UNLV | TRANSPORTATION RESEARCH CENTER

COVER LETTER

Ms. Lucy Koury, Assistant Chief
Nevada Department of Transportation
1263 S. Stewart Street
Carson City, NV 89712

July 1, 2024

Dear Ms. Lucy Koury,

Sub: Design of Surface Treatments with Reclaimed Asphalt Pavement Aggregates in Nevada (ID # 24-01-E3)

The University of Nevada, Las Vegas (UNLV) Transportation Research Center (TRC), along with the Universal Engineering Services (UES) and Nichols Consulting Engineering (NCE), is pleased to submit this proposal in response to the State of Nevada, Department of Transportation (NDOT) solicitation for research proposal for project ID # 24-01-E3 and problem statement title “Design of Surface Treatments with Reclaimed Asphalt Pavement Aggregates in Nevada”.

The UNLV, UES, and NCE team is composed of an excited, talented, and experienced team of academics and professionals dedicated and committed to working collaboratively with NDOT and excelling in our responsibilities for this research proposal if successful. Our team has a proven record of accomplishment in managing engineering and business operations and resolving complex and challenging projects. Our research proposal aims for a sustainable and economical maintenance approach for AC pavements in the state of Nevada aligning with national efforts to reduce the carbon footprint of road construction.

Our proposal and its attachments comply with the requirements noted in the FFY25 Research Proposal Guidelines. Specifically, the proposal includes our response to the eleven evaluation factors listed in the guidelines along with five appendices, which contain the budget justification, aggregate gradations for SS and MS, resumes of our team’s principal investigator, senior personnel, and other team members, advisory board members and the advisory board invitation letter with the board’s responsibilities. If selected to carry out the research project, we commit to complying with the laws and regulations of the state of Nevada.

We look forward to working with NDOT and other stakeholders to fulfill the scope of work of the solicitation. Thank you for your time and consideration.

Sincerely,

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to the

State of Nevada
Department of Transportation
Research Section

Submitted by
Transportation Research Center
University of Nevada, Las Vegas
4505 S. Maryland Parkway
Las Vegas, NV 89154-4007

DESIGN OF SURFACE TREATMENTS WITH RECLAIMED ASPHALT PAVEMENT AGGREGATES IN NEVADA

(ID # 24-01-E3)

Date Submitted: July 1, 2024

Principal Investigator: Moses Karakouzian, Ph.D., P.E., Professor of Civil Engineering
Senior Personnel: Juliana Byzyka, Ph.D., Assistant Research Engineer, Transportation Research Center
Team Members: Universal Engineering Services (UES) and Nichols Consulting Engineering (NCE)

SECTION I: RESPONSE TO EVALUATION FACTORS

1. TITLE: Design of Surface Treatments with Reclaimed Asphalt Pavement Aggregates in Nevada

2. PRINCIPAL INVESTIGATOR: Moses Karakouzian, Ph.D., P.E., Department of Civil and Environmental Engineering and Construction, Howard R. Hughes College of Engineering, 4505 Maryland Parkway, Box 454015, Las Vegas, NV 89154-4015, mkar@unlv.nevada.edu and phone: 702-895–0959
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3. PROBLEM DESCRIPTION: The use of reclaimed asphalt pavement (RAP) materials in hot mix asphalt (HMA) and non-HMA construction projects can have great economic, environmental, and engineering impacts on pavement recycling (FHWA 2020). Chip seals (CS), slurry seals (SS), and micro seals (MS) are non-HMA surface treatments (ST) used to add value and extend the life of an asphalt concrete (AC) pavement. There is a growing interest among transportation agencies and contractors to increase the use of RAP in STs. However, for the state of Nevada, lack of sufficient research, and issues during the mix design and construction of STs with RAP using Nevada's established ST mixtures are barriers to successfully implementing this technology in the state's roadways.

4. BACKGROUND SUMMARY:

a. Nevada Department of Transportation (NDOT) current practices: NDOT currently uses RAP materials either in HMA or on paved shoulders. There is no use of RAP materials in ST aggregates in AC pavements. NDOT currently uses sections 408 and 418 in the 2014 Standard Specifications for Road and Bridge Construction (Nevada Department of Transportation 2014) for STs and MS asphalt pavement preservation treatments respectively. There is no laboratory mixture design for CS. The application rate is determined in the field, and the final product is based on a test strip at the proposed application site, with adjustments made depending on its performance.

b. Preliminary literature review: Recycling asphalt pavements dates back to 1915. In the early 1970s, in response to increasing asphalt binder prices, the asphalt paving industry developed recycling technologies to reduce reliance on asphalt binders and lower the cost of asphalt paving mixtures (West 2015). Besides cost, recycling offers environmental benefits and prevents old pavement materials removed during rehabilitation from ending up in landfills (Copeland 2011, Blacktop 2024).

The requirement for recycled mixes is to provide similar or better performance or service life to that of virgin mixes and the current literature from paving projects throughout the U.S. states supports this. In its latest guidance document to local agencies, San Diego County (2023) offers recommendations for utilizing RAP aggregates in MS, SS, and CS mixes. The County highlights the potential depletion of local aggregate reserves by 2030. Currently, 30 percent of its aggregate demand is met through imports, significantly increasing aggregate costs and thereby construction costs. Utilizing RAP in STs produces high quality mixes that meet the required specifications, reduces the demand for new virgin aggregates, and is a cost effective and sustainable solution. Other benefits are higher early aggregate retention, increased compatibility with catatonic emulsions, and a deeper black color which allows for superior pavement delineation.

A study funded by FHWA documented case studies from multiple agencies (Los Angeles County (LAC) California, San Bernardino County (SBC) California, New Mexico Department of Transportation (NMDOT)) and service providers on the utilization of RAP in non-HMA STs such as chip seals, slurry seals, and microsurfaces. The requirements were different for each. One agency reported that SS sealing and MS with 100 percent RAP aggregates had similar performance characteristics to virgin aggregates. The same was reported for CS application rates and construction techniques. RAP SS were reported to benefit from pneumatic-tire roller passes. Other benefits of RAP aggregates were enhanced bonding with the applied binder, darker more uniform surface color, prolonged resistance to oxidation, less chip loss, smoother surface texture, and reduced aggregate costs by 30 percent (Duncan et al. 2020).

Michigan State University researched the use of RAP aggregates in MS and CS mixes for local roadway applications in Ohio. They conducted surveys and interviews with contractors and agencies to gain information on the use of RAP aggregates in STs. They also performed several laboratory tests based on the American Association of State Highway and Transportation Officials (AASHTO) standards, such as bulk density and voids, sieve analysis, specific gravity and water absorption test, abrasion test, sand equivalent test, test for aggregate durability index and others. It was concluded that the use of RAP aggregates in MS and CS mixes is feasible. Testing of RAP sources is necessary to verify whether they satisfy mix design criteria for each specific application (Durrani 2021). Another study conducted multiple tests such as mix time test, cohesion test, consistency test, wet stripping test, wet track abrasion test (WTAT), and classification compatibility test, to evaluate the performance of SS with 100 percent RAP aggregates and virgin aggregates. The results showed that SS with 100 percent RAP performed similarly or better than SS with virgin aggregates (Ye 2021).

Saghafi et al. (2019) studied SS with RAP and virgin aggregates containing cement and hydrated lime as fillers. The authors used WTAT and loaded wheel test (LWT) to evaluate the performance of the mixtures. Cohesion and friction tests were also performed. The results showed that RAP is a good candidate for SS with better overall performance at lower costs (up to 14 percent) than the virgin SS.

c. Research need by NDOT: RAP is generated by removing and/or reprocessing AC pavement materials. Once crushed and screened, RAP provides high-quality and well-graded aggregates coated by asphalt cement. This recycling method is both economical and eco-friendly, reducing greenhouse gas emissions and landfill waste while conserving other natural resources. Moreover, recycled asphalt materials improve durability and longevity. Thus, the research proposes a sustainable maintenance approach for AC pavements in the state of Nevada aligning with national efforts to reduce the carbon footprint of road construction.

The RAP behaves similarly to black rock in the non-reheated HMA environment, allowing for using black-colored aggregates suitable for ST, as long as the scalped gradation on the ⅜” screen meets the specifications for type 3 MS and SS (Appendix B). The key question is whether all the RAP piles could provide a gradation that results in 100% RAP, thereby eliminating the need to blend with virgin aggregates. While blending virgin with RAP might not be practical in the field, it could be managed at a central plant. Therefore, it would be sound to evaluate local RAP stockpiles for their gradation and mix designs to assess abrasion compared to virgin aggregates.

In the hot deserts of Nevada, another important consideration is the potential melting and clumping of RAP piles. This issue is well-documented in the use of RAP stockpiles for HMA production in southern Nevada. However, it does not affect the 15% RAP used in HMA production, as it undergoes heating and mixing. On the other hand, for ST, the surface of the RAP pile exposed to the sun, whether on the ground or in the slurry truck, can reach temperatures between 160 and 180 degrees Fahrenheit. These temperatures are high enough to cause the binder to flow and the fine materials to clump together, as reflected in on the pavement temperature. Covering the stockpile with a tent can mitigate this issue. However, according to the NDOT specification, ST cannot be placed when surface temperatures exceed 140 degrees Fahrenheit. Therefore, it is necessary to determine

the ambient temperature in the shade to ensure compliance and optimal material performance. The Regional Transportation Commission of Southern Nevada (RTCSN) has set a maximum ambient temperature of 105 degrees Fahrenheit, but this must be verified to prevent any potential clumping issues. Another aspect is the long-term desert temperature for the life of the product, which for slurry is six to seven years. This may cause more degradation due to the oxidation of the new binder on the oxidized RAP aggregate. To ensure minimal impact, conducting a long-term heating study comparing RAP slurry with virgin material is essential.

5. PROPOSED RESEARCH: The overall objective of the research is to develop procedures for effective use of RAP materials from Nevada as aggregates for STs, RAP material selection, mixture design, and quality assurance, and immediate implementation of the results in STs for AC pavements throughout Nevada. The research team will utilize existing NDOT test methods for testing RAP and may develop new tests if deemed necessary. The team will concentrate on three particular surface treatments CS, type 3 SS, and type 3 MS, excluding sand or emulsion surface treatments that would not qualify for the study. Additionally, the team will evaluate the performance and durability of surface treatments containing RAP materials by conducting a comprehensive literature review and laboratory testing, the most suitable ST type of SS and MS, and the application rate for the optimal use of RAP in CS. The literature reviewed by NDOT and presented in the research problem statement gives a clear indication of a favorable use of RAP with improved reduction of abrasion.

Prior to beginning the main portion of the research testing, the research team will investigate the long-term durability of oxidized materials like RAP due to excessive climate temperatures. Specifically, the team will review the current literature for studies that have utilized long-term oven aging of samples to simulate a lifespan over four years. The objective of this task is to determine if the degradation of the mix exceeds that of virgin materials in a statistically significant manner. This will be the primary objective before testing the MS, SS, and CS mixture design. This is followed by actual long term oven cure and wet track testing to check the RAP mixture versus the virgin mixture. The findings of this research will provide valuable insights and recommendations for transportation agencies and pavement engineers in Nevada and other regions with similar geological and climatic conditions. Ultimately, the goal is to promote the cost-effective and sustainable use of RAP materials in surface treatments, thereby extending the service life of AC pavements and reducing the need for 100% virgin aggregates, which would thereby have an environmental benefit for the reduction of greenhouse gases.

a. Technical objectives and task descriptions: The following are objectives and key activities for the duration of the research study. Task 0 applies to all objectives.

Task 0. Carry out project management and administrative activities during the course of the project.

Objective 1: Develop and conduct laboratory test methods for the evaluation of RAP materials as aggregates for STs of AC pavements, using locally available sources from each of the three NDOT districts. As noted above, the team will utilize established NDOT test methods and ISSA procedures for testing RAP and may develop new tests if deemed necessary.

Task 1. Literature review: Conduct a comprehensive literature review to enhance understanding of various factors that affect the impact of using RAP in MS, SS, and CS. The review will focus on reports, white papers, and scientific publications specifically related to STs with RAP aggregates. The main focus will be state-of-the-art practices, including historical specifications of reports prepared by the other state departments of transportation and counties, manuals of practice, and case studies (published and unpublished), information regarding MS/SS/CS characteristics of using RAP over time and research studies on the performance of the use of RAP.

The literature search may involve the use of the following sources: Transport Research International Documentation (TRID), Transportation Research Information Service (TRIS) Database, The International Transport Forum (ITF) at the Organization for Economic Co-operation and Development (OECD) Library, Organization for Economic Co-operation and Development's (OECD) Joint Transport

Research Centre's International Transport Research Documentation (ITRD) Database, Federal Highway Administration, State Departments of Transportation, National Highway Institute, Surface treatment industry groups: International Slurry Seal Association (ISSA), Roadresource.org, Pavement Preservation and Recycling Alliance (PPRA), Asphalt Recycling and Reclaiming Association (ARRA), Asphalt Emulsion Manufacturers Association (AEMA), and the University of Nevada, Las Vegas (UNLV) Library Search. Deliverable: Literature review progress note.

Task 2. Information Gathering and Interviews: Develop an online survey (which includes questions with validated scales as well as interview questions) and obtain Institutional Review Board (IRB) approvals at UNLV. Complete researcher education training for team members who have not yet completed the required training by UNLV IRB. The anticipated participants in the online survey and interviews are surface treatment contractors involved with RAP used in MS, SS, and CS; mix design test laboratories, and agencies that would help to identify best practices and challenges in laboratory and field performances of the RAP ST mixtures. The team anticipates gathering information to identify relevant differences in specifications and determine if these differences have impacted the treatments' performance. Deliverable: Report to summarize results of the analyses of survey responses of operators, contractors, and other participants.

Task 3. Develop the project schedule with milestones. Deliverable: Project schedule submitted to NDOT for approval.

Task 4. Acquire materials from three pits, one per district, and basic processing and emulsion. Pit source approval testing is not required as NDOT approves pits. Deliverable: Aggregate reports from UES to UNLV and NCE.

Task 5. Determine long-term aging of STs with RAP aggregates for performance testing and prediction: For this task, the research team plans to utilize the long-term oven heating experiment to determine if the long-term climate heating on the surface of the AC pavement will impact the emulsion coated RAP in comparison to the virgin aggregate coated with asphalt using the emulsion. NDOT input on approved designs and testing will be obtained. Each Type 3 MS virgin and RAP mix would need a mix design. Then triplicates of the optimum for each. The testing will be in accordance to Table 1. Deliverable: Long term heating feasibility evaluation report of MS type 3 virgin and RAP aggregate.

Table 1. Testing for Long-Term Oven Study

Design **MS**, Type 3	Replicates for Baseline Mixes Each
1	3
Design **MS**, Type 3 with **RAP**	Replicates for **RAP** Mixes Each
1	3

Task 6. MS and SS type 3 work plan: 16 private aggregate sources are listed from NDOT, covering all districts. However, to streamline the testing process and be sensitive to research costs, initially, only one pit and RAP source will be selected per district. However, material will also be obtained from another source per district as directed by NDOT for further testing if desired from NDOT. This task will only focus on testing Type 3 for MS and SS. A comprehensive work plan will be created to meet the project goals and detail the tasks required for completion. The goal is to utilize 100 percent RAP to minimize the use of multiple piles for a specific design.

The initial work plan for MS and SS will encompass (i) one aggregate source per NDOT district; (ii) established NDOT virgin mix designs per district; (iii) analysis of the quality and characteristics of RAP aggregates obtained from the three NDOT districts; and (iv) laboratory testing based on NDOT specifications and ISSA test procedures. For (iii) the process of fractionating each RAP is either equal to or smaller than the Nominal Maximum Aggregate Size of the desired mix as recommended by the National Asphalt Pavement Association (NAPA) (West 2015). For the trials, the laboratory technicians

will manually perform this task to ensure consistent materials for research. Table 2 shows the number of tests for the type 3 MS and SS designs. Deliverable: Report to summarize laboratory testing results and analysis of SS and MS.

Table 2. Testing for MS and SS Type 3

Material Sources	Design **MS** Type 3	Total Mixes for **MS** Design	Design **SS** Type 3	Total Mixes for **SS** Design	Replicates for Baseline Mixes Each	Total Replicate Test Points
3	1	3	1	3	3	18
Material Sources	Design **MS** Type 3 with **RAP**	Total Mixes for **MS** Design	Design **SS** Type 3 with **RAP**	Total Mixes for **SS** Design	Replicates for **RAP** Mixes Each	Total Replicates Test Points
3	1	3	1	3	3	18

Task 7. CS work plan: The chip seal operation is specified in the contract by NDOT, including the application rate. Since there is no laboratory mix design, any issues with the application rate would be adjusted by NDOT in the field, and the final process to be approved by NDOT via a test strip at the proposed application and adjusted depending on performance.

The existing literature indicates that there is no need to adjust the application rate when using the RAP compared to using virgin aggregate. However, from an intuitive perspective, it seems that the uncoated virgin aggregate would absorb the emulsion, whereas the RAP would not. Additionally, the behavior of the emulsion may differ in a "black rock" environment.

Thus, there is a need to assess the impact of reducing surface area absorption of the emulsion in the laboratory and quantify the amount of asphalt cement that is absorbed into aggregate pores after the emulsion breaks in the non-RAP. Specifically, the research team will determine the quantity of retained binder in both the original virgin application and the application with X percent (as determined by the RAP pile) RAP. If the available literature does not provide a suitable method for determining the binder content, the team will employ the use of the wet track abrasion on virgin versus RAP chips embedded in the emulsion. Deliverable: Progress report to summarize laboratory testing results and analysis of CS. Table 3 shows the number of tests for the CS application rate verification.

Table 3. CS Application Rate Laboratory Verification Using Wet Track Abrasion

Design **CS** – One Application Rate for Virgin	Replicates for Baseline Application Each	Tests
1	3	3
Design **CS** with **RAP** – Four Application Rates	Replicates for **RAP** Application Each	Tests
4	3	12

Objective 2: Identify potential issues or limitations with the current RAP aggregate and emulsion sources used in NDOT districts and propose solutions for improvement.

Task 8. Determine the critical climate temperature at which the RAP piles become ineffective and suggest appropriate mitigation measures: The bulk gradation of the RAP sources will be checked for consistency. However, the binder content will not be checked as it does not impact the total binder content. In hot climates, the RAP piles may melt, causing the MS, SS, and CS applications to clump.

Perform an oven heating test of the RAP at a temperature representing surface temperatures in the Spring, Summer, and early Fall. Perform gradations before and after to determine a statistically significant change. Deliverable: Recommendations on RAP material management in hot climates for effective ST.

Objective 3: Develop new testing methods if necessary. The development of new testing will only be required if the existing methods do not fully quantify the value. However, if the mix designs

evaluation yielded some illimitation, it will be noted and be part of the method and NDOT specification 418 for MS (Nevada Department of Transportation 2014).
Task 9. Revise the NDOT specification 408, 418, and 705 (Nevada Department of Transportation 2014). Deliverable: Progress report on NDOT specification (408, 418, and 705) update on testing methods, handling, and testing of RAP aggregates for STs.

Objective 4: Develop test methods for quality assurance (QA) of MS, SS, and CS during construction. This is crucial for ensuring the durability and performance of these pavement treatments. NDOT prefers the use of established test methods, however, in the research process, if new tests are established or deemed necessary, the research team will recommend them.
Task 10. Revise the NDOT specification 408 and 418 to incorporate the RAP QA testing. Deliverable: Progress report on NDOT specification (408 and 418) update the RAP QA testing.

Objective 5: Develop specifications for the material processing and construction of MS, SS, and CS using RAP aggregates. This is critical for successfully implementing MS, SS, and CS using RAP aggregates. However, the research team does not anticipate revising all specifications since RAP is the changing parameter to the existing specifications. The requirements for aggregating RAP involve a scalping sieving process using a 3/8" sieve commonly used in MS, SS, and CS materials, then a gradation on the pile. These requirements include meeting the gradation and moisture content criteria, as required for the overall mixture with the virgin aggregates. Processing the RAP to eliminate harmful substances like clay, silt, and organic matter is essential.
Task 11. Revise NDOT specifications 408 and 418 to incorporate the RAP processing for STs. Deliverable: Report on NDOT specification (408 and 418) update on RAP processing for STs.

Objective 6: Perform a feasibility and economic analysis to understand the potential use of RAP in STs statewide and develop an implementation plan for STs with RAP based on the results of the proposed research. The implementation plan scope is to be directly and immediately deployable by NDOT. The feasibility assessment will examine several key factors. Firstly, it will evaluate the availability and quality of RAP materials across the state. This will involve assessing the quantity of RAP available from existing pavements and the potential for future RAP generation. Additionally, the analysis will consider the technical feasibility of incorporating RAP into MS, SS, and CS mixtures, including any potential modifications or adjustments required.

Furthermore, the economic analysis will focus on the cost implications of using RAP in these projects. It will examine the cost of acquiring and processing RAP materials, including transportation, crushing, and screening expenses. Additionally, it will consider any necessary modifications to the existing infrastructure or equipment to accommodate RAP usage. The analysis will also assess the potential cost savings associated with using RAP compared to conventional materials, such as virgin aggregates and asphalt. Additionally, the analysis will consider the potential environmental benefits of using RAP in MS, SS, and CS projects. This will involve evaluating factors such as reduced energy consumption, greenhouse gas emissions, and the conservation of natural resources. The environmental impact will be weighed against the economic costs to determine the overall sustainability of incorporating RAP into these projects.
Task 12. Conduct a feasibility and economic analysis and report its conclusions for the use of RAP in STs in the state of Nevada. Develop an implementation plan for MS, SS, and CS for all NDOT districts. Deliverable: Progress report on economic and feasibility analysis of RAP in STs statewide. Developed implementation plan for MS, SS, and CS statewide.

Objective 7: Produce a final report to include but not limited to test methods and procedures, specifications (materials, mix design, and QA), and implementation plan for all NDOT districts.
Task 13. Prepare draft interim report. Deliverable: Draft interim report submitted to NDOT for review and comments.
Task 14. Address draft interim report review comments and submit final report. Deliverable: Address draft report review comments and submit final report to NDOT.

6. URGENCY AND ANTICIPATED BENEFITS: Many government agencies are prioritizing the reduction of their carbon footprint and are in a position to lead efforts in this area. One way to achieve this is by using RAP in pavement preservation treatments (SS, MS, and CS) which can significantly decrease the environmental impact associated with these treatments. This is essential to the life cycle of pavement, from the acquisition of raw materials to material processing, field processes, use, and end-of-life.

Determining the appropriate amount of RAP to use in STs requires further investigation, especially in Nevada. The main consideration is the aggregate gradation, which needs to be carefully managed, possibly through scalping at the pit crusher, ideally using a #4 sieve or finer. While there is a desire to incorporate more recycled materials into AC pavements, the main obstacle is ensuring the performance is not compromised over time. It is crucial to balance quality and the theoretical reduction of the carbon footprint. Nonetheless, using RAP in STs has been long-awaited, and its need is urgent. Per the literature mentioned in item 4.b., there is a real economic benefit to reducing the use of expensive virgin crushed aggregates for MS and SS. Using the currently available RAP stockpiles, which are a by-product of reclaiming the HMA, directly saves on crushing costs. Additionally, the reduction of emulsion used in ST is reduced when using RAP due to the coated aggregate, further increasing cost savings.

7. IMPLEMENTATION PLAN: The research falls under implementation stage five, known as the "Specification & Standards with Full Corporate Deployment Stage". Task 12 (Objective 6, Section 5) outlines developing an implementation plan for all mixes as part of the proposed research. This plan will detail training and educational needs for NDOT personnel on the proper selection, handling, and application of RAP aggregate. Currently, the contractor manages the RAP portion of the MS and SS projects in Nevada. However, NDOT personnel oversee the application of CS. Therefore, they must understand the RAP stockpile materials thoroughly. The research team can be available for any on-call clarification of the specifications and NDOT's assessment of results.

8. PROJECT SCHEDULE (not included in the page limit): Table 4 summarizes the proposed schedule for key tasks for the duration of the research project and their anticipated deliverables. The schedule mirrors the aforementioned tasks in section 5 (Proposed Research).

Table 4. Tasks, Project Schedule and Deliverables

Task	From	To	Deliverable(s)
0	10/01/2024	09/30/2026	Project management and administrative activities.
1	10/01/2024	12/31/2024	Literature review progress note.
2	10/01/2024	03/31/2025	Report to summarize results of the analyses of survey responses of operators, contractors, and other participants.
3	03/01/2025	04/30/2025	Project schedule submitted to NDOT for approval.
4	05/01/2025	05/31/2025	Aggregate reports from UES to UNLV and NCE.
5	06/01/2025	07/31/2025	Long term heating feasibility evaluation report of MS type 3 virgin and RAP aggregate.
6	05/01/2025	04/30/2026	Report to summarize laboratory testing results and analysis of SS and MS.
7	01/01/2026	04/30/2026	Report to summarize laboratory testing results and analysis of CS.
8	05/01/2026	04/30/2026	Recommendations on RAP material management in hot climates for effective ST.
9	05/01/2026	05/31/2026	Progress report on NDOT specification (408, 418, and 705) update on testing methods, handling, and testing of RAP aggregates for STs.

10	05/01/2026	05/31/2026	Progress report on NDOT specification (408 and 418) update the RAP QA testing.
11	06/01/2026	06/30/2026	Report on NDOT specification (408 and 418) update on RAP processing for STs.
12	05/01/2026	06/30/2026	Progress report on economic and feasibility analysis of RAP in STs statewide. Developed implementation plan for MS, SS, and CS statewide.
13	01/01/2026	08/31/2026	Draft interim report submitted to NDOT for review and comments.
14	09/01/2026	09/30/2026	Address draft report review comments and submit final report to NDOT.

9. FACILITIES AND EXPERTISE:

a. Facilities: The UES Las Vegas laboratory is accredited by the AASHTO Accreditation Program for several material scopes, including Asphalt Mixture and Aggregate. Currently, the laboratory staff has more than ten certified technicians, who will be available to participate in proposed testing activities as needed. The facility spans approximately 6,000 square feet, which provides sufficient space for physically separate areas for each scope of testing.

It is planned that any new equipment required for the proposed testing will be permanently installed in the designated Asphalt Mixture testing area. All the testing equipment is available to perform the tests related to the project except the one listed in Appendix C. The team has secured internal funds, not included in the budget of this proposal, for the acquisition of the equipment. After the completion of the project, the equipment will be the property of the team. Additionally, the lead time for the purchase of the equipment and training will not interfere with the progress of the project.

b. Expertise: Moses Karakouzian, Ph.D., P.E., is a Professor of Civil Engineering at the University of Nevada, Las Vegas (UNLV). In this position, Dr. Karakouzian leads research programs and teaches and develops undergraduate and graduate courses. He has conducted research in pavement materials (asphalt and concrete), soil mechanics, geotechnical engineering and foundations, geology, tectonics, statistics, systems, chemistry, and environmental science at UNLV totaling over $ 4 Million from 1988 through the present. He has collaborated with researchers in other disciplines such as geology, chemistry, statistics, and environmental engineering. Sponsors of his research include the U.S. Department of Energy (DoE), U.S. Department of Defense (DoD), NDOT, Clark County Comprehensive Planning Office, and the Nuclear Waste Project Office of the State of Nevada.

Juliana Byzyka, Ph.D., is an Assistant Research Engineer at the Transportation Research Center (TRC) at UNLV. She has over 10 years of experience in teaching, research, and the civil engineering industry. She conducts collaborative research with international institutions (e.g., Aston University, UK, and Mutah University, Jordan) to advance road materials and sustainability in construction and her research has been supported by public- and private-sector organizations. Since 2023, in collaboration with TRC at UNLV she has expanded her research portfolio to surface transportation. Her research work on MS (refer to research publications in the resume), HMA, and HMA repairs is relevant to this project and will support the project's laboratory testing and analysis. **Dr. Karakouzian and Dr. Byzyka** will both support the overall technical, administrative, and management activities on the project and coordinate activities with external partners and collaborators.

Sam Palmer, P.E., is a dedicated Code Official and Engineer with over 36 years of experience in the building industry. He is knowledgeable in the overall development and construction processes including building and fire code development, interpretations, and ordinances; design; plan review; zoning, engineering; code and special inspections; code enforcement; and public works. Mr. Palmer is experienced in managing engineering and business operations in both the public and private sectors. He has an excellent reputation for resolving complex and challenging projects within the parameters of the codes, regulations, and standards while ensuring life-safety requirements. He has

successfully managed staffs of over 400 engineers, inspectors, and administrative personnel with annual budgets exceeding $45 million.

Forest Grayson has over seven years of laboratory experience with the UES team. Forest's primary duties and responsibilities include supervising, coordinating, performing construction materials and geotechnical laboratory testing, and maintaining quality systems and accreditations for the Las Vegas laboratory. He also oversees mobilization of start-up labs with regional stakeholders, including procurement of equipment, facility build-out, and initial accreditation. Forest manages regional lab assets and consults with office management on operating and capital expenditures, directs the development and implementation of operations and quality-focused digital systems, and serves as a technical and staff liaison to the branch-level and divisional-level leaders to assist in training, mentorship, and other employee-focused efforts. His knowledge and experience make him a valuable team member and strong resource.

John Sloan has over 17 years of experience as a Geotechnical/Environmental Laboratory Supervisor. Mr. Sloan's primary duties and responsibilities include supervising and coordinating all lab testing, verifying that lab data meet quality control standards, performing concrete and masonry lab testing, managing projects and communicating with clients, and training personnel in the standards set by the Cement and Concrete Reference Library (CCRL). Given his knowledge and experience in chemical testing, he is also responsible for the setup and certification of soil chemical testing by the Clark County Public Works Association. **Mr. Palmer, Mr. Grayson, and Mr. Sloan** will have a essential role in mix design, laboratory testing. They plan to collaborate with **Ms. Jan Dunning**, an SS materials specialist, to train their technical personnel in this type of material.

Jeff Stempihar, Ph.D., P.E., has over 19 years of experience focusing on engineering and applied research of asphalt and concrete pavements. His experience includes pavement evaluation and design, material selection, use of recycled materials, and developing best-practice guidance which is relevant to this research. He has worked on numerous engineering and research projects at the local, state, and national level. Dr. Stempihar previously served as the state materials testing engineer for the Arizona Department of Transportation, a role where he provided materials-related technical support statewide. He is engaged in industry groups to support technology transfer and training efforts for practicing engineers. Jeff has authored numerous technical specifications, test procedures, technical reports, as well as industry publications.

Michael Dunning, Ph.D., P.E., has over 21 years of experience as a Quality Assurance (QA) Supervisor. He possesses specific skills that are relevant to this project. His expertise includes overseeing the Construction Materials section and managing a full laboratory. In addition to providing recommendations for STs such as SS, scrub seals, sand seals, and ultrathin asphalt concrete surfaces (UTACS), he collaborated with industry representatives to revise the MS/SS specification for the Regional Transportation Commission (RTC) of Southern Nevada. Dr. Dunning was responsible for conducting quality checks on mix designs and aggregate materials, as well as performing field QA inspections on behalf of the county. Furthermore, he successfully implemented a field verification test that proved effective in assessing the quality of the field application and generating valuable insights. **Dr. Stempihar and Dr. Dunning's** expertise will support this research on specifications and implementation plans. Resumes of the research team are included in Appendix D.

The research team will work collaboratively to produce a final report. The team has also started forming an Advisory Board for the project. Appendix E shows a copy of the letter of invitation to the board and the names of industry experts who have already agreed to serve on the board.

10. BUDGET (not included in the page limit):

The budget for the proposed research is shown below. A budget justification is included in Appendix A.

Attachment D

Standard Budget Itemization for Department Research Projects

Project Title: Design of Surface Treatments with Reclaimed Asphalt Pavement Aggregates in Nevada

Project Duration: 10/01/2024 to 09/30/2026

Name and/or Position[1]	Salary (Monthly or Hourly)	Wage	Fringe Benefit	Total Year 1
Moses Karakouzian, PI	$ 20,436.00	$ 20,436	$ 6,826	$ 27,262
Juliana Byzyka, Senior Personnel	$ 9,146.50	$ 36,586	$ 12,220	$ 48,806
Program Coordinator	$ 4,995.00	$ 4,995	$ 1,668	$ 6,663
				$ -
				$ -
Year 1 Total		**$ 62,017**	**$ 20,714**	**$ 82,731**

Name and/or Position[1]	Salary (Monthly or Hourly)	Wage	Fringe Benefit	Total Year 2
Moses Karakouzian, PI	$ 21,049.08	$ 21,049	$ 7,030	$ 28,079
Juliana Byzyka, Senior Personnel	$ 9,420.90	$ 37,684	$ 12,586	$ 50,270
Program Coordinator	$ 5,144.85	$ 5,145	$ 1,718	$ 6,863
				$ -
				$ -
Year 2 Total		**$ 63,878**	**$ 21,335**	**$ 85,213**

Name and/or Position[1]	Salary (Monthly or Hourly)	Wage	Fringe Benefit	Total Year 3
				$ -
				$ -
				$ -
				$ -
				$ -
Year 3 Total		**$ -**	**$ -**	**$ -**

Name and/or Position[1]	Salary (Monthly or Hourly)	Wage	Fringe Benefit	Total Year 3
				$ -
				$ -
				$ -
				$ -
				$ -
Year 4 Total		**$ -**	**$ -**	**$ -**

		Year 1	Year 2	Year 3	Year 4
A. Personnel		$ 82,731	$ 85,213	$ -	$ -
B. Travel[2]		$ 1,000	$ 1,076		
C. Operating Costs					
D. Final Report Preparation and Submission					
E. Equipment					
F. Other Costs		$ 1,000	$ 1,000		
G. Subcontract (1st $25,000 w/Indirect Cost)		$ 50,000			
H. Subtotal of Direct Costs (sum of A thru G)		$ 134,731	$ 87,289	$ -	$ -
I. Total Indirect Cost (% at current rate)	10%	$ 13,473	$ 8,729	$ -	$ -
J. Student Tuition and Fees (if applicable)					
K. Subcontract (w/o Indirect Cost)		$ 59,893	$ 113,839		
L. TOTAL PROJECT COSTS PER YEAR (sum of H thru K)		**$ 208,096**	**$ 209,856**	**$ -**	**$ -**
TOTAL PROJECT COST[3]			**$**		**417,952**

Notes:

(1) Categories can be added and, with the exception of personnel and fringe, removed as best fits the proposed research.

(2) Department only pays for travel that is essential for the completion of the project and at costs per GSA rates and Department policies. Travel costs to professional and other meetings are not allowed. Travel outside of Nevada requires written Department approval in advance.

(3) The budget will be tracked according to the categories identified herein. Invoicing is expected to match, within reason, these categories for accurate budget tracking.

11. NDOT CHAMPION, COORDINATION AND INVOLVEMENT:

The team will work closely with Mrs. Anita Bush and Dr. Charlie Pan, NDOT champions of the project. The team will provide the champions via email or online meetings with periodic updates on the progress of the project. The team will solicit advice from the champions when interim results necessitate adjustments to the direction of the project. For the feasibility and economic analysis, the research team needs NDOT's assistance in identifying costs of past projects and materials.

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Duncan, G.M., Sibaja, L.V., Seeds, S.B. and Peshkin, D.G. (2020). *Using Reclaimed Asphalt Pavement in Pavement-Preservation Treatments*. Report No. FHWA-HRT-21-007. United States. Federal Highway Administration. Office of Infrastructure.

Durrani, A. (2021). *Analysis of Reclaimed Asphalt Pavement (RAP) Proposed for Use as Aggregate in Microsurfacing and Chip Seal Mixes for Local Roadways Applications in Ohio.* (Master's thesis, Ohio University).

Federal Highway Administration. (2020). *Asphalt Pavement Recycling with Reclaimed Asphalt Pavement (RAP)* [online]. Available from: https://www.fhwa.dot.gov/pavement/recycling/rap/ (Accessed 17 June 2024).

Nevada Department of Transportation. (2014). *Standard Specifications, Standard Plans, and Design Guides. Standard Specifications. 2014 Standard Specifications for Road and Bridge Construction* [online]. Available from: https://www.dot.nv.gov/doing-business/public-involvement-information/transportation-planning/standard-specifications-and-plans (Accessed 17 June 2024).

Saghafi, M., Tabatabaee, N. and Nazarian, S. (2019). *Performance evaluation of slurry seals containing reclaimed asphalt pavement*. Transportation Research Record, 2673(1), pp.358-368.

San Diego County. (2023). *Guidance Document R-3. RAP Use in Pavement Preservation Treatments*.

West, R.C. (2015). *Best practices for RAP and RAS management* (No. QIP 129).

Ye, H. (2021). *Innovative Evaluation of Recycled Asphalt Pavement (RAP) Use in Slurry Seal Applications*. Michigan State University. (Master's thesis, Michigan State University).

SECTION II: APPENDICES

Appendix A: Budget Justification
Design of Surface Treatments with Reclaimed Asphalt Pavement Aggregates in Nevada
Nevada DoT

A. SENIOR PERSONNEL

Dr. Moses Karakouzian – PI, Professor, Civil and Environmental Engineering and Construction: Based on a 9-month contract of $183,924, we request one summer month's salary per year for a total request of $41,486. A 3% cost of living allowance (COLA) is added in year 2. This is in accordance with budgeting practices at UNLV. Dr. Karakouzian will be the Principal Investigator (PI) at UNLV. He will lead the administrative and management activities on the project, and coordinate activities with external partners and collaborators. His technical efforts will focus on analyses, work plan development, and reporting, support the needs analysis, coordinate efforts to testing, and prepare progress notes, reports, presentations, and other documents to disseminate efforts in the project and their outcomes.

Dr. Juliana Byzyka – Senior Personnel, Civil and Environmental Engineering and Construction + Transportation Research Center: We request four (4) calendar months per year based on a year 1 salary of $109,757. This amounts to a total request of $74,269. A 3% COLA is added in year 2. Dr. Byzyka will support Dr. Karakouzian in all his activities for the project.

The total salary requested for senior personnel is $115,755.

B. OTHER PERSONNEL

TBD – Program Coordinator: We request one calendar month per year based on a year 1 salary of $59,940. This amounts to a total request of $10,140. A 3% COLA is added in year 2. The program coordinator will support administrative duties.

The total salary requested for other personnel is $10,140.

C. FRINGE BENEFIT RATES

UNLV has federally approved pooled fringe benefit rates that are specifically identified to each employee and charged as direct costs. FY25 fringe benefit rates are pending review by CAS and rates may be adjusted per approval. FY25 proposed rates for Faculty/Professional Staff (including Postdoctoral Scholars) is 33.4%. For detailed fringe benefit rate information please access url: https://www.unlv.edu/controller/fringe-pool-rates

The total fringe benefit cost requested for senior and other personnel is $42,049.

D. TRAVEL

Funds are requested for the PI and senior personnel to travel to Carson City and/or Reno, NV to meet with members of the project team for exchange of ideas and chart project progress relating to the research being proposed and the Client if necessary. The cost of travel is calculated for 2 days and includes airfare, lodging, per diem, and ground transportation. The cost of airfare and ground transportation is estimated. Hotel and meal costs are based on GSA lodging and per diem rates.

Table 1 Travel to Carson City, NV

Cost category: 2 persons	Rate	Year 1
Airfare	$200/person/trip	$400
Lodging (1 night)	$107/night	$214
Meals & incidental expenses (2 days)	$59/day	$236
Ground transportation	$75/person/trip	$150
Total		$1,000

Table 2 Travel to Reno, NV

Cost category: 2 persons	Rate	Year 2
Airfare	$200/person/trip	$400
Lodging (1 night)	$125/night	$250
Meals & incidental expenses (2 days)	$69/day	$276
Ground transportation	$75/person/trip	$150
Total		$1,000

The total amount requested for travel is $2,076.

E. Other Direct Costs

Subawards: We request a total of $223,730 for the contracted services of two companies as follows:

- Universal Engineering Services (UES): $147,675
- Nichols Engineering Consulting (NCE): $76,055

Other: Advisory Board Travel: We request $1,000 per year to cover the cost of any necessary travel to members of the Advisory Board for meetings.

The total amount requested for other direct costs is $225,730.

F. Indirect Costs

UNLV F&A cost is calculated using a predetermined rate as stipulated by DHHS Rate Agreement dated 08/29/2023. However, the Nevada DoT has capped the indirect cost rate at 10% for this project.

The total amount requested for indirect costs is $22,202.

G. Total Direct and Indirect Costs (Budget Summary)

Total Requested Direct Costs	= $395,750
Modified Total Direct Costs, MTDC	= $222,020
Total Requested Award Project Costs	**= $417,952**

Appendix B: Aggregate Gradation for SS and MS

Sieve Size	Type I Percent Passing	Type II Percent Passing	Type III Percent Passing	Stockpile Tolerance from the Mix Design Gradation
3/8 (9.5 mm)	100	100	100	
# 4 (4.75 mm)	100	90 – 100	70 - 90	± 5%
# 8 (2.36 mm)	90 – 100	65 – 90	45 – 70	± 5%
# 16 (1.18 mm)	65 – 90	45 – 70	28 – 50	± 5%
# 30 (600 um)	40 – 65	30 – 50	19 – 34	± 5%
# 50 (300 um)	25 – 42	18 – 30	12 – 25	± 4%
# 100 (150 um)	15 – 30	10 – 21	7 – 18	± 3%
# 200 (75 um)	10 – 20	5 - 15	5 - 15	± 2%

Appendix C: List of Laboratory Equipment

As stated in section 9a, the team has secured internal funds, not included in the budget of this proposal, for the acquisition of the equipment shown below. After the completion of the project, the equipment will be the property of the team.

- Benedict Cohesion Tester
- Loaded Wheel Tester
- Pneumatic Pill Press
- Schulze-Breuer Test Machine
- Wet Track Abrasion Test Assembly
- Benedict Sweep Test Assembly

Appendix D: Resumes

MOSES KARAKOUZIAN, Ph.D., P.E.
Professor of Civil Engineering
University of Nevada, Las Vegas, Las Vegas, NV 89154-4007
Mobile: 702-895-0959; E-mail: mkar@unlv.nevada.edu

EDUCATION & PROFESSIONAL LICENSURE

Ph.D. Civil Engineering, The Ohio State University. 1978
M.B.A. Business Administration, The Ohio State University. 1975.
M.S. Civil Engineering, The Ohio State University, 1973.
B.C.E. Civil Engineering, The American University of Beirut, 1971.
Licensed Professional Civil Engineer, State of Nevada (License Number 010475)

Dr. Karakouzian is a **Professor of Civil Engineering** at the University of Nevada, Las Vegas (UNLV). He has conducted **research at UNLV totaling over $ 4 Million** from 1988 through the present. The research utilizes methods, procedures, and data from his focus area of **soil mechanics** and other diverse disciplines including **geology, tectonics, statistics, systems, chemistry, and environmental science**. The research has applications in diverse fields of engineering including geotechnical, petroleum, environmental, transportation, and earthquake engineering. He has collaborated with researchers in geology, chemistry, statistics, and environmental engineering. Sponsors of his research include the **U.S. Department of Energy (DOE), U.S. Department of Defense (DoD), NDOT, Clark County Comprehensive Planning Office, and the Nuclear Waste Project Office of the State of Nevada**.

Key experiences include:

1. ***Univ. of Nevada, Las Vegas, Dept. of Civil & Environmental Engineering & Construction. Professor, Civil Engineering.*** (1996 to date).

Associate Professor, Civil Engineering. (1988 to 1996).

- Responsibility and leadership in research programs development, undergraduate and graduate teaching, undergraduate and graduate curricula development, and undergraduate and graduate student advisement in the following three major geotechnical engineering areas: soil mechanics and foundations engineering; rock mechanics; and highway and construction materials.

2. ***Battelle Project Management Division. Columbus, Ohio. Project Manager and Senior Geotechnical Engineer.*** (1982 to 1988).
   - Responsible for the conception, development, management, and integration of results of geo-engineering and related interdisciplinary research and development projects in support of the mined geologic disposal and isolation of high–level nuclear waste program sponsored by the U.S. DOE.
3. ***Battelle Columbus Laboratories. Columbus, Ohio. Principal Research Scientist.*** (1979 to 1982).
   - Responsible for marketing, program development, client contact, responding to requests for proposals (RFPs), personnel management, laboratory testing, data analysis, and report preparation.
4. ***The Ohio State University. Columbus, Ohio. Research Associate.*** (1972 to 1979).
   - Responsible for conducting research in civil engineering and construction materials, supervising graduate students in testing, data analysis, and report writing.
5. ***Other Professional Experience:***
   - Part-time Design Engineering Work with A&E Consulting Firms (Franklin Consultants, Inc.; Rackoff Engineers; and Columbus Bin Company) all in Columbus, Ohio (1975-1978).

Awards:

- **Two-time recipient of the UNLV College of Engineering Distinguished Research Award (1998 and 2004).**
- Awarded "**2018 UNLV Professor of the Year**" by Tau Beta Pi, Honorary Engineering Fraternity.
- Two-time recipient of the UNLV College of Engineering Distinguished Teaching Award (1991 and 1999).
- Five-time recipient of the UNLV Department of Civil and Environmental Engineering **Outstanding Teacher Award,** (1991, 1994, 2004, 2005 and 2009).
- American Society for Testing Materials (ASTM) Award for Outstanding Article on the Practice of Geotechnical Testing, (awarded in 1998) for the paper by Karakouzian et. al., "Measurements of Soluble Salt Content of Soils from Arid and Semi-Arid Regions", Geotechnical Testing Journal, American Society for Testing Materials, ASTM, GTJODJ, Vol. 19, No. 4, December 1996, pp. 364-372
- UNLV Foundation **Outstanding Graduate Faculty Award** (1996).
- CSUN Student Government **Faculty Excellence Award**, Engineering (1993)
- **Professor Worthy of Recognition** at the UNLV Alumni Association Recognition Luncheon (Roy Johnson, 1991; Tony May, 1993; and Daniel W. Muirhead, 1994).

Research and Academic Accomplishments

- 150+ Peer Reviewed Articles Publications
- Presentations in several reviewed conferences
- Conducted several multi-year funded research projects with a total budget of $ 4 Million
- Graduated 25 PhD and over 30 Masters students
- Currently, advise 3 PhD and 2 Masters students

Illustrative Publications: Asphalt Related

1. Jadidi, Kazem and Khalili, Mehdi and **Karakouzian, Moses**, (2021), Feasibility of Using Non-Destructive Ultrasound Measurement Technique to Evaluate Binder Content of Asphalt Mixtures, CivilEng, 2(2), pp. 396--405.
2. Jadidi, Kazem and Esmaeili, Morteza and Kalantari, Mehdi and Khalili, Mehdi and **Karakouzian, Moses**, (2021) A Review of Different Aspects of Applying Asphalt and Bituminous Mixes under a Railway Track, Materials, 14(1).
3. Khalili, M., Jadidi, **K., Karakouzian**, M., & Amirkhanian, S. (2019). Rheological properties of modified crumb rubber asphalt binder and selecting the best modified binder using AHP method. Case Studies in Construction Materials, 11, e00276.
4. Jadidi, K., Khalili, **M., Karakouzian**, M., & Amirkhanian, S. (2019). Toughness, Tenacity and Maximum Initial Strength of Rubber Modified Asphalt Binders. Engineering, Technology and Applied Science Research, 9(1), 3765.
5. Khalili, M. and **Karakouzian, M.** (2015), "Feasibility of Ultrasonic Measurements for Characterizing Rheological Properties of Asphalt Binders", Construction and Building Materials, Vol. 75, pp. 220-226.
6. Xiao, F., Amirkhanian, S., **Karakouzian, M.** and Khalili, M. (2015) "Rheology Evaluations of WMA Binders Using Ultraviolet and PAV Aging Procedures," Construction and Building Materials, Vol. 79, pp. 56-64.
7. Michael R. Dunning, **Moses Karakouzian**, Robert L. Dunning, "Feasibility for the Use of Non-contact Ultrasound for Application in Asphalt Concrete Materials", Journal of the Association of Asphalt Paving Technologists (AAPT), Volume 76, 2007, pp. 851-886.
8. **Karakouzian, M**., Dunning, R. L., Dunning, M. R., and Jerold Stegeman, "Performance of Hot Mix Asphalt Utilizing Coarse and Skip Graded Aggregates," American Society of Civil Engineers, Journal of Materials in Civil Engineering, Vol. 8, No. 2, May 1996, pp. 101-107.
9. **Karakouzian, M.** and Majidzadeh, K., "Practical Method for Evaluating Fatigue and Fracture Toughness of Paving Materials," Association of Asphalt Paving Technologists (AAPT), 1978.

10. Majidzadeh, K. and **Karakouzian, M**., "Practical Method for Evaluating Fatigue and Fracture Toughness of Paving Materials," Transportation Research Record, No. 695, 1978, pp. 15-20.

Concrete Related Publications

1. Shirani, Seyed Sajad; Eslami, Abolfazl; Ebrahimipour, Amirhossein; **Karakouzian, Moses** (2024). "Dominant factors in MiniCone, CPT and pile correlations: A data-based approach" Deep Underground Science and Engineering, 2 (4), 346-358
2. Kazem, Masoud; Nazari-Sharabian, Mohammad; Afzalimehr, Hossein; Darban, Nader; and **Karakouzian, Moses** (2023). "The Impact of Operational Scenarios and Concrete Aging Factor on the Freeboard Height of an Irrigation Canal", Engineering, Technology & Applied Science Research", 13 (1), 10199-10203
3. Rezvan, Sina; Moradi, Mohammad Javad; Dabiri, Hamed; Daneshvar, Kambiz; and **Karakouzian, Moses**; Farhangi, Visar (2023). "Application of machine learning to predict the mechanical characteristics of concrete containing recycled plastic-based materials, Applied Sciences, 13 (4), 2033
4. Moein, Mohammad Mohtasham; Saradar, Ashkan; Rahmati, Komeil; Rezakhani, Yousof; Ashkan, Seyed Arash; and **Karakouzian, Moses** (2023). "Reliability analysis and experimental investigation of impact resistance of concrete reinforced with polyolefin fiber in different shapes, lengths, and doses", Journal of Building Engineering, 69, Elsevier
5. Gebremichael, Negasi N; Jadidi, Kazem; and **Karakouzian, Moses** (2023). "Waste glass recycling: The combined effect of particle size and proportion in concrete manufactured with waste recycled glass", Construction and Building Materials, 392, 132044, Elsevier
6. Mohmmad, Sarwar H; Shakor, Pshtiwan; Muhammad, Jaza H; Hasan, Mustafa F; and **Karakouzian, Moses** (2023). "Sustainable alternatives to cement: synthesizing metakaolin-based geopolymer concrete using nano-silica", Construction Materials,3 (3), 276-286
7. Akbarimehr, Davood; Rahai, Alireza; Eslami, Abolfazl; and **Karakouzian, Moses** (2023). "Deformation Characteristics of Rubber Waste Powder-Clay Mixtures", Sustainability,15 (16), 12384
8. Jazaei, Robabeh and **Karakouzian, Moses** and O'Toole, Brendan and Moon, Jaeyun and Gharehdaghi, Samad, (2022), Energy dissipation capacity of cementitious nanocomposite reinforced by hybrid carbon nanotubes, Construction and Building Materials, Vol. 323, https://doi.org/10.1016/j.conbuildmat.2022.126396
9. Mohtasham, M., Mohammad, Saradar, A., Rahmati, K., Shirkouh, A. H., Sadrinejad, I., Aramali, V., and **Karakouzian, M.** (2022). Investigation of Impact Resistance of High-Strength Portland Cement Concrete Containing Steel Fibers. Materials, 15(20), 7157. https://doi.org/10.3390/ma15207157
10. Saidi, H. and Jadidi, K. and **Karakouzian, M**., (2022), Assrssement of Quality of Fresh Concrete Delivered at Varying Temperatures, CivilEng 3 (1), 135-146. https://doi.org/10.3390/civileng3010009
11. **Karakouzian, Moses** and Farhangi, Visar and Farani, Marzieh Ramezani and Joshaghani, Alireza and Zadehmohamad, Mehdi and Ahmadzadeh, Mohammad, (2021), Mechanical characteristics of cement paste in the presence of carbon nanotubes and silica oxide nanoparticles: An experimental study, Materials, 16(6).
12. Borrero, Edgar LS and Farhangi, Visar and Jadidi, Kazem and **Karakouzian, Moses**, (2021), An Experimental Study on Concrete's Durability and Mechanical Characteristics Subjected to Different Curing Regimes, CivilEng, Vol. 7, pp. 676—689.

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EDUCATION

Ph.D. Civil Engineering (Pavement Materials), Brunel University, London, UK. 2019.
M.S. Advanced Engineering Design (Mechanical Eng.), Brunel University, London, UK. 2015.
PG Cert (Master's) Academic Practice, University of Salford, Greater Manchester, UK. 2020.
B.S. Civil Engineering (Highways & Infrastructure), Alexandreio Technological Educational Institute, Thessaloniki, Greece. 2009.

Dr. Byzyka is an **Assistant Research Engineer** at the University of Nevada, Las Vegas. Previously she was a **Lecturer in Civil Engineering** at the University of Salford in the UK. She has 10+ years of experience in **teaching, research,** and the **civil engineering industry**. Her **expertise** is in transportation engineering (**asphalt concrete materials**) and her research has been supported by public- and private-sector organizations. The **Nevada Department of Transportation**, and the **US Department of Transportation's University Transportation Centers Program** are among the sponsors funding the research projects in which she is currently involved at the UNLV Transportation Research Center (TRC).

Key experiences include:

- Led 5 civil engineering courses from 2018 to 2023. Created, delivered, assessed, and provided feedback to 1,500+ undergraduate engineering students.
- Leads cutting-edge basic and applied research from 2015 to date in pavement engineering and from 2015 to 2018 worked toward the development of an automated asphalt repair method. This contribution to the asphalt industry market is of significant economic value and laid the groundwork for the design of more resilient and safer roadways.
- Since 2015, conducts collaborative research with international institutions (e.g., Aston University, UK, and Mutah University, Jordan) to advance road materials and sustainability in construction.
- Since 2023, conducts research in collaboration with TRC at UNLV on transportation operations, safety, shared mobility, equitable mobility, emerging technologies in transportation, and sustainable transportation.

1. ***Univ. of Nevada, Las Vegas, Dept. of Civil & Environmental Engineering & Construction / Transportation Research Center (TRC). Instructor, Civil Engineering & Assistant Research Engineer.*** (April 2023 to date).
   - Teach, support, and guide students; conduct transportation systems related research and development work; provide ongoing research-based input and advice. Prepare proposals, grant applications, and technical and administrative reports.
2. ***Univ. of Salford, Greater Manchester, UK. Lecturer, Civil Engineering, School of Science, Engineering, & Environment.*** (Oct 2018 to May 2022).
   - Formulated comprehensive modules, delivered interactive content, evaluated performance, and provided feedback to undergraduate students undertaking various civil engineering courses; utilized learner-centered and activity-based methodologies to ensure student understanding of all program-related concepts; led research related to pavement engineering and sustainability in construction.
3. ***Brunel University, London, UK. Teaching Assistant, Dept of Civil and Environmental Engr. & Dept of Mechanical and Aerospace Engr.*** (Jan 2016 to Sept 2018).
   - Delivered fundamental and complex content to undergraduate civil and mechanical engineering students; assessed and provided relevant feedback; improved teaching deliveries by facilitating the creation of course curriculum, showing commitment to inclusion and diversity, partnering

- with various university personnel, and promoting the importance of professionalism, effective communication, and the application of skills during real-time technical situations.

4. ***Ch2M Hill, London, UK***. ***Civil Engineer, Highways Team*****.** (Sept to Dec 2015).
   - Utilized expertise in technical reporting to outline construction strategies and project specifications, draft drawings, and bill of quantities as well as prepare other documents that ensure smooth execution of civil engineering projects such as the West Sussex and A14 Cambridge Huntingdon Improvement Scheme and the construction of a parking lot at Gatwick Airport in London, UK.
5. ***Edil Hellas Group of Companies, Thessaloniki, Greece***. ***Civil Engineer and Designer.*** (Jan 2010 to March 2014).
   - Designed, developed, and maintained the entire design process –from the feasibility research phase to the construction drawing phase– for a collection of telecommunication development projects for various networking companies including Cosmote, Vodafone, Wind, and Huawei proposed.

Professional organization affiliations / leadership roles:

- Coatings Journal, MDPI (2024 to date): Guest Editor
- Applied Sciences Journal, MDPI (2023 to date): Guest Editor
- Standing Committee on Pavement Maintenance – AKT30 (2024 to date): Member
- ASTM International (2022 to 2024): Participating Member
- American Society of Civil Engineers (2022 to date): *Associate Member*
- Institution of Civil Engineers Publishing UK (2021 to date): *Associate Editor*
- Chartered Institution of Highways and Transportation, UK, Fellowship (2020 to 2022): Fellow
- Higher Education Academy, UK, Fellowship (2019 to date): Fellow

Honors, awards, and recognitions:

- **Vice Chancellor's Prize for Doctoral Research Excellence,** Brunel University, London, UK, 2019.
- **Engineering and Physical Sciences Research Council - Doctoral Training Partnership - Studentship Ph.D. Fees Award,** Brunel University, London, UK, 2017 to 2018.
- **Vice-Chancellor Travel Prize**, Attendance to the 10th Annual International Conference on the Bearing Capacity of Roads, Railways, and Airfield, Brunel University, London, UK, 2017.
- ***Best Paper Award*****,** *Thermal segregation of asphalt material in road repair, 8th Conference Maintenance, and Rehabilitation of Pavements*, Singapore, 2016.
- **Woman in Engineering Scholarship,** M.S. Studies, Brunel University, London, UK, 2014 to 2015.
- **Honorary Scholarship,** Top Performing Student, Alexandreio Technological Educational Institute of Thessaloniki, Greece, 2009.
- **Honorary Scholarship,** Third Academic Year, Alexandreio Technological Educational Institute of Thessaloniki, Greece, 2007.

Publications and Presentations

- 15+ Peer Reviewed Articles Publications● 5+ Peer Reviewed Conf. Publications
- 10+ International Conf. Presentations

Illustrative Publications

1. **Byzyka, J.**, Rahman, M., and Al-Kheetan, M. *A Pilot Laboratory Study on Hot Mix* ***Micro surfacing***. 8th International Conference in Bituminous Mixtures and Pavements, Thessaloniki, Greece, June 12-14, 2024.
2. Nambisan, S., **Byzyka, J.**, Islam, K.A., and Chindepalli, S. A Study of Electric Vehicles Ecosystem in Nevada. 2024 Forum for Innovative Sustainable Transportation Systems (FISTS), Riverside, CA, USA, pp. 1-6. 10.1109/FISTS60717.2024.10485587.
3. Albayati, A.H., Al-ani, A.F., **Byzyka, J.**, Al-Kheetan, M. and Rahman, M. *Enhancing Asphalt*

4. *Performance with Nano Calcium Carbonate and Nano Hydrated Lime*, Sustainability, 16(4), 1507. https://doi.org/10.3390/su16041507, 2024.
5. Nabighods, K., Saradar, A., Mohtasham Moein, M., Mirgozar Langaroudi, M. A., **Byzyka, J.**, & Karakouzian, M. *Evaluation of self-compacting concrete containing pozzolan (zeolite, metakaolin & silica fume) and polypropylene fiber against sulfate attacks with different PH: an experimental study*. Innovative Infrastructure Solutions, 9(1), 1. https://doi.org/10.1007/s41062-023-01309-0, 2024.
6. **Byzyka, J.**, Hayden, D., Al-Kheetan, M. and Rahman, M. M. *A study on cold laid **microsurfacing** containing water-based epoxy modified bitumen emulsion*, International Journal of Pavement Research and Technology, https://doi.org/10.1007/s42947-023-00285-z, 2023.
7. **Byzyka, J.**, Rahman, M., Chamberlain, D.A. and Malieva, M. (2023) '*Improving Asphalt Patch Repair Performance through Innovative Heating Technology*', 32nd Annual Fall Transportation Conference. Las Vegas, Nevada, November 1-2.
8. Al Ashaibi, A., Wang, Y., Albayati, A., **Byzyka, J.**, Scholz, M. and Weekes, L. *Thermal Properties of Hydrated Lime-Modified Asphalt Concrete and Modelling Evaluation for Their Effect on the Constructed Pavements in Service*. Sustainability, 7827(14). https://doi.org/10.3390/su14137827. 2022.
9. Al-Kheetan, M., Azim, T., **Byzyka, J.**, Ghaffar, S. H. and Rahman, M. M. *Performance of Magnetite-based Stone Mastic Asphalt (SMA) as a Superior Surface Course Material*, Construction and Building Materials, 332, p.126463, https://doi.org/10.1016/j.conbuildmat.2022.126463. 2022.
10. **Byzyka, J.**, Rahman, M. and Chamberlain, D.A. (2021). A laboratory investigation on thermal properties of virgin and aged asphalt mixture. Construction and Building Materials, 305, p.124757. https://doi.org/10.1016/j.conbuildmat.2021.124757.
11. Al-Kheetan, M. J., Ghaffar, S. H., Awad, S., Chougan, M., **Byzyka, J.**, & Rahman, M. M. (2021). *Microstructural, mechanical and physical assessment of Portland Cement Concrete pavement modified by sodium acetate under various curing conditions*. Infrastructures, 6(8), 113. https://doi.org/10.3390/infrastructures6080113.
12. **Byzyka, J.**, Rahman, M., Chamberlain, D. A. and Malieva, M. (2020), '*Performance enhancement of **asphalt patch repair** with innovative heating strategy*', Proceedings of the Institution of Civil Engineers – Transport (IF 1.099). https://doi.org/10.1680/jtran.19.00007.
13. **Byzyka, J.**, Rahman, M. and Chamberlain, D. A. (2019), '*Thermal analysis of hot mix asphalt pothole repair by **Finite Element Method***', Journal of Transportation Engineering, Part B: Pavements (IF 1.500), 146 (3). https://doi.org/10.1061/JPEODX.0000156.
14. **Byzyka, J.**, Rahman, M. and Chamberlain, D. A. (2018), '*An innovative **asphalt patch repair pre-heating** method using dynamic heating*', Construction and Building Materials Journal (IF 4.419), 188, pp. 178-197. https://doi.org/10.1016/j.conbuildmat.2018.08.086.
15. **Byzyka, J.**, Rahman, M. and Chamberlain, D. A. (2018), '*An **improved interface temperature distribution** in shallow hot mix asphalt patch repair using dynamic heating*', International Journal of Pavement Engineering (IF 2.590). https://doi.org/10.1080/10298436.2018.1559315.
16. **Byzyka, J.**, Chamberlain, D.A. & Rahman, M. (2017) '*Development of advanced **temperature distribution** model in hot - mix asphalt patch repair*', Proceedings of the Institution of Civil Engineers-Transport (IF 1.099), 1-11. https://doi.org/10.1680/jtran.17.00022.
17. **Byzyka, J.**, Rahman, M. and Chamberlain, D. A. (2017) '***Thermal segregation** of asphalt material in road repair*', Journal of Traffic and Transportation Engineering (English Edition) (IF 2.18), 4(4), 360-371. https://doi.org/10.1016/j.jtte.2017.05.008.

SAM PALMER, P.E. CBO/CFM, F.ASCE
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EDUCATION, PROFESSIONAL LICENSURE AND CERTIFICATIONS

MBA Management, University of Nevada, Las Vegas.
B.S. Geological Engineering with a Minor in Environmental Studies, University of Nevada, Reno.
Licensed Professional Civil Engineer, State of Nevada (License Number 7841); State of Utah (License Number 8288); Canada: British Columbia (License Number 154694), Alberta (License Number M94097), Saskatchewan (License Number 15878)
ICC No. 1669: Certified Building Official (CBO); Certified Fire Marshall (CFM); Residential Combination Inspector (Building/Plumbing/Mechanical/Electrical); Reinforced Concrete Special Inspector; Structural Masonry Special Inspector; and Spray-applied Fireproofing Special Inspector
SHRM – Senior HR Certification
ACI No. 0128385, Instructor (Field and Lab Grade I & II/Transportation/Flatwork)

Sam Palmer is a dedicated **Code Official and Engineer** with **over 36 years** of experience in the **building industry**. He is knowledgeable in the overall **development and construction processes** including **building and fire code development**, **interpretations,** and **ordinances**; **design**; **plan review**; **zoning**, **engineering**; **code and special inspections**; **code enforcement**; and **public works**. Sam is experienced in **managing engineering and business operations** in both the public and private sectors. He has an excellent reputation for resolving complex and challenging projects within the parameters of the codes, regulations, and standards, while still ensuring life-safety requirements. He has successfully **managed staff** of over 400 engineers, inspectors, and administrative personnel **with annual budgets exceeding $45 million**. Sam is a long-time, respected professional partner within the Southern Nevada and Nevada development community, especially within the local jurisdictions, engineering, architectural, contractors, developers, and academic sectors. He provides **strong, ethical leadership** with a clear **vision and robust communicative skills**, allows for collaborative problem-solving, and has the ability to effectively manage diverse teams. He was selected by the **International Code Council** as the **2022 Gerald R Jones Code Official of the Year**.

Key experiences include:

1. ***Formula 1 Las Vegas Grand Prix. Las Vegas, NV. Client's Liaison and Quality Assurance/Quality Control Reviewer.***
   - The project involves the construction of an approximately 275,000 SF multi-level garage and paddock club building and a 3.8-mile asphalt paved city circuit racetrack. UES is providing field and lab asphalt testing services for the racetrack, which involves sampling and testing of Hot Mix Asphalt, Cold Feed Aggregates, and Asphalt Binder Cement. Also, UES is providing continuous grading inspections and observations. As the UES Las Vegas Branch Manager, Sam is involved in the periodic review of laboratory test data, field special inspection reports, technical evaluator for earthwork soil stabilization concerns, low compressive strength tests, and asphaltic concrete smoothness testing. As the CCBD Assistant Director, Sam provided general oversight of the permitting, plans check, interface with all government and private agencies, and in particular, the project inspection from the AHJ perspective.
2. ***Las Vegas Allegiant Stadium. Clark County, NV. Clark County Building Department (CCBD) Assistant Director.***
   - In this position Sam provided general oversight of the permitting, plans check, and in particular the inspection of the project from the Authority Having Jurisdiction (AHJ) perspective. The

- CCBD staff included multiple permitting technicians, plan check engineers, and plan reviewers, along with special inspectors and code inspectors. CCBD also oversaw the special inspections program for the project. The Allegiant stadium is a state-of-the-art venue with a seating capacity of 65,000 and is home to the Las Vegas Raiders NFL team. The stadium includes a sliding field tray with natural grass along with movable lanai doors, a translucent roof, and a 3D-printed memorial torch. Mortenson-McCarthy was the construction joint venture, and the total construction cost was approximately $1.9 billion dollars.

3. ***Las Vegas Allegiant Ball Park. Clark County, NV. Clark County Building Department (CCBD) Assistant Director.***
   - This project included the construction of a 412,705 SF, 10,000-seat stadium to host a Triple-A Minor League Baseball team, 22 suites, a pool, a kid's zone, and bars. As the CCBD Assistant Director, Sam provided general oversight of the permitting, plans check, and in particular the inspection of the project from the AHJ perspective. The CCBD staff included multiple permitting technicians, plan check engineers, and plan reviewers, along with special inspectors and code inspectors. CCBD also oversaw the special inspections program for the project.
4. **Resort World.** ***Clark County, NV. Clark County Building Department (CCBD) Assistant Director.***
   - As the CCBD Assistant Director, Sam provided general oversight of the permitting, plans check and in particular the inspection of the project from the AHJ perspective. The CCBD staff included multiple permitting technicians, plan check engineers, and plan reviewers, along with special inspectors and code inspectors. CCBD also oversaw the special inspections program for the project. Resorts World Las Vegas is the first integrated resort built on the Las Vegas Strip in over a decade. It is a 59-story hotel with 3,500 rooms from three premium Hilton brands. It has a mall and casino on site, along with the first leg of the Las Vegas Boring Company underground tunnel system. Construction cost was approximately $4.3 billion dollars.
5. ***Vegas Loop. Las Vegas, NV. Clark County Building Department (CCBD) Assistant Director.***
   - As the CCBD Assistant Director, Sam provided general oversight of the permitting, plans check, and in particular the inspection of the project from the AHJ perspective. The CCBD staff included multiple permitting technicians, plan check engineers, and plan reviewers, along with special inspectors and code inspectors. CCBD also oversaw the special inspections program for the project. The Vegas Loop, which is a below-grade tunnel system, will provide fast and convenient transportation to the Las Vegas community. The Vegas Loop will include the LVCC Loop and any future service extensions including those to casinos along the Strip, Harry Reid International Airport, Allegiant Stadium, downtown Las Vegas, and eventually to Los Angeles. Once complete, the Vegas Loop is anticipated to transport more than 90,000 passengers per hour. Clark County and the City of Las Vegas have approved a total of 65 miles of tunnel and 69 stations for the Vegas Loop.

Affiliations:

- Clark County School District-Bond Oversight Committee
- International Accreditation Service (IAS), Chairman - Board of Directors
- Clark County Air Quality Board – Alt. Member
- LV Chamber of Commerce - Leadership Las Vegas Program
- ICC Major Jurisdiction Committee, Chair
- Nevada State Board of Engineers and Land Surveyors (Governor - Appointed Past Chair)
- Nevada Organization of Building Officials (NOBO), Past President
- UNLV Civil & Environmental Engineering Advisory Board & Guest Lecturer
- ACEC Nevada President

- Clark County Building Dept Combined Board of Appeals Member
- American Society of Civil Engineers – Fellow/NV & So. NV President
- American Concrete Institute - Las Vegas (Past President)
- International Code Council (ICC), Region I (NV, CA, HI), President
- Terracon, Inc., Board of Directors and Operations Committee Member

FOREST GRAYSON
Major Project Specialist, Universal Engineering Services (UES)
Las Vegas, NV 89118
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EDUCATION, PROFESSIONAL LICENSURE AND CERTIFICATIONS

B.S. Civil Engineering, University of Nevada, Las Vegas (ongoing).

Advanced Honors Diploma
International Baccalaureate Diploma Green Valley High School Henderson, Nevada. (2008-2012)
General Courses University of Oklahoma, Norman, Oklahoma. (2012-2014)

ACI No. 1357307

- Concrete Field Testing Technician – Grade I
- Concrete Laboratory Testing Technician – Level I
- Concrete Laboratory Testing Technician – Level II
- Aggregate Base Testing Technician
- Aggregate Testing Technician – Level I
- Aggregate Testing Technician – Level II
- Concrete Strength Testing Technician
- Masonry Laboratory Testing Technician
- Masonry Field Testing Technician

Asphalt Institute, Mix Design Technology
ICC No. 8802363

- Spray-applied Fireproofing Special Inspector
- Soils Special Inspector
- Reinforced Concrete Special Inspector

NAQTC No. NV001870

- Sampling and Density
- Aggregate
- Asphalt Extended

Nevada EIT No. 0T8795

Forest Grayson has over nine years of **laboratory experience** with the UES team. Forest's primary duties and responsibilities include **supervising**, **coordinating**, **performing construction materials** and **geotechnical laboratory testing**, and **maintaining quality systems** and **accreditations** for the **Las Vegas laboratory**. He also oversees the **mobilization of start-up labs** with regional stakeholders, including procurement of equipment, facility build-out, and initial accreditation. Forest **manages** regional **lab assets** and consults with office management on operating and capital expenditures, directs the development and implementation of operations and quality-focused digital systems, and serves as a technical and staff liaison to the branch-level and divisional-level leaders to assist in **training**, **mentorship**, and other **employee-focused efforts**. His knowledge and experience make him a valuable team member and a strong resource.

Project experience:

1. ***Formula 1 Las Vegas Grand Prix, Las Vegas, NV.*** (2023)
   - The project involves the construction of an approximately 275,000 SF multi-level garage and paddock club building and a 3.8-mile asphalt paved city circuit racetrack. UES is providing field and lab asphalt testing services for the racetrack, which involves sampling and testing of Hot-Mix Asphalt, Cold Feed Aggregates, and Asphalt Binder Cement. Also, UES is providing continuous grading inspections and observations. Forest is Quality Assurance Manager, overseeing asphalt testing, documentation, and reporting.

2. ***Wells Cargo Mix Designs, Las Vegas, NV.*** (2017-2021).
   - Forest performed testing on aggregate samples and lab-prepared asphalt mixtures while learning the asphalt mix design process from beginning to end.
3. ***Project Neon. Clark County, NV.*** (2016-2019).
   - Project Neon is the largest public works project in Nevada history. This project included the widening of 3.7 miles of Interstate 15 between Sahara Avenue and the "Spaghetti Bowl" interchanges in downtown Las Vegas. This section of the interstate is currently the busiest stretch of highway in Nevada with 300,000 vehicles daily or one-tenth of the state population, seeing 25,000 lane changes an hour. Forest performed Hveem stability tests and TSR on asphalt mixtures as well as compressive strength tests on concrete cylinders. He also performed LA abrasion tests, clay lump, friable particle determinations, and specific gravity testing to ensure the quality of concrete aggregates. Forest also performed sulfate soundness testing for MSE backfill.
4. ***Northgate Distribution Center. North Las Vegas, NV.*** (2015-2017).
   - The project consisted of the construction of six buildings located off of Lamb Boulevard and Tropical Parkway. The six primary structures totaled 3,100,000 SF, consisting of office/warehouse structures. The buildings are one to three stories in height, concrete tilt-up construction with concrete slab-on-grade lower floors and conventional foundations or post-tension slab foundations. The project also consisted of the installation of wet utilities (water/sewer). The overall length of the wet-utility alignment is approximately 14,340 feet. Because of the location of the wet-utilities installation, there were 12,240 linear feet of roadway improvements. Forest tested concrete cylinders from slabs, footings, and panel pours for compressive strength. He also performed testing to verify the quality of aggregate base and hot mix bituminous courses for off-site pavements.
5. ***University Gateway Retail Development and Parking Garage, Las Vegas, NV.*** (2018-2019).
   - Forest served as the Laboratory Manager for this project, which included the construction of a mixed-use building and parking garage for the UNLV community. This development includes retail space on the first level, professional offices for UNLV administration on the second level, and residential studio apartments on the third level and above. The building is also shared with UNLV Police Head-quarters and a ±820 space parking structure with the majority of the spaces leased to UNLV for student and staff parking. UES conducted a geotechnical investigation prior to construction of the project. UES also performed materials testing and inspection services during construction of the parking garage.
6. ***Las Vegas Wash Improvements. Clark County,*** **NV.** (2016-2017).
   - The project consisted of improvements to the Las Vegas Wash, including removal of riprap, concrete slope lining, and articulated concrete block; construction of concrete reinforced rectangular channel, confluence structures, transition structures, concrete box storm drain, storm drain inlets, and laterals; accommodations for existing large diameter sewer, trail, and utilities; and sewer manhole adjustments. The Las Vegas Wash Pedestrian Bridge and Phase II Trail project included a pre-fabricated grade-separated bridge structure, concrete substructures, approaches to tie into sidewalks, ramps, trail lighting and guardrail, graffiti removal, concrete retaining walls and footings, bollards, modifications to existing drainage outlets, and signage. Forest performed tests to verify the quality of drain backfill and selected backfill.

JOHN SLOAN
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EDUCATION, PROFESSIONAL LICENSURE AND CERTIFICATIONS

B.S. Biochemistry, University of Nevada, Las Vegas.

ACI No. 1888950

- Concrete Field Testing Technician - Grade I
- Concrete Laboratory Testing Technician - Level I
- Concrete Laboratory Testing Technician - Level II
- Concrete Strength Testing Technician
- Aggregate Testing Technician - Grade I
- Masonry Laboratory Testing Technician

NAQTC No. NV002331

- Sampling & Density
- Asphalt Extended
- Aggregates

John Sloan has over 17 years of experience as a **Geotechnical/Environmental Laboratory Supervisor**. John's primary duties and responsibilities include **supervising** and c**oordinating** all **lab testing**, **verifying** that **lab data** meet quality control standards, **performing concrete** and **masonry lab testing**, **managing projects** and communicating with clients, and **training personnel** in the standards set by the **Cement and Concrete Reference Library (CCRL)**. Given his knowledge and experience in **chemical testing**, he is also responsible for the setup and certification of **soil chemical testing** by the **Clark County Public Works Association**.

Project experience:

1. ***Formula 1 Las Vegas Grand Prix, Las Vegas, NV.***
   - The project involves the construction of an approximately 275,000 SF multi-level garage and paddock club building and a 3.8-mile asphalt paved city circuit racetrack. UES is providing field and lab asphalt testing services for the racetrack, which involves sampling and testing of Hot-Mix Asphalt, Cold Feed Aggregates, and Asphalt Binder Cement. Also, UES is providing continuous grading inspections and observations. John is Laboratory Manager, overseeing all lab testing for soils, asphalt, concrete, and shotcrete.
2. ***Henderson Hospital Tower Addition, Henderson, NV.***
   - This project consisted of a six-story, 175,000 SF hospital tower addition, with a two-story podium structure for the various hospital departments and facilities. UES provided materials testing and inspections of reinforced concrete, structural masonry, and EIFS. Steel framing and welding was inspected by UES' NAQTC-certified inspector. John was the Laboratory Supervisor of the UES Las Vegas lab, which provided soils, concrete, and asphalt testing for the project.
3. ***Tropical Parkway Improvements, North Las Vegas, NV.***
   - This project consisted of roadway improvements from the intersection of CC-215 and Tropical Parkway east to the intersection of Tropical Park-way and Linn Lane, as well as south on Linn Lane to the intersection of Linn Lane and El Campo Grande Avenue. Roadway improvements included construction of roadway embankment, excavation, grading, concrete barrier rail, storm drain culverts, and headwalls, storm drain-age collection system, bituminous asphalt pavement, raised medians, concrete ADA ramps at intersections, bituminous asphalt sidewalks on the north side of Tropical Parkway and the east side of Linn Lane, water line, sewer line, and

- appurtenances. Additionally, a street light system was installed on Tropical Parkway, which included a four-inch FAST conduit, striping, signage, vertical adjustment of utilities, associated appurtenances inherit in roadway, and flood control work. John worked in the laboratory performing Quality Assurance materials testing during construction.

4. ***Las Vegas Raiders Training Facility, Las Vegas, NV.***
   - Located on an approximately 55-acre site along Executive Airport Drive, this project consisted of the construction of a three-story executive office building; a 100-foot-tall indoor practice field; and state-of-the-art equipment/training center, including three outdoor fields and a maintenance building. UES' services included Quality Assurance materials testing and inspection services during construction. John was the Laboratory Supervisor of the UES Las Vegas lab, which provided soils, concrete, and asphalt testing for the project.
5. ***Tropical Parkway Improvements, North Las Vegas, NV.***
   - This project consisted of roadway improvements from the intersection of CC-215 and Tropical Parkway east to the intersection of Tropical Parkway and Linn Lane, as well as south on Linn Lane to the intersection of Linn Lane and El Campo Grande Avenue. Roadway improvements included construction of roadway embankment, excavation, grading, concrete barrier rail, storm drain culverts and headwalls, storm drain-age collection system, bituminous asphalt pavement, raised medians, concrete ADA ramps at intersections, bituminous asphalt sidewalks on the north side of Tropical Parkway and the east side of Linn Lane, water line, sewer line, and appurtenances. Additionally, a street light system was installed on Tropical Parkway, which included a four-inch FAST conduit, striping, signage, vertical adjustment of utilities, associated appurtenances inherit in roadway, and flood control work. John worked in the laboratory performing Quality Assurance materials testing during construction.
6. ***Buffalo Drive Pavement Improvements. Clark County, NV.***
   - This project involved pavement and sidewalk improvements on Buffalo Drive, between Tropicana Avenue and Sahara Avenue. The work involved placing plant mix bituminous surface and UTACs, constructing median islands, reconstructing non-compliant sidewalk ramps to current ADA standards, and adjusting utilities. UES provided Quality Assurance testing services on the project. The team sampled and tested soils, aggregates, asphaltic concretes, Portland cement concretes, and other materials. John was the Laboratory Supervisor of the UES Las Vegas lab, which provided soils, concrete, and asphalt testing for the project.
7. ***Las Vegas Convention Center (LVCC) Expansion Phase II, Las Vegas, NV.***
   - This project involved a major expansion and renovation of the Las Vegas Convention Center to accommodate current customer needs and capture future trade show opportunities. The LVCC Phase II expansion project added 1.4 million SF to the current convention center facility, including at least 600,000 SF of new, leasable exhibit space. UES provided QAA materials testing and special inspections for the building and its components during construction to verify the compliance of construction with the design, engineering, and required codes of the project. John was the Laboratory Supervisor of the UES Las Vegas lab, which provided lab testing for concrete, soils, and masonry.

JEFF STEMPIHAR, Ph.D., P.E.
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EDUCATION AND PROFESSIONAL LICENSURE

Ph.D. Civil Engineering, Arizona State University. 2013
M.S. Civil Engineering, Michigan Technological University. 2004.
B.S. Civil Engineering, Michigan Technological University. 2002.
Licensed Professional Civil Engineer, State of Arizona (License Number 54753); State of California (License Number 93854); State of Nevada (License Number 027110); State of Michigan (License Number 6201054923)

Jeff Stempihar, PhD, PE, has focused on **engineering** and **research** of **asphalt** and concrete pavements. His experience includes **pavement evaluation** and **design**, **material selection**, **use of recycled materials**, **forensic analysis**, and developing **best-practice guidance**. He has worked on numerous engineering and research projects at the local, state, and national levels. Jeff previously served as the **state materials testing engineer** for the **Arizona Department of Transportation**, a role where he provided materials-related technical support statewide.

Jeff is a **registered professional engineer** and is active in local industry groups to support technology transfer and training efforts for practicing engineers. He has **authored numerous technical specifications**, **test procedures**, **technical report**s, as well as **industry publications**. Jeff's strong communication skills allow him to engage stakeholders to arrive at solutions that satisfy clients' needs.

Key experiences and projects include:

1. ***Surface Treatment Relative to Airfield Location. Applied Pavement Technology, Inc./FAA. Pavement Engineer***.
   - The FAA's Airport Technology Research and Development Branch sponsored a study of asphalt concrete pavement surface treatments with two main objectives: to identify best practices and to propose guidance for selecting surface treatments as the appropriate treatment strategy for airport pavements. Tasks included a literature review, targeted information gathering surveys, development of case studies highlighting the use of surface treatments, review of FAA material specifications, and experimental design for a future nationwide field study on the use of asphalt concrete surface treatments on airfield pavements.
2. ***Effects of Diamond Grinding on Airfield Pavements. Iowa State University/FAA. Principal Investigator***.
   - The FAA-sponsored Airport Concrete Pavement Technology Program initiated this project to investigate how diamond grinding impacts concrete airfield pavements. Project elements include a literature review, outreach to airports and contractors to identify diamond ground pavements, project record collection, site visits, and macrotexture measurements. This project will result in a best-practices guidance document that can be used by FAA, DOD, engineers, and airport operators for grinding specification development and airfield operations.
3. ***Investigation of Wildfire Impacts on Pavements. Applied Pavement Technology, Inc./FHWA. Pavement Engineer.***
   - The Federal Highway Administration sponsored a project to compile, synthesize, and document the direct and indirect impacts of wildfires on pavement infrastructure. Tasks include a comprehensive literature search and interviews with selected agency personnel who have experience with wildfires and associated damage. The final project report and associated outreach materials will present the current state of knowledge on wildfire impacts on pavements and identify critical information gaps and research needs.

4. ***Balanced Mix Design Implementation for Caltrans. California Department of Transportation, Sacramento, CA. Principal Investigator.***
   - Assisted Caltrans Pavement Program by developing an initial road map for the implementation of Balanced Mix Design (BMD) for asphalt concrete mixtures. The road map outlines major tasks and milestones necessary for Caltrans to assess and implement BMD. This road map was supported by gathering technical information and interviews (other state DOTs, California asphalt concrete industry groups, and academics working with BMD). Concrete surface treatments on airfield pavements.
5. ***Waste Plastic Incorporation into Asphalt Concrete Pavements - A Literature Review. Interwest/CalRecycle, Sacramento, CA. Technical Advisor.***
   - Provided technical advice and review on a CalRecycle project that evaluated the efficacy of using recycled plastic in asphalt concrete paving mixtures, either as a binder modifier or filler materials. This project produced a report that included an extensive review of the literature, case examples where recycled plastic was used in asphalt concrete paving mixtures, a summary of findings, and recommendations for future work.
6. ***Performance Evaluation and Comparison of Rubberized Hot Mix Asphalt and Conventional Hot Mix Asphalt. California Department of Transportation, Sacramento, CA. Co-Principal Investigator.***
   - NCE compared the statewide performance of rubberized hot-mix asphalt (RHMA) and conventional hot-mix asphalt. Elements include gathering and organizing Caltrans performance and project data, identifying factors that impact performance, data analysis, statistical analysis, and performance comparison. Findings were used to support Caltrans's efforts to use waste-tire-derived crumb rubber modifiers in asphalt paving materials.
7. ***Assessment of Recycled Plastics in Asphalt Pavements. California Department of Transportation, Sacramento, CA. Co-Principal Investigator.***
   - NCE evaluated the use of modified urethane binder (“plastic binder”) in partial depth recycling surface layer test sections. Project elements included construction field observation, material sampling, development of a laboratory test plan, laboratory testing, forensic investigation of premature test section failure, and identification of additional work needed before additional test sections are considered.
8. ***Pavement Evaluation and Design Recommendations. Several Cities in Nevada and California. Pavement Engineer.***
   - Pavement Engineer. These projects include preparing recommendations for pavement preservation and rehabilitation of asphalt concrete on city roads and streets. Work includes site visits, evaluation of existing pavement conditions, preparation of primary and alternative pavement treatments, pavement design, and final reporting.

MICHAEL DUNNING, Ph.D., P.E.
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North Las Vegas, NV 89031
Mobile: 702-901-1846; E-mail: mdunning@ncenet.com

EDUCATION & PROFESSIONAL LICENSURE

Ph.D. Civil and Environmental Engineering, University of Nevada, Las Vegas. 2006.
M.S. Civil and Environmental Engineering, University of Nevada, Las Vegas. 1996.
B.S. Civil Engineering, California State University, Long Beach. 1976.
Licensed Professional Civil Engineer, State of Nevada (License Number 8805; since 1990); State of Washington (License Number 25323; since 1988); National Council of Engineering Examiners (License Number 8855; since 1989)

Dr. Dunning applied his acquired work experience in **soil and asphalt testing** and **Civil Engineering** education to the **construction industry** on various overseas and stateside projects to the current government agency oversight of the construction materials in the Clark County region. The field experience ranged from **Construction Engineer** to **Project Manager**, while the office experience varied from **bidding** projects and the current **supervision of government construction quality assurance systems and laboratory**. He acquired extensive knowledge in the theory and practice of **asphalt concrete paving** and **Portland concrete placement and designs**. This experience had given him the means to see the "whole picture" of a project of both the private and public sectors. It has helped to emphasize **problem-solving** and the development of **workable systems** to reduce the repetition of errors. Extensive travel into foreign countries necessitated the learning of skills in the **managing** of people and public relations. This, along with the acquired **construction knowledge**, enabled Dr. Dunning to work successfully with people in various fields and management problems to bring them to a positive conclusion. The culmination of this experience was transferred successfully as the supervisor of the Quality Assurance section at **Clark County, Nevada**, which is involved in the **construction of quality systems and laboratories**.

Key experiences include:

1. ***Nichols Consulting Engineering (NCE). Associate*** (2019 to present)– *Primarily in the m*aterials division.
   - In general support the materials division in training, coordination, and client presentations on services and support.
2. ***Forensic Study of PCCP Surface Degradation/215 Beltway. Associate Engineer***. Clark County, NV. (2019).
   - Performed a surface degradation survey for the 215 beltways from South Decatur to West Tropicana (about 4 miles). Plotted the data for a visual report display. From this, he selected the worst and relatively best for petrographic core analysis. Researched the beltway history for construction documents and photos, then reported as a part of the final.
3. ***Plastic Pavement Study- Literature Search. Associate Engineer.*** Interwest/Caltrans. (2021).
   - Associate Engineer. A study was conducted, a literature search, for uses of plastic roads in peer-reviewed papers or other studies. The focus was on the use of post-production and post-consumer recycled plastics in all types and methods including environmental concerns. This encompassed incorporation in crumb rubber, terminal blend rubber, neat binder, polymer modified binder, and full liquid binder replacement.
4. ***Caltrans Postproduction Recycled Plastic Pavements Plastic Road Demonstration. Associate Engineer.*** City of Saint George, UT. (2021).
   - A new type of post-production recycled plastic binder was placed in an asphalt pavement through a mill and replacement process. In place of adding emulsion as a binder, plastic was used. Dr. Dunning performed the QC review of the report. Dr. Dunning performed the field

- inspection of the same product as in Oroville. He generated the final report that was integrated into the Oroville report for Caltrans.

5. ***Caltrans Postproduction Recycled Plastic Pavements Plastic Road Demonstration Project Report QC. Associate Engineer***. City of Oroville, CA. (2021).
   - A new type of post-production recycled plastic binder was placed in an asphalt pavement through a mill and replacement process. In place of adding emulsion as a binder, plastic was used. Dr. Dunning performed the QC review of the report.
6. ***Construction Management Division, Quality Assurance Division. Supervisor.*** Clark County Department of Public Works, NV. (1997 to 2018).
   - Dr. Dunning joined the Clark County Department of Public Works, Construction Management Division, as supervisor of the Material Quality Assurance Section. In this role, he was involved with the implementation of new specification criteria and independent assurance for the Contractor Quality Control program on new construction contracts, material source, and production inspections in the Clark County Region, as well as research and development of new testing processes and quality control/assurance specifications. Dr. Dunning researched materials that would increase the pavement life and more effective test methods in collaboration with the University of Nevada, Las Vegas.
7. ***Industrial Construction. Industrial Construction, Inc. Plant Manager.*** Clark County, NV. (1994 to 1997).
   - Dr. Dunning increased efficiencies and built a strong team over three years capable of keeping the plant online by scheduling maintenance and changing the Marshall design that accounted for absorption, improving and changing the Marshall design that accounted for absorption, and increasing the mix longevity. In addition, Dr. Dunning prepared to bid for the Nevada Department of Transportation and Clark County, supervised quality control laboratory mix designs and inspections, and managed various construction projects.
8. ***GC Wallace Las Vegas, NV. Construction Management Division*** (1990 to 1994)
   - Construction manager for heavy highway and infrastructure throughout the southern Nevada region.
9. ***Frehner Construction, Elko and Las Vegas Nevada (1986 to 1990)***
   - Worked in Elko, Nevada, as a project Engineer on the Southfork Dam after which was reassigned to Las Vegas for major highway projects.
   - Hoover Dam Road Realignment: Assigned as the scheduler for the construction program. Other duties included construction engineering functions to aid the superintendent and ranged from bid estimating to construction supervision.
10. ***Asphalt Mix Engineering. Petroleum Sciences, Inc. Consultant.*** *Spokane, WA.* (1984 to 1986).
    - Dr. Dunning was responsible for all engineering services, including but not limited to asphalt mix design and consulting; educating contractors and government agencies on asphalt technology, construction practices, and specifications through seminars; and development of quality assurance and control programs for construction companies.
11. ***The United Arab Emirates, ARCO Dubai, Inc. Fluor Construction, Inc. Construction Engineer.*** Dubai, UAE. Senior (1982 to 1984).
    - Dr. Dunning was responsible for managing the civil, building, and mechanical contractor's engineering staff to ensure the grassroots gas and oil separation plant in Dubai was built according to the Fluor Construction, Inc. drawings and specifications.
12. ***Construction Engineering Corporate Office. Fluor Construction, Inc. Senior Construction Engineer.*** Irvine, CA. (1982).
    - Senior Construction Engineer. Dr. Dunning developed methods to maintain and appraise field and design problems, which helped field and design problems, which helped to field and design

- problems, which helped make parties for “rapid” solutions to issues that were hindering field operations.

13. ***Amway Exxon facility process unit addition, Fluor Construction, Inc.*** Punto Fijo Venezuela (1979 to 1982)
    - Senior Construction Engineer refinery expansion (EXXON) Lagoven, field engineering and inspection team was created that both aided the construction crews while assuring compliance with the specifications and drawings.
14. ***ARAMCO Gas Gathering Project,*** Abqaiq Saudi Arabia (1978 to 1979)
    - Assigned as the site control engineer responsible for the monitoring of the contractors during the construction.
15. ***National Iranian Oil Company (NIOC),*** Esfahan, Iran, Grass roots refinery (200,000 B/dy). (1976 to 1978)
    - Construction Engineer In charge of the construction engineering of the waste water facilities, 20 tank farm, and the asphalt/sulfur loading areas.

Affiliations:

- Association of Asphalt Paving Technologists (AAPT) (1989 to date)
- American Publix Works Association (APWA) (1997 to date)
- Construction Management Association (CMAA) (1997 to date)
- Nevada Alliance for Quality Transportation Construction (NAQTC) (1997 to date)

Illustrative Publications:

1. **Dunning**, M.R. Feasibility for the use of non-contact ultrasound for application with asphalt concrete materials. University of Nevada, Las Vegas, 2006.
2. **Dunning**, M., Karakouzian, M., Vun, R. and Bhardwaj, M. Non-contact ultrasonic characterization of hot mix asphalt (HMA). Las Vegas, Nevada, University of Nevada, The Ultran Group, Inc. Boalsburg, Pennsylvania, Unites States, 2004.
3. Karakouzian, M., **Dunning**, M., Hudyma, N., Avar, B., Bukhari, M. and Singh, A.K. Comparison of In-Place versus Laboratory Aged HMA Binder Properties. In Airfield Pavements: Challenges and New Technologies (pp. 327-333), 2004.
4. Karakouzian, M., **Dunning**, M.R., Dunning, R.L. and Stegeman, J.D. Performance of hot mix asphalt using coarse and skip graded aggregates. Journal of Materials in Civil Engineering, 8(2), pp.101-107, 1996.