Automated Cracking Survey and Multi-Function Vehicle

Kelvin CP Wang

University of Arkansas & WayLink

kcw@uark.edu

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Four Parts of Presentation

- Part One: History
- Part Two: Technology Solutions
  - Automation: Data collection and Processing
- Part Three: Cracking Survey Comparisons and Variations with Protocols
- Part Four: Keys to Protocol Application

Part One

- History

UK HARRIS (Highways Agency Road Research Info System)

- Multi-Function
- Automation of Cracking Survey
  - Primarily Image Collection
  - Automated Detection and Classification of Cracks: Not in Production

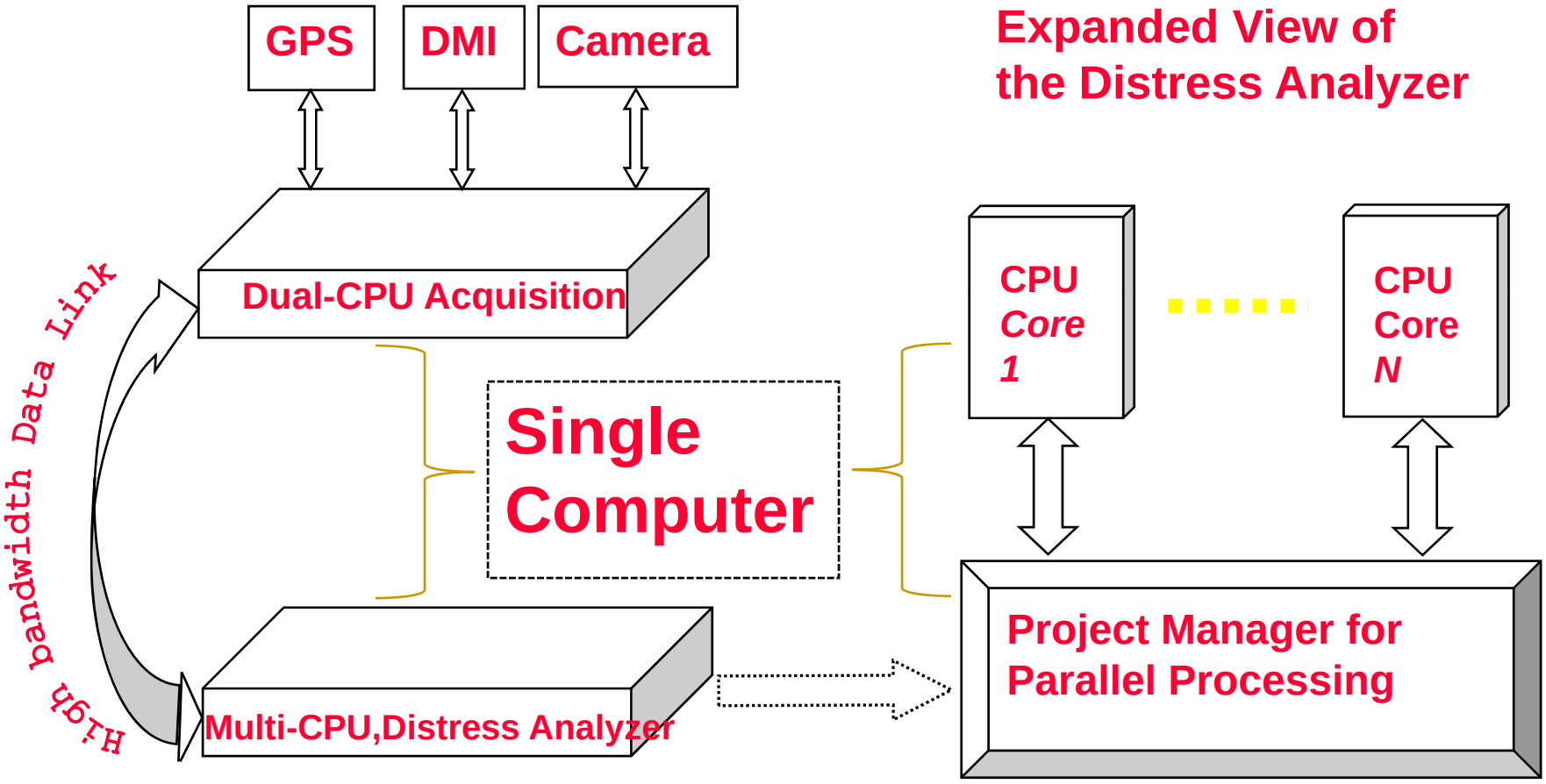
Australian RoadCrack, RTA & CSIRO

Pavement Evaluation (Non-Structural)

- Roughness: Mature but Different
- Rutting: Point Lasers or 1200 Points on 4-Meter Width
- Right-of-Way Imaging
  - Support Multiple HD 1080P Cameras
  - Ready for Automated Asset Management
- Laser based Pavement Surface Imaging
  - 1-mm Resolution (X & Y), Complete Coverage, High Quality at Any Time
- Automated Cracking Software: the New Frontier

Digital Highway Data Vehicle (DHDV, Last Generation)

The Parallel Computing Approach



New Laser based Illumination

- Same 1-mm Resolution
- Complete Pavement Coverage, 4-meter Wide
- Any Weather Condition as long as Dry Pavement
- No Bad Shadow under Any Lighting Condition
- Uniform Image Quality

DHDV with LRIS (# 1, Early 2006)

Part Two

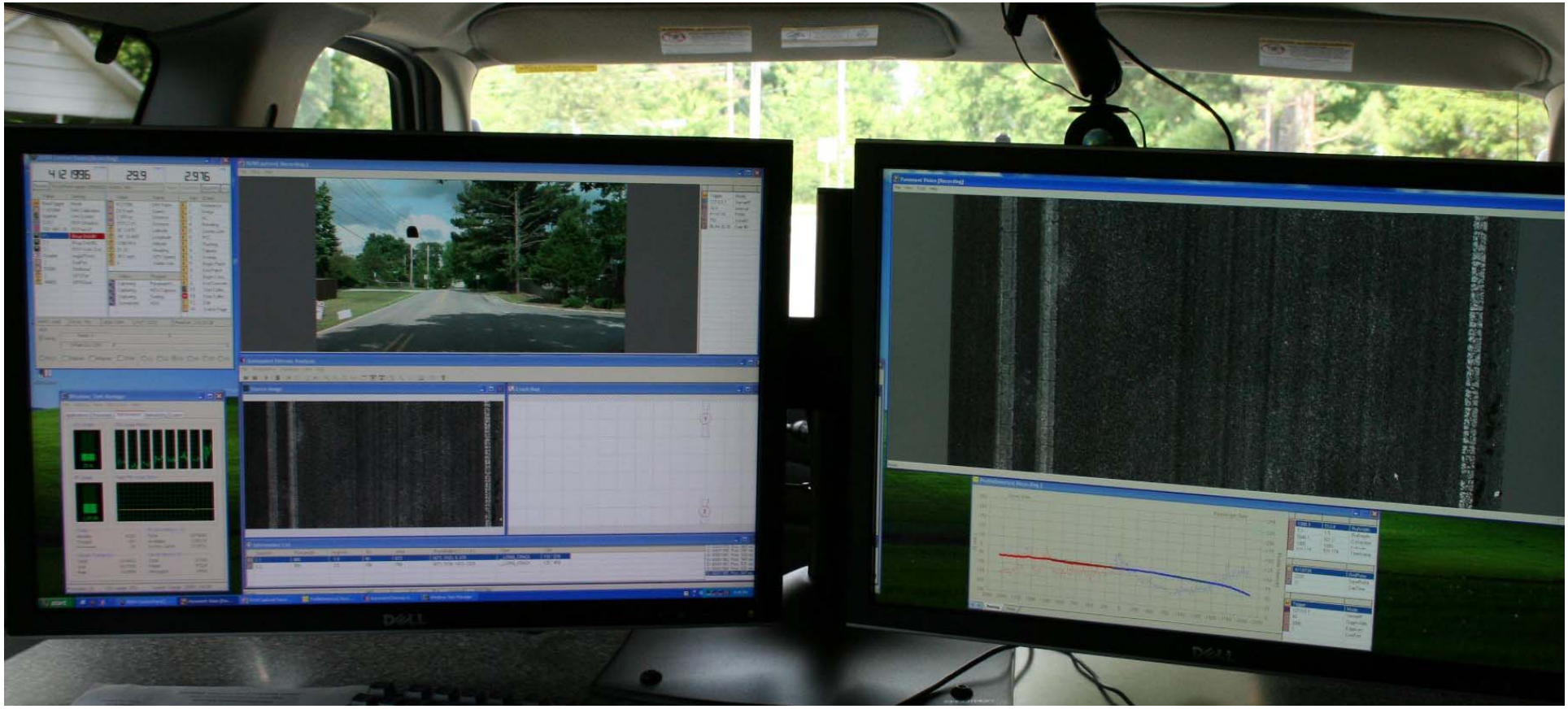
- Technology Solutions

DHDV with LRIS (# 8, June 2008)

Recent Delivery, Ohio US

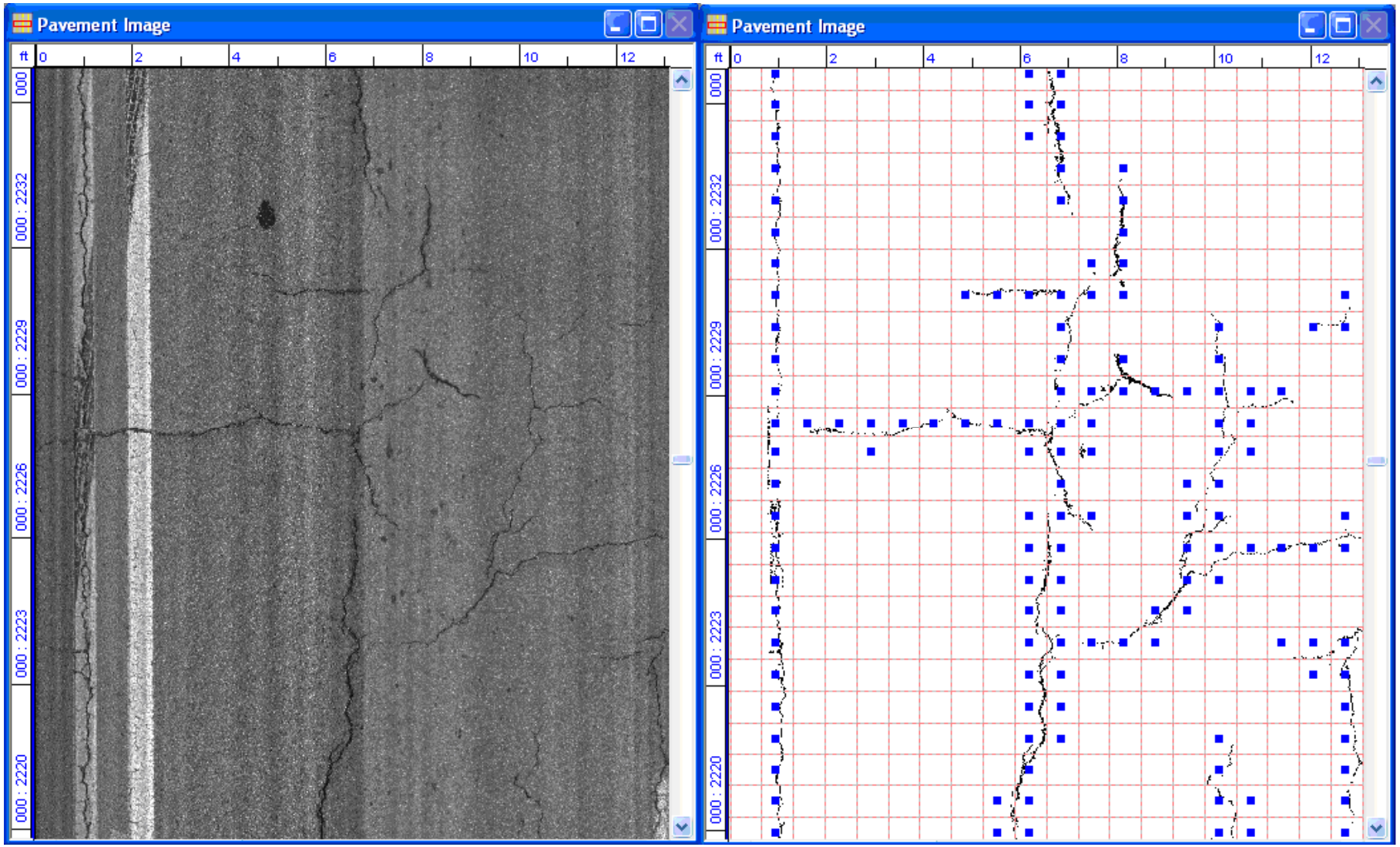
Recent Delivery, Ohio US, 800Watts

Recent Delivery, Ohio US During Data Collection



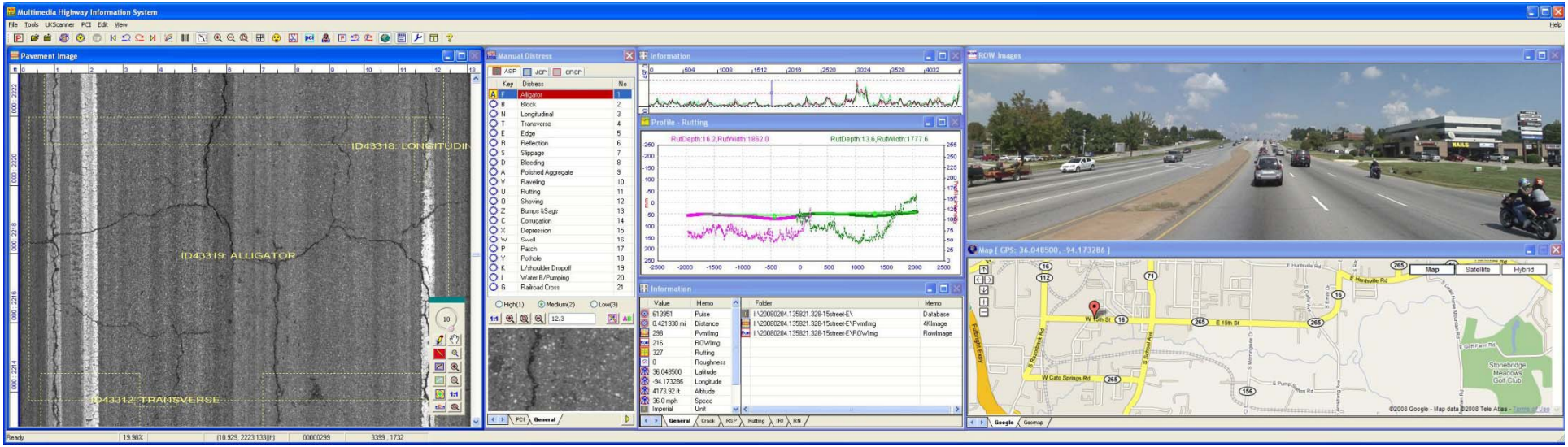
Workstation for Post-Processing

Grid based SCANNER Method

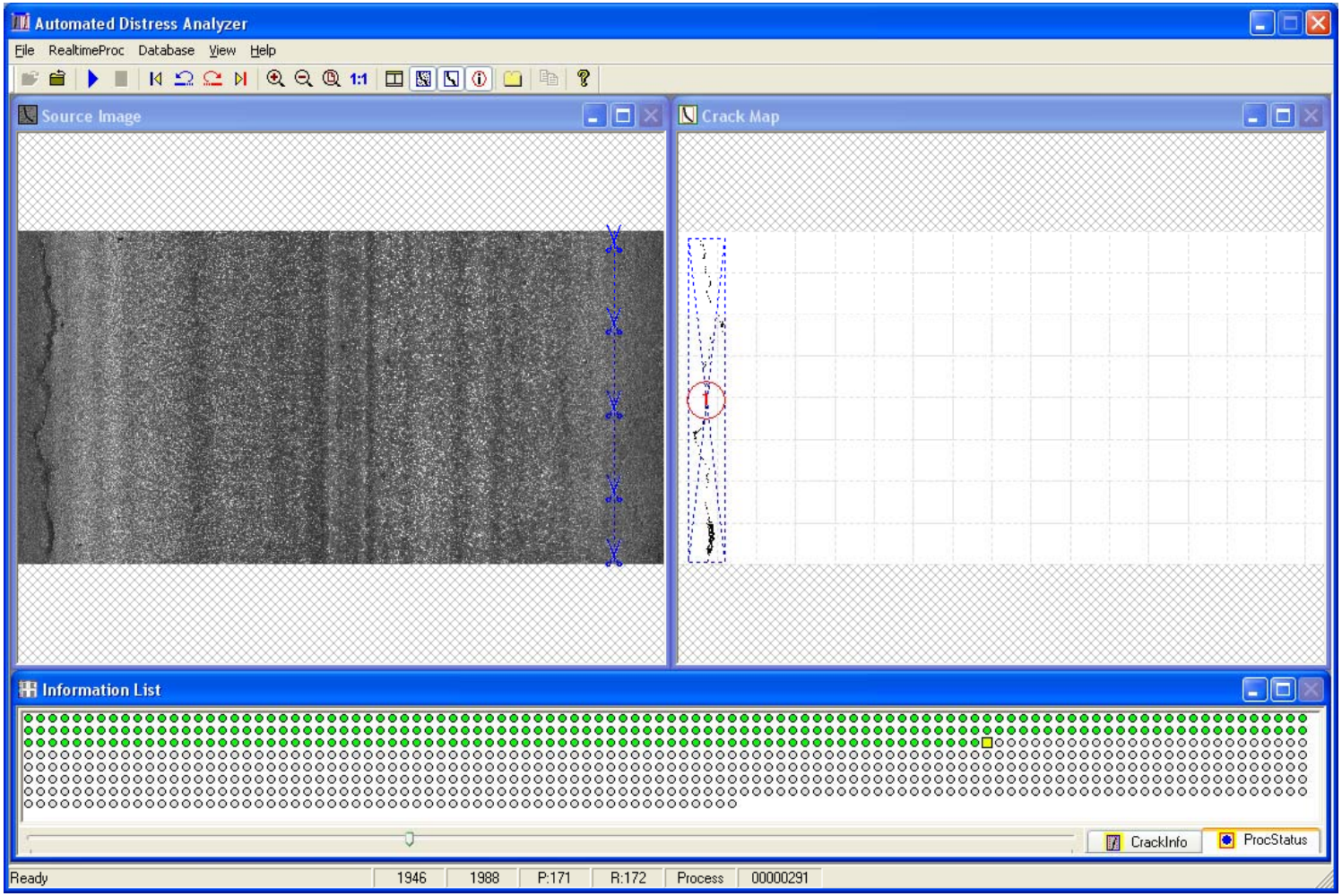


Software Solution

- Automated Distress Analyzer
  - Real-time or Post-process
- MHIS Deluxe, MHIS Web



ADA-Automated Distress Analyzer



ADA (Automated Distress Analyzer)

- RAW image: 2048 by 4096 pixels(~1mm/pixel)
- Processing speed: Real-time (60MPH or higher)
- Platform: DHDV & Workstation
- Pavement type: Supports both Asphalt and Concrete
- Result: Crackmap, Crack geometries
- Applicability: User Decision

Performance Measures of Network Level Pavement Surveys

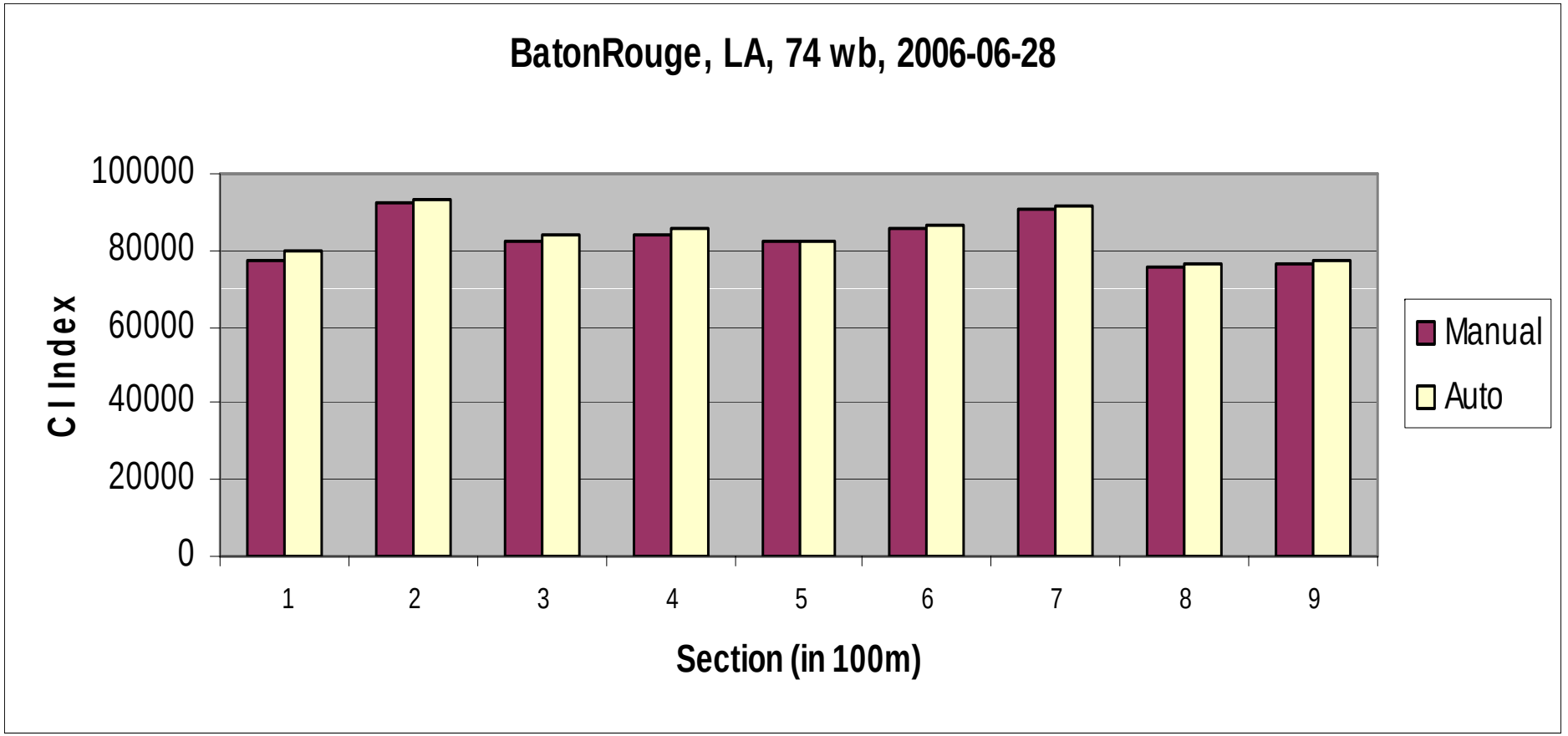
- Roughness, Rutting, and Cracking
- Performance Requirements
  - Fully Automated
  - Highway Speed

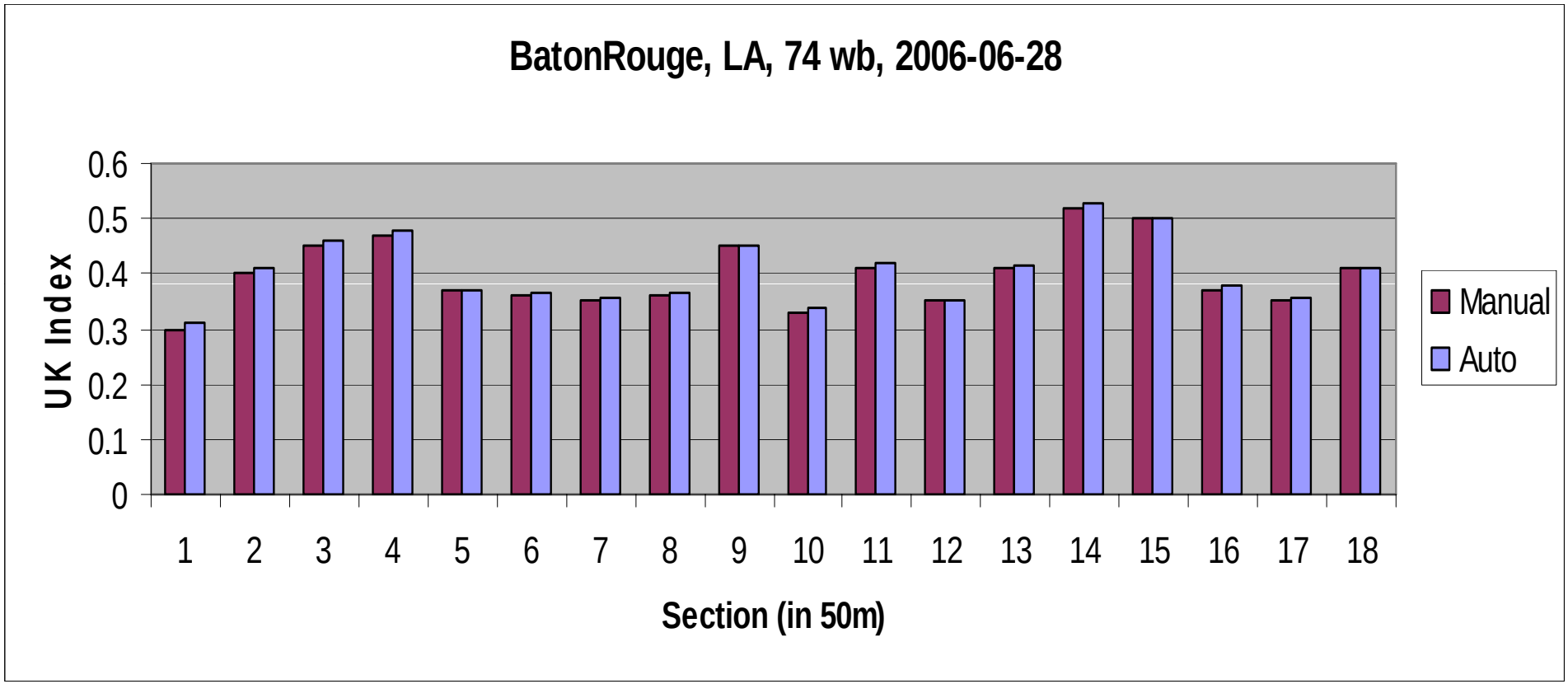
Simple, Realistic, and without Baggage

- UK SCANNER
  - UK National Standard
  - Roughness, Rutting, & Cracking
  - Fully Automated
  - Fully Implemented, 2006-Now
  - A Model to Follow by Countries and Territories

Part Three

- Cracking Survey Comparisons and Variations with Protocols


BatonRouge, LA, 74 wb, 2006-06-28
CI Index
100000
80000
60000
40000
20000
0
1
2
3
4
5
6
7
8
9
Section (in 100m)
Manual
Auto


BatonRouge, LA, 74 wb, 2006-06-28
UK Index
0.6
0.5
0.4
0.3
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8
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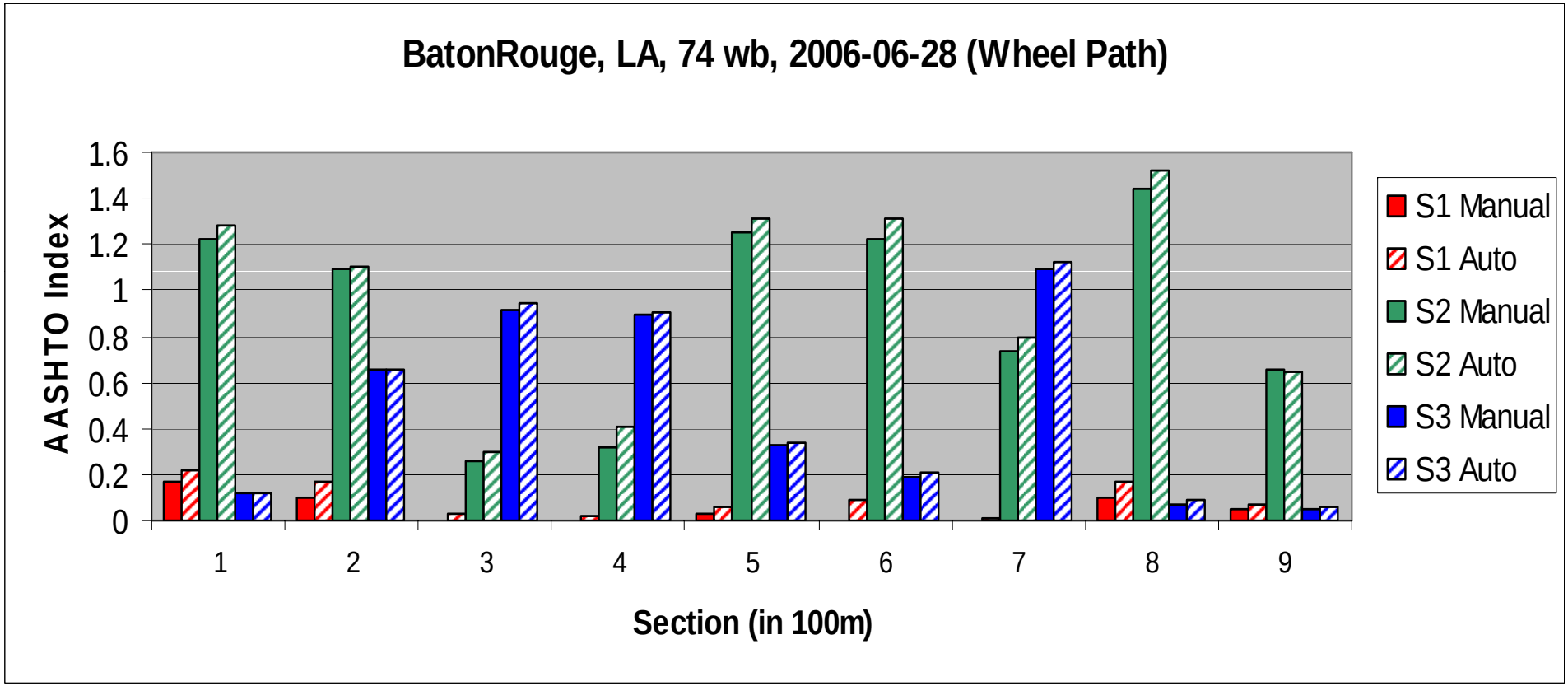
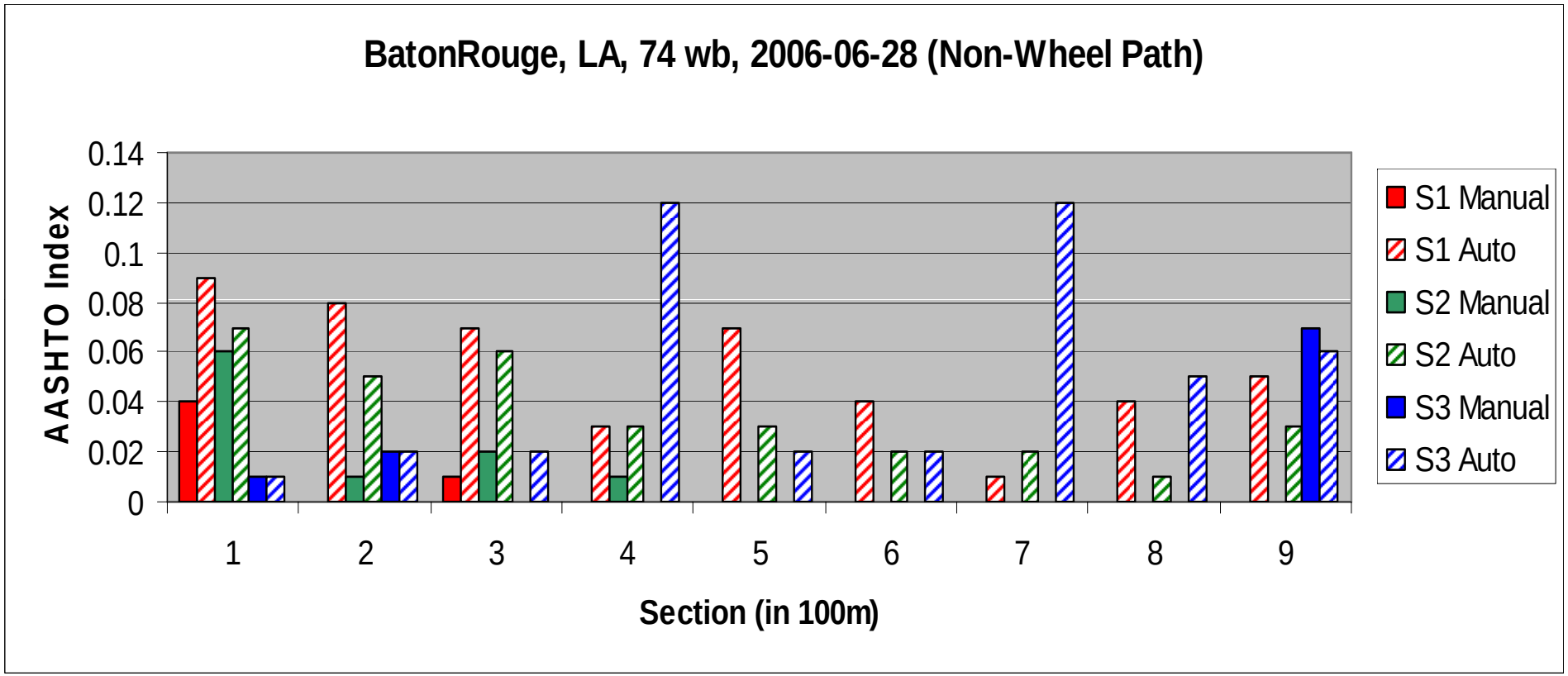
11
12
13
14
15
16
17
18
Section (in 50m)
Manual
Auto


BatonRouge, LA, 74 wb, 2006-06-28 (Wheel Path)
AASHTO Index
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
2
3
4
5
6
7
8
9
Section (in 100m)
S1 Manual
S1 Auto
S2 Manual
S2 Auto
S3 Manual
S3 Auto


BatonRouge, LA, 74 wb, 2006-06-28 (Non-Wheel Path)
AASHTO Index
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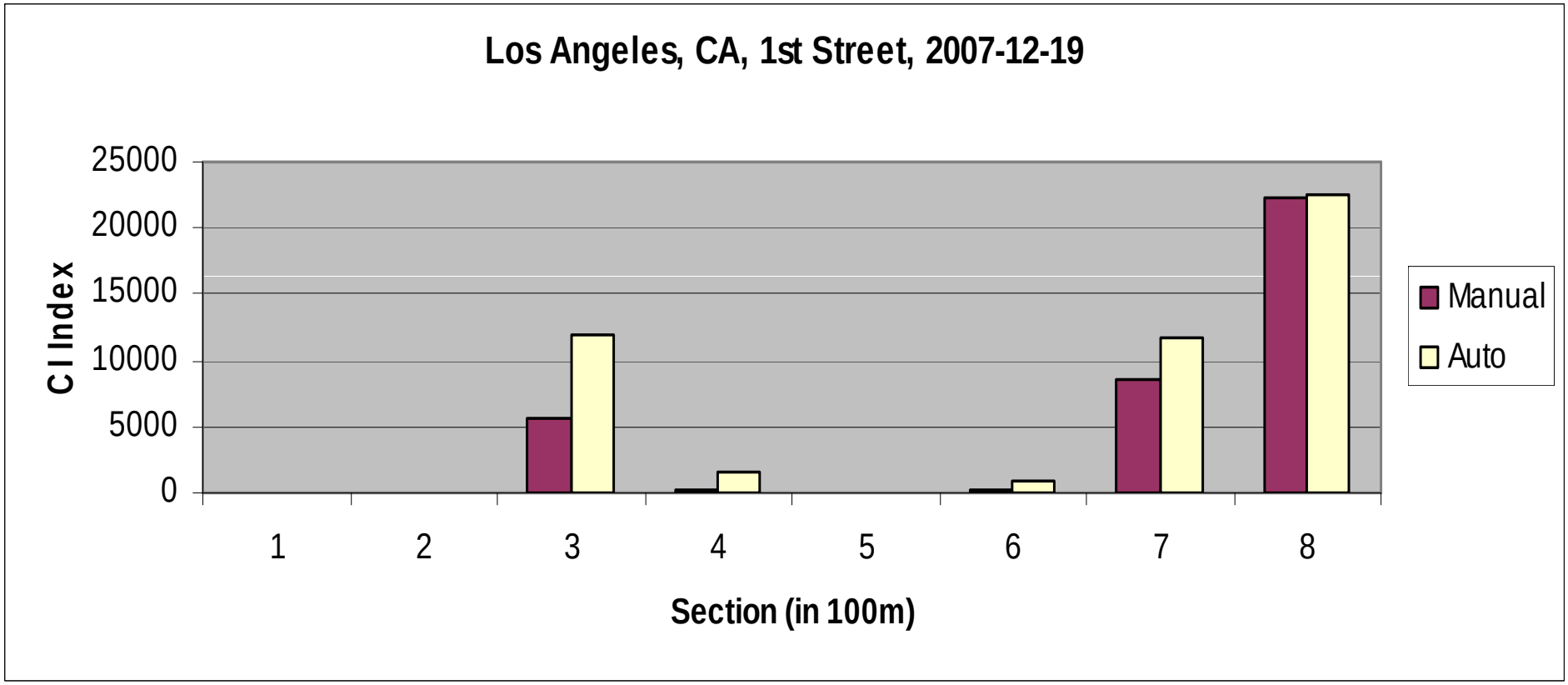
0.12
0.1
0.08
0.06
0.04
0.02
0
1
2
3
4
5
6
7
8
9
Section (in 100m)
S1 Manual
S1 Auto
S2 Manual
S2 Auto
S3 Manual
S3 Auto


Los Angeles, CA, 1st Street, 2007-12-19
CI Index
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20000
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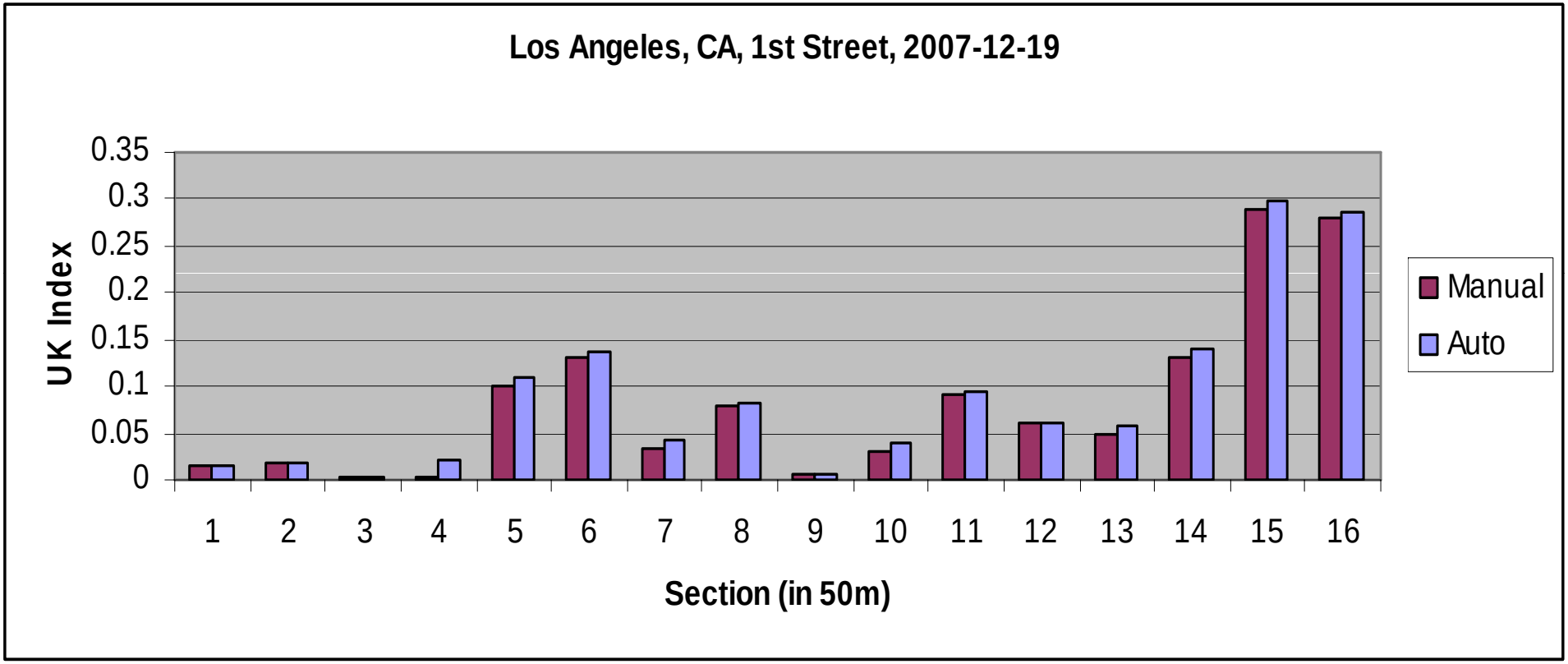
8
Section (in 100m)
Manual
Auto


Los Angeles, CA, 1st Street, 2007-12-19
UK Index
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
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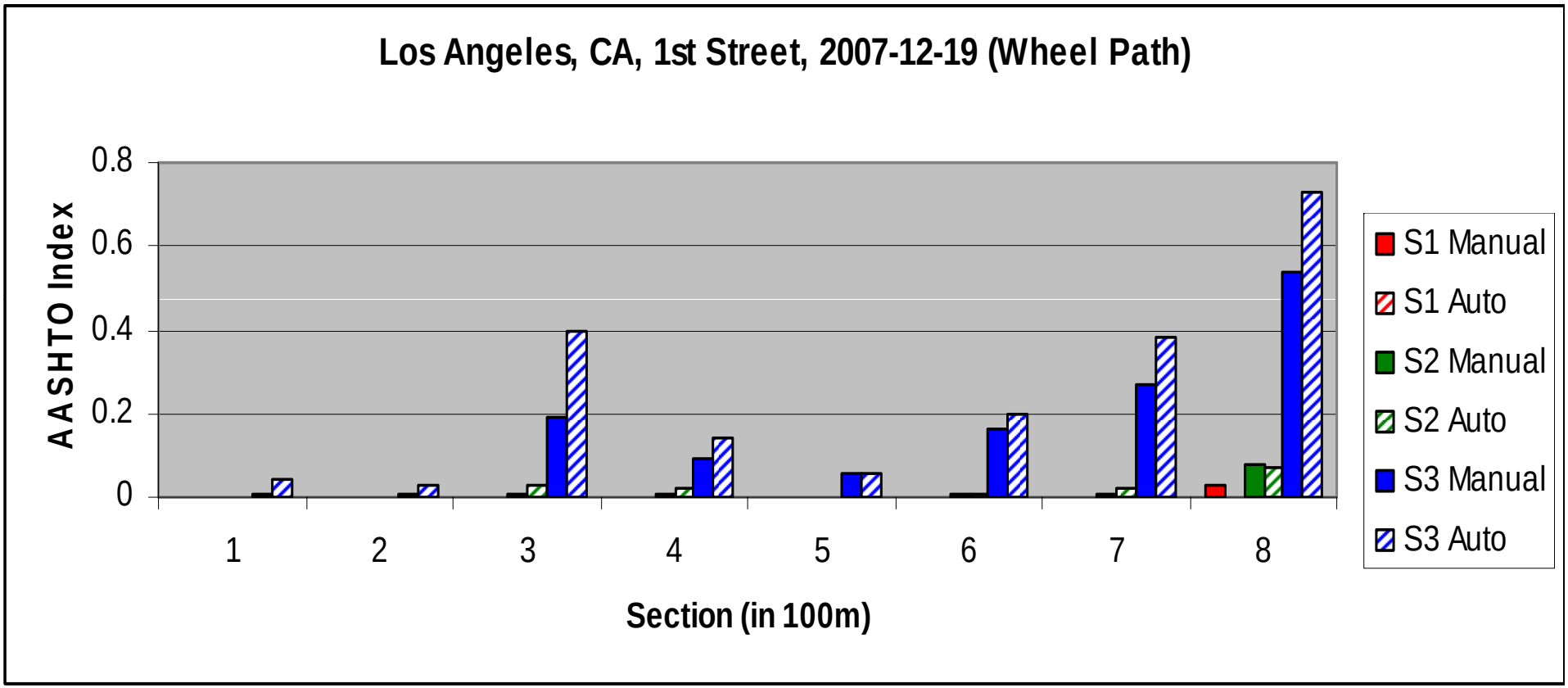
16
Section (in 50m)
Manual
Auto


Los Angeles, CA, 1st Street, 2007-12-19 (Wheel Path)
AASHTO Index
0.8
0.6
0.4
0.2
0
1
2
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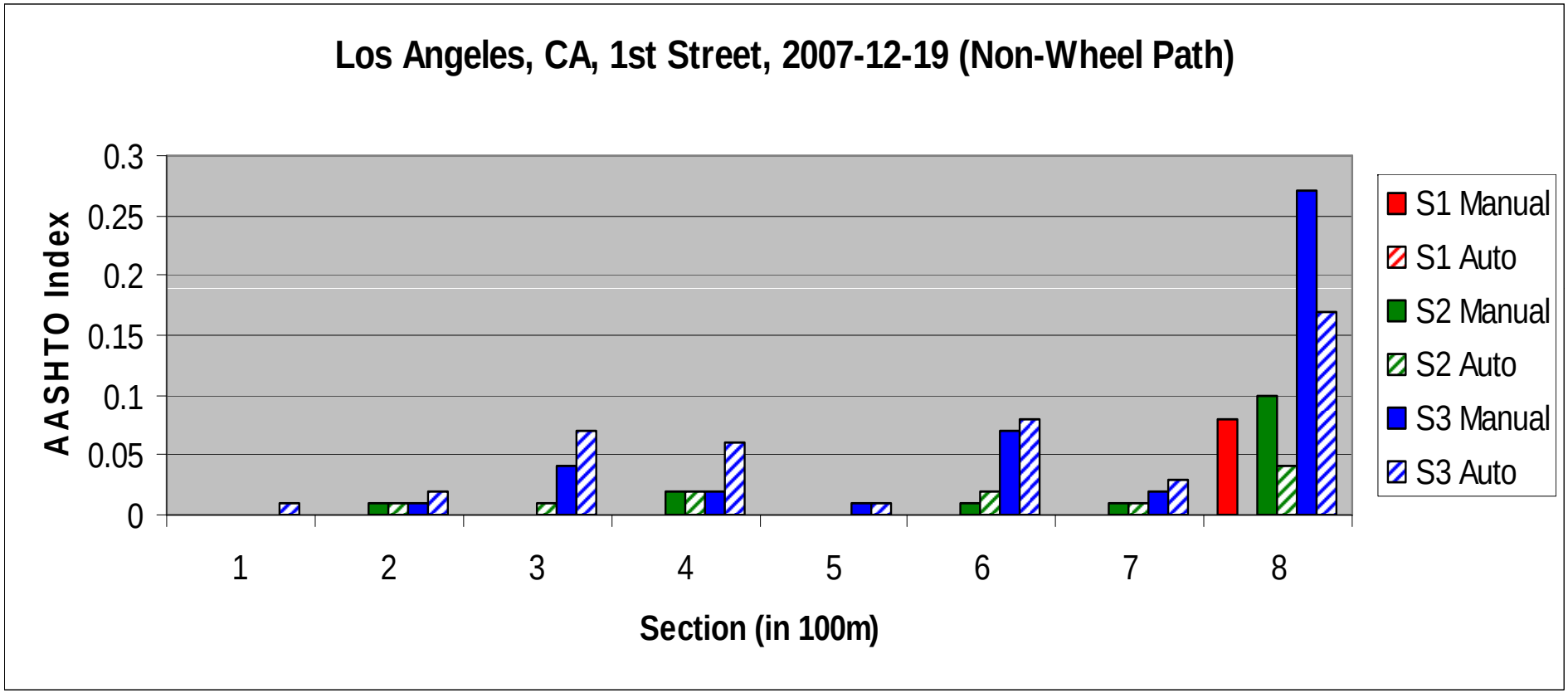
6
7
8
Section (in 100m)
S1 Manual
S1 Auto
S2 Manual
S2 Auto
S3 Manual
S3 Auto


Los Angeles, CA, 1st Street, 2007-12-19 (Non-Wheel Path)
AASHTO Index
0.3
0.25
0.2
0.15
0.1
0.05
0
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2
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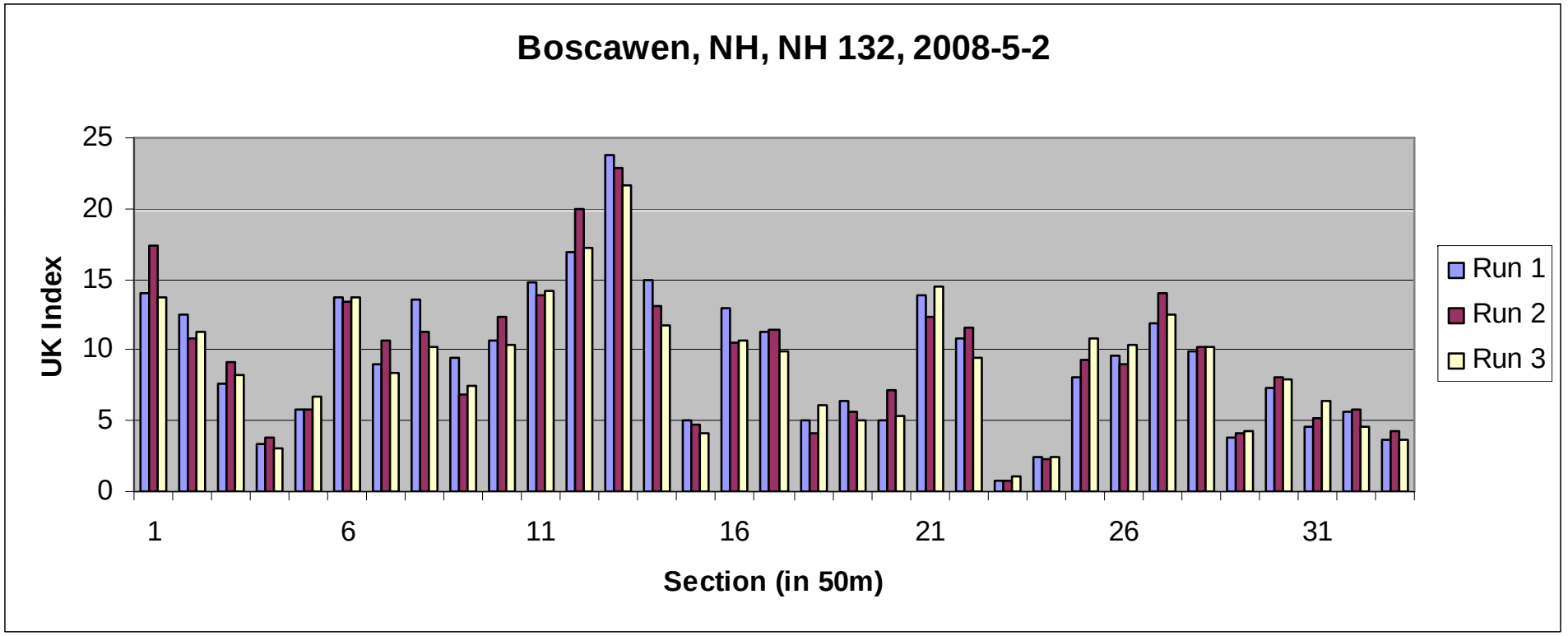
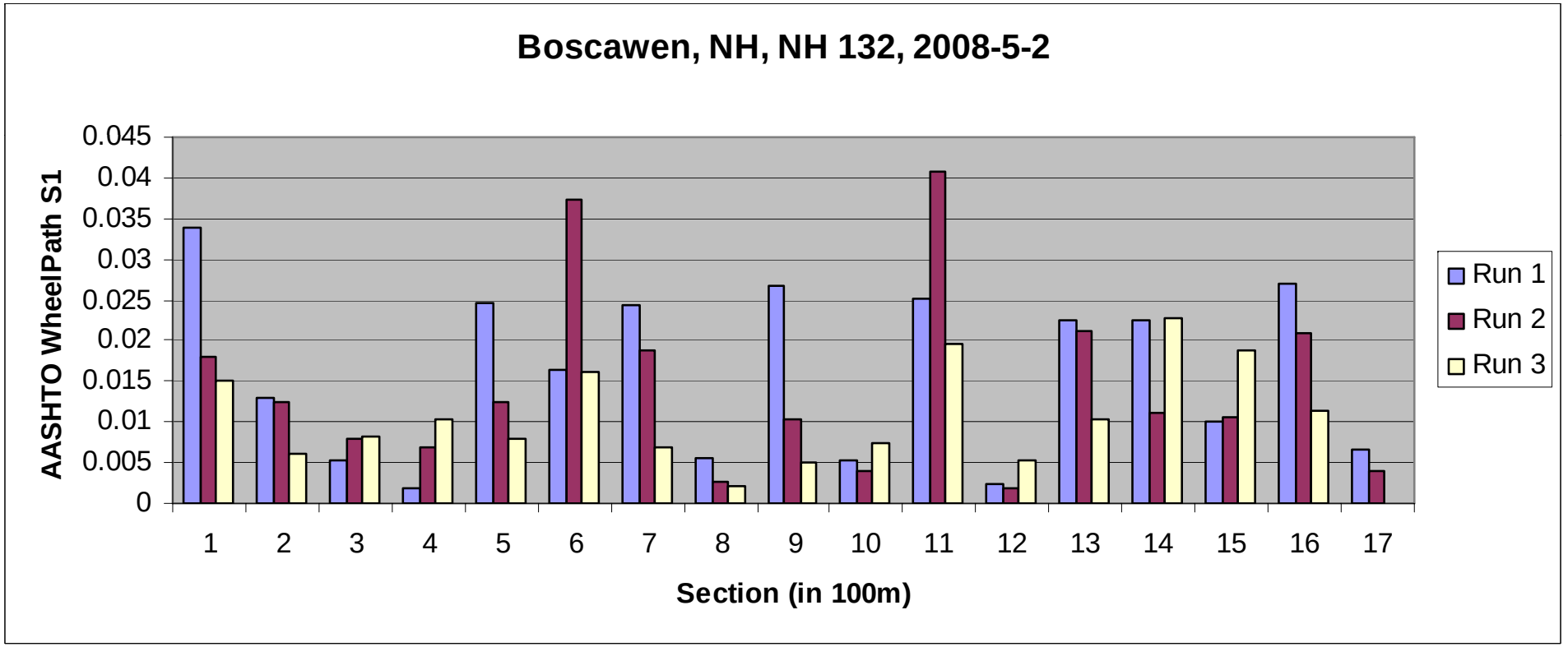
8
Section (in 100m)
S1 Manual
S1 Auto
S2 Manual
S2 Auto
S3 Manual
S3 Auto

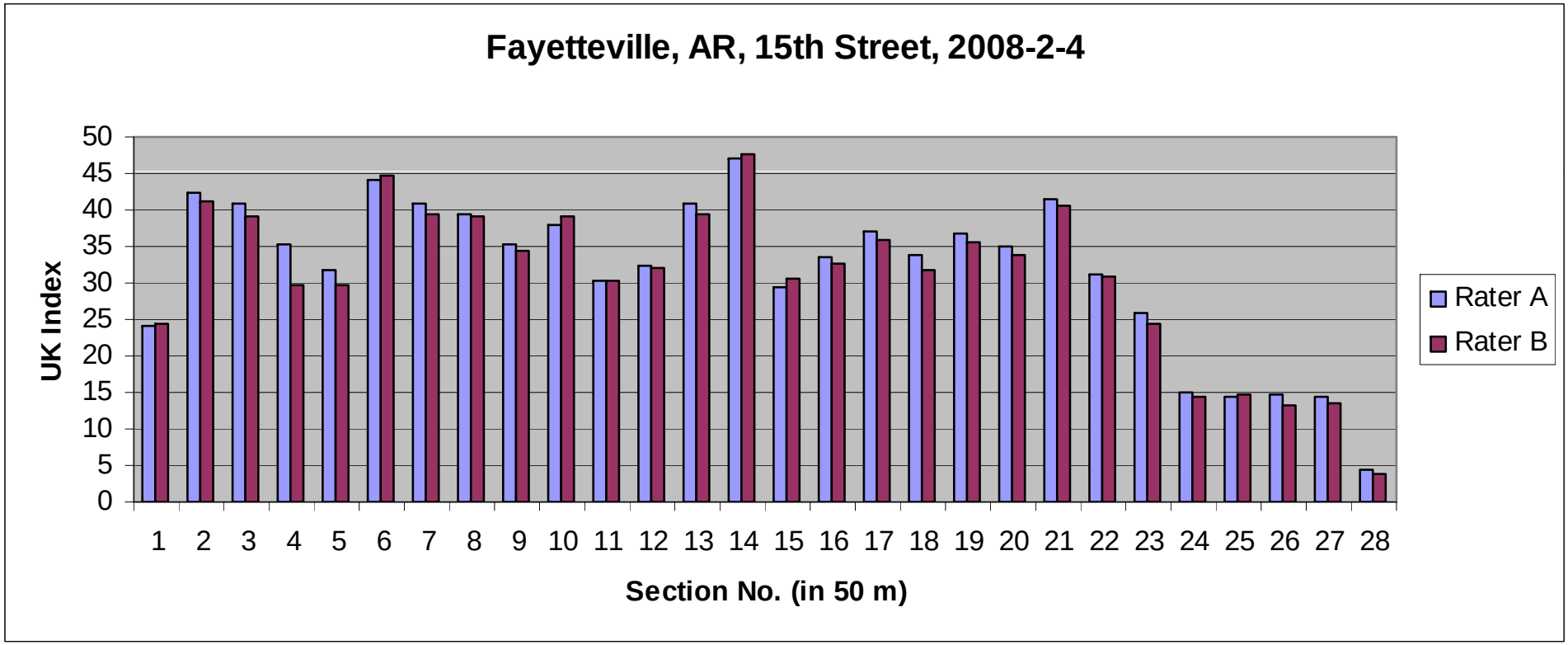
Repeatability (SCANNER)



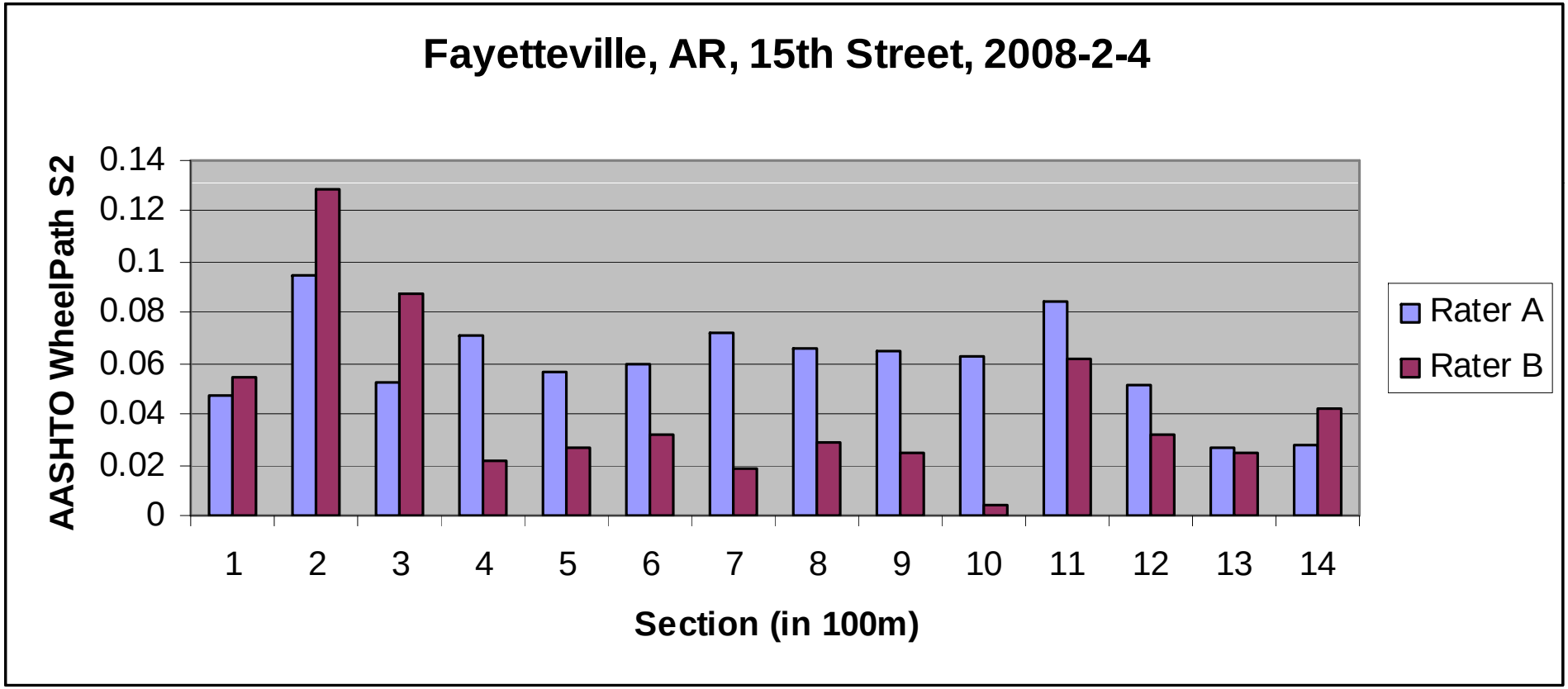
Repeatability (AASHTO)



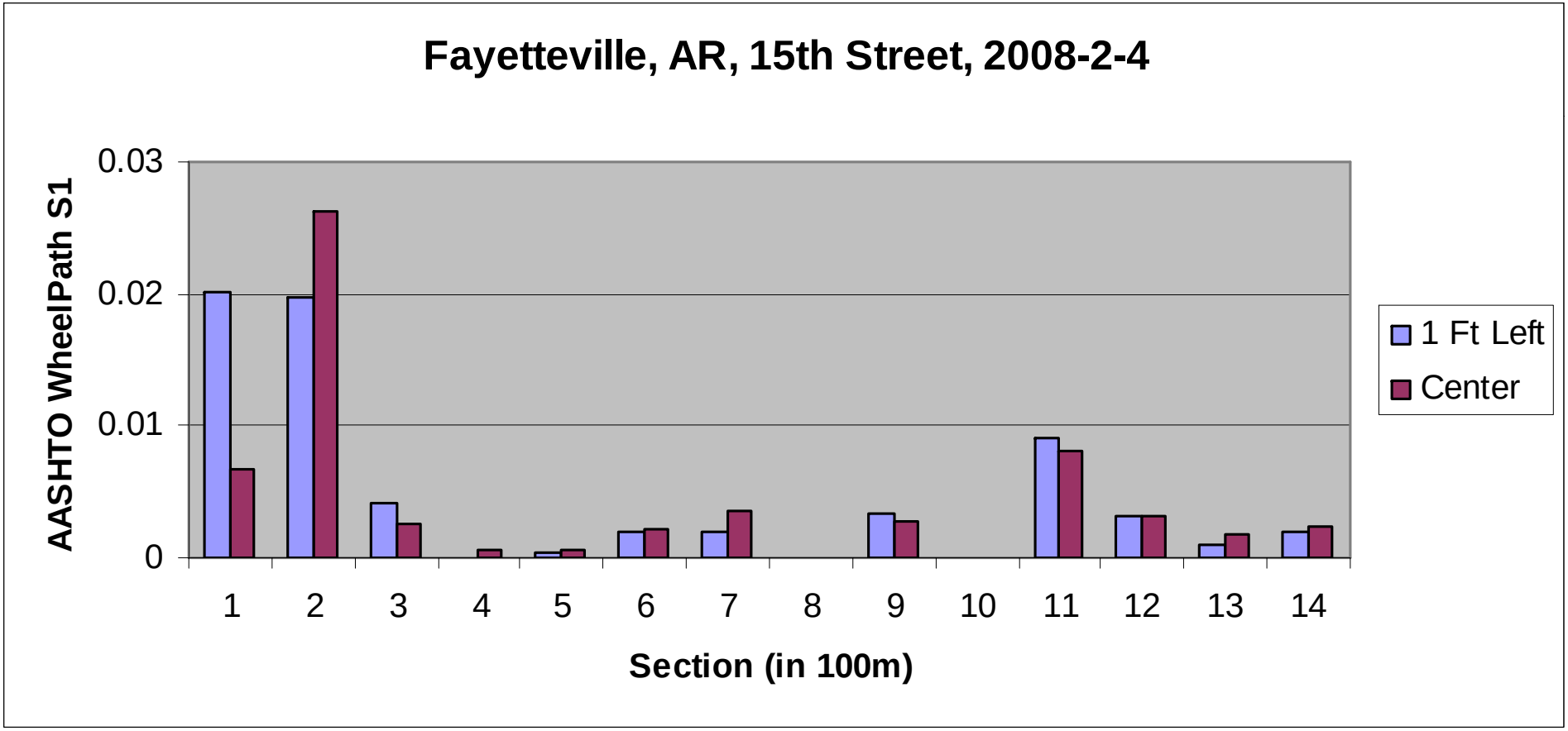
Variations Between 2 Raters (SCANNER)



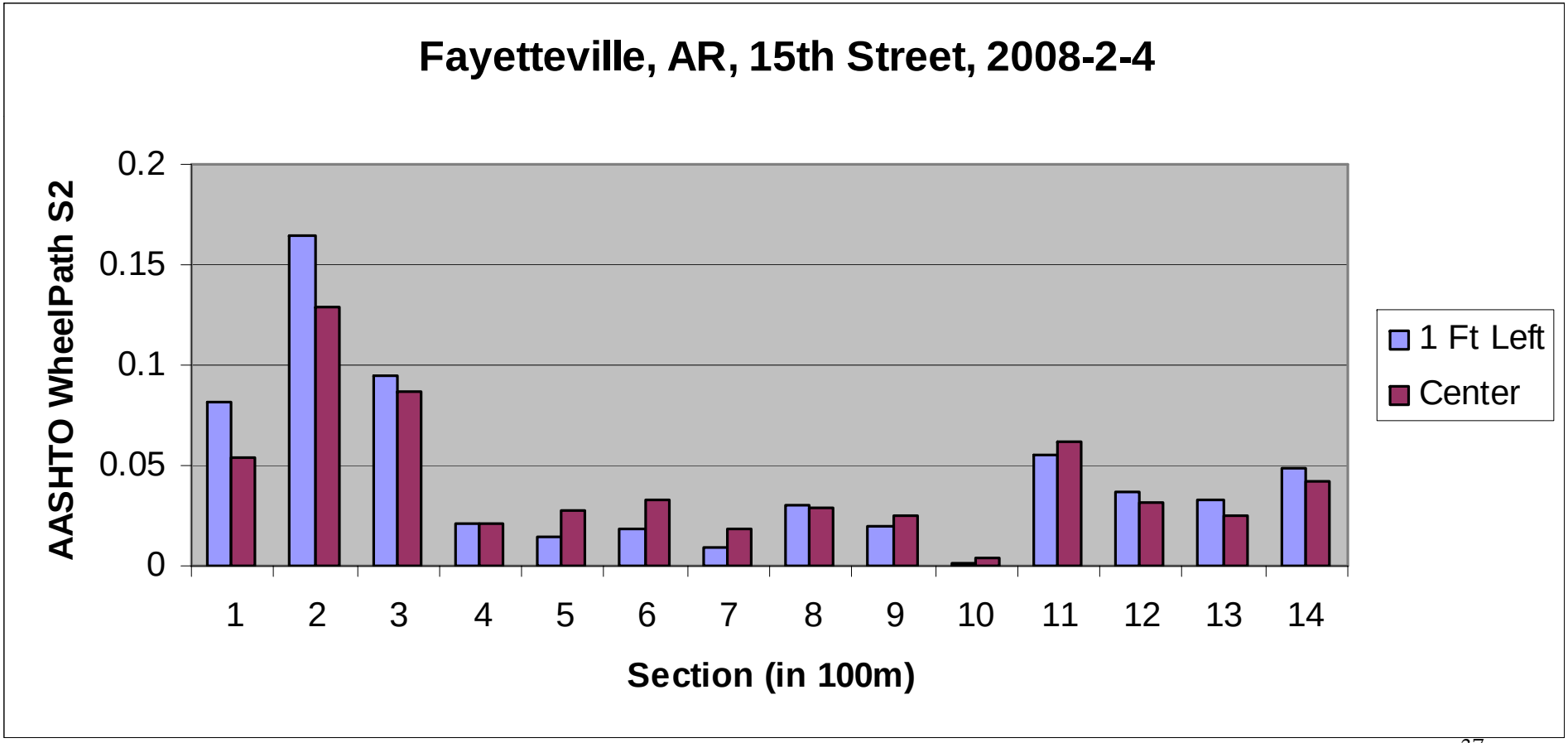
Variations Between 2 Raters (AASHTO)



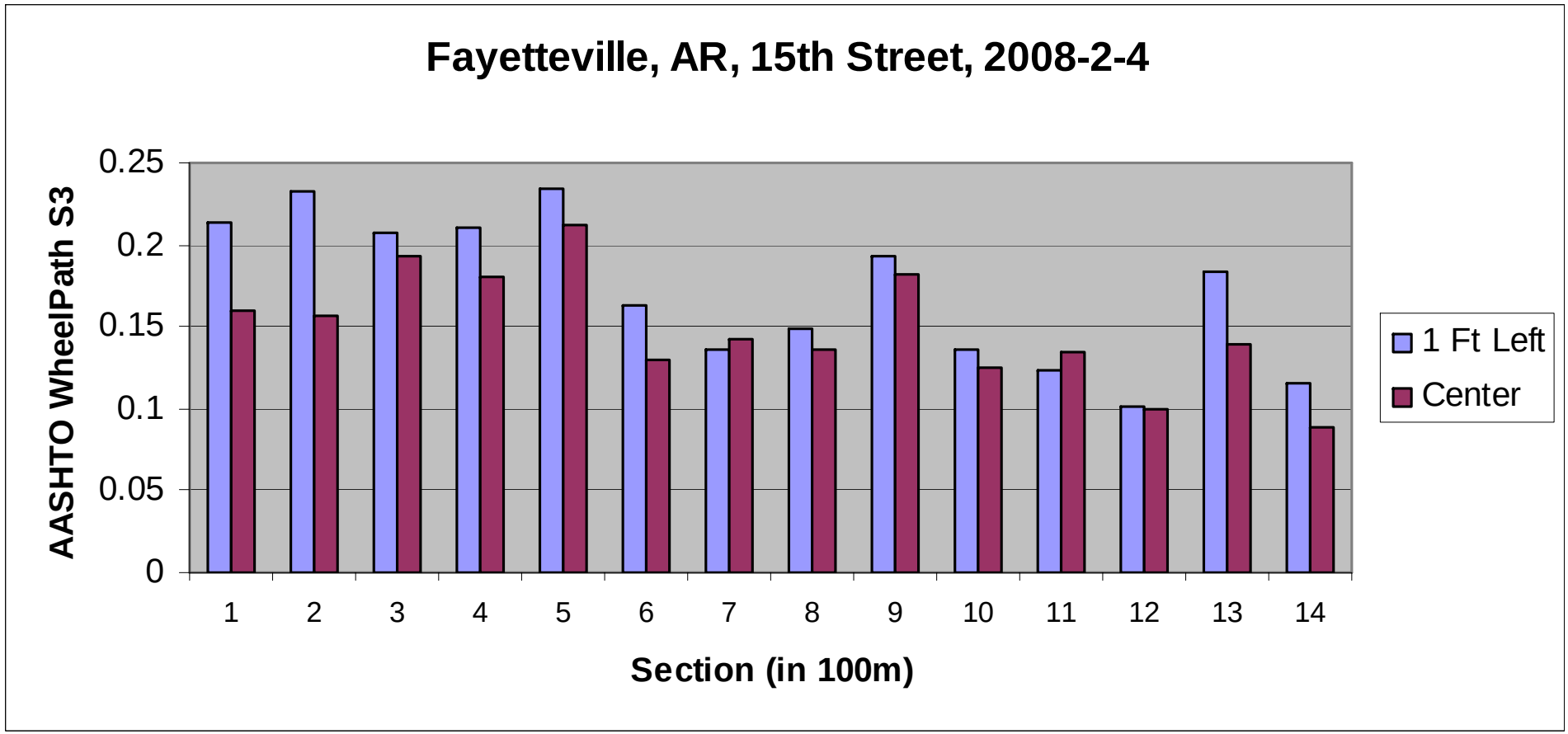
Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)



Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)



Variations Due to Shifting of Wheel-Path Between 2 Runs (AASHTO)



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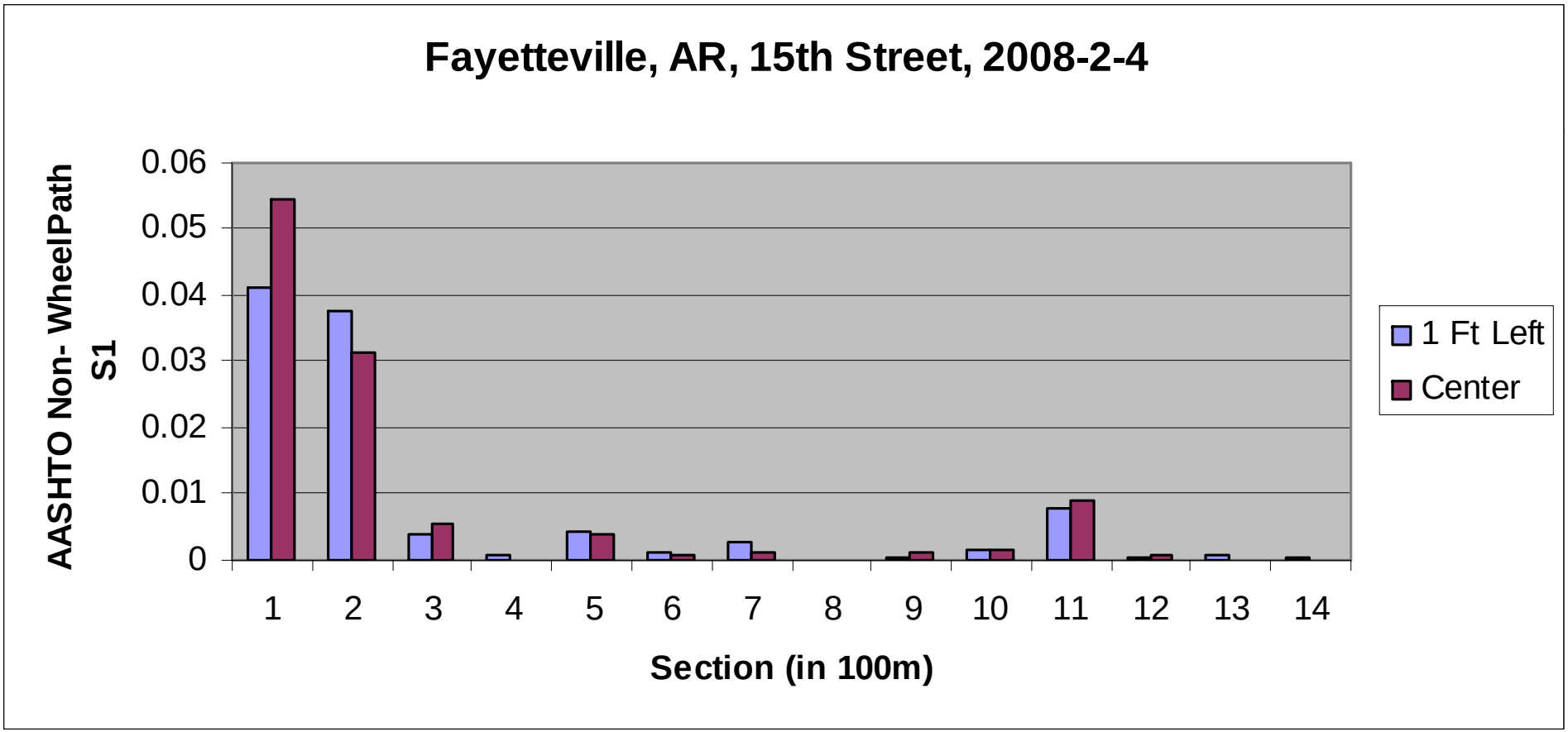

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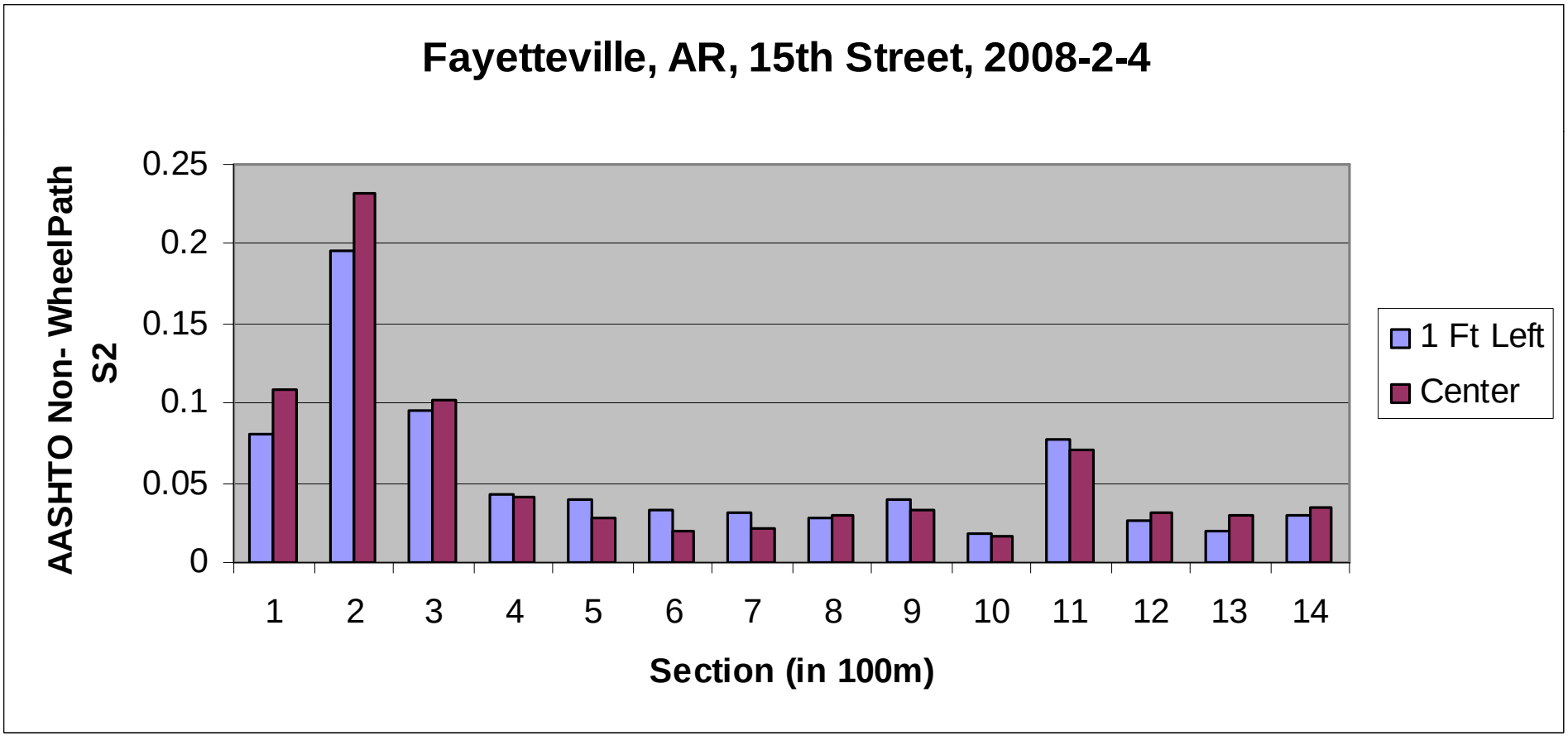

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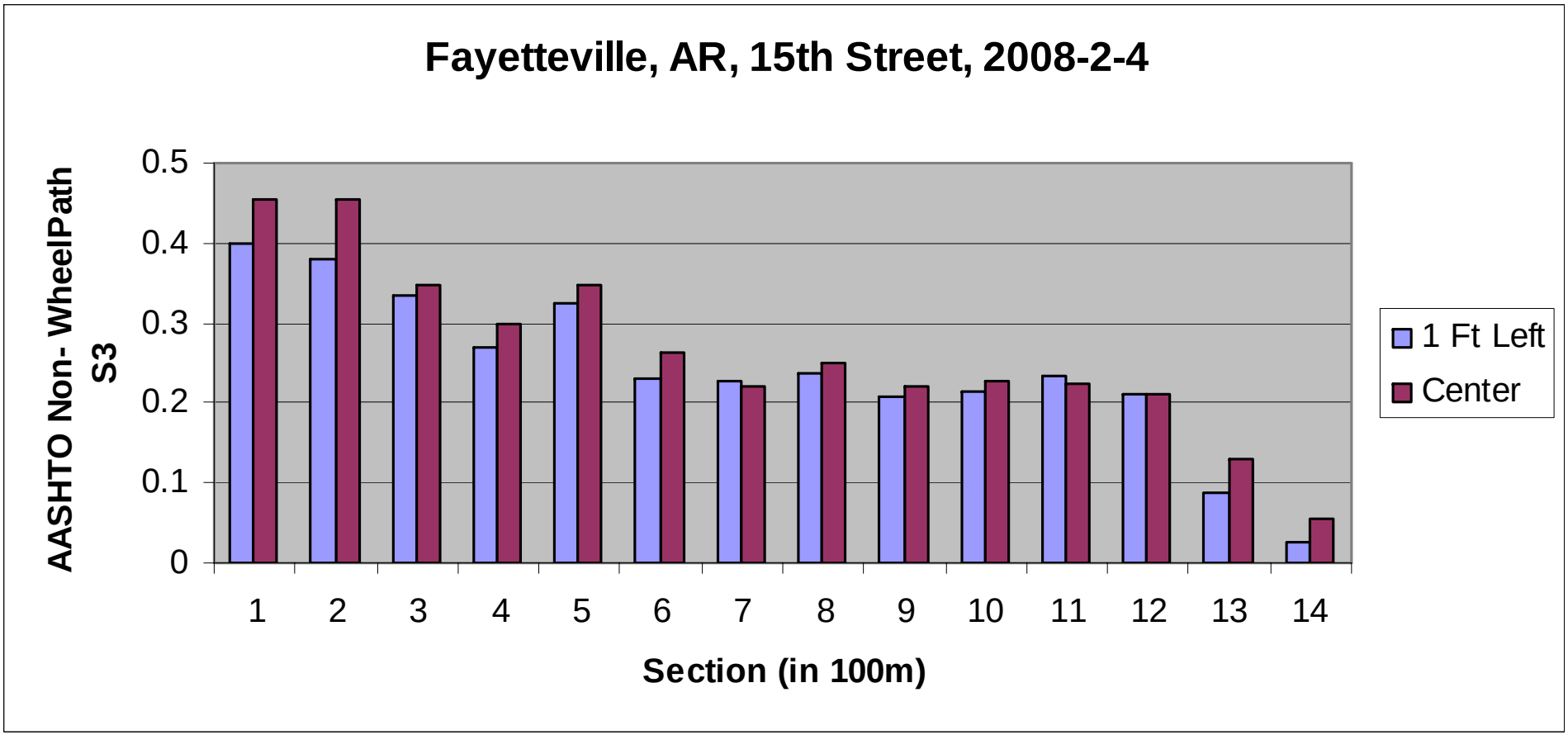


Part Four

- Keys to Protocol Application

Ideal Capabilities in Distress Automation (US Practices)

- PCI, cracking & many others
- LTPP, cracking & many others
- AASHTO Interim Protocol
- Cracking:
  - Linear Cracking, Block & Alligator Cracking
  - Wheel-Path Cracking (Load-Associated)
  - Non-Wheel-Path Cracking (Non-Load Associated)

Reality

- Poor Image Acquisition Technologies Until 2006
- Protocol Development for Automation
  - Which is First? Protocol or Technology Maturity?
  - Network Level or Project Level?
  - How to Use the Data for PMS?
  - Are All or Most Influencing Factors under Control for A Particular Protocol?

Reality

- Data Acquisition Technology Has Reached Stability in 2006: First Time Ever
- Network Level or Project Level?
  - Project Level Expectation in Many Cases, Why?
- Application of the Data for PMS?
  - Network Application: Priority
- Are All or Most Influencing Factors under Control for A US Particular Protocol?
  - NO

Influencing Factors

- Ground Truth of Crack Measurements
  - Comparability Among Manual Results?
- Accurate Positions of Cracks in Wheel-Path, Possible for Accuracy/Repeatability?
- Classification of Linked Cracks
  - Block or Alligator?
- Severity Levels
  - Width Measurement Accuracy?
- Benchmark for QC
  - Subjective

US Rodeo History from Early 1990's for Automated Cracking Survey

- All Unsuccessful (No Exception)
- All with Complex Protocols
  - Longitudinal, Transverse, Block, & Alligator
  - Linear Cracks & Load Associated
  - Severity, Extent, et al
- No Questions Asked by Agencies
  - Do it again next time
  - Continue with current method
  - Some day the vendors will get it right (really?)

The Devil is the Protocol!!!

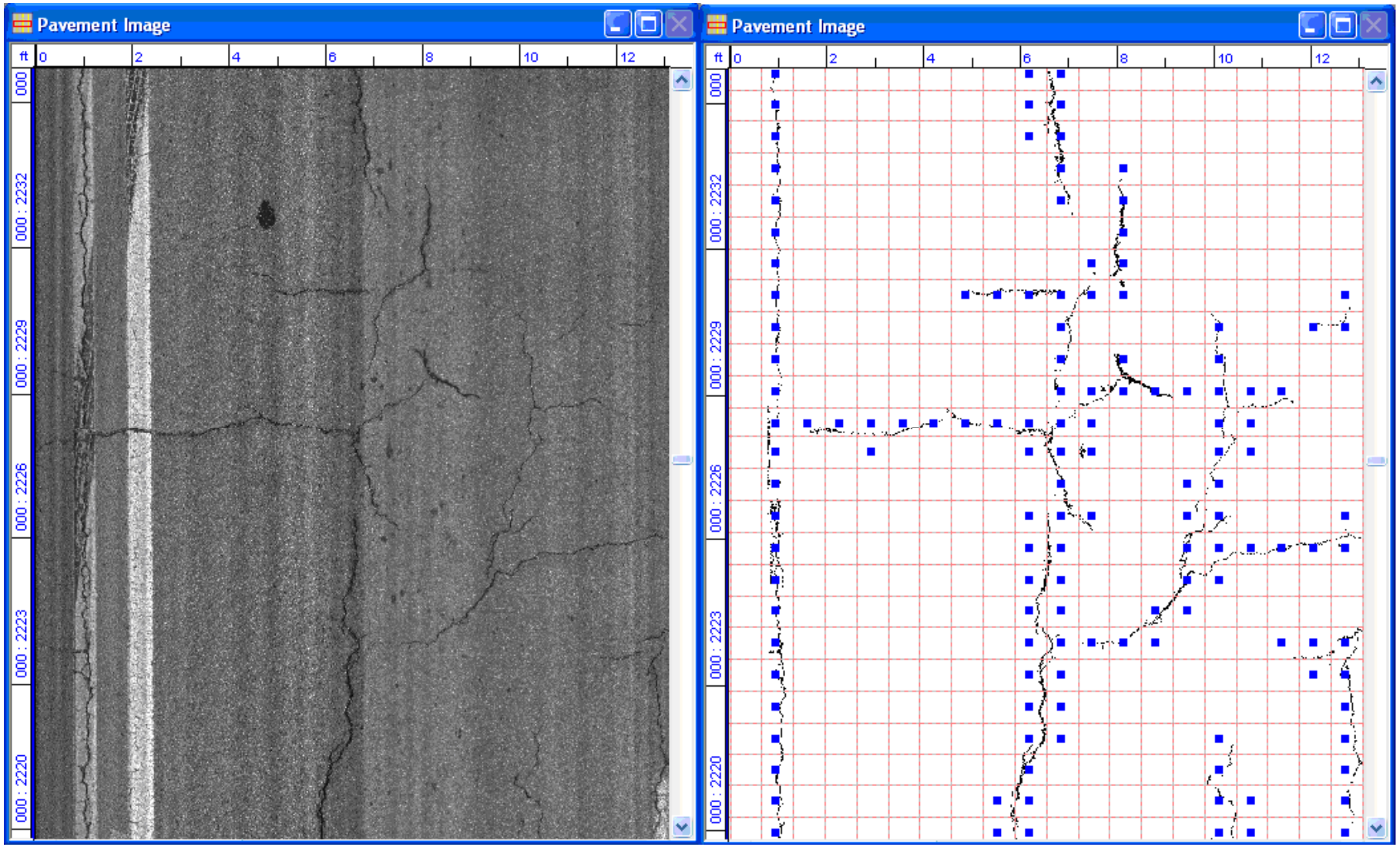
Need Simple and Controllable Protocol: Ultimate Importance

- Automation Target: Network Level Survey Only
  - Alert for Sections with Distress Problems for Additional Manual or Auto Analysis
- Eliminate or Reduce Influence of Un-Controllable Factors
- Automated Results: Easily Verifiable with Acceptable Variability
- Repeatable and Consistent

Available Protocol Outside US

- SCANNER in UK
  - Ratio: # of Grids with Cracks Over Total # of Grids
  - Simple, Relatively Powerful, Consistent and Objective
  - Easily Expandable to Include (1) Load and non-Load Cracking Information by Locating Data on Selected Grids, (2) Severities

Grid based SCANNER Method



Thank You !