ALASKA DOT&PF RESEARCH
ANNUAL WORK PLAN

Federal Fiscal Year 2023-2024

Summer 2022

Research Development and Technology Transfer

Alaska Department of Transportation & Public Facilities

The Research Development and Technology Transfer (RD&T2) Section within the Division of Design and Engineering Services of the Alaska Department of Transportation & Public Facilities (DOT&PF) provides research management, library, technical assistance, training, and technology deployment services to DOT&PF, local transportation agencies, and their partners.

RD&T2 provides services largely through the collaborative relationships with and financial support from the Federal Highway Administration, the University of Alaska, University Transportation Centers, and the DOT&PF. By leveraging resources and developing partnerships with a variety of transportation organizations and professionals. RD&T2 taps into a vast network of expertise and resources and eliminates duplication of effort. RD&T2 also provides an avenue for multidisciplinary support from a network of engineering, management, leadership, law, planning, and the environment.

This document is the proposed work plan for the DOT&PF Research program for federal fiscal year 2023 based on project selection process outlined in our Standard Operating Procedures Manual available online at our website: http://dot.alaska.gov/stwddes/research/index.shtml

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I, Anna Bosin, Research Program Manager, DOT & PF of the State of Alaska, do hereby certify that the State of Alaska is in compliance with all requirements of 23 U.S.C. 505 and its implementing regulations with respect to the research, development, and technology transfer.

For additional information, contact:
Anna Bosin, P.E.
Research, Development, & Technology Transfer Manager
Division of Statewide Design & Engineering Services
Alaska Department of Transportation & Public Facilities
820 E 15th Ave
Anchorage, AK 99501
907.269.6208
Anna.bosin@alaska.gov

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Research Funding Distribution

Research Projects Selected for FFY23

All the projects are funded by 80% Federal (SP&R-B) and 20% State match for the combined totals shown. All projects are total project costs. Completion dates and durations are estimates.

Title	Champion(s)	Researcher(s)	Est. Comp. Date
Implicit Safety Benefits for Vulnerable Road Users	Matt Walker Mary McRae	Dr. Nathan Belz, UAF	1 year 11/2023
Alaska's transportation workforce detours: Maximizing training opportunities and outcomes in DOT&PF's key industries	Katherine Keith, Aaron Nickols, Cina Fisher	Katherine Keith, ISER/UAA	1 year 11/2023
Alaska Low Emission Ferries Pilot Program	Katherine Keith	Katherine Keith, SEC	6 months 5/2023
DOT&PF Image Server deployment	David Oliver Jeremey Arnold Adam Rolfe Ryan Marlow	TBD	11/2023
Remote Management of Facilities and Assets with Digital Twins Digitalization of Remote Assets (STIC)	Ryan Marlow Vine Yelmene, Troy Hicks, Jillian Nicolazzo	In-House	10/2023

Structural Adequacy of Culverts in Poor Condition	Dr. Paul Janke, Jake Ciufo, Jeff Stutzke, Bob Trousil	Ken Karle, Hydraulic Mapping and Modeling	3 years 10/2025
Avalanche Detection and Warning System Using an Infrasound Monitoring Network along Thane Road, Juneau AK.	Pat Dryer	Pat Dryer, Snowbound Solutions	4/2023
Use of Polymer Fluids in Stabilized Base Courses	Steve Saboundjian, Jeff Currey	Billy Connor, UAF	1 year 11/2023
Hydroacoustic Down-the-Hole Drilling Noise Study	Doug Kolwaite	Illingworth & Rodkin, Inc. James Reyff	2 years 10/2024
Computer Vision Tools for Bridge Inspections and Reporting	Elmer Marx, Larry Owen and Nicholas Murray	Dr. Mostafa Tazarv, South Dakota State University	2 years 10/2024
Seismic Behavior of Hider Wing-Walls	Elmer Marx and Nick Murray	Dr. Mervyn Kowalsky, NCSU	40 months 4/2026
Weldability of Bridge Steel with Protective Coatings	Leslie Daugherty	Carolin Fink, Ohio State Univ.	2 years 10/2024
Roadway foundation cooling using structured foam layers	Mathew Billings, Jeff Currey, Steve Saboundjian	Douglas J. Goering, PhD, PE UAF	2 years 11/2024
Shake Table Tests of Grade 80 Piers	Elmer Marx and Nick Murray	Dr. Mervyn Kowalsky, NCSU	27 months 2/2025
Capacity and Acceptance Criteria of Welded Splices in Cold-Bent Reinforcing Steel	Leslie Daugherty	Carolin Fink, Ohio State	18 months 6/2024
Research Administration FFY23/24	Anna Bosin	N/A	24 months
Rapid Research & Deployment FFY23/24	Anna Bosin	Varies	24 months
Grand Total		$3,273,000	

Research Projects Selected for FFY24:

All the projects are funded by 80% Federal (SP&R-B) and 20% State match for the combined totals shown. All projects are total project costs. Completion dates are estimates.

Title	Champion	Researcher(s)	Est. Comp. Date
Alaska DOT&PF Equity Sample Review of Programming and Policies	Rashaud Joseph, Judy Chapman, James Marks	TBD	18 months 6/2026
Evaluation of Low Earth Orbit Broadband	Vince Yelmene Ryan Marlow	TBD	15 months 3/2026
Alaska DOT&PF Human Trafficking Data Collection and Strategic Recommendations	Troy LaRue, Dylan Blankenship, John Clendenin	TBD	18 months 6/2026
Alaska Transportation Systems Management & Operations Strategic Plan	Pam Golden	TBD	9 months 8/2025
Innovation Corridors	Anna Bosin	TBD	3 years 10/27
Statewide GNSS Network	Travis Test, Troy Hicks, Hans Pederson	TBD	5/2025
Estimating inelastic displacement demands for bridges under seismic forces	Elmer Marx, Nick Murray	Dr. Mervyn Kowalsky, NCSU	42 months 4/2028
Analysis of existing aufeis data near bridge embankments collected by airborne surveys	Mike Knapp	Horacio Toniolo, UAF	2 years 10/26
Decked Bulb Tee Girder – Loss of pre-stress validation	Elmer Marx, Nick Murray, Douglas Gelineau	Dr. Andrew Metzger and Billy Connor, UAF	12/2025
Next Generation of Reinforced Concrete Structure: Electric Energy Storing, Self-Sensing Reinforced Concrete Elements	Elmer Marx	Dr. Mohammad Pour-Ghaz, NCSU	42 months 4/2028

Camera Based Computer Vision Measurements for Bridge Field Testing	Elmer Marx, Larry Owen and Nicholas Murray	Dr. Mostafa Tazarv, South Dakota State University	2 years 11/2026
AI Tools for Rapid Post-Earthquake Damage Assessment of Bridges with Standard and Substandard Columns	Elmer Marx and Nick Murray	Dr. Mostafa Tazarv, South Dakota State University	2 years 11/2026
Seismic Detailing of Steel H-Pile Connections	Elmer Marx and Nick Murray	Dr. Mervyn Kowalsky, CSU	42 months 4/2028
Improved modeling for ACE and ventilated shoulder design	Mathew Billings, Jeff Currey, Steve Saboundjian	Douglas J. Goering, UAF	1 year 11/2025
Grand Total		$2,765,000	

TBD – To be determined. No identified person/institution at this time.

Pooled Fund Studies FFY23/24

The Pooled Fund program is a joint effort between State DOTs and FHWA to share resources towards common research goals. FHWA or a DOT can be a lead agency for a pooled fund project. Alaska DOT&PF participates in pooled fund studies by transferring 100% SP&R federal funds to the lead agency and assigning a DOT&PF staff person as the technical advisor to participate in the national effort. Pooled funds generally take 3-5 years of commitment participation from each member agency as projects are developed, conducted, and disseminated.

Title	FFY23	FFY24	Commitment	Lead Org.
Aurora	25,000	25,000	Previously committed	Iowa
Universal Consequences-Based Liquefaction Hazard Analysis Framework for All CPT-Compliant Soils	20,000	20,000	Previously Committed	Utah
Connected Vehicle Pooled Fund Study	25,000	25,000	25K/year	Virginia
Clear Roads Phase III	25,000	25,000	25K/year	MN
Avalanche Research Pool	25,000	25,000	25K/year	CO
Roadside Safety Research for MASH Implementation	50,000	50,000	**50k/year, increase from $25K/year**	WA
Develop Countermeasure Strategies for Protecting Bridge Girders Against Overheight Vehicles Impact	50,000	50,000	50K/Year, previously committed	FHWA
Developing and Calibrating Fragmental Rockfall Models using Physics Engines	30,000	30,000	Previously Committed	WA
Assmt. and Repair of Pre-strssd Bridge Girders Sbjtd to Over-Height Truck Impacts	0	0	Ends in 2023	Missouri
Road Usage Charge West	0	0	Ends in 2022	Oregon
Western Alliance for Quality Transportation Construction (WAQTC) 2021-2025	12,000	12,000	$12K/year	Utah
Center for the Aging Infrastructure: Steel Bridge Research, Inspection, Training and Education Engineering Center - SBRITE	35,000	35,000	3-year commitment required.	Indiana
NCHRP dues - Alaska	351,999*	351,999*	*Estimate from 2022	NCHRP

TRB Core Program Services for a Highway RD&T Program	121,336*	121,336*	*Estimate from 2022	FHWA

FHWA Approved Pooled Fund Studies can be found at: https://www.pooledfund.org/Home

FFY23 Selected Project Summaries

Implicit Safety Benefits for Vulnerable Road Users
Category: Traffic & Safety
Funding: $**
Manager: Paulette Hoffmann/Mary McRae
Champion and Technical Advisors: Matt Walker, Mary McRae,

Current methodologies and project tracking do not allow for the assessment of relative safety benefits achieved for motor vehicles and Vulnerable Road Users (VRU) on a project type level. To that end, the goal of this project is to develop an Implicit Safety Benefit Tool that can be used by engineers and transportation practitioners to estimate the implicit safety benefits for VRUs at the Highway Safety Improvement Project (HSIP) improvement type level for project types categorized as something other than "Pedestrian" and "Bicyclist."

In Alaska, VRUs represented 18% of fatalities between 2016 and 2020, the most recent HSIP reporting period, and nearly 22% of fatalities in 2020. Nationwide, there has been a new focus on the unacceptably high rates of fatality among pedestrians, bicyclists, and other non-motorized road users. This is reflected in the new requirements of the IIJA, which dictate that states with more than 15% VRU fatalities must commit "15% or more of the [Highway Safety Improvement] Program funds on projects that address the safety of Vulnerable Road Users." For FFY23, this amount will be approximately $6 million; the IIJA includes no phase-in or grace period for this requirement. In the coming fiscal year, Alaska expects be subject to this penalty.

Benefits to the State: This project is directly linked to the purpose of the Alaska Highway Safety Improvement Plan, as well as the goals in Section 2.3 of the DOT&PF *Alaska Strategic Highway Safety Plan*, the Safety Core Value in the DOT&PF *Strategic Plan*, and Goal 7 of the *Alaska Statewide Long-Range Transportation Plan*. It will also allow Traffic and Safety Engineers to quantify expected benefits for bicyclists, pedestrians, and other vulnerable road users as a part of project evaluation.

Alaska's transportation workforce detours: Maximizing training opportunities and outcomes in DOT&PF's key industries
Category: Policy
Funding: $**
Manager: Paulette Hoffmann
Champion: Katherine Keith, Aaron Nickols, Cina Fisher

Understanding the number, nature, and capacity of existing workforce training programs for our key industries is a first step to identifying how well Alaska is able to respond to changing demands for skilled workers. But meeting Alaska's workforce needs is more than just identifying over- or under-subscribed training programs, but also understanding how individuals progress through (and drop out) of those preparation pipelines. Identifying where we lose eligible workers – and what may be done to retain them in programs – can help the state to develop responsive and data-driven interventions. There may be short-term coordination efforts across programs that could capture these students before we lose out on initial investments in their career

development. State government wise, there may be state policies and/or practices that are also creating barriers for traditionally marginalized communities. A plan to optimize existing efforts while also addressing gaps/pitfalls would help DOT&PF address the plateau in workforce development across the transportation industry.

Benefits to the State: The final product will be a report with profiles and strategic recommendations for DOT&PF, as well as general recommendations that transcend industry specificities.

Alaska Low Emission Ferries Pilot Program
Category: Environmental
Funding: $**
Manager: Anna Bosin/Katherine Keith
Champion and Technical Advisors: Katherine Keith, Dan Askins

The problem to be solved is the production of carbon-range emissions from ferry operations in coastal Alaska. Conceptual design work will determine cost/benefit analysis of construction and operation of low emission diesel-electric hybrid or all-electric propulsion system vessels on specific routes. Research approach includes energy consumption characteristics of comparative vessels; availability of renewable electricity at recharging ports; recharging capacity at ports; passenger and vehicle capacity of low emission vessels on given routes; quantification of avoided emissions compared to conventional propulsion vessels; life cycle cost comparisons of conventional and low emission vessels over fixed time period. Other on-board or shore-based capital and operating variables may also be considered.

Public Law 117-58 (also known as the "Bipartisan Infrastructure Law") directs the US Department of Transportation to carry out a pilot program to provide grants for the purchase of electric or low-emitting ferries and the electrification of or other reduction of emissions from existing ferries. As the ferry service in the United States with the largest number of marine highway system miles, AMHS is well-positioned to sponsor the evaluation of alternative fuel, low emission propulsion systems on specified routes in coastal Alaska. What's more, the research into alternative fuel ferries can advance the state of low emission technology toward increasing the range and capacity of zero-emission power source ferries.

Benefits to the State: Economic benefits include federal financing of new port infrastructure development and new, low emission vessels designed for Alaska ports. Other benefits can include marketing opportunities to promote zero and reduced emission operation of vessels along coastal Alaska powered by zero-emission hydroelectric generation.

DOT&PF Image Server deployment
Category: Administration
Funding: $**
Manager: Anna Bosin
Champion: David Oliver, Garry Remsberg, Jeremey Arnold, Adam Rolfe, Ryan Marlow

This project lays the foundation for our next steps into the standardization of reality capture, and remote sensing data. Image server will allow the Department to collect, manage, and serve

imagery from a wide range of sensors on platforms ranging from satellites, aircraft, and drones. Combine overlapping, time-variant imagery from multiple devices, sensors, resolutions, bands, and raster formats into a single image service. Raster analytics quickly extract information from massive image and raster collections. Faster results for computationally intensive tasks such as deep learning, hydrologic analyses, or temporal analysis of multidimensional data. Lastly, the ability to quickly process hundreds or thousands of images collected by satellite, aerial, or drone sensors to create orthoimage mosaics, digital surface models (DSM), and digital terrain models (DTM). Create accurate maps for interpretation and analysis such as vegetation health and volumetric change all in one place.

Benefits to the State:
Data storage is expensive. Our slow migration to cloud services is inevitable and will be costly in the first couple years as services will need to be duplicated in two places at once. Once we get over this hump though, we can expect considerable savings and increased flexibility on long term storage for historical data vs high speed access requirements with active projects.

By deploying data with cloud hosting, we gain the ability to store a large amount of data with a very low cost. By using AI, we can set lifecycle policies that monitor and migrate our data automatically to standard – infrequent access which further reduces costs.

Remote Management of Roadway Infrastructure Assets with Digital Twins
**Digitalization of Critical and Linear Infrastructure (2022 STIC Application resubmitted)
Category: Innovation
Funding: $ managed together
Manager: Paulette Hoffmann
Champion: Ryan Marlow, Vince Yelmene, Jillian Nicolazzo, Troy Hicks

Alaska DOT&PF manages hundreds of critical infrastructure assets across the state. There are three major challenges that we balance when it comes to management. The first being remoteness and how fast/often we can get there, the second is site specific knowledge, and lastly and most important the management data so it can be viewed by the department anytime, anywhere.

**This proposal seeks to identify a way to efficiently collect a reasonable amount of data for sufficient planning level decision support that can also be upcycled later in project design and maintenance in areas that are historically data poor and underserved.

Benefits to the State: Well informed, preventative operations, powered by modern data management, results in reduced downtimes of assets, increased operational efficiency, less high-cost reactive maintenance, and increased life of facilities and equipment. Concerning workforce, improved trainings and orientations lead to faster training times, leading to more effective workers in shorter amounts of time. Training that is interactive and 3D, instead of passive and 2D, results in more than 2x better long-term retention of knowledge transferred. Virtual walkthroughs that can take the place of site visits cut down on expensive travel and could provide a next generation understanding of the entire DOT&PF system within a few clicks.

**If remote sites could be visited virtually, then many of the logistical challenges of site planning or management disappear. Emerging 3D scanning technologies offer the answer to facility and asset management.

Structural Adequacy of Culverts in Poor Condition
Category: Hydrology
Funding: $**
Manager: Paulette Hoffmann
Champions: Paul Janke, Jake Ciufo, Jeff Stutzke, Bob Trousil

Culverts are buried structures designed to allow passage of water under roadways, railways, or embankments. (AASHTO 2020) A typical culvert is structurally adequate when the culvert material and the adjacent soil act together to support the applied live load and dead load. DOT&PF regional hydraulic engineers and their staff intermittently inspect culverts under road and airport embankments. The 2020 AASHTO Culvert and Storm Drain System Inspection Guide provides a condition rating system based on a numerical scale. A rating of "1" (Good) indicates a like-new component. Rating numbers increase with worsening condition, up to a rating of "4" (Severe). AASHTO recommends a special inspection with structural evaluation for culverts with a rating 4. Structural failures can be life-threatening to the traveling public, and at a minimum can cause roadway closure and traffic delays (AASHTO 2020).

Benefits to the State: The economic benefit of a planned versus unplanned culvert repair or replacement could be significant. The planned replacement could provide significantly less impacts to the traveling public and construction cost with advance notice and a detour, if necessary. An unplanned replacement could be much more expensive with a road closure and a temporary quick repair that could significantly disrupt traffic, especially if no alternate adequate route is available.

Avalanche Detection and Warning System Using an Infrasound Monitoring Network along Thane Road, Juneau AK.
Category: Maintenance & Operations
Funding: $**
Manager: Shane Moller
Champion: Pat Dryer

Currently, road closures are used to mitigate the avalanche hazard by not allowing DOT&PF or the public to travel the roadway. By having real time information on the size and distribution of avalanches, the avalanche specialist can make informed decisions on avalanche hazard and closure durations. Alaska Electric Light and Power's Thane Substation is inaccessible during Thane Road closures. This substation provides the City and Borough of Juneau with power from the hydroelectric facility south of Juneau. The transmission lines from the Thane Substation follow the road corridor and cross the avalanche paths. When repairs or maintenance is needed along the transmission line the infrasound monitoring network could alert workers to potential hazards in the area. The installation of the infrasound network would have economic benefits for the public, private, and commercial sectors.

Benefits to the State: There are many economic benefits to the installation of the infrasound motioning network. Shorter duration road closures are possible with the ability to track and record when avalanches are occurring during times of increased avalanche hazard. Avalanche mitigation is most successful during periods of instability shortly after or during storm events. Data from the infrasound array can be analyzed to make informed decisions on if and when avalanche mitigation should be conducted. This could lead to a reduction in helicopter flight time and the total number of explosives used during avalanche hazard reduction missions. By using infrasound to help inform the timing of if and when mitigation should be conducted it would reduce the overall cost of the program.

Use of Polymer Fluids in Stabilized Base Courses
Category: External Features
Funding: $**
Manager: Steve Saboundjian/Drew Pavey
Champion: Steve Saboundjian and Jeff Currey

One of the major costs of stabilizing base courses is the inclusion of specialized equipment. These costs increase rapidly in remote areas where mobilization become a significant cost to the project. Copolymers do not require any equipment that is not already on the project site – it simply requires a water truck, a grader, and compaction equipment. One of the advantages of copolymers is the range of soils it can stabilize which can include silty sands, sands, sandy gravels and high fines content gravels. The addition of Portland Cements allows copolymers to be effective in gravels with high clay content provided there is no organic clays.

Because the equipment costs are lower, we can expect the cost of stabilized bases to be lower, especially in remote areas.

Benefits to the State: The cost of polymer stabilized base courses is not expected to be attractive near urban areas where fixed asphalt plants exist, and reclaimers are readily available. However, as mobilization costs increase the ease of construction and minimal equipment begin to make the use of copolymers look attractive. The use of copolymers in Shishmaref as a surface course cost less than ½ the cost of pavement. However, the life expectancy has yet to be determined. Copolymers offer an alternative to asphalt based stabilizers while using common equipment found on all highway and airport projects. Third world countries are increasing their use of these materials for soil stabilization and dust management due to the simplicity of their use.

Hydroacoustic Down-the-Hole Drilling Noise Study
Category: Environmental
Funding: $**
Manager: Shane Moller
Champions: Doug Kolwaite, Ben Storey, Christy Gentemann

There is a general lack of data on in-water sound levels for DTH drilling. DOT&PF, SCR conducted two Sound Source Verification Studies in 2020 and has two upcoming studies in 2021 that need to be analyzed by an acoustic specialist in order to gain an understanding of the results as well as produce recommendations on how the data should be used when calculating level A and level B isopleths.

Tasks:
1. Search for, review, and compile data from other marine projects with relevant sound source information on DTH drilling.
2. Review the Sound Source Verification Study Plans and Final Reports during the two upcoming studies to ensure all necessary data is collected.
3. Analyze the data collected on DTH installation for rock sockets and tension anchors in the four DOT&PF SCR Sound Source Verification Studies.
4. Draft and finalize a report summarizing the results. Include recommendations on how to use the data going forward and any findings/recommendations from Task 1 in this report.

Benefits to the State: This project has the potential to provide information resulting in cost-savings by shortening the permitting and consultation timeframes as well as potentially reducing the level B and level A zones that must be monitored and more often result in shutdown during construction when marine mammals enter the zone.

Computer Vision Tools for Bridge Inspections and Reporting
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Larry Owen and Nicholas Murray, Kirk Warren

The main goal of the present study is to develop AI tools that help inspectors with measurements and reporting of bridge defects following NBI and MBEI requirements. To achieve this goal, the following will be carried out (1) selecting a few bridge elements (e.g., decks, girders, caps, columns) for further investigation, (2) collecting inspection data from DOT including photographs of the selected elements with/without damage, and (3) development of computer vision tool for each element that can recognize the element defects, can quantify the defect per NBI/MBEI, and can produce a report following the DOT standard practice. The tools can be cloud-based and may incorporate mobile devices for the ease of data collection, preservation, access, sharing, and reuse in future inspections.

Benefits to the State: Current inspection often involves manual identifications and measurements of bridge defects, which are time consuming. The inspection reports are also generated manually. New technologies can streamline the process and might substantially reduce the time thus costs of each bridge inspection.

AI Tools for Rapid Post-Earthquake Damage Assessment of Bridges with Standard and Substandard Columns
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Nicholas Murray

The main goal of the present study is to develop tools (AI and analytical) that perform post-earthquake PDA and DDA on both standard and substandard columns that are in-service in Alaska. To achieve this goal, the following will be carried out (1) review of the BrM database

and other resources such as drawings and inspection reports to extract the common column detailing specific to Alaska and to categorize them into standard and substandard columns, (2) a comprehensive literature review on the performance of such columns, (3) development of a comprehensive experimental database for substandard columns, (4) performing large-scale testing to establish damage pattern for substandard columns common in Alaska, and (5) development of AI and other analytical tools that can perform PDA and DDA on Alaska's standard and substandard columns.

Benefits to the State: Cloud-based tools or mobile applications equip with PDA and DDA tools can significantly expediate post-earthquake assessment of bridges by deploying local DOT personnel that are not necessarily bridge engineers/inspectors. These tools provide quick and safe evaluation to decide to open, partially open to first responders, or close the bridge.

Shake Table Tests of Grade 80 Piers
Category: Bridge
Funding: $**
Manager: Paulette Hoffmann
Champions: Elmer Marx, Nicholas Murray

Pre-stressed bulb-tee girders are the mainstay of bridge construction in Alaska. The pre-stressing force in a bulb-tee contributes to strength of the beam as well as its durability. For the latter, the prestressing force reduces or eliminates cracking of the concrete which, in turn, protects the reinforcing steel inside the beam. Having empirical data as to the loss of pre-stress from an aged girder specimen will allow designers to verify the strength of the beam and asses its durability of the prescribed 75-year design life of a bridge, per AASHTO.

Benefits to the State: It is accepted the cost/benefit ratio is small and this study will have substantial impact considering the cost to repair or replace a bulb-tee girder; realizing the number of bulb-tee girder bridges in Alaska. The girder specimen already exists and need only be shipped to Fairbanks. Additional costs would be for fixturing and labor of the researcher and lab staff. The beam test, itself, is straightforward and should be accomplished over the summer of 2023.

Weldability of Bridge Steel with Protective Coatings
Category: Bridge
Funding: $**
Manager: Paulette Hoffmann
Champions: Leslie Daugherty

The *AASHTO/AWS D1.5 2020 Bridge Welding Code* is required by FHWA for use with all bridge welding on ASTM A709 steel. Both fabricators and contractors would have an interest in welding over coatings, i.e. it applies to both shop and field welding of new and in-service bridges. Before adopting the new welding code provision, the DOT&PF should evaluate if this practice will produce acceptable quality welds and define any limitations if acceptable welds can be produced. Lack of quality welds over coatings affects the serviceability of both new steel bridges and any repaired steel bridges. Contractors also weld temporary supports on galvanized pier pipe piles. Contractors are supposed to remove the coating before welding. However, the

DOT&PF would benefit from knowing how detrimental these welds could be to the pipe pile base metal is the coating is not removed prior to welding. Overall, research would help determine if acceptable welds can be produced over coatings, and also if more strict limitations related to welding process, coating thickness or other variables would be required to produce acceptable welds.

Benefits to the State: A savings in construction and steel fabrication time could be realized if welding over coatings is allowable. More significant costs and disadvantages could be encountered if weld defect problems related to the new Code provisions were to arise in bridges. This would also qualify as National Research as it directly affects what is required by the *AASHTO LRFD Bridge Design Specifications* and required by FHWA for all states.

Roadway foundation cooling using structured foam layers
Category: Roadway
Funding: $**
Manager: Paulette Hoffmann
Champions: Jeff Curry, Mathew Billings, Steve Saboundjian

Embankment deformation that results from thawing permafrost foundation soils often results in safety and drivability problems, and in extreme cases can result in structural embankment failure. Regular maintenance (often on an annual or bi-annual basis) is then needed to avoid safety and drivability problems. Cost-effective solutions that can help reduce permafrost thaw and embankment deformation are needed to reduce maintenance costs and increase the safety and drivability of Alaska's highways.

Benefits to the State: The potential economic benefits generated by the proposed work will vary substantially depending on permafrost characteristics, roadway type, and traffic loading. Cost reductions will be greater for paved highways where maintenance costs for resurfacing tend to be large. Savings may be less for unsurfaced highways or corridors where the traffic load is light and greater surface distortion may be allowable.

Seismic Detailing of Steel H-Pile Connections
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Nicholas Murray

The objective of the research is to:

- Evaluate the existing connection via full-scale tests under reversed cyclic and axial loads
- Assess the accuracy of existing analysis methods for prediction of connection capacity (form the literature as well as current AKDOT&PF practice), and propose alternative strut and tie models, as needed.
- Revise connection design, based on initial tests and modelling
- Conduct additional full-scale tests on revised designs.
- If needed proposed retrofits for existing cap-beams.

Benefits to the State: While there is some confidence in the performance of the existing AKDOT&PF H-pile to cap-beam connection design, there is also some uncertainty, based on embedment length of the pile. The research described in this RNS will either affirm existing practice (while also providing a unified process for analysis and design), or identify deficiencies that will require revision, and possible retrofit.

Research Administration
Category: Administration of Research Program
Funding: $150,000 (75,000 each fiscal year)
Manager: Anna Bosin
Champion: N/A

This is money specifically for research staff to administer the federal research program as outlined in the Alaska RD&T2 Standard Operating Procedures. Activities include reporting to FHWA, AASHTO RAC participation, UTC advisory, Master agreements with universities, regional outreach, peer-exchange participation, TRB participation, and other such activities to maintain the research program. This funding is still required to comply with federal regulations for research projects as stated in Alaska's RD&T2 Standard Operating Procedures.

Benefits to the State: Compliance with FHWA regulations for SP&R B funding.

Rapid Research/Deployment
Category: Varies
Funding: $150,000 (75,000 each fiscal year)
Manager: Anna Bosin
Champion: Varies

This is money specifically for quick turnaround of small research projects that are needed to answer specific questions for department consideration before proceeding to larger research projects or products. Rapid Research could include laboratory testing, literature reviews, or national surveys for best practices. Deployment is used to facilitate implementation of successful research products, training, outreach, etc for wider department use. Example deployment deliverables could be: 1) targeted compliance, 2) new content creation for trainings, 3) training video content for implementation, or 4) targeted workshops. This funding is still required to comply with federal regulations for research projects as stated in Alaska's RD&T2 Standard Operating Procedures.

Benefits to the State: Ready funding available for time sensitive research needs as well as assistance for implementation.

FFY24 Selected Project Summaries

Alaska DOT&PF Equity Sample Review of Programming and Policies
Category: Policy
Funding: $**
Manager: Anna Bosin
Champions and Technical Advisors: Rashaud Joseph (Civil Rights Division Manager), Judy Chapman (NR Planner), James Marks (SW Program Director),

An objective analysis of DOT&PF's policies and decision-making processes is needed to assess Alaska's unique transportation network of connected and non-connected communities to ensure an equitable overall program. Pavement condition is an indicator of resources (capital, economic, and M&O resources) but that data needs to be compared against environmental drivers (locality costs to construct, population density, community led development, census data, oil prices, inflation, etc.). Other ways to analyze could be reviewing service priority maps, public requests/complaints, community priorities.

Benefits to the State: Evaluation could provide confirmation for DOT&PF that existing policies are meeting Title VI compliance and help decision makers adjust practices as budgets evolve. Results could also help correct non-equitable policies found.
• Recommendations for DOT&PF policy changes
• Recommended DOT&PF training

Statewide GNSS Network
Category: Survey
Funding: $**
Manager: Anna Bosin
Champion: Travis Test, Troy Hicks, Hans Pederson, Robert Keiner

As we are late to the implementation game, we have an opportunity to skip the physical infrastructure and base station installation and deploy NTRIP (Network Transport of RTCM via Internet Protocol). This would allow for the creation of a VRS (Virtual Reference Station) where needed allowing for our field crews, drones or self-driving cars to stay connected as needed.
Benefits to the State: This project allows us to save a considerable amount of money by deploying a digital public service while laying the foundation for next gen precision technologies.

Evaluation of Low Earth Orbit Broadband
Category: Innovation
Funding: $**
Manager: Paulette Hoffmann
Champions: Vince Yelmene, Ryan Marlow

High speed broadband and rural Alaska are not commonly referenced in a positive manner, however Alaska is getting a much needed upgrade with Low Earth Orbit Internet Services and coverage areas coming online daily. Even today within DOT&PF staff are forced to operate in

connectivity dead zones or even call into meetings because their internet connectivity cannot support the bandwidth. What we consider normal features at the workplace, many places in Alaska have yet to experience true broadband connectivity. With connected driving technologies, including IOT devices it is vital that we catch up with the rest of the nation on connected services. If we ever expect to operate as one DOT then we need to fix connectivity and bandwidth.

Benefits to the State: This project fixes Alaska's biggest problem, infrastructure. We are unable to provide a single solution across the state. Using this innovative space based solution will offer more bandwidth for a fraction of the cost and enable nextgen technologies to be used at projects across the state.

Alaska DOT&PF Human Trafficking Data Collection and Strategic Recommendations
Category: Policy
Funding: $**
Manager: Paulette Hoffmann
Champions: Troy LaRue, Dylan Blankenship, John Clendenin

The Combating Human Trafficking in Commercial Vehicles Act (Pub. L. No. 115-99) required the establishment of a Department of Transportation Advisory Committee on Human Trafficking (ACHT) to make recommendations on actions the USDOT can take to help combat human trafficking, and to develop recommended best practices for States and State and local transportation stakeholders in combating human trafficking.

There has been a national push for each transportation industry to combat human trafficking within their means. This has been a positive step however a more coordinated and customized approach would be more effective to address gaps and needs across industries and partners. USDOT recommends creating a local task force amongst crosscutting industries such as: law enforcement, DMV, rail, ferry, airport, transit, hospitality, and non-profits who specialize in victim reporting.

Benefits to the State: Alaska's transportation system is uniquely challenging to apply lower 48 solutions to a complex network of transportation modes so geographically spread out. Staff need specific data for Alaska and recommendations from local experts to have a comprehensive approach to effectively combat this activity.

Alaska Transportation Systems Management & Operations Strategic Plan
Category: Policy
Funding: $**
Manager: Paulette Hoffmann
Champion: Pam Golden

Transportation Systems Management & Operations (TSMO) focuses on operational improvement strategies to better manage both recurring and non-recurring congestion in urban and rural settings. States across the country that have embraced TSMO are able to increase efficiencies between internal working groups, provide better real time information to travelers, and provide better system reliability for the traveling public. Many states have reported the need

to break down silos between current user groups (traffic signal operations and M&O operations as one example). Challenges regarding data, workforce and technology are other barriers that have needed to be overcome. Many DOTs across the country that have not yet adopted TSMO strategies are currently assessing their own needs and developing plans for implementing TSMO as a standard business practice. Alaska needs to find an optimal approach to system operations that address our state's unique transportation system and regional differences. This project would create a working group guided by experts resulting in the creation of a collaborative strategic plan.

Benefits to the State: TSMO strategies include technological advances that are developing at a fast pace among industry leaders and researchers such as smart traffic control devices and other CAV technologies. If Alaska doesn't prepare to address gaps/needs for implementation of both existing and up-and-coming technologies, then Alaska may lose the opportunity to rollout the technology in the best manor possible.

Innovation Corridors- Pilot Study Partnerships with Transportation Technology Industries

Category: Innovation
Funding: $**
Manager: Shane Moller
Champion: Anna Bosin

As technology advances in many areas of the transportation industry, Alaska DOT&PF is committed to readiness through the Connected and Autonomous Vehicle Working Group. DOT&PF also recognizes that technology may provide new methods to evaluate long-standing challenges in transportation such as safety improvements, asset management, human behavior trends, etc. The recent Mini-RWIS pilot study within the RD&T2 Division showed that DOT&PF can successfully evaluate new products in the public Rights of Way through Public-Private Partnership contracting and evaluating. Pilot studies implemented in public ROW allow for advancing theory into practice and can provide useful trials for DOT&PF, the private industry that is leading the technology and University of Alaska. This project would create an avenue to partner with industry that meets the goals for technology readiness outlined in the recently completed CAV Strategic Plan.

Tasks included:
1. Define corridors within each region and define technology areas/topics for each that technology industry may trial
2. Draft an RFP for pilot studies.
3. UAA and UAF engineering departments evaluate pilot studies under RSA(s)
4. Report out on lessons learned for each study.
5. Successful pilot studies could expand into implementation mechanisms such as experimental features, adoption into practice or Public Interest Findings.

Benefits to the State: Technological advances that are developing at a fast pace among industry leaders and researchers such as smart traffic control devices and other CAV technologies may struggle in Alaska's harsh transportation conditions. If Alaska doesn't prepare to address gaps/needs for implementation of both existing and up-and-coming technologies, then Alaska

may lose the opportunity to influence the national rollout of transportation technology in the best manor possible.

Estimating inelastic displacement demands for bridges under seismic forces
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Nicholas Murray

The objective of the research is to develop robust procedures for calculation of inelastic displacement demands in bridges while also providing guidance on how to best model damping in non-linear response history analysis.

Benefits to the State: Based upon observations developed during the conduct of NCHRP 12-106, current methods for evaluating displacement demands may be substantially non-conservative, leading to bridges that may sustain much higher displacements (and hence damage) than what was expected during the design phase. Implementation of PBSD requires accurate estimation of displacement demand, making this vitally important to the engineering community.

Analysis of existing aufeis data near bridge embankments collected by airborne surveys
Category: Hydrology
Funding: $**
Manager: Anna Bosin
Champion: Mike Knapp

Providing adequate river ice clearance is often a controlling factor for bridge layouts. We have good analytical tools for ice-free hydraulic conditions, but anticipating future river ice dynamics is largely a speculative endeavor. Even for bridges where aufeis is known to frequently accumulate, AKDOT&PF has a very limited record of past winter ice levels and must consider what new challenges future climate conditions might bring. Unlike many other states, Alaska is contemplating new routes into undeveloped areas where little on-the-ground observations have been made, especially during winter. Any research efforts that help to reduce risks and minimize uncertainties are valuable. Currently, AKDOT&PF has a data set on aufeis accumulations, collected over a few years, but only a limited amount of review has been conducted to date. With the assistance of UAF cold region experts, we hope to gain insights on the relative influence of infrastructure on aufeis growth, rates of accumulation, and any discernable patterns related to antecedent conditions or weather events.

Benefits to the State: The knowledge gained by conducting the analysis could be incorporated in bridge design manuals. The Alaska DOT&PF is presently working to update its Highway Drainage Manual. The new manual will be tailored to supplement the AASHTO Hydraulics and Water Resources Manual with Alaska-specific guidance. Aufeis represents one of several cold region topics that we do not expect will be well-covered in the AASHTO manual. This project, if selected, will be well-timed for providing meaningful information for inclusion in AKDOT&PF's manual update.

Decked Bulb Tee Girder – Loss of pre-stress validation
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Nicholas Murray, Douglas Gelineau

Pre-stressed bulb-tee girders are the mainstay of bridge construction in Alaska. The pre-stressing force in a bulb-tee contributes to strength of the beam as well as its durability. For the latter, the prestressing force reduces or eliminates cracking of the concrete which, in turn, protects the reinforcing steel inside the beam. Having empirical data as to the loss of pre-stress from an aged girder specimen will allow designers to verify the strength of the beam and asses its durability of the prescribed 75-year design life of a bridge, per AASHTO.

Benefits to the State: It is accepted the cost/benefit ratio is small and this study will have substantial impact considering the cost to repair or replace a bulb-tee girder; realizing the number of bulb-tee girder bridges in Alaska. The girder specimen already exists and need only be shipped to Fairbanks. Additional costs would be for fixturing and labor of the researcher and lab staff. The beam test, itself, is straightforward and should be accomplished over the summer of 2023.

Camera Based Computer Vision Measurements for Bridge Field Testing
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Larry Owen and Nicholas Murray

The main goal of this proposal is to develop a framework and necessary tools to field test bridges using computer vision including either low-cost ground cameras or off-the-shelf drones. Instead of using conventional displacement/strain sensors and data acquisition system, a few cameras or a fleet of drones each equipped with a camera will be deployed for the measurements. To achieve this goal, the following will be carried out (1) literature review, (2) evaluation of current products that utilize computer vision for measurements, (3) development of low-cost tools for bridge field testing using stationary cameras and/or drones, (4) development of field testing frameworks, and (5) load testing a few bridges to validate/refine the tools.

Benefits to the State: The project main benefit is to reduce the bridge field testing time, effort, and costs through computer vision without the need for conventional sensors.

Next Generation of Reinforced Concrete Structure: Electric Energy Storing, Self-Sensing Reinforced Concrete Elements
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx

The objective of this research are (i) to develop and design cementitious materials to increase the electric energy storage in ESSE elements, (ii) to analytically and experimentally assess the structural performance of ESSE RC elements designed with plate reinforcement, (iii) to

analytically estimate and experimentally measure the amount of electric energy that can be stored in ESSE RC elements, and (iv) to experimentally measure the change of electric energy storage capacity during loading and failure of ESSE elements and assess the self-sensing potential of ESSE RC elements.

Benefits to the State: Electric energy storage in infrastructure has significant economic and environmental benefits since they can potentially contribute to the reduction of our dependence on fossil fuels and nuclear power and can be well-integrated with solar and wind energy production. Electric energy storage technologies can reduce the demand on the grid and therefore reduce its maintenance cost, increase its service life, and reduce the associated environmental emissions with energy production. Distributed electric energy storage technologies such as ESSE RC, can increase the resilience of electricity grid against natural hazards such as hurricanes and earthquakes. The self-sensing aspect of ESSE members will contribute to the enhancement of infrastructure safety, in particular to that of transportation.

Decked Bulb Tee Girder – Loss of pre-stress validation
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Nicholas Murray, Douglas Gelineau

There are many benefits from studying the column performance in shake table tests. The columns are subjected to real ground motion records which will more accurately represent the performance of the column under the expected seismic loading. Shake table tests also account for the dynamic effects of strain rate absent from quasi-static testing. The authors of this RNS are not aware of any shake table tests on structures using Grade 80 reinforcing steel.
The objective of the research is to:

Evaluate the dynamic performance of reduced scale Grade 80 reinforced concrete columns. This includes columns with conventional bars, as well as smooth bars in the plastic hinge.
Compare performance to that observed during reversed cyclic loading. Specifically of interest are strain limit states, plastic hinge lengths, bond-slip and development length, member deformation, and hysteretic energy dissipation.
Develop (confirm) recommendations for design.

Benefits to the State: The use of high strength steel can reduce congestion of reinforcement into adjoining members, such as cap beams and footings. There are also performance advantages, especially when deployed for transverse steel. Furthermore, steel manufacturers are moving towards ever increasing steel strengths, and ultimately, Grade 80 steel may become the norm, thus necessitating design recommendations for its deployment.

Seismic Behavior of Hider Wing-Walls
Category: Bridge
Funding: $**
Manager: Shane Moller
Champions: Elmer Marx, Nicholas Murray

The objective of the research is to:

Develop tools to determine the seismic demands experienced by abutment hider walls.
Develop details for abutment hider walls that are compatible with the intended performance.
Develop recommendations for design.

Benefits to the State: The outcome of the research will provide Alaska DOT&PF engineers with the tools to accurately estimate the demand on hider walls, and a suite of options of design details to accomplish different performance objectives.

Capacity and Acceptance Criteria of Welded Splices in Cold-Bent Reinforcing Steel
Category: Bridge
Funding: $**
Manager: Paulette Hoffmann
Champions: Leslie Daugherty

The *AASHTO LRFD Bridge Design Specifications* require welding of bridge reinforcing steel splices to conform to the American Welding Society (AWS) *D1.4 Structural Welding Code – Steel Reinforcing Bars*. DOT&PF uses bent reinforcing steel hoops and spiral bars as confinement in its concrete-filled steel pipe pile bent system. Structural adequacy of this system is essential for seismic performance. Alaska, along with other seismic states, have used cold-bent reinforcing steel for a number of years, but these splices are technically not in compliance with AWS D1.4 which does not allow welding within 2 bar diameters of the bent portion of steel. Despite this code provision and decades of research of the pipe pile system, no known defects have arisen from these splices. However, specific testing of the reinforcing steel welds has not been completed to ensure that current materials and methods would not lead to problems. This research gap would be addressed by a definitive study to confirm that welding of cold-bent reinforcing steel is not detrimental to the pipe pile system. Any specific requirements for welding beyond those in the AWS D1.4 Code could also be identified.

Benefits to the State: Welding specifications and welder qualification testing is an expensive and time-consuming process for contractors. The research could seek to determine if a DOT&PF-specific welder qualifications or welding procedure specifications would help save time and money for contractors.

Improved modeling for ACE and ventilated shoulder design
Category: Roadway
Funding: $**
Manager: Anna Bosin
Champions: Mathew Billings, Jeff Currey, Steve Saboundjian

Embankment deformation that results from thawing permafrost foundation soils often results in safety and drivability problems, and in extreme cases can result in structural embankment failure. Regular maintenance (often on an annual or bi-annual basis) is then needed to avoid safety and drivability problems. ACE and ventilated shoulder systems can reduce or eliminate thaw settlement and related maintenance problems, but they are expensive to construct. Improved modeling and design tools would allow better “tuning” of these systems leading to improved

thermal performance and reduced costs. AKDOT is currently using the Geoslope suite of modeling tools to analyze heat transfer in highway embankment designs, including ACE and ventilated shoulder installations. However, the existing Geoslope models are not capable of including the complex boundary conditions that arise when ambient air is drawn into and out of these roadway features, thus limiting the amount of detailed design that can be accomplished.

Benefits to the State:
The potential economic benefits generated by the proposed work will result from AKDOT design engineers being better able to predict the cooling behavior of ACE and ventilated shoulder layers. Currently these features are used sparingly due to the high cost of the required rock fill materials, even though they have proven effective at cooling foundation soils and maintaining the structural integrity of the supporting permafrost. Costs could be reduced significantly through the utilization of better modeling and design tools that would allow designers to reduce the required rockfill volumes without sacrificing the necessary amount of convective cooling capacity.