VILLANOVA UNIVERSITY
College of Engineering

UPPER DARBY TOWNSHIP
Delaware County, Pennsylvania

Use of Spectral Analysis Surface Wave (SASW) Equipment for Determining Properties of Existing Asphalt Pavements

NEAUPG
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Leslie Myers McCarthy, Ph.D., P.E.

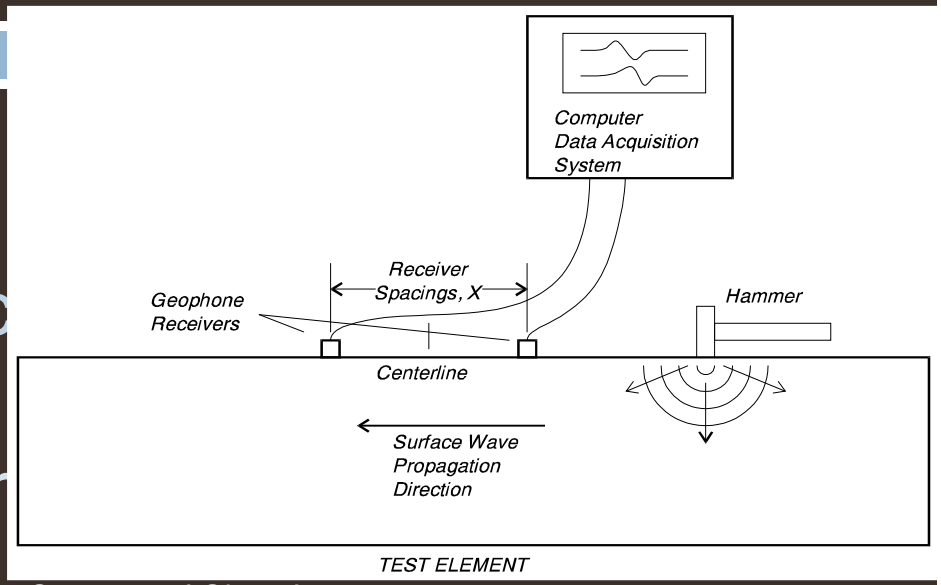
Overview of Research

- Focus on: Municipally-owned local roads
  - Unfunded research, through VU Service Project concept
  - Applied research
- Considerations: Limited staff, limited budget
  - Lack of info on existing pavement cross-section
- Equipment Used: Olson Instrum
  - Lowest Cost of ~ $8,000
- Equipment Limitations: Manual
  - Intensive analysis software

Spectral Analysis Surface Wave (SASW)

- Non-destructive test
- Measures shear wave veloc
- High velocity = stiffer matls
- Cracks or voids cause shar

decrease in velocity



Courtesy of Olson Instruments

Comparable results to portable seismic pavement analy (p-SPA) used by DOTs & in NCHRP research

Differs from FWD in that it measures shallow depths (su layers) rather than deeper into the foundation layers

Overarching Research Goals

- Purpose: determine whether SASW is a cost-effective useful alternative to trenching/coring & useful for pavement management inventory

Approach: Combination of field validation and analytical studies

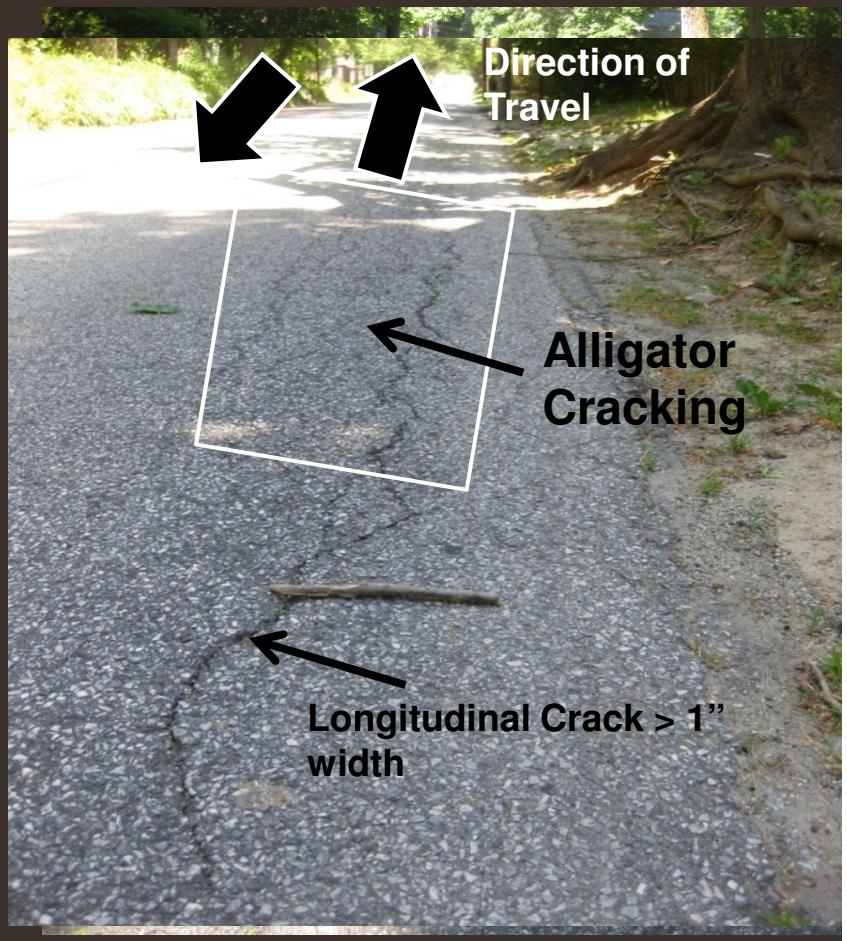
- Outcomes:
  - Confirm structural profile on existing roadways
  - Identify extent of superficial damage / surrogate for structural capacity estimation
  - Use for pavt management decisions & documentation

Past Research with SASW for Municipalities

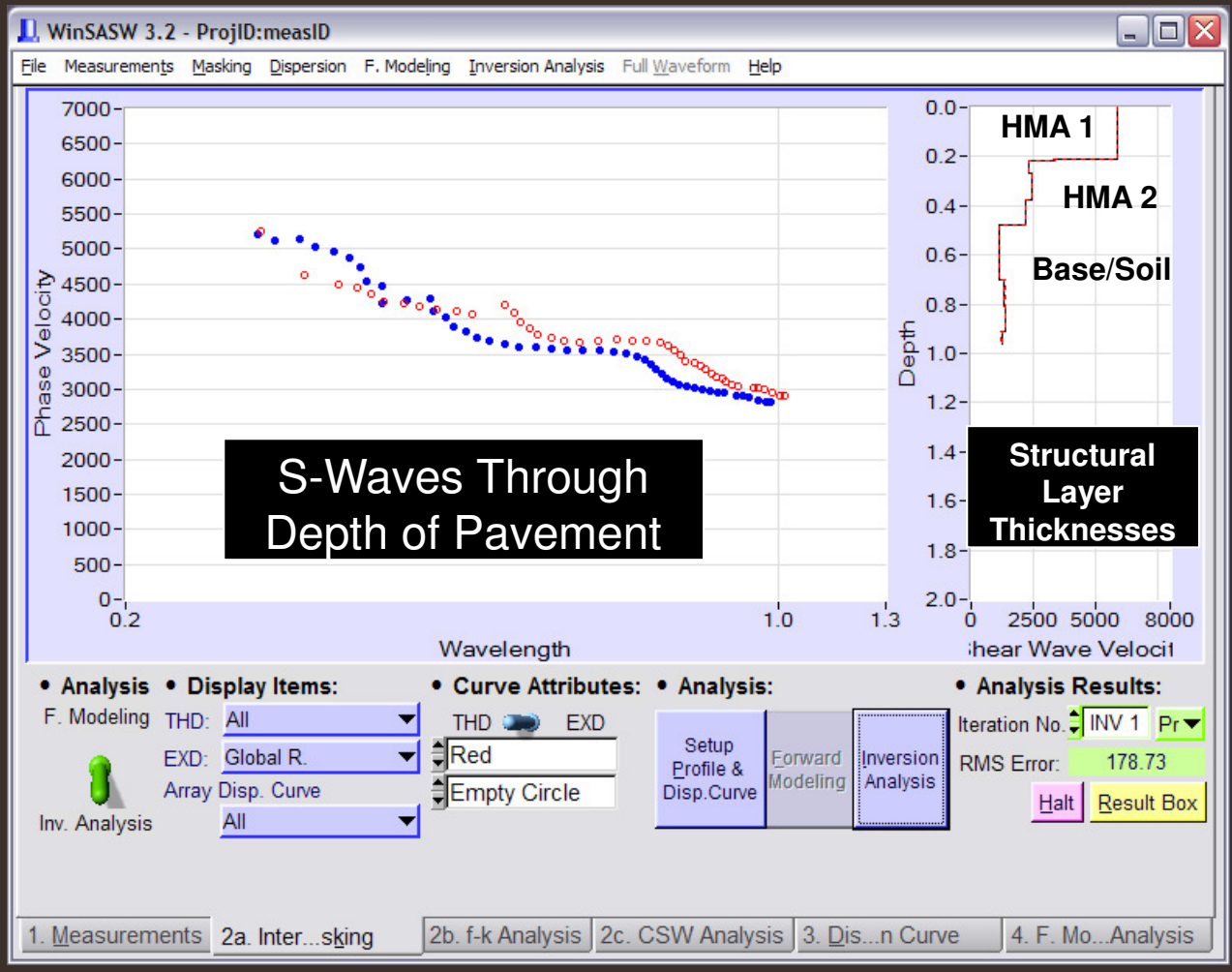
- Radnor Township in Pennsylvania, ~ 15 miles west of the City of Philadelphia (pop: 31,000+)
- Township Engineer concerned about condition of existing asphalt pavement on local road
  - Increase in % heavy trucks diverting from congested PA routes
  - No existing x-section plans o
  - Road being used as Collecto

Past Research with SASW for Municipalities

- ASTM D6433-11 condition survey yielded PCI rating of “Failed”
- SASW capable of finding cracks & depth of cracks
- Older PennDOT plans of section of the same road about 0.75 mile away showed HMA thickness of 3.75-inches



- HMA layer thickness of 2.5” (probably overlay at some time)
- HMA underlying thickness of 4.0” (probably original asphalt)



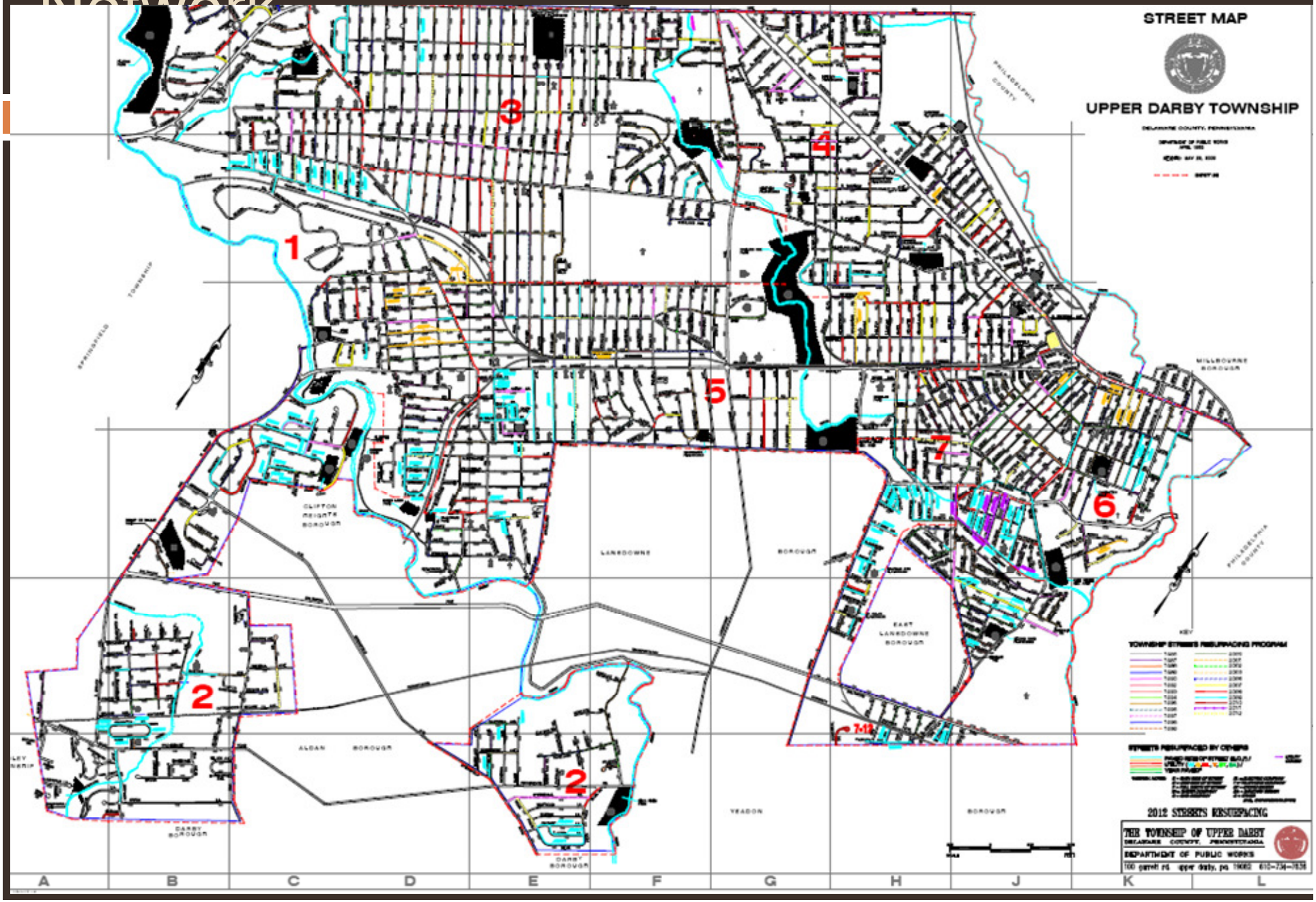
Applications of SASW in 2013

Upper Darby Township – urbanized & low tax base, extensive local road network, high (12%) heavy vehicle presence

Pavement management approach - - DPW conducts biannual windshield inspections

- Significant damage noted in handwritten notebook
- No records kept electronically
- Lacking plan sets of majority of locally-owned roadway pavement

Upper Darby Township – Local Road Network



Upper Darby Township

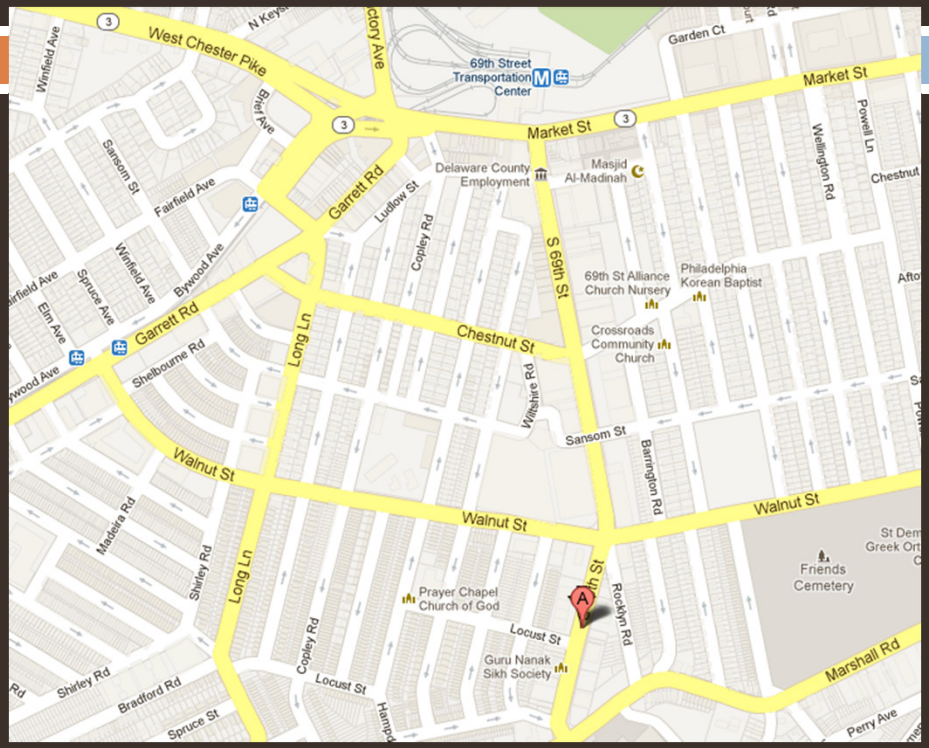
Development of Pavement Management Database &

Identify Inspection Approach for Twp

Surveyed several pavements using crafted approach which combined PennDOT and National Park Service survey methods

- PCI results for the current conditions at 69th Street show reflective cracking as a major problem.
- Exhibited corrugation approaching intersections.

SASW Testing of 69th Street



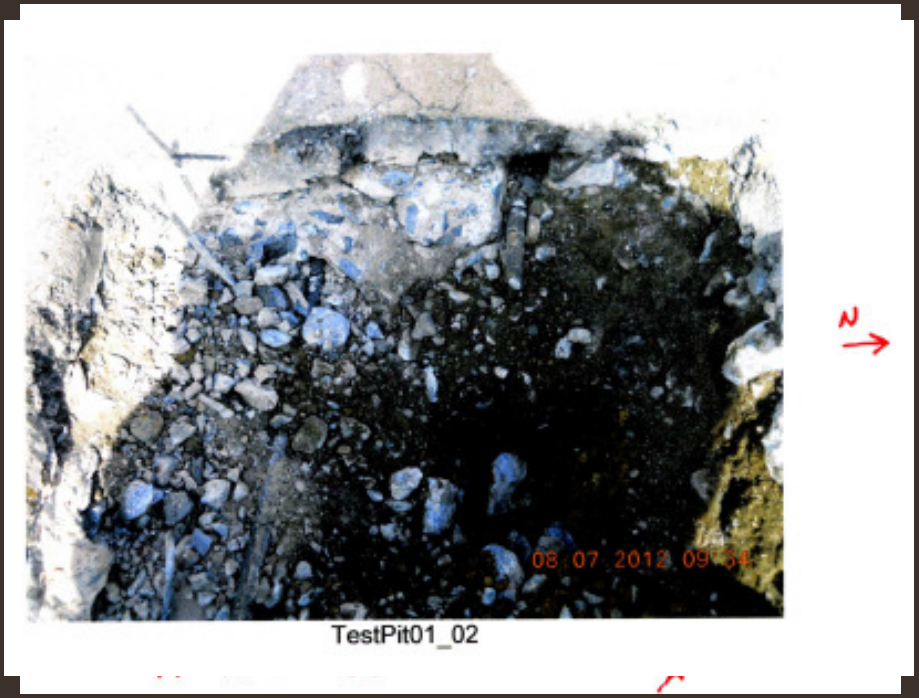
Confirmed pavement profile of section of most heavily traffick

Township-owned road (69th street)

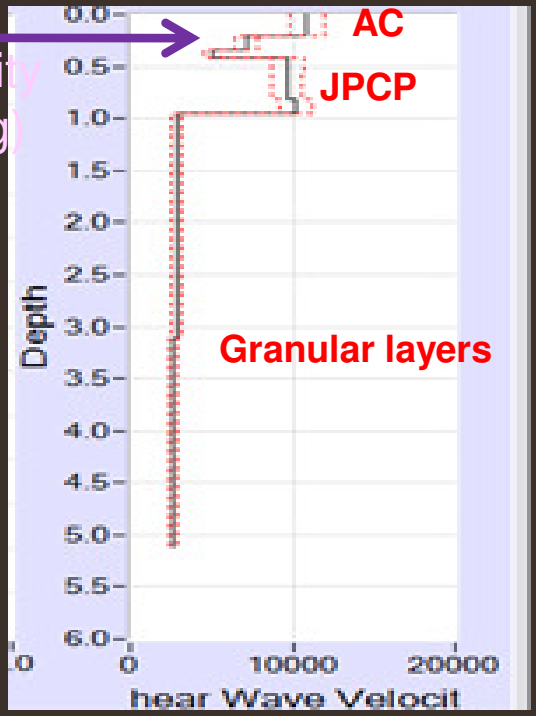
- AADT estimated by DVRPC: ~12,000 veh/day
- Major intermodal center at terminus of 69th street
- Resurfaced in 2009

69th Street Test Site

SASW testing - versus - Test Pits



Discontinuity (debonding)



Test pits showed 3” asphalt overlay of 6-8” JPCP

SASW showed 2.9” top layer & 7.3” second layer

SASW Results at 69th Street Test Site

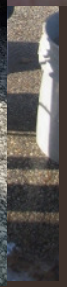
Shear wave velocities of ~ 10,000 ft/sec

- Show stiffer layers down to 1.0 feet
  - Discontinuities in the profile (sudden, relatively large jumps from a velocity to a higher or lower velocity) indicate a change in material stiffness
  - Indicative of cracking or debonding
- Below 1.0 ft, much lower shear wave velocity indicates a less stiff material is present.
  - Test pit confirmed that below 1.0' is soil layer

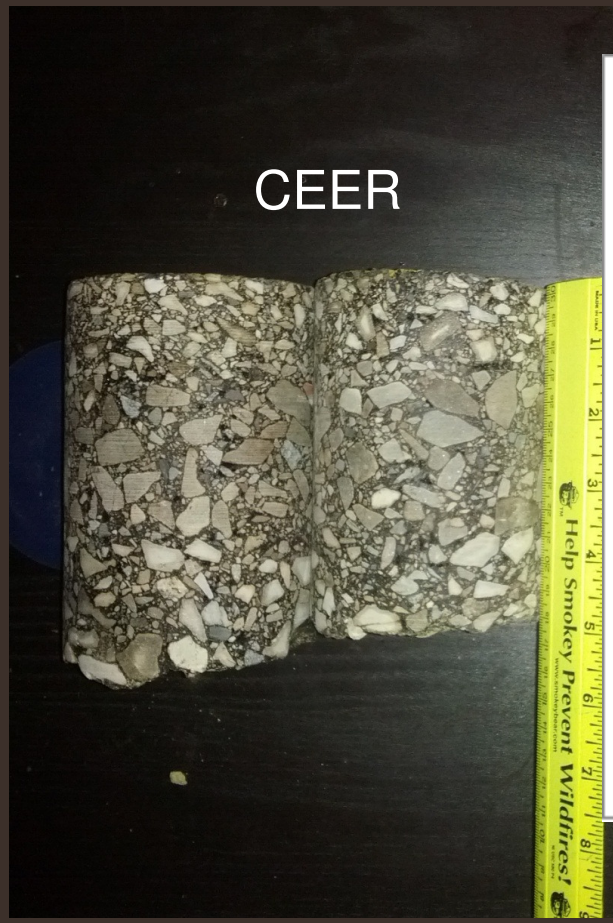
Additional Field Validation

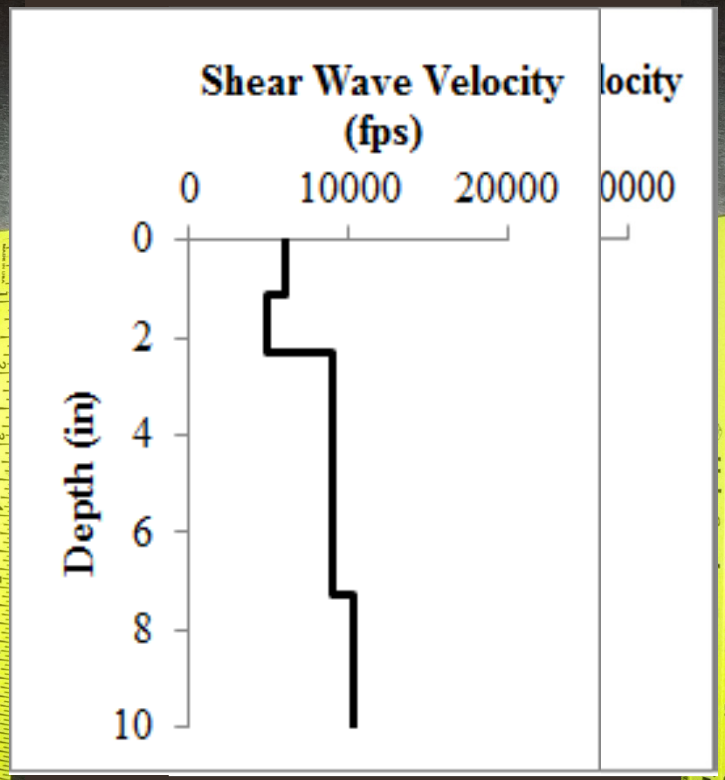
- Tested 2 asphalt pavement sites on Villanova University campus
  - SASW and cores extracted
- Alumni Hall access road
  - Bypass road to other main campus routes, minimal traffic
  - PCI rating of “Very Poor” with extensive fatigue & thermal cracking
- CEER Hall
  - Parking lot servicing 100 parking spaces, minimal traffic
  - Resurfaced 6 mos. before testing, PCI rating of “Good”

Villanova University Test Sites



Villanova University Test Sites





Summary of Research

- Can predict thickness of pavement's shallow layers with reasonable (within ± 0.5") ac

Site	SASW		Actual	
	cm	inches	cm	inches
CEER (Full)	16.3	6.4"	14.6	5.75"
Alumni (Full)	10.4	4.1"	10.8	4.25"
69th St (Asphalt)	7.4	2.9"	2.5-7.6	1-3"
69th St (Concrete)	18.4	7.25"	15-20	6-8"

- Found to be effective for locating cracks and voids (e.g., debonding) in the structure.

- Appears to overestimate elastic modulus associated asphalt pavements, but researching a conversion factor

Other Future Research with SASW

- Identification of shallow layers under regional railroad

Other Future Research with SASW

Acknowledgments

- Upper Darby: Dan Lutz (Township Mgr) & Allison Lee (Asst Township Engineer)
- Radnor: Dan Malloy (prev. Twp Engineer) & Sgt. George Smith (prev. RPD Traffic Officer)
- SEPTA: Bob Lund (Director of Capital Improvement) and Amanda Robinson (Track Section Engineer)

Leslie McCarthy, Contact I

Assistant Professor
Department of Civil & Environmental Engineering

- Email: leslie.mccarthy@villanova.edu
- Phone: 610-519-7917

Since 2009, conducted 10 projects related to asphalt through NCHRP, FHWA, and state DOTs in region

TRB Affiliate University

13 miles outside Philadelphia, Pennsylvania!!!!