



Martins Creek Bridge  
SR-53

# Corrosion Evaluation of HPS Bridges in Tennessee



Clear Fork River Bridge  
SR-52

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Third Creek Bridge  
SR-450 Knoxville



Clinch River Bridge  
SR-58



Loudon County Bridge  
SR-2 over Tennessee River

This presentation is available  
at [www.RustDr.com](http://www.RustDr.com)

## Bridge Corrosion Evaluation

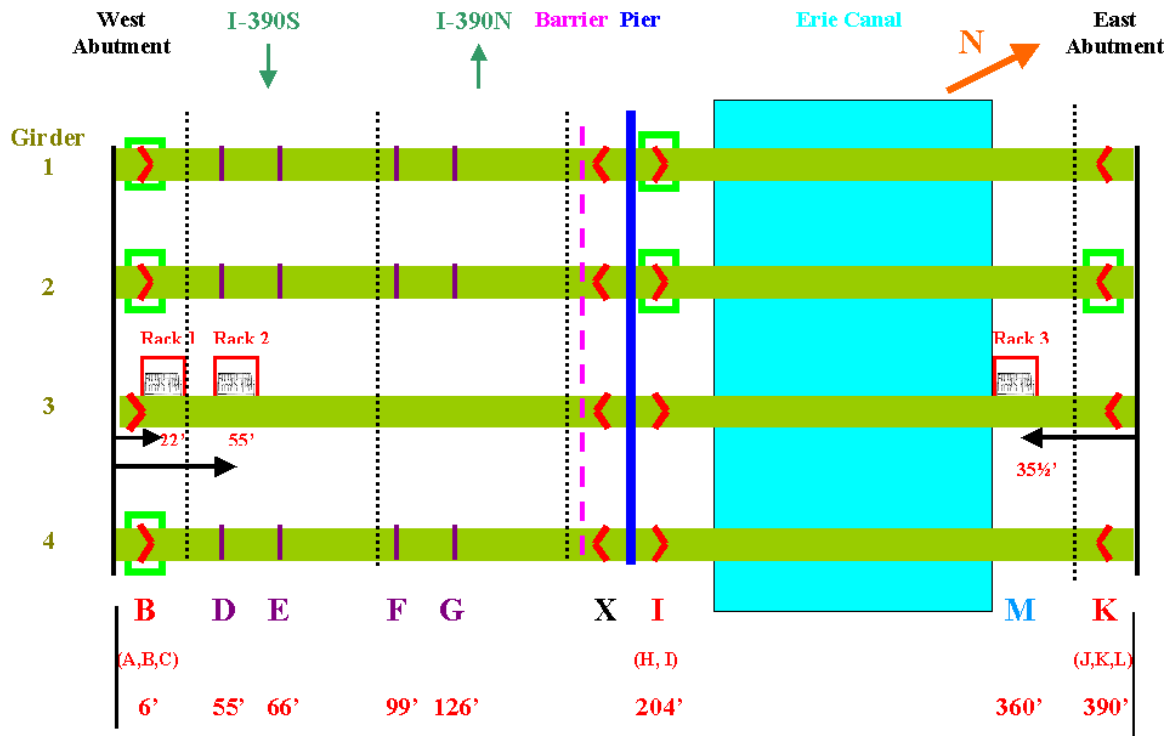
### Purpose:

- Determine if protective patina is forming.
- Estimate corrosion rates.
- Correlate rust composition and corrosion rates with regional and under-bridge environment (wetness and pollutants).

# Bridge Corrosion Evaluation

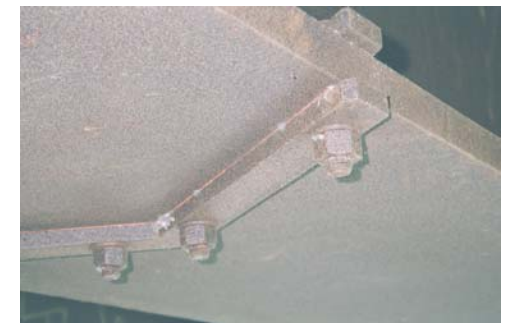
## Techniques:

- Remove and collect rust to bare steel. Analyze rust composition.
- Measure web and flange thickness (ultrasonic).
- Girder locations: Protected and non-protected (abutment and across road or water)
- Girders: Typically exterior and one interior, both sides.



Rust Collection

Thickness measurements

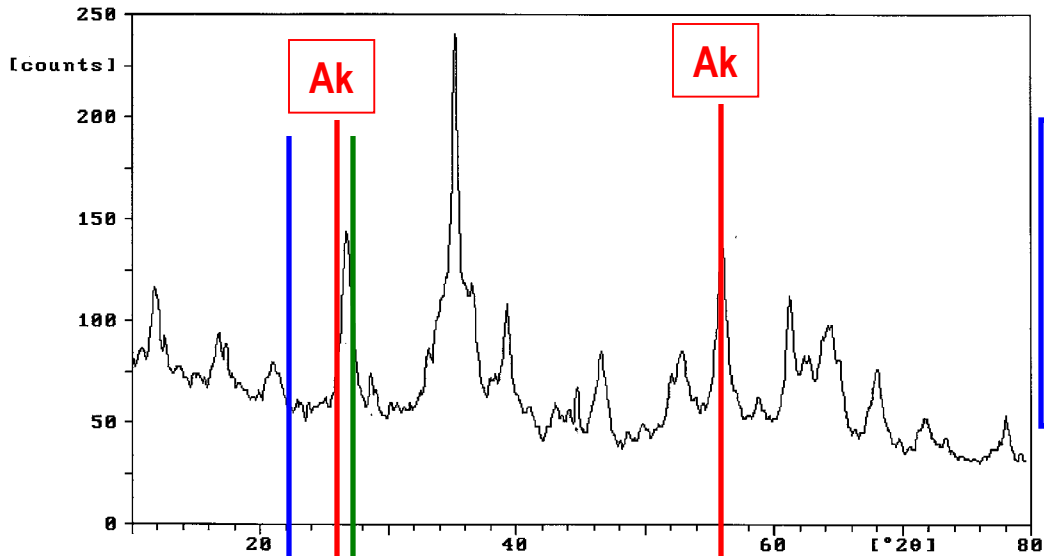


## Bridge Corrosion Evaluation

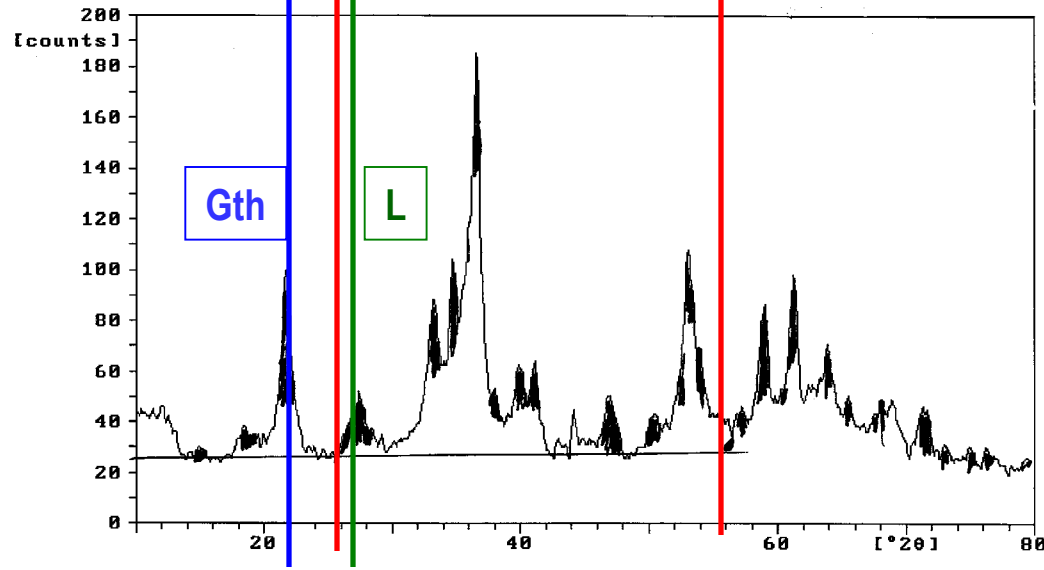
### Rust Analysis:

- X-ray diffraction: Type of large particle oxides.
- Mössbauer Spectroscopy: Type, amount, and size of each oxide.
- Raman Spectrometry: Location of each oxide in the rust.

# X-Ray Diffraction Analysis

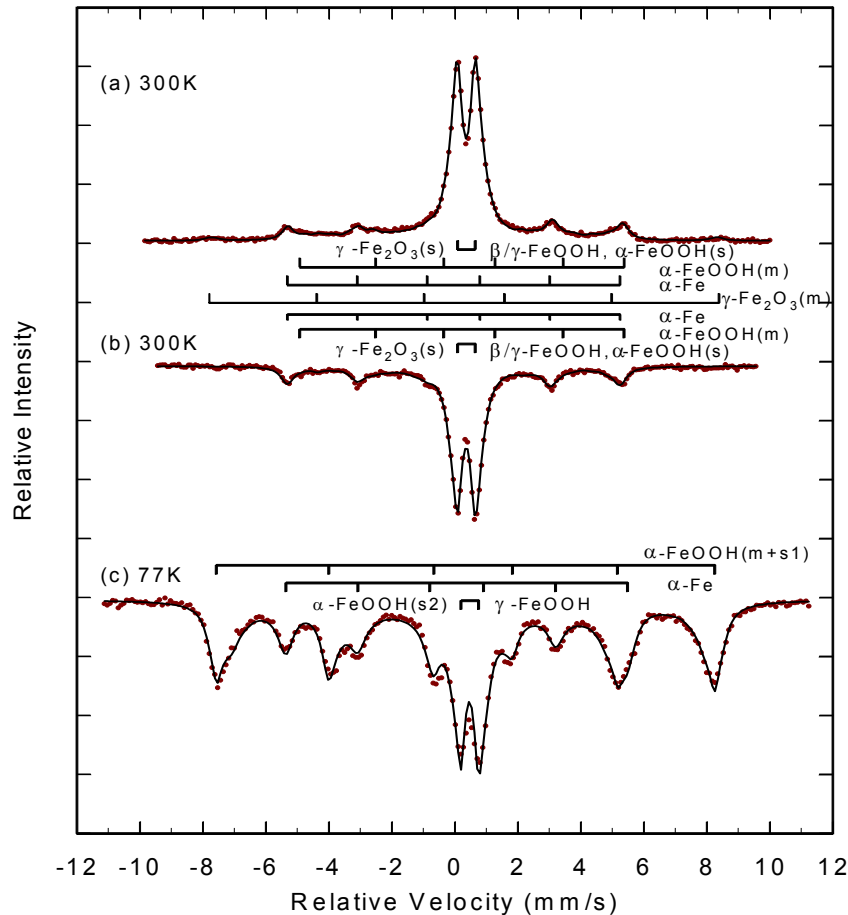


Non-Protective Rust  
**Akaganeite: 80%**  
**Goethite: 20%**  
**Lepidocrocite: 0%**



Protective Rust  
**Akaganeite: 0%**  
**Goethite: 75%**  
**Lepidocrocite: 25%**

# Mössbauer Analysis Weathering Steel (A588B) Rust Composition



## Protective Rust Layer Formed:

- Lepidocrocite 15%
- Goethite 80%
- Maghemite 5%

## Goethite

### WS

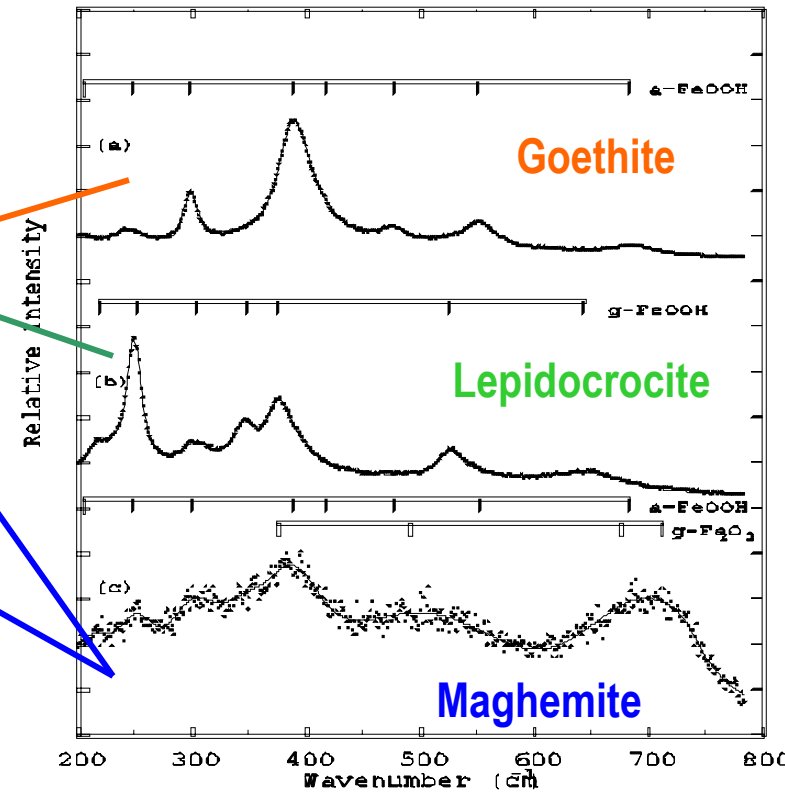
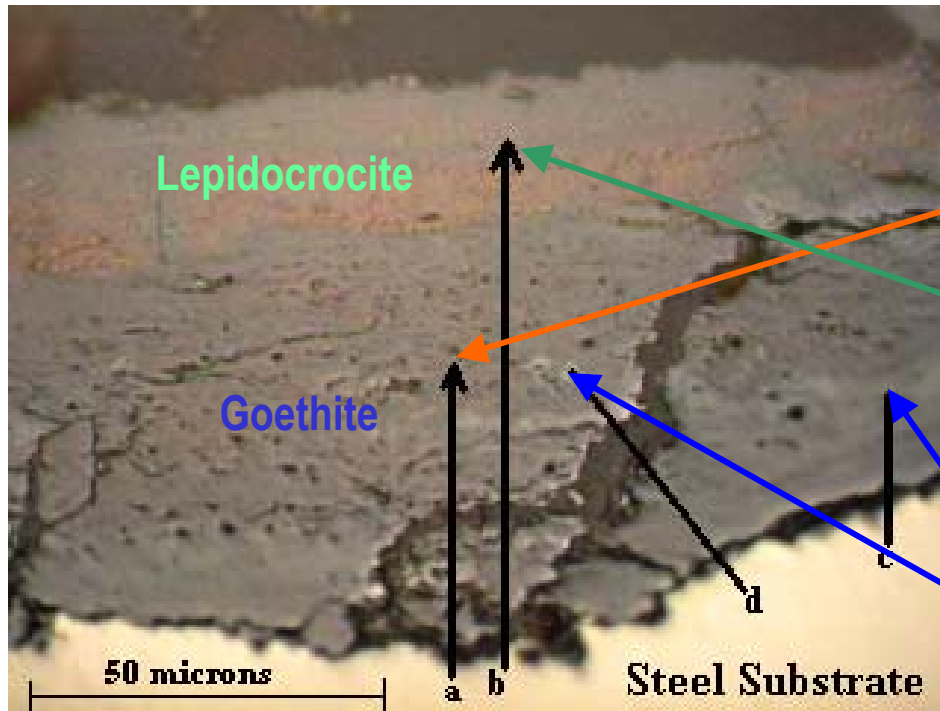
### CS

•m:	>15 nm	27%	40%
•s1:	<15nm	46%	12%
•s2:	<8 nm	7%	3
<b>Total</b>		<b>80%</b>	<b>55%</b>

# Weathering Steel (A588B)

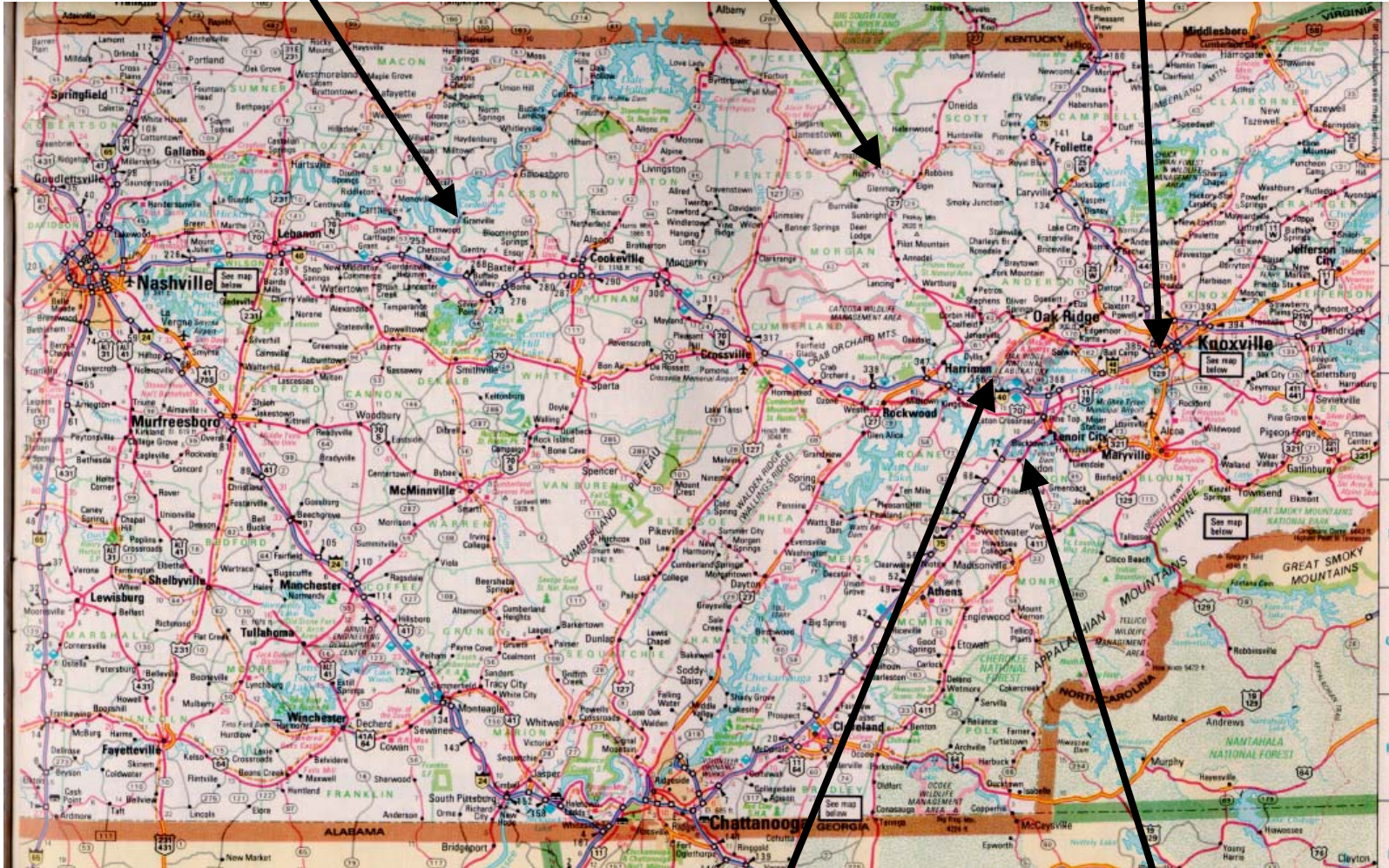
## Protective Rust Layering

### Micro-Raman Spectrometry



# Tennessee: HPS Bridge Locations

1. Martins Creek Bridge SR-53
2. Clear Folk River Bridge SR-52
3. Third Creek Bridge SR-450 Knoxville



5. Clinch River Bridge  
SR-58

4. Loudon County Bridge  
SR-2



## 1. Martins Creek Bridge SR-53

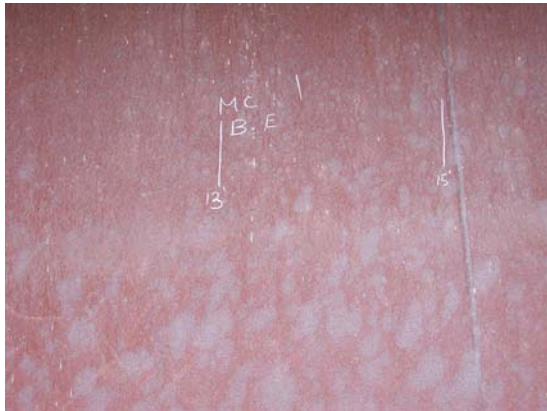
- Built: February 1998
- Length: 473'
- Spans: 2 (236' + 236')
- Girders: 4
- Steel: HPS 70W (all webs and flanges).
- No joints.
- Height 18'

### Results so far:

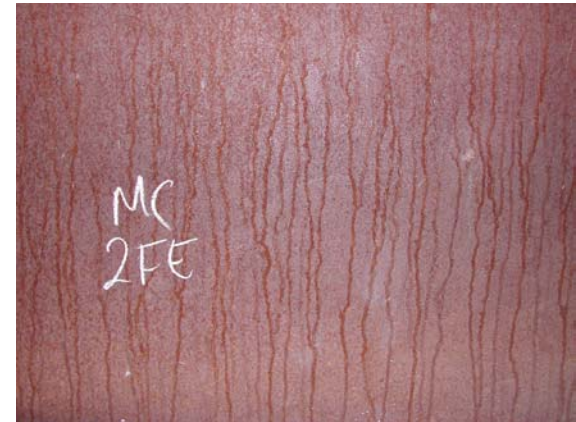
Rust composition:

- Abutments: Goethite 40%, Lepidocrocite 55%, Maghemite 5%
- Pier 1(over water): Goethite 35%, Lepidocrocite 55%, Maghemite 10%
- Exterior facias: Akaganeite 5-10%

1. Martins Creek Bridge  
SR-53



Facias



Interior Webs  
(over water)



Drainage



Upper Flange



Water leak



## 2. Clear Fork River Bridge SR-52

- Built: 1999
- Length: 995'
- Spans: 4 (145' + 220' + 350' + 280')
- Girders: 4
- Steel: HPS 70W (at Piers)
  - Grade 50W elsewhere).
- Height 200'

### Results so far:

Rust composition:

- Abutments (50W): Goethite 45%, Lepidocrocite 55%, Maghemite 0%
- Pier 2: Goethite 50%, Lepidocrocite 50%, Millscale (lots on interior girders)
- Goethite broad peaks>>>>> small particle size (protective)

## 2. Clear Fork River Bridge SR-52



Fascias



Millscale



Condensation



### 3. Third Creek Bridge SR-450 Knoxville



- Built: 2002
- Length: 617'
- Spans: 3 (184' + 175' + 258')
- Girders: 7
- Steel: HPS 70W (at Bents)
  - Grade 50W elsewhere).
- Height 65'

#### Results so far:

Rust composition:

- Abutments (50W): Goethite 35%, Lepidocrocite 65%, Maghemite 0%
- Pier 2: Goethite 35%, Lepidocrocite 65%,
- Goethite broad peaks>>>>> small particle size (protective)

**3. Third Creek Bridge  
SR-450 Knoxville**



Fascias



Scaffolding



Condensation/leakage



Paint



## 4. Loudon County Bridge SR-2 Loudon

- Built: May 2004
- Length: 791'
- Spans: 17
- Girders: 3
- Steel: HPS 70W (at Piers)
  - Grade 50W elsewhere).
- Height 22'

### Results so far:

Rust composition:

- Pier 7, Splice 2 (50W): Goethite 25%, Lepidocrocite 75%.....Flanges
- Pier 7, Splice 2 (HPS 70W): Goethite 25%, Lepidocrocite 75%,.....Flanges
- Goethite broad peaks>>>>> small particle size (protective)
- Webs 10% more goethite than flanges

#### 4. Loudon County Bridge SR-2 Loudon



Fascias



Grade 50W<<<Splice 2>>HPS 70W



Condensation/leakage



Paint/Leakage



## 5. Clinch River Bridge SR-58

- Built: July 2001
- Length: 655'
- Spans: 3
- Girders: 7
- Steel: HPS 70W (at Piers)
  - (TMCP for <1")
  - (Q&T for >1")
  - Grade 50W elsewhere).
- Height 44'

### Results so far:

Rust composition:

- Abutment: (50W): Goethite 50%, Lepidocrocite 50%
- Pier 2, Splice 3 (South) (50W): Goethite 50%, Lepidocrocite 50%
- Pier 2, Splice 3 (North) HPS 70W (Web = TMCP, Flange = Q&T)
  - Web Goethite 50%, Lepidocrocite 50%
  - Flange Goethite 40%, Lepidocrocite 60%
- Goethite broad peaks>>>>> small particle size (protective)
- Webs 10% more goethite than flanges

## 5. Clinch River Bridge SR-58



Fascias



**Grade 50W<<<Splice 3>> HPS 70W(TMCP)  
HPS 70W (Q&T)**



Interior girders



Paint

# General Findings

Bridge	Constructed	Steel	Protective Patina	Corrosion Rate (Thickness Loss)
Martins Creek (SR-53)	Feb 1998	HPS 70W (All Webs & Flanges)	Yes (salt on facias)	Low
Clear Fork River (SR-52)	1999	HPS 70W above Piers. some 50W	Yes	Low
Clinch River (SR-58)	July 2001	HPS 70W (Q&T) and (TMCP) and 50W	Yes	Low
Third Creek (SR-450)	2002	HPS 70W. and 50W	Yes	Low
Loudon County (SR-2)	May 2004	HPS 70W. and 50W	Yes	Low

**Conclusion: Each bridge is forming the correct protective patina.**