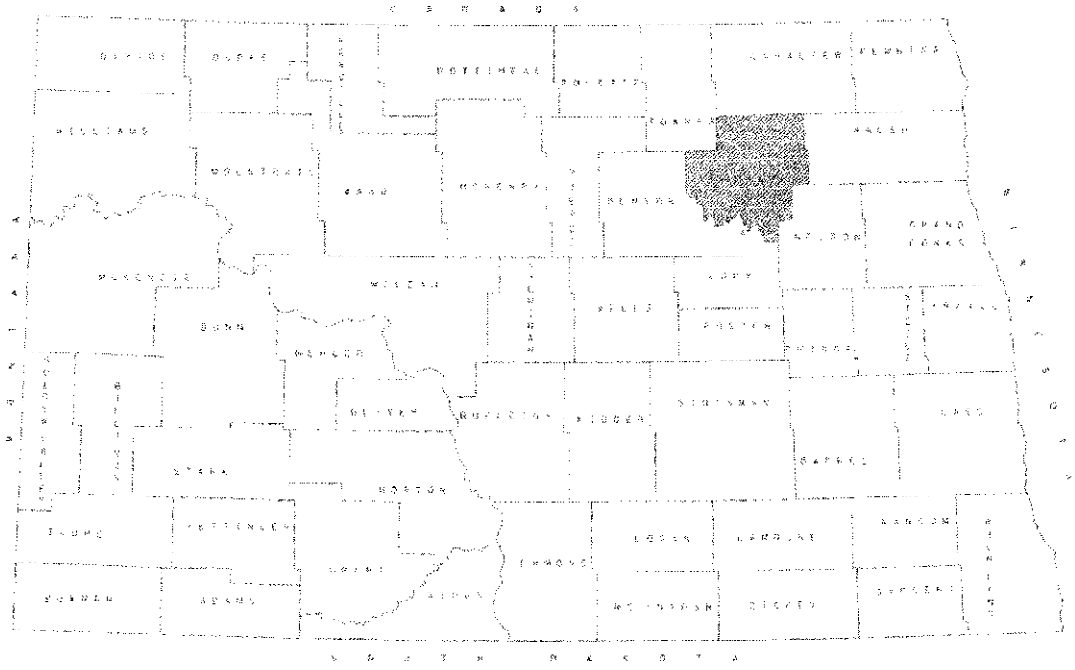
Geotechnical Report
Addendum 1

PROJECT NO. SU-3-020(074)103

PCN 17504

COUNTY Ramsey

Bridge #: 0020-103.403



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NORTH DAKOTA DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

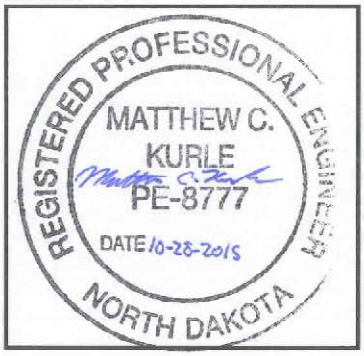
October 2015

SU-3-020(074)103

Railroad Underpass - Bridge #0020-103.403

CERTIFICATION

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of North Dakota. This document was originally issued and sealed by Matthew C. Kurle, Registration number PE-8777 on 10/28/15 and the original document is stored at the North Dakota Department of Transportation.



Matthew C. Kurle, P.E.

28 OCTOBER 2015
Date

Introduction

This addendum will provide additional information for the design of the proposed permanent and temporary shoofly structures over ND Highway 20 (Bridge #0020-103.403). The Geotechnical Section was asked by the Bridge Design Team (KLJ) for more information in regards to the allowable pullout load of the piling as well as depths of pile fixity. Information and recommendations provided in this addendum will supersede any recommendations provided in the Geotechnical Report dated 9/21/2015.

Downdrag

Downdrag was determined using the neutral plane method while considering the estimated settlement of the shoofly embankment. The pile sizes that have been analyzed are HP10x42, HP12x53, HP14x73, and HP14x102.

The software "APile" (v2014) was utilized with the FHWA Method (Reese, Wang, Arrellaga, & Vasquez, 2014). The FHWA Method derives pile load carrying ability from the frictional resistance of the soil around the shaft and the bearing capacity at the pile tip. The computations were performed with the assumption that end of the pile was plugged.

Temporary Shoofly Structure

The Geotechnical Report dated 9/21/2015 stated that the piling should be predrilled to account for any downdrag forces. Concerns over the fixity and lateral capacity of the piling will not allow for the piling to be predrilled. The piles have been analyzed for downdrag forces under two conditions. The first condition (Table 1) assumes that no measures will be taken to reduce downdrag (Load Factor =1.4). The second condition (Table 2) assumes that there will be measures in place to reduce the downdrag load (Load Factor = 0.35). In order to reduce the downdrag load the piling was assumed to utilize a friction reduction system used such as Bitumin Coating, Yellow Jacket™ pile sleeves, or Slickcoat™ epoxy coating. These friction reduction methods were assumed to be used from ground elevation to an elevation depth 1435 ft.

Table 1 – Downdrag Temporary Shoofly (Load Factor = 1.4)

Pile Type	West Abutment-1	Pier-2	Pier-3	Pier-4	Pier-5	East Abutment-6
Assumed Ground Elevation (Feet)	1454	1448	1438	1438	1448	1454
	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)
HP10x42	216	184	NA	NA	158	190
HP12x53	261	224	NA	NA	199	236
HP14x73	308	265	NA	NA	241	284
HP14x102	315	270	NA	NA	246	291

Table 2 – Downdrag Temporary Shoofly with Friction Reduction Techniques (Load Factor = 0.35)

Pile Type	West Abutment-1	Pier-2	Pier-3	Pier-4	Pier-5	East Abutment-6
Assumed Ground Elevation (Feet)	1454	1448	1438	1438	1448	1454
	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)	Downdrag Load (kips)
HP10x42	54	46	NA	NA	40	48
HP12x53	65	56	NA	NA	50	59
HP14x73	77	66	NA	NA	60	71
HP14x102	79	68	NA	NA	62	73

Proposed Permanent Structure

Downdrag will not be a concern if the pile is driven through the existing embankment as settlement is not expected to occur.

Pullout Resistance

Pullout resistance was determined using the skin friction available while considering the estimated pile termination elevation as well as any downdrag forces. A load factor of 0.25 was used based on the calculation method used. The pile sizes that have been analyzed are HP10x42, HP12x53, HP14x73, and HP14x102.

The software "APile" (v2014) was utilized with the FHWA Method (Reese, Wang, Arrellaga, & Vasquez, 2014). The FHWA Method derives pile load carrying ability from the frictional resistance of the soil around the shaft and the bearing capacity at the pile tip. The computations were performed with the assumption that end of the pile was plugged.

Temporary Shoofly Structure

The pullout resistance for the temporary shoofly structure was determined under two conditions. The first condition being that no downdrag mitigation techniques were used. The second condition being that friction reduction techniques were used to an elevation depth of 1435.

Table 3 – Pullout Resistance Temporary Shoofly with no Friction Reduction Technique (Load Factor = 0.25)

Pile Type	West Abutment-1	Pier-2	Pier-3	Pier-4	Pier-5	East Abutment-6
Assumed Ground Elevation (Feet)	1454	1448	1438	1438	1448	1454
	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)
HP10x42	107	101	90	93	101	107
HP12x53	130	123	111	116	126	133
HP14x73	160	152	141	143	154	162
HP14x102	177	169	167	160	172	180

Table 4 – Pullout Resistance Temporary Shoofly with Friction Reduction Technique (Load Factor = 0.25)

Pile Type	West Abutment-1	Pier-2	Pier-3	Pier-4	Pier-5	East Abutment-6
Assumed Ground Elevation (Feet)	1454	1448	1438	1438	1448	1454
	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)
HP10x42	68	68	90	93	73	68
HP12x53	83	83	111	116	90	83
HP14x73	105	105	141	143	112	105
HP14x102	121	121	167	160	128	121

Proposed Permanent Structure

Assuming no downdrag forces will be acting on the proposed permanent structure, the following table lists the factored pullout resistance of the piling.

Table 5 – Pullout Resistance Proposed Permanent Structure (Load Factor = 0.25)

Pile Type	West Abutment-1	Pier-2	Pier-3	East Abutment-4
Assumed Ground Elevation (Feet)	1447	1432	1432	1447
	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)	Pullout Resistance (kips)
HP10x42	100	84	89	100
HP12x53	122	104	108	125
HP14x73	151	130	137	153
HP14x102	168	156	164	171

Fixity

Temporary Shoofly Structure

Fixity of the piling for the temporary shoofly structure was determined using the methods described in *Bending and Buckling of Partially Embedded Piles (Davisson, Robinson, 1965)*. The following table lists the depth to fixity as per the pile type and loads provided from the bridge designer

Table 6 – Depth to Fixity Temporary Shoofly

Pile Type	West Abutment-1	Pier-2	Pier-3	Pier-4	Pier-5	East Abutment-6
	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)	Depth (ft)
HP12x53	4.2	NA	NA	NA	NA	4.2
HP14x102	NA	9.8	9.2	9.2	9.8	NA

Recommendations

Temporary Shoofly Structure

For Abutments 1&6 and Piers 2&5 it is recommended that a system such as Bitumin Coating, Yellow Jacket™ pile sleeves, or Slickcoat™ epoxy coating be used to reduce the downdrag loading. These friction reduction methods should be used from the ground surface to an elevation depth of 1435 feet.