Weaver Street over New England Central Railroad
Structural Assessment
Winooski, VT

Stantec

November 18th, 2011

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1.0 Introduction

The purpose of this investigation was to conduct a structural assessment of the existing bridge, summarize its condition and determine appropriate repair options. On site assessment included sounding the soffit of the concrete arch as well as obtaining concrete cores for laboratory testing.

Alternatives presented in this report are potential solutions for addressing concerns about the structural degradation of the existing arch bridge. This is not a scoping study, and does not attempt to define the alternatives in enough detail to identify environmental or permitting constraints, or to define the purpose and need for a project.

2.0 Bridge Description and Condition

The existing single span arch bridge was built in 1916 and spans New England Central Railroad's Burlington branch-line. Currently, the bridge is not posted, however Weaver Street is posted for a legal load limit of 24,000 pounds.

The bridge is inspected at 2-year intervals (maximum) by VTrans in accordance with the Federal Surface Transportation Act of 1978. Inspection reports and inventory/appraisal sheets from those inspections are included in Appendix A. VTrans' 2009 inspection reports indicate that the bridge is in satisfactory to good condition; however, the inspection reports note cracking and delaminating of the concrete surface in the soffit of the arch.

Stantec conducted an investigation of the bridge on April 26, 2011. This included sounding the soffit of the arch for delamination and collecting concrete samples for testing. The following is a summary of the observations:

- It appears that there had been previous attempts to repair the surface of the arch. Sounding of the surface revealed a dull/hollow sound indicating repaired areas were poorly bonded to the substrate and reinforcement. The area of poorly bonded repairs is estimated at 5%-15% of the soffit area.

- Approximately 5% to 10% of the soffit was spalled, exposing the reinforcing steel, for a total surface area of 10% to 25% that is either spalled or delaminated.

- Significant spalling, cracking and delamination of concrete in west fascia of the arch was observed.

- In areas where delamination was not encountered, the majority of the concrete surface yielded a dull sound indicating that the surface of the concrete was soft. This is possibly due to poor mixture of the aggregate and cement in the original construction. It was observed that the original concrete was poorly mixed and poorly consolidated, with many voids, and some areas having large concentrations of stone with little or no cement and other areas with a mixture of sand and cement with little or no aggregate.

- No weep holes were observed in the arch, raising the question of how and if the backfill of the arch is drained. The surface of the concrete appeared moist in areas suggesting that the backfill might be saturated.
- Sounding of the concrete bridge railing revealed nearly 100% of the top surface of the rail is delaminated.

2.1 FEDERAL SUFFICIENCY RATING

The city should be aware that VTrans current inventory and appraisal of the structure indicates that the structure has a Federal Sufficiency Rating of 95.

The sufficiency rating is a computed numerical value that is used to determine eligibility of a bridge for Federal funding. The formula includes factors for structural condition, bridge geometry, and traffic conditions. A bridge with a sufficiency rating of 80 or less is eligible for Federal bridge rehabilitation funding. A bridge with a sufficiency rating of 50 or less is eligible for Federal bridge replacement funding.

Kansas Department of Transportation developed the following pie graph (figure 1) to illustrate the factors influencing the bridge sufficiency ratings. The entire document from which the figure was taken is available (http://www.transportation.org/sites/bridges/docs/Sufficiency%20Ratings%20Explained.pdf). A copy of the document is also included in appendix A.

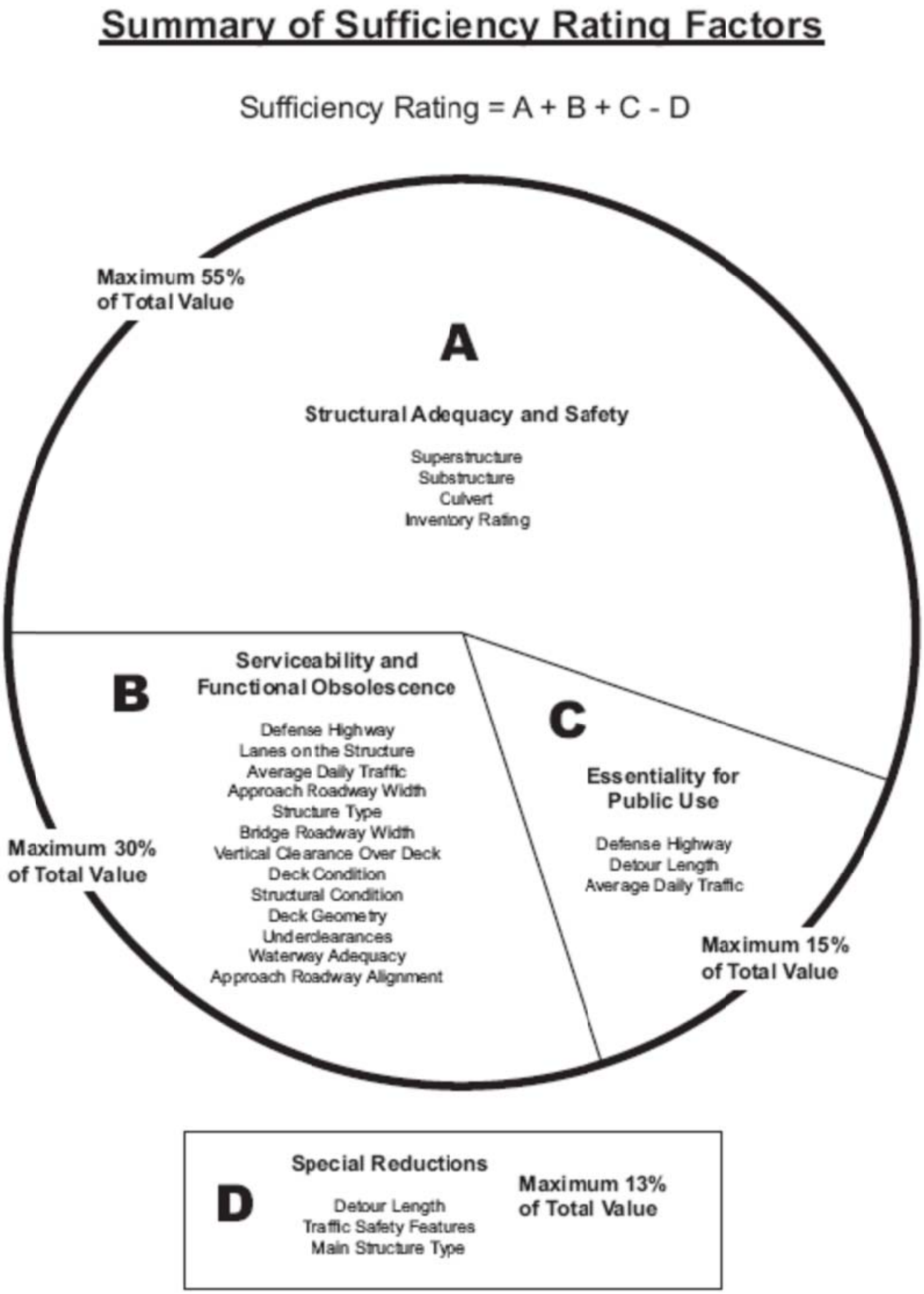


Figure 1: Kansas DOT Summary of Bridge Sufficiency Ratings.

3.0 Testing

3.1 BACKGROUND ON TESTS CONDUCTED AND THE CORROSION PROCESS

To assist in determining the cause of the spalling and corrosion on the soffit of the arch, concrete cores were obtained at four locations near the spring line of the arch. Samples were tested to determine the concentration of chlorides (which can accelerate corrosion) and to determine the depth of carbonation from the surface of the concrete. The following definitions are intended to give the reader some understanding of how the presence of these conditions in the concrete affects the structure.

Corrosion Process: Steel oxidizes in the presence of air and water to form rust which has a volume of up to 10 times that of the steel consumed. This swelling of the steel causes the surrounding concrete to pop off (or spall) or to become delaminated from the rest of the structure, which in turn leads to more exposure and more corrosion.

Chloride Contamination: Salt (sodium chloride) is used for de-icing roads and was even historically used as a concrete additive. The presence of salt is a major problem for reinforced concrete structures. When dissolved in water, sodium chloride forms a versatile, highly corrosive solution of sodium ions (Na+) and chloride ions (Cl-). The very mobile chloride ions disperse through concrete pores in solution and where they come into contact with the reinforcing steel they attack the passive layer that protects the steel. For bridge structures, it has generally been found that concrete chloride content in the range of 0.025% to 0.035% by weight of concrete (1.0 to 1.4 pounds chloride per cubic yard) at the reinforcement depth is critical because at values above this threshold, corrosion of reinforcing steel in concrete can occur rapidly.

Carbonation: In normal concrete, the reinforcing is protected by the naturally high alkalinity of the concrete with a pH of about 12. A passivating layer of stable mineral scale is formed on the reinforcing which protects it from corrosion. Carbonation is the reduction of the protective alkalinity of the concrete. It is caused by the absorption of carbon dioxide and moisture which lowers the pH to 10 or less and renders the reinforcing vulnerable to corrosion. Reinforcing steel embedded in carbonated concrete will corrode in the presence of water and oxygen, and the reinforcement will have less resistance to chemical corrosion from chloride compounds that may be present in the concrete as a result of deicing chemicals used on the bridge or salt that may have been added to the concrete during construction.

3.2 TEST RESULTS

Concrete samples taken from the Weaver Street Bridge indicated Chloride concentrations ranged from .04% to .173% by weight of concrete, putting them beyond the threshold (0.035%) where chloride contamination accelerates corrosion. Levels in excess of the threshold were observed at all locations sampled. Chloride samples did not vary appreciably with depth but rather with location. Higher levels were observed in the samples taken adjacent to the west fascia of the bridge.

The depth of carbonation from the concrete surface was between 1.5 to 2 inches at 3 of the 4 sample locations and was greater than 3.5 inches at the 4th location. This carbonation reduces the concrete ability to protect reinforcement from corrosion.

As discussed previously, in new concrete with a pH of 12 to 13, about 0.035% soluble chloride by weight of concrete (1.4 lbs per cubic yard) is the threshold to start corrosion of embedded steel. When the pH is lowered to a range of 10 to 11 (thru carbonation), the chloride threshold for corrosion is significantly lower.

Test results and concrete sample locations are included in Appendix B.

4.0 Repair Alternatives

4.1 DO NOTHING

Many factors influence the rate of deterioration including environmental factors such as moisture, chloride content, locomotive exhaust as well as composition of the existing concrete, the thickness of the arch and loading of the structure.

Without plans for the bridge, the geometry of the structural components of the arch is unknown and predicting the remaining lifespan of the existing arch and its current rating are difficult.

Given the test results and observation that indicate the poor condition of the existing concrete, we would anticipate an increase in rate of deterioration of the arch soffit in the coming years. It would not be unexpected to see the structure deteriorate more rapidly within the next 5 to 15 years. However, currently no visual signs of structural distress were observed; indicating that the structure is still adequate to carry current traffic. In our opinion, the standard biannual inspection interval is still appropriate for monitoring the safety of the bridge. The frequency of inspections on this bridge should be increased if the deterioration gets considerably worse or if there are any signs of distress, i.e. cracking or crushing concrete.

4.2 CONCRETE REPAIRS

Repairing or patching areas of spalled or delaminated concrete will not address the carbonation and chloride contamination which are the underlying causes of deterioration. Any repairs or patching of the concrete would be relatively short lived (similar to previous repair work).

In order to halt active corrosion within the bridge, it would be necessary to either remove the chloride contamination and reverse the effects of concrete carbonation, or prevent moisture and oxygen from reaching the reinforcement. The carbonated concrete could be removed and replaced with repair material, but given the distribution of chloride contamination indicated by the concrete sampling, it is not considered practical to address chloride contamination thru concrete removal.

There is an electro-chemical process for extracting chlorides from the concrete, which involves saturating the concrete and using an electric current to cause the chlorides to migrate out to the concrete. However, given the condition and geometry of the bridge and the distribution of the chlorides, the effectiveness of this process is considered highly questionable.

Sealing the structure to prevent moisture from penetrating the concrete would involve excavating the roadway above and applying a protective membrane to the structure. This approach would be costly and again, the results are also considered highly questionable.

The cost of concrete repair work could vary widely based on what repairs were attempted. However, it is our opinion that repairs would likely be superficial and ultimately would only be temporarily effective.

4.3 PERMANENT SHORING

For comparison, Stantec estimated the cost of providing permanent shoring of the arch by constructing a new reinforced arch under the existing arch. This approach would involve installing a reinforcing steel cage and constructing the new arch with a sprayed concrete (e.g. shotcrete). This portion of the arch would have a design life of approximately 75 years, however, over the lifespan of the shoring it would be expected that other bridge elements (e.g. spandrel walls, pavement, sidewalk and the bridge railing would require repair). For comparison purposes, we recommend considering the design life for the overall structure under this approach to be 35-50 years. The cost of this permanent shoring alternative is estimated between $200,000 and $300,000. It should be noted that this alternative would reduce the existing vertical clearance by approximately 12”-18” over the New England Central Railroad; however, this reduction in vertical clearance may be acceptable to the railroad as the controlling vertical obstruction on the branch line is the tunnel at the Burlington end of the line.

4.4 BRIDGE REPLACEMENT

Also for comparison purposes, Stantec estimated the cost of replacing the existing arch with a new prefabricated concrete arch at approximately $700,000. The design life for the replacement bridge is considered 75 years. This cost estimate is based on an approximate square foot cost for a similar project, but does not include site specific factors such as utilities, coordinating with the railroad, and potential right of way costs (if applicable). If replacement is pursued, other structure types such as pre-cast voided slab or steel beam with concrete deck superstructures should be considered.

5.0 Conclusion and Recommendations

Currently, the arch does not show any signs of structural distress and it is appropriate for the bridge to continue carrying the current traffic and to maintain the current biannual safety inspection interval.

Concrete sampling and sounding of the arch soffit revealed that the concrete is carbonated to at least the depth of the reinforcing steel, and chloride levels in the concrete are above the threshold level for corrosion. Beyond that, previous patch and surface repairs to the soffit of the arch have debonded, revealing a substrate of poorly mixed concrete of suspect quality that comprises the original structure.

Based on this information, it is the principal conclusion of this investigation that any attempts repair the concrete arch should be considered temporary.

There are many factors that influence the rate of deterioration of the structure and prediction of the remaining lifespan of the structure with any accuracy is not possible. However, given the current level of deterioration, the levels of chloride contamination and increase PH of the concrete, an increase in the rate of deterioration can be expected. While these concrete arch structures can be very resilient, Stantec suggests that the structure may have as little as 10 to 15 years or service life remaining. We recommend that the City begin planning for a long term solution which may include the replacement of the structure. The first step in this process would be to conduct a scoping study to define a potential project.

I

APPENDIX A

VTrans Structure Inspection, Inventory and Appraisals

STRUCTURE INSPECTION, INVENTORY and APPRAISAL SHEET

Vermont Agency of Transportation ~ Structures Section ~ Bridge Management and Inspection Unit

Inspection Report for WINOOSKI CITY *bridge no.:* 00001 *District:* 5

Located on: C30WE *over* NEW ENGLAND CENT *approximately* 0.05 MI TO JCT W ALLEN *Owner:* 03 TOWN-OWNED

CONDITION

Deck Rating: N NOT APPLICABLE
Superstructure Rating: N NOT APPLICABLE
Substructure Rating: N NOT APPLICABLE
Channel Rating: N NOT APPLICABLE
Culvert Rating: 6 SATISFACTORY
Federal Str. Number: 100418000104181
Federal Sufficiency Rating: 95
Deficiency Status of Structure: ND

AGE and SERVICE

Year Built: 1916 *Year Reconstructed:* 0000
Service On: 5 HIGHWAY-PEDESTRIAN
Service Under: 2 RAILROAD
Lanes On the Structure: 02
Lanes Under the Structure: 00
Bypass, Detour Length (miles): 00
ADT: 000750 *% Truck ADT:* 02
Year of ADT: 2007

GEOMETRIC DATA

Length of Maximum Span (ft): 0038
Structure Length (ft): 000056
Lt Curb/Sidewalk Width (ft): 8
Rt Curb/Sidewalk Width (ft): 7.6
Bridge Rdwy Width Curb-to-Curb (ft): 53
Deck Width Out-to-Out (ft): 55.7
Appr. Roadway Width (ft): 030
Skew: 00
Bridge Median: 0 NO MEDIAN
Min Vertical Clr Over (ft): 99 FT 99 IN
Feature Under: RAILROAD BENEATH STRUCTURE
Min Vertical Underclr (ft): 22 FT 08 IN

STRUCTURE TYPE and MATERIALS

Bridge Type: CONCRETE ARCH
Number of Approach Spans: 0000 *Number of Main Spans:* 001
Kind of Material and/or Design: 1 CONCRETE
Deck Structure Type: 1 CONCRETE CIP
Type of Wearing Surface: N NOT APPLICABLE
Type of Membrane: N NOT APPLICABLE
Deck Protection: N NOT APPLICABLE

APPRAISAL *AS COMPARED TO FEDERAL STANDARDS

Bridge Railings: 0 DOES NOT MEET CURRENT STANDARD
Transitions: 0 DOES NOT MEET CURRENT STANDARD
Approach Guardrail: 0 DOES NOT MEET CURRENT STANDARD
Approach Guardrail Ends: 0 DOES NOT MEET CURRENT STANDARD
Structural Evaluation: 6 EQUAL TO MINIMUM CRITERIA
Deck Geometry: N NOT APPLICABLE
Underclearances Vertical and Horizontal: 4 MEETS MINIMUM TOLERABLE CRITERIA
Waterway Adequacy: N NOT OVER WATER
Approach Roadway Alignment: 8 EQUAL TO DESIRABLE CRITERIA
Scour Critical Bridges: N NOT OVER WATERWAY

DESIGN VEHICLE, RATING, and POSTING

Load Rating Method (Inv): 5 NO RATING ANALYSIS PERFORMED
Posting Status: A OPEN, NO RESTRICTION
Bridge Posting: 5 NO POSTING REQUIRED
Load Posting: 01 NO LOAD POSTING SIGNS EXIST NEAR BRIDGE
Posted Vehicle: POSTING NOT REQUIRED
Posted Weight (tons):
Design Load: 0 OTHER OR UNKNOWN

INSPECTION and CROSS REFERENCE

X-Ref. Route:
Insp. Date: 082009 *Insp. Freq. (months)* 24 *X-Ref. BrNum:*

INSPECTION SUMMARY and NEEDS

08/18/09 This struction is in satisfactory to good condition. There is cracking and delams in places and some spalling on the abutment 1 side. DCP

Run Date 5/5/2011
District 5
Rec. No. 5806
Cross Ref.

Vermont Agency of Transportation
NBIS Field Inspection Form
Long Structures 20 Feet and Over

Rte. No. C30WE
Rte Log Br # 00001
Town WINOOSKI CITY

3 - County Code	_ _ _	007
4 - Place Code	_ _ _ _ _	85150
5 - Inventory Route	_ _ _ _ _ _ _ _ _	180C30WE0
6 - Features Intersected	_ _	NEW ENGLAND CENTRAL RR
7 - Facility Carried by Structure	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	C30WE
8 - Structure Number	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _	100418000104181
9 - Location	_ _	0.05 MI TO JCT W ALLEN ST
10 - Inventory Route, Minimum Vertical Clearance	_ _ _ _	9999
16 - Latitude	_ _ _ _ _ _ _ _	44293100
17 - Longitude	_ _ _ _ _ _ _ _ _	073112300
19 - Bypass, Detour Length	_ _	00
21 - Maintenance Responsibility	_ _	03
22 - Owner	_ _	03
26 - Functional Classification of Inventory Route	_ _	19
27 - Year Built	_ _ _ _	1916
106 - Year Reconstructed	_ _ _ _	0000
208 - Last Project Number	_ _	
209 - Last Project Name	_ _	
28 - Lanes On and Under the Structure	_ _ _ _	0200
29 - Average Daily Traffic	_ _ _ _ _ _	000750
30 - Year of Average Daily Traffic	_ _ _ _	2007
242 - Source of ADT	_	1
31 - Design Load	_	0
32 - Approach Roadway Width	_ _ _	030
33 - Bridge Median	_	0
34 - Skew	_ _	00
35 - Structure Flared	_ _	0
36 - Traffic Safety Features	_ _ _ _	0000
37 - Historical Significance	_	3
41 - Structure Open, Posted, or Closed to Traffic	_	A
42 - Type of Service	_ _	52
43 - Structure Type Main	_ _ _	119
800 - Bridge Type	_ _	CONCRETE ARCH

Run Date 5/5/2011
District 5
Rec. No. 5806
Cross Ref.

Vertical Agency of Transportation
NBIS Field Inspection Form
Long Structures 20 Feet and Over

Rte. No. C30WE
Rte Log Br # 00001
Town WINOOSKI CITY

44 - Structure Type Approach Spans	_ _ _	000
45 - Number of Spans in Main Unit	_ _ _	001
46 - Number of Approach Spans	_ _ _ _	0000
47 - Inventory Route Total Horizontal Clearance	_ _ _	530
48 - Length of Maximum Span	_ _ _ _	0038
49 - Structure Length	_ _ _ _ _ _	000056
50A - Left Curb or Sidewalk Width	_ _ _	080
50B - Right Curb or Sidewalk Width	_ _ _	076
51 - Bridge Roadway Width Curb-to-Curb	_ _ _ _	0530
246 - Type of Bridge Curb	_	2
52 - Deck Width Out-to-Out	_ _ _ _	0557
53 - Minimum Vertical Clearance Over Bridge Rdwy	_ _ _ _	9999
54 - Minimum Vertical Underclearance	_ _ _ _ _	R2208
55 - Minimum Lateral Underclearance on Right	_ _ _ _	R108
56 - Minimum Lateral Underclearance on Left	_ _ _	000
58 - Deck	_	N
59 - Superstructure	_	N
60 - Substructure	_	N
61 - Channel and Channel Protection		N
62 - Culverts	_	6
207 - Covered Bridge Inventory	_ _ _ _ _ _	
70 - Bridge Posting	_	5
71 - Waterway Adequacy	_	N
72 - Approach Roadway Alignment	_	8
211 - Rating of Paint	_	N
212 - Year Structure Last Painted	_ _ _ _ _ _ _ _	0000
75 - Type of Work	_ _ _	
90 - Inspection Date	_ _/_ _ _ _	082009
91 - Designated Inspection Frequency	_ _	24
92 - Critical Feature Inspection	_ _ _ _ _ _ _ _ _	NNN
93 - Critical Feature Inspection Date	_ _	
98 - Border Bridge	_ _ _ _ _	
99 - Border Bridge Structure Number	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _	
101 - Parallel Structure Designation	_	N
102 - Direction of Traffic	_	2
103 - Temporary Structure Designation	_	
107 - Deck Structure Type	_	1
108 - Wearing Surface/Protective System	_ _ _	NNN
109 - Average Daily Truck Traffic	_ _	02
113 - Scour Critical Bridges	_	N

Run Date 5/5/2011 District 5 Rec. No. 5806 Cross Ref.	**Vermont Agency of Transportation** **NBIS Field Inspection Form** **Long Structures 20 Feet and Over**	Rte. No. C30WE Rte Log Br # 00001 Town WINOOSKI CITY

202 - Town or State Line Indicator	_	0
203 - Special Access Indicator	_ _ _ _ _ _ _ _ _	0
204 - Principal or Duplicate Report Indicator	_ _	0
205 - Program Indicator/Bid Let	_ _ _ _ _ _ _ _ _ _ _ _	N
206 - Route Log Station Number	_ _ _ _ _ _ _	158000
213 - Number of Utilities	_	0
214 - Year of Last Maintenance Activity	_ _ _ _	
215 - Type of Maintenance Performed	_ _ _ _ _ _ _ _ _	
214-1	_ _ _ _	
215-1	_ _ _ _ _ _ _ _ _	
214-2	_ _ _ _	
215-2	_ _ _ _ _ _ _ _ _	
220 - Alignment of Bridge Deck and Superstructure	_	0
221 - Type of Bridge Rail	_ _ _ _ _ _	000241
222 - Type of Approach Railing	_ _ _ _ _ _	000000
223 - Type of Expansion Joint	_ _	00
224 - Type of Expansion Bearing Device	_ _	00
225 - Type of Foundation	_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	0101
226 - Vertical Clearance Under Bridge (Highway)	_ _ _ _	0000
227 - Vertical Clearance Under Bridge (Railroad)	_ _ _ _	0228
228 - Vertical Clearance Under Bridge (Waterway)	_ _ _ _	0000
64 - Operating Rating	_ _ _	260
66 - Inventory Rating	_ _ _	236
229 - H Truck at 67% YP	_ _ _	NR
230 - 3 Axle Straight Truck at 67% YP	_ _	
231 - 4 Axle Straight Truck at 67% YP	_ _	
234 - 5 Axle Semi-Trailer Truck	_ _	
235 - 6 Axle Semi-Trailer Truck	_ _	
236 - Load Posting Signs	_ _ _ _ _	01
237 - Federal Sufficiency Rating	_ _ _ _ _	0950
239 - Deficiency Status of Structure	_ _	ND
241 - Bridge Plans on File	_	

Winooski Town Highway 3 Bridge 1 6/25/03

Structure Type: Closed spandrel concrete arch over the New England Central Railroad

Summary: Bituminous pavement wearing surface on this structure has many areas of map cracks through out, a few of the cracks have been sealed. Concrete curbs have a few areas of spalling; there are sidewalks behind the curbs with concrete railing sidewalk tips down toward the railing. There are many areas of cracking in the railing in the top; these are full height vertical cracks. This is a solid concrete rail. There are a few chips along the right railing on the top, side walks and railings are on both sides. There is some spalling on the fascia area of arch, on the ends about 6 feet up along the arch there are areas of map cracks through out. There are also a few delaminations in random spots on the left side. The underside of the arch has some areas of minor cracking and some spalling next to the spring line about 3 feet up into the arch on the north east side about 14 feet in. There is light scaling and spalling at mid-span of the arch, there is another area just beyond the mid-span about 15 feet up from the spring line. There are areas of delaminations with heavy rust scale in the rebar that is exposed with minor section loss. Otherwise the arch is in fair condition.

Inspectors: Doane Preedom & Floyd Earle
DCP0624_0626.doc

Winooski City, TH #3, Weaver St., Br. 1 8/24/99

Structure Type: Closed spandrel concrete arch bridge over the New England Central Railroad.

Approach: The paved town highway is on a straight alignment with a steep upgrade from south to north through the structure. Asphalt wearing surface is littered with areas of map cracking. Some of the cracks have been sealed. Approach rail is only short extensions of the concrete parapet bridge rail without proper terminal ends. There are concrete sidewalks along each side of the bridge. Bridge rail is solid concrete parapet type. Rail does have some random fine vertical and horizontal cracks along with some small chips and areas of minor spalling.

Arch: The western wall does have some random areas of heavy spalling with some sections of rusted rebar exposed, mainly along the base of the bridge rail. For the most part the eastern wall is fairly clean with only some areas of minor cracking and some light scaling. There is some minor spalling along a pour line at the southeastern corner along the extrados of the arch along the west side. There are some random areas of cracking, delaminated concrete, and some spots of heavy spalling with some short sections of rusted rebar exposed. For the most part the section loss is still fairly minor. Underside of the arch soffit was once covered with tar paper. Most of the tar paper has worn away. The concrete is covered with soot from railroad engine blasts. The underside also has quite a few areas of honeycombing and some random spalling. Some of the spalls do expose sections of rusted rebar. Some of the rebar was probably exposed to the air not long after the arch was constructed due to poor concrete cover over the rebar. Majority of the section loss is relatively minor. Currently the heaviest deterioration is along a spall which is approximately 10' out in front of the south end of the bridge where there is a spall approximately 1' wide by 4' long and approximately 4" to 5" deep and located to the west of centerline. The arch soffit does have some random areas of minor hairline cracking along with some moderate efflorescence leakage. Generally the arch is still fairly sound overall. The arch is poured directly to ledge outcroppings. The shallow abutment stems do have some random cracks, leaks, and a few spalls. There is a single railroad line below.

Posting: The structure itself is not posted, however the end of the town highway is posted for a legal load limit of 24,000 lbs.

Summary: Overall the structure is in fair condition. The arch itself is still fairly sound. However, it could use some concrete repair work.

Inspectors Matt Joy and John Sladyk

APPENDIX B

Concrete Testing Data

ATLANTIC TESTING LABORATORIES

June 14, 2011

RECEIVED

JUN 20 2011

STANTEC
SOUTH BURLINGTON, VT

Stantec Consulting Services
55 Green Mountain Drive
South Burlington, Vermont 05403

Attn: Tom Knight

Re: Concrete Laboratory Testing
Weaver Street Bridge
Winooski, Vermont
ATL Report No.: CT3158CL-01-06-11

Mr. Knight:

On June 2, 2011, we received four concrete core samples (ATL CT3158C1 through CT3158C4) from the Weaver Street Bridge in Winooski, Vermont at our Canton, New York facility for testing. A Water-Soluble Chloride Ion in Concrete test in accordance with AASHTO T 260 (Procedure A) was performed on these samples and the depth of Carbonation was determined utilizing Phenolphthalein. The results follow:

WATER-SOLUBLE CHLORIDE IN CONCRETE
AASHTO T 260 (Procedure A)

ATL Sample No.	Depth of Carbonation* (in.)	Depth of Chloride Sample* (in.)	Chloride (%)
CT3158C1	1.6	2.0	0.110
		3.5	0.114
CT3158C2	1.6	2.0	0.117
		3.5	0.173
CT3158C3	Full Depth	2.0	0.064
		3.5	0.056
CT3158C4	1.9	2.0	0.050
		3.5	0.041

*Sample depth referenced from outside face of core.

Please contact our office should you have any questions or if we may be of further service.

Sincerely,
ATLANTIC TESTING LABORATORIES, Limited

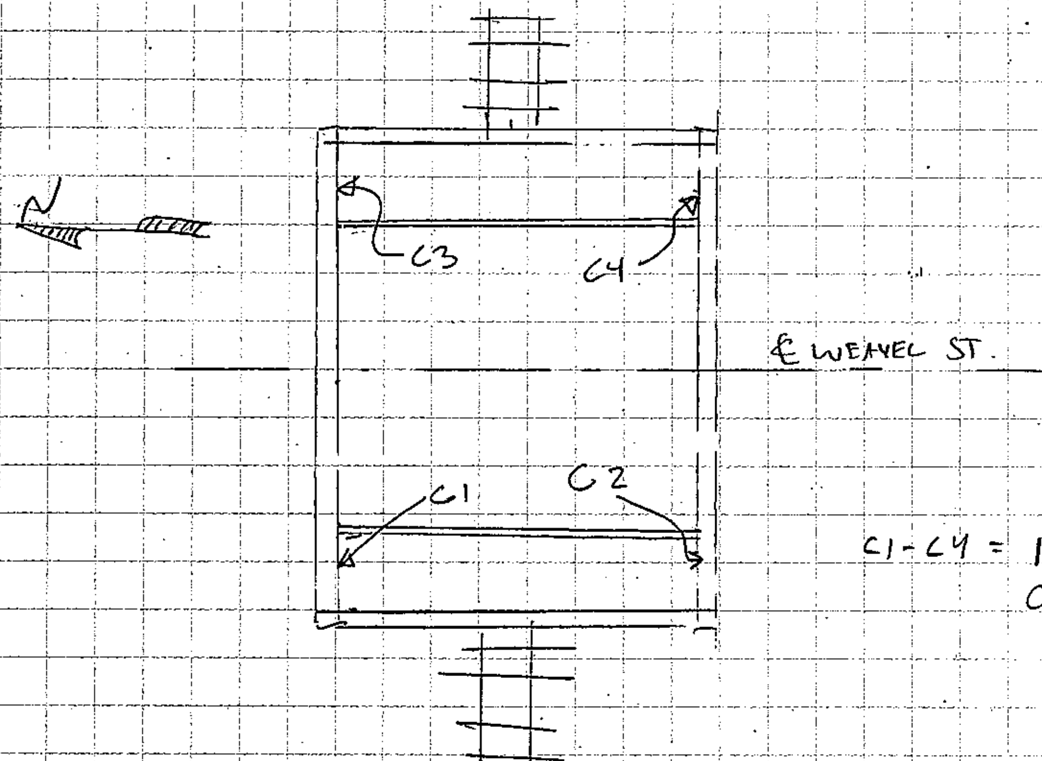
Ryan C. Armstrong, CET
Laboratory Supervisor

RCA/rca

Stantec

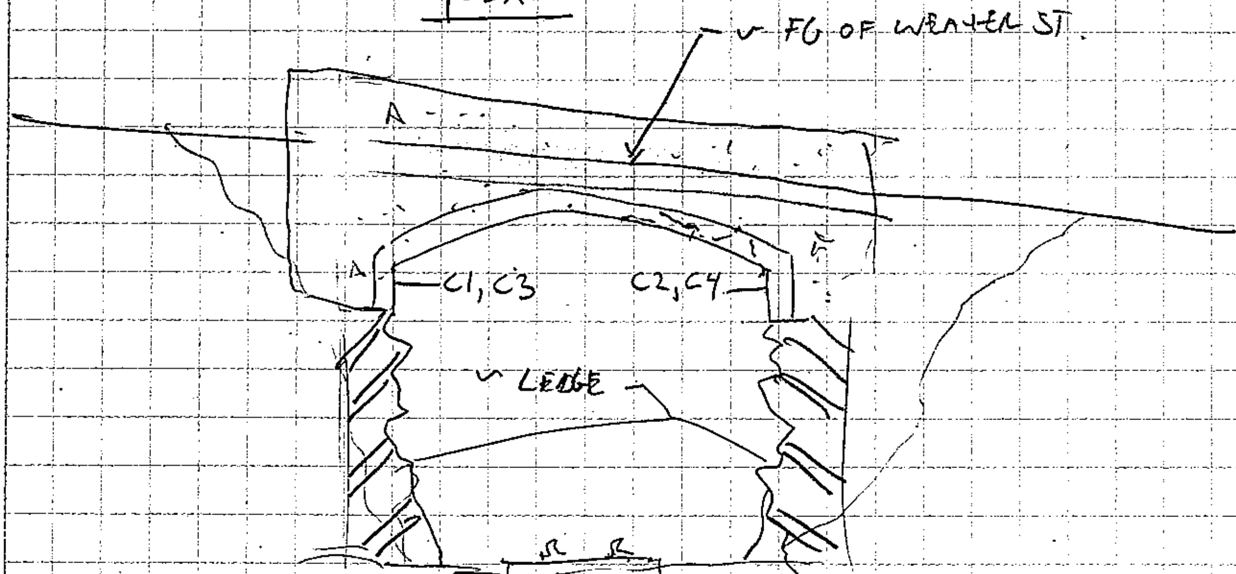
WEAVER ST. -

CONCRETE TESTING LOCATIONS



C1 - C4 = 1½" ϕ x ~4" DEEP CORES FOR CONCRETE TESTING.

PLAN



ELEVATION

Designed by: TEK 4/11 Checked by:

APPENDIX C

Opinion of Probably Cost

195310507

WEAVER ST. / NICK

Stantec

COMPARISON COST – ALT. 1:

- CONC IS CARBONATED TO 1.6" +/-
- CHLORIDE CONTENT IS ABOVE THRESHOLD, ALL LOCATIONS SAMPLED W/ MUCH HIGHER READINGS ON WEST SIDE

SPAN = 38', WIDTH = 56', ~ AREA OF ARCH ASSUME 56 x 38 x 1.2 = 2553

USE 2600 SF ~ 290 SY

∴ ASSUME

TYPE II CONC. SURF REPAIRS

290 SY * $1050/SY = 304,500

COST OF CHLORIDE EXTRACTION = $45/SF x 2600 = $117,000

IOWA DOT REPORT TR499 STUDY ON CHLORIDE EXTRACTION USED $25/SF ON TOP OF BRIDGE DECK, BUT WOULD COST MORE IF TRIED ON BOTTOM OF ARCH

SUBTOTAL = $421,500

INCREASE 15% MOB/DEMOB & RR COORDINATION

$484,725

100% TYPE II W/ EXTRACTION ⟹ SAY $500 000

IF AREA OF REQUIRED REPAIR WAS LESS, SAY 50% TYPE 2 & 50% TYPE 1,

THAT COST ~ 145 * $780/SY + 145 * $1050/SY = 265 350

\+ ~ 60 000 ← EXTR

~ 316 000

x 1.15

$ 363 000

Designed by: Checked by:

Stantec

IF THE APPROACH WAS TO USE CONC REMOVAL & CORROSION INHIBITORS, COST MIGHT BE REDUCED TO $300,000

OR $250,000

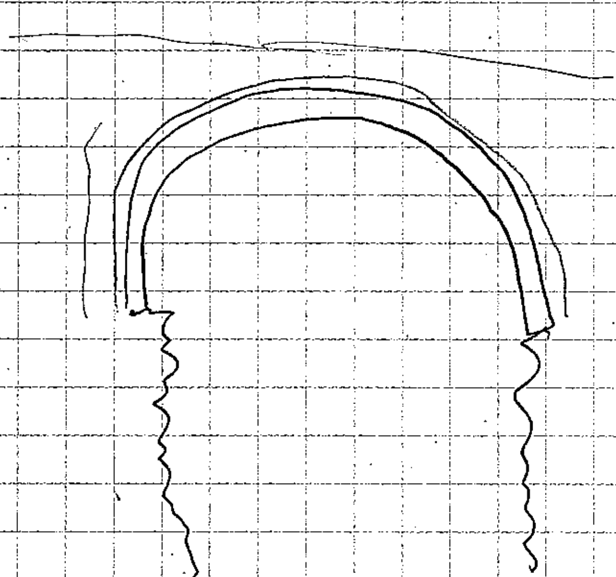
∴ RANGE FOR CONC. REPAIR ~ $250 000 TO $500 000.

Designed by: Checked by:

Stantec

ALTERNATIVE 2

PERMANENT SHORING - SHOTCRETE ARCH.



ASSUME PRICE OF CONC. BASED ON FORMED ALTHOUGH SPRAYED CONC. WOULD ASSUME 30% + SAVINGS FOR SPRAYED VS. FORMED CONC.

$2600 \text{ SF} * \frac{18''}{12} \text{ THICK} * 1/27 \approx 150 \text{ CY}$

150 CY
1100/CY ← REINFORCED & OVERHEAD
~170 000
+100 000 ← MOB/DEMOB/RR COORDINATION/RISK
$ 270 000

SAY $300 000

Designed by: Checked by:

Stantec

ALTERNATIVE 3

NEW PRECAST CONC. ARCH

REMOVAL OF EXIST ARCH ~ $75 000 ← seems low / from where • creosote • concrete

NEW ARCH ~ 2600 SF X $160/SF = $416,000

ASSUME + 100 000 RUNAWAY

$591 000

X 1.2 ← MOB/DEMOB RR COORDINATION

$710 K

USE $700,000

Designed by: Checked by:

Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
0925	900.645 SPECIAL PROVISION *(ELECTRIC DEMOLITION)*	1.000	LS	$10,000.00000	$10,000.00
0930	900.645 SPECIAL PROVISION *(ELECTRIC POWER BOARD AND CABINET)*	1.000	LS	$10,000.00000	$10,000.00

Total for Group 1081:$333,039.59

Group 1211: BRIDGE

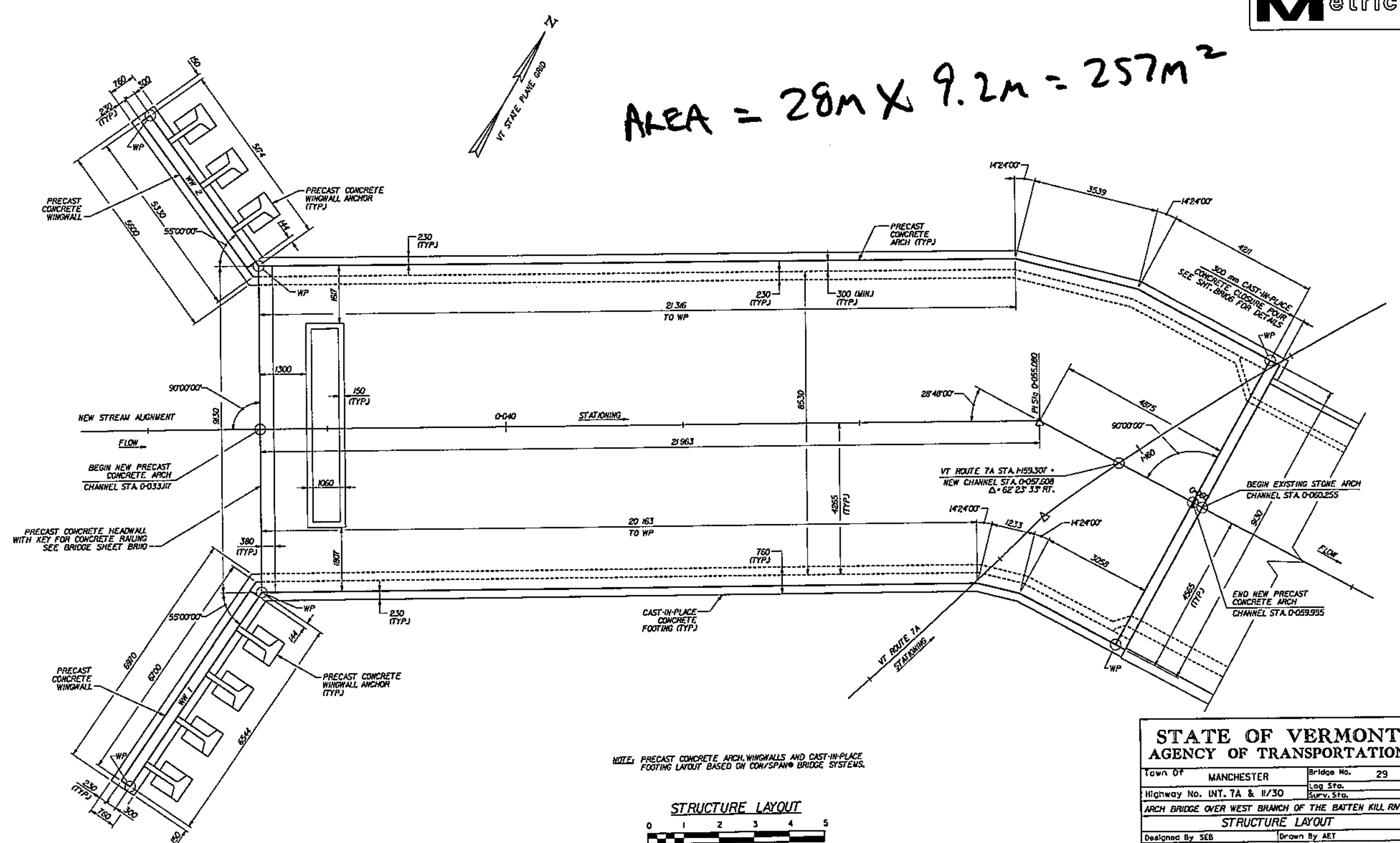
Line #	Item Number / Description / *Supplemental Description*	Quantity	Units	Unit Price	Extension
~~0935~~	~~203.17~~ UNCLASSIFIED EXCAVATION	~~10.000~~	~~CM~~	~~$15.69390~~	~~$156.94~~
~~0940~~	~~203.27~~ UNCLASSIFIED CHANNEL EXCAVATION	~~231.000~~	~~CM~~	~~$20.05550~~	~~$4,632.82~~
0945	204.25 STRUCTURE EXCAVATION	330.000	CM	$25.85744	$8,532.96
0950	204.30 GRANULAR BACKFILL FOR STRUCTURES	270.000	CM	$41.38990	$11,175.27
0955	501.34 CONCRETE, HIGH PERFORMANCE CLASS B	50.000	CM	$930.85741	$46,542.87
0960	507.15 REINFORCING STEEL	3,535.000	KG	$3.42499	$12,107.34
~~0965~~	~~507.16~~ DRILLING AND GROUTING DOWELS	~~50.000~~	~~M~~	~~$86.99032~~	~~$4,349.52~~
0970	507.17 EPOXY COATED REINFORCING STEEL	169.000	KG	$3.83920	$648.82
0975	514.10 WATER REPELLENT, SILANE	50.000	L	$18.55925	$927.96
0980	525.15 METAL HAND RAILING	45.000	M	$484.21889	$21,789.85
~~0985~~	~~520.20~~ PARTIAL REMOVAL OF STRUCTURE	~~1.000~~	~~EACH~~	~~$50,000.00000~~	~~$50,000.00~~
~~0990~~	~~613.11~~ STONE FILL, TYPE II	30.000	CM	$66.17878	~~$1,985.36~~
~~0995~~	~~649.31~~ GEOTEXTILE UNDER STONE FILL	~~60.000~~	~~SM~~	~~$7.25035~~	~~$435.02~~
1000	651.40 GRUBBING MATERIAL	18.000	SM	$22.59618	$406.73
1005	900.640 SPECIAL PROVISION *(EPOXY ANCHORED DOWELS)*	15.000	M	$200.00000	$3,000.00
1010	900.640 SPECIAL PROVISION *(CAST-IN-PLACE CONCRETE BRIDGE RAIL)*	60.000	M	$1,750.00000	$105,000.0…
~~1015~~	~~900.645~~ SPECIAL PROVISION *(WATER MAIN ON BRIDGE)*	~~1.000~~	~~LS~~	~~$25,000.00000~~	~~$25,000.0…~~
~~1020~~	~~900.645~~ SPECIAL PROVISION *(TEMPORARY DIVERSION OF STREAM)*	~~1.000~~	~~LS~~	~~$50,000.00000~~	~~$50,000.0…~~
1025	900.645 SPECIAL PROVISION *(PRECAST CONCRETE ARCH)*	1.000	LS	$225,000.00000	$225,000.0…

Total for Group 12~~11:$571,691.46~~

$435,000 / 257 m² = 169…

= $160/SF

Group 1999: FULL C.E. ITEMS



NOTE: PRECAST CONCRETE ARCH, WINGWALLS AND CAST-IN-PLACE FOOTING LAYOUT BASED ON CON/SPAN® BRIDGE SYSTEMS.

STRUCTURE LAYOUT

SCALE = 1:50

STATE OF VERMONT
AGENCY OF TRANSPORTATION

Town Of MANCHESTER	Bridge No. 29
Highway No. INT. 7A & 11/30	Log Sta. / Surv. Sta.
ARCH BRIDGE OVER WEST BRANCH OF THE BATTEN KILL RIVER	
STRUCTURE LAYOUT	
Designed By SEB	Drawn By AET
Checked By MJC Date	Bridge Design Supervisor Date
PROJECT MANCHESTER, VT	PROJECT NO. STP 0137(17)S
CAD Dwg: ...\PlotFiles\77 ARCH LAYOUT.pff Plot Date: 3/9/2011	
Bridge Sheet No. BR103	Sheet #3 of 145

Stantec

APPENDIX D

Representative Photos

PHOTO 1: WEST FASCIA: CRACKING, SPALLING SOFFIT

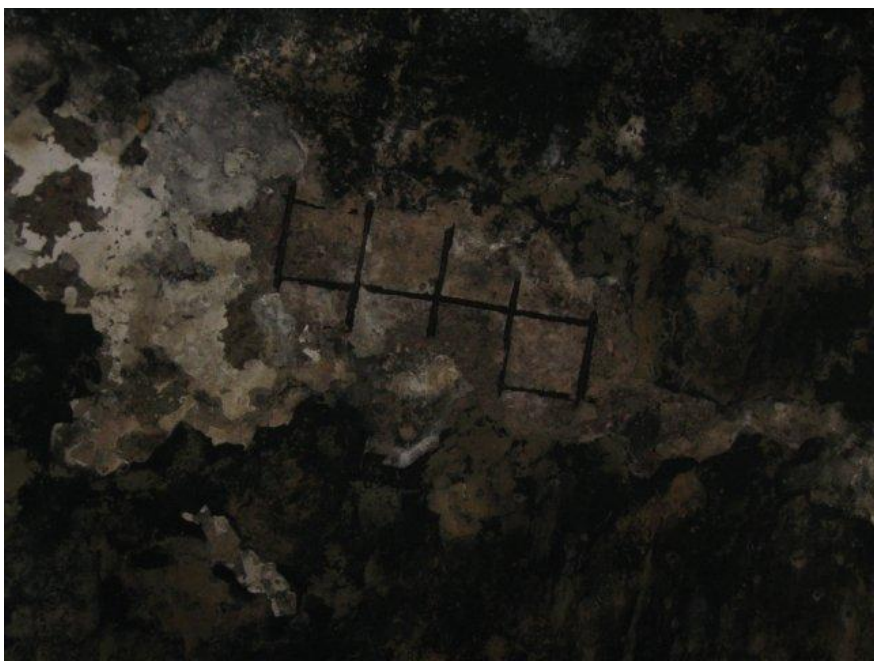


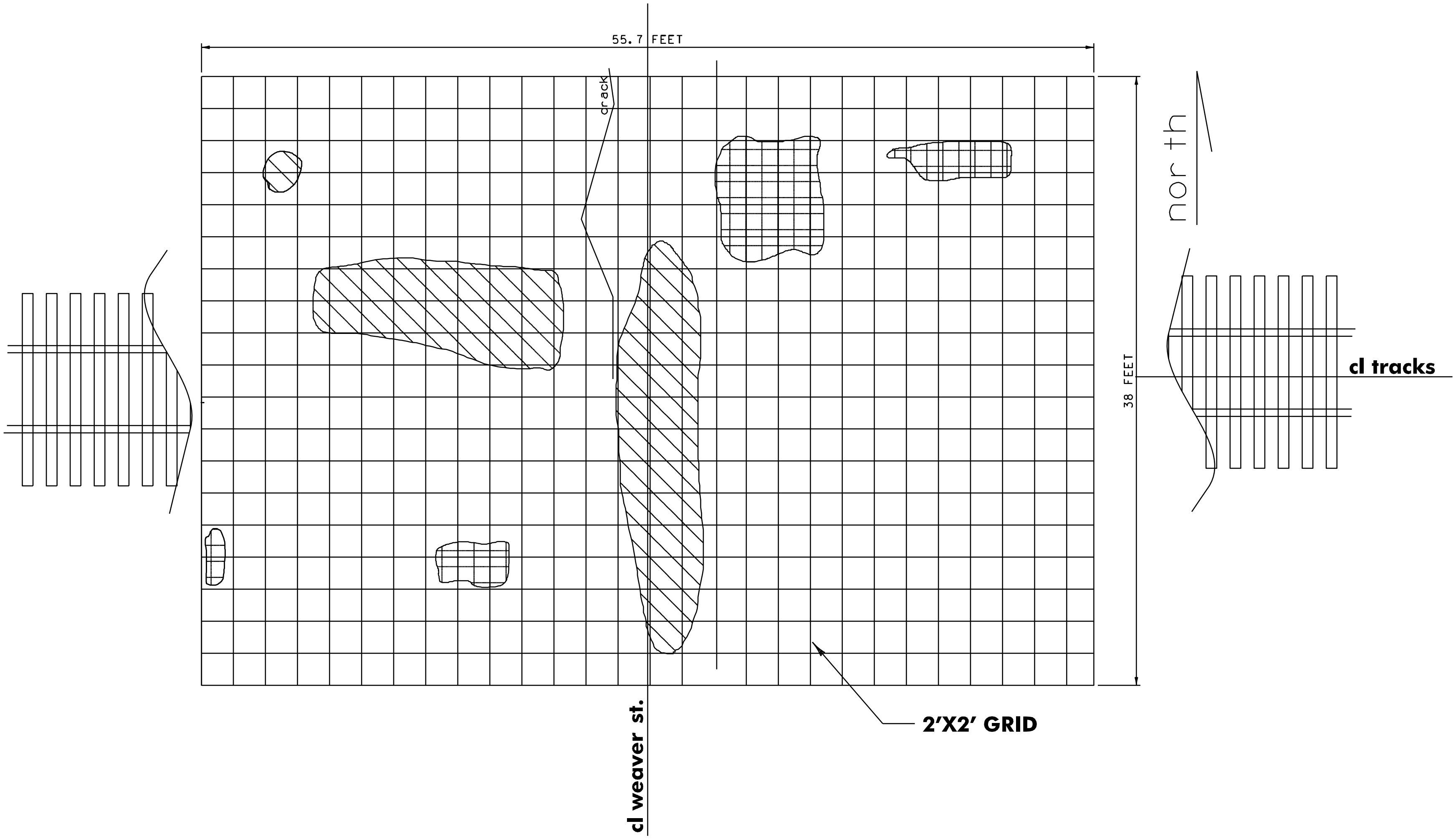
PHOTO 2: SPALLING SOFFIT, EXPOSED REBAR

PHOTO 3: SPALLING SOFFIT, EXPOSED REBAR

PHOTO 4: CLOSE UP, POORLY MIXED CONCRETE

APPENDIX E

Sketch of Spalling Areas, Arch Soffit
By Stantec - April, 2011



spalling

spall w/ rebar exposed

WEAVER ST. OVER NECR
REFLECTIVE CEILING PLAN

0 10 15 20 25

This reflective ceiling plan is a snapshot of the condition of the arch soffit at the time of inspection. The sketch is approximate (made without meausrements). This sketch was made prior to sounding the underside of the soffit in April, 2011. The intent is to update this sketch at subsequent inspections to track the progress of deterioration.