles

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
EN	2022-035	2022	7/9/2020 12:00:00 AM

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Sponsor/Champion:

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Hummer	Joseph	State Traffic Management Engineer	jehummer@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety

Explain Anticipated Benefits:

Accomplishing the objectives of this research will mean that NCDOT will have intersection design practices that are much better prepared for CAVs. That will mean operational benefits and safety benefits when the projects designed in the new ways are built. The project should also result in cost savings, as the need to rebuild intersections for CAVs will be reduced. It would be tragic and wasteful for projects designed in the early 2020s and built in the late 2020s are obsolete by 2045; this research should help us avoid that.

What is the problem or issue needing investigation?

As connected and automated vehicle (CAV) technology advances and the prospect of widespread adoption becomes more realistic, the transportation community must consider strategies and standards to facilitate safe CAV operation. Although NCDOT's current design year is 2045 – by which time CAVs will likely make up a significant portion of the vehicle fleet – CAVs are rarely considered when designing transportation facilities. Though CAVs will in some ways adapt and be able to operate in all conditions, there are likely certain conditions, features, and environments that are more CAV-friendly.

While there is ultimately a need to consider CAVs in all design environments, this research is limited in scope to intersections. The objective of this research is to determine how NCDOT should modify its intersection design practices to better prepare for the arrival of large numbers of CAVs. We are interested in two questions in particular.

First, we would like to know whether CAVs are relatively better or worse at alternative designs like Reduced Conflict Intersections (RCIs) instead of conventional designs. A pooled fund study that NCDOT is participating in led by Oregon DOT has shown via simulation work that CAVs gain their biggest advantage over human-driven vehicles when they can form platoons and take advantage of progression through several signals. Since RCIs and some other alternative designs are better at encouraging signal progression than conventional intersections, maybe they will be better in a CAV environment as well. Other aspects of alternative design concepts could also matter, including minimizing conflict points – which could help humans more than machines – and increasing reliance on permissive gap acceptance rather than protected signal movements -which could help CAVs more than humans.

Second, we would like to know how to better design intersections to minimize conflicts between CAVs and vulnerable road users (e.g., pedestrians, cyclists, etc.). A common concern regarding CAVs is their difficulty detecting and reacting appropriately to vulnerable road users in the roadway environment. Similar to a human driver, CAVs need to be able to instantly gather sufficient information about an object to understand what the object's intentions are and make the proper decision. Certain design features and roadway characteristics can affect how easy or difficult it is for a CAV to detect vulnerable road users and gather enough information about their intention to react appropriately. For example, environments which are well-lit, have limited obstructions, have clearer sight lines, and incorporate connected infrastructure technology may be better situated to safely accommodate both CAVs and vulnerable road users. More research is needed to determine the specific design elements which optimize safety in roadway environments where CAVs and vulnerable road users coexist.

Background:

Even pessimistic forecasts about the prospects of connected and automated vehicles (CAVs) in the US show that by the current NCDOT design year of 2045 more than one-third of all motor vehicle travel will be in CAVs. More optimistic forecasts, for more urban and tech-savvy areas like Charlotte and the Triangle, show a much higher percentage than one-third CAVs. However, the current NCDOT design process does not consider CAVs at all—we generally design new facilities as if the vehicle fleet of the late 20th century will still be using our roads in 2045. Ideally, designers should be able to account for the increasing prevalence of CAVs to design roadway environments which maximize safety and mobility. Incorporating appropriate design concepts now will ensure NCDOT is prepared for the likely ubiquitous adoption of CAVs in the future.

This research will result in design guidelines and recommendations for NCDOT and partners to use when designing intersections to ensure CAVs are properly accommodated.

Research Tasks:

- 1) Literature review,
- 2) Interviews of experts on CAVs or convening of an expert panel,
- 3) Design of microscopic simulation experiment on CAV operations at intersection forms of interest,
- 4) Conduct microscopic simulation experiment,
- 5) Analyze simulation experiment data
- 6) From analysis of simulation data and review of information gathered from related NCDOT studies regarding CAVs, determine the key factors impacting CAV detection of vulnerable road users.
- 7) Develop design guidance, proposed standards and other recommendations to ensure CAVs are appropriately considered when designing intersections.
- 8) Write final report incorporating literature review, interview findings, simulation results, recommended design guidance, and recommended next steps or additional research needs.

Products of the Research:

The main product of the research would be a report containing the data sets, the analyses, and the conclusions from the research, with recommendations for how NCDOT should change its intersection design practices to better conform to the era of CAVs. The research will also result in specific guidance for designers to ensure intersections are conceptualized and designed with CAVs in mind.

Possible IT Components:

IT might have to approve the researchers for access to NCDOT databases that contain inventory information for example. Otherwise, IT would seem to have a minimal role in the research.

Implementation:

The Integrated Mobility and Mobility and Safety Divisions would be able to implement the findings throughout the NCDOT through webinars. Key documents like the Roadway Design Manual might have to be revised to include new information from the research.

Additional Comments and Information:

This problem statement is co-sponsored by Joe Hummer of the Mobility and Safety Division and Ryan Brumfield of the Integrated Mobility Division.

Subcommittee Comments:

Need to include in the proposal what the capabilities are success at a design level concept. The team should includes someone who is an expert in CAVs and logic. Please ensure the proposal is reviewed prior to submittal by Ryan Brumfield (mbrumfield@ncdot.gov) of the Integrated Mobility Division and Joe Hummer (jehummer@ncdot.gov) of the Mobility and Safety Division. Lisa Penny (lepenny@ncdot.gov) from Research and Development is glad to coordinate any preliminary conversations and review of the proposal prior to submittal with these individuals.

Research Idea Title:

Risk Factors for Systemic Pedestrian Safety Analysis

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
TR	2022-057A	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Carter	Daniel	Traffic Safety Project Engineer	dlcarter4@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety

Explain Anticipated Benefits:

Currently, NCDOT is challenged to address pedestrian crashes, which are rare but serious. The dispersed nature of these crashes makes them hard to address through NCDOT's traditional methods of safety screening, such as hot spots and sliding scale analyses. The guidance from this research would pave the way for NCDOT to implement a systemic approach to pedestrian safety in both rural and urban areas.

What is the problem or issue needing investigation?

Pedestrian crashes are a significant problem in North Carolina, representing 1% of all crashes but 10% of fatal and serious injury crashes. A systemic approach to safety shows promise in addressing this issue. A systemic approach, as opposed to a “hot spot” approach, enables NCDOT to identify, prioritize, and select appropriate countermeasures for locations with a high risk of pedestrian-related crashes before crashes occur.

One of the key ingredients for the systemic approach is identifying risk factors. The pool of potential risk factors is large and encompasses traditional data, such as pedestrian volume, traffic volume, and traffic speed, but also data which has not typically been used by NCDOT safety analysis, such as land use, transit stops, household income levels, and vehicle availability per household.

Up till now, NCDOT has explored the use of systemic analysis by selecting pedestrian risk factors based on general guidance from nationwide research as well as engineering judgment. There is currently no data-driven guidance to identify which specific risk factors should be used in systemic pedestrian analysis in North Carolina.

The objective of this research project would be to use traditional and non-traditional data to identify pedestrian risk factors for North Carolina and produce guidance on how those risk factors should be used in pedestrian systemic safety analysis. The guidance should specify which risk factors apply to urban and rural areas and what level of priority should be given to each factor. The risk factors should be based on data that is available to NCDOT through existing statewide or national data sources so that it will not be necessary to collect new data solely for systemic analysis. Pedestrian crash data should be used as much as possible to verify the relevance of each risk factor.

Background:

The systemic approach to safety has been a growing field on the national scale. FHWA has advocated this approach for years (<https://safety.fhwa.dot.gov/systemic/>) and produced several guidance documents on how to implement the systemic approach. NCHRP has sponsored multiple research projects to produce guidance on the systemic approach, including a guide on systemic pedestrian safety analysis (NCHRP Research Report 893).

Research Tasks:

The tasks of this proposed research include:

- 1) Conduct literature review
- 2) Collect data from existing data sources
- 3) Link data and reduce or derive data variables
- 4) Analyze data and identify risk factors
- 5) Develop guidance document and final report

Products of the Research:

The product of this research would be guidance on implementing systemic pedestrian safety analysis in North Carolina, focusing on the identification and use of pedestrian risk factors in both urban and rural areas. This guidance document should be a standalone document, separate from the final research report.

Possible IT Components:

There is not an anticipated role for IT in this research.

Implementation:

The Traffic Safety Unit would be the primary party to implement the findings by using systemic analysis to identify and treat corridors and intersections that are shown to be high risk for pedestrian safety. The Integrated Mobility Division would also be able to use the findings of the research to direct their efforts, especially regarding the collection of pedestrian-related data.

Additional Comments and Information:**Subcommittee Comments:**

It is requested that Daniel Carter and Brian Mayhew be contacted very early in the process if interested in pursuing this Proposal. Please ensure the proposal is reviewed prior to submittal by Daniel Carter (dlcarter4@ncdot.gov) and Brian Mayhew (bmayhew@ncdot.gov) of the Mobility and Safety Division. Lisa Penny (lepenny@ncdot.gov) from Research and Development is glad to coordinate any preliminary conversations and review of the proposal prior to submittal with these individuals.

Research Idea Title:

Economic Impact of Reduced Conflict Intersections: Traffic Volume Changes

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
TR	2022-072	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
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Secondary Generator:

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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Dunlop	James	Congestion Management Engineer	jdunlop@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Other (Specify below)

Explain Anticipated Benefits:

Data providing traffic volume impacts (positive and/or negative) that result from conversion of a traditional intersection to an RCI that would aid in development of future projects (resulting in increased operational efficiency and time savings.) The results of this research will also provide more detailed information to the public, leading to better understanding of these concepts.

What is the problem or issue needing investigation?

This is a follow-up to the current project - RP2020-47 Economic Impact of Superstreets. This project is looking at economic impacts, reviewing specific economic effects of the implementation of superstreets (now called RCIs by the Department.) The current research is looking at business levels before/after, a corollary to this is if more traffic volume moves to and from the businesses/attractions.

Background:

Congestion Management Section is the lead traffic operations analysis group in the Department. We are charged with reviewing projects and proposals and making recommendations on roadway laneage and intersection/interchange configurations to improve mobility and safety across the State.

Research Tasks:

RCIs provide significant overall travel time savings (and improved safety) at busy signalized intersections. While there are clearly major improvements for the primary corridor, there are questions about whether they help the side streets. Some businesses claim that the RCIs deter consumers from traveling to certain businesses due to increased travel distance or perceived inconvenience of the additional movements. The current research is looking at this issue from a business activity standpoint. This proposed follow-up would review traffic data to show if traffic volumes stayed the same, increased, or decreased, and if traffic diverted to avoid the RCI intersections. This research could be expanded to include other innovative designs, such as CFIs, Quadrant Roadways and DDIs.

Much of the data collection could be done using "big data", such as the origin-destination capabilities of traffic data companies such as StreetLight. They have the capability of providing "before-after" data dating back about ten years (depending on the site.) I would envision StreetLight, or a similar vendor, being a partner in this research (to the extent allowed by our contracts.)

Products of the Research:

Data providing traffic volume impacts (positive and/or negative) that result from conversion of a traditional intersection to an RCI that would aid in development of future projects (resulting in increased operational efficiency and time savings.)

This would be "general guidance" for project managers and traffic engineers, specifically to aid in the public involvement part of projects. More positive information will likely result in more implementation of concepts that improve traffic operations and safety. It can also be used to determine which alternative would be a better fit for a location, depending on existing/proposed businesses and guide local zoning.

Possible IT Components:

Limited. Results will be more related to public involvement/public information initiatives.

Implementation:

The results will be used to help refine alternative selection for projects and provide data for public involvement tasks.

Additional Comments and Information:

Potential members of the project panel could include Project Development Unit (and/or Division equivalents), and Public Involvement Unit, including the public involvement and community studies groups. TPD may be interested, to assist in development of lo

Subcommittee Comments:

The project proposal should be 1 year or less in duration. Please ensure the proposal is reviewed prior to submittal by Joe Hummer (jehummer@ncdot.gov) and Jim Dunlop (jdunlop@ncdot.gov) of the Mobility and Safety Division. Lisa Penny (lepenny@ncdot.gov) from Research and Development is glad to coordinate any preliminary conversations and review of the proposal prior to submittal with these individuals.

Research Idea Title:

Costs and Risks of Incident Clearance Time

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
TR	2022-097	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

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Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety

Explain Anticipated Benefits:

The primary benefits of this research will be the ability to communicate the quantitative benefits of reduced Incident Clearance Time to a wide range of audiences as well as estimate the benefits of Incident Management initiatives. The outcomes will be used to address gaps in current TSOU evaluation methods and are expected to lay the groundwork for future research projects. The NCDOT will be able to calculate historical and future benefits (e.g. secondary crashes and responder struck-bys prevented) of programs that aim at reducing incident duration (e.g. towing contracts, quick clearance, multi-discipline training, IMAP, etc.) by looking at historical data. This will equip the NCDOT with an improved ability to estimate benefits for project proposals and funding requests of operational projects/programs that reduce incident clearance time and incident exposure.

What is the problem or issue needing investigation?

There is a lack of information relating incident duration (e.g. Incident Clearance Time) with the cost of first responders (equipment and personnel) being struck while on-scene and secondary crashes. Understanding these costs and risks are important for

communicating the value of efficiently clearing a traffic incident scene as well as estimating benefits of Incident Management (IM) programs that aim to reduce clearance times of unplanned incidents. In depth data collection, analysis, and modeling is needed in order to develop a methodology which the NCDOT can use for evaluating current and planned IM projects with more precision.

Background:

The Traffic Systems Operations Unit (TSOU) regularly struggles to estimate benefits of its IM programs and tools. This ability is critical for communicating with partner agencies, training, analysis, and applying for funding. The TSOU has good data sources regarding incidents (location, time, duration, responders on-scene, etc.) but not responder struck-by information (property damage costs, injuries/fatalities, etc.) or the resources to identify secondary crashes and their severity on a statewide level.

The NCDOT has implemented a series of IM projects in the state which target both incident management in the vicinity of active work zones as well as coordinating incident management with traveler information and integrated corridor management. Past evaluations of these projects have utilized planning level models or assumptions in order to estimate secondary incident impacts and note in their findings that more in-depth analysis is needed in order to better quantify these benefits. None of the evaluations have evaluated impacts to responder struck-bys. Additional benefits of reduced secondary incident and responder struck-by frequency and severity include reduced delay which is currently not measurable under existing methodologies.

The NCDOT and FHWA have developed methodologies for estimating the benefits of IM initiatives including user delay savings, user fuel use savings, emissions savings and reduction in secondary incidents. Specifically, the secondary incident analysis often requires assumptions from microsimulation in the case of the FHWA method and assumed incident reduction rates in the case of the NCDOT method. These methods do not incorporate reduction of responder struck-bys.

National literature generally does not provide a method of estimating secondary incident and responder struck-bys that is relatable to programs aimed at reducing incident clearance time either historically or for estimating future benefits. An internal NCDOT study estimated that on I-95 for every hour of incident-induced congestion, the cost of secondary crashes was \$125; or, approximately 1 PDO crash for every 56 hours of incident-induced congestion. This study only covered a 3-month period and did not account for variations in AADT along the corridor, which is expected to be a key independent variable of the relationship.

Research Tasks:

1. Literature Review and Preliminary Data Gathering
2. Data Collection Plan and Methodology Development
3. Crash History Analysis
4. Responder Struck-By History Analysis
5. Computational Model Development
6. Final Report/Presentation

Products of the Research:

The project will develop analysis and models for secondary incident and responder

struck-by frequency and severity impacts.

It is anticipated that the computational models developed will be easily implemented by practitioners and rely on data that is readily available. Depending on availability of data, the computational models could result in a simple statewide aggregate value (e.g. \$/hour) or a more complex nomograph or equation.

This research will also develop a methodology for planning studies and before/after evaluations of incident management strategies that aim to reduce incident duration and exposure (i.e. impacting secondary incidents and responder struck-bys).

Possible IT Components:

Special IT components are not anticipated for this project. This project should be able to rely on computers, spreadsheet software, database software, and ability to work with a variety of data sources.

Implementation:

NCDOT Traffic Systems Operations unit typically performs planning estimates and evaluations of incident management projects including ongoing programs such as IMAP and individual projects. Traffic Systems Operations and Traffic Safety Unit will review the methodology and identify which projects can utilize the methodology. After these advanced IM strategies are deployed and well understood, NCDOT local Division staff are trained on implementing and this evaluation methodology may be included in that training.

Additionally, the NCDOT TSOU will share results with national groups and professional organizations, such as the SSP Idea Sharing Network, ITS America, and the FHWA Traffic Incident & Event Management Team. Implement outcomes into project reporting and business case analyses.

Additional Comments and Information:

We do know that NCSHP keeps good records of struck-bys and are confident that we will be able to get that data and information.

Subcommittee Comments:

Please ensure the proposal is reviewed prior to submittal by Zachary Clark (ztclark@ncdot.gov) of the Mobility and Safety Division.

FY 2022

REQUEST FOR PROPOSALS

**PLANNING, PROGRAMMING,
POLICY & MULTIMODAL**

Research Idea Title:

Multimodal Connections to North Carolina Ferries

Sub Committee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-022	2022	7/7/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Peele	Catherine	Environmental Officer	cdpeelee@ncdot.gov

Secondary Generator:

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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Brumfield	Ryan	Innovations and Data Branch Manager	rmbrumfield@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Other (Specify below)

Explain Anticipated Benefits:

The report and subsequent implementation discussions at NCDOT will lead to new ideas, projects, policies, and strategies to better link pedestrian, bicycle, and public transportation infrastructure to the ferry system. A better-connected system will improve access to opportunities, services, and attractions for residents and visitors

What is the problem or issue needing investigation?

The ferry system in North Carolina currently has limited connections to public transportation, pedestrian and bicycle infrastructure, limiting access for many residents and visitors to the ferry system and the many destinations and attractions it serves. Better integration of the ferry system into the multimodal transportation network will help NCDOT ensure transportation systems in the state are well-connected and accessible to all residents.

Background:

The NC Ferry Division within NCDOT runs nearly two dozen boats on seven year round routes, connecting residents and tourists from the mainland to many coastal destinations, including Southport, Fort Fisher, Cherry Branch, Minnesott Beach, Aurora, Bayview, Cedar Island, Swan Quarter, Ocracoke, Hatteras, Currituck and Knotts Island.

Most of the ferries primarily serve vehicular traffic. All ferries can accommodate walk-on passengers, though pedestrian and bike infrastructure is often limited near ferry access points. Currently, no public transportation routes provide service to/from the ferry routes.

Many North Carolina residents do not have regular access to a personal automobile and, therefore, have limited ability to utilize the ferry system.

The ferry system is primarily funded through state funds, though there may be opportunities to utilize Federal Transit Administration (FTA) funding or other federal sources. However, use of FTA funds would be difficult to justify and may not be approved by FTA if connections to transit are not available.

Research Tasks:

The tasks of this proposed research should include:

- 1) Literature review,
- 2) Interviews of peer states with ferry systems about linking ferries with other transportation modes,
- 3) Interviews with North Carolina transit systems, transportation planners, municipal leaders, and NCDOT staff serving areas with ferry routes to determine challenges and opportunities related to multimodal connections to ferries,
- 4) Conduct ferry passenger surveys and analyze other data sources to quantify potential demand/interest in utilizing other transportation modes to access the ferry system.
- 5) Assess relative access to the ferry system – and, subsequently, access to opportunities, services, and tourist and recreational attractions facilitated by ferries – for various sociodemographic groups in North Carolina. Assess how access may be improved by increasing multimodal connections to ferries.
- 6) Estimate the economic impacts to North Carolina of having greater multimodal connections to ferry and better access to services and attractions facilitated by ferries.
- 7) Develop short and long-term plans and goals to link other transportation modes to each of the ferries operating in North Carolina, including specific project suggestions and policy recommendations for transportation planners and engineers.
- 8) Develop final report which includes best practices from other states, results of interviews, surveys, data analysis, and economic impact assessments, and summary of plans, goals, and policies for NCDOT and partners.

Products of the Research:

The main product of the research will be a final report which includes best practices from other states regarding multimodal connections to ferries, results of interviews, surveys, data analysis, and economic impact assessments completed during the project, and a summary of plans, goals, and policies for NCDOT and partners.

Possible IT Components:

No IT products or components anticipated, other than possible support for project meetings and survey tools.

Implementation:

Projects, policies, and strategies recommended in the report would be implemented jointly between the Ferry Division and the Integrated Mobility Division. Public transit organizations, local municipalities, and planning bodies will also be involved in identifying and prioritizing projects for funding and implementation.

Additional Comments and Information:

This problem statement is co-sponsored by Catherine Peele of the Ferry Division and Ryan Brumfield of the Integrated Mobility Division.

Subcommittee Comments:

Research Idea Title:

COVID-19 Impacts and Pandemic Planning for NCDOT Construction and Maintenance Operations

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-041	2022	7/9/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Penny	Lisa	Research Engineer	lepenny@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
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Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Models Performance/Traffic/Financial etc.;New or Improved Specifications;Other (Specify below)

Explain Anticipated Benefits:

With a tool or model to predict trends and specifications to follow during a pandemic or recession there will be reduced decision making time leading to cost savings, time saved, and operational efficiency. Other outcomes include training and policy for a pandemic or recession state to ensure the budget is not compromised.

What is the problem or issue needing investigation?

COVID-19 is having a major impact on the utilization of roadways and the associated funding coming into the department. The department needs a way to forecast near and distant road use to make proper planning decisions for construction and maintenance projects. With less road users on the road with COVID-19 such as businesses transitioning to remote work, it is very important that the department have a methodology to make good budget and operational decisions in this changed

environment and to account for what the future may hold as a result of the pandemic. The department needs tools and processes to be prepared for any future pandemics as well. Documenting not only the road use data trends but the actions taken place to date by the department to operate defining what decisions were successful and what had opportunities would be important to ensure a structured plan for any future pandemics or recessions that impact travel behaviors like a pandemic.

Background:

There is not a structured statistical methodology to account for the COVID-19 impacts to plan and program construction and maintenance initiatives. There needs to be a way to look at trends since COVID-19 actions were taken, statistical trends over time on the change of behaviors of road users, and a methodology to account for those changes to be prepared for any future pandemics and manage for the current COVID-19 pandemic. The ability to forecast timing of the norm resuming or a new normal transpiring would allow the department to make more informed decisions. Documenting the changes the department has made to manage for the current pandemic is needed to determine the best processes and procedures for the remainder of and any future pandemics or recessions that impact travel behaviors like a pandemic.

Research Tasks:

The objective of this research request is to evaluate COVID-19 trends and impacts on the NCDOT managed roadway system to make better construction and maintenance decisions in current and future planning efforts for current and future pandemics. To do this tasks would include gathering road use data such as probe and camera data to note the trends in road use, gathering actions taken by the department and construction/maintenance firms to manage COVID-19 regarding maintenance and construction project initiatives, then to analyze that data and information gathered to create a forecasting tool to predict use conditions over time and define best practices to utilize during a pandemic, and then finally the team would correlate those predictions with the current project construction and maintenance plans to determine if aligned or identify what changes are needed to align the plans to trends and budget thresholds. If possible, defining what impacts were due to COVID-19 and what were budget shortfall decision making and impacts would be beneficial.

Products of the Research:

The research team will produce the following: A list of what tools the department has and/or what tools the department can create to estimate impacts to travel/road usage. The department will receive a how to guide for how we use those results to estimate revenue impacts and produce a forecasting model based on the current tools available. Having the department have the capability to update that model based on additional data gathered over time is needed. The department will have a method to determine how we can use the revenue projections to create budgetary plans to ensure we stay within budget and how to know road usage details impacting the construction and/or maintenance activity decision/investments that we make. A processes and procedures guide for department Construction and Maintenance efforts will be provided, this documentation will allow for a clear path forward for the department to prioritize efforts based on budgetary plans for the remainder of this pandemic and any future pandemics or recessions that impact travel behaviors like a pandemic.

Possible IT Components:

There is a potential IT Component for the model to be integrated into the department for use for independent model use and update or integration of model components in the planning process.

Implementation:

A forecasting tool and guide will be made available to the department for representatives in planning, construction, and maintenance to implement during the remainder of this pandemic and future pandemics. Process and procedures for the remainder of the pandemic and future pandemics will be supplied and utilized by the department.

Additional Comments and Information:

Many units and divisions can take advantage of the results of this research to have an improved plan for future pandemics, recessions, and the remainder of the COVID-19 pandemic. Other approvers of this idea include Burt Tasaico, Jamal Alavi, Emily McGra

Subcommittee Comments:

Research Idea Title:

Develop Guidance for a Vehicle Weight Monitoring Program for the NCDOT

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-061	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Taylor	Kent	State Traffic Survey Engineer	kltaylor@ncdot.gov

Secondary Generator:

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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Morrow	Kerry	Transportation Engineer	kmorrow@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Material Structure/Pavement/Performance

Explain Anticipated Benefits:

Developing a strategic approach to vehicle weight monitoring will result in data products suited to all processes it is designed to support. It will result in efficiencies of scale due to a single program managing the resources needed and will eliminate redundancies if this data were acquired by individual units. Given the level of effort and high cost of weight monitoring there will be a substantial savings in both time and money. Additionally, vehicle weight laws are modified periodically which results in changes in the loads being applied to highway infrastructure. Having a continuous monitoring process will ensure the monitoring and design statistics reflect the effect of current regulations for weight limits. This will ensure the decisions made based on estimated service life of the highway system and the designs developed for new highways are based on real measures rather than assumed estimates.

What is the problem or issue needing investigation?

New requirements for freight monitoring and planning have increased the need for vehicle class and weight traffic data. Other users of this type of data include pavement monitoring and design, bridge design, planning, traffic monitoring, enforcement, and regulatory management. The NCDOT has not had a comprehensive vehicle weight monitoring program to support these processes. As a department we need to investigate the requirements for developing a comprehensive program that will generate statistics for monitoring how freight is served and how that translates to loads on the highway system so that planning and design activities will support a healthy transportation infrastructure. Developing a strategic approach to vehicle weight monitoring will address the needs of all data users and minimize the cost to provide reliable and timely data to the agency. Collect once, use many times!

Background:

The Traffic Survey Group has collected vehicle weight data previously to support pavement research. They have worked with pavement designers, bridge management, and enforcement in promoting the use of that data for other purposes. However, this approach results in limited utility of the data due to sampling and data standards inconsistent with the secondary uses. Vehicle weight monitoring programs can be expensive (more than the cost of all other monitoring combined) so having a stable funding source to ensure timely maintenance and regular scale calibration are critical to providing good quality data. We are seeing an increase in the need for vehicle weight data in the agency by freight monitoring and planning stakeholders due to new requirements in the FAST Act. Trip and commodity data are needed also and would be of much more value if collected simultaneously with weight data. NCDOT needs to develop an understanding of the spectrum of vehicle weight data needs within the agency, inventory the statistics needed by stakeholders, and identify the standards required to generate them reliably. We need to develop an understanding of the technology required to collect that data and the level of sampling necessary to characterize the system properly. This information will be used to define how monitoring should be performed and the approximate scope of monitoring activities. This assessment will enable the agency to make an informed and unified decision on pursuing vehicle weight data that balances the costs of investing in this type of monitoring with the benefits to the agency as a whole.

Research Tasks:

Task 1: Survey NCDOT stakeholders regarding their weight data needs, statistics used, related data standards, and the frequency and timing of updates.

Task 2: Survey other State DOTs regarding weight monitoring programs, customers served, statistics generated, technology used, and costs of these activities.

Task 3: Literature search of the technologies best suited to meet NCDOT's data needs, best practices in weight monitoring, and the costs and benefits of this activity.

Task 4: Evaluate the information gathered and develop recommendations for a comprehensive weight monitoring program for the NCDOT. This should include:

- a. Program design – specify options for technologies, standards, and relative size
- b. Product inventory – specify the data products the program design supports
- c. Costs – identify the general startup and recurring costs
- d. Benefits – characterize the direct and indirect benefits of a strategic approach to weight monitoring
- e. Funding sources – identify sources of funding based on processes supported
- f. Sourcing options – identify agency and out-sourced resources
- g. Implementation plan – specify the sequence of actions necessary to implement effectively
- h. Emerging technologies – identify new technologies and services that may be impactful to the program expected to be available in the near term

Products of the Research:

Inventory of stakeholders' requirements for a weight monitoring program

Survey of state practices in weight monitoring

Literature Review of technologies and best practices in weight monitoring

Guidance on the design of a comprehensive weight monitoring program

Possible IT Components:

None

Implementation:

The information generated will be used to inform stakeholders, provide the basis for making decisions regarding program development, support decisions in identifying funding sources and amounts, and facilitate implementing a solution to meeting the weight data needs of the NCDOT.

Additional Comments and Information:

Many groups within the agency and its partners would be involved in this project. This program would support freight monitoring and planning, pavement monitoring, pavement design, bridge design, traffic monitoring, vehicle size and weight regulation, and

Subcommittee Comments:

Research Idea Title:

Risk & Resiliency Profiles on Primary & Secondary Freight Routes

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-078	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Magliola	Dana	Logistics & Freight Division Senior Supply Chain Analyst	damagliola@ncdot.gov

Secondary Generator:

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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Magliola	Dana	Logistics & Freight Division Senior Supply Chain Analyst	damagliola@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Improved Models
Performance/Traffic/Financial etc.;New or Improved Specifications;Permitting or
Regulatory Compliance

Explain Anticipated Benefits:

More relevant information and specific analysis on the resiliency of North Carolina's highway freight network will improve efficiency and resiliency in response to events or scenarios where roads, networks, or corridors are rendered unusable or there are other mitigating factors. Creating resources for transportation planning professionals, industry and supply chain planners, emergency and crisis response officials, and others to understand the level of risk or what levels of service would look like in different scenarios, will provide a new and relevant way of looking at the highway network, planning for development, future infrastructure investment, or even public health and safety investments.

What is the problem or issue needing investigation?

When a road is closed in the case of an emergency or other issue, alternative routing options may exist but may be costly in terms of time or expense. Better understanding the risk profiles for our freight routes will help emergency management, highways safety, community transportation planners and industry ensure their networks (and supply chains) are resilient to delays and closures, or that our freight network reliably supports public health.

Background:

Whether it is hurricanes in the east, flooding across the state, or landslides in the west, road (and rail) closures can prove extremely costly in terms of both economic and human impact. Major shifts in traffic or travel patterns in response to major events like a hurricane or a pandemic like COVID19, knowing how North Carolina's freight network can respond or maintain reliability will keep supply chains moving, and support everything from disaster recovery to public health. Recognizing the risk and potential costs for each primary and secondary freight route (established in the NCDOT Statewide Multimodal Freight Plan 2017) will ensure users of those routes are better prepared to make decisions to find alternative options to connect to markets, customers, support resources, and critical destinations.

Research Tasks:

For each primary and secondary freight route, perform a sensitivity analysis to different events that would force a closure, delay, re-routing, or major shifts in road usage in response to issues like a pandemic or domestic military action. After classifying/categorizing/scoring these routes, identify the key alternative routes which would be relevant and determine the cost differences in terms of time, money, and other important metrics. This would take into account freight patterns, market access for key regions of the state, as well as limitations and restrictions relevant to trucks and other freight movement (oversize, heavy, hazmat, etc). Alternative routing and costing phase can focus on strategic roads, corridors, or routes on the network as a wholesale catalog may prove burdensome.

Products of the Research:

Some Ideas: Data resources and products relevant to NCDOT such as GIS-based data layers available and relevant from planning through design and construction. Alternative routing guidance and information for each primary and secondary freight routes will support emergency management, repair and construction response, and the unfettered movement of critical freight or supplies. An industry-facing product supporting supply chain management professionals in route and risk planning may strengthen the value NCDOT can provide to the commercial marketplace. Analysis for routes that provide information on cost/time/risk or perhaps a risk rating for each route statewide. Information for public, elected officials, chambers, planners, industry, others on how to use risk profiles in planning. A statewide dashboard could also be built based on risk values to provide a system-wide approach to risk mitigation and scenario planning.

Possible IT Components:

GIS products; possible dashboard interactive by the highway network (would most likely be GIS based or GoNC)

Implementation:

Once completed, making this available to planners and industry to use in their business and routing decisions. Support rollout with information, presentations, and stakeholder outreach. Internal and/or external training on risk + resiliency and how to use the information gained in the project; Integrate risk scoring into short and long term planning activities; engage RPOs, MPOs, TACs/TCCs, others to understand the info, then incorporate it into their local policy, planning, emergency management, or economic activities.

Additional Comments and Information:**Subcommittee Comments:**

Research Idea Title:

Drone applications to improve operations of freight facilities including maritime ports and intermodal operations

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-087	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

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Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Models Performance/Traffic/Financial etc.;Improved Worker or Public Safety;Other (Specify below)

Explain Anticipated Benefits:

Improved on-site operational efficiencies; identified new and innovative ways in which UAS technology can be used in an industrial context; more robust applications for the UAS platform and IPP

What is the problem or issue needing investigation?

Expanding footprints and operational complexity for port facilities, intermodal operations or railroad facilities means equipment or other material transport on site is time consuming and burdensome, reducing efficiency and slowing operations in areas of

maintenance, repair, compliance and clearance, ongoing data capture. Drone technology and UAS platforms offer a potential solution, but limited work has been done in this area in the US.

Background:

Drone technology is constantly improving. Capabilities of this tech platform to support operations on site at maritime ports or intermodal facilities such as railroad yards or intermodal terminals have increased. Not necessarily for the primary movement of freight, but for the expediting of moving repair or replacement equipment, sending physical documentation or even things like twist locks and other security equipment. Additionally, the optical/video capabilities for oversight and operational awareness offer a potential major improvement to managing operations on such a facility. Regular data collection via UAS is also relevant to port and intermodal sites with precedent for this practice abroad, as well as through previous NCDOT research. European maritime and industrial facilities have pioneered the use of UAS on site with efficiencies gained and technology innovations inspired. North Carolina has a unique opportunity to leverage the NCDOT Aviation's IPP designation to determine where the UAS technology might provide benefits in North Carolina freight facilities and strengthen our economic competitive position.

Research Tasks:

Survey current practices for industrial drone application; identify key platforms by capability and relevance to intermodal, maritime, and freight applications; learn and understand the liability, business and safety risks of the UAS in an industrial environment; identify what areas of NC facilities could serve to host pilot programs or initiatives to apply UAS to on-site efficiency or operational issues; Compare NC scenarios to other facilities where UAS technology is in place to determine applicability/potential

Products of the Research:

an understanding of ways in which the UAS platform may provide efficiency gains or operational improvements on site at major transportation asset facilities such as ports, rail intermodal sites, and more; guidelines and planning for pilot applications and test sites; feasibility of the idea and application of UAS on site at these type facilities

Possible IT Components:

possibly on both operations and security for UAS on secured sites

Implementation:

Develop a pilot program or initiative that utilizes UAS technology to address operational challenges or efficiency opportunities on industrial freight facilities such as maritime ports, intermodal facilities, and rail yards

Additional Comments and Information:

We have some interest in the drones-on-port concept from NC Ports and it is also super relevant to an industrial site like CSX's Carolina Connector (CCX); the IPP gives us great flexibility and this can further cement NCDOT's place as an innovator in UAS

Subcommittee Comments:

Research Idea Title:

Equity Analysis for Long Range Transportation Planning

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-096	2022	7/10/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

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Alavi	Jamal	Branch Manager	jalavi@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;Cost Savings;Improved Models Performance/Traffic/Financial etc.;New or Improved Specifications;Permitting or Regulatory Compliance;Other (Specify below)

Explain Anticipated Benefits:

The benefits of addressing equity in long range transportation planning are great to a community in terms of impacts to economy, quality of life, and addressing other areas of past inequality. Benefits of addressing equity well in early planning propagate through the project development process. By identifying issues early, engaging all populations, and conducting equity analysis during the earliest planning phase, benefits are realized throughout project prioritization, development, and implementation. It helps ensure that inequality in transportation investment and decision-making do not occur, starting early in the planning process, where the ideas for many project proposals are generated and the prioritization for projects begins. Benefits are gained in the quality of project proposals that are developed, in that equity is considered and accounted for appropriately. Additional benefits may be realized in cost savings and time savings in project development and delivery, as equity analysis results in early identification of affected people and issues, so that they can be addressed appropriately and project proposals can be better scoped early, resulting in less project delays, less rework, and more predictable cost estimates.

What is the problem or issue needing investigation?

The importance of Transportation Equity is highlighted in the following excerpt from FHWA's publication 'The Transportation Planning Process Briefing Book- Key Issues for Transportation Decisionmakers, Officials, and Staff' (A Publication of the Transportation Planning Capacity Building Program, FHWA-HEP-18-015).

“Transportation equity refers to the way in which the needs of all transportation system users are reflected in the transportation planning and decision-making process. In particular, transportation equity focuses on the needs of those traditionally underserved by existing transportation systems, such as low-income and minority households, older adults, and individuals with disabilities. Transportation equity means that transportation decisions deliver equitable benefits to a variety of users and that any associated burdens are avoided, minimized, or mitigated so as not to disproportionately impact disadvantaged populations.

USDOT and modal administration regulations and guidance outline specific program requirements as well as best practices for achieving more equitable outcomes. Considering equity early and often through methods such as public participation and data collection and analysis improves the planning process's ability to adequately respond to the needs of the community it serves. It may also improve project delivery by preventing costly and time-consuming delays that could arise from previously unrecognized conflicts as projects move from planning into implementation.”

The scope of this proposal is to conduct a thorough literature review, then develop data collection/ usage and methodology for considering/incorporating, analyzing, measuring, coordinating on, and reporting equity in a long range transportation plan. The unique types of planning conducted in NC would need to be considered (state required Comprehensive Transportation Plans), as well as other types of long range plans such as Metropolitan Transportation Plans, corridor plans, statewide plans, subarea plans, etc. Specific examples of questions to be answered include the following.

- How can equity best be addressed during development of vision, goals and objectives, and performance measures for a long range transportation plan?
- What are best practices for addressing equity during implementation of complete streets in development of proposals?
- How can purpose and need / identified need development be influenced by and reflect equity?
- What methodology can be applied to ensure equity is appropriately addressed during project proposal development/ alternatives analysis during long range transportation planning?
- What coordination with stakeholders and public engagement efforts are key, related to the developed best practices/ recommendations in this project?
- How can equity analysis in long range transportation planning be measured and evaluated (specific performance measures and evaluation tools)?
- What are documentation best practices for equity analysis in long range transportation planning?

This research project would need to be conducted with a strong component of outreach and coordination with affected stakeholders, including NCDOT Transportation Planning Division, NCDOT modal divisions, other NCDOT units, FHWA, MPOs, RPOs, transit agencies, community representatives, and others.

Background:

Current practices seek to use available guidance, data, and methods to consider equity appropriately in long range transportation planning. However, with specific research, and development of more specific methodology and performance measures, the handling of this topic could be enhanced. This would benefit of the communities of NC, as well as result in efficiency in the project delivery process by having earlier identification of issues and engagement of interested/ affected parties.

Research Tasks:

Research tasks are likely to include:

- 1- Literature Review
- 2- Problem Identification, Gap Analysis from literature review
- 3- Outline/ scope specific Guidance/ Best Practices and Tools to be developed
- 4- Develop Guidance/ Best Practices and Tools to Address Equity Analysis in Long Range Transportation Planning

These steps, as typical with research projects, will be done in coordination with the affected stakeholders mentioned above. Beyond the steering committee, outreach such as stakeholder interviews may be necessary. There is, and will continue to be, variance that must be accounted for in guidance and recommendations in how long range transportation plans are conducted and the resultant products. This variance is due to the different planning products, the size and nature of communities across NC, and other factors.

Products of the Research:

- Summary of Literature Review
- Documentation of Problem Identification, Gap Analysis from literature review
- Draft Outline/ scope specific Guidance/ Best Practices and Tools to be developed
- Develop Guidance/ Best Practices and Tools to Address Equity Analysis in Long Range Transportation Planning:
 - -equity in vision, goals and objectives, and performance measures development
 - -equity during implementation of complete streets in development of proposals
 - -equity in purpose and need / identified need
 - -equity analysis methodology for project proposal development/ alternatives analysis
 - -equity related stakeholder coordination and public engagement efforts considerations
 - -equity specific performance measures and evaluation tools
 - -equity documentation best practices
- Communication/ Outreach Material(s) (The focus of this research proposal is not to develop the training or the materials for it, as the submitters thought that would make the scope too broad. However, some brief materials can easily be produced from this initial work that could be useful in early outreach, such as a brochure-style overview.)

Possible IT Components:

There is a possibility that one or more of the tools developed as part of this project to address equity evaluation may have an IT component. Tools already exist for travel demand modeling (TransCAD) and for mapping GIS data (statewide geodatabase) related to equity. So it is anticipated that the methodology developed for equity analysis will need to use outputs from these tools, and be compatible and utilize these existing

tools to the maximum extent practicable. In that sense, there may not end up being a 'new' IT tool or component, but methodology and use of existing tools (or add-ons).

Implementation:

Implementation components will need to include standardization of practice by inclusion of accepted proposals in the TPD Procedure Manual. One challenge is that NCDOT may choose to follow these practices on all long range planning studies for which they are the project lead (such as CTP outside of MPO areas, and other studies) by including it in their Procedures Manual and communicating to staff the new policy. But NCDOT TPD does not have the authority to compel other partners to follow new best practices on other types of long range transportation planning studies for which NCDOT is a partner and not the lead agency, such as MPOs leading Metropolitan Transportation Plans. Therefore, implementation hinges on the planning partners realizing the benefits of the practices and the resources needed to conduct them not being overly burdensome. Outreach efforts and education/ training are key to implementation. NCDOT TPD will lead the training and outreach for implementation.

Additional Comments and Information:

This research project will need to compliment the research for 'Transportation Equity Needs Assessment Toolkit' (CTEDD 020-01, start date 7/1/2020 and expected completion 7/31/2021) and the 'Transportation Equity Scorecard' (<https://rip.trb.org/view/16354>)

Subcommittee Comments:

Research Idea Title:

NCDOT Standard Design Specifications for Vertiports

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PL	2022-103	2022	7/13/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Meyer	Todd	Senior Airport Project Manager (CS Airports)	tmeyer@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Walston	Bobby	Aviation Director	bwalston@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Increase Operational Efficiency/Time Savings;New or Improved Specifications

Explain Anticipated Benefits:

A standardized documented instruction set to identify the minimal safety and operation needs of a new or rehabilitated vertiport will support the quickly expanding growth of a new interstate system of commerce and passenger transport for public use facilities.

What is the problem or issue needing investigation?

There is no standard design on how NCDOT will help support the safe movement (takeoff and landing) of autonomous vehicles on NCDOT and publicly owned facilities.

Background:

Autonomous drones that carry cargo and people have been invented and are now in use in the world. To support the safe movement of these vehicles in North Carolina there should be research and guidance on standard designs of structures, markings,

navigational aids, and storage facilities to support and expand their use as a future transportation network.

Research Tasks:

1. Identify current and planned needs of autonomous vehicles pertaining to takeoff, landing, and parking.
2. Collaborate with vehicle manufacturers on specifications to support standard designs.

Products of the Research:

Create a guidance manual, specifications, or standard operation procedure on the construction of vertiports for autonomous vehicles at public facilities in North Carolina.

Possible IT Components:

Equipment, databases and communication networks to identify, publish and track aircraft taking off and landing from the autonomous vehicle airway network.

Implementation:

Compile a team of NCDOT engineers, consultants, and aircraft manufacturers to identify the needs.

Work with nationally recognized research group, such as the Transportation Research Board, to adhere to federally standardized goals of autonomous vehicle movements in national airspace.

Additional Comments and Information:

Subcommittee Comments:

FY 2022

REQUEST FOR PROPOSALS

**PAVEMENT, MAINTENANCE &
MATERIALS**

Research Idea Title:

Moisture, Shear Stress and Effects on the Resilient Modulus of ABC

SubCommittee:	Research Idea #:	Fiscal Year:	Created Date:
PV	2022-040	2022	7/9/2020 12:00:00 AM

Research Idea Generator:

Last Name:	First Name:	Title:	Email:
Morrison	Clark	State Pavement Design Engineer	cmorrison@ncdot.gov

Secondary Generator:

Last Name:	First Name:	Title:	Email:
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Sponsor/Champion:

Last Name:	First Name:	Title:	Email:
Morrison	Clark	State Pavement Design Engineer	cmorrison@ncdot.gov

Benefit or Knowledge Gain for NCDOT:

Cost Savings;Improved Material Structure/Pavement/Performance;Improved Models Performance/Traffic/Financial etc.

Explain Anticipated Benefits:

The laboratory test results will allow the design of reliable and cost-effective ABC pavement using a Mechanistic-Empirical Design procedure.

What is the problem or issue needing investigation?

Resilient Modulus is a required input for the Pavement ME Design procedure. In addition, understanding the mechanical behavior of ABC is necessary to both predict the performance of ABC pavements and to successfully choose rehabilitation strategies. Moisture and shear stress are known to effect Mr, but the effects need to be quantified. In addition, changes to the NCDOT gradation limits have been proposed that would change the % passing the 1-1/2" sieve from 100% to 95-100%. This change may also have an impact on Mr.

Background:

In project 2016-01, Montoya and Castorena showed that changes in moisture content

had a relatively small effect on Mr (resilient modulus). This was based on testing two replicates of ABC from each of two sources. The sources were the Arrowood and Belgrade quarries, which usually produce ABC with non-plastic fines. This conclusion is consistent with the Cary and Zapata (2010) model, but only for non-plastic fines. For ABC with non-zero PI within NCDOT spec, the Cary and Zapata model indicates the reduction in Mr would be much larger. Some of our quarries produce ABC with fines that are not non-plastic. Verification of the validity of the Cary and Zapata model, or other models would be valuable, and increase the reliability of designs produced with a Mechanistic-Empirical procedure. Some of the other models rely on knowing the soil water characteristic curve.

It is widely believed among DOT engineers that, over time, ABC can become wet, and less effective as a pavement structural layer. If the Montoya and Castorena conclusion is correct, the loss of stiffness in ABC must be due to something other than moisture. One possibility is that as the ABC experiences shearing stress, it dilates and the density is reduced. This density reduction may account for the lessening of Mr over time. Chow, Mishra, and Tutumluer, in NCDOT Research project 2013-18 have suggested some benefits of limiting the shear stresses in aggregate base course layers.

Cary, C., and Zapata, C. (2010). "Enhanced Model for Resilient Response of Soils Resulting from Seasonal Changes as Implemented in Mechanistic-Empirical Pavement Design Guide," Transportation Research Record: Journal of Transportation Research Board, Vol. 2170, 36-44.

Research Tasks:

- Select 4 ABC sources, two with non-plastic fines and two with plastic fines.
- Measure gradation and PI for each source.
- Measure Soil-Water Characteristic Curve for each source.
- Measure Mr for each source at varying moisture contents using a similar procedure to that used by Montoya and Castorena.
- Compare the results to the Cary and Zapata model, and other models including a model based on partially saturated soil mechanics.
- For each source, determine the shear strength parameters.
- For samples from each source, subject the sample to varying levels of shear stress while measuring sample dilation. Measure Mr on the same sample to determine if the change in density due to shearing has changed Mr.
- Determine if there is an allowable level in shear stress level that does not result in a decrease in Mr, or results in only modest decrease.
- If possible, create a model that predicts Mr based on moisture content and shear stress level.

Products of the Research:

Laboratory Test results that guide the selection of models and parameters for design of ABC pavement. This would include guidance on selection of parameters for use with Pavement ME design.

Benefit or Knowledge Gain for NCDOT Cost Savings; Improved Material Structure/Pavement/Performance; Improved Models Performance/Traffic/Financial etc.

For the same 4 ABC sources, modify the samples to conform to the proposed changes in gradation (% passing 1-1/2" sieve – 95-100%). Measure Mr for these samples and compare to Mr for the unmodified gradations.

Possible IT Components: None

Implementation:

The research project should provide recommendations on using the results in a Mechanistic-Empirical design procedure.

Additional Comments and Information:**Subcommittee Comments:**