Advanced Infrastructure Design, Inc.

05/10/2024

Nordan Murphy, PE, PP
Assistant County Engineer
County of Passaic
Department of Engineering
401 Grand Street
Room 524
Paterson, NJ

Re: Passaic County, New Jersey - Pavement Condition Assessment and Management System

Dear Mr. Murphy:

As per your request, Advanced Infrastructure Design, Inc. (AID) is pleased to present you with this proposal, which highlights our proposed scope of services, deliverables and cost.

We trust that the enclosed package is satisfactory; however, should you require any additional information, please do not hesitate to contact us.

Sincerely yours,

Manuel Celaya

Manuel Celaya, Ph.D., P.E.
Practice Lead, NDT/NDE
mcelaya@aidpe.com
609-838-2216 x208
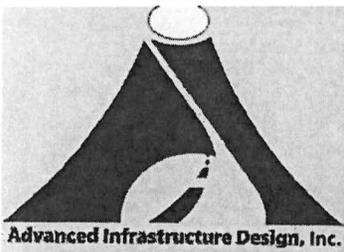
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Advanced Infrastructure Design (AID)

Advanced Infrastructure Design, Inc. (AID) is a consulting engineering firm located in Mercer County New Jersey that specializes in pavement testing, evaluation, design, and management. Working under the County Engineer, AID looks forward to the potential opportunity to serve   Passaic County through this project. The objective is to provide an   automated pavement data collection method as a way to provide the County with the data needed to make informed programming decisions regarding the preservation and treatment of their roadway.

AID, a certified WBE, SBE and DBE/ESBE firm, is staffed with a diversified, strong team of pavement engineers and owns and operates all equipment required for data collection on this project, including a state-of-the-art "Integrated Testing Vehicle" that collects all data necessary for this project. As demonstrated by its past performance on similar projects, AID will commit the required resources, including staff and equipment, to deliver the pertinent data on time, within budget, and meeting or exceeding quality standards. As such, AID will lead all data collection, analysis, and reporting efforts. Manuel Celaya, Ph.D., P.E., will serve as the AID Team's Project Manager and lead the project from AID's Hamilton, NJ office. Dr. Celaya will also be the point of contact and can be reached as follows:

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Hamilton, NJ 08691-3389
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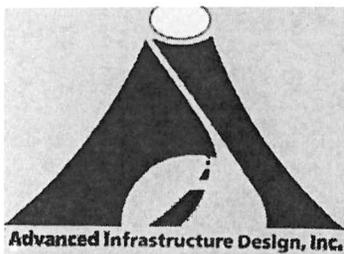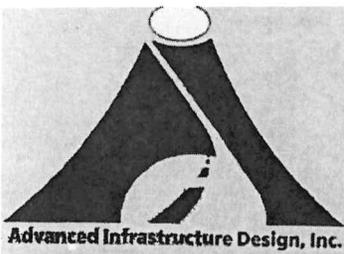
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Project Understanding

In an effort to assist the Passaic County Engineering Department to establish a roadway maintenance program, AID proposes to collect pavement condition data as per the Highway Performance Monitoring System (HPMS) Field Manual. HPMS is a national program that houses inventory information for all of the Nation's public road mileage, as certified by State Governments and updated on an annual basis. All roads open to public travel are reported in HPMS, regardless of ownership, including Federal, State, County, City, and privately-owned roads such as toll roads. NJDOT and other MPOs are required to annually furnish all data per the reporting requirements specified in the HPMS Field Manual. HPMS data is used to categorize the performance measures in terms of "Good" or "Bad" condition, independent of whether or not the roadway under consideration is classified as an interstate or non-interstate system. As noted in the HPMS Field Manual, pavement data that needs to be collected and reported includes: International Roughness Index (IRI), Present Serviceability Rating (PSR), Rutting, Faulting (for concrete pavements), and Cracking Percent.

Passaic County's Engineering Department has requested an assessment of a total of about two hundred forty sveven (247) lane miles of County roadway. To allocate funding in the most effective manner and prioritize resurfacing projects and to perform preventative maintenance, pavement condition analysis as a data-driven method is highly recommended by the Federal Highway Administration (FHWA). Pavement condition data is a valuable resource when developing work programs. This project will also provide the necessary groundwork to implement FHWA's Every Day Counts "Pavement Preservation" initiative. The goal of incorporating a Pavement Preservation approach is to improve or maintain the condition of transportation assets in a state of good repair. Preservation activities generally do not add capacity or structural value but do restore the asset's overall condition. A "mix of fixes" approach, utilizing various treatments and construction methods, helps infrastructure owners to cost-effectively achieve and sustain the desired state of good repair.

AID, possessing expertise and experience in these tasks, welcomes the opportunity to assist the County of Passaic with this effort. As demonstrated by previous similar project experience, AID is committed to fulfilling the project objectives in a timely manner. Samples of AID's similar projects include:

- Pavement Condition Evaluation– City of Rahway, New Jersey (Ongoing)
- Pavement Condition Assessment– Putnam County, New York (2023)
- Pavement Condition Assessment and Management System –Jackson Township, New Jersey (2022)
- New Jersey Turnpike and Garden State Parkway Pavement Asset Data Collection, OPS No. A3352 (2013-2015) and A3384 (2016-Present)
- Atlantic City Expressway Pavement Data Collection & Support (2009, 2014 & 2019)
- South Jersey Transportation Planning Organization (SJTPO), Regional Pavement Condition Data Collection Project on 4 counties – Atlantic, Cape May, Cumberland & Salem (2018 – 2019)
- Development of a Pavement Management Initiative, Burlington County (2017-2018)
- Development of a Pavement Evaluation, Management, and Design for County Roads, Middlesex County (2015-2016)
- Sign Inventory and Roadway Assessment Program, Union County (2012)

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Project Approach

In addition to its experienced team of pavement engineers, AID brings a unique asset to complete the objectives of this project – dedicated equipment, locally housed at our company headquarters in Hamilton Township, Mercer County, New Jersey, and ready for use at a moment's notice. AID proposes to collect all pavement condition data simultaneously at posted roadway speeds without interruption to traffic using our Integrated Testing Vehicle (ITV), which is an all-encompassing pavement data collection van. AID will collect and report pavement condition as well as provide pavement treatment techniques if desired.

Our approach will fully satisfy data gathering requirements with regard to FHWA's HPMS reporting and help the Passaic County in optimizing the condition of its pavement network. Our efforts will enable the the County to develop optimized roadway improvement programs that consider the needs of the pavement network and current or anticipated funding levels. Optimization involves maximizing the long-term performance of the pavement network within the forecasted budget by selecting a mix of fixes for a prioritized listing of project segments. AID will identify appropriate pavement treatment types based on the collected pavement condition data and other pertinent factors. As an option, AID can also provide a physical inventory of selected assets, including pavement markings, traffic signs, utility assets, street lighting, sidewalks, curbs, etc. within the county roadway network limits. To achieve this objective, AID's asset extraction software package will be applied to a geo-referenced image database obtained during pavement condition data collection.

The pavement condition and pavement treatment database will be delivered in an ESRI ArcGIS 10 format that will contain the condition and treatment data mapped to the pavement segments. The resulting database will be developed in such a manner to allow easy access and use by County's staff, officials, and other stakeholders. Quality assurance/Quality control (QA/QC) will be incorporated into all facets of the project from project planning to data collection to analysis and compilation through data delivery. The final task will be to provide training and technical support on all software and hardware developed to ensure comfortable understanding and use of the new system by all prospective users.

Task 1: Pavement Condition Assessment

Project Setup

AID will initiate the project by coordinating a kick-off meeting and follow-up meetings as necessary to gather the project requirements and ensure that all stakeholder concerns and interests are fully understood. AID will use this information to develop and fine-tune an appropriate plan for collection, processing, QA/QC, and delivery of the desired data. Under the project setup task, the following one-time work efforts will be undertaken before data collection:

1. Obtain LRS (Linear Referencing System) and Passaic County map and geodatabase files with the street network for the County.
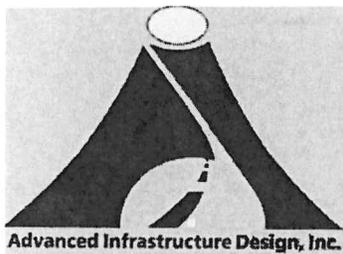
The existing LRS and geodatabase files related to the road network will be reviewed, enabling AID to fully understand the design, and if applicable, connecting attributes between systems. AID will also determine the beginning and end points of all County roads to be inspected by comparing maps to GIS and other available sources.

2. Assess the County's existing Asset Management System.
The County's existing asset management system will be reviewed to better understand the current use of GIS and asset management applications and study the feasibility of proposing new options for implementing a PMS.

3. Create data tables and develop data fields for each traveled lane divided into segments.
AID will outline the design of the pavement database. The geodatabase model will be set up with standard domains, tracking pavement attributes to describe pavement condition, index ratings, and positional information. A template will be developed and its format will be provided to county staff for approval. Attributes will include: route number (i.e., street name), route type, functional class, length, divided/undivided route section, pavement type, number of lanes and width, shoulder type and width, municipality, IRI, rut depth, distresses (percentages by type and severity) and corresponding SDI, and cracking percent for every tenth of a mile, or from intersection to intersection (whichever is preferred by the County) of lanes tested, referenced in terms of both the County's LRS and GPS coordinates (start and end of each segment). Video links will also be generated to allow access to video files for every segment.

*4. Develop plan for data collection.*
AID will generate route mapping from the data received from the County. These maps will be used as an informative scheduling visual aid that will outline weekly routes of travel and peak traffic times. A test plan will be developed by AID in close coordination with County staff. If heavy traffic, construction, or other impediments are anticipated for specific roads, these issues will be discussed with County Engineering staff. Weather constraints such as snow coverage and rain (wet roadways) will impede data collection, thus forecasted weather will be factored into the test plan.

5. Establish data collection and formatting protocols.
Data will be collected and delivered to the County in an agreed upon electronic format. The following data will be collected and reported for each selected segments (0.1 lane-mile, other) : IRI per *ASTM E950-09* and *E1926-08* and *AASHTO M 328-10-UL* and *R 057-10-UL* with reporting of left and right wheel paths and the average; SDI per NJDOT's New Jersey Pavement Management System Pavement Condition Indices & Analysis; distresses, cracking percent, rut depths (all wheel paths and the average) and average cross-slope. GPS coordinates to sub-meter accuracy, including Latitude and Longitude, will be reported along with locations per the County's LRS.

6. Establish Quality Management Plan for project.
AID recognizes the importance of QA/QC at every step of a successful project. The Quality Management Plan will be prepared and submitted to the County at the outset of the project. This plan will be distributed and reviewed with all members of AID to ensure an understanding of the required procedures to be followed. QA/QC will occur at each stage of the project – field data collection, processing of field data,
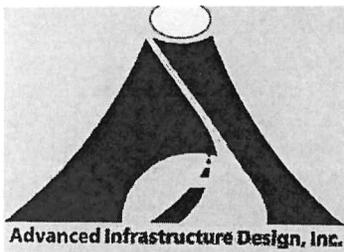
analysis of field data, data compilation, and reporting. QA/QC will include the following standards and operations to control quality as well as carrying out random inspections to assure quality.

7. Obtain from the County, where available, and populate data tables with activity type and date of last pavement treatment.

Where available, existing data outlining pavement treatment activities and dates of last pavement treatment will be obtained from the County and organized into a database that will be used as reference data for the pavement treatment program.

Data Collection – Pavement Functional Adequacy

All the roads within the County road network will be tested with AID's ITV. It is anticipated that all roads will be collected in both directions of travel. Therefore, approximately 496 lane-miles will be collected using AID's testing vehicle. AID's ITV, shown below, integrates linear distance measurement and GPS, 3 high-resolution forward-facing video cameras, a Laser Crack Measurement System (LCMS), and Ground Penetrating Radar (GPR) antennas, such that video, 3D distress mapping, IRI, SDI, rut depth, cross-slope, and asphalt pavement thickness data are simultaneously collected at normal roadway speeds. AID's ITV is also equipped with an Applanix POS LV 420 unit to enhance its GPS capabilities to provide sub-centimeter accuracy.
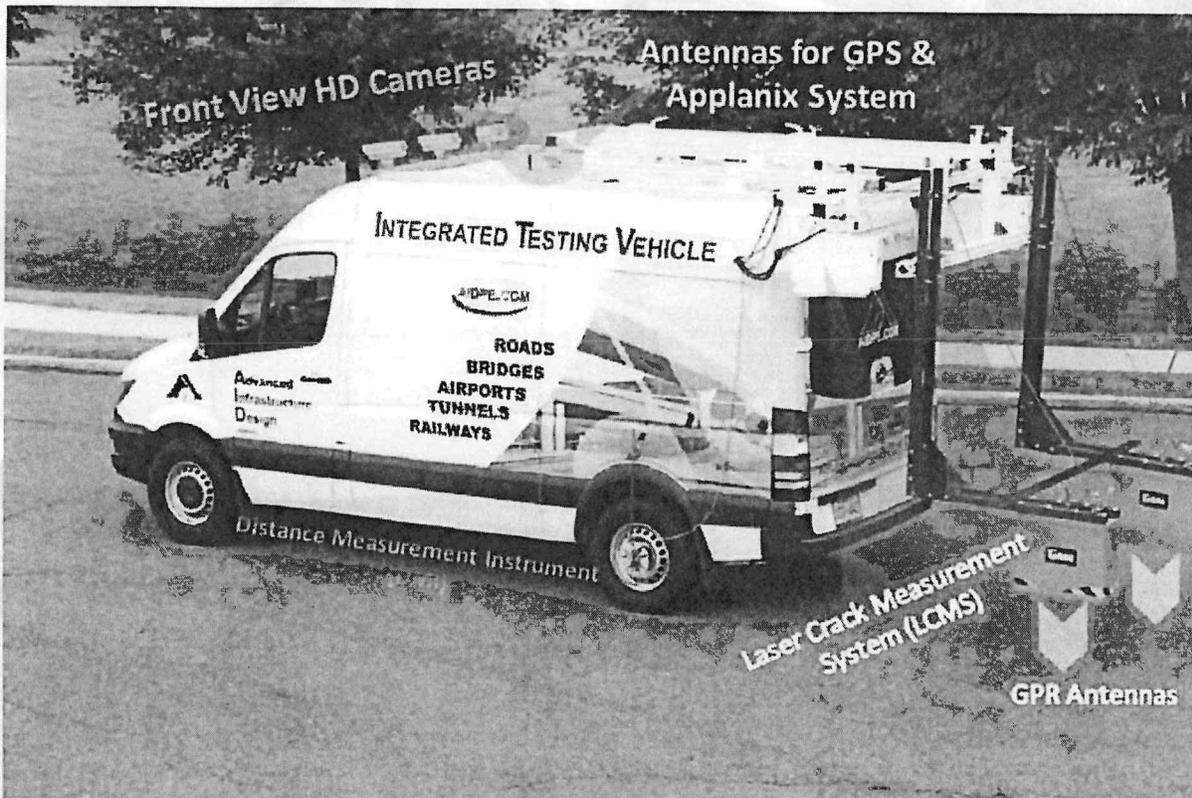
*AID's ITV Equipped with LCMS, HD Cameras, GPR, and GPS w/Applanix*
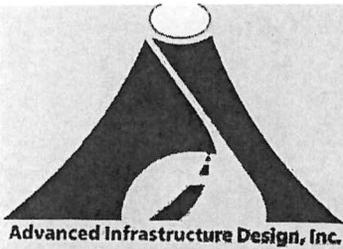
The LCMS system utilizes single-pass 3D sensors for pavement inspection. This technology is able to automatically detect, measure, and quantify all key functional pavement parameters within a lane in a single pass, including but not limited to: rutting, cracking (longitudinal, transverse, and alligator), roughness (IRI), and lane/shoulder drop off and faulting (for concrete pavements).

The automated distress analysis system will be used to convert identified distresses (including their severity and extent) to NJDOT's SDI. Additional distresses will be captured through semi-automated methods (raters reviewing automated images in the office). These include bleeding, block cracking, bumps and sags, corrugation, depressions, edge cracking, joint reflection cracking, patching and utility cuts, polished aggregate, potholes, railroad crossings, and weathering and raveling. For concrete pavements (if they exist), additional distresses include buckling, joint seal damage, patching, and utility cuts, polished aggregate, pumping, punch-outs, railroad crossings, shrinkage cracking, and spalling (corner and joint).

A typical visual output from the LCMS system, showing the integrated 3D surface laser images (with superimposed distresses) and video images from the center camera, is shown below for reference. In addition, the LCMS is able to collect and report longitudinal profile and roughness (IRI) with the precision and bias of an *ASTM E950* Class 1 profiler across the entire lane width. Continuous bound pavement thickness is also be collected simultaneously with the ITV via GPR testing per *ASTM D4748*. Although pavement thickness data is not required, it will be available for analysis at an additional cost if requested.
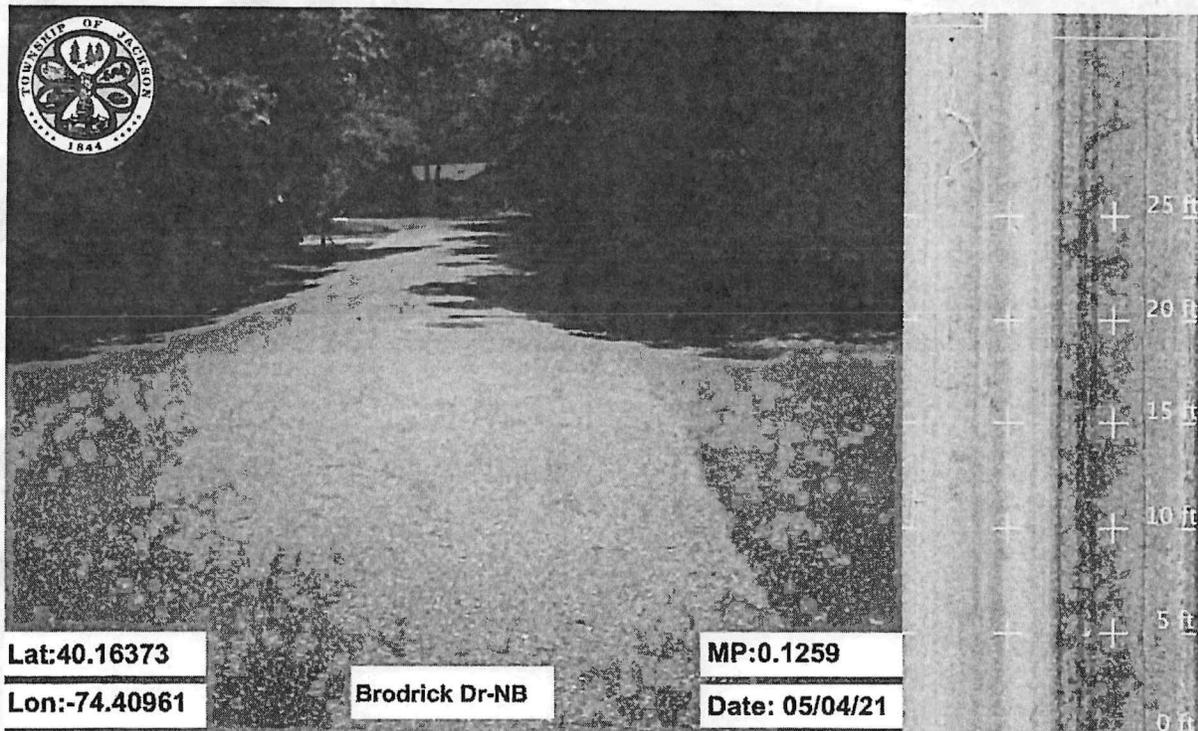

Integrated Camera and LCMS Images
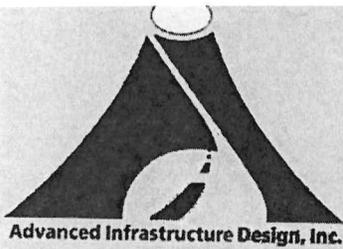
A route mapping plan will be generated from the data received from the County, which will act as the visual management component to describe the mission planning of our field collection. These maps will outline weekly routes of travel and peak traffic times. AID will meet with the County to outline the locations and/or days where route travel may be inaccessible due to construction, weather constraints (as noted in item 4 above) or other obstructions. These areas will be noted prior to the project data collection efforts. Data collection with AID's ITV will be performed by two people, a driver/technician and an experienced engineer who will set up and supervise the data collection.

Roadway video log data collection will be simultaneously performed to enable a cost-efficient method of implementing this task as well as to provide a back-up for QA and a tool to identify additional pavement distress data and extract features of interest (pavement markings, traffic signs, utility assets, street lighting, sidewalks, curbs, trees, etc.). AID will conduct QA of the distress data by simultaneously reviewing video and LCMS images at a sampling rate of ~10% on a random basis within each tenth mile of road. For QA of the video log images, the AID Team will examine the images to identify and catalog abnormalities, including distortion, sun overexposure, darkness, occasions when parts of the collection vehicle are visible in the image, and others. 10% of the images will be randomly selected and reviewed initially for QA purposes. AID's Quality Management Plan will detail action plans for correcting all errors, both random and systematic. No Maintenance and Protection of Traffic (MPT) is required for data collection efforts.

Video will be collected with 3 high-resolution cameras affixed to the roof of the ITV. The video cameras are arranged to provide diagonally left, straight, and diagonally right angle views of the roadway pavement and are capable of recording high-quality images at a rate of 5 images per second on each camera. The system in use includes Lumenera LT425C cameras with USB 3.0, Gigabit (GigE) and Ethernet capabilities, which provide 4.2 Megapixel images. AID has developed an in-house post-processing system that allows stitching 3 images to obtain a panoramic image (see sample below). All images will be accessible via hyperlinks in spreadsheets and geo-referenced with other information of interest (date/time of testing, speed, etc.).

| Image File	LaneDes	Milepost	Latitude	Longitude	Veh. Speed (mph)	Date of Testing	Time of Testing
2018_TPK_HWE_CL_0.023138.jpg	2	0.023	40.70808	-74.15607	23.8	5/21/2018	1:10:53 PM
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2018_TPK_HWE_CL_0.030834.jpg	2	0.031	40.70803	-74.15594	24.4	5/21/2018	1:10:54 PM
2018_TPK_HWE_CL_0.036032.jpg	2	0.036	40.70799	-74.15585	25.2	5/21/2018	1:10:55 PM
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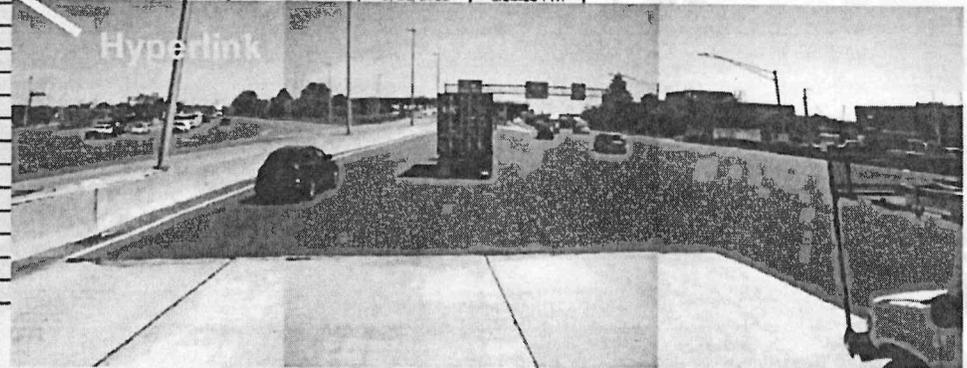
Typical Summary Spreadsheet (and Stitched Panoramic Image Link) for Video Images

Physical Inventory of Assets of Interest (Optional)

Provided as an option, AID can record assets of interest (pavement markings, traffic signs, utility assets, street lighting, sidewalks, curbs, etc.). AID's in-house software allows for surface feature extraction and exports these features to a GIS platform. Features are selected from the recorded images, and the software enables GPS coordinates to be obtained. These coordinates can later be converted to NJ State Plane Coordinates. All selected features can thus be exported to a database and cataloged into GIS. Typical information that is exported includes GPS location, orientation, type, date of collection, etc.

The database will be exported as an Excel table that can be easily integrated into the County's GIS platform/Asset Management tool of preference. For each target, a unique geo-referenced digital image of the object will be obtained and will be accessible through a link in the database. Other attributes that will be included are: unique identifier, type, location (GPS and NJ State Plane Coordinates), GPS date, placement, orientation, inventory date, and operator's name. The database will also be exported in a map format (ArcGIS, Google Earth, other) for easy reference.

GPS Target Selected: 40.708106°, -74.155918°
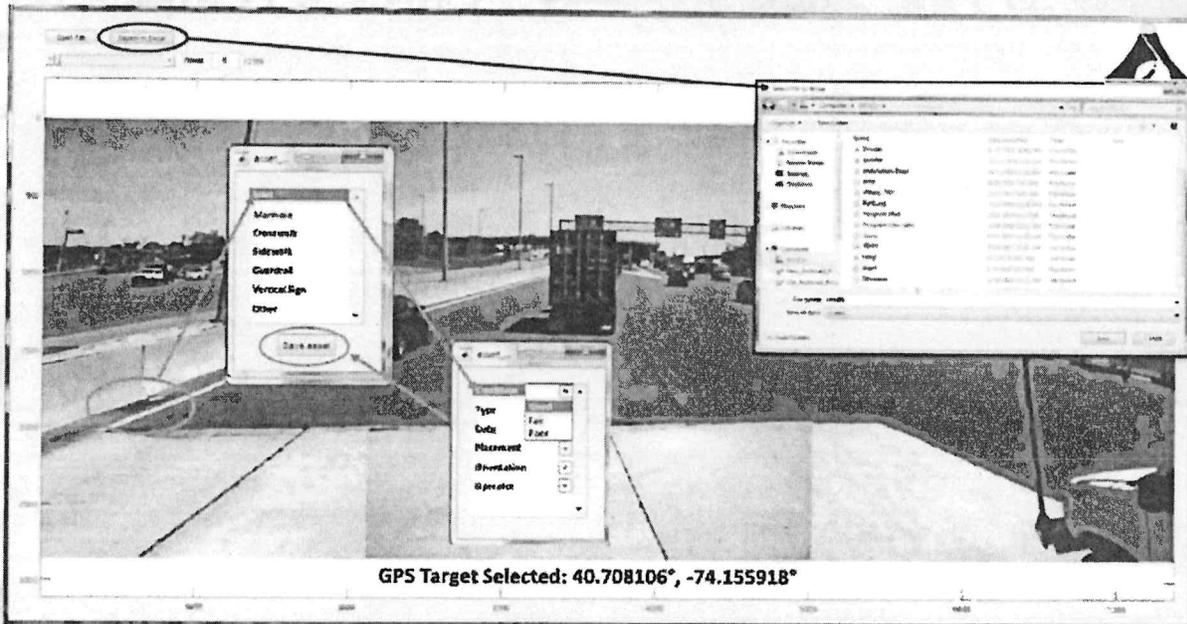
AID's in-house Software Sample for Asset Extraction

Task 2: Pavement Treatment Program (Optional)

Developing the pavement management platform is a critical task that transforms the data collected and compiled from the previous tasks into an effective management tool. It involves setting up the engine that digests the data and yields treatment needs and rankings that can be used to develop the multi-year pavement improvement plan. This task will be accomplished by carrying out subtasks, which are described in more detail below.
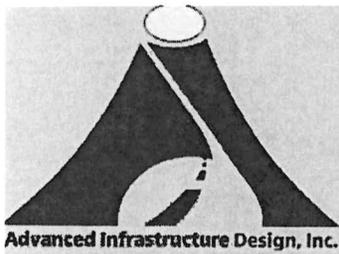
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Selection of Treatment Types

AID will meet with the County to decide on the types of pavement treatments that should be incorporated into the PMS. AID will look to utilize Pavement Preservation treatments to the maximum extent appropriate. Such treatments (thin overlays, slurry seals/micro-surfacing, micro-milling, and crack sealing) are a cost-effective means of extending life for pavements with minimal distress. More conventional alternatives, such as Rehabilitation (e.g., Mill and Overlay) and Reconstruction (Full-Depth Replacement), will be applicable where more significant deterioration has occurred. Because NJDOT has made significant progress with the development of a mix of fixes approach and the contractors and material suppliers are primarily the same as those that bid County projects, it would be advantageous to utilize treatments that NJDOT is using to the extent that they make sense for the County. With AID's expertise designing pavement solutions for hundreds of NJDOT and New Jersey County projects over the past two decades, AID is well-positioned to develop an appropriate menu of options. Communication with the County will be critical for this step to incorporate the County's lessons learned and experience with various treatment methods. It is envisioned that the ultimate mix of fixes to be considered will include those favored by the County supplemented by additional options that hold promise for the successful use and cost savings. With such options available, the County can be proactive in its pavement program, maintaining smooth-riding roads by making data-driven decisions that employ a "best first" approach rather than a "worst first" mentality that chases poor pavements in a vicious cycle of fiscal futility.

Development of Data-Driven Logic for Treatment Selection

This subtask will involve developing logic in the form of a decision matrix/tree that relates the data collected under the previous tasks to the optimal pavement treatment type. Specifically, similar to the approach taken by NJDOT, it is envisioned that the Surface Distress Index (SDI), including its components Non-load Related Distress Index (NDI) and Load Related Distress Index (LDI), and IRI (roughness/ride quality) will be utilized to determine the pavement treatment type. These various indices, along with the individual distresses (including Rutting), give a composite picture of the overall condition of the pavement and therefore enable selection of appropriate treatments to address the pavement needs. For example, a pavement section with an SDI above 3.5, age greater than 5 years, and IRI less than 285 in./mi. maybe assigned for micro-surfacing to seal surface distresses, prevent moisture intrusion, fill shallow ruts, and provide a new riding surface. If the same conditions exist but the IRI was greater than 285 in./mi., micro-milling and application of a thin overlay could be assigned to enhance the ride quality in addition to the previously mentioned improvements, all the while maintaining profile. Other factors, such as traffic and NHS classification, may also play a role in the treatment selection. Triggers employed by NJDOT are often a good starting point with adjustments made to account for the difference in use and funding at the county level.

Project Segmentation, Treatment Selection, and Prioritization

Under this subtask, all County roadways will be divided into optimized project segments, appropriate treatment types will be assigned per the decision matrix/tree developed under the previous subtask, and the segments will be ranked as a basis for prioritization. The limits of project segments will be selected
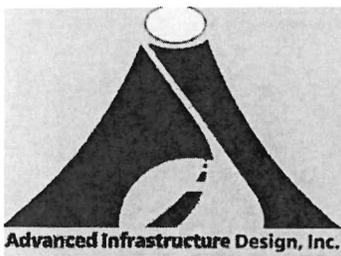
with various considerations in mind, including a reasonable length for an actual construction project and logical project termini (changes in pavement type, intersections, etc.) in addition to the pavement condition and structure and corresponding treatment needs. Once all segments and their treatments have been identified, the segments will then be ranked for prioritization. The logic for the ranking will be determined based on collaboration with the County, utilizing the pavement engineering expertise and experience of the AID Team along with the in-house expertise, experience, and preferences of the County. Typically, the project segments will be ranked based on the benefit yielded by the project (i.e., improvement to condition), traffic demands, and other factors deemed important by the County.

Deliverables

The pavement condition and inventory data will be provided in MS Excel format for every tenth mile (or whatever is preferred, typically 0.05 mile for urban environment) of each road, allowing for easy syncing back into the County's geodatabases and/or Pavement Management System (see sample below). In addition, stitched LCMS and video image files and links via MS Excel will be provided every 20 ft., similar to that shown below. A prioritized listing of constructable road segments with corresponding pavement treatments will also be provided.


Typical Summary Spreadsheet Showing Pavement Condition Data and Recommended Treatment

Geo-Coded Pavement Images

Roadway video log data from the center camera will be stitched with the LCMS-laser images. All images will be accessible via hyperlinks in spreadsheets and geo-referenced with other information of interest (date/time of testing, speed, etc.), as shown in the sample below. Images will be provided for each street/roadway on separate folders for easy access. These spreadsheets are easily converted to an ESRI supported GIS format as well.
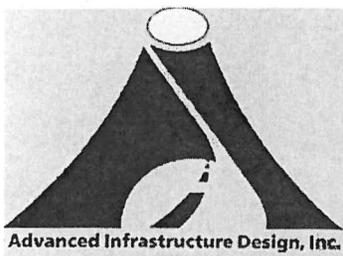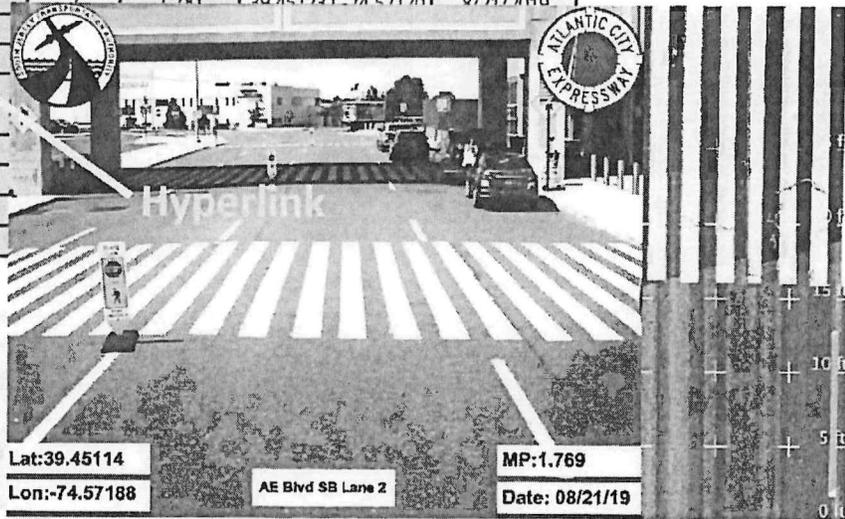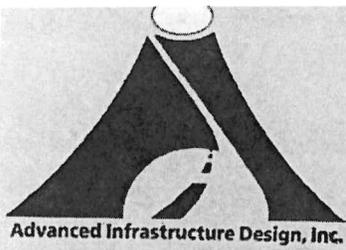
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Image File	LaneDes	Milepost	Latitude	Longitude	Date of Testing
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AE_Blvd_2019_SB_L2_MP_1.797.jpg	2	1.797	39.45135	-74.57146	8/21/2019
AE_Blvd_2019_SB_L2_MP_1.793.jpg	2	1.793	39.45132	-74.57152	8/21/2019
AE_Blvd_2019_SB_L2_MP_1.789.jpg	2	1.789	39.45129	-74.57158	8/21/2019
AE_Blvd_2019_SB_L2_MP_1.785.jpg	2	1.785	39.45126	-74.57164	8/21/2019
AE_Blvd_2019_SB_L2_MP_1.781.jpg	2	1.781	39.45123	-74.57170	8/21/2019
AE_Blvd_2019_SB_L2_MP_1.777.jpg					
AE_Blvd_2019_SB_L2_MP_1.773.jpg					
AE_Blvd_2019_SB_L2_MP_1.769.jpg					
AE_Blvd_2019_SB_L2_MP_1.766.jpg					
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AE_Blvd_2019_SB_L2_MP_1.758.jpg					
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AE_Blvd_2019_SB_L2_MP_1.75.jpg					

Hyperlink

Lat:39.45114
Lon:-74.57188

AE Blvd SB Lane 2

MP:1.769
Date: 08/21/19

Typical Summary Spreadsheet That Links Geocoded Pavement Images

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COST PROPOSAL

The cost for performing the Pavement Condition Assessment, Physical Inventory of Assets of Interest (Optional), Asphalt Thickness and Pavement Treatment Program is $296,728.77:

ADVANCED INFRASTRUCTURE DESIGN, INC.
County of Passaic
Proposal: Pavement Condition Survey Services, Passaic County

Tasks	Senior Manager ASCE VIII	Senior Project Manager ASCE VII	Project Manager ASCE VI	Project Manager ASCE V	Project Engineer ASCE IV	Senior Engineer ASCE III	Engineer ASCE II	Engineer ASCE I	Senior NDT Specialist	Total Hrs.
Task 1: Pavement Condition Assessment										
Project Setup										
Data Collection, 12 long days				4		8				12
Data Processing & Reporting		8						120	120	240
Physical Inventory of Assets of Interest (Optional)		8		40		80		400		528
Asphalt Thickness (Optional)		8		24		80		400		512
Task 2: Pavement Treatment Program (Optional)		8		24		80		400		512
Selection of Treatment Types		4		24	80					108
Development of Data-Driven Logic for Treatment Selection		4		24	80					108
Project Segmentation, Treatment Selection, and Prioritization		4		40	80					124
Task 3: Project Management and Administration	4	8		16						28
Total Staff Hrs.	4	44	0	196	240	248	0	1320	120	2172
Hourly Rate	$105.01	$92.16	$68.55	$64.92	$56.67	$48.45	$0.00	$40.26	$34.93	
Direct Labor Cost	$420.04	$3,615.04	$0.00	$12,724.32	$13,600.80	$12,015.60	$0.00	$53,143.20	$4,191.60	

Total Direct Labor Cost	$99,710.60
Overhead (172.59%)	$172,080.52
Fixed Fee (25% of Labor)	$24,927.65
TOTAL AID	$296,728.77

Detailed Cost Breakdown