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THE STATE OF NEW HAMPSHIRE
DEPARTMENT OF TRANSPORTATION



Victoria F. Sheehan
Commissioner

William Cass, P.E.
Assistant Commissioner

Bureau of Materials & Research
July 8, 2019

His Excellency, Governor Christopher T. Sununu
and the Honorable Council
State House
Concord, New Hampshire 03301

REQUESTED ACTION

Authorize the Department of Transportation to enter into a **SOLE SOURCE** Cooperative Project Agreement with the University of New Hampshire Sponsored Programs Administration (vendor 177867), Durham, New Hampshire, for a fee not to exceed \$159,987.00 for a cooperative development of New Hampshire specific deterioration curves for key bridge elements effective upon Governor and Council approval through December 31, 2021. 100% Federal Funds.

Funds to support this request are anticipated to be available in the following accounts in FY 2020, FY 2021 and FY 2022 upon the availability and continued appropriation of funds in the future operating budget, with the ability to adjust encumbrances between State Fiscal Years through the Budget Office, if needed and justified.

	<u>FY 2020</u>	<u>FY 2021</u>	<u>FY 2022</u>
04-96-96-962015-3036			
SPR Research Funds			
046-500464 General Consultants Non-Benefit	\$111,990.00	\$32,000.00	\$15,997.00

EXPLANATION

The following research study will address an immediate Department need; is unique to New Hampshire's environment and conditions, thereby requiring substantial local experience; and are directly aligned with a particular area of University expertise. In addition, the Principal Investigator is a nationally recognized expert in her respective field. As such, the proposed work does not lend itself to a selection process that includes private industry or out-of-state organizations, and it is in the Department's and the State's best interest to work directly with the University of New Hampshire.

This work is part of the Department's Statewide Planning and Research (SPR) program. The Department of Transportation and the University of New Hampshire (UNH) is a long-standing cooperative relationship of transportation research. This relationship has been mutually beneficial, culminating in savings to the State while enhancing work force development and maintaining New Hampshire's position on the leading edge of new technology. Research studies conducted by UNH for the Department have led to numerous innovations in the highway and bridge industry, including such improved pavement design, increased use of recycled materials, storm water management evaluation, and rapid construction techniques.

Statewide-SPR 26962V, Using Data Analytics in Forecast Bridge Condition

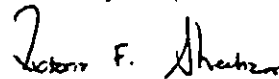
The Department is collaborating with the University of New Hampshire (UNH) to conduct a cooperative research study, "Using Data Analytics in Forecast Bridge Condition", to develop a tool that tracks adherence to Recommended Bridge Strategies (RIS) and factors that weigh RIS adherence against impacts on condition. The framework will measure the long term ramifications of investment strategies for NHDOT's bridge assets. The results will be used to predict life extension of New Hampshire's bridges resulting in long term cost savings for a total fee not to exceed \$159,987.00 effective upon Governor and Council approval though December 31, 2021.

The funding is 80% Federal Funds with 20% state match. Turnpike toll credit is being utilized for match requirement, effectively using 100% Federal Funds. The Capital Budget Overview Committee approved the use of Turnpike Toll Credits on February 11, 2019.

This Agreement has been approved by the Attorney General as to form and execution. Copies of the fully-executed Agreement are on file at the Secretary of State's Office and the Department of Administrative Services, and subsequent to Governor and Council approval will be on file at the Department of Transportation.

It is respectfully requested that authority be given to enter into these sole-source Agreements for consulting services as outlined above.

Sincerely,



Victoria F. Sheehan
Commissioner

Attachments

RECEIVED

FEB 18 2019

Bureau of Materials Research
NH Dept. of Transportation



CAP 19-002

MICHAEL W. KANE, MPA
Legislative Budget Assistant
(603) 271-3161

CHRISTOPHER M. SHEA, MPA
Deputy Legislative Budget Assistant
(603) 271-3161

State of New Hampshire

OFFICE OF LEGISLATIVE BUDGET ASSISTANT
State House, Room 102
Concord, New Hampshire 03301

STEPHEN C. SMITH, CPA
Director, Audit Division
(603) 271-2785

February 11, 2019

Victoria F. Sheehan, Commissioner
Department of Transportation
John O. Morton Building
7 Hazen Drive
Concord, New Hampshire 03302-0483

Dear Commissioner Sheehan,

The Capital Budget Overview Committee, pursuant to the provisions of RSA 228:12-a, on February 11, 2019 approved the request of the Department of Transportation, Bureau of Materials and Research, to use \$147,400 of Turnpike Toll Credit, based on the \$737,000 estimated research related work costs to meet funding match requirements for; eight (8) proposed research projects as described in the federally approved Department's 2019 State Planning and Research Part II (SPR2) Work Program, subject to the conditions as specified in the request dated January 10, 2019.

Sincerely,

A handwritten signature in black ink, appearing to read "Michael W. Kane".

Michael W. Kane
Legislative Budget Assistant

MWK/pe
Attachment

Cc: William Cass, P.E., Assistant Commissioner, Department of Transportation
Chuck Dusseault, Bureau of Materials and Research, Department of Transportation ✓

COOPERATIVE PROJECT AGREEMENT

between the

STATE OF NEW HAMPSHIRE, Department of Transportation

and the

University of New Hampshire of the UNIVERSITY SYSTEM OF NEW HAMPSHIRE

- A. This Cooperative Project Agreement (hereinafter "Project Agreement") is entered into by the State of New Hampshire, **Department of Transportation**, (hereinafter "State"), and the University System of New Hampshire, acting through **University of New Hampshire**, (hereinafter "Campus"), for the purpose of undertaking a project of mutual interest. This Cooperative Project shall be carried out under the terms and conditions of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, except as may be modified herein.
- B. This Project Agreement and all obligations of the parties hereunder shall become effective on the date the Governor and Executive Council of the State of New Hampshire approve this Project Agreement ("Effective date") and shall end on **12/31/21**. If the provision of services by Campus precedes the Effective date, all services performed by Campus shall be performed at the sole risk of Campus and in the event that this Project Agreement does not become effective, State shall be under no obligation to pay Campus for costs incurred or services performed; however, if this Project Agreement becomes effective, all costs incurred prior to the Effective date that would otherwise be allowable shall be paid under the terms of this Project Agreement.
- C. The work to be performed under the terms of this Project Agreement is described in the proposal identified below and attached to this document as Exhibit A, the content of which is incorporated herein as a part of this Project Agreement.

Project Title: Using Data Analytics in Forecast Bridge Condition

- D. The Following Individuals are designated as Project Administrators. These Project Administrators shall be responsible for the business aspects of this Project Agreement and all invoices, payments, project amendments and related correspondence shall be directed to the individuals so designated.

State Project Administrator

Name: Deirdre Nash
Address: NHDOT Bureau of Materials & Research
5 Hazen Dr. PO Box 483
Concord, NH 03302-0483
Phone: 603 271-8995

Campus Project Administrator

Name: Karen Rooney
Address: University of New Hampshire
Sponsored Programs Administration
51 College Rd. Rm 116
Durham, NH 03824
Phone: 603-862-5412

- E. The Following Individuals are designated as Project Directors. These Project Directors shall be responsible for the technical leadership and conduct of the project. All progress reports, completion reports and related correspondence shall be directed to the individuals so designated.

State Project Director

Name: David Gaylord
Address: NHDOT Bureau of Highway Design
7 Hazen Drive, PO Box 483
Concord, NH 03302-0483
Phone: 603 271-0785

Campus Project Director

Name: Erin Bell
Address: University of New Hampshire
Kingsbury Hall, W289
33 Academic Way
Durham, NH 03824
Phone: 603-862-3850

F. Total State funds in the amount of \$159,987 have been allotted and are available for payment of allowable costs incurred under this Project Agreement. State will not reimburse Campus for costs exceeding the amount specified in this paragraph.

Check if applicable

Campus will cost-share _____ % of total costs during the term of this Project Agreement.

Federal funds paid to Campus under this Project Agreement are from Grant/Contract/Cooperative Agreement No. NA from USDOT Federal Highway Administration under CFDA# 20.205. Federal regulations required to be passed through to Campus as part of this Project Agreement, and in accordance with the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002, are attached to this document as Exhibit B, the content of which is incorporated herein as a part of this Project Agreement.

G. Check if applicable

Article(s) _____ of the Master Agreement for Cooperative Projects between the State of New Hampshire and the University System of New Hampshire dated November 13, 2002 is/are hereby amended to read:

H. State has chosen **not to take** possession of equipment purchased under this Project Agreement.
 State has chosen **to take** possession of equipment purchased under this Project Agreement and will issue instructions for the disposition of such equipment within 90 days of the Project Agreement's end-date. Any expenses incurred by Campus in carrying out State's requested disposition will be fully reimbursed by State.

This Project Agreement and the Master Agreement constitute the entire agreement between State and Campus regarding this Cooperative Project, and supersede and replace any previously existing arrangements, oral or written; all changes herein must be made by written amendment and executed for the parties by their authorized officials.

IN WITNESS WHEREOF, the University System of New Hampshire, acting through the University of New Hampshire and the State of New Hampshire, Department of Transportation have executed this Project Agreement.

By An Authorized Official of:
University of New Hampshire
Name: Karen M. Jensen
Title: Manager, Sponsored Programs Administration
Signature and Date: [Signature] 5/7/19

By An Authorized Official of:
Department of Transportation
Name: Peter E. Stamnas
Title: Director of Project Development
Signature and Date: [Signature] 5/15/19

By An Authorized Official of: the New
Hampshire Office of the Attorney General
Name: EMILY C. GOERING
Title: ASSISTANT AG
Signature and Date: [Signature] JUNE 28, 2019

By An Authorized Official of: the New
Hampshire Governor & Executive Council
Name: _____
Title: _____
Signature and Date: _____

Exhibit A

A. **Project Title:** The Development of a Predictive Tool for Bridge Condition with Respect to Recommended Investment Strategies

B. **Project Period:** Governor and Council approval through December 31, 2021

C. **Objectives:**

1. Data Collection and storage tool for bridge investment records
2. Recommended Investment Strategy adherence measure and effectiveness measure
3. Recommendation of appropriate deterioration functions for NH bridge inventory
4. Proof-of-concepts deterioration forecast using a sample data set

D. **Scope of Work:**

Reliable data-driven forecasting models allow asset owners to strategically plan for future needs and resource allocation. Conditions of bridge assets are managed through maintenance, preservation, rehabilitation and reconstruction. The New Hampshire Department of Transportation (NHDOT) documents the appropriate timing of these treatments in Recommended Investment Strategies (RIS). According to NHDOT best practice and expert judgement, adhering to a bridge's RIS extends expected service life. Quantification of the service life extension as well as tracking how well bridge investments have adhered to RIS remains a challenge. Bridge work is often documented in disparate formats through multiple bureaus and systems.

Element-level condition assessment data is collected and tracked in a standardized format for each bridge asset in a transportation network. Maintenance and repair records, however, are not standardized and must be tabulated before correlation with other data. Correlating the tabulated data with field conditions, in combination with subject matter expertise, will support the development of deterioration functions. Condition models using such deterioration functions will provide insight into the long term ramifications of investment strategies that leverage varying amount of maintenance, preservation, and rehabilitation.

Outcomes of this research include a tool to track RIS adherence, factors that weigh RIS adherence against impacts on condition, deterioration functions that use adherence, and a forecast that demonstrates the utility of the deterioration functions. This research effort can be accomplished in six major tasks;

1. Assessment of published data mining and analysis to select the appropriate scheme for NHDOT based on inventory and investment records. This assessment will include an evaluation of data availability and actions needed to improve availability, if appropriate.

This task will identify how investments recommended in the RIS have been tracked and correlated with condition data to date. Potential technology applications (e.g. machine vision) to extract data from paper drawings will be investigated as well as recommended

work documentation procedures contained in industry standard Bridge Management software.

2. Development of a framework to measure adherence to RIS.

This task will examine RIS activities and determine the available data to assess adherence, such as work orders or invoices. Data mining will focus on RIS activities as changes in condition will be correlated with this level of detail.

3. Data mining and preparation of element-level bridge condition assessment data and maintenance records.

This task will be conducted in conjunction with Task 4 and will include undergraduate students in data extraction operations.

4. Develop deterioration functions..

This task will leverage the framework and data mined in previous tasks to determine the significance, or weight, of the various activities described in the RIS. Mined data will be correlated with National Bridge Inventory (NBI) data combined with subject matter expertise, to develop predictive functions.

5. Proof-of-concept deterioration forecasts using sample adherences for New Hampshire bridges for girder type bridges, including network-wide and region/corridor specific zones.

This task will forecast bridge conditions using the deterioration functions and sample data. The results will demonstrate how conditions may be predicted assuming varying amounts of adherence to RIS through comparison to historic bridge condition data.

6. Report Research Results and Deliver Final Products

This task will be used to summarize the results, deliver associated products to the NHDOT, and identify meaningful next steps. Extracted data and other items will be made navigable through proper documentation which includes a detailed Final Report and a brief Technical Sheet.

E. Deliverables Schedule:

The following schedule will be used to execute this research. Specific deliverables are listed below and included in the deliverables table.

- Month 0-3
 - Project kick-off Technical Advisory Group (TAG) meeting
 - Identify the types of existing data that is available from NHDOT
 - Review Recommended Investment Strategies
 - Review the available condition data in the NBI
- Month 4-6

- Summarize preliminary data descriptions and future data needs
 - Design an electronic framework to track investment adherence
 - Conduct literature review to develop a preliminary weighting factor scheme
- Month 7-9
 - TAG Meeting 2
 - Refine project scope as appropriate based on TAG feedback
 - Build electronic framework and test ease of use with simulated data
 - Conduct literature review to select method for developing deterioration functions using limited data
- Month 10-12
 - Develop presentation of electronic framework for TAG and potential users.
 - Conduct literature review to select method to perform analysis that will leverage adherence to RIS.
 - Select a sample of bridges for data extraction
- Month 13-15
 - TAG Meeting 3 – Present electronic framework
 - Refine project scope as appropriate based on TAG feedback
 - Design network analysis that incorporates RIS adherence
 - Select a weighting factor scheme
 - Begin data extraction with students and potentially incorporate machine vision
- Month 16-18
 - Continue data extraction and populate framework tool with extracted data
 - Build network analysis model that incorporates electronic framework
 - Develop weighting factors using selected scheme and available data
 - Select method for deterioration functions that incorporates weighting factors
- Month 19-21
 - TAG Meeting 4 – Present data extraction efforts
 - Complete data extraction and population of framework
 - Develop deterioration functions
 - Refine and complete weighting factors
 - Test network analysis model using simulated data
- Month 22-24
 - Complete deterioration functions
 - Test and refine network analysis model using sample data
- Month 25
 - TAG Meeting 5 - Present weighting factors, deterioration functions, network analysis model
 - Finalize all documentation for running model
 - Produce final report that details efforts and identifies next steps
 - Deliver any remaining products

Deliverables Table

Item	Description	Est. Date*
Quarterly Reports	<p>Reports, generally less than 6 pages in length, that summarize ongoing achievements and mitigates risk to schedule and quality</p> <ul style="list-style-type: none"> • June 30 2019 • June 30, 2020 • March 31, 2021 • September 30, 2019 • September 30, 2020 • June 30, 2021 • December 31, 2019 • December 31, 2020 • September 30, 2021 • March 31, 2020 	Varies
Electronic Framework	An electronic form used to compile preservation, maintenance, rehabilitation, and construction activities as they are identified in Bridge RIS	February 2020
Weighting Factors	A measure of individual contribution by each activity to Bridge condition performance for Bridge RIS activities based on adherence to intended schedule	December 2020
Deterioration Functions	Functions that forecast conditions over time given various adherences to Bridge RIS	March 2021
Extracted Data	Data that has been extracted from NHDOT systems and plans to support this project. This will include the data as it is populated in the electronic framework as well as any intermediate formats used to prepare the data for the electronic framework	March 2021
Commonalities Report	A report that discusses commonalities observed when collecting bridge data from historic plans intended for use in planning extractions that leverage machine learning.	March 2021
Network Analysis Model	A model that incorporates deterioration functions, condition data, and estimates of future work to project network conditions.	May 2021
Technical Sheet and Poster	A brief informational sheet that describes the technical applications of the research and a graphical poster that displays highlights.	June 2021
Final Report	A report, generally about 15-20 pages in length, that details efforts related to the project, describe accessibility to products and other project outcomes, and identifies next steps.	June 2021

*These dates are subject to changes based on the start date of the project.

Appendix: Additional Details

Using Data Analytics in Forecast Bridge Condition

Position Title	Description	Annual Effort	Duties
Principal Investigator	Erin Bell, CEE	2 weeks of summer +As needed	Project management, interaction with NHDOT, budgetary compliance, required reporting, integration with synergistic research activities
Co-Investigator	Kyle Kwiatkowski, CEE	2 weeks of summer +As needed	Support framework development and lead outreach and training activities including workshop schedule and delivery
Senior Personnel	Marek Petrik, CS/IT	1 week of summer +As needed	Support UG Student in CS/IT for framework tool development and detecting commonalities between data sets that can used to develop future research needs and potential application for machine learning
Graduate Research Assistant	TBD	20 hours/week during the AY and full summer	CEE student that will work with the Investigators to develop this program including data collection, data formatting, framework development, weighting factors and RJS adherence measures
Undergraduate Assistants	TBD	Summer:3 students @20hr/week, AY:1 student@10/week	Support data collection for investment tracking, work with faculty and graduate student. 2-CEE and 1 CS/IT, as appropriate
Suggested TAG Members			
AMPS	David Gaylord		
Bridge Design	Nick Goulas, David Scott, Aaron Janssen		
Research	Dee Nash		
FHWA	Karim Naji		

F. Budget and Invoicing Instructions: UNH will submit invoices to State on regular UNH invoice forms no more frequently than monthly and no less frequently than quarterly. Invoices will be based on actual project expenses incurred during the invoicing period and shall show current and cumulative expenses. State will pay UNH within 30 days of receipt of each invoice. UNH will submit its final invoice not later than 60 days after the Project Period end date. State may withhold 10% of funds until receipt of final report from UNH. State will provide final payment within 30 days of receipt of the accepted final report, poster, and technical fact sheet.

Budget Items

1. Salaries & Wages	92,647
2. Employee Fringe Benefits	5,572
3. Tuition	18,279
4. Materials & Supplies	3,000
5. Travel	3,750
Total Direct Costs	123,248
Facilities & Administrative	36,739
Total Project Cost	\$ 159,987

EXHIBIT B

This Project Agreement is funded under a Grant/Contract/Cooperative Agreement to State from the Federal sponsor specified in Project Agreement article F. All applicable requirements, regulations, provisions, terms and conditions of this Federal Grant/Contract/Cooperative Agreement are hereby adopted in full force and effect to the relationship between State and Campus, except that wherever such requirements, regulations, provisions and terms and conditions differ for INSTITUTIONS OF HIGHER EDUCATION, the appropriate requirements should be substituted (e.g., OMB Circulars A-21 and A-110, rather than OMB Circulars A-87 and A-102). References to Contractor or Recipient in the Federal language will be taken to mean Campus; references to the Government or Federal Awarding Agency will be taken to mean Government/Federal Awarding Agency or State or both, as appropriate.

Special Federal provisions are listed here: None or **Uniform Guidance issued by the Office of Management and Budget (OMB) in lieu of Circulars listed in paragraph above.**