



9th International Conference on  
**MANAGING PAVEMENT ASSETS (ICMPA9)**

# A Case Study in Establishing Quality Assurance Limits for Automated Pavement Distress Data in North Carolina

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# Presentation Outline

- **Background**
- **Data Collection**
- **Analysis**
- **Benefits**



# BACKGROUND

# Background

- **Began automated data collection in 2012**
  - **Transition from manual to automated rating**
  - **Maintained two distress guides**
- **19,000 miles of interstate & primary**
- **Develop quality limits for control of the distress data**

# Control Site Selection

- **Important that control sites represent a range of representative conditions**
  - **Variety of distress types**
  - **Variety of extents**
  - **Variety of severity levels**
- **NCDOT was provided with an initial matrix**
  - **Review historical data to fill the cells**
  - **Sites within a day's drive of Raleigh**

# Control Site Selection

OID	SURFACE TYPE	COUNTY NAME	COUNTY NUMBER	DIVISION	ROUTE	BEG MP	END MP	LENGTH (miles)
1	AC	Davidson	29	9	30000008	7.63	8.13	0.5
2	AC	Davidson	29	9	30000008	8.68	9.18	0.5
3	AC	Davidson	29	9	30000008	10.152	10.652	0.5
4	AC	Randolph	76	8	30000022	11.83	13.16	1.33
5	AC	Stokes	85	9	30000008	19.052	19.302	0.25
6	AC	Stokes	85	9	30000066	15.355	15.655	0.3
7	AC	Stokes	85	9	30000066	16.397	16.697	0.3
8	AC	Stokes	85	9	30000066	17.797	18.057	0.26
9	AC	Edgecombe	33	4	30000111	8.23	8.73	0.5
10	AC	Edgecombe	33	4	30000111	11.54	12.04	0.5
11	AC	Edgecombe	33	4	20000258	14.322	14.652	0.33
12	AC	Richmond	77	8	20000001	20.451	20.951	0.5
13	AC	Chatham	19	8	30000751	6.41	6.91	0.5
14	AC	Wake	92	5	30000054	9.573	10.073	0.5

# Control Site Selection

- Windshield definitions

DISTRESS TYPE	SEVERITY		
	LIGHT	MODERATE	SEVERE
Alligator (Small Quantity)	4, 7, 10	2, 3	2, 11
Alligator (Large Quantity)	1, 5, 9, 12, 14	5, 11, 13, 14	
Transverse Cracking	4,5,6,9,10,11,12, 14	4, 5, 14	
Rutting	6, 13		
Raveling	6, 8, 13		
Bleeding	8		6, 7
Patching	5, 9		
Oxidation			

# Control Site Selection

- High speed definitions

DISTRESS TYPE	SEVERITY		
	LIGHT	MODERATE	SEVERE
Transverse	4,5,6, 13,14	4,5,7, 11,12,14	9,10,11
Longitudinal (Outside of WP)	12		
Longitudinal Lane Joint			
Alligator	1,2,3,4,5,7,9,10,11,12,14	2,3,4,5,9,11,12,13,14	2,11
Patching (WP)	5		
Patching (NWP)			
Delamination			
Bleeding	8		6,7
Rutting	6,12,13		
Raveling	6,8		
Transverse Reflective	12	12	
Longitudinal Reflective	12		





# DATA COLLECTION

# Field Reviews

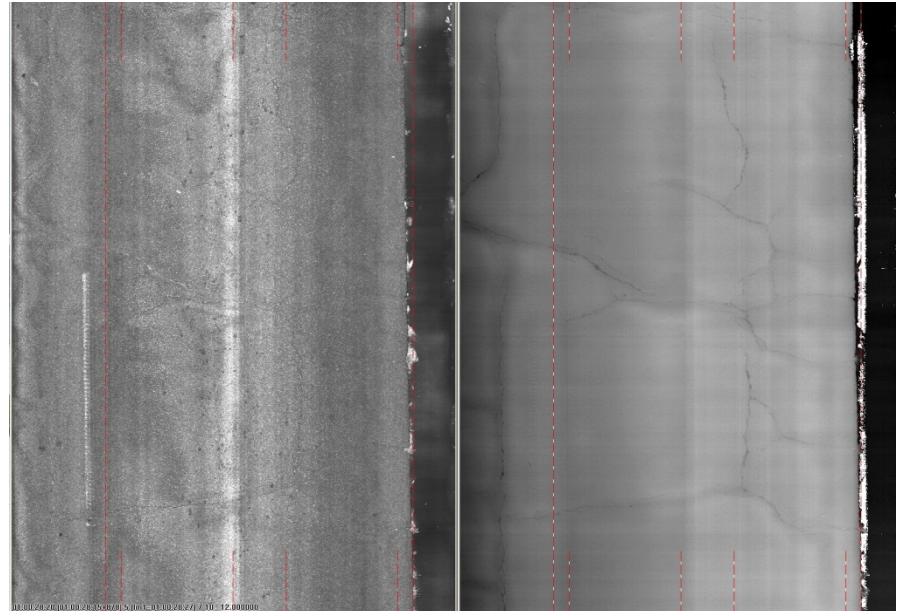
- Data collection team of NCDOT and contractor experienced distress raters
- Historical windshield review
  - Drive at low rate of speed
  - Document ride quality (low, moderate, high)
  - Identify distress in bins (combined severity, estimate quantity)
  - Stop and reviewed ratings, but did not change windshield rating

# Field Reviews

- Vendor collected high speed data
  - Data collected over 2 month period
- Data includes:
  - Roadway geometrics
  - Ride quality (IRI)
  - Rutting
  - 3-D pavement images
  - Semi-automated distress ratings

# Rater Pool

- Rater pool was used to independently evaluate each control site from images
  - 4 raters from the QA contractor
  - 3 raters from NCDOT
  - 1 vendor rating

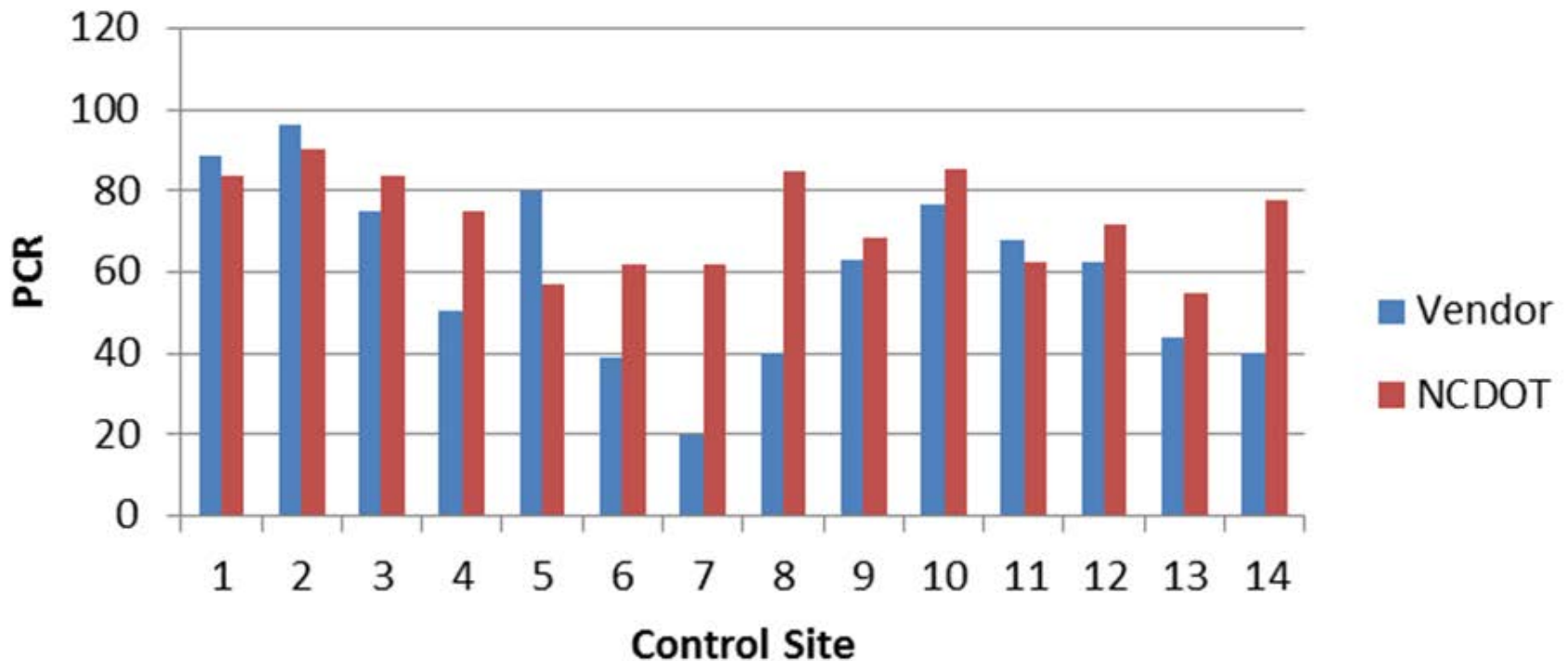




# ANALYSIS

# Comparison to Field Ratings

- Vendor reported more distress for 9 out of 14 control sites based on PCR



# Comparison to Field Ratings

- General differences
  - Vendor identified larger % of alligator cracking at higher severities
  - Vendor reported more moderate ride quality, compared to low from windshield
  - Vendor had severe patching on site 13 compared to no patching from field team
  - Field raters generally reported the transverse cracking in a lower bin

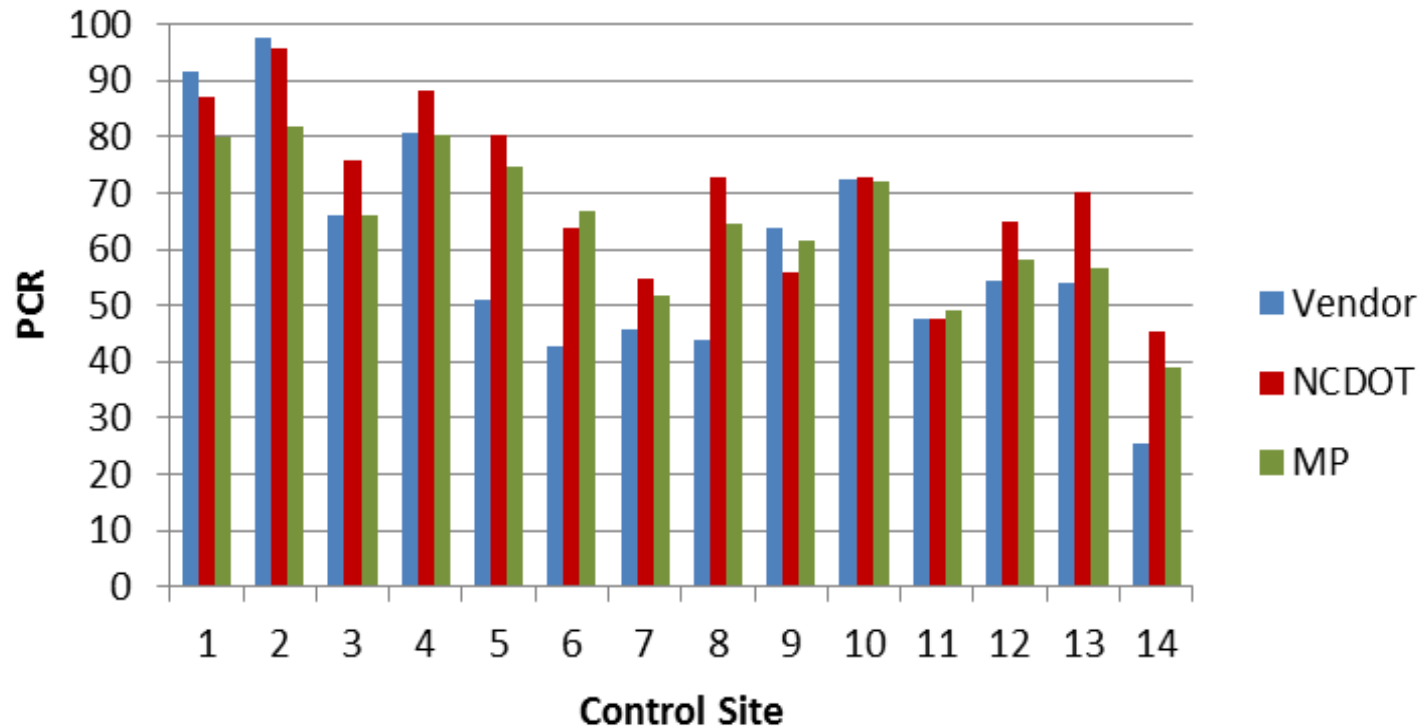
# Comparison to Field Ratings

- The distress identified by the vendor was generally more complete than the windshield surveys
- This comparison did identify some deficiencies in the automated rating process
  - Identification of bleeding
  - Transverse crack algorithm



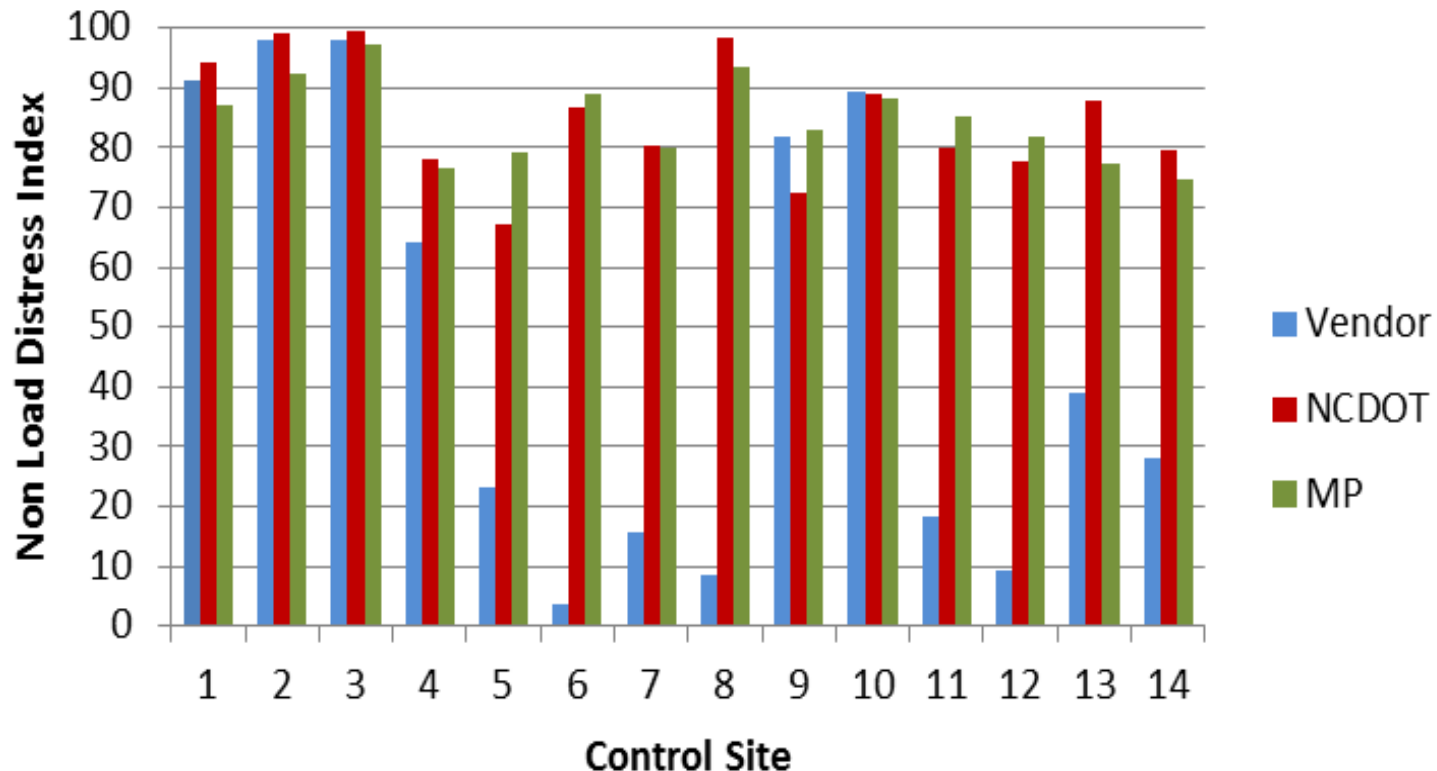
# Comparison to Image Ratings

- Vendor reported more distress for 8 out of 14 control sites based on PCR



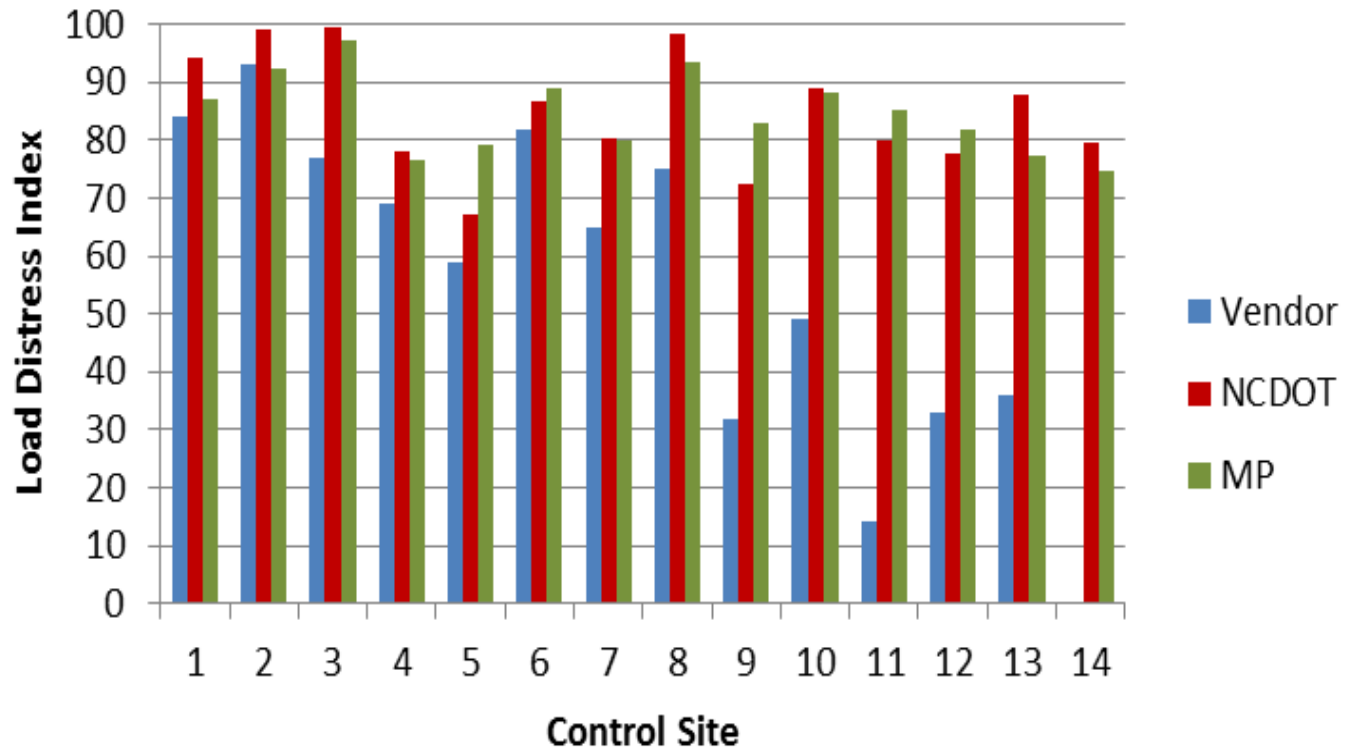
# Comparison to Image Ratings

- Based upon VDOT Non-Load Related Distress Index (NDR)



# Comparison to Image Ratings

- Based upon VDOT Load Related Distress Index (LDR)



# Comparison to Image Ratings

- General differences
  - Rater pool generally identified higher quantities of low severity alligator cracking but lower quantities of longitudinal cracking
  - Rater pool identified more transverse cracking on most sites
  - Vendor generally rated higher quantities of bleeding

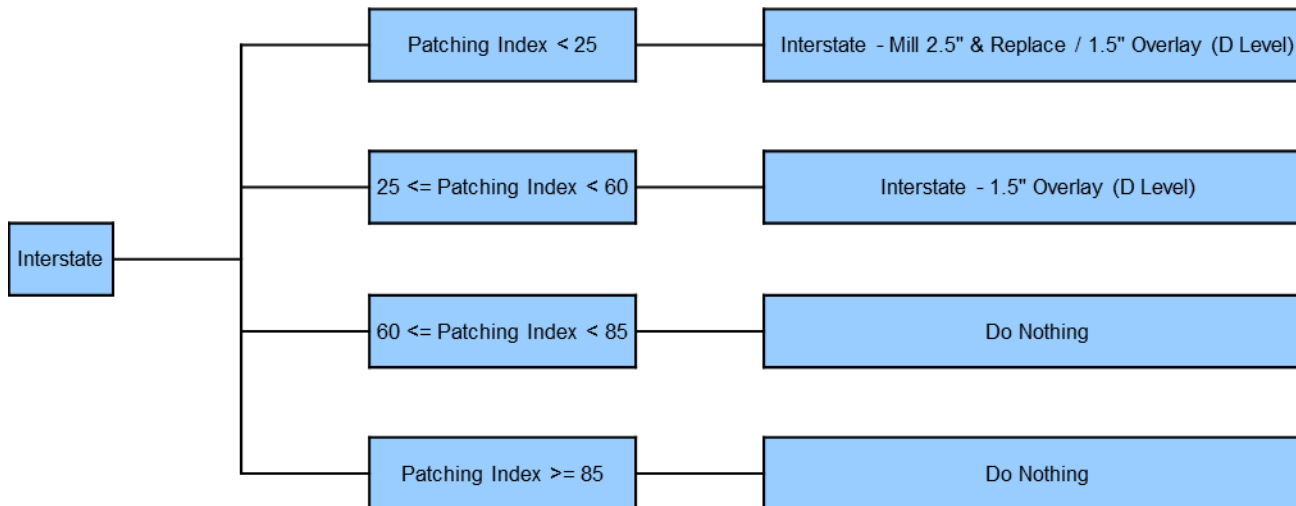
# Recommendations from Comparisons

- Redefine transverse cracking
- Review ride quality rating limits
- Review the rating/reporting of patching
- Differences in distress identification and classification existed (low alligator cracking, longitudinal cracking, patching and bleeding)
- Detailed distress rater training was recommended

# What to Control & How

- Review the current NCDOT PMS decision trees for treatment to identify significant distress

## PATCHING TREE - INTERSTATE



# What to Control & How

- Considered options
  - Individual distress
  - Index values (PCR, LDR, NDR)
- Statistical analysis based on ASTM d2s methodology (represents reproducibility of the process)

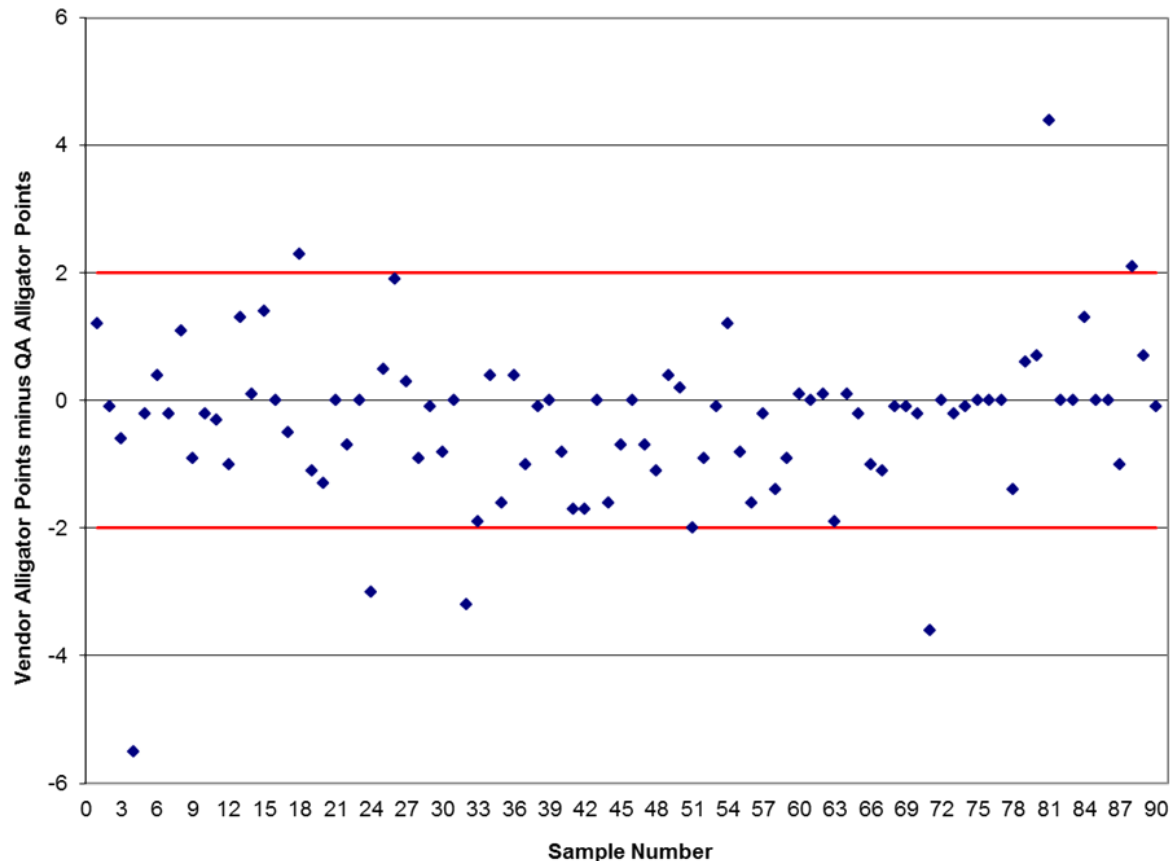
# Determination of QA Limits

- Applied d2s to the 14 control sites (rater pool)
- The difference in PCR values between the vendors reported data and QA determined data should not exceed the absolute value of 15
- The difference in the total quantity of alligator cracking data reported (based upon the windshield reporting and summary method) should not exceed a value of 2.0



# Application of QA Limits

- When outside of the limits – investigate



Error Type?  
Random  
Systematic



# BENEFITS

# Benefits of Control Sites

- **Early identification of misinterpretation of distress definitions**
- **Confirmation of computer algorithms**
- **Acceptance of summarization and reporting methods**
- **Minimal time & effort compared to inaccurate data reporting**

# Recommendations

- **Select control sections with a wide range of distresses (type, severity, extent)**
- **The larger the rater pool the better**
- **Vendor must report data as for production ratings**
- **Vendor should repeat control site efforts annually**



**THANK YOU**