# Can Traffic Signs Be Too Bright on Low-Volume Roads?

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Originally Presented at TRB's 11th International Conference on Low-Volume Roads

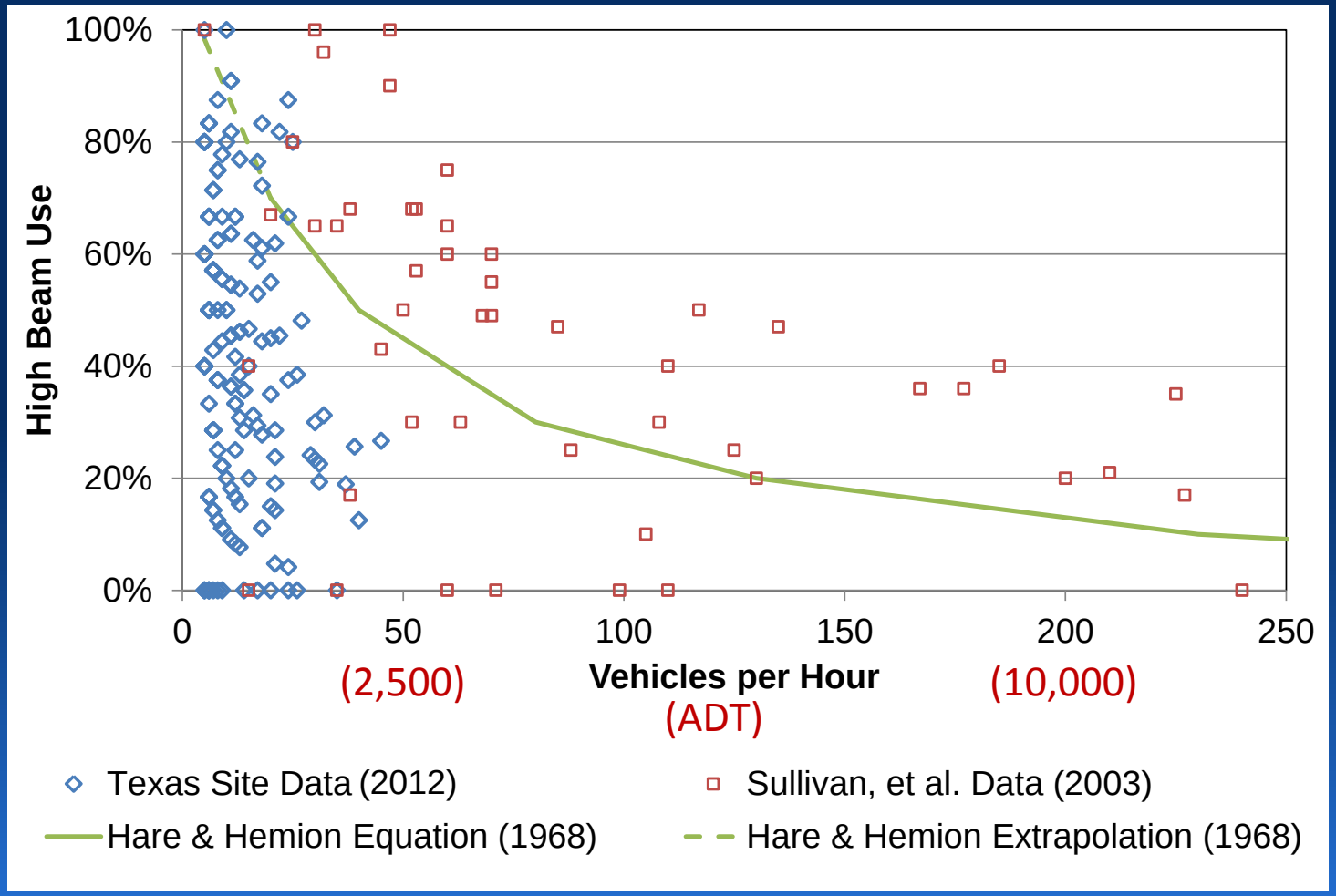
# Research Focus

- Can signs along rural roadways be too bright?
  - Glare
  - Distraction
  - Legibility
- If so, develop guidelines for sign sheeting materials

# Background

- MUTCD minimum retroreflectivity levels
- Ample research to support minimum nighttime driver needs
- Additional research exists for sign sheeting selection for guide signs
- Practically no research on sign sheeting selection for rural roads

# High-Beam Usage

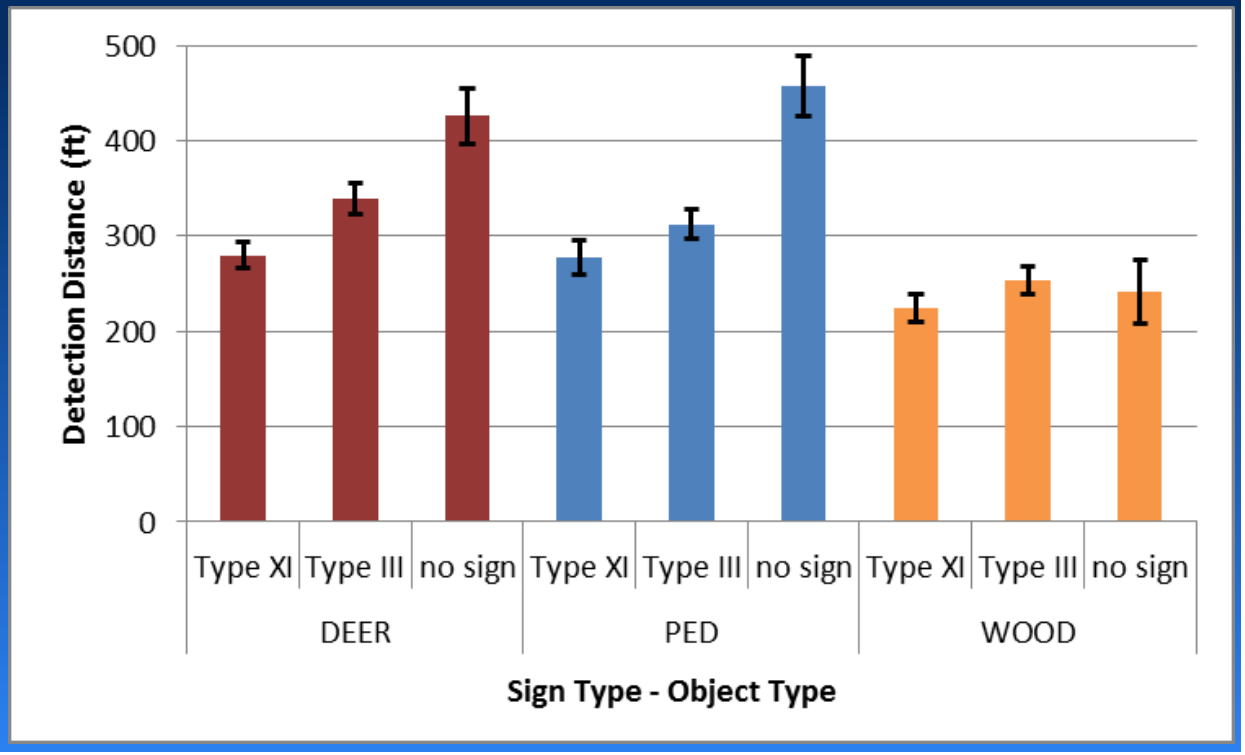


# Study Design

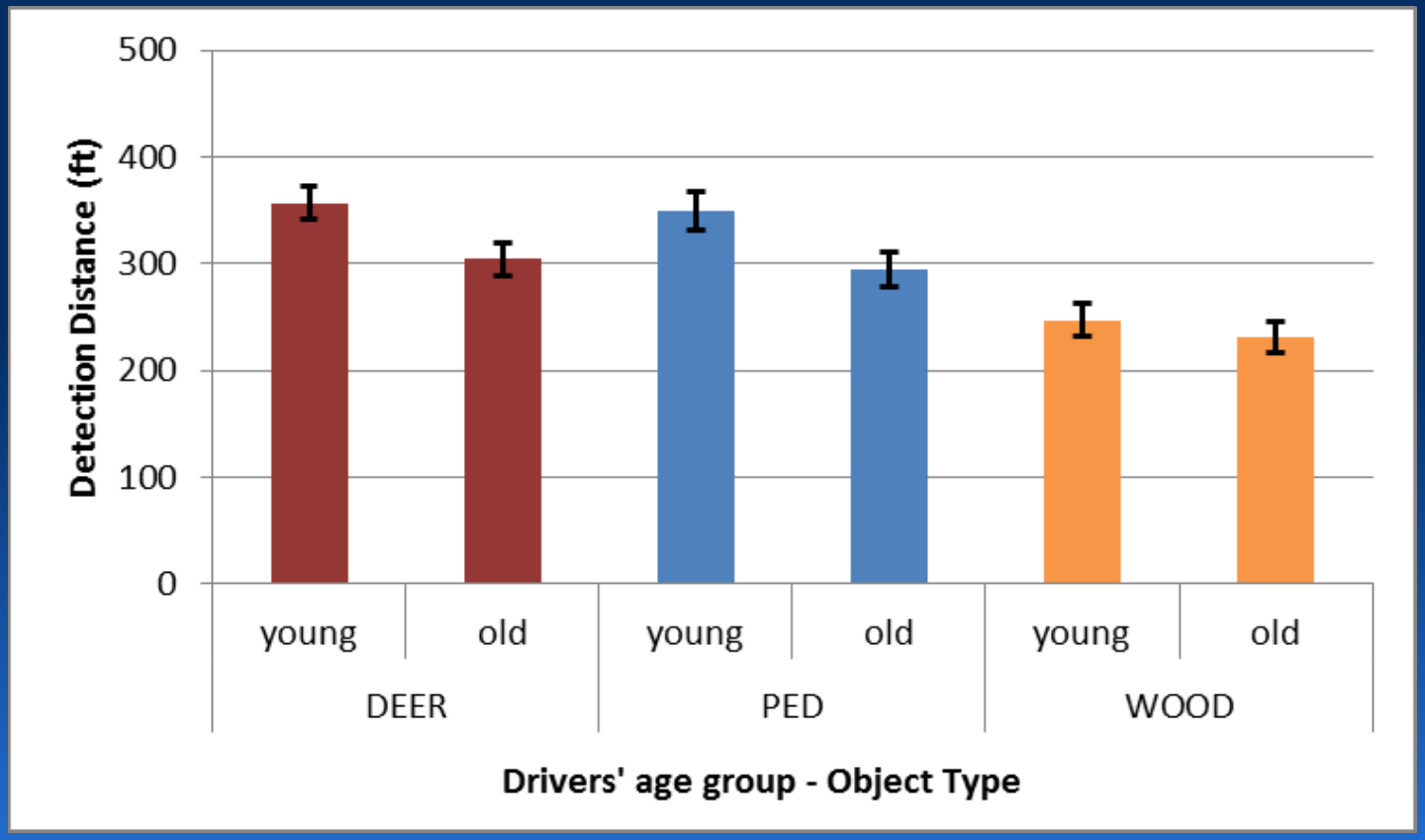
- Metrics
  - Legibility
  - Detection distance
- 2 Materials
  - Type III
  - Type XI
- Participants
  - 12 Old (>60 yrs)
  - 11 Young (<36 yrs)
- 3 Targets

# Detection Distance Results

- Almost 1200 observations
  - 381 pedestrian
  - 404 wood square
  - 393 deer



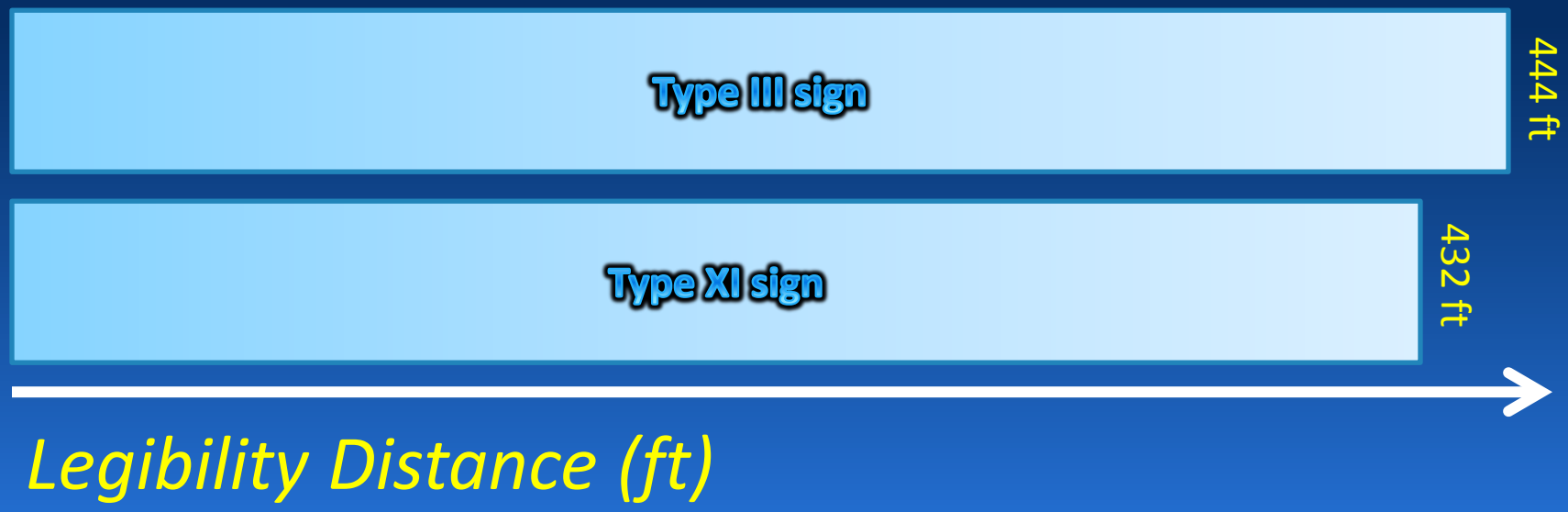
# Detection Distance by Age



# Average Detection Distances

# Legibility Results

- Over 1100 observations
  - 567 Type III material
  - 563 Type XI material



# Conclusions

- Can signs be too bright?
  - Legibility
    - Maybe
    - LED signs
  - Detection distance
    - Yes

# Recommendations

- Avoid unnecessary signs because of glare, maintenance, potential hazards, disrespect for TCDs in general

- For rural highways with ADT < 5000 vpd:
  - Use Type III or IV for Regulatory and Warning signs
  - No Type III or IV available in fluorescent colors, so use Type VIII, IX, or XI (sparingly)

# Questions

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Greg Schertz, Federal Lands Highway

Michael Chacon, Texas DOT

# Cost-Effective Safety Treatment of Trees on Low-Volume Rural Roads

**Lechtenberg, Stolle, and Faller**
Midwest Roadside Safety Facility
University of Nebraska-Lincoln

**Schrum**
University of Alabama-Birmingham

TRB Webinar
Safety on Low-Volume Roads
November 2016

# Background

- Naturally occurring roadside fixed objects
- 8% all traffic-related fatal crashes (FARS 1999-2009)
- 90% tree impact fatalities located on 2-lane roadways (FARS 1999-2009)
- 30% fatalities occur on low-volume roads (FARS 1999-2009)
- 26% fixed-object fatal crashes (FARS 2009)

# Available Guidance

- AASHTO RDG
  - Extrapolated from high-speed/high-volume
  - Remove from clear zone
- AASHTO *Guidelines for Geometric Design of Very Low Volume Local Roads*
  - ADT < 400 vpd
  - Documentable accident history
- NCHRP 500 Vol. 3
  - Prevent tree growth
  - Eliminate hazard or reduce severity

# Problem Statement/Objective

- Roadside trees are dangerous
- Limited safety improvement funds
- No proven methodology
- Need to determine benefit-cost of treating trees on roadways:
  - Less than 500 vpd
  - Posted speed limits ≥ 55 mph
  - Full range of impact speeds in RSAP

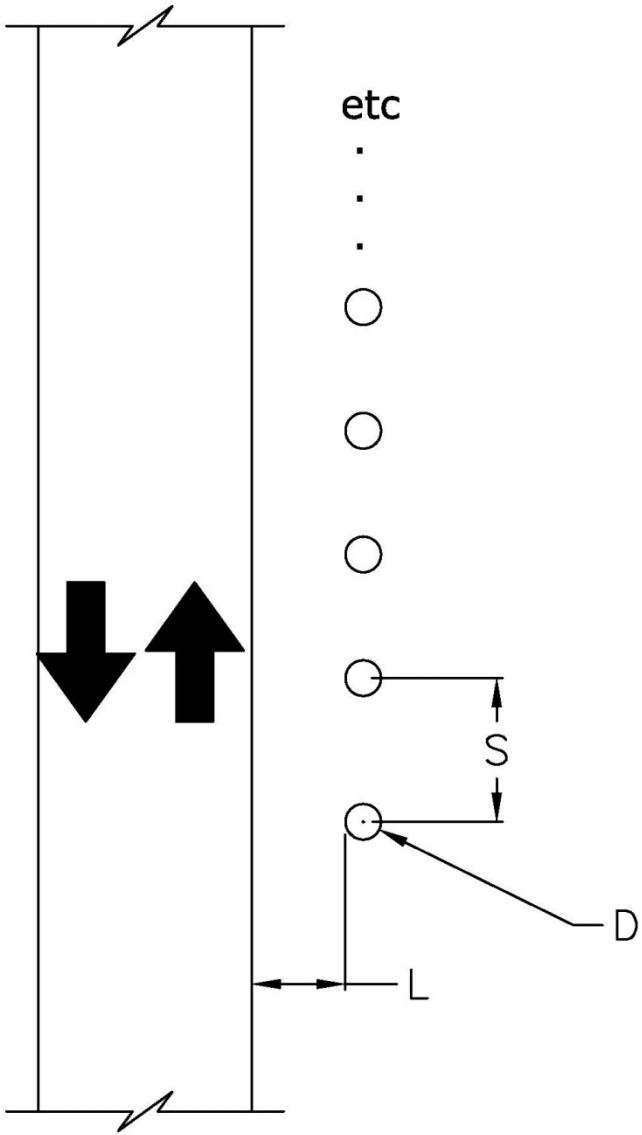
# Field Investigation

- KDOT typical low-volume roadways
- High frequency of roadside trees observed
- Collected data
  - Arrangements: individual, clusters/groups
  - Tree diameter
  - Cluster dimensions
  - Offset from roadway
  - Widths: roadway, shoulder, travel-way

# Road Geometry Modeling

- Rural local road
- Simulated straight, level roadways
  - Conservative
  - Applicable to vertical grades and horizontal curves
- Lane width = 12 ft

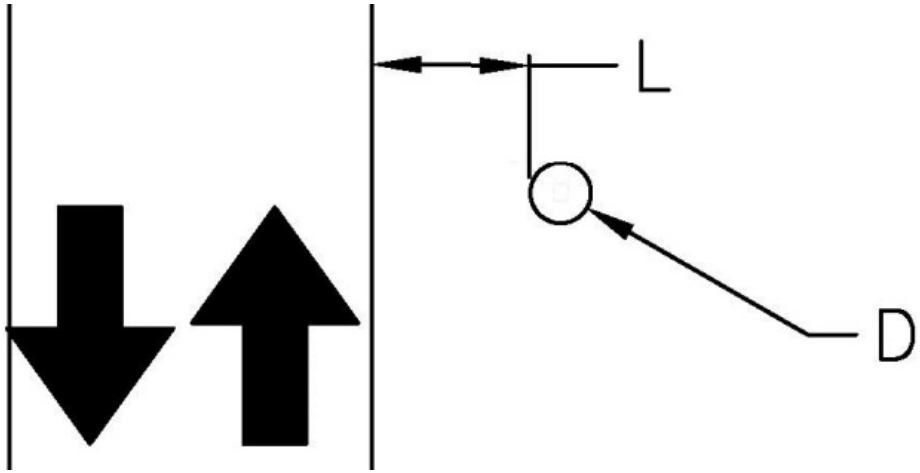
# Tree Geometry Modeling




- Tree profiles
- Tree offset
- Tree spacing

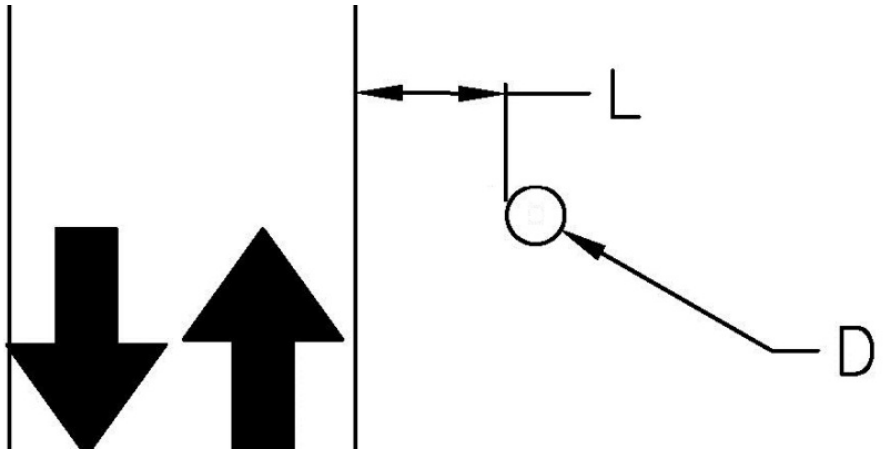
# Tree Profiles

- Predefined tree sizes in RSAP
- Dia. > 4 in. considered rigid fixed object (RDG)
- Dia. ≤ 4 in. reduced fatality probability
- Selected sizes representative of range of larger tree



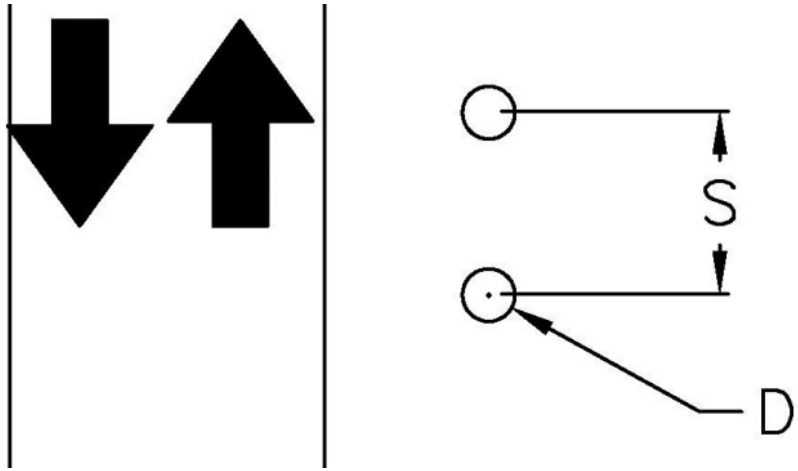
# Tree Offset

- Lateral offset from travel-way to traffic-side of tree trunk
- User specified value in RSAP
- Not responsible beyond clear zone (CZ)



# Tree Spacing

- Potential vehicle run-off-road trajectories help determine maximum tree spacing
- S > 40 ft allows vehicles to pass, more representative of individual trees
- Close spacing = worst-case tree density



# Safety Treatment Options

- Simulated
  - “Do nothing” – baseline
  - Tree removal
  - Install longitudinal barrier
- Other Options
  - Delineation
  - Edge treatments

# Delineation and Edge Treatments

- Delineation
  - Only warn, do not shield
  - Densely-forested areas where removal is difficult or not cost-effective
- Edge treatment
  - Require paved roadway
  - Common practice min. 400 ADT for rumble strip application
- Difficult to evaluate in RSAP

# Install Longitudinal Barrier

- High installation costs
  - $18.16/lf plus terminal
  - $45/lf plus terminal
- Viable situations
  - Very long sections of close spaced trees
  - Difficult tree removal
  - Regular new tree growth
- Scenarios evaluated not cost effective

# Tree Removal

- Costs from tree removal experts, county forestry commissioners, & county engineers
- Multiple tree removal costs conservative
  - Based on removal of 1 tree
- Upper bound costs = less safety benefit but leave more trees

# Tree Removal, B/C = 2

| ADT | No. of Trees | | | |
|---|---|---|---|---|
| | 1 | 2-10 | 11-25 | >25 |
| 0-99 | | | | |
| 100-199 | | | | |
| 200-299 | | | | |
| 300-399 | | | | |
| 400-500 | | | | |

Tree Diameter, Spacing, and Offset Dependent

Remove Tree(s)

# Tree Removal, B/C = 4

| ADT | No. of Trees | | | |
|---|---|---|---|---|
| | 1 | 2-10 | 11-25 | >25 |
| 0-99 | | | | |
| 100-199 | | | | |
| 200-299 | | | | |
| 300-399 | | | | |
| 400-500 | | | | |

Tree Diameter, Spacing, and Offset Dependent

Remove Tree(s)

# Summary and Conclusions

- Shielding trees
- Tree removal cost-effective treatment
- B/C ratios determined by RSAP and used to make tree removal recommendations
- All cases: B/C ratios > 1.0
  - No safety benefit to leaving trees in place

# Recommendations

- Engineer encouraged to use guidelines as foundation
- Restricted removal
  - Delineation
  - Edge treatments
  - Install barrier
- Applicable to higher-volume, higher-speed roadways

# Acknowledgements

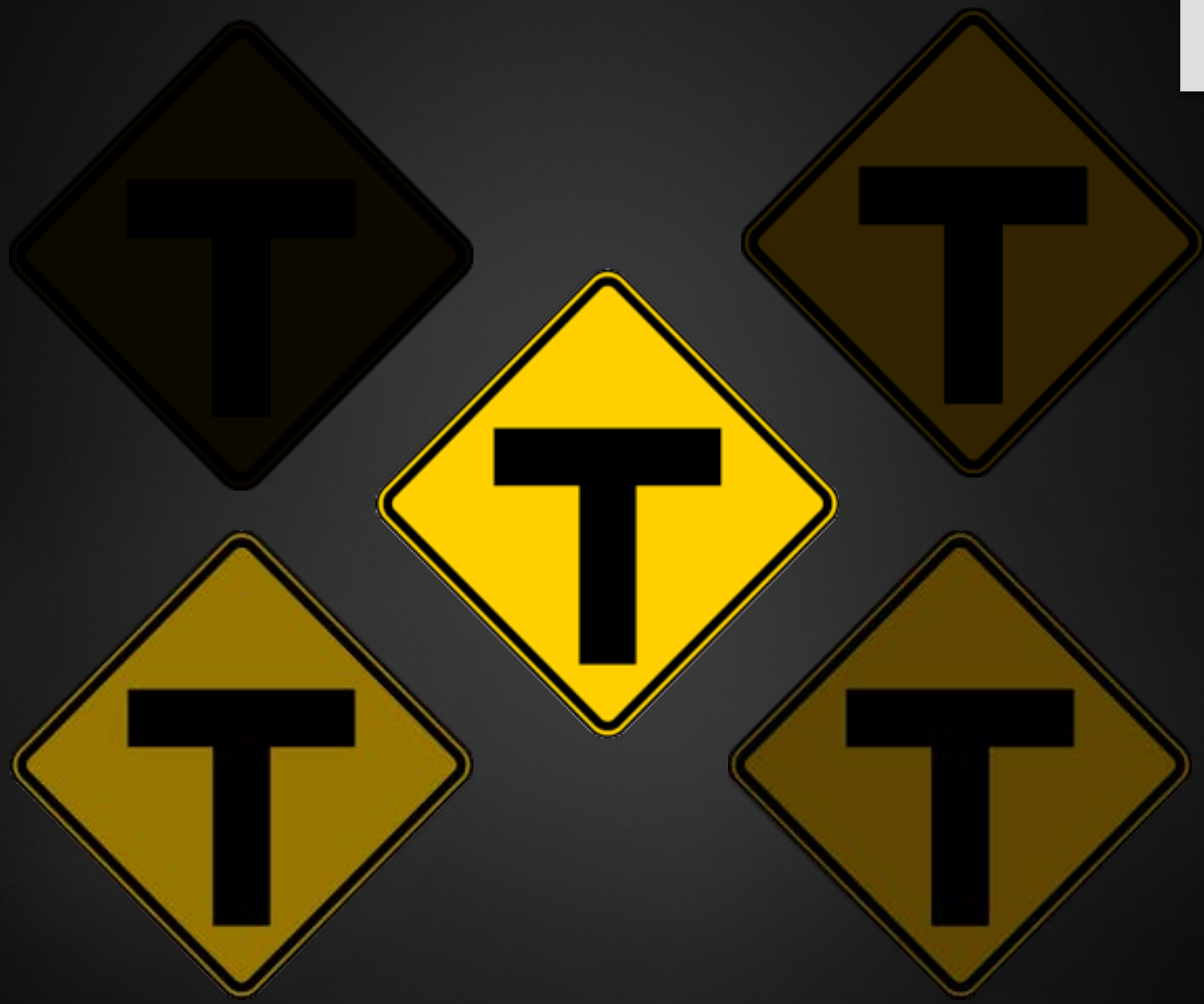

- Midwest States Pooled Fund Program – research funding
- KDOT and Marshall County Officials – field investigation locations

# An Inexpensive Retroreflectivity Field Inspection Kit

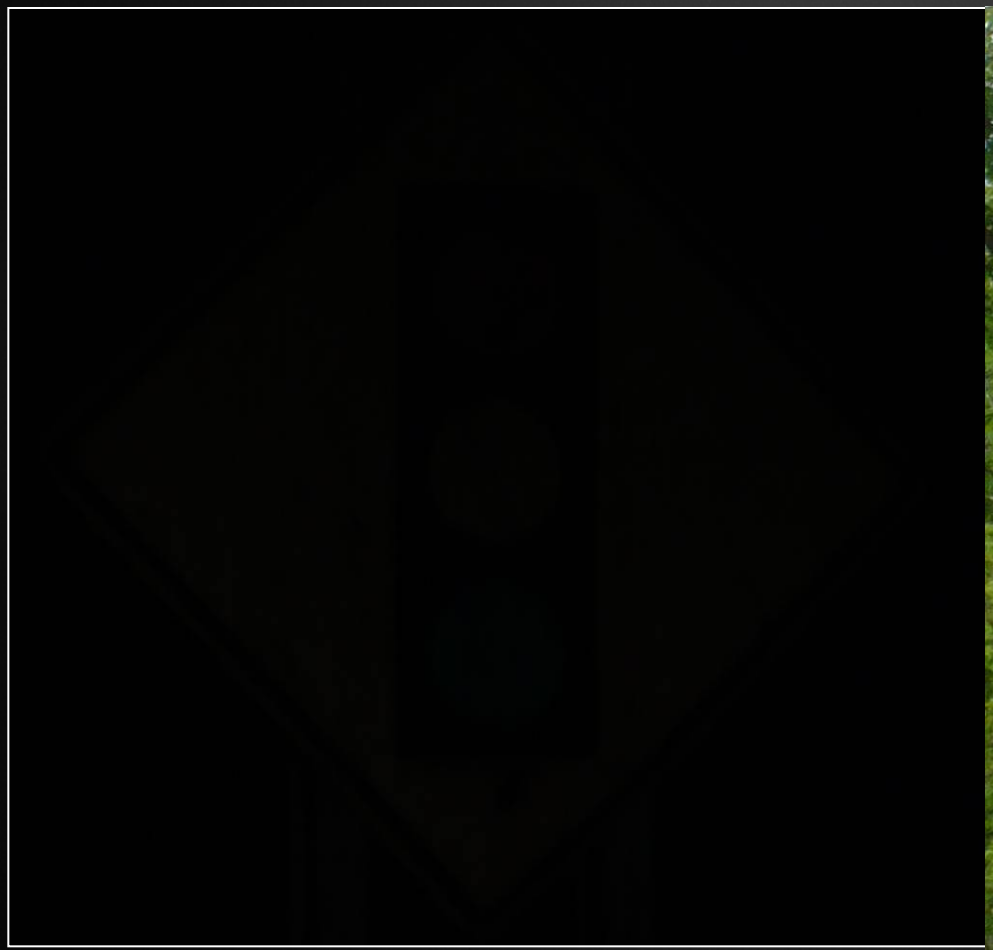
David P. Orr, PE, PhD

Geoffrey Scott, PE

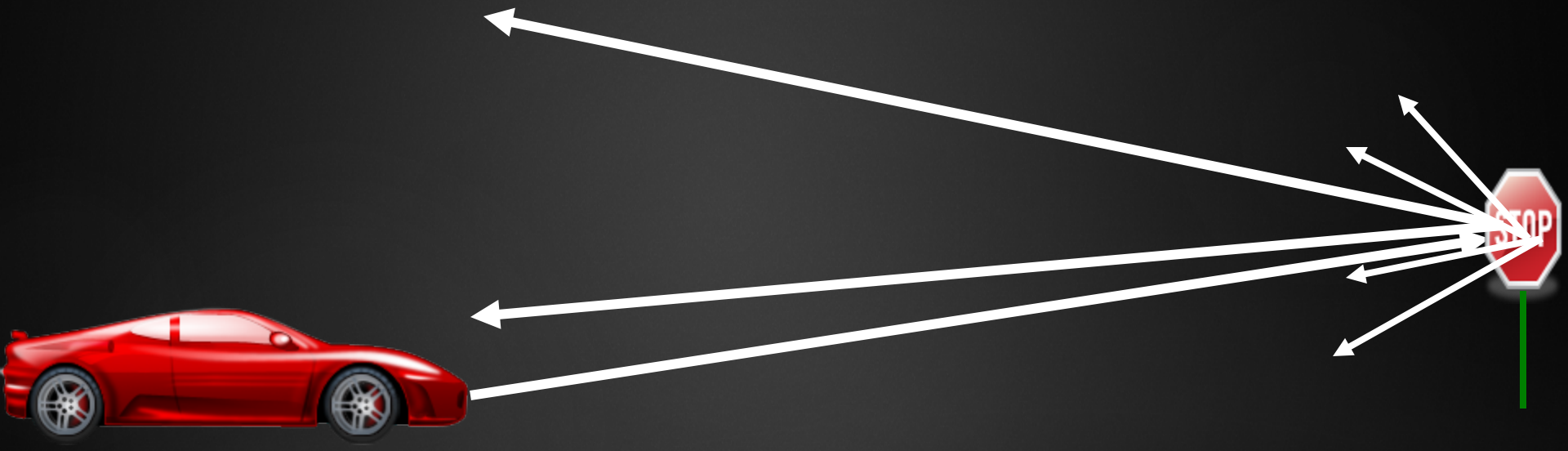
Cornell University Local Roads Program



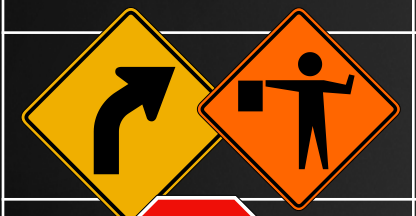
# Brightness



# Retroreflectivity



# New MUTCD Table 2A.3
# Which Sheeting is Allowable
# (Ground Mounted Only)

| Colors | Beaded Sheeting | | | Prismatic Sheeting |
|---|---|---|---|---|
| | Engineer | Super Eng. | Hi-Intensity | |
|   | Yellow | Green | Green | Green |
|  | Red | Green | Green | Green |
|   | Green | Green | Green | Green |
|   | Green | Green | Green | Green |

# Allowable Methods

- Nighttime - calibrated sign
  - Nighttime - comparison panels
    - Nighttime – consistent parameters
      - Measured sign retroreflectivity
        - Expected sign life
          - Blanket replacement
            - Control signs

# ASAP Project

# Retroreflectometer Sharing Project

| County | County | Town | City | Village | Total |
|---|---|---|---|---|---|
| **Genesee** | 1 | 13 | 1 | 6 | **21** |
| **Livingston** | 1 | 17 | 0 | 9 | **27** |
| **Wyoming** | 1 | 16 | 0 | 9 | **26** |
| **TOTALS** | **3** | **46** | **1** | **24** | **74** |

# Goals

- Current status and capability
- Methods to determine condition
- Simple tool to meet retroreflectivity standard
- Multiple jurisdictions sharing a retroreflectometer

# Inspections

- Counties – Annual
- Towns and Villages – no pattern

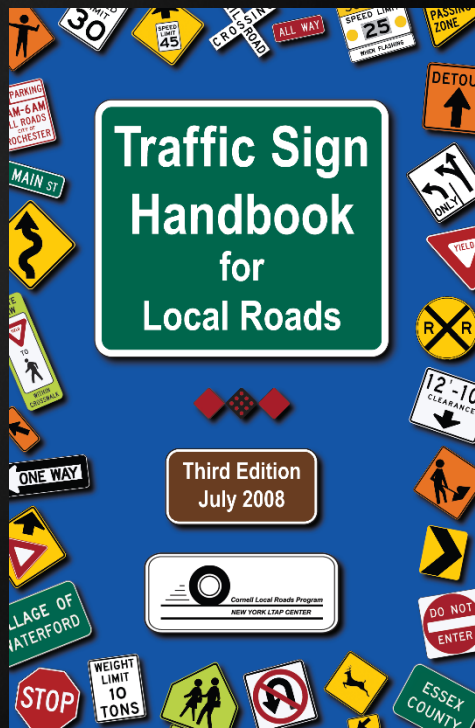
# Manpower and Budget

- Counties – Sign crew
- Towns and Villages – no crew

- 24 hour response

# Regulation Awareness

- Need for training
- Traffic Sign Handbook



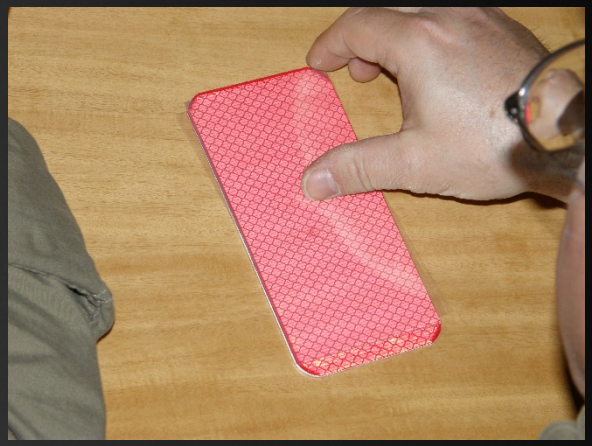
# Field Kit

- One panel per color
- Transparency film
- <$50 each

# Making the Panels

1. Panel above $R_A$ minimum value
2. Measure panel with retroreflectometer
3. Cut and place overhead sheets
4. Measure panel
5. Repeat until below min $R_A$
6. Remove last sheet
7. Confirm RA value
8. Record on back of panel

# Making the Panels

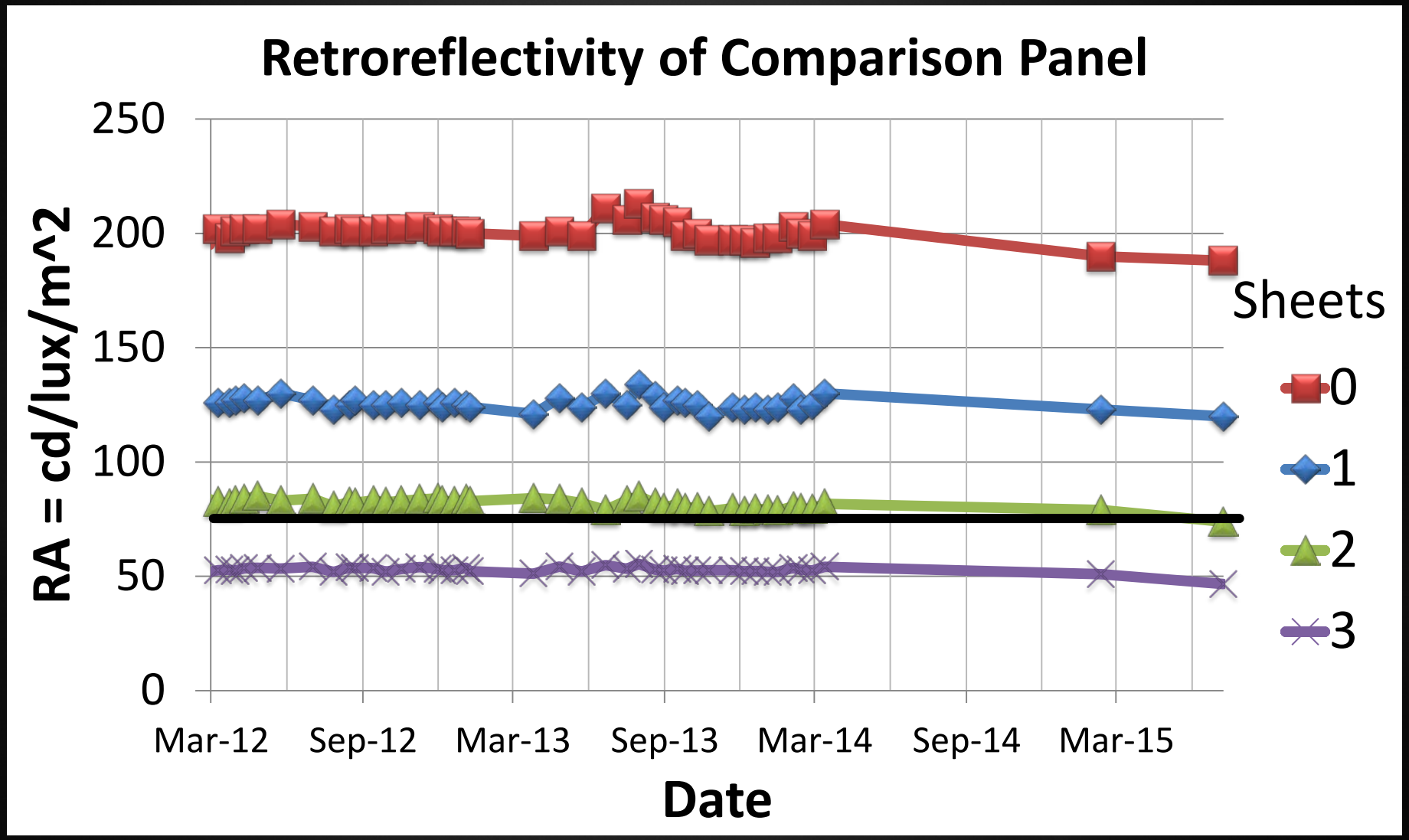



# Use in the Field

# Results

- Wyoming County
  - 3 days to inspect all signs vs. 4
  - 30 less sign replacements
    - $3,000 annual savings

# Lifetime of Panels



# Thank You

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Cornell University Local Roads Program