Pavement Management System and Data Collection

RFP #8-2015

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Introduction

Applied Research Associates, Inc. (ARA) presents this proposal to implement a new pavement management system for the Lexington-Fayette Urban County Government (LFUCG) including implementation of appropriate software tools, collection of data to populate the software tool's databases and support pavement maintenance decisions, tailoring of the system to meet both the existing and desired needs of the LFUCG public works department, and training on the overall system.

To provide additional support in this implementation, ARA has included local assistance from GRW and Hall-Harmon Engineers. Both firms are local to the Lexington area and Hall-Harmon is a woman-owned business. ARA plans to use these firm's expertise to research maintenance history, add a local point-of-view on pavement management options (in addition to LFUCG's, of course), integrate the existing GIS into the pavement management system, provide quality control services for the data collection effort, and perform other local services as needed. With the team of ARA, GRW, and Hall-Harmon, we believe that the LFUCG will get the system that will most improve the maintenance of the LFUCG pavement network.

ARA's 35 years of experience in pavement engineering and pavement management make us uniquely qualified to meet the needs of the LFUCG. Our experience includes research into pavement management and evaluation techniques; one of our founders was a key member of the team that developed the PAVER methodology which was the basis for the ASTM D6433 standard. Our experience with pavement management software tools includes government standards such as MicroPAVER, commercial products such as Cartegraph, and the development of our own tools, RoadCare and PAM. On the data collection side, our company has experience going back to film-based vehicles; for LFUCG, we plan to use state-of-the-practice Digital Survey Vehicles (DSVs) for this project. Finally, on the personnel side we offer a project manager with over 15 years of pavement management and data collection expertise, local experts that understand the specific situations that the LFUCG faces, experienced technicians that have years of experience, and a deep bench of professionals, technical staff, and equipment to complete the job within the required timeframe.

The following proposal is broken down in accordance with the selection criteria. We cover the experience and capacity of each team member, the resources each team member can contribute to the project, an explanation of our understanding of the details of the project, a proposed approach to implementing the pavement management system and collecting data, project references for each team member, and a discussion of what work the project team plans to provide with people in the Lexington area.

Capabilities

As mentioned in the Introduction, the proposed project team has three members. ARA will be the lead firm on this project. We will be supported by local offices of GRW and Hall-Harmon, both of whom will provide key expertise on elements of this work. The ARA project manager, Mr. Jacob Walter will serve as a single point-of-contact to ensure the efficient operation of this project. This section begins with the experience of each company on the project team, then explains the organization of the project team, and finally discusses the capabilities each key person from the project team brings to the project.

Team Members

Applied Research Associates, Inc.

ARA is an international research and engineering company recognized for providing technically excellent solutions to complex and challenging problems in the physical sciences. In the transportation community, this focus translates into providing innovative technologies and services in the areas of asset management, pavement management, and traffic monitoring. Our expertise in these areas allows agencies to better address the challenges they face in cost-effectively designing, building, maintaining, and preserving a network of horizontal infrastructure.

Our mission is to provide in-depth and diversified engineering, research, and technical support services. We have a broad range of technical expertise in civil engineering, computer software and simulation, systems analysis, system integration, data collection, technology transfer, and physical testing & measurement. We also provide sophisticated technical products for pavement evaluation, roadway asset inventory, traffic data collection, and robotics.

Founded in Albuquerque in 1979, ARA has grown steadily and now has offices throughout North America, serving clients worldwide. With over 1200 employees, most of whom have advanced degrees in engineering and the physical sciences, we have the breadth to tackle the most challenging technical problems. ARA is an employee-owned company dedicated to producing innovative solutions in a timely and cost-effective manner. One of our greater strengths is our ability to recruit and retain renowned experts from diverse technical fields. This keeps us fresh technically and continually broadens our capabilities.

ARA's success stems directly from our Operating Principles:

- Technical excellence
- Responsiveness
- Effective communication
- Strong fiscal and schedule control
- Client confidentiality

ARA provides a working environment in which highly qualified technical professionals can pursue their specialties with a maximum of support and a minimum of bureaucracy. These individuals form a network of colleagues with complementary capabilities, similar goals, and a willingness to cooperate on challenging and important technical problems. We strive for long-term associations among our staff and with our clients. In fact, two of the clients discussed in the experience section

have been working with ARA for over 10 years on their pavement management systems. Honesty and integrity are paramount at ARA.

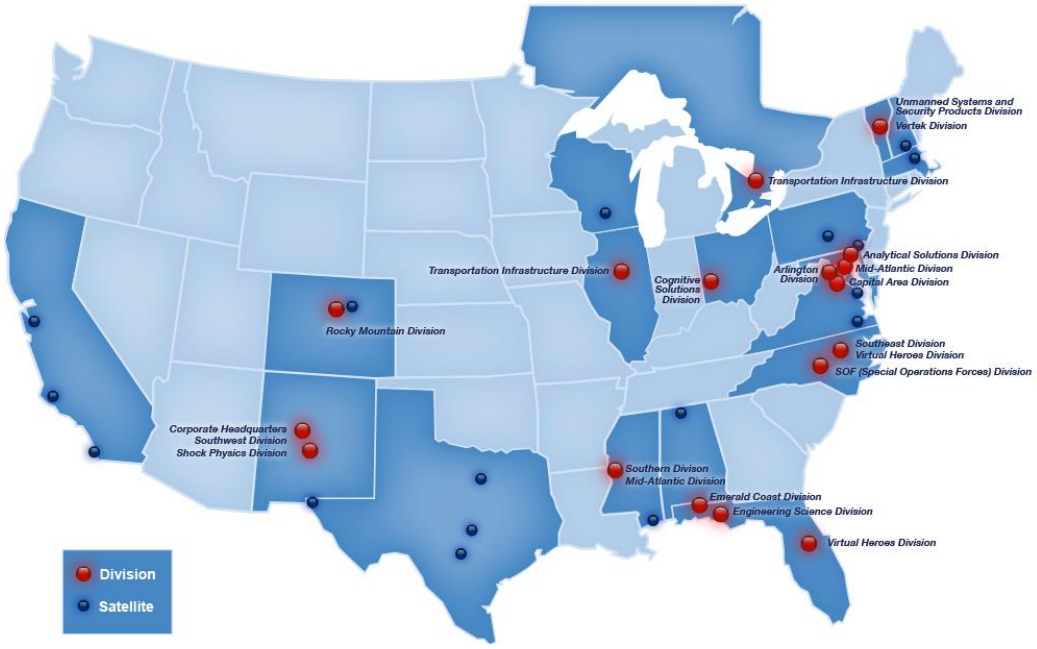
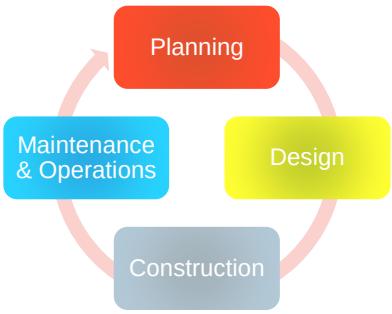


Figure 1. ARA North American offices.

ARA specializes in solving difficult engineering problems, and we are internationally recognized for high standards and quality engineering and research. We have an outstanding record for on-time and high-quality work and exceptional products.

We are unique in the engineering consulting community. While many consultants provide "traditional" planning, design, and construction related services, our mission is to provide technologies and services that enhance each of these key stages of a roadway's life cycle. We take great pride in helping agencies optimize planning decisions, enhance designs, administer high-quality construction projects, and implement cost-effective maintenance programs.



The **Transportation Infrastructure Division of ARA** provides a full spectrum of engineering solutions for agencies such as the LFUCG. Our staff includes many well-known and respected leaders in pavement research, analysis, design, management, maintenance, and materials. Composed of more than 130 engineers, technicians, and support staff; our staff is equipped with a comprehensive set of asset preservation and traffic monitoring services to help agencies get the most out of operation and maintenance funds.

ARA's core services for local government include infrastructure asset management, pavement management, pavement engineering, and vehicle-based data collection. We are internationally recognized leaders in these fields, with decades of experience and hundreds of satisfied clients. Within each of these fields, our core services include:

Pavement Management/Engineering

- Pavement management system implementation

- Design (new & rehabilitated pavements)
- Pavement evaluation (distress, smoothness, structural capacity, etc.)
- Construction quality assurance
- Software development, tailoring, and implementation
- Training
- Design and rehabilitation guidelines and specifications

Vehicle-Based Data Collection
- Pavement condition surveys
- Video logging
- Roadway profile, ride quality, and rutting measurement
- Signage inventory and evaluation
- Roadside asset inventories

Asset Management
- Asset management system development and implementation
- Enterprise-wide system integration
- Gap-analysis and needs evaluation
- Compliance review and reporting (GASB-34, state reporting, inter-agency agreements, etc.)
- On-site support
- Geographic information systems (GIS)
- Inventory and condition assessment surveys
- Maintenance quality assurance

Our research and training projects within each of these areas keep us at the cutting edge of technology, and our evaluation, design, and management projects keep us in touch with real-world concerns about pavement and asset management. The combined knowledge allows ARA to use the latest technology to develop cost-effective, yet practical solutions for our customers' pavement-related needs.

Pavement Management

ARA is in its fourth decade of providing pavement management services throughout the world. ARA staff members served key roles in the inception of pavement management techniques, and they were instrumental in the development of procedures that are used to evaluate pavement conditions worldwide.

Our goal is to ensure that clients always receive the system most suited to their needs. For some, this involves upgrading or optimizing an existing pavement management system. For others, it may mean implementing an entirely new system. Some of the diverse agencies for which ARA has developed, implemented, and updated pavement management systems include the following:

- Local Government Agencies—Metro Nashville, TN; Washington, DC; Lee County, FL; Vicksburg, MS; Champaign County, IL; Denton & Arlington, TX; Waynesboro, VA.
- Toll Authorities—Illinois State Toll Highway Authority, North Texas Toll Authority, Florida Turnpike, Orlando-Orange County Expressway Authority, and the Oklahoma Turnpike.
- State Highway Agencies—North Dakota DOT, South Dakota DOT, Illinois DOT, Pennsylvania DOT.
- National Governments – Transport Canada, U.S. Federal Highway Administration

- Private Industry—VMS, Inc. (for three interstate highways in Virginia), Route 1 Gateway (Maintenance of Route 1 in New Brunswick, Canada), Sea to Sky Highway and Highway 407 ETR.

Pavement Condition Surveys

Visual condition surveys have been one of ARA's primary services since the company was founded. In fact, to say that ARA wrote the book on PCI surveys is not much of an exaggeration—one of our principals, Mike Darter, was a co-developer of the PCI method. This is the method that has become the basis of the ASTM D6433 standard that was requested in the proposal.

We routinely perform condition surveys for all of our network-level pavement management projects, as well as for some project-level applications. ARA is familiar with both manual and automated survey methods and can evaluate the cost-effectiveness of each approach. ARA has an extensive team of engineers and engineering technicians that are trained and certified in pavement condition surveys. This expertise is also backed by a thorough understanding of pavement performance and the causes of pavement deterioration, allowing our condition survey teams to collect distress data accurately and efficiently.

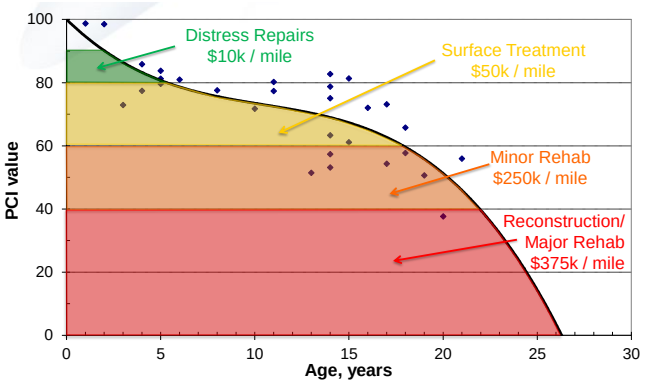
Pavement Management Software

ARA has extensive experience working with government-supported and commercially-available software packages. This includes packages such as MicroPAVER and StreetSaver on the government side and Cartegraph and AgileAssets on the commercial side. We have also been exposed to many more products either because those are the selected tools our clients choose to use or because we have recommended them after a client-led decision making process.

In addition to the software tools available commercially and from various government agencies, ARA has also developed several other pavement and asset management systems including our RoadCare pavement management system. This software allows agencies to perform advanced analysis and capital programming beyond what is available in commercial packages. In fact, ARA is currently working with several commercial software providers to integrate our analysis engine with their products. This allows these firms to focus on their areas of expertise while we provide our expertise in optimizing maintenance and rehabilitation planning for pavements and similar transportation assets.

Pavement Management System Implementation

Since 1980, ARA has implemented pavement management systems for hundreds of clients. One of the keys to ARA's success is the understanding that pavement management is an integrated set of processes, not just a computerized software package. A successful implementation first requires a detailed understanding of the agency's needs and decision-making processes. Once these are clearly identified, the ARA staff embark on a regimented scope of data collection, modeling, and system implementation tasks.



Vehicle-Based Data Collection

ARA has extensive experience in performing pavement condition data collection, data analysis, and coordination of activities with other agencies. We also have developed long-range data collection schedules and performed nationwide data collection activities. To meet our project requirements, ARA maintains, calibrates, and repairs a fleet of sophisticated test equipment.

ARA provides clients with timely, high-quality data collection and analysis services to meet their specific needs. We have developed the capability to be flexible in our operations as required to meet the ever-changing circumstances affecting field data collection operations. We continue to provide our services to agencies such as Waynesboro (VA), Nashville (TN), and Lee County (FL) to collect detailed pavement condition data on literally thousands of lane miles of arterial, collector, and local streets.

ARA is experienced in testing continuous thruway mileage, rural county mileage, and the demanding operations of working in an urbanized, busy street environment. Our projects have involved a wide range of network sizes from agencies with less than 50 centerline miles to large cities and regional governments with thousands of miles of pavement.

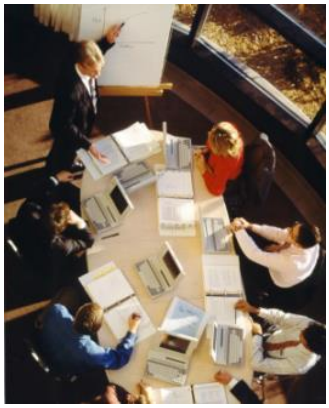
ARA has dozens of engineers and technicians that are experienced in analyzing video distress data using our own specialized workstations, performing quality checks, and incorporating the data into pavement/asset management systems. These technicians and engineers typically have at least 5 years' experience in pavement evaluation and work under the direct supervision of ARA engineers in our Camp Hll, PA office. This is in contrast to other firms that may ship data out of country to reduce the costs of data collection.

As part of these image-based services, ARA has integrated digital photographs into several pavement management systems. These integration services include the display of imagery and related data through simple to use, web-based tools such as ARA's RoadCare Image Viewer (RCIVe).

Training

ARA is a world leader in developing and teaching training courses dealing with all aspects of pavement design, materials, construction, rehabilitation, and maintenance. We have developed courses for the National Highway Institute (NHI), American Association of State and Highway Transportation Officials (AASHTO), State and municipal governments, international agencies, and industry trade organizations. ARA offers more than 20 technical courses, including:

- Introduction to Mechanistic Design of Pavements
- AASHTO Procedures for New Pavement Design
- AASHTO Pavement Overlay Design
- Pavement Subsurface Drainage Design
- Probabilistic Life Cycle Cost Modeling
- Pavement Preventive Maintenance Programming
- Maintenance Methods and Materials for Asphalt-Surfaced Pavements
- Pavement Maintenance Quality Assurance
- AASHTOWare DARWin 3.1 Pavement Design Software
- Asphalt Mix Design and Superpave
- Construction of Hot-Mix Asphalt Concrete



In addition, an ARA-led team is developing training materials for the 2002 Design Guide. ARA also routinely provides training as part of pavement management system implementation projects, teaching agency personnel how to perform field surveys and use the system software.

For pavement management projects such as this, ARA's training includes documentation and user guides focused on the specific implementation, training from all members of the project team (as needed), and inclusion of key personnel at every step of the process so that they can see the choices (and assumptions) made in the development of the system.

GRW

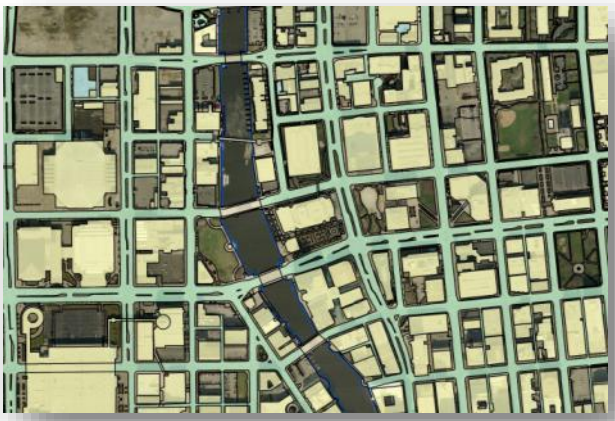
GRW is a national award-winning Engineering and Geospatial Mapping firm. We provide comprehensive GIS, mapping, surveying, and utility engineering services. Established in 1965 by Mr. G. Reynolds Watkins, Watkins' insistence on technical excellence and personal service lives on as the guiding principle at GRW. This dedication to service has resulted in repeat clients providing 90 percent of GRW's current workload**.**

engineering | architecture | geospatial

Based in Lexington, KY, the GRW Team is using 100% local personnel, and all of our key personnel are familiar with LFUCG projects. GRW has worked with LFUCG for five decades.

Below is a list of services provided by GRW:

- GIS Design and Implementation
- GIS Data Base Development
- Data Conversion, Parcel Mapping
- GIS Needs Analysis
- Custom Programming
- Web-Based GIS
- Customized Training, On-Site Tech Support
- Scanning
- GPS and Conventional Surveying
- Airport Obstruction Surveying
- Height Modernization
- 3D Terrestrial Laser Scanning
- Digital Aerial Photography/ABGPS/IMU
- LiDAR (Aerial, Mobile, and Terrestrial)
- Sign Inventory
- Aerial Triangulation
- Photogrammetric Mapping
- Impervious Surface Mapping
- DTM/DEM Development
- Digital Orthoimagery
- Computer Hydraulic Modeling
- Architectural Design and Landscape Architecture
- Mechanical, Electrical, and Structural Engineering
- Civil, Water & Wastewater System Engineering
- Transportation Engineering
- Community & Master Planning



Milwaukee County, WI

Lexington-Fayette Urban County Government, KY

For this project, GRW will be providing GIS-related and software tool services to the LFUCG. This will include retrieval of critical data from the GIS system, participating in the software evaluation phase of the project, assisting with the software tool installation and integration, and providing local support for the software tools installed as part of the pavement management system.

Hall-Harmon

Firm Overview

Hall-Harmon Engineers, Inc. (HHE) is a Lexington, Kentucky firm specializing in civil engineering and land surveying with major emphasis in transportation facilities, site development, site utilities and land surveying. HHE has extensive experience with providing engineering design and surveying services on various types of projects for the Lexington-Fayette Urban County Government (LFUCG) as both

prime consultant and as a subconsultant and is very familiar with LFUCG Practices and Policies, Standard Drawings and Infrastructure Manuals.

HHE is prequalified with KYTC to perform the following services:

- Rural Roadway Design
- Urban Roadway Design
- Surveying
- Pedestrian and Bicycle Facility Planning & Design
- Airport Design
- Airport Master Planning
- UST & HAZMAT Site Analysis / Preliminary Site Assessment

DBE/WBE Status

HHE has been a certified DBE/WBE with Kentucky Transportation Cabinet (KYTC) for the past twenty years and was presented with the 1997 Disadvantage Business Enterprise Firm of the Year Award based upon outstanding performance in the DBE Program.

Key Personnel

The experience of whole companies does not matter unless a customer receives the knowledge through capable, experienced individuals who are able to focus each company's knowledge, staff, and assets on the problems specific to a particular agency such as the LFUGC. To that end, we present the key personnel that the project team proposes to use on this project subject to the specific work that is agreed upon through the course of contract negotiation. Brief biographies are shown here with complete résumés are provided in Appendix A. Figure 2 shows how the project team is organized; please note that while communication between various team members and the appropriate personnel at the LFUCG will be permitted (in fact, encouraged as part of our training efforts), the project manager will serve as the single point-of-contact for the work performed. This will allow the efficient completion of the project and the delivery of a system that is consistent throughout its tools, data, and processes.

Jacob Walter, P.E. – Project Manager

Mr. Walter is the proposed project manager. He will be responsible for overseeing progress on this project and will be involved in the details of each phase. This oversight will include maintenance of the project schedule once one has been agreed upon by LFUCG and the project team. It will also include the bi-weekly status reports requested in the RFP provided via email and a project website setup to share documents, data, software, and reports on the current status of the project. Mr. Walter will also oversee the implementation of the training program which will start upon project kickoff and continue through the support phase of the project. Finally, Mr. Walter will assist LFUCG personnel in the required presentation to the LFUCG Council (specific presenters will be decided as part of the project).

Mr. Walter has fifteen years of experience implementing asset management systems using a wide variety of tools and data collection procedures. His experience includes both performing and managing data collection, implementing and supporting software systems, developing data collection systems, and analyzing data for engineering departments (e.g., current condition analysis, repair strategy development, and long-term capital improvement planning). His project

management experience includes the implementation and updating of pavement management system for dozens of agencies including project manager roles for Metro Nashville, Waynesboro, Virginia, Arlington, Texas, and Lee County, Florida.

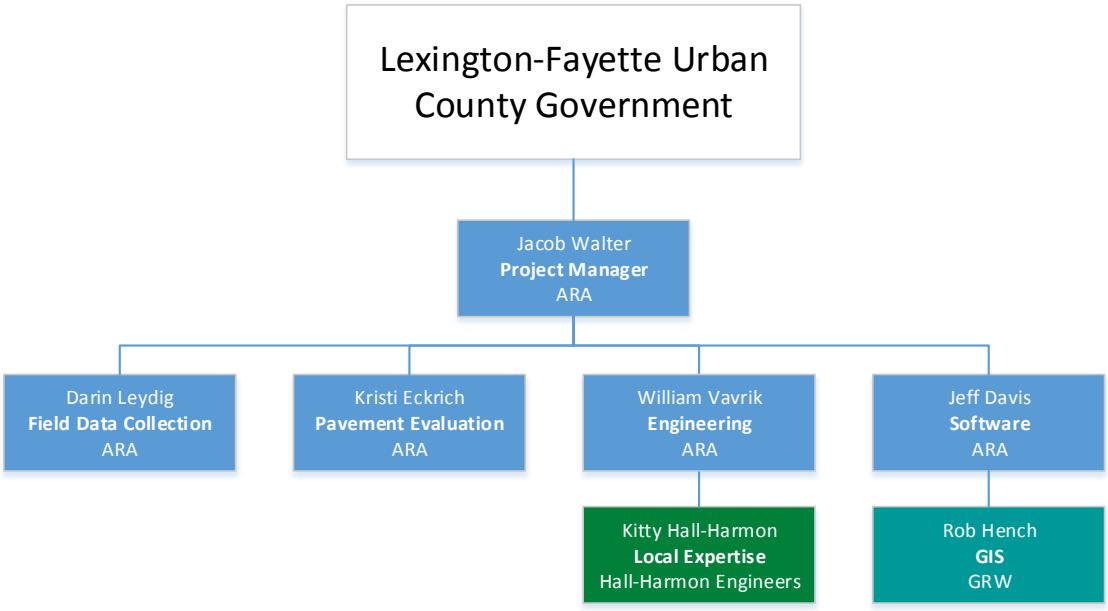


Figure 2. Suggested organization chart.

Darin Leydig – Field Data Collection

Mr. Leydig is the manager of ARA's field operations in our Camp Hill, PA office and has been working with field-based data collection units such as ARA's DSVs for over 20 years. Mr. Leydig will oversee the field crew in the project, ensure the efficiency of the data collected in the field, and handle any issues that occur due to crew availability, equipment issues, and other factors that may affect work with the LFUCG.

Kristi Eckrich – Pavement Evaluation

Ms. Eckrich has over 10 years of experience in extracting infrastructure asset management data from images and data collected using automated infrastructure asset management data collection methodologies. She has managed ARA's data reduction section since 2005, and oversees the analysis of pavement distress from the images collected during ARA's pavement management data collection efforts.

Ms. Eckrich performs initial distress data quality control reviews and is responsible for developing and implementing training procedures and tools for training ARA's data reduction technicians.

William Vavrik, Ph.D., P.E. – Engineering

Dr. Vavrik is a Vice President and Principal Engineer in the Transportation Infrastructure Division of Applied Research Associates, Inc. He joined ARA in 2000 and is responsible for overseeing the execution of hundreds of consulting and research projects in transportation engineering. Dr. Vavrik has a Ph.D. in Civil Engineering from the University of Illinois at Urbana-Champaign and is a registered professional engineer. For this project, Dr. Vavrik will be using his extensive

experience in pavement design, pavement management, and engineering software design to assist the LFUCG in the evaluation of their existing processes, the selection of new processes, and the implementation of those processes into the pavement management system. He will also use his 15 years of experience in training and presenting technical material to work with the team on the training phase which includes presentation of the results to the LFUCG Council.

Jeff Davis – Software

Mr. Davis has over 10 years of experience as a software developer, database administrator, and system integrator with a focus on pavement and transportation asset management projects. His experience includes software packages such as MicroPAVER, Cartegraph, Street Saver, RoadCare, RCIVe, and a long history of other systems custom developed for specific client issues. In association with the project manager, Mr. Davis will lead ARA's effort to select, tailor, and integrate a package of software tools that will supply the functionality required by the LFUCG pavement management system. He will also oversee the build of the pavement management database and the transfer of data collected for that database throughout this project.

Rob Hench – GIS

Mr. Hench is the GIS Manager and Technical Advisor of GRW's GIS Division. With over 25 years of experience, he has specialized expertise in all areas of GIS database design and development, ensuring quality control for GIS projects. Mr. Hench oversees GIS needs analysis, implementation, development, and data conversion. He has managed numerous complex GIS projects for utility companies, cities, counties, state, and federal clients. His skills include managing the components of a GIS, from collection to custom design and on-site support. A certified Geographic Information System Professional, he is extremely proficient with the leading GIS software. Under Mr. Hench's guidance, GRW has successfully implemented award-winning GIS programs across the nation.

In this project, Mr. Hench will lead GRW's efforts to evaluate LFUCG's existing GIS infrastructure and integrate the selected pavement management software tools into the existing system. His team will also perform any necessary GIS cleanup as part of the project. He will also assist ARA personnel in the software selection and implementation process.

Kitty Hall-Harmon – Local Expertise

Ms. Hall-Harmon is a principal engineer and owner of Hall-Harmon Engineers in Lexington. As a part of her 37 years of experience with LFUCG, she has worked on the planning, design, and repair of the LFUCG's pavement network. She will oversee the local staff that will perform the records review, assist in the process review necessary for the setup of the pavement management system, and provide on-site quality control as needed.

Capacity

As mentioned previously, the project team has a deep bench of personnel and equipment available to complete the project requirements set out in the RFP and any other that may become required after examining the results of the initial phases of the pavement management implementation. We divide this chapter by participating company to show that each team member is both capable and critical to the success of this implementation.

Applied Research Associates, Inc.

Personnel

The Transportation Sector of ARA consists of 130 engineers, technicians, and administrative staff focused on providing our clients state-of-the-practice capabilities and answers to their most difficult pavement-related questions. Table 1 shows the distribution of our staff across categories applicable to this project. A specific organization chart including key personnel is included in the previous chapter.

Table 1. Distribution of ARA staff.

Classification	Employees
Principal Engineer	23
Senior Engineer	22
Staff Engineer	23
IT Specialist	9
GIS Technician	3
Senior Technician	13
Field Technician	14
Data Reduction Technician*	3

* - Full time data reduction technicians. GIS technicians and field technicians also perform this work in addition to their other duties.

For clarity, each of these staff categories are described below:

- Staff Engineers, Senior Engineers, and Principal Engineers – ARA is a company built by and principally staffed by engineering professionals. An engineer's title is based not only on years of experience but depth of technical knowledge and management capability. On this project, engineers will oversee both process and results, provide training, assist in the development of the pavement management parameters, and help answer the City's pavement-related questions.
- IT Specialists – These employees will assist with the examination of the data received from the City and the upload of the final dataset into the RCIVe and OMS/DE databases. Our specialists have degrees in computer science or engineering and average five years of experience performing this type of work including extensive experience with Cartegraph and its pavement-related components.
- GIS Technician – Our staff of GIS technicians have over five years of experience with GIS and CAD in the transportation industry. They have extensive experience with ARA working on pavement management related projects and will work on this project with raw data analysis and project tracking.
- Senior Technician – Technicians that are in charge of teams that perform work such as data reduction and field data collection are classified as Senior Technicians for the

purposes of this proposal. We expect to use one or two of our senior technicians on this project to manage the field effort and the pavement evaluation process.

- Field Technician – The operators and drivers that run our DSVs in the field need to be able to switch from driving and on-the-fly evaluation to computer technician to mechanic as needed in their daily work. These personnel are expected to handle all routine maintenance on our equipment (at our Camp Hill, PA office) and any unexpected maintenance (in the field) as issues occur. This also includes staff that operate other equipment and perform other work; these staff may be used for backup to our main staff or to evaluate pavements.
- Data Reduction Technician – These personnel examine the digital images from the DSV and evaluate the pavement based on the images. They are all based in the same office as the project manager (Camp Hill, PA) and have multiple years of experience evaluating pavements. Please note that this category only includes *full time* data reduction technicians. We also use field technicians and GIS technicians to meet our data reduction needs. Regardless of title, all technicians have experience in the evaluation of pavement as this is a core capability of ARA.

Equipment

ARA maintains a large fleet of pavement testing equipment including falling weight deflectometers, friction testing equipment, and coring rigs. However, the required equipment for this project is one of ARA's Digital Survey Vehicles (DSVs). An example of one of these vehicles is shown in Figure 3 and Figure 4.

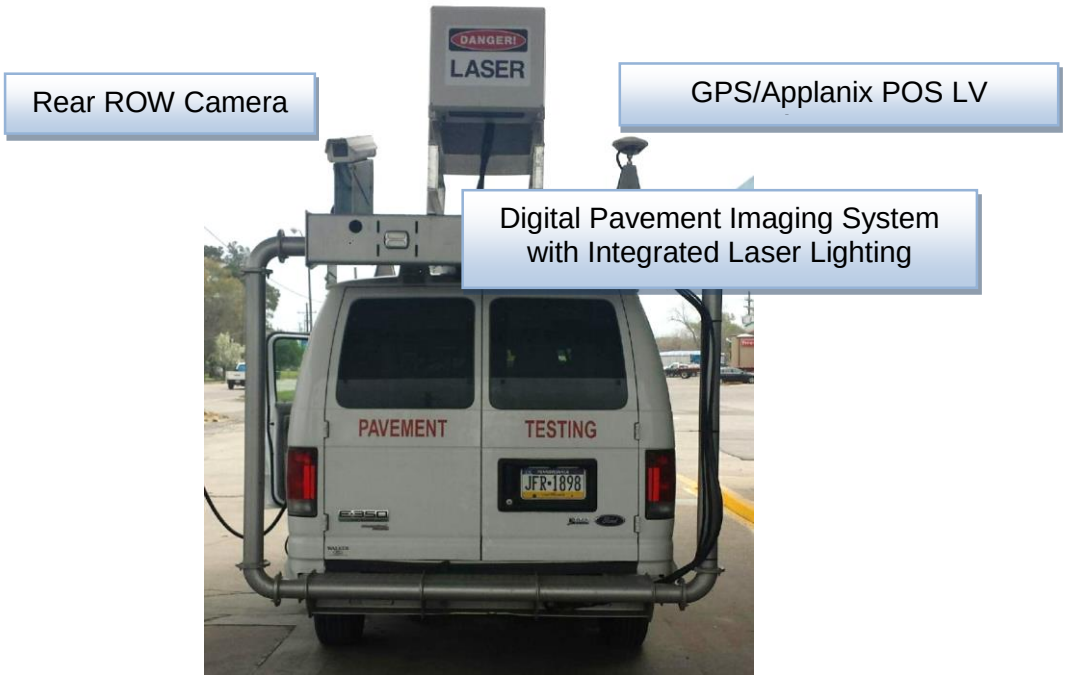


Figure 3. Rear photo of Digital Survey Vehicle.

Figure 4. Front photo of Digital Survey Vehicle.

ARA maintains three DSVs that meet or exceed the requirements listed in the RFP. A single vehicle will be required to meet the eight week data collection window listed in the RFP and the equipment must work when there is no standing water on the pavement. The only issue that could delay the schedule is a significant weather event (i.e., major flooding or a very long period of rain); the project team will work with the LFUCG to address schedule issues if this would happen.

GRW

GRW will perform their tasks on this project with professional staff located in their corporate headquarters in Lexington. GRW's personnel are immediately available and committed to providing superior responsive professional service to LFUCG in a timely and efficient manner.

GRW intends to provide all services they are responsible for with their in-house staff of more than 35 Kentucky-based geospatial employees. In addition to their sizable geospatial staff, GRW's in-house team includes transportation engineering staff, over 30 architectural, mechanical/HVAC, electrical/instrumentation and structural professionals.

Table 2. Distribution of GRW staff.

Classification	Employees
Professional Engineers	65 Engineers registered in 27 states
Professional Land Surveyors	18 Land Surveyors registered in 13 states
Registered Architects	7
GISCPs	5
Certified Photogrammetrists	4
Certified Mapping Scientist	1

Hall-Harmon Engineers, Inc.

HHE currently employs three engineers, three engineering/CADD technicians and survey field crew with the potential to expand, as the workload requires. The size of HHE allows for rapid and efficient project management based upon the high value placed on communication and teamwork by the firm's hands-on design principals.

Kitty Hall-Harmon, PE, PLS, principal engineer and project manager, has specialized in roadway design, site development, ADA compliance, site utilities, land surveying, quality assurance and interdisciplinary teamwork during her 37-year career. She serves as principal project manager for many of the firm's site development projects, and manages the business and administration operations of the firm.

Larry D. Harmon, PE, PLS, principal engineer and project manager, has over 40 years of technical experience with all aspects of the design of transportation facilities, site development, site utilities and land surveying. He also coordinates and manages the efforts of HHE survey crews.

Brian C. Knapp, PE, PLS, serves as project engineer and is involved in site design, roadway and bike lane/trail design, stormwater management and site utilities.

HHE's highly trained engineering/CADD technicians William C. McNutt and Keith G. Winstead, PLS prepare all plans and drawings for the firm using AutoCAD and/or MicroStation software.

HHE's survey team is led by Clay Tackett, who has a broad surveying background and excellent public relations skills in the field.

Project Familiarity

ARA is very familiar with the implementation of pavement management systems as we have been doing this work for over 35 years for a variety of clients in the United States, throughout North America, and around the world. This experience goes beyond data collection and software installation; ARA has been at the forefront of the development of pavement management and evaluation techniques since our inception. However, every agency is subject to its own local considerations including climate, political structure, funding source, legal requirements, and available resources. To that end, we have supplemented our experience and capabilities with those of local firms: GRW and Hall-Harmon. These firms bring with them the knowledge of actually designing and building the roadway network in the LFUCG area both for the LFUCG and the Kentucky Transportation Cabinet (KYTC). This section briefly points to the other areas of this RFP that describe the level of familiarity that the proposed project team has with system that the LFUCG would like to implement.

The first point is the process that needs to be used in the implementation of a pavement management system. As mentioned previously, ARA has 35 years of experience doing this work. We have setup system frameworks, evaluated government and commercial software packages, developed our own software where the available packages fell short, collected data through both foot-on-ground surveys and through the use of vehicle-based equipment, created a detailed and standardized quality control program for our data collection processes, created capital improvement programs, trained our clients in how to effectively use our systems, and presented our results to a wide variety of government officials. Most of this is discussed in the Capabilities section.

The equipment that we plan to use as part of this project meets or exceeds all the stated requirements of the RFP. The detailed specifications and requirements are discussed in the Field Testing section of the Project Approach. We have multiple vehicles in our fleet which will ensure that we can meet the deadlines in the RFP if there are unforeseen equipment issues.

Our pavement engineering capabilities and experience are unmatched in North America, as can be seen through the proposed members of our project team. These are all staff members that have decades of experience in pavement testing and engineering. They will create a system that the LFUCG can use to determine budget needs and the optimally apply that budget to the pavement network. Further, their experience with pavement treatment technology (both at the nationwide and local level) may provide the LFUCG with new, better suited options to the current system. Again, all of this is listed in the Capabilities chapter of the proposal in the Key Personnel section.

The management of this project will be handled by an experienced project manager with nearly two decades of experience in pavement management and system development. Mr. Walter, the proposed manager for this effort, currently manages over $1 million dollars of project work per year and has done so for the past several years. The ARA projects presented in the Experience chapter of this proposal are all managed by Mr. Walter. In addition to Mr. Walter's work, the overall progress of the work will be monitored by an ARA Principal, in this case Dr. William Vavrik. But Dr. Vavrik will not just oversee the project, he will participate in the details of the project as the person leading ARA's engineering efforts on this work. While it has already been mentioned in this chapter, the quality control system that we are using as part of the project is one that has been developed over the past 10 years of experience ARA has with the use of Digital Survey Vehicles and their associated equipment.

Finally, the GIS elements of this project will be handled by our local partner, GRW. As can be seen in their section of the Capabilities chapter of this proposal, GRW has extensive experience with GIS and a deep familiarity with the GIS systems of the LFUCG. This existing knowledge combined with our methodical approach to the implementation of the software tools in the pavement management system should combine to create a frictionless integration between the GIS and the pavement management system. Or course, GRW will be able to do any minor cleanup that may be necessary for the effective operation of the pavement management system.

Project Approach

To meet the goals and requirements summarized in the RFP requires a detailed, results-oriented plan to execute the project and deliver the products required to successfully implement the LFUCG's pavement management system. This section describes our overall approach to the implementation of the pavement management system, selection of appropriate tools for the system, data collection, and quality control. This approach may be modified to meet both the needs and budget of the LFUCG.

Management

A key step in a successful project is the active management of that project. As discussed in the previous chapter, Mr. Jacob Walter will serve as Project Manager for this effort. In the management role, his principal duty will be serving as the single point of contact between the LFUCG and the project team. This does not mean the LFUCG will have no contact with the other team members though; team members will work directly with LFUCG staff as needed for a successful project. However, Mr. Walter will be involved in these conversations to address any issues that a particular team member may not be aware of as they work with the LFUCG to meet a specific goal. Using a single point of contact has been a successful method for frequent, accurate communication between the project team and the client in many of our previous efforts.

The second element of management is tracking. Mr. Walter will also be responsible for this but will be assisted by various members of the team as needed. Tracking consists of two parts. First, it answers the question "How close is the team to meeting a specific milestone?" In some tasks, this may be measured quantitatively (e.g., number of mile surveyed) while others will require a more qualitative approach (e.g., expected time to complete the GIS integration). All tasks will be tracked by the project manager. A bi-weekly status update, per the requirements of the RFP, will be provided by email.

In addition to these updates, the Project Manager will also maintain a project website. This site will be secure but accessible by all team members and LFUCG stakeholders. It will list current progress versus the agreed upon schedule, current documents and software developed for the project, and the capacity to communicate between team members.

Quality management, another key element in this phase of the project, will be overseen by the Project Manager while being an integral part of each of the tasks in the project approach. The quality management plan is based on existing processes that ARA has developed over the past fifteen years of data collection activities (of which ten of those years involved collection of data through digital means) and system implementation experience. Quality management responsibilities will be shared between ARA and Hall-Harmon as discussed in the quality control plan section below.

Kickoff

Our efforts to ensure frequent and effective communication begin at the start of the project. At this time, the ARA project manager, an ARA Vice President, staff from each team member, and the City stakeholders will meet on-site to determine a final implementation plan, schedule (including tasks, start and end dates, milestones, and deliverables), and desired results for the project. Depending on how close the LFUCG's vision is to the attached project plan, this process may start prior to the kickoff meeting if there are significant differences between the two or if there

are budget constraints that would prevent the implementation of this plan as presented in this proposal.

The meeting will start with a presentation on the project team's plans for implementation (based on this proposal and prior discussions with the LFUCG) and then move to a round-table question and answer phase. Upon completion of this meeting, the project team will interview specific stakeholders individually regarding how the planned system might affect their personal work and what products each stakeholder needs from the system. These interviews will also cover existing business processes at the LFUCG for the design, construction, management, maintenance, and rehabilitation of pavements.

Records Review

After the kickoff, both Hall-Harmon and GRW staff will investigate the availability of pavement-related data at the LFUCG. GRW staff will look at the data available in the GIS while Hall-Harmon staff will look at data from other sources such as paper files. Two data elements are required for the successful implementation of the pavement management system:

- Pavement Inventory: This tells the project team which pavement segments are maintained by the City and determines which attributes are known for each pavement segment. Typical attributes that are required for pavement management are unique identifiers, road names, location information (from and to streets, addresses, linear references, or other items that help LFUCG staff locate a particular area of pavement in the field), geometry (length, width, and area), functional classification, direction (one-way or bi-directional), and materials.

- Construction History: To effectively model pavement performance, the project team needs to determine the age of individual pavement segments in the network. In pavement management, age typically refers to the time since the last major activity was performed in the segment (i.e., construction or overlay). While almost no municipal agencies have a complete pavement age database, more data will lead to better accuracy of the initial pavement performance models. Also helpful to the effort would be information on pavement cross-section. The ability to differentiate between thick and thin asphalt pavements or asphalt overlays of concrete pavements also assists with pavement performance prediction.

The project team will work with the LFUCG to create GIS files that can be used for processes such as data extraction and routing. This will also form the basis of the data initially used for integration purposes.

At the conclusion of this portion of the project, the team will use the inventory and construction data to create a pavement inventory database. After confirming the data with observations in the field (see the section "Field Testing", below), the inventory will become the basis of the pavement management database that is a significant element of the new system.

Existing Processes

As mentioned previously, interviews will be conducted as part of the kickoff process. Part of those interviews will be to determine the existing processes related to the management of the LFUCG's pavement network. As part of the records review of this project, the team will document these

processes, confirm those processes with the appropriate personnel, and then finalize them for use in the pavement management implementation phase of the project.

Software Selection and Implementation

Another critical element of a pavement management system is the software tool (or tools, as needed) used to manage and analyze the data stored as part of the pavement management system. As the LFUCG has not indicated existing software or desired software in their RFP, ARA and GRW will work with LFUCG staff to select the software tools for the system. This work will be performed in several steps:

1. Determine the existing IT infrastructure and software currently used by the LFUCG in other elements of their work. While GIS will be the most critical part of this evaluation (as its integration is critical to the success of the system), other systems will also be evaluated as providers or consumers of pavement management data. These systems may include work management systems, customer service applications, existing software used to manage other assets, electronic document systems, and anything else that may hold, process or use pavement data.
2. Based on the interviews conducted during the kickoff, determine the required outputs from the pavement management system and the desired complexity of the analysis used to optimize pavement maintenance plans.
3. Create a shortlist of pavement management tools that would be appropriate for the LFUCG.
4. Demonstrate each shortlisted option to key LFUCG personnel.
5. Work with the LFUCG to acquire the appropriate tools.
6. Install the tools on the LFUCG system (if the tools are locally hosted).
7. Integrate the tools with existing LFUCG IT systems (i.e., GIS).

It is the project team's plan to have the LFUCG acquire the software independently of this contract. This will ensure that the ownership of the licenses, subscription plans, and/or maintenance agreements are setup directly with the LFUCG and not with a member of the project team. Please note that at the conclusion of the software implementation, the following capabilities will be available:

- The software tools will either store appropriate pavement attributes or pull them in real-time from the GIS. This will most likely be a hybrid system where existing attributes are kept in the GIS and any additional attributes will be kept in the pavement management system.
- An export function will be provided to convert selected pavement data from the internal database format of the software tools to standard formats such as Microsoft Excel, Text, and Adobe PDF.
- Any selected tool will be integrated with the GIS, at a minimum. There are also tools available that extend certain GIS software to include pavement management functions. The project team will examine both alternatives with the LFUCG.
- PCI values and composite indices (referred to by the LFUCG as OCI in its RFP) will be calculated by the software tools based on individual distresses and pavement attributes. PCI calculations will be in accordance with ASTM D6433.
- One of the functions of the pavement management system will be the ability to view the images collected by the project team. This may be a standalone system integrated with other software tools or an integrated feature depending on the selection of other software tools by the LFUCG.

Field Testing

Upon completion of the records review and in parallel with the software evaluation, ARA will use the available data to create a routing plan for one of ARA's Digital Survey Vehicles (DSVs), an example of which is shown in Figure 5. This vehicle collects digital images and laser-based sensor data used in the evaluation of pavement condition. The condition of LFUCG pavement assets will be evaluated according to two criteria. First, surface condition will be evaluated according to ASTM D6433 based on the images collected by the vehicle in accordance with the requirements of the RFP. Second, ride quality, expressed through the International Roughness Index (IRI, in accordance with ASTM E1926) will be measured for each pavement segment.

ARA's fleet of DSVs meet all the requirements presented in the RFP including:

- Images are encoded as standard JPEG files. Additional metadata including location is stored in an associated database although it could be moved to the EXIF header if required. ARA recommends keeping the metadata separate to allow for queries of the data (i.e., find the images on Main Street between 1st and 2nd Avenue).

- Georeferencing is provided by an onboard DGPS/INS system. The raw GPS signal is received by a pair of antennas mounted to the roof of the DSV and differentially corrected by Trimble's OmniStar service. This provides an accuracy of 1m or less. An Inertial Navigation System (INS) supplements the DGPS signal improving its accuracy and allowing for "dead reckoning": the ability to determine location during brief GPS outages through the measurement of vehicle movement. This same system can also provide other attributes such as pavement cross-slope and grade when used in conjunction with the DSV's laser sensors.

- All images can be collected at 20 foot intervals. Downward imaging is continuous but cut into 20 foot intervals (e.g., downward images are 20 feet long and 14 feet wide).

- The downward camera system is a 4000 pixel per scan line camera with a supplemental infrared lighting system. It can collect downward images at speeds up to 60 miles per hour. The resolution on this camera is fine enough to show 1-mm cracks. This ability is tested daily by photographing a resolution board that has 1 through 5 millimeter lines cut into it. Our field technicians ensure that all lines on the board are visible before starting their daily work.

- All control computers have USB ports and these ports are used to transfer data between the field DSV and ARA's offices. Typically, we exchange data twice a week so that quality control and data collection are parallel processes. This also allows ARA staff to identify any systematic problems prior to the initial survey of the entire network.

- The left wheelpath laser has a minimum frequency of 32 kHz (some of our DSVs use a 64 kHz laser in this position) for the measurement of pavement texture which is used to objectively determine raveling.

Figure 5. An example of a Digital Survey Vehicle.

The cameras on the DSV will be arranged in a fashion following the layout shown in Figure 6. This allows the vehicle to obtain front facing images of assets on both side of the roadway while only traveling in a single direction. For this survey, on two lane roads, the DSV will perform a single pass (1 survey mile for each centerline mile). For roads wider than two lanes, the DSV will perform a pass in each travel direction (2 survey miles for each centerline mile). This is permissible under D6433 as the evaluation methodology is based on a sampling technique. However, it does cause a problem with right-of-way asset capture which the layout in Figure 6 solves. While right-of-way asset data collection is not included in this scope of work, collecting this data for future efforts is a good idea if the LFUCG expands its asset management system to other transportation assets.

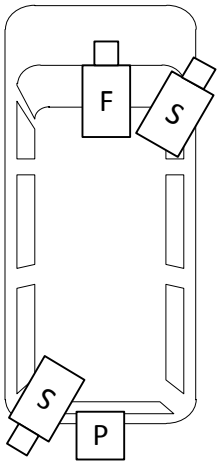


Figure 6. Camera layout for pavement network survey.

As mentioned previously, another criteria that will be evaluated during this survey will be ride quality. Laser sensors located in the front bumper measure a longitudinal profile of the pavement for both right and left wheelpaths according to ASTM standard E950. IRI for each wheelpath is calculated from these longitudinal profiles. An average IRI is calculated and will be provided as part of the data to be uploaded in the pavement management database. This calculation is fairly automated although post-processing is used to determine IRI for specific pavement areas.

Also, the sensors in the front bumper, supplemented by center, far left, and far right lasers are used to measure pavement rutting (for asphalt pavements) and faulting (for jointed concrete pavements). These are elements of the surface condition criteria and will be used directly in the next step of the process.

In addition to ride quality and rutting measurements, the same sensors will measure Mean Texture Depth (MTD), a means to measure the macrotexture of the pavement surface. Macrotexture is a key element in skid resistance and can also be used in pavement condition evaluations. For this work, it will be used in the objective determination of weathering and raveling. The conversion of MTD to a weathering and/or raveling index will be covered in the next phase of the project.

Finally, all data recorded by the DSV is located through two different means. First, the DSV is equipped with a pair of GPS antenna, a Differential GPS receiver, and an Inertial Navigation System (INS). These technologies combine to provide georeferences at accuracies of less than 1 meter (about 3 feet) absolute. Further, a Distance Measurement Instrument (DMI) is attached to a rear wheel providing a linear reference for the data as well. Both these systems are used in the quality control phase of the project and will be provided to the LFUCG as part of its pavement management system.

To ensure good quality data, ARA will collect data based on these requirements:

- Start data collection an hour after sunrise
- Stop data collection an hour before sunset
- Clear and dry pavements

All of the testing performed will be done with the safety of both employees (City and ARA) and patrons in mind. If our operators feel that data collection is unsafe due to roadway conditions (short lanes, heavy traffic, etc.) they will attempt to return at a later time when conditions have improved. There may be some limited locations where it is not possible to collect data due to safety concerns, although these occur very infrequently for municipal customers.

Pavement Evaluation

When the field data has been collected, it will move to ARA's staff of data reduction survey technicians. This experienced group is based in our Camp Hill, PA office; this work is not outsourced to a different office or to other companies. This group will complete the evaluation the pavement using workstations such as the one shown in Figure 7. A sampling rate of 50% of the pavement captured by the DSV will be evaluated. In the traditional PCI methodology, this sampling would be done in congruent samples. For example, an 8000 ft^2 pavement segment would be divided into four 2000 ft^2 samples and the first and third sample would be evaluated. With the DSV, ARA will use frame sampling. Every other 20 foot long, 14 foot wide downward image will be evaluated. This provides better sampling and is easier to perform when using equipment such as the DSV.

Per the RFP, rutting measurements will be taken directly from the DSV's sensors at this stage and converted into a measurement compatible with ASTM D6433. This involves taking the direct measurements from the sensors (rut depth at 1 foot intervals along the surveyed direction of the segment) and convert those measurements into none, low, moderate, and high bins with the appropriate area affected noted. The area affected will be calculated based on a standard wheelpath which will be determined by the LFUCG with the assistance of the project team.

Finally, MTD will be converted to a weathering index that can either be applied to the entire pavement surface or isolated areas. Generally, this process involves working with LFUCG staff to determine their thresholds for weathering on pavement segments by an on-site examination of sample segments that have high MTD measurements. These thresholds are converted to a bin system (similar to that used for rutting) and the area affected determined by either overall segment size or an assumed width. There will also need to be exclusions for certain pavement types or ages (i.e., open graded asphalt mixes) to ensure that the high MTD is not a designed feature of the pavement. The implementation of weathering *may* be partially based on the selected software; therefore specifics of the implementation will be determined as part of the project.

Figure 7. Example of a pavement evaluation workstation.

Data Upload

Once data is collected, the next step is to upload it into the database that supports the pavement management software tools. Of course, this means that the Software Selection phase of this project must be completed by this phase of the project. While the overall data upload process will vary based on the selected software, there are a few important elements that are universal:

1. A preliminary test system should be setup to test user interface configuration, GIS integration, training, and to allow LFUCG staff to review the data in the pavement management system.
2. A quality control step must exist to confirm that the pavement management data in the new software matches the data collected by the DSVs and evaluated in-house. Data integrity checks such as consistent record counts, calculation checks (i.e., do the PCI values match based on in-house calculations), and spot checks should be used.
3. Upon acceptance of the test system, the production system should be made available to the general user population.
4. Data security should be tested (users who are allowed to change and add data should be able to while read-only users should not be able to change any data).

Pavement Management Implementation

Once the inventory and condition database has been completed, the work on implementing the management side of the software can begin. Where inventory and condition are concerned with the current conditions of the pavement network, the management side of the process concerns itself with the analysis of conditions, prediction of future conditions, and generation of Capital Improvement Plan (CIP) scenarios. The implementation of the pavement management functions

will be performed by experienced ARA pavement engineers assisted by Hall-Harmon staff for a local perspective on pavement maintenance and construction. Just as data requires quality control to ensure accurate results, the management parameters require expertise to create entries that are appropriate to LFUCG. Without accuracy in both of these factors, any CIPs generated by the system will also be inaccurate

Performance Modeling

ARA will work on development of pavement performance models appropriate to the pavement network. These models will group pavements that are expected to perform in a similar manner due to thickness, material type, construction technique, and traffic loading and show the *average* performance expected for that pavement type. Each of these models is known as a "performance family" and every pavement segment will belong to exactly one. As an example, Figure 8 shows performance models for three separate pavement families. The first basis for these models is the construction history data collected during the Records Review. ARA will supplement that data with expertise from both LFUCG personnel and our team's engineers to refine the performance models. Upon the creation of the initial models, they will be discussed with LFUCG personnel, compared to expected results, and then finalized.

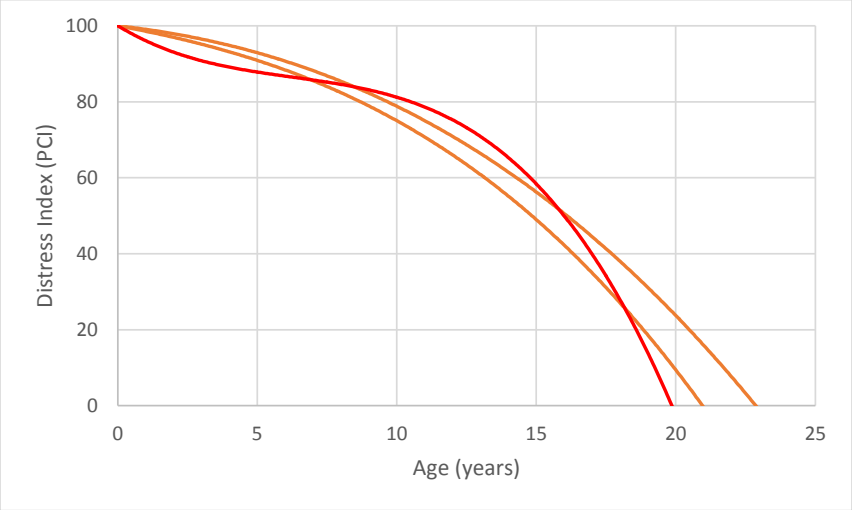


Figure 8. Examples of pavement performance models.

Activity Selection & Process Engineering

Most software tools use the equivalent of an activity library to establish both what can be done to the pavement and what should be done. Project team engineers will work with LFUCG staff to populate this library with the necessary options. We will start with current activities and discuss processes to make sure that work done to the pavement is reflected in the pavement management system. Unit costs for maintenance and rehabilitation projects will also be stored in the system. These costs will be based on an analysis by Hall-Harmon using data from both the local level and at the State level. The project team will then work with the LFUCG to determine if other rehabilitation options should be considered. These options will require unit costs from other sources as they are not in use yet; Hall-Harmon will also gather this cost data through local and regional contractors in addition to any available State data.

In addition, the project team will discuss the business processes involved in keeping the pavement management system up to date. While these two activities may not seem related, this is the best point to discuss these methods and the performance of an activity usually leads to changes in the pavement management database. In particular, the project team will focus on processes for the following tasks:

- Adding new roads to the pavement database. This may include roads that exist but were maintained by other entities (e.g., KYTC, developers, or commercial entities).
- Changing maintenance responsibilities for roads (i.e., turning roads over to the KYTC for maintenance).
- Performing work on pavement (maintenance, rehabilitation, or construction) and updating pavement attributes.
- Providing intermediate inspections of the pavement.

Activity Impacts

The objective of performing a maintenance or rehabilitation activity is to improve the pavement condition in some way; either by improving the pavement surface or the ride quality. For each activity that will be used in the pavement management program, the project team will work with the LFUCG to determine the correct impact to surface condition, ride quality, and any pavement attribute (i.e., surface type). The format of these impacts will depend on the software, but typically can be absolute (e.g., a reconstruction sets the distress index to 100, a perfect score, and the IRI to 80 in/mi), relative (a crack sealing job adds 10 points to the distress index), or percentage relative (a seal coat increases the distress index by 10%).

Feasibility Setup

Activity feasibility determines which segments in the pavement network are eligible for specific activities in the pavement management database when CIP scenarios are developed. These protocols use a combination of pavement condition (modified for expected performance as determined by the performance models), pavement type, functional class, and other segment attributes to determine if a given pavement segment is eligible for a particular activity. It is possible for a segment to be eligible for multiple activities but this feature is not expected to be used in this implementation; all condition decisions should evaluate to no more than one rehabilitation type. Based on the activity selection discussed above, the project team will help the LFUCG determine which activities should be selected in a CIP scenario and when segments will be eligible for that activity.

Budgets

A budget is typically the limiting resource for a particular CIP scenario although scenarios can also be constrained by a desired average overall condition or deficiency level (depending on the software). Activity unit costs and pavement areas are used to calculate the cost for doing one particular activity in the plan. The overall budget limits the number of activities that can be performed in a single year. The project team will develop a minimum of three budgets for this implementation:

- An “Unlimited Funds” budget which allows all feasible work to be performed in the first eligible year. This budget is used to test the MR&R Protocol and to calculate backlog.
- A “No Funds” budget which does not allow any capital improvement work (a budget of $0 for all plan years).

- A realistic budget based on planned funding availability.

Scenario Generation

At this point, CIP scenarios can be generated. Each scenario has several settings, but there are four critical settings:

- Budget – A particular budget to use for this scenario.
- Desired Condition – Settings that define a desired average condition level.
- Activity Lists and Feasibility Conditions – Scenarios can operate from different activity lists or different feasibility conditions. For example, a user may want to run scenarios where pavement overlays are placed later than recommended by the project team.
- Time Frame – The number of years a CIP should cover.

The result of a scenario is a CIP and average conditions at the end of each year of that CIP. The latter is shown in Figure 9. CIP results are a detailed list of activities to be performed each year on a segment-by-segment basis. Most pavement management software tools allow a user to commit certain projects due to factors such as capacity expansion, associated work (e.g., work performed in association with underground utility efforts), and ease of work and then reestablish the CIP. Through iterative efforts, the City can generate an accepted CIP to present to stakeholders and their citizens.

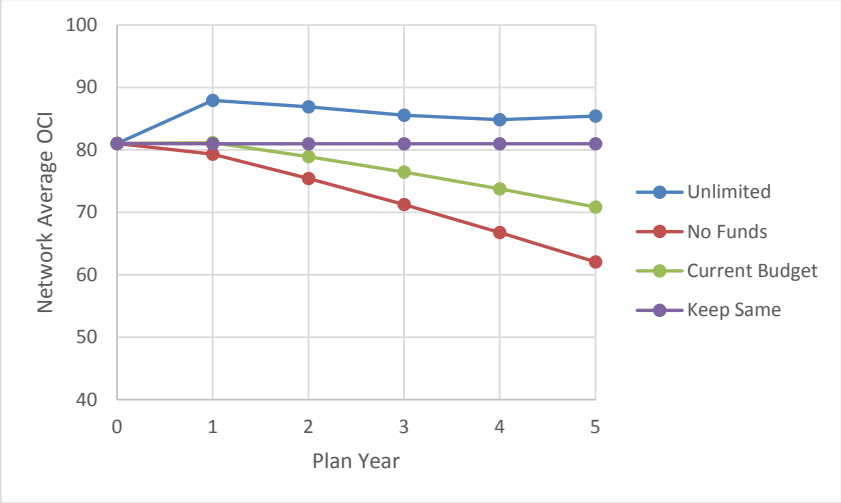


Figure 9. Example of a comparison of scenarios using average network conditions.

Testing Results

Like the quality control checks applied to data, the results of the analysis need to be tested. This is another reason "Unlimited Funding" and "No Funding" scenarios are created. The former allows the user to test the implementation of activities and the feasibility setup while both allow for the testing of the performance models versus real world expectations. As part of this project, the project team will examine the results of the initial scenarios created in the pavement management tool for expected performance.

Training

Effective training is a requirement for a successful implementation of a pavement management system. At ARA, we measure success by the ability of users to go into the system without assistance and either retrieve data or answer questions related to the pavement network (e.g., how much funding would we need to get to an average PCI of 80 in five years?).

As mentioned previously, training starts at the kickoff getting users involved in what we are doing and explaining why we are doing it. Training continues during data collection through items such as ridealongs in the DSV and participation in the selection of software tools. After initial acceptance of the data, the process of pavement management implementation requires the project team to work closely with LFUCG staff so that the configuration of the management portion of the software tools accurately reflects what LFUCG is currently doing and what they would like to do. Finally, a user should be able to use the documentation developed during this project to learn how to use the system.

Despite this, there is still some need for both classroom and one on one training. The project team will present a classroom style course covering two days on use and administration. Representatives from both ARA and GRW will be present. At the conclusion of this, we will conduct four hour, one on one sessions with two of the most frequent users of the system (the "power users").

In addition to standard training, the project team will also provide a presentation to the LFUCG Council, per the requirements presented in the RFP. This presentation will be led by one of ARA's principal engineers and vice presidents, William Vavrik, who has extensive experience in presenting this kind of information to upper-level government bodies. Dr. Vavrik will work with LFUCG staff to develop the presentation prior to the Council meeting.

Quality Control

The Quality Control (QC) process is critical to the success of this project and is performed as an integrated part of the project process so that any systematic issues can be identified and rectified as the project continues. This both improves the quality of the data and results and also minimizes the time required to complete the work. QC can be divided into individual processes according to the system needs. In this case, the quality control checks are divided into three phases. The raw data QC covers data collected directly from the field. Pavement condition evaluation QC covers the evaluations of the surface distress data by our in-house technicians. Finally, data upload QC covers the transfer of the data from ARA's systems to the pavement management software tools.

Raw Data QC

The DSV and its crew perform checks in the field to make sure the data recorded is viable and consistent. However, most of the QC performed with the raw data (e.g., data directly from the DSV computers) is performed upon receipt of the data in our Camp Hill, PA office. This subsection covers that raw data QC.

Phase I: Tracking & Archiving

During this phase, tracking the data is started. This includes what testing was performed (e.g., what pavement segments were covered) and the current state of quality control. As soon as the

tracking slip is complete (an electronic entry in our QC database), an archive of the data is created on the ARA network. This provides ARA with two copies of the data: the hard drives from the DSV and the full data store (all data shipped to the office) on the network.

Phase II: Image Quality Control

In this phase, ARA office personnel check all of the images to make sure that the image set is complete and the quality of the images is acceptable. The following steps are used during this phase:

Check for Missing Images

The DSV data includes a database of images that were collected as part of the survey. This is where georeference and linear reference data are stored for each image. This step assures that there is a matching image for each entry in the database. There may be cases where a few images may be missing (< 0.5% of the total images on a camera by camera basis). In this case, it is the decision of the project manager to accept the run or have it recollected. Typically, an isolated missing image does not cause a problem because the ASTM methodology uses sampling to calculate a distress index. However, if missing images are clustered, the run must be recollected to avoid an error in the evaluation phase of the project.

Check Image Quality

Once all images for a run are accounted for, a 10% sample is taken (every 10th image) and checked for quality. ARA technicians are looking for clear photos (small pavement distresses are easily seen and signs can easily be read) with correct colors and without any data distortion (e.g., corrupted images). ROW camera angles are also checked during this step. Poor image quality is usually systemic; a recollection is required if a run fails this check.

The one exception to this is corrupted images. If the number of corrupted images is small (< 0.5% of the total images on a camera by camera basis) the project manager ***may*** accept the run for the same reasons as accepting a run with missing images. However, if there are both missing and corrupted images, that number may not exceed the 0.5% total for both types of failure.

Check Image Interval

If the dataset has all the images and those images are of an acceptable quality, the next check is to make sure that the DSV collected the images at the appropriate interval. In this case, this should be every 20 feet. This check is performed against the data from the Distance Measurement Instrument (DMI) on the DSV which is included in the database sent with the images. There is a list of known flags ARA checks against when performing this work. These flags include:

- DMI values that are close to twice the stated project interval (39 to 41 feet in this case)
- DMI values much lower than the interval (<14 feet for this project)
- Number of images collected do not correlate with the known length of the segment

Usually, any failures in this check will cause the run to be recollected. There are a few special isolated cases where the data may be useful. If this is the case, the ARA project manager will make the decision and provide an explanation on the QC tracking form.

During the Image QC Process, all run files that have image quality issues and are accepted into the final database will be documented. The documentation will include identifying the image quality issue(s) encountered, which images are affected by which issue and the overall percent of images affected in the particular run file.

Phase III: Sensor & Calibration Checks

Finally, ARA checks the automatic data collected by the vehicle to make sure it is accurate and reasonable. These checks are performed after the image QC checks because they are the least likely to fail. Data for the onsite calibration location are taken every day.

GPS Data

GPS data is checked against the agency's existing data or publically available datasets if the agency does not have that data. In addition to checking against this baseline, the GPS logs are reviewed for outages and failures. This check fails if data deviates too far from the baseline or if a GPS outage occurs for more than 10 minutes. These checks rarely fail and are not typically seen in a summary QC report.

Calibration Data

Every day, the DSV performs calibration checks in the field including resolution checks for the downward camera, distance checks for the DMI, and IRI checks to ensure consistency in profile measurement. While this data is checked in the field, it is rechecked in the office by a senior technician. These checks include:

- Image Quality – A 100% survey of the daily calibration data is checked for quality according to the guidelines described earlier in this section.
- DMI – The calibration site is measured using a chalk line and measuring wheel. The DMI readings are compared every day to make sure they match this measurement.
- Sensor Settings – IRI and rutting are checked for reasonableness and consistency.
- GPS data – Collected latitude and longitude are compared against known values for the site.

Sensor Data

The laser sensors in the front bumper of the DSV are calibrated on our home test site before the vehicle is sent to the client's location. QC checks at the on-site calibration site check for consistency of the data as described in the calibration data section.

Evaluation QC

This process involves a multi-phase approach to ensure quality surface distress data. This process checks the distress ratings on randomly selected segments, global distress QC checks, and checks of the surface distress data produced.

Phase I: Distress Rating Review.

This phase covers performing random sampling of the segments surveyed by each rater within a set timeframe to ensure that they are rating the distresses correctly and consistently. This phase consists of the following items:

- Divide the segments into 20 segment lots, based upon the rater performing the data reduction and the timeframe in which the data reduction was completed.
- Randomly select 10% of the segments in each lot for quality control review
- Review the distress data recorded and compare it to the distress images. Review includes:
    - Are the distresses present on the image properly identified?
    - Is the severity of each distress correctly identified?
    - Is the extent of the distress correctly recorded?
- If both segments in the sample meet acceptable parameters, then the lot is accepted as passing.
- If one segment passes and the other fails, the lot is still accepted as passing. The rater is not required to correct mistakes within the failing lot. However, the rater will be provided with notification from the QC reviewer what problems were found so that the rater is aware of the problems that were found.
- If both segments in the sample fail, the lot fails. The rater is instructed in what was rated incorrectly and the segments within the lot containing the problem distress are flagged for review and possible correction.

Phase II: Global Distress QC

This phase covers programmatic "sanity" checks of the distress data and is performed on all segments. The following checks are performed:

Asphalt

- Block cracking and transverse/longitudinal cracking called together in the same frame.
- Block cracking and large patching in the same frame.
- Patching longer than 200 feet.
- Pavement changes to "Other" involving 10 frames (200 feet) or less.
- Raveling.

Concrete

- Joint seal damage.
- Transverse joints within 10 feet of one another.

All Pavement Types

- "No Distress" calls occurring along with one or more regular distress calls.

Upload QC

When data is moved from one source to another (such as moving raw DSV data to the RCIVe image database), checks should be performed to ensure that the transfer was complete and accurate. While this step will depend on the software tools selected, there are some typical checks that can be used.

First, record counts are very important; these ensure that all data in the evaluation database is copied into the appropriate software tool. Reasons that this might fail include communication errors, failed validation checks, or data format errors. Second is a comparison of PCI calculations between those the software makes and a secondary calculation. ARA uses an internal tool based on and calibrated to the US Army Corps of Engineers MicroPAVER software to calculate PCI

values independently. This independent calculation is compared to the software tool calculation to ensure that similar values are being calculated. Reasons this check may fail include software failures (a mistake in the software code itself), data format issues, and data transfer issues. Finally, a coverage check is performed to ensure that all surveyed sections have associated data in the pavement management system.

Experience

As with the prior chapters, this chapter is broken down into the individual experience of each firm participating in the project.

Applied Research Associates, Inc.

Metro Nashville & Davidson County, Tennessee

Client Information

Organizational Name	Metropolitan Nashville Public Works Paving Division
Official Address	939 Dr. Richard G. Adams Drive Nashville, TN 37207
Contact Person	Donald Reid
Contact Title	Director, Paving Operations
Number of Years in Use	10
Phone Number	(615) 880-3358

Description of Project

The metropolitan government of Nashville and Davidson County, a single entity responsible for both the County and City, maintains approximately 2,400 centerline miles of roadways encompassing many different street types from wide urban arterials to two lane rural roads. In 2003, ARA helped Metro's Paving Department modernize their pavement management system with new software, new data collection procedures, and improved procedures.

Metro Nashville PUBLIC WORKS

Pavement Management

In 2002, ARA performed a complete survey of Metro's paving network including the alleys found in many of the urban locations within Davidson County. Since then, ARA has performed condition assessments on the pavement network annually; each year half of the network is surveyed. Pavement surveys are performed in accordance with ASTM D6433 with modifications to meet the needs of Metro's paving staff. An example of these modifications is the automated raveling survey that determines the level of raveling on the pavement based on Mean Texture Depth (MTD) as measured by ARA's Digital Survey Vehicles (DSV).

Strategic Planning

In addition to ARA's monitoring of pavement condition and updating of the pavement management database (with the assistance of the Paving Department, of course), ARA and Metro have generated a publicly available, detailed plan for the maintenance of Metro's pavement network. This plan explains the basics of pavement management, the tools used by Metro (software and hardware), and the regulations Metro is required to address (local reporting requirements and GASB-34). It then goes on to discuss in detail the procedures used to select projects and the different rehabilitation options available to Metro engineers. These options consist of tried-and-

true methods used in Metro Nashville for years, state-of-the-practice paving methods used throughout the region, and new paving methods tested on samples of Metro pavement.

The complete guide can be downloaded at http://mpw.nashville.gov/Row/Paving/MasterPlan.aspx#.

City of Waynesboro, Virginia

Client Information

Organizational Name	City of Waynesboro, Virginia Public Works Department
Official Address	941 Fir Street Waynesboro, VA 22980
Contact Person	Chris Garrison
Contact Title	Engineering Assistant (GIS Specialist)
Phone Number	(540) 942-6624

Description of Project

The City of Waynesboro, with a population of approximately 21,000, has a road system of approximately 120 miles (or about 250 moving lane miles). The City is responsible for maintaining all pavements within the City limits. Most pavement maintenance funds are derived from the Virginia Department of Transportation's (VDOT) Urban Maintenance Program but some roads do not qualify for maintenance with these funds. To better maintain this paved network, ensure that VDOT funds are leveraged to maximize their effectiveness, and determine the funding requirements for those roads not funded by VDOT maintenance funding, the City contracted Applied Research Associates, Inc. (ARA) to implement a Pavement Management System (PMS).

Prior to this implementation, the City had implemented Cartegraph's asset management software to manage their water utilities (storm, potable, and sewer) along with the work management features of the software. Under this contract, the City expanded their system to include their pavement assets. ARA assisted the City through a thorough records review, GIS updates, field surveys via a DSV, and condition analysis of the pavement ride quality and surface condition. ARA helped the City's experienced staff load this data into the Cartegraph software and modify that software to produce a five year pavement management plan (PMP). The PMP is based on current conditions (as evaluated by ARA), current practices at the City, and suggested modifications to existing practices.

Lee County, Florida

Client Information

Organizational Name	Lee County, Florida Department of Transportation
Official Address	1500 Monroe Street Fort Myers, FL 33902
Contact Person	Randy Cerchie
Contact Title	County Engineer
Phone Number	(941) 479-8573

Description of Project

Lee County, located in Southwest Florida, maintains over 2,600 centerline miles of pavement and associated assets. In addition to the network the County is responsible for maintaining, it also must coordinate with the municipalities of Fort Myers, Cape Coral, Sanibel, Bonita Springs, and Fort Myers Beach. The County hired ARA in 2001 to provide an objective evaluation of their pavement network and to implement a new pavement management system. Since the initial implementation, ARA has performed updates of the network condition and helped the County implement a management system for their signage.

The initial round of pavement management was started in 2001 and was performed using handheld computers (Compaq iPaqs) and a windshield evaluation method developed from ASTM D6433. This method allowed an objective analysis of pavement condition to be performed by either ARA at the network level or by County personnel for evaluations between network-level pavement surveys. It also allowed the County to track issues that were County-specific such as drainage issues and level of occupancy for a particular residential road. County staff were paired with ARA technicians and engineers to train County personnel. Cartegraph's PAVEMENTview Plus software was selected for their pavement management needs after a review of several options was completed.

In 2005, ARA updated the pavement condition survey using its Digital Survey Vehicle (DSV). This method of data collection allowed the creation of a digital archive of pavement condition and a survey of roadside assets, particularly signage. Condition data was compared to the data collected in 2001 and 2002 and found to be comparable. The system was updated with new pavement deterioration models and modified to reflect the current rehabilitation alternatives the County was using due to the rapidly growing area and the price of raw materials.

ARA has returned to the County again in 2008 to update the condition of the County's arterial and collector network. The same technology used in 2005 (a DSV) was used to collect data. In this round, ARA has helped County staff answer several difficult questions related to the management and rehabilitation of pavement after a natural disaster and methods to reduce costs of pavement rehabilitation due to reduced budgets.

As of the 2008 contract, ARA returns to the County on an annual basis to update conditions for a part of their systems. While many of these data updates are routine, one unique update involved ARA using a single camera digital system and lightweight laser profiler to create a utility cart-based survey vehicle capable of collecting images and condition data for the County's asphalt bike paths. The County's bike paths are not adjacent to the streets (and, in some cases are not associated with streets at all) which means they cannot be evaluated through the DSV right-of-way cameras. The data collected using this system was enough to add the bike path network to the pavement management system; the County now includes bike path needs when it creates its annual rehabilitation program.

GRW

Town of Avon – GIS Pavement Management and Stormwater Services

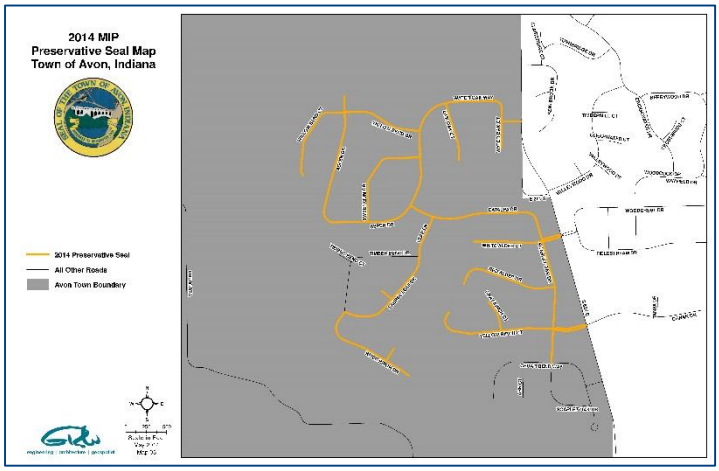
Client Information

Organizational Name	Town of Avon, Indiana
Official Address	E US Hwy 36 Avon, Indiana 46123
Contact Person	Ryan Cannon
Contact Title	Public Works Director
Phone Number	317-272-0948

Description of Project

GRW provided a variety of Engineering, Surveying, and GIS services for the Town of Avon, IN including Pavement Management and Stormwater services. The Stormwater work involved the GPS survey and GIS database development for Town's entire stormwater system including manholes, curb inlets, catch basins, pipe ends, headwalls, pipes, culverts, channels, and ditches.

As part of the Pavement Management work, GRW used data from the Pavement Surface Evaluation and Rating (PASER) Manual to provide roadway improvement recommendations for the Town of Avon, IN. The PASER system classifies roads on a scale of 1 to 10 with "10" being Excellent and "1" being "Failed". The PASER system also defines the general treatment measures for each of the classifications. Road area calculations, analysis and final map products were performed and delivered using ESRI ArcGIS software. Road repair and maintenance work was prioritized, budgeted and scheduled based on the PASER rating, meetings with the City, surface area and available budget. The final GIS database classified roads for repair using:



- Preservative Seal
- Crack and Seal
- Chip and Fog Seal
- Reconstruction/Resurface

The final GIS database was delivered in ArcGIS GeoDatabase format and all map products were delivered in Adobe PDF format.

Lexington-Fayette Urban County Government

GRW has worked with the Lexington - Fayette County Urban County Government (LFUCG) on dozens of Engineering, Mapping, Surveying and GIS projects over the past four decades. A small sampling of these project includes:

- Countywide Aerial Photography and Mapping
- Countywide GPS Monumentation (135 Monuments, 116 NGS Bluebook Monuments)
- Downtown 3D-Terrestrial Scanning Streetscape in Preparation for World Equestrian Games
- Stormwater Management
- Countywide Impervious Surface Mapping
- FEMA Map Modernization – Digital Flood Insurance Rate Maps (DFIRM)
- Liberty/Todds Road (KY 1927) Section 2- $9.5 M (Completion Fall 2015)
- Stormwater Supplemental Project Implementation/Master Planning/Program Manager - $430,000 (Ongoing)
- Red Mile Road Widening -$2M
- Town Branch 22 MG Wet Weather Flow Storage Basin- $19 M (Completion 2016)
- Expansion Area 2A Watershed Pumping Station and Force Mains - $4.8 M
- North Elkhorn Watershed Force Main and 19 MGD Pumping Station- $16 M

LFUCG References

Keith Lovan, Municipal Engineer Senior
(859) 258-3478
klovan@lexingtonky.gov

Charles Martin, Director of Division of Water Quality

(859) 425-2455
chmartin@lexingtonky.gov

Mark Fischer, Project Engineering Coordinator
(859) 258-3415
mfischer@lexingtonky.gov

Hall-Harmon

Hall-Harmon has extensive experience working with the LFUCG on various civil engineering projects. Many of these projects involve working with GRW. Those projects include:

- Newtown Pike Extension; LFUCG; Lexington, KY; subconsultant to Stantec Consulting Services for surveying and engineering services
- Cisco Road Survey; LFUCG; Lexington, KY; prime consultant for surveying services
- Florence Avenue Survey; LFUCG; Lexington, KY; prime consultant for surveying services
- Traffic Study Data Collection; LFUCG; Lexington, KY; subconsultant to Jordan, Jones and Goulding for data collection services for New Circle Road from Woodhill Drive to Boardwalk and Man O'War Blvd. from Sir Barton Way to Alumni Drive roadway study corridors
- Congestion Management Study; LFUCG; Lexington, KY; subconsultant to Jordan, Jones and Goulding for data collection services
- Hummons Subdivision; LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Cherokee Park; LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Updated 201 Plan for Lexington-Fayette County; LFUCG; Lexington, KY; subconsultant to Strand Associates (formerly PEH Engineers) for engineering services
- Bike Lane Study – Rose Street & Avenue of Champions; LFUCG; Lexington, KY; prime consultant for bike lane study services
- Alumni Drive Turn Lane and Bike Lane Improvements at Nicholasville Road: LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Streetscape Project; LFUCG; Lexington, KY; subconsultant to GRW Engineers for CADD services
- GPS Downtown Sewers; LFUCG; Lexington, KY; subconsultant to GRW Engineers for surveying services
- Maxwell Street Bike Lane and Sidewalk Improvements; LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Red Mile Road Widening; LFUCG; Lexington, KY; subconsultant to GRW Engineers for setting centerline, deed research, right of way and easements and storage lane calculations
- Todds Road; LFUCG; Lexington, KY; subconsultant to GRW Engineers for surveying services
- Beaumont Centre Roadway Widening; LFUCG; Lexington, KY; prime consultant for surveying and roadway design services
- LFUCG Infrastructure Construction Inspection Manual; LFUCG; Lexington, KY; subconsultant to Stantec Consulting Services (formerly FMSM Engineers) for erosion control chapter

- LFUCG Infrastructure Roadway Manual; LFUCG; Lexington, KY; subconsultant to Tetra Tech (formerly PDR Engineers) for writing four chapters
- Standard Drawings; LFUCG; Lexington, KY; prime consultant for updating of standard drawings
- LFUCG Standard Drawings Metric Study; LFUCG;, Lexington, KY; prime consultant for preparing study
- Clays Mill Road/Wellington Way Intersection Improvements; LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Clays Mill Road/Post Road Intersection Improvements; LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Walnut Hill-Chilesburg Road Closing; LFUCG; Lexington, KY; prime consultant for surveying and engineering services
- Palumbo Drive Intersection Improvements; LFUCG; Lexington, KY; prime consultant for surveying and engineering services

Local Employment & DBE Usage

In ARA's experience, the success of a pavement management system involves three factors:

1. The suitability of the tools and processes to the agency. Overly complicated systems or systems that do not recommend viable options are quickly shelved as the results are not easy to access or useful.
2. The accuracy of the supporting data. No matter the analysis process, decisions are based on the underlying data (road conditions, pavement attributes, engineering settings, etc.); if that data is inaccurate, the suggested plans will be sub-optimal.
3. The support processes for the users of the system. Support should be both knowledgeable and accessible so that problems can be dealt with quickly and agency users can return to their jobs: maintaining the pavement network.

ARA has found that local expertise can help with all three of these factors. They can ensure that the processes and treatments used in the system match the expectations and capabilities of both the agency and the local resources (contractors, in-house crews, etc.). As part of this project, ARA plans to work with two local team members: GRW and Hall-Harmon. GRW will work on GIS integration, software tool selection, and local software tool support while Hall-Harmon will provide a thorough records review, assist in the selection of pavement treatments for the planning modules of the pavement management system, calculation of the unit costs of those treatments, and on-site quality control of the data collection process. ARA plans to spend 20% of the project budget on subcontracts with these local firms.

ARA is also dedicated to helping the LFUCG meet the goals of its Minority Business Enterprise Program as described in the RFP. To meet those goals, ARA has included Hall-Harmon, a Woman Owned Business as part of the project team. Hall-Harmon will provide *at least* 10% of the work on this project as measured by costs incurred as a subconsultant to ARA.

Appendix A

Jacob Walter, P.E.
Senior Engineer

Professional Summary
Mr. Walter specializes in the implementation and maintenance of infrastructure and transportation asset management systems, the management of data collection and implementation projects, end-user training, mobile data collection techniques, and maintenance of the technology that supports these activities. Mr. Walter also has expertise in integrating asset management systems with other information systems. He is proficient in several different database management systems (Oracle, Microsoft Access, Microsoft SQL Server, and other custom systems), GIS (ESRI), pavement and asset management systems (RoadCare, PA Manager, Cartegraph, and MicroPAVER), and can create custom software when the client's needs call for a solution that is not commercially available.

Specialization
Over 17 years of experience as a civil engineer, specializing in the use of information technology to meet the objectives, needs, and requirements of the public works and transportation engineering industries.

Registration(s)
Professional Engineer – Ohio, 2004

Education
B.S., Civil Engineering, The George Washington University, 1996

Experience
North Texas Toll Authority – Project Manager
April 2002 – Present

The North Texas Tollway Authority (NTTA) network in the Dallas-Ft. Worth area contains approximately 850 lane miles of 4- to 6-lane urban, limited-access highways in addition to an off-network tunnel and pair of bridges. Mr. Walter serves as the project manager for the pavement data collection and reporting efforts for this client. This work includes collecting georeferenced digital images, ride quality measurement, surface friction testing, and other project and network-level testing required to comply with existing regulations, identify problem areas, and properly design rehabilitation approaches. The data collected in this project are used to create an annual update to the client's ten year capital improvement program and meet the NTTA's requirements regarding financial reporting in accordance with the Governmental Accounting Standards Board Rule 34 (GASB-34).

City of Nashville & Davidson County – Project Engineer and Manager
November 2003 – Present

The combined government of the City of Nashville, Tennessee and Davidson County is responsible for approximately 2,400 centerline miles of pavement within the County limits. Mr. Walter led the effort to choose, customize, and install the software for the pavement management system. The final system includes customizations to allow inline viewing of the digital images collected during the survey. Included in this effort was the transferring of the data from the data collection vehicle's native database to the selected software system. These data were integrated with data from Nashville's GIS and prior

pavement management systems. This work has continued with data updates and process refinements on an annual basis since the initial implementation. Since 2008, Mr. Walter has been the project manager responsible for overseeing this work, updating data for half the pavement network each year and implementing additional refinements to the system.

City of Arlington, TX – Project Engineer and Manager
May 2005 – May 2014

Mr. Walter assisted the City with the selection of software for their combined pavement, roadside asset, and work management system, which covers approximately 1,300 centerline miles of urban pavement. He worked with the City to customize the user interface for the pavement management system, create reports on pavement status, and upload pavement, lighting, and sign data into the system's database. He also integrated data from the former pavement management system into the new system and assisted the City with the setup of the GIS/asset management system integration. Mr. Walter also led the training effort for the end users and IT managers responsible for the smooth operation of the system.

In 2008, the City began annual updates to the pavement management system, surveying one third of the system every year and updating the asset management system software, reporting, and tools as needed. Mr. Walter manages this project and assists the City with determining the proper means to meet their goals and answer the questions of their stakeholders (public works management, the City's executive management, and the City's citizens). Recently, Mr. Walter has also help the City improve their system with the improved optimization and decision making tools in RoadCare Analysis and the implementation of a web-based image viewer to replace their existing desktop system.

Lee County, FL & City of Fort Myers, FL – Project Engineer and Manager
August 2001 – Present

In 2001, Mr. Walter used the existing City and County GIS (two different systems) to greatly increase the efficiency of pavement and asset data collection. This was done by developing software for a PocketPC based device and using the street centerline layer to populate the software with known data (street names, from and to street, pavement widths, surface types, and segment lengths). By using the connectivity information in the database, the handheld software was able to anticipate the next segment that the surveyor would evaluate, eliminating the time usually required to write down or find location information. Once the data were collected, they were added to the available data on street segments in the GIS. The results of pavement management analysis also were displayed in the system, allowing the City and County engineers to consider the locations of the projects in their long-term work plans. Mr. Walter also provided training and support for the software (collection and analysis) and the integration between the pavement management and GIS databases.

Since the initial survey in 2002, the County, City, and ARA have begun collecting data using ARA's fleet of digital survey vehicles (DSVs). At the beginning of this phase of the project, the DSV data had to be made to be compatible with data collected by hand to ensure that the County and City could continue inspections on their own as needed while incorporating the additional data the DSV can provide. Mr. Walter oversaw this integration and now manages the annual partial-network update.

City of Lincoln, NE – Project Engineer and Manager
January 2005 – February 2009

Mr. Walter served as the project manager for the pavement management updates at the City of Lincoln, Nebraska. This includes data updates, software tailoring, and user support. Mr. Walter performed the initial implementation of the software systems and provided training to the key personnel at the City. The software implementation and maintenance required extensive coordination with the City's GIS personnel, as both the pavement management system and the pavement centerline must continue to be compatible.

Illinois State Toll Highway Authority – Project Engineer and Manager
Illinois State Toll Highway Authority Pavement Management System
August 1999 – Present

Mr. Walter worked as a member of the team that implemented a pavement management system for the client's entire network. He developed the databases of distress, condition, and construction history for the network, then integrated that database with off-the-shelf software for the asset management system and GIS. In addition to the database work, he was part of the team that performed the quality control checks on the existing distress and condition information from 1997 through 1999. After the initial system was implemented, he trained the client's employees in the use of the GIS component of the system.

In 2000, ARA started to perform the pavement evaluations using our own equipment and staff. Mr. Walter led the data collection and evaluation projects for the data through 2002. This involved working with a staff of approximately 12 to 15 engineers and technicians to complete the data collection quickly and cost-effectively and provide useful improvements to the pavement management system. Since the 2002 surveys, Mr. Walter has served in a technical support role on this project.

Illinois State Toll Highway Authority Maintenance Management System
October 2002 – Present

Mr. Walter has lead the team that has developed and supports software for handheld GPS & Windows Mobile data collection (Trimble's GeoXT and Panasonic Toughbooks). This software enables field personnel to collect maintenance-related data on their pavement and roadside assets along with coordinates from the GPS either integrated into the hardware or connected via technologies such a Bluetooth. This software increases the productivity of field personnel, supervisors, quality control staff, and data entry personnel. It also allows them to collect additional information to create a more robust survey while collecting and verifying GIS data in the field. Since 2009, Mr. Walter serves in an advisory capacity on this project due to his relocation to the Pennsylvania office of ARA Transportation.

Illinois State Toll Highway Authority GIS Service
January 2004 – Present

Mr. Walter assisted in the development of a basemap for the Illinois Tollway and used the basemap to display pavement condition results (surface condition, current traffic, falling weight deflectometer test points, etc.) in the GIS. He also provided training on using the basic functionality of the Tollway's GIS (ESRI's ArcView) and led the development of the maintenance survey system software. After the first round of testing, the software was improved to collect data required for the Tollway's National Pollutant Discharge Elimination System (NPDES) reporting.

Illinois State Toll Highway Authority Signage Management System
September 2004 - Present

Mr. Walter is a member of the team that has developed and currently maintains the Tollway's sign management system. This work includes an annual update of the sign inventory based on the digital images collected for the pavement management project. Each sign is georeferenced using the GPS on the DSV and specialized software to determine a sign's offset from this measurement. The project team also implemented Cartegraph's SIGNview software to manage and report on the inventory.

City of Denton, TX – Project Engineer
May 2003 – February 2004

Mr. Walter managed all software-related aspects of this pavement management system implementation. This included software selection, customization, installation, and training. He determined what was required by the users of the system, provided required information to the data collection teams, and uploaded the results of data collection into the City's asset management database. He provided the city with georeferenced photography collected during a pavement condition evaluation. The data were provided in two parts: the digital images and a database containing image identification and GPS positioning. In addition, the "iron in the street" (manholes, drop inlets, etc.) was inventoried and integrated into the current GIS. The City now displays these data through an ArcIMS implementation on their intranet.

Long Term Pavement Performance Program, North Central Region – Database Manager
June 2000 – July 2003

Mr. Walter was responsible for overseeing the electronic storage of data collected by a field staff of 15 engineers and technicians related to the Long Term Pavement Performance Program (LTPP) conducted by the Federal Highway Administration. Duties in this position included quality control of field data, management of data entry operations, implementation of data integrity and disaster recovery plans, training, and maintenance of the hardware and software components of the system.

City of Griffin, GA – Project Engineer
June 2000 – February 2001

As a member of the team that implemented the pavement management system for this client, Mr. Walter integrated ARA's pavement management software with the City's GIS to store and display current and predicted results calculated by ARA's software. In addition to this integration, he wrote software to display images taken during the survey along with curb, gutter, and sidewalk condition data. Later, this tool was expanded to include data from a sign inventory performed by another consultant.

Darin D. Leydig
Field Operations Manager

Professional Summary
Mr. Leydig joined ARA in September 2003, through ARA's acquisition of CGH Pavement Engineering, Inc. Mr. Leydig has over 23 years of experience and is responsible for managing field pavement survey operations, equipment, and technicians for the ARA Camp Hill, PA office. Mr. Leydig troubleshoots and repairs automated pavement distress data collection systems and is responsible for coordinating routine and preventive maintenance and major repairs of the company's pavement survey vehicles.

Specialization
Over 23 years of experience as an engineer, specializing in the use of information technology to meet the objectives and requirements of the public works and transportation engineering industries in field survey operations.

Education
B.S., Electrical Engineering Technology, University of Pittsburgh, 1991

Experience
Mr. Leydig's duties include the following:
- Develops improvements to the company's pavement survey systems hardware.
- Manages vehicle budgets and cost centers.
- Hires and trains employees in operation and repair of the company's survey vehicles.
- Produces cost estimates for engineering projects and selects vendors and equipment for new systems hardware.
- Obtains necessary survey system and operator certifications from various agencies as required.
- Schedules field personnel; coordinates travel and lodging.
- Advises others on various survey system capabilities and applications for clientele.
- Operates and maintains ARA's digital video asset management data collection systems, as well as high-speed and lightweight road profilers, surface friction testing equipment, SURPro inclinometer, FWD, and HWD.

Some of Mr. Leydig's other positions with ARA/CGH have included the following:

Crew Leader, Field Survey Technician
- Supervised survey personnel assigned to assist in pavement distress survey operations. Responsible for the preparation and submission of daily progress reports, expense reports, preventive maintenance logs, Atroll reports, shipping of film, trucker's log sheets, timesheets, and illumination graphs for lighting system on pavement test vehicle.
- Managed and maintained daily operations of field survey, which included facsimile and phone contact with office supervisor, reviewing schedules, and decisions on when and where to start and stop operations.
- Performed routine maintenance and troubleshooting of electronics. Located and coordinated truck maintenance. Performed quality control on all field operations. Responsible for conducting demonstrations of pavement survey equipment for transportation agencies.

Field Survey Technician

- Assisted the field crew leader in conducting survey operations, preparation of daily reports, check sheets, graphs, maintenance logs, shipping film media, and performing quality control tests.
- Assisted the field crew leader in cleaning controllers, computer, unit interior and exterior, and checking the entire truck for needed repairs. Responsible for timesheets, expense reports, and truckers logs. Responsible for the safe operation of the ROADRECON vehicles.

Other Project Experience

FHWA-LTPP: Managed field pavement survey operations and technicians, repaired automated pavement distress data collection systems as needed, operated data collection equipment
City of Denton, TX: Managed field pavement survey operations and technicians
City of Colleyville, TX: Managed field pavement survey operations and technicians
City of Regina, SK: Managed field pavement survey operations and technicians
City of Greenwich, CT: Managed field pavement survey operations and technicians
City of Arlington, TX: Managed field pavement survey operations and technicians
City of Nashville, TN: Managed field pavement survey operations and technicians, coordinated with project manager on GIS mapping and routing
Washington, DC: Managed field pavement survey operations and technicians, managed routing and planning of actual survey, performed routine and preventive maintenance on data collection survey systems
FHWA-Eastern Federal Lands: Managed field pavement survey operations and technicians
Koch Performance Roads: Warranty testing
Wisconsin rutting surveys: Warranty testing
PA turnpike Warranty: Warranty testing
Staunton, VA: Warranty testing
Knoxville, TN airports: Digital pavement condition surveys
Newark International Airport: Digital pavement condition surveys
JFK International Airport: Digital pavement condition surveys
Boston Logan International Airport: FWD testing
NTTA North Texas Tollway Authority: Digital pavement condition surveys
PA turnpike: Friction testing, digital video log, IRI, and rutting data collection
Sea to Sky-Vancouver, BC: Managed field pavement survey operations and technicians

Kristi Eckrich

Infrastructure Asset Data Reduction Manager

Professional Summary

Ms. Eckrich has over 15 years of experience in extracting infrastructure asset management data from images and data collected using automated infrastructure asset management data collection methodologies. She has managed ARA's data reduction section since 2005, and she oversees the analysis of pavement distress and roadside asset data from the images collected during ARA's automated pavement/asset management surveys.

Ms. Eckrich is familiar with several data extraction tools, including ICC workstation software, Geo-3D's Trident 3D Analyst, and numerous custom applications developed in-house. She is also knowledgeable in a number of pavement distress analysis methodologies, including FHWA's LTPP, MicroPAVER (ASTM D5340 & D6433), PASER, PennDOT (Pub 336), and a variety of State and municipal methodologies, including Delaware DOT and Wisconsin DOT.

Ms. Eckrich performs initial distress data quality control reviews and roadside asset inventory quality control checks. She is also responsible for developing and implementing procedures and tools for training ARA's data reduction technicians.

Ms. Eckrich was also team leader for pavement distress data reduction on ARA's LTPP project with FHWA (2003-2005). She was responsible for managing the research grade data reduction effort of her team and performing quality control reviews of the data extracted.

Between 1999 and 2003, she was a data reduction technician working on the ARA's LTPP Distress Measures project, and other projects as needed.

Ms. Eckrich has worked on all of the automated ASTM data collection projects conducted by the ARA Pennsylvania office in the past 10 years. Her efforts included distress data analysis, quality control, and training others in the ASTM distress analysis methodologies.

Specialization

Pavement Distress Data Reduction
Roadside Asset Inventory Data Reduction
Data Quality Control

Education

B.S. Meteorology, Millersville University, Millersville, PA, 1997

Continuing Education

MicroPAVER Course, University of Illinois Champaign-Urbana, IL, 1999
LTPP Distress Rater Accreditation Course, FHWA, 2000-2004

Experience

ASTM distress data analysis & quality control

Washington, DC; Arlington, TX; Waynesboro, VA; Colleyville, TX; Greenwich, CT; Nashville, TN; Lee County, FL; US Air Force and US Marine Bases; Lincoln Tunnel, Holland Tunnel, Port Elizabeth and Laguardia International Airport (New York Port Authority); VA I-895 ; Lincoln, NE

Distress data analysis & quality control using State & Municipal Proprietary Methodologies

Andrews Air Force Base, Wisconsin DOT; Knoxville, TN Airports; VA Route 460, PA I-81, Route 1 in New Brunswick, KOCH Performance Roads, North Texas Tollway Authority (CRS methodology)

Asset Inventory Data Collection

Washington, DC; Arlington, TX; Lee County, FL; North Texas Tollway Authority

Awards

Transportation Sector Distinguished Technician, 2006

William R. Vavrik, Ph.D., P.E.

Vice President & Principal Engineer

Education

Ph.D., Civil Engineering, 2000, University of Illinois Urbana-Champaign
M.S., Civil Engineering, 1997, University of Illinois Urbana-Champaign
B.S., Civil Engineering, 1995, University of Illinois Urbana-Champaign

Registrations

Professional Engineer – Illinois #062-055022
Professional Engineer – Texas #112431

Affiliations

Transportation Research Board, member
American Society of Civil Engineers, member
National Society of Professional Engineers, member
Illinois Society of Professional Engineers, member
Association of Asphalt Paving Technologists, member

Publications & Presentations

Over 30 peer reviewed publications. Over 50 invited presentations.

Professional Summary

Dr. Bill Vavrik is a Vice President and Principal Engineer and director of the research and technology deployment group in the Transportation Infrastructure Division of Applied Research Associates, Inc. He joined ARA in 2000 and has been responsible for a diverse project portfolio including projects in pavement engineering, management, evaluation, materials, and design, as well as transportation research, technology transfer, forensics, sustainability, operations & maintenance, and software implementation.

Throughout his career, Dr. Vavrik has held a taken variety of responsibilities in project delivery, including program manager, project manager, quality manager, technical expert, subject matter expert, and project engineer. Dr. Vavrik has delivered a diverse project portfolio, including projects in pavement management system implementation and update, pavement evaluation, materials, design, research, technology transfer, and forensics, infrastructure asset management, maintenance management, sustainability, and software implementation. He has experience in diverse infrastructure applications, including local roads and streets, rural roads, highways, airports, ports, and intermodal yards. His experience includes multiple project delivery types including design-bid-build, design-build (DB), design-build-finance-operate-maintain (DBFOM), and public private partnership (P3). This breadth of experience provides a depth in understanding the components of a successful team and the required actions to get the job done.

Dr. Vavrik is dedicated to ARA's operating principals of technical excellence, responsiveness, effective communication, strong fiscal and schedule control, individual and corporate acceptance of responsibility, and frank, open and ethical dealings with each other, our clients and our partners.

Representative Experience

Pavement/Infrastructure Management Services – *Illinois State Toll Highway Authority*. Dr. Vavrik served as the program manager and principal-in-charge for a comprehensive infrastructure asset management, pavement design, and technical assistance program. As part of this program, Dr. Vavrik has designed hundreds of miles of new and rehabilitated interstate pavements with a construction value of several billion dollars.

Pavement Management System Implementation – *Harris County Toll Road Authority*. Dr. Vavrik served as technical expert and quality control manager a pavement management system implementation that uses traditional PMS methods and advanced capital and maintenance programming. Dr. Vavrik presents the results of this work to the engineering management of HCTRA.

Pavement Management System Implementation – *Fort Bend County Toll Road Authority.* Dr. Vavrik served as technical expert and quality control manager a pavement and transportation asset management system implementation. Dr. Vavrik presented the results of this project to the FBCTRA Board of Directors.

Pavement Management System Implementation – *Champaign County, IL.* Dr. Vavrik served as technical expert and quality control manager for the first of its kind pavement management system that is based on traditional PMS methods and the Rolling Wheel Deflectometer. Dr. Vavrik presents the results of this work to the Champaign County Board.

Pavement Management System Implementation – *Sangamon County, IL.* Dr. Vavrik served as technical expert and quality control manager a pavement management system implementation that uses traditional PMS methods, the Rolling Wheel Deflectometer, and advanced capital and maintenance programming. Dr. Vavrik presents the results of this work to the Sangamon County Board and its Transportation Committee.

Pavement Management System Implementation – *Kane County, IL.* Dr. Vavrik served as technical expert and quality control manager a pavement management system implementation that uses traditional PMS methods, the Rolling Wheel Deflectometer, and advanced capital and maintenance programming.

Pavement Management System Implementation – *DuPage County, IL.* Dr. Vavrik served as technical expert and quality control manager a pavement management system implementation that uses traditional PMS methods and advanced capital and maintenance programming.

Pavement Management System Implementation – *McHenry County, IL.* Dr. Vavrik served as technical expert and quality control manager a pavement management system implementation that uses traditional PMS methods, the Rolling Wheel Deflectometer, and advanced capital and maintenance programming.

Jefferson M. Davis
Computer Scientist

Professional Summary
Mr. Davis is a computer scientist responsible for developing and implementing user applications and utilities, both for clients and for intraoffice activities. He also is responsible for maintaining the integrity of raw field data and processing the raw sensor data for engineering analysis. Mr. Davis leads efforts to process pavement condition data to meet each client's specific needs and deliver data in a format useful to the client.

Specialization
Specializes in the use of information technology to meet the objectives and requirements of the public works and transportation engineering industries.

Education
B.S., Computer Science, Pennsylvania State University, 2003

Experience
Pavement Management Software

Mr. Davis has experience working with various pavement management software packages, such as MicroPAVER, Cartegraph, and RoadCare. Most pavement management software contains very similar analysis and procedural requirements, but each has different formatting, loading, and summarization requirements. Mr. Davis's challenge and responsibility is to develop software and SQL scripts unique for each client in order for the data to be loaded into the pavement management software.

Computer Programming (Visual C++, Unix C, SQL, HTML & UML)

- Teamed with members of the data collection team and developed a C++ application that allowed ARA to match collected GPS data to collected image data as part of our quality assurance procedure. This application is used for all projects.
- Developed a C++ application to organize digital images collected during survey to a client's pavement management sections. This application is customized to meet each client's software applications and formats.
- Developed an Android-based data collection application that can run on Nexus tablets.

Database Applications

- Teamed with the ARA Pennsylvania office's data reduction team to create C++ and SQL scripts that allowed the supervisor to produce quality control reports on their work. These applications are used on all projects.
- Helped develop a software application to collect, validate, and summarize lane information.
- Developed an application to validate and summarize attribute information.
- Developed an application to produce a quick PCI to provide feedback to project managers.

Computer Hardware

- Provided help in troubleshooting software-related issues in ARA's field equipment.
- Assists the LAN Manager in managing the Pennsylvania office network.

Representative Projects

City of Lincoln NE 2005 & 2008 - Mr. Davis was responsible for collecting, summarizing, and performing quality control checks on the collected pavement distress data. These checks included comparing the data to previous surveys to ensure consistency in procedures both during the current survey and across multiple surveys. He was also responsible for collecting, processing, and delivering digital images to the client in a format acceptable to both the engineering staff and the IT staff.

City of Arlington TX 2005, 2008-2012 - Mr. Davis was responsible for collecting and summarizing pavement distress data. He also ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

Metro Nashville and Davidson County 2003 to Present - Mr. Davis was responsible for collecting and summarizing pavement distress data. He also designed a program to read ICC texture reports to detect weathering in a section based on client-specific parameters. He then uploaded the data into Cartegraph PAVEMENTview Plus and ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

Lee County, FL 2006-2007, 2009-Present - Mr. Davis was responsible for collecting and summarizing pavement distress data. He then uploaded this data into Cartegraph PAVEMENTview Plus and ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He also implemented a Cartegraph SIGNview database to store signs and attribute data for those signs. He was also responsible for collecting, processing, and delivering digital images to the client. For this project, in addition to the PAVEMENTview Plus and SIGNview systems, ARA also implemented RoadCare asset management software to view the digital image collected during survey.

Washington D.C. Pavement Distress Surveys 2003 to 2012 - Mr. Davis was responsible for collecting and summarizing pavement distress data. He then uploaded this data into MicroPAVER and ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client. ARA also implemented and maintains RoadCare asset management software for this effort.

US Air Force Bases 2003 to 2010 - Mr. Davis has worked on various Air Force bases throughout the United States. He was responsible for collecting and summarizing pavement distress data. He then uploaded this data into MicroPAVER and ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

US Marine Bases 2009 to 2010 - Mr. Davis has worked on various Marine bases throughout the United States. He was responsible for collecting and summarizing pavement distress data. He then uploaded this data into MicroPAVER and ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

Collier County FL 2006 - Mr. Davis was responsible for collecting and summarizing pavement distress data. He then ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

City of Toronto 2008 - Mr. Davis was responsible for collecting and summarizing pavement distress data. He then wrote a utility to associate the IRI data collected with the summarized distress data. Then he ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

Waynesboro, VA 2012 - Mr. Davis was responsible for collecting and summarizing pavement distress data. He then wrote a utility to associate the IRI data collected with the summarized distress data. Then he ran quality assurance checks on the newly uploaded data and compared it to previous surveys to ensure quality data. He was also responsible for collecting, processing, and delivering digital images to the client.

Delaware Department of Transportation 2009 to 2011 - Mr. Davis was responsible for collecting pavement distress data. He then ran quality assurance checks on the collected distress data. He also collected and summarized IRI and rutting data and placed it into the client's specified format. He was also responsible for collecting, processing, and delivering digital images to the client.

Koch Performance 2008 to 2012 - Mr. Davis was responsible for collecting pavement distress data. He then ran quality assurance checks on the collected distress data. He also collected and summarized IRI and rutting data and placed it into the client's specified format.

WI Warranty 2011 to 2012 - Mr. Davis was responsible for collecting pavement distress data. He then ran quality assurance checks on the collected distress data. He also collected and summarized IRI and rutting data and placed it into the client's specified format.

R1G 2011 to 2013 - Mr. Davis was responsible for collecting and summarizing pavement distress data and places it into the client's specified format. He also implemented asset manangement software to view the digital image collected during survey.

New York and New Jersey Port Authority 2009 to 2012 - Mr. Davis was responsible for collecting pavement distress data. He then ran quality assurance checks on the collected distress data. He also collected and summarized IRI and rutting data and placed it into the client's specified format.

IL Tollway MQA Survey 2012 – Mr. Davis developed a mobile application that was based on the Android operating system. The application was used to aid in the collection of certain maintenance-related data. The data that was collected was then loaded into data tables to be QC and processed for final data delivery.

GRW

Rob Hench, GISP
GIS Manager

Mr. Hench is the GIS Manager and Technical Advisor of our GIS Division. With over twenty-five years of experience, he has specialized expertise in all areas of GIS database design and development, ensuring quality control for GIS projects. Mr. Hench oversees GIS needs analysis, implementation, development, and data conversion. He has managed numerous complex GIS projects for utility companies, cities, counties, state, and federal clients. His skills include managing the components of a GIS, from collection to custom design and on-site support. A certified Geographic Information System Professional, he is extremely proficient with the leading GIS software. Under Mr. Hench's guidance, GRW has successfully implemented award-winning GIS programs across the nation. A sample of recent projects accomplished by Mr. Hench is shown below.

Town of Avon, IN – GIS Manager, GRW provided a variety of Engineering, Surveying, and GIS services for the Town of Avon, IN including Pavement Management and Stormwater services. As part of the Pavement Management work, GRW used data from the Pavement Surface Evaluation and Rating (PASER) Manual to provide recommendations for the Town of Avon, IN. Road area calculations, analysis and final map products were performed using ESRI ArcGIS software. Road repair and maintenance was prioritized, budgeted and scheduled based on the PASER rating, meetings with the City, surface area and available budget.

City of Mobile, AL – GIS Manager. GPS surveying and GIS processing for the Mobile, Alabama storm, water and sanitary sewer utility systems. The GPS inventory covered approximately 75,000 features including inlets, manholes, catch basins, fire hydrants and valves. All utility systems were delivered in ArcGIS GeoDatabase format with full geometric network connectivity supporting upstream traces, downstream traces and isolation traces. A variety of custom ArcGIS applications were developed including web-based GIS hosting, address matching, automatic feature ID numbering and customized feature editing tools.

Lexington-Fayette Urban County Government, KY - GIS Manager. Accomplished a comprehensive impervious surface mapping project covering all of Fayette County, Kentucky. The data was digitized from the 2007 Lexington-Fayette Urban County Government digital orthophotography and was delivered in ESRI Personal GeoDatabase format.

Louisville Water Company, KY - Project Manager. GRW has accomplished multiple GIS projects for the Louisville Water Company since 2002. Tasks have included extensive data collection, the production of a GIS database in ArcInfo SDE Geodatabase format, water utility mapping, data conversion, as-built scanning and custom application development, ongoing maintenance, and development of a Plant Drawing Management System.

Kitty Hall-Harmon, PE, PLS
Principal Engineer / Project Manager

Kitty is a principal engineer and project manager for HHE with over 37 years of practical experience with specific work experience in land surveying, roadway design, site development, site utilities, sanitary sewers, storm water management, and ADA compliance. She is responsible for the firm's administration and provides project management and QA/QC reviews for HHE projects.

Kitty has an extensive background in surveying, design and construction document preparation with various clients, including: Lexington-Fayette Urban County Government (LFUCG), Kentucky Finance and Administration Cabinet (KFAC), Blue Grass Airport (BGA), US Army Corps of Engineers (USCOE), Kentucky Department of Transportation (KYTC), various A/E firms and private clients.

Registration:

Professional Engineer -
- *Kentucky, #15,486, 1988*
- *West Virginia, #12,407, 1994*

Professional Land Surveyor -
- *Kentucky, #3,267, 1995.*
- *West Virginia, #1,502, 1995*

Education:

University of Kentucky -
- *Bachelor of Science in Civil Engineering, 1983*

Lexington Technical Institute -
- *Associate of Applied Science in Civil Engineering, 1980*

Relevant Experience: HHE Principal Engineer / Project Manager -

- *Terminal Drive Pavement Rehabilitation Survey and Design; Blue Grass Airport; Lexington, KY; BGA / GRW Engineers*
- *Todds Road Survey; Lexington, KY; LFUCG / GRW Engineers*
- *Town Branch WWTP Wet Weather Storage Facility Survey and Design; Lexington, KY; LFUCG / GRW Engineers*
- *Maxwell Street Sidewalks and Bike Lane Survey and Design; Lexington, KY; LFUCG*
- *Alumni Drive Bike Lane and Turn Lane Survey and Design; Lexington, KY; LFUCG*
- *Rose Street Bike Lanes Survey and Design; Lexington, KY; LFUCG*
- *Downtown Lexington Traffic Movement and Revitalization Study – UST / HazMat Overview and Traffic Data Collection; Lexington, KY; LFUCG / Stantec Consulting Services*
- *Southend Park Survey and Design; Lexington, KY; LFUCG / Stantec Consulting Services*
- *Hummons Subdivision Survey and Design; Lexington, KY; LFUCG*
- *Clays Mill Road & Wellington Way and Clays Mill Road & Post Road Intersection Improvements Survey and Design; Lexington, KY; LFUCG*

Appendix B

AFFIDAVIT

Comes the Affiant, Curt A. Beckemeyer, P.E., and after being first duly sworn, states under penalty of perjury as follows:

1. His/her name is Curt A. Beckemeyer, P.E. and he/she is the individual submitting the proposal or is the authorized representative of Applied Research Associates, Inc., the entity submitting the proposal (hereinafter referred to as "Proposer").

2. Proposer will pay all taxes and fees, which are owed to the Lexington-Fayette Urban County Government at the time the proposal is submitted, prior to award of the contract and will maintain a "current" status in regard to those taxes and fees during the life of the contract.

3. Proposer will obtain a Lexington-Fayette Urban County Government business license, if applicable, prior to award of the contract.

4. Proposer has authorized the Division of Central Purchasing to verify the above-mentioned information with the Division of Revenue and to disclose to the Urban County Council that taxes and/or fees are delinquent or that a business license has not been obtained.

5. Proposer has not knowingly violated any provision of the campaign finance laws of the Commonwealth of Kentucky within the past five (5) years and the award of a contract to the Proposer will not violate any provision of the campaign finance laws of the Commonwealth.

6. Proposer has not knowingly violated any provision of Chapter 25 of the Lexington-Fayette Urban County Government Code of Ordinances, known as "Ethics Act."

Continued on next page

7. Proposer acknowledges that "knowingly" for purposes of this Affidavit means, with respect to conduct or to circumstances described by a statute or ordinance defining an offense, that a person is aware or should have been aware that his conduct is of that nature or that the circumstance exists.

Further, Affiant sayeth naught.

Curt A Beckemeyer

STATE OF ILLINOIS

COUNTY OF CHAMPAIGN

The foregoing instrument was subscribed, sworn to and acknowledged before me by Curt A. Beckemeyer, P.E. on this the 16th day of March, 2015.

My Commission expires: 04/06/2016

OFFICIAL SEAL
DEBRA L. TIFFAN
NOTARY PUBLIC, STATE OF ILLINOIS
MY COMMISSION EXPIRES 4/06/16

Debra L Tiffan

NOTARY PUBLIC, STATE AT LARGE

Debra L. Tiffan

EQUAL OPPORTUNITY AGREEMENT

The Law

- Title VII of the Civil Rights Act of 1964 (amended 1972) states that it is unlawful for an employer to discriminate in employment because of race, color, religion, sex, age (40-70 years) or national origin.

- Executive Order No. 11246 on Nondiscrimination under Federal contract prohibits employment discrimination by contractor and sub-contractor doing business with the Federal Government or recipients of Federal funds. This order was later amended by Executive Order No. 11375 to prohibit discrimination on the basis of sex.

- Section 503 of the Rehabilitation Act of 1973 states:

  The Contractor will not discriminate against any employee or applicant for employment
  because of physical or mental handicap.

- Section 2012 of the Vietnam Era Veterans Readjustment Act of 1973 requires Affirmative Action on behalf of disabled veterans and veterans of the Vietnam Era by contractors having Federal contracts.

- Section 206(A) of Executive Order 12086, Consolidation of Contract Compliance Functions for Equal Employment Opportunity, states:

  The Secretary of Labor may investigate the employment practices of any Government
  contractor or sub-contractor to determine whether or not the contractual provisions specified in Section 202 of this order have been violated.

****

The Lexington-Fayette Urban County Government practices Equal Opportunity in recruiting, hiring and promoting. It is the Government's intent to affirmatively provide employment opportunities for those individuals who have previously not been allowed to enter into the mainstream of society. Because of its importance to the local Government, this policy carries the full endorsement of the Mayor, Commissioners, Directors and all supervisory personnel. In following this commitment to Equal Employment Opportunity and because the Government is the benefactor of the Federal funds, it is both against the Urban County Government policy and illegal for the Government to let contracts to companies which knowingly or unknowingly practice discrimination in their employment practices. Violation of the above mentioned ordinances may cause a contract to be canceled and the contractors may be declared ineligible for future consideration.

Please sign this statement in the appropriate space acknowledging that you have read and understand the provisions contained herein. Return this document as part of your application packet.

Bidders

I/We agree to comply with the Civil Rights Laws listed above that govern employment rights of minorities, women, Vietnam veterans, handicapped and aged persons.

Curt A Beckemeyer

Signature

Curt A. Beckemeyer, P.E.
Senior Vice President

Applied Research Associates, Inc.

Name of Business

WORKFORCE ANALYSIS FORM

Name of Organization: Applied Research Associates, Inc. - Transportation Sector

Date: 3 / 16 / 2015

Categories	Total	White		Latino		Black		Other		Total	
		M	F	M	F	M	F	M	F	M	F
Administrators	8		7				1				8
Professionals	77	48	7	2		2		15	3	67	10
Superintendents											
Supervisors											
Foremen											
Technicians	33	27	4			1			1	28	5
Protective Service											
Para-Professionals											
Office/Clerical	12	4	8							4	8
Skilled Craft											
Service/Maintenance											
Total:	130	79	26	2		3	1	15	4	99	31

Prepared by: Robin L. Jones, Transportation Sector HR Administrator

Name & Title

DIRECTOR, DIVISION OF CENTRAL PURCHASING
LEXINGTON-FAYETTE URBAN COUNTY GOVERNMENT
200 EAST MAIN STREET
LEXINGTON, KENTUCKY 40507

NOTICE OF REQUIREMENT FOR AFFIRMATIVE ACTION TO ENSURE EQUAL EMPLOYMENT OPPORTUNITIES AND DBE CONTRACT PARTICIPATION

Notice of requirement for Affirmative Action to ensure Equal Employment Opportunities and Disadvantaged Business Enterprises (DBE) Contract participation. Disadvantaged Business Enterprises (DBE) consists of Minority-Owned Business Enterprises (MBE) and Woman-Owned Business Enterprises (WBE).

The Lexington-Fayette Urban County Government has set a goal that not less than ten percent (10%) of the total value of this Contract be subcontracted to Disadvantaged Business Enterprises, which is made up of MBEs and WBEs. The goal for the utilization of Disadvantaged Business Enterprises as subcontractors is a recommended goal. Contractor(s) who fail to meet such goal will be expected to provide written explanations to the Director of the Division of Purchasing of efforts they have made to accomplish the recommended goal, and the extent to which they are successful in accomplishing the recommended goal will be a consideration in the procurement process. Depending on the funding source, other DBE goals may apply.

For assistance in locating MBE/WBE Subcontractors contact Marilyn Clark at 859/258-3320 or by writing the address listed below:

Marilyn Clark, Division of Central Purchasing
Lexington-Fayette Urban County Government
200 East Main Street – Room 338
Lexington, Kentucky 40507
mclark@lexingtonky.gov

Firm Submitting Proposal: Applied Research Associates, Inc.

Complete Address: 3605 Hartzdale Drive Camp Hill, PA 17011
Street City Zip

Contact Name: Jacob Walter, P.E. Title: Senior Civil Engineer

Telephone Number: 717-975-3550 Fax Number: 717-975-3557

Email address: jwalter@ara.com

Appendix C

AFFIRMATIVE ACTION PROGRAM
for WOMEN and MINORITIES

ARA
Company

Transportation Sector
Establishment

100 Trade Centre Drive, Ste. 200
Street Address

Champaign, IL 62820
City and State

Program Completed by: **Beth James, Human Resources Director**

Telephone Number: **505-881-8074**

TABLE OF CONTENTS

CONFIDENTIALITY OF RECORDS

This affirmative action program contains confidential, trade secret and commercial information protected from disclosure by the Office of Federal Contract Compliance Programs pursuant to 18 U.S.C. 1905. In addition, exemptions 3 and 4 of the Freedom of Information Act (FOIA) protect information in this document from mandatory disclosure to FOIA requestors. See, e.g., Chrysler v. Brown, 441 U.S. 281 (1979). The release of any trade secret, confidential statistical or commercial information would be arbitrary and capricious in violation of the Administrative Procedure Act. See, e.g., CAN Financial Corp. v. Donovan, 830 F.2d 1132, 1144 and N.73 (D.C. Cir.), cert. Denied, 485 U.S. 977 (1988).

If supplied to a public official or representative of a governmental agency, whether pursuant to review proceedings or otherwise, it is understood that it is for review only, or examination for authorized purposes and may not be retained, copied or made available to others without receipt of express written permission of a duly authorized representative of our firm.

PRELIMINARY STATEMENT

This affirmative action program has been voluntarily prepared as a reaffirmation of the company's commitment to equal employment opportunity and affirmative action. In preparation of the program, the terminology used in Executive Order 11246 and its implementing regulations has been used as a guide. Therefore, the use of such terms as "placement goal", "expected number", "problem area", "utilization", "distribution", etc., should not be construed as an admission that in fact either minorities or women have been or presently are being discriminated against in any way in violation of federal, state or local fair employment practice laws. Further, nothing contained in this material or the data supporting this program should be construed as an admission that any such federal, state or local fair employment practice laws have been contravened.

In developing and implementing this program, the company has been guided by its established policy of providing equal employment opportunity. Any goals, which are established herein, are not intended as rigid, inflexible quotas that must be met, but rather as targets reasonably attainable by applying every good faith effort in implementing its affirmative action program. The use of goals in this program is not intended to discriminate against any individual or group of individuals with respect to any employment opportunity for which they are qualified on the grounds that they are not the beneficiaries of affirmative action themselves. Nothing herein is intended to sanction the discriminatory treatment of any person. Thus, this program has been developed in strict reliance upon the affirmative action guidelines issued by the Equal Employment Opportunity Commission (EEOC) and the regulations issued by the Department of Labor's Office of Federal Contract Compliance Programs (OFCCP).

EEO POLICY STATEMENT

This company is an equal opportunity employer. All decisions concerning the employment relationship are made without regard to age, race, color, religion, creed, sex, national origin, marital status, veteran status, the presence of any physical or mental disability, genetic information or any other status or characteristic protected by federal, state, or local law. Discrimination or harassment based upon any of these factors is wholly inconsistent with our company values and will not be tolerated.

COMPLIANCE OF PERSONNEL POLICIES AND PRACTICES
WITH THE SEX DISCRIMINATION GUIDELINES
41CFR 60-20

The company's personnel policies and practices are monitored to ensure that they are in keeping with the letter and spirit of applicable EEO regulations and the affirmative action program. It is expressly stated that there shall be no discrimination against any employee or applicant on account of sex.

It is the policy of this company to recruit employees of both sexes for all jobs. Advertisements in newspapers and other media for employment do not express a gender preference and in fact carry an affirmative action statement.

When dealing with a bargaining unit for employees, if there is a written agreement on conditions of employment, such agreement does not contain language that is discriminatory on the basis of sex. The company insists that employees of both sexes have equal opportunities to any available job that he or she is qualified to perform. The company and this facility have instituted personnel policies and practices which ensure that employment opportunities, wages, hours, or other conditions of employment are not discriminatory to either sex; this includes employer contributions for insurance, pensions, and other similar group benefits.

There is no distinction between married and unmarried persons of one sex that is not made between married and unmarried persons of the opposite sex. Employment is not denied to women with young children. Employees of one sex are not given any preferential treatment over the other sex in cases of termination, layoff or other similar actions. Physical facilities are made available to employees of both sexes. The company does not follow any state guidelines on sex limitations if they are contrary to federal regulations issued by appropriate compliance agencies. Women are not denied particular jobs because of any state "protective" laws.

Female employees are not penalized in their conditions of employment because they require time away from work on account of childbearing. Women are granted medical leaves of absence upon evidence from the woman and her physician that she is pregnant. The start of the medical leave is left up to the employee and her physician. The female employee on medical leave is entitled to return to work to her former position or a position similar in status and wages for which she is eligible. She continues to accrue credited service while on leave.

The company pension program provides no age distinction for male or female employees in either mandatory or optional retirement. Neither are wage and salary scales or seniority lists related to or based upon the sex of employees.

COMPLIANCE OF PERSONNEL POLICIES WITH GUIDELINES ON DISCRIMINATION BECAUSE OF RELIGION OR NATIONAL ORIGIN

41 CFR 60-50

Discrimination in any term or condition of employment with the company on the basis of religion and/or national origin has always been and will continue to be prohibited.

As such, we do not seek or request information regarding the religious beliefs and/or national origin from any employee or applicant.

This policy is published and publicized internally and externally. Internally, our policy prohibiting discrimination on the basis of religion and national origin is included in all posted Equal Employment Opportunity policy statements. Similarly all recruiting sources are directed to refer applicants without regard to religion or national origin.

In keeping with this policy, reasonable accommodations are made for individual religious observances and practices unless such an accommodation would impose an undue hardship on the conduct of our business. Generally, we will try to make reasonable accommodations to the religious observances and practices of any employee who regularly observes Friday evening and Saturday, or some other day of the week, as Sabbath and/or who observes certain religious holidays during the year and is conscientiously opposed to performing work or engaging in similar activity on such days. In determining the extent of the hardship imposed, we may consider business necessity, financial costs and expenses, and employee relations.

RESPONSIBILITIES FOR IMPLEMENTATION OF CORPORATE EEO POLICY

41 CFR 60-2.17(a)

With the support of senior management, Beth James, Human Resources Director, has overall primary responsibility for implementation of the company's EEO policy and affirmative action program. All employees are responsible to cooperate with this person and act in accordance with the prescribed policies and procedures. All members of management are familiar with the policy, fully support it, and apply these principles in good faith.

To ensure compliance with the Equal Employment Opportunity policy and affirmative action program, Beth James, and/or designated staff, will as appropriate:

1. Develop policy statements and internal and external modes of communication;

2. Conduct regular discussions with managers, supervisors, and other employees to be certain the company's policies are being followed;

3. Advise supervisors that they are responsible for complying with company policies;

4. Implement audit and reporting systems that will measure the effectiveness of the affirmative action program, identify the need for action areas, determine the degree to which the company's goals and objectives have been attained, and ensure that the company is in compliance with applicable employment laws and regulations;

5. Advise management regarding the effectiveness of the affirmative action program and offer suggestions for remedial action if warranted;

6. Keep management informed of the latest developments in the areas of affirmative action and equal employment opportunity.

PROBLEM AREAS
41 CFR 60-2.17(b)

This establishment conducts in-depth analyses of its total employment process to determine whether and where impediments to equal employment opportunity exist. These analyses include evaluation of the following:

(1) Workforce by organizational unit and job group to determine whether there are any problems with utilization or distribution of minorities or women;

(2) Personnel activity, including applicant flow, hires, terminations, and promotions to determine whether there are selection disparities;

(3) Compensation systems to determine whether there are gender-, race-, or ethnicity-based disparities;

(4) Selection, recruitment, and other personnel procedures to determine whether they result in disparities in the employment or advancement of minorities or women; and

(5) Other areas that might impact the success of the affirmative action program.

Job groups where underutilization of minorities or women exists are identified in the "Placement Goals" section of this AAP.

During the year, every good faith effort will be made to meet these placement goals as opportunities arise in recruiting, promoting, and transferring. Our ultimate goal is to reach and maintain 100% availability in all job groups.

ACTION-ORIENTED PROGRAMS

41 CFR 60-2.17(c)

This establishment is committed to increasing the diversity of its workforce and to promoting equal employment opportunity for all at all levels of the organization. It undertakes affirmative steps to reach the placement goals identified while continuing to hire and promote the best qualified people to carry out its mission.

The following are among the action-oriented programs designed to eliminate problems and attain goals and objectives:

Continue to recruit minorities and women in percentages consistent with their availability; maintain records of all applicants; conduct an adverse impact analysis to determine if minorities and women are applying in insufficient numbers.

Recruit for a diverse pool of applicants through the state employment security agency, diversity recruiting events, target schools, and job postings in a variety of media which targets minorities, women, veterans, and individuals with disabilities.

Select qualified individuals without regard to sex, race, color or any other status or characteristic protected by federal, state, or local law. When apparently qualified minority or female employees are rejected for promotion or upgrading, supervisory personnel provide justification.

Train human resources personnel in affirmative action best practices.

Provide human resources related training to managers and supervisors.

Train all employees in non-discrimination, anti-harassment, and company values.

Ensure that facilities and company sponsored social and recreational activities are not segregated and encourage all employees to participate in all company sponsored events. (41 CFR 60-1.8)

AUDIT AND REPORTING

41 CFR 60-2.17(d)

This establishment monitors the effectiveness of its affirmative action program.

This establishment's EEO coordinator will:

(1) Monitor records of all personnel activity, including referrals, placements, transfers, promotions, terminations, and compensation, at all levels to ensure the non-discriminatory policy is carried out;

(2) Require internal reporting on a scheduled basis as to the degree to which equal employment opportunity and organizational objectives are attained;

(3) Review report results with all levels of management; and

(4) Advise top management of program effectiveness and submit recommendations to improve unsatisfactory performance.