Attachment 9
Updated SHPO Correspondence

Kevin Malloy

From: Kevin Malloy
Sent: Tuesday, June 21, 2022 10:13 AM
To: Clark, Andrew
Subject: PS-RAM-02
Attachments: 06212022_SHSND_PS-RAM-02-Testing Plan.pdf

Hello Andy,

Please find attached the proposed testing plan that we discussed last week. We currently have a crew in the field and are able to complete the testing as soon as possible. I am aware you are short staffed at the moment but if you could send me your comments/approval of the plan by the end of the week, it would be most appreciated.

Please feel free to reach out to me with any questions or comments.
Thank you!
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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222 South 9th Street | Suite 2900 | Minneapolis, MN 55402
M 906.285.0361
E Kevin.Malloy@erm.com | **W** www.erm.com

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	6/17/2022
Time of Conversation	11:19 am
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Andy Clark (State Archaeologist SHSND) called Dr. Kevin Malloy (ERM) to discuss a number of questions. Dr. Malloy asked about the status of the outstanding report comments. Dr. Clark stated he thought that he had forwarded his comments along. Dr. Malloy said he had not received them. Dr. Clark said he would check and see if he had forwarded them. Dr. Malloy then asked about if it would be acceptable to submit a testing plan and have the SHSND review it quickly in order to get work under way during the current mobilization. Dr. Clark stated they would accept a letter workplan but that they were extremely understaffed at the moment. They would try to review it as quickly as possible but not to expect it overnight. Finally Dr. Malloy asked about potential testing and whether they would prefer that in a separate testing report or included in the main Class III report. Dr. Clark stated he was fine with a separate testing report.

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	06/23/2022
Time of Conversation	11:18 am
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Dr. Andrew Clark (State Archaeologist SHSND) to discuss the submitted testing plan for site PS-RAM-02. He did not get through. A message was left.

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Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/11/2022
Time of Conversation	13:46
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Dr. Andrew Clark (State Archaeologist SHSND) to discuss the submitted testing plan for site PS-RAM-02. He did not get through. A message was left.

Kevin Malloy

From: Kevin Malloy
Sent: Tuesday, July 19, 2022 9:46 AM
To: Bleier, Amy C.
Subject: RE: NDCRS: Proposed Wahpeton Expansion-Richland County

Thanks Amy! I just got your email. I was out on Friday and yesterday.

Have a great rest of the week!
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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From: Bleier, Amy C. <ableier@nd.gov>
Sent: Friday, July 15, 2022 9:32 AM
To: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: NDCRS: Proposed Wahpeton Expansion-Richland County

Hi Kevin,

Attached is the number assignment letter for the NDCRS forms submitted recently.

Thank you,
Amy

Amy C. Bleier
Research Archaeologist
State Historical Society of North Dakota/SHPO
612 E Boulevard Ave, Bismarck ND 58505

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/19/2022
Time of Conversation	10:05 am
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Dr. Andrew Clark (State Archaeologist SHSND) to discuss the submitted testing plan for site PS-RAM-02. He did not get through. A message was left.

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/20/2022
Time of Conversation	10:05 am
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Dr. Andrew Clark (State Archaeologist SHSND) to discuss the submitted testing plan for site PS-RAM-02. He did not get through. A message was left.

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/22/2022
Time of Conversation	11:53 am
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Dr. Andrew Clark (State Archaeologist SHSND) to discuss the submitted testing plan for site PS-RAM-02. He did not get through. No message was left.

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Lisa Steckler (SHSND)
Phone number	701.328.2666
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/22/2022
Time of Conversation	11:50 am
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Lisa Steckler (SHSND) to discuss the submitted testing plan for site PS-RAM-02. He did not get through. No message was left.

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Lisa Steckler (SHSND)
Phone number	701.328.2666
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/22/2022
Time of Conversation	14:04
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Kevin Malloy (ERM) called Lisa Steckler (SHSND) to discuss the submitted testing plan for site PS-RAM-02. He informed her that it had been 30 days since the plan was submitted. Ms. Steckler looked for the plan but wasn't able to immediately find it. She requested it be sent directly to her, and she would ensure it is reviewed by early next week.

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Call Log

Log of Telephone Conversation

ERM

Call To/From Whom	Andrew Clark (SHSND)
Phone number	701.328.3574
Company	SHSND
ERM Contact	Kevin Malloy
Phone number	906-285-0361
Date	7/22/2022
Time of Conversation	15:00
Reference	Wahpeton Expansion Project (Project)
Signature	

LOG OF CONVERSATION

Dr. Andrew Clark (SHSND State Archaeologist) called Dr. Kevin Malloy (ERM) to discuss the submitted testing plan for site PS-RAM-02. Dr. Clark acknowledged receipt of the document and stated he would attempt to review it today or have it done by early next week.

Kevin Malloy

From: Kevin Malloy
Sent: Friday, July 22, 2022 2:29 PM
To: Steckler, Lisa L.
Subject: RE: WBI Wahpeton Expansion Testing Plan

Thank you Lisa! Have a great weekend.
Best,
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Friday, July 22, 2022 2:26 PM
To: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: WBI Wahpeton Expansion Testing Plan

Got it! I will make sure it gets back to you early next week!

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Friday, July 22, 2022 2:18 PM
To: Steckler, Lisa L. <lsteckler@nd.gov>
Subject: WBI Wahpeton Expansion Testing Plan

Hi Lisa,

Thank you again for chatting with me. Per our conversation, please fine our testing plan for site PS-RAM-02.

If you have any questions or need anything else, please let me know.

Best,
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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Kevin Malloy

From: Bleier, Amy C. <ableier@nd.gov>
Sent: Wednesday, September 7, 2022 8:55 AM
To: Emily Dodson
Cc: Kevin Malloy
Subject: RE: Wahpeton Expansion: Resource 001 question

Got it, thanks!

Amy C. Bleier
Archaeologist
Archaeology & Historic Preservation/SHPO
State Historical Society of North Dakota
612 E Boulevard Ave
Bismarck ND 58505
701 328 3088

HISTORY FOR everyone.

From: Emily Dodson <Emily.Dodson@erm.com>
Sent: Friday, September 2, 2022 5:24 PM
To: Bleier, Amy C. <ableier@nd.gov>
Cc: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: Wahpeton Expansion: Resource 001 question

Hello Amy,

I have attached the correct site topo for "Resource 001." Please let me know if you need anything else!

Thank you and enjoy your holiday weekend!

Emily Dodson
Architectural Historian, Consultant I

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From: Bleier, Amy C. <ableier@nd.gov>
Sent: Thursday, September 1, 2022 2:20 PM
To: Emily Dodson <Emily.Dodson@erm.com>
Cc: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: Wahpeton Expansion: Resource 001 question

WARNING: The sender of this email could not be validated and may not match the person in the "From" field.

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Sounds good, thank you.

Amy C. Bleier
Archaeologist
Archaeology & Historic Preservation/SHPO
State Historical Society of North Dakota
612 E Boulevard Ave
Bismarck ND 58505
701 328 3088

HISTORY FOR everyone.

From: Emily Dodson <Emily.Dodson@erm.com>
Sent: Thursday, September 1, 2022 1:19 PM
To: Bleier, Amy C. <ableier@nd.gov>
Cc: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: Wahpeton Expansion: Resource 001 question

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Hi Amy,

My apologies for the issues with the topo map. I am working on getting the issue resolved and will send you the map as soon as possible.

Thank you,

Emily Dodson

Architectural Historian, Consultant I

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From: Bleier, Amy C. <ableier@nd.gov>
Sent: Thursday, September 1, 2022 2:06 PM
To: Emily Dodson <Emily.Dodson@erm.com>
Cc: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: Wahpeton Expansion: Resource 001 question

Hi Emily,

I have run into an issue with the NDCRS form for Field Code Resource 0001 (32RI924). The topo map attached to the form indicates the location of 32RI920. That is why I changed the legal description on page 1 when I sent you the number assignment letter. Will you email me the correct topo map so I may re-collate the form? I will change the legal description and map quad back to what they were.

Amy C. Bleier
Archaeologist
Archaeology & Historic Preservation/SHPO
State Historical Society of North Dakota
612 E Boulevard Ave
Bismarck ND 58505
701 328 3088

HISTORY FOR *everyone.*

Kevin Malloy

From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Tuesday, October 11, 2022 2:02 PM
To: Kevin Malloy
Subject: RE: Deep Testing Workplan

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I found it! It is the next thing in our queue

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Tuesday, October 11, 2022 1:55 PM
To: Steckler, Lisa L. <lsteckler@nd.gov>
Subject: RE: Deep Testing Workplan

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Thank you Lisa!

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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E Kevin.Malloy@erm.com | **W** www.erm.com

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From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Tuesday, October 11, 2022 1:54 PM
To: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: Deep Testing Workplan

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Ok. Thanks. I will look for it and get back to you!

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Tuesday, October 11, 2022 1:53 PM

To: Steckler, Lisa L. <lsteckler@nd.gov>; Clark, Andrew <andrewclark@nd.gov>
Subject: RE: Deep Testing Workplan

Hi Lisa,

We submitted a hard copy as well. I sent it on the 9/15 and it should have arrived 9/19.
Thanks!
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Tuesday, October 11, 2022 1:51 PM
To: Kevin Malloy <Kevin.Malloy@erm.com>; Clark, Andrew <andrewclark@nd.gov>
Subject: RE: Deep Testing Workplan

Kevin,

Did you submit a hard copy or just digital? Just to the ftp or via email?

Thanks!

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Tuesday, October 11, 2022 1:50 PM
To: Clark, Andrew <andrewclark@nd.gov>; Steckler, Lisa L. <lsteckler@nd.gov>
Subject: Deep Testing Workplan

Hello Andy and Lisa,

I hope this email finds you both well and you're enjoying the fall weather! A few weeks ago we submitted a geomorphological analysis and a proposed deep testing workplan for your review for the WBI Wahpeton Project. I was wondering if either of you had had a chance to at least review the workplan? We would like to try to get in the field before everything freezes. We are just looking for SHSND approval to proceed with that.

Thank you for your help!
Best,
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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Kevin Malloy

From:	Steckler, Lisa L. <lsteckler@nd.gov>
Sent:	Wednesday, October 12, 2022 11:49 AM
To:	Kevin Malloy
Subject:	21-6245 Deep Testing
Attachments:	21-6245 GeoMorph Plan Acceptable Malloy.pdf

Please see attached. No hard copy to follow.

Lisa L Steckler
Historic Preservation Specialist
State Historical Society of North Dakota

Kevin Malloy

From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Tuesday, November 29, 2022 10:17 AM
To: Kevin Malloy
Subject: RE: ERM 2022 Annual Permit Application
Attachments: ERM MN Permit 2022.pdf

Please see attached.

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Tuesday, November 29, 2022 10:15 AM
To: Steckler, Lisa L. <lsteckler@nd.gov>
Subject: RE: ERM 2022 Annual Permit Application

Hi Lisa,
Do you happen to have a pdf of ERM's 2022 permit? I don't seem to have it in my email.
Thank you!
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Monday, March 7, 2022 2:28 PM
To: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: ERM 2022 Annual Permit Application

Not as far as I know, I think it has always been that way!

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Monday, March 7, 2022 2:27 PM
To: Steckler, Lisa L. <lsteckler@nd.gov>
Subject: RE: ERM 2022 Annual Permit Application

Hey Lisa,

I just paid the permit cost. I had one question for you. I guess I wasn't aware that I needed to notarize the permit application. Is that a new requirement?

Thanks for the help!
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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E Kevin.Malloy@erm.com | **W** www.erm.com

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From: Steckler, Lisa L. <lsteckler@nd.gov>
Sent: Monday, March 7, 2022 11:53 AM
To: Kevin Malloy <Kevin.Malloy@erm.com>
Subject: RE: ERM 2022 Annual Permit Application

We need a hard copy of the notarized application, not the rest of it. A check is fine or if you prefer to call in a credit card payment that works as well. 701-328-2666

Thanks!

From: Kevin Malloy <Kevin.Malloy@erm.com>
Sent: Monday, March 7, 2022 11:50 AM

To: Steckler, Lisa L. <lsteckler@nd.gov>
Subject: ERM 2022 Annual Permit Application

***** **CAUTION:** This email originated from an outside source. Do not click links or open attachments unless you know they are safe. *****

Hi Lisa,

Hope you had a nice weekend! I just uploaded our 2022 permit application for fieldwork. I had two questions for you. Do you need a hard copy and would you prefer to invoice ERM for the $100 or do you want, as it says, a physical check?

Thank you!
Kevin

Kevin Malloy, Ph.D.
Senior Consultant/Archaeologist

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December 1, 2022

Andrew Clark, State Archaeologist
State Historic Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck, ND 58505-0830

Subject: WBI Energy Transmission, Inc.
Wahpeton Expansion Project –Class III Archaeology Survey Report and Class III Structures Survey Report from 2021 and 2022
Cass and Richland Counties, North Dakota

Dear Dr. Clark:

Please reference WBI Energy Transmission, Inc.'s (WBI Energy's) previous correspondence regarding the above referenced project. WBI Energy proposes to construct and operate the Wahpeton Expansion Project (Project) in Cass and Richland Counties, North Dakota.

The Project is regulated by the Federal Energy Regulatory Commission (FERC) under Section 7(c) of the Natural Gas Act. Under the Energy Policy Act of 2005, FERC is the lead agency for coordinating federal authorizations and complying with the National Environmental Policy Act on natural gas pipeline projects subject to its jurisdiction. FERC similarly is the lead federal agency for complying with Section 106 of the National Historic Preservation Act (NHPA) on natural gas pipeline projects under its jurisdiction. In accordance with 36 CFR 800.2(c)(4), WBI Energy is assisting the FERC in meeting its obligations under Section 106 of the NHPA by coordinating with agencies and tribes and conducting surveys to identify historic properties that may be affected by the Project.

Enclosed for your review, please find the Class III Archaeology Survey Report and the Class III Structures Survey Report in support of the Project for survey efforts conducted from October to November 2021, and in June 2022.

WBI Energy would appreciate your comments on the attached reports. If you have any questions or comments on the Project or the reports, please contact me at 906-285-0361 or kevin.malloy@erm.com. Please direct written correspondence to Dr. Malloy's attention at:

Environmental Resources Management
222 South 9th Street
Suite 2900
Minneapolis, MN 55402

Sincerely,

Kevin Malloy
Senior Consultant

Enclosures: Class III Historic Architectural Survey: WBI Energy Transmission, Inc. Wahpeton Expansion Project, Cass and Richland Counties, North Dakota
Class III Archaeological Inventory Survey Report: WBI Energy Transmission, Inc. Wahpeton Expansion Project, Cass and Richland Counties, North Dakota

cc: Jill Linn, WBI Energy
Maggie Suter, ERM
Kevin Malloy, ERM
Emily Laird, ERM
Andrew Clark, SHSND
Lisa Steckler, SHSND
Teanna Limpy, Northern Cheyenne Tribe
Allen Demaray, Three Affiliated Tribes of the Fort Berthold Reservation
Dyan Youpee, Assiniboine and Sioux Tribes of the Fort Peck Reservation
Ione Quigley, Rosebud Sioux Tribe
Michael Black Wolf, Fort Belknap Indian Community
Tom Brings, Oglala Sioux Tribe
Jon Eagle, Standing Rock Sioux Tribe
Ben Ridgely, Northern Arapaho Tribe
Steven Vance, Cheyenne River Sioux
Erich Longie, Spirit Lake Tribe
Kip Spotted Eagle, Yankton Sioux Tribe
Jeff Desjarlais, Jr., Turtle Mountain Band of Chippewa
Dianne Desrosiers, Sisseton Wahpeton Oyate
Kade Ferris, Red Lake Band of Chippewa Indians of Minnesota
Samantha Odegard, Upper Sioux Community of Minnesota

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December 1, 2022

Lisa Steckler
State Historic Society of North Dakota
North Dakota Heritage Center
612 East Boulevard Avenue
Bismarck, ND 58505-0830

Subject: WBI Energy Transmission, Inc.
Wahpeton Expansion Project –Class III Archaeology Survey Report and Class III Structures Survey Report from 2021
Cass and Richland Counties, North Dakota

Dear Ms. Steckler:

Please reference WBI Energy Transmission, Inc.'s (WBI Energy's) previous correspondence regarding the above referenced project. WBI Energy proposes to construct and operate the Wahpeton Expansion Project (Project) in Cass and Richland Counties, North Dakota.

The Project is regulated by the Federal Energy Regulatory Commission (FERC) under Section 7(c) of the Natural Gas Act. Under the Energy Policy Act of 2005, FERC is the lead agency for coordinating federal authorizations and complying with the National Environmental Policy Act on natural gas pipeline projects subject to its jurisdiction. FERC similarly is the lead federal agency for complying with Section 106 of the National Historic Preservation Act (NHPA) on natural gas pipeline projects under its jurisdiction. In accordance with 36 CFR 800.2(c)(4), WBI Energy is assisting the FERC in meeting its obligations under Section 106 of the NHPA by coordinating with agencies and tribes and conducting surveys to identify historic properties that may be affected by the Project.

Enclosed for your review, please find the Class III Archaeology Survey Report and the Class III Structures Survey Report in support of the Project for survey efforts conducted from October to November 2021 and June 2022.

WBI Energy would appreciate your comments on the attached reports. If you have any questions or comments on the Project or the reports, please contact me at 906-285-0361 or kevin.malloy@erm.com. Please direct written correspondence to Dr. Malloy's attention at:

Environmental Resources Management
222 South 9th Street
Suite 2900
Minneapolis, MN 55402

Sincerely,

Kevin Malloy
Senior Consultant

Enclosures: Class III Historic Architectural Survey: WBI Energy Transmission, Inc. Wahpeton Expansion Project, Cass and Richland Counties, North Dakota
Class III Archaeological Inventory Survey Report: WBI Energy Transmission, Inc. Wahpeton Expansion Project, Cass and Richland Counties, North Dakota

cc: Jill Linn, WBI Energy
Maggie Suter, ERM
Kevin Malloy, ERM
Emily Laird, ERM
Andrew Clark, SHSND
Lisa Steckler, SHSND
Teanna Limpy, Northern Cheyenne Tribe
Allen Demaray, Three Affiliated Tribes of the Fort Berthold Reservation
Dyan Youpee, Assiniboine and Sioux Tribes of the Fort Peck Reservation
Ione Quigley, Rosebud Sioux Tribe
Michael Black Wolf, Fort Belknap Indian Community
Tom Brings, Oglala Sioux Tribe
Jon Eagle, Standing Rock Sioux Tribe
Ben Ridgely, Northern Arapaho Tribe
Steven Vance, Cheyenne River Sioux
Erich Longie, Spirit Lake Tribe
Kip Spotted Eagle, Yankton Sioux Tribe
Jeff Desjarlais, Jr., Turtle Mountain Band of Chippewa
Dianne Desrosiers, Sisseton Wahpeton Oyate
Kade Ferris, Red Lake Band of Chippewa Indians of Minnesota
Samantha Odegard, Upper Sioux Community of Minnesota

Scope of Work
for Proposed Targeted Phase 1b Geomorphological and Geoarchaeological Testing
for Presence, Absence and Geological Potential for Buried Cultural Deposits
at Seven Locations on the Glacial Lake Agassiz Plain,
Wahpeton Pipeline, Southeast North Dakota

Prepared For
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Edwin R. Hajic
GeoArc®
GeoArc Research, Inc.
Santa Fe, NM 87508

August 29, 2022

INTRODUCTION

On behalf of their client WBI Energy Transmission, Inc. (WBI), Environmental Resources Management (ERM) is performing a Phase 1 cultural resource survey of the Wahpeton Pipeline (Project) corridor across a section of the southwest end of the Glacial Lake Agassiz basin in Cass and Richland Counties, North Dakota (Figure 1). WBI proposes to construct the Project, a 95.8-km-long (59.5-mile-long) pipeline, between a station about 10.8 km (6.7 mi) west of the west side of Fargo, North Dakota, south-southeast to a station about 5.7 km (3.5 mi) west of the Red River, the boundary between North Dakota and Minnesota.

The North Dakota SHPO Guidelines Manual for Cultural Resource Inventory Projects (State of North Dakota, 2020) includes provision for specialist studies as needed to conduct archaeological surveys in a thorough manner. ERM contracted GeoArc Research, Inc., (GeoArc) to conduct a Phase 1a desktop assessment of the geological potential for buried intact cultural deposits along the Project corridor (Hajic, 2022). Seven deep test locations (DTLs) were identified and recommended for further subsurface investigation based on having a moderate to high geological potential for hosting cultural deposits of pre-Euroamerican settlement age buried to depths greater than standard archaeological shovel testing where the Project crosses them. Six of the DTLs have landform sediment assemblages associated with one or more of the rivers or creeks that cross the glaciolacustrine plain and post-date Glacial Lake Agassiz drainage. At one DTL, the Project crosses an aeolian dune field that likely post-dates lake drainage. It is the alluvial, and dune sediment assemblages that overlie and / or are inset into Glacial Lake Agassiz features, and the locally buried paleogeomorphic surface marking the top of the glaciolacustrine clay, that are of concern for hosting buried cultural deposits. The body of glaciolacustrine clay also represents a moderate or high geological potential for burial and preservation of cultural deposits of pre-Euroamerican settlement age. However, while artifacts of significance, such as canoes, potentially could be present within glaciolacustrine clay increments of appropriate age, the discovery of such rare finds historically has been nearly entirely, if not entirely, by happenstance. Given the extensive length of pipeline route, and the lack of physical criteria to narrow a search for such artifacts, GeoArc is focused on those locations with a greater chance of encountering buried cultural deposits of significance, if present. Thus, for the purpose of this investigation, the paleogeomorphic surface representing the pre-drainage lake floor is considered a basement, while acknowledging the age of underlying glaciolacustrine deposits does not preclude the possibility of them hosting buried, potentially significant, cultural deposits.

SUBSURFACE TESTING OF DTLs

GeoArc will conduct geomorphological / geoarchaeological deep subsurface testing investigations in accordance with the North Dakota SHPO Guidelines at seven locations identified along the Project in the desktop assessment (Hajic; 2022) (Figure 1; Figures 2-8 in Appendix A). Testing of these locations will be conducted along the Project centerline from northwest to southeast at:

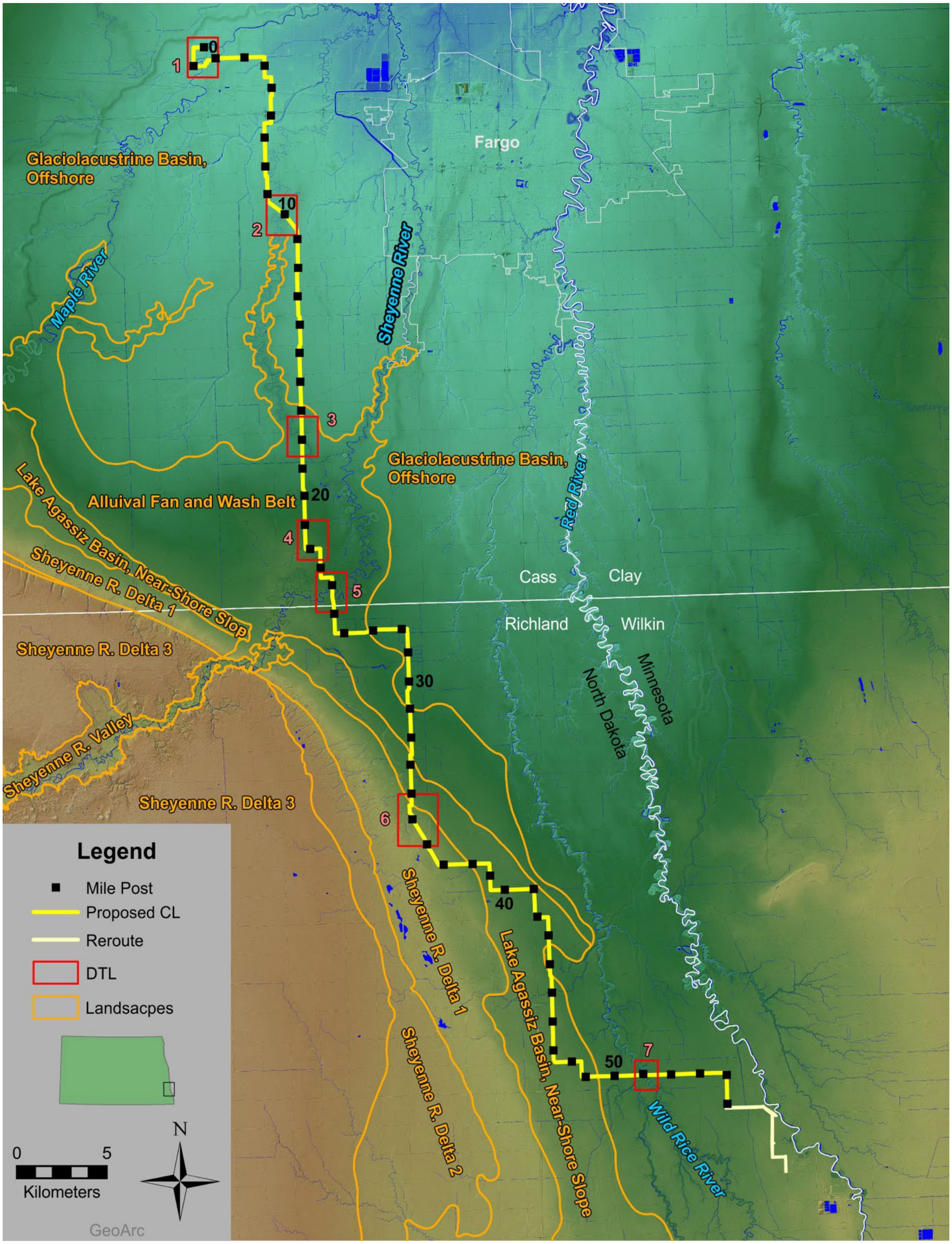

Figure 1. Project pipeline centerline, macro-geomorphology and potential deep test locations

- the Maple River Valley and associated overwash (DTL-01; Figure 2);
- a paleochannel belt of the Sheyenne River, now occupied by an unnamed creek, and associated natural levees (DTL-02, -03; Figures 3 and 4);
- a large crevasse splay lobe off of a Sheyenne River paleochannel (DTL-04; Figure 5);
- the Sheyenne River Valley and associated levees and crevasse splay (DTL-05; Figure 6);
- twelve aeolian dunes located on the youngest surface of the relict Sheyenne River Delta (DTL-06; Figure 7)); and,
- the Wild Rice River Valley and Antelope Creek Valley just above their confluence (DTL-07; Figure 8).

The objective is to determine the presence, absence and geological potential for deeply buried cultural deposits based on deep testing of targeted sediment assemblages. Specific and largely subtle alluvial geomorphological features rising above, and inset into, the glaciolacustrine lake bed will be sampled. These include some of the highest local landscape positions along the route, excluding the relict Sheyenne River delta. It is anticipated that, with the exception of a small number of these alluvial settings, underlying glaciolacustrine sediment will be encountered before the 3 m (10 ft) depth of pipeline trench excavation is attained in subsurface tests. However, the glaciolacustrine surface likely will be deeper than the depth of standard shovel testing in most, if not all, projected specific deep test locations. Sampling of the aeolian dunes may extend a little deeper than 3 m (10 ft) in an effort to reach their base.

Subsurface testing at DTLs will occur in agricultural fields, with a few locations being in local pastures or in forested patches. GeoArc is committed to conducting the subsurface work safely while adhering to safety requirements of GeoArc, the client, and any third party pipeline or other utility operators. It is anticipated that ample safe workspace will be available within the pipeline survey limit and workspace corridor at the DTLs proposed for subsurface testing. The targeted minimum distance of sampling from any existing pipeline, if present, will be no less than 15 m (50 ft).

North Dakota utility One-Calls will be conducted in advance of any fieldwork. One Call locations will request all underground utilities be located within a substantial buffer for each projected subsurface test or group of tests. For contextual purposes, DTL boundaries extend far beyond the targeted limits of that part of the route where subsurface testing will be accomplished. However, any in-field repositioning of subsurface test locations will be confined within the survey / work corridor.

Positions of projected subsurface tests might be subject to minor shifts to accommodate on–the–ground obstacles and field conditions, North Dakota One Call responses, or other identified safety– or access–related field conditions. If access is challenging, landowners impose restrictions for the work, or preceding field results indicate a different position would better fulfill the objective(s) of a specific deep test, GeoArc will have the flexibility to reposition nearby a specific projected deep test, subject to the repositioned test being positioned collectively within the limits of the submitted or a new one-call, the survey / work corridor, and land access agreement limits. In the case of the absence of a suitable alternative location that would fulfill the objective(s) of the deep test, that specific projected deep test could be abandoned. Final specific subsurface test locations, spacing and numbers could further be adjusted depending on results of preceding tests to maximize information return and efficiency.

FIELD METHODS

A combination of sediment / soil coring and mechanical augering will be used to test for buried cultural deposits and document near–surface sedimentologic, soil and stratigraphic contexts within the Project survey area at the seven DTLs (Figure 1). Forty-three paired core and mechanical auger locations are projected for investigation (Figures 2-8, Appendix A). Final numbers may vary according to in-field conditions, access, and progressive general assessment of observed results.

Sediment / Soil Coring

Cores will be the primary source for formal sediment and soil descriptions, and provide sediment, soil and stratigraphic context at the DTLs. Solid, continuous sediment / soil cores will be taken with an ATV–mounted Giddings Hydraulic Soil Probe, or a trailer-mounted Heavy Duty Giddings Probe, utilizing a 1.2 meter–long (4 foot–long) barrel that is either 6.4 centimeter (2.5 inch) or 5.1 centimeter (2.0 inch) in diameter, depending on location and anticipated sediment assemblage and soils. Coring will proceed by inserting a clear liner in the barrel, pushing the barrel into the ground, retracting the barrel, extracting the liner, examining and noting sediment at the ends of the liner and changes within the liner, and labeling and capping the ends of the liner for later detailed description. Depth of coring will be 3 meters (10 feet), a typical depth of pipeline trenching, here considered the vertical APE for this project. If the paleogeomorphic surface atop glaciolacustrine clay is not encountered before this depth is achieved, one or two additional core segments may be collected for contextual data. Conversely, cores may be terminated at shallower depths if the lake bed paleogeomoprhic surface and underlying glaciolacustrine clay is encountered above this depth.

Mechanical Post–Hole Augering

Following extraction of the core, a 22.9 centimeter (9.0 inch) diameter post–hole auger adapted to the Giddings Hydraulic Soil Probe (HD trailer–mounted unit, or, if forested conditions prevent such access, ATV–mounted rig with a 15.2 centimeter (6.0 inch) diameter auger, will be used for testing for the presence or absence of buried cultural deposits at the core hole location. The volume of auger spoil generated per vertical foot is about 0.5 m^3, comparable to, or slightly greater than, what is produced while shovel testing with a typical shovel. Target depth of augering will be either 3.0 meters (10.0 foot) if glaciolacustrine deposits are not encountered, or the depth to such deposits if less than the target maximum depth, informed with initial in–field assessment of any preceding subsurface tests at any given location. Spoil will be segregated in 0.3 meter (1.0 foot) intervals as augering proceeds and treated as shovel test spoil. Each one–foot increment is inspected for artifacts as it is extracted from the auger hole, and then screened through a one–quarter–inch mesh screen onto a tarp, if possible. In the case of clayey sediment or exceedingly dry or firm B–horizon material, clods are broken apart and examined for artifacts, burnt soil, charcoal, and other evidence of pre–Euroamerican settlement age materials. Auger tailings, screened or otherwise, will be returned to the auger hole upon completion, with an admixture of medium bentonite chips, and the auger will be used to compact fill in the hole during backfilling.

Coring, then augering, at the seven DTLs will continue by these processes until one or more of the following conditions are met:

- A depth of about 3.0 meters (10.0 feet) is achieved without encountering glaciolacustrine deposits;
- Sediment representing depositional environments unfavorable for significant prehistoric settlement or preservation of archaeological evidence is encountered;
- bedrock, impenetrable soil horizons, or impenetrable cobble or boulder gravel is encountered;
- Sediment known to pre–date North American cultural occupation is encountered;
- Saturated sand is encountered that either impedes deeper progress by flowing into the boring or auger hole, or refuses to remain within the core liner during extraction; or,
- Cultural deposits of pre–Euroamerican settlement age are encountered.

All seven DTLs will be subject to the following prior to fieldwork:

- Attainment of landowner consent for the work by the client;
- Staking of deep test locations, and arrangements made by the client for such staking, in immediate advance of state utility one-calls and fieldwork;
- North Dakota One-Call submissions, following staking, and reception of utility responses by GeoArc in advance of fieldwork;
- Recordation of a test location with an RTK-GNSS unit w/ 1-centimeter precision, or similar unit.
- GeoArc is notified of approval of this scope of work, along with a notice to proceed.

In the event that features of pre–Euroamerican settlement age or other cultural deposits (e.g., midden, borrow pit, etc.) are encountered, subsurface testing will be halted at that subsurface test location and the designated responsible party of the client will be notified. The location and context of any cultural finds will be documented to the extent possible without additional disturbance. Further activity at such a location, and the nature of the work, if any, will be determined in consultation with the responsible party.

POST-FIELD ANALYSIS AND REPORT OF RESULTS

Evaluation of the geology at the seven deep test locations will involve a synthesis of geomorphological, stratigraphic, sedimentological, and soil data, along with facies analysis, and incorporation of any archaeological data derived from subsurface tests and field observations. Cores will be split longitudinally along natural planes of fracture or cleavage, described and graphically logged. Standard NRCS soil and sedimentologic techniques and terminology will be used to record soil horizons, thickness, color, texture, redoximorphic features, soil structure, sediment structure, consistency, carbonates, inclusions and special features, and boundary characteristics (Schoeneberger et al., 2012; Vepraskas, 1994). Graphic sediment / soil logs illustrating sediment and soil trends with depth, will be constructed as part of the core description process. Interpretations will be informed by an evolution model of soil development that acknowledges the interaction of sedimentological and soil forming processes. For soil color, standard Munsell soil colors will be used, but with distinctions at the half-chip level to emphasize subtle vertical trends in darker soil colors.

Stratigraphic and facies analyses of cores will be conducted. Figures of graphic sediment / soil logs will be prepared to illustrate detailed stratigraphy and the stratigraphic context of any buried cultural deposits. They will be prepared in a schematic core / trench profile that illustrates stratigraphy, facies, landform – sediment assemblage relationships, and, if uncovered, the context of any buried cultural deposits.

Results of the field effort will be provided in a Technical Report that meets all state and federal guidelines. The final report will include project background information; an overview of the physiographic and geologic setting; description of methodologies applied and methods used; results; discussion of results; and conclusions summarizing key results. All aspects of the project will be illustrated. The final report will be supplied in digital form.

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APPENDIX A

DEEP TEST LOCATION (DTL) GEOMORPHOLOGY AND PROJECTED SUBSURFACE TEST LOCATIONS

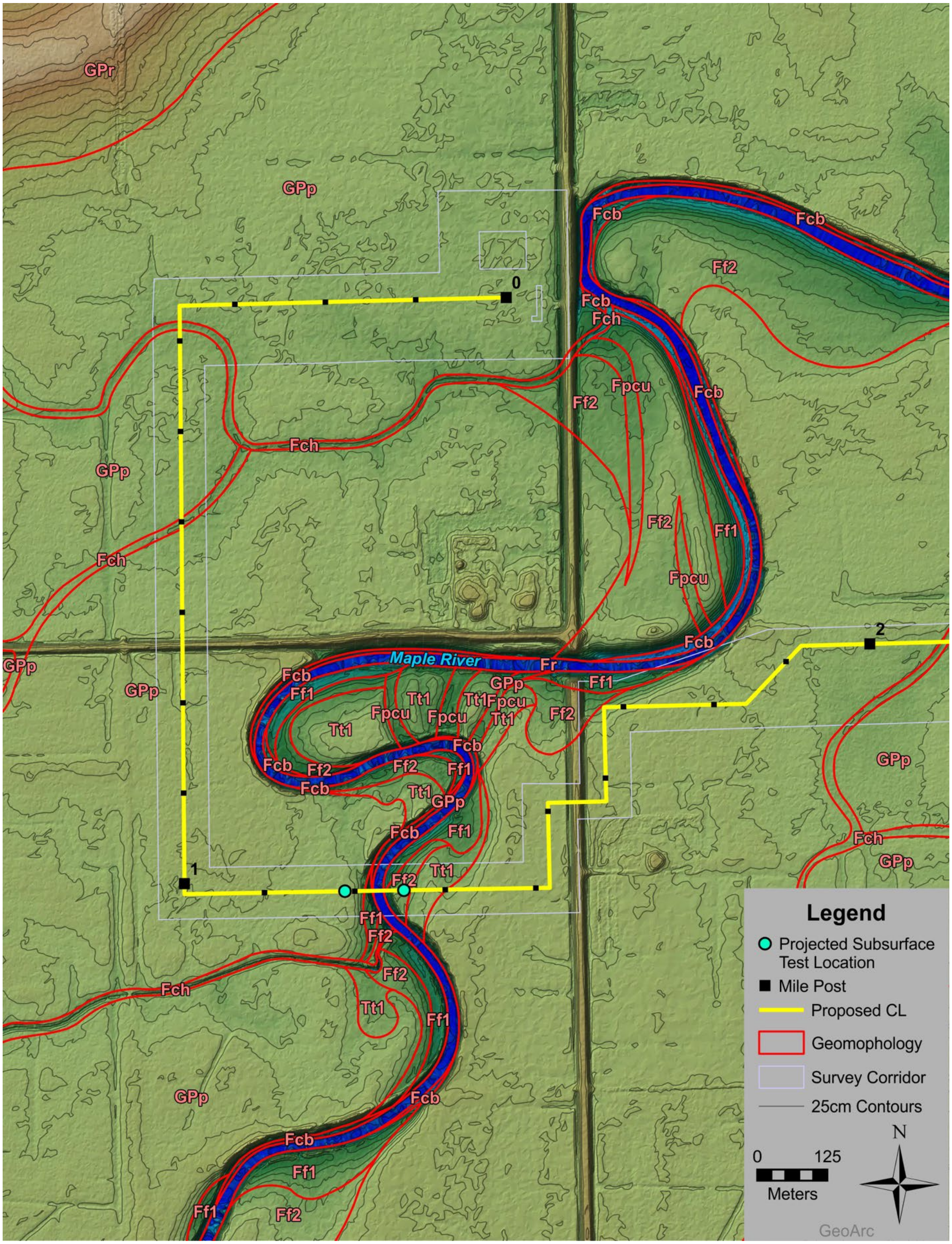

Figure 2. Geomorphology and projected subsurface test locations, pDTL-01.

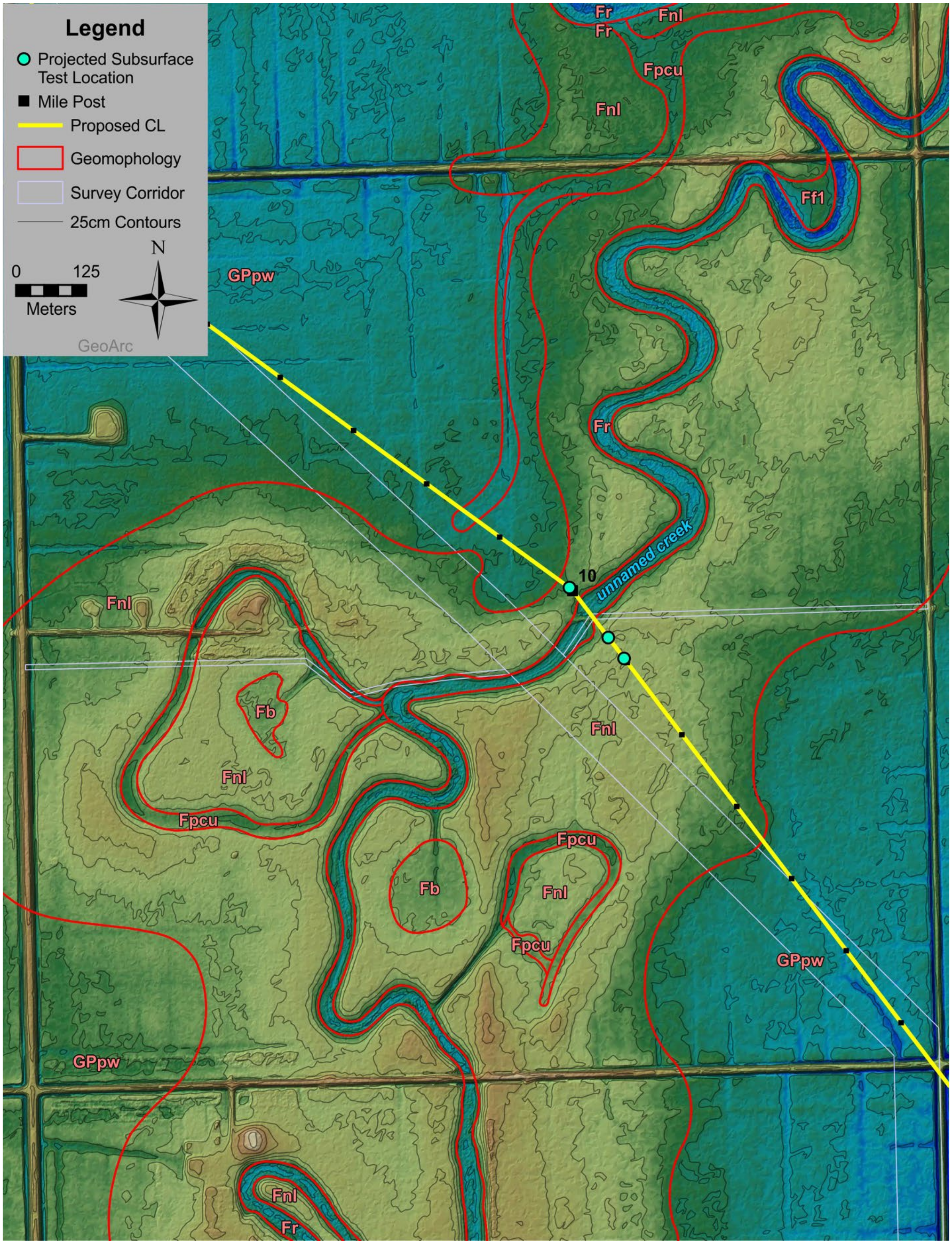

Figure 3. Geomorphology and projected subsurface test locations, pDTL-02.

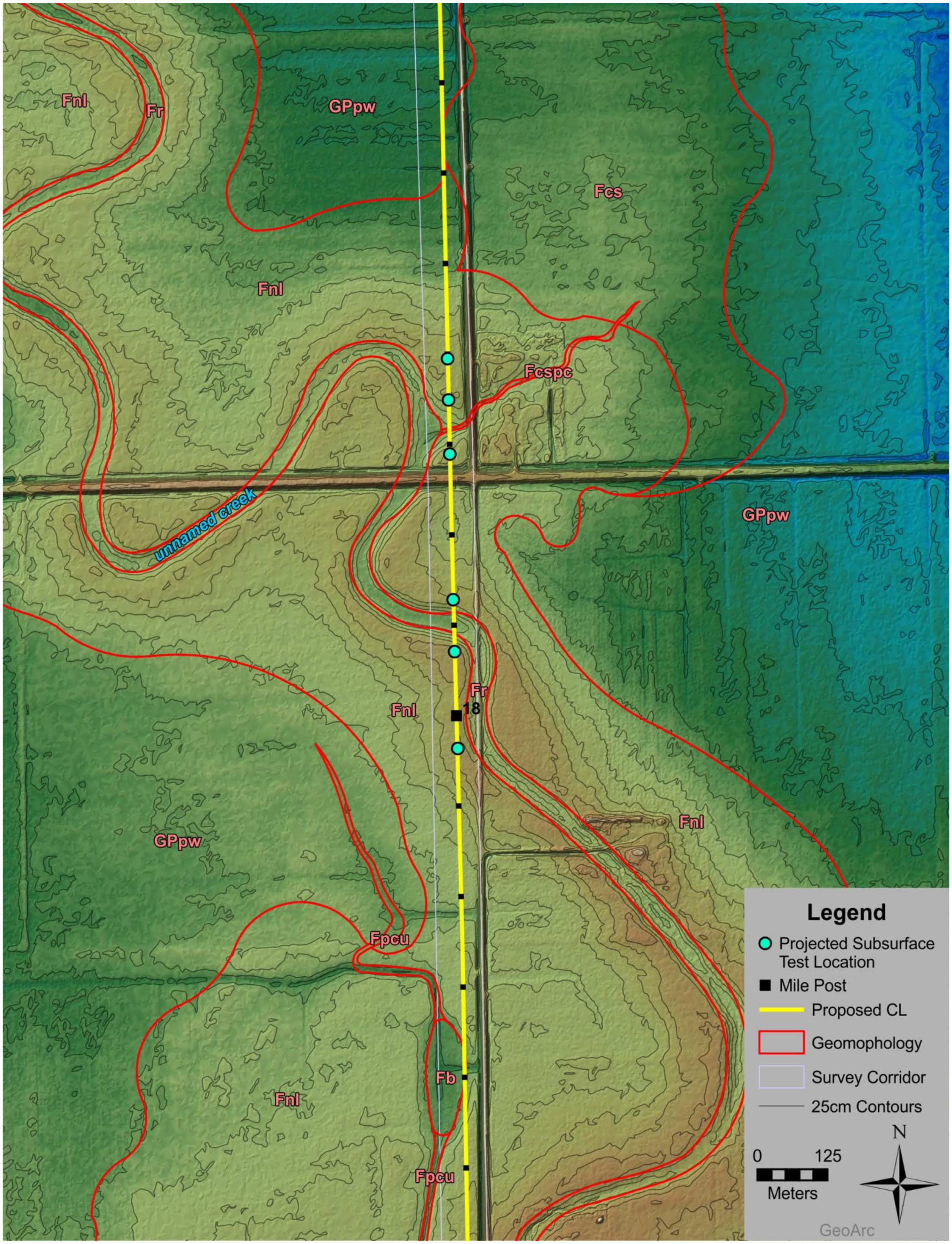

Figure 4. Geomorphology and projected subsurface test locations, pDTL-03.

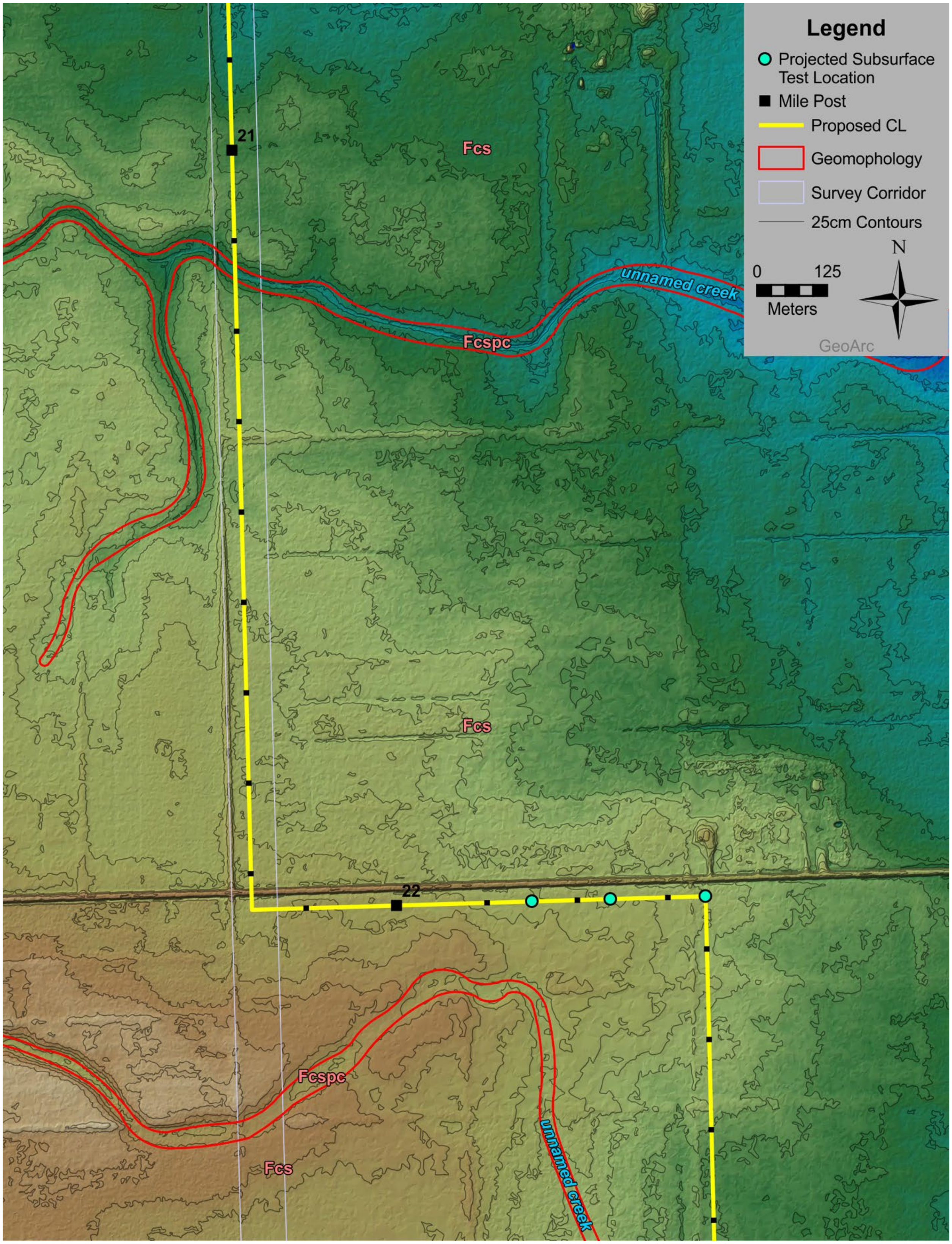

Figure 5. Geomorphology and projected subsurface test locations, pDTL-04.

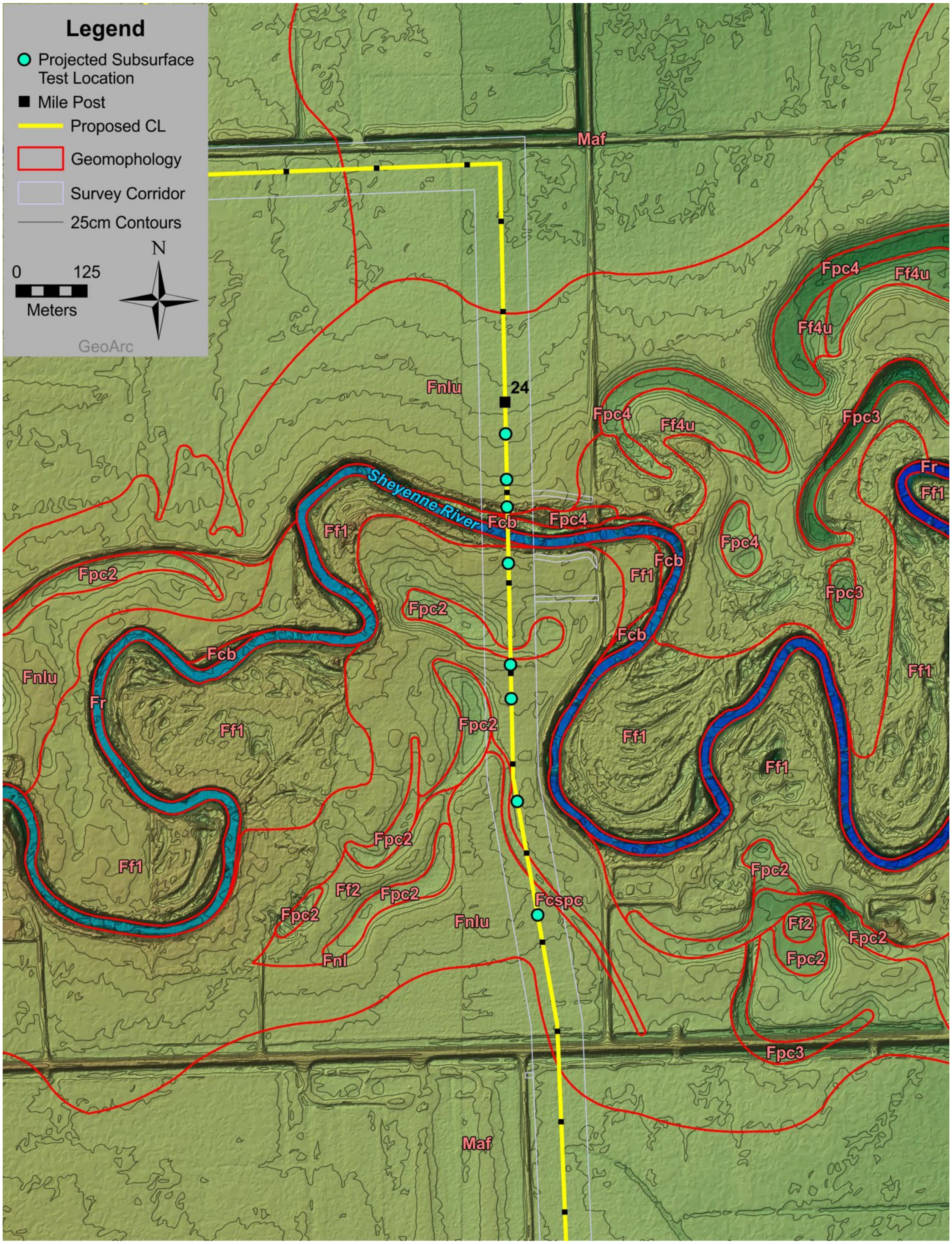

Figure 6. Geomorphology and projected subsurface test locations, pDTL-05.

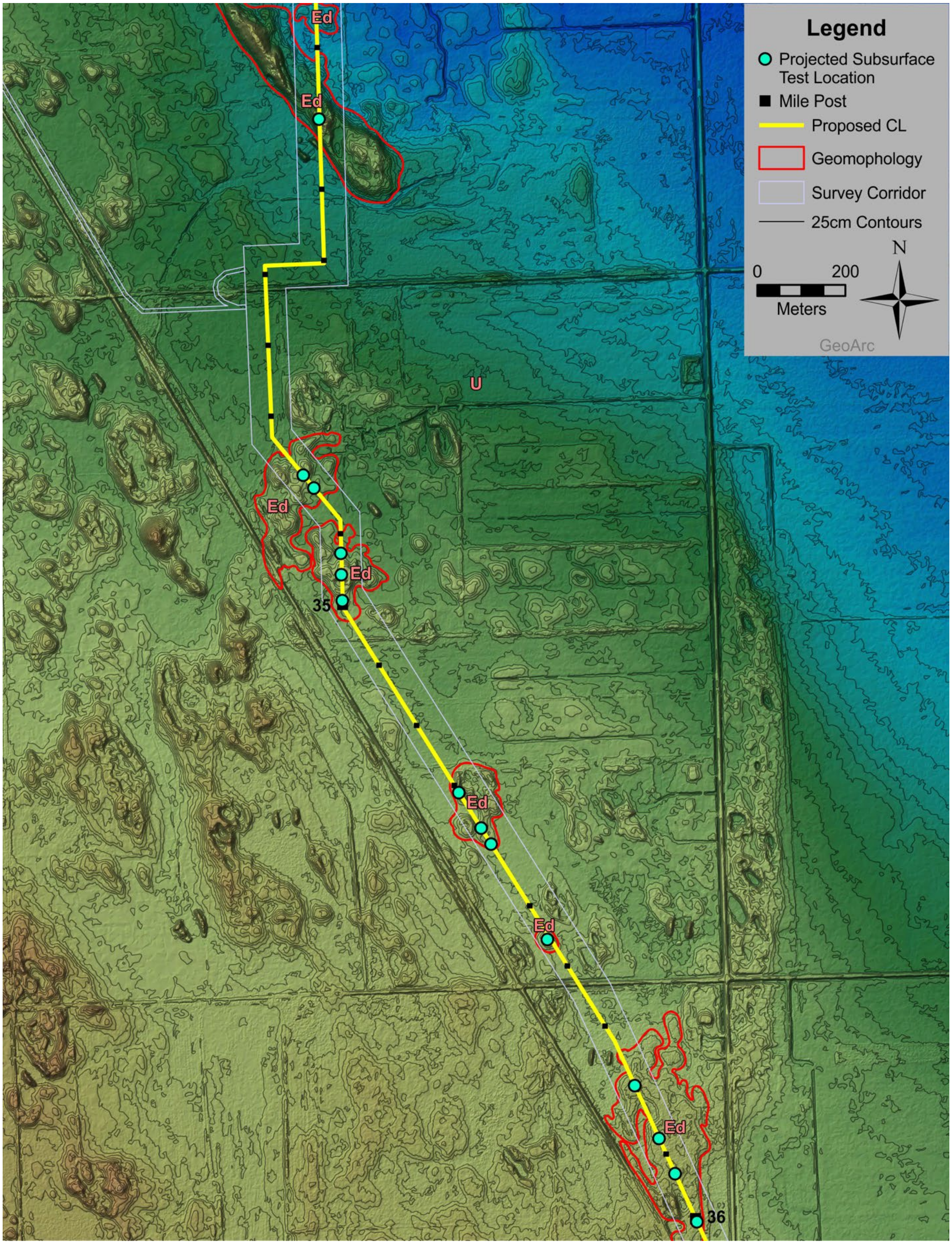

Figure 7. Geomorphology and projected subsurface test locations, pDTL-06.

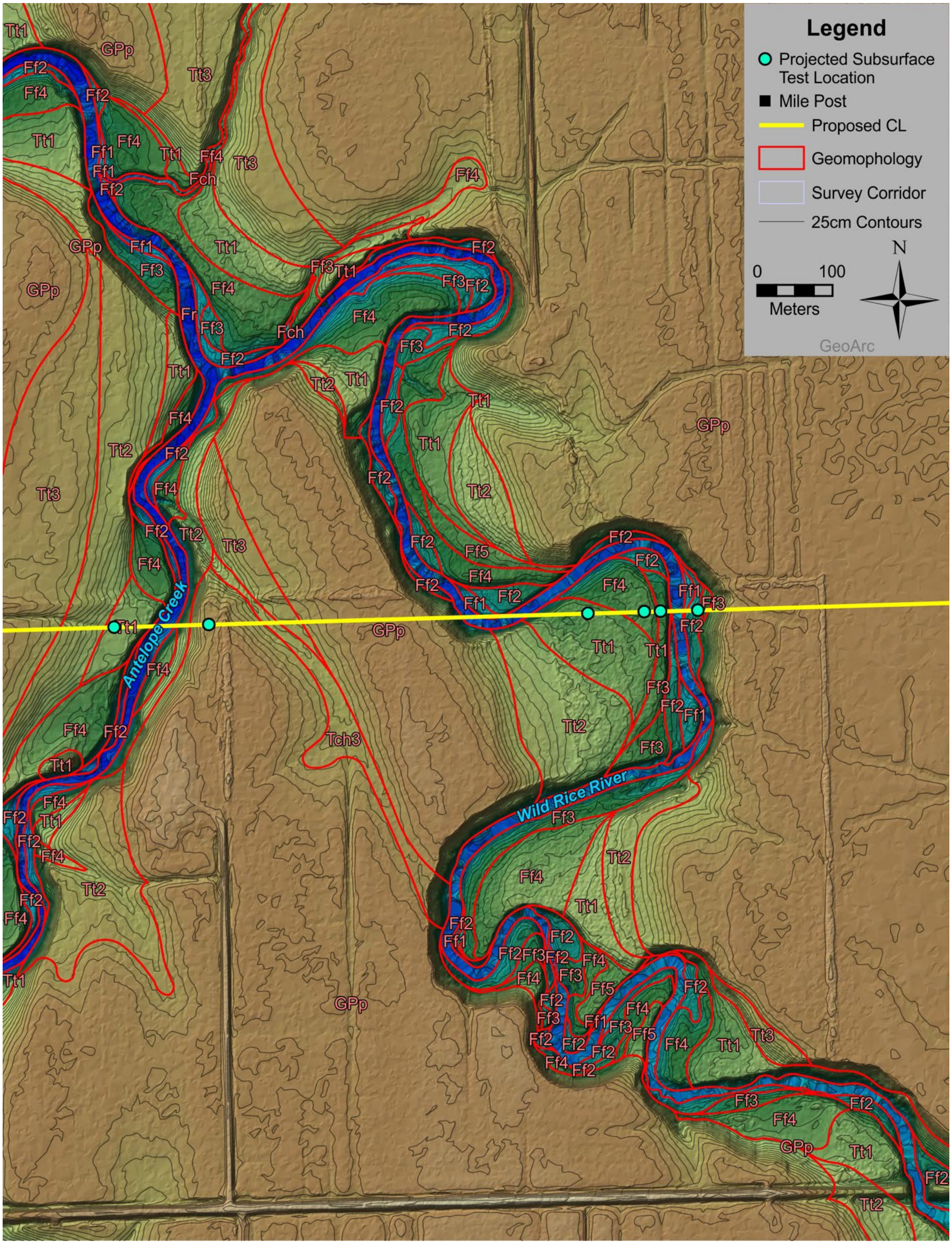

Figure 8. Geomorphology and projected subsurface test locations, pDTL-07.

PHASE 1 GEOMORPHOLOGICAL DESKTOP ASSESSMENT
OF GEOLOGICAL POTENTIAL FOR
BURIED PREHISTORIC CULTURAL DEPOSITS
ALONG THE WAHPETON EXPANSION PIPELINE CORRIDOR,
SOUTHEAST NORTH DAKOTA

Prepared For

ERM
Environmental Resources Management Group Inc.

3300 Breckinridge Blvd., Suite 300
Duluth, GA 30096

Prepared By

Edwin R. Hajic, PhD, PG

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31 August 2022

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Edwin R. Hajic
GeoArc®
GeoArc Research, Inc.

INTRODUCTION

Background

On behalf of their client WBI Energy Transmission, Inc. (WBI Energy), Environmental Resources Management (ERM) is performing a Phase 1 cultural resource survey of their Wahpeton Expansion Project (Project), a proposed pipeline corridor. WBI Energy proposes to construct a 97.3-km-long (60.5 mile-long) pipeline between an existing compressor station about 10.8 km (6.7 mi) west of the west side of Fargo, North Dakota, south-southeast to a delivery point about 5.7 km (3.5 mi) west of the Red River, the boundary between North Dakota and Minnesota (Figure 1). In terms of physiography, the Project crosses a section of the southwest end of the Glacial Lake Agassiz basin in Cass and Richland Counties, North Dakota (Figure 1).

North Dakota SHPO Guidelines Manual for Cultural Resource Inventory Projects (State of North Dakota, 2020) includes provisions for specialist studies as needed to conduct archaeological surveys in a thorough manner. ERM contracted GeoArc Research, Inc. (GeoArc) to conduct a Phase 1a desktop assessment of the geomorphology of the Project route specifically to assess the geological potential for deeply buried prehistoric cultural deposits along the Project. The purpose of the assessment is to evaluate near - surface geological contexts and, if present, identify for deep geoarchaeological testing specific locations that have a moderate to high geological potential for hosting buried intact cultural deposits of pre-Euroamerican settlement age that could be impacted by construction of the proposed Project.

General Physiography, Quaternary Geology and Geomorphology

The Project crosses very low relief landscapes within the southwestern part of the Glacial Lake Agassiz Plain (Figure 1). The Lake Agassiz Plain is a huge north-south oriented basin originally sculpted by the Des Moines Lobe of glacial ice that advanced southward through the project vicinity from the southwest margin of the Laurentide Ice Sheet. The Des Moines Lobe entered Iowa shortly before about 15,000 ^{14}Carbon years before present (^{14}C yrBP). At the maximum extent, the Des Moines Lobe reached central Iowa about 13,800 ^{14}C yrBP (Bettis et al., 1996). Multiple surging advances to progressively more northern positions into southwest Minnesota were each followed by stagnation and wastage (Kemmis, 1981; 1991). The Big Stone Moraine in southwest Minnesota was a local part of the continental drainage divide at the south end of the Lake Agassiz basin. At this position, the transition from glacial to glaciolacustrine environment occurred between about 12,140 and 11,800 ^{14}C yrBP, establishing the earliest manifestation of

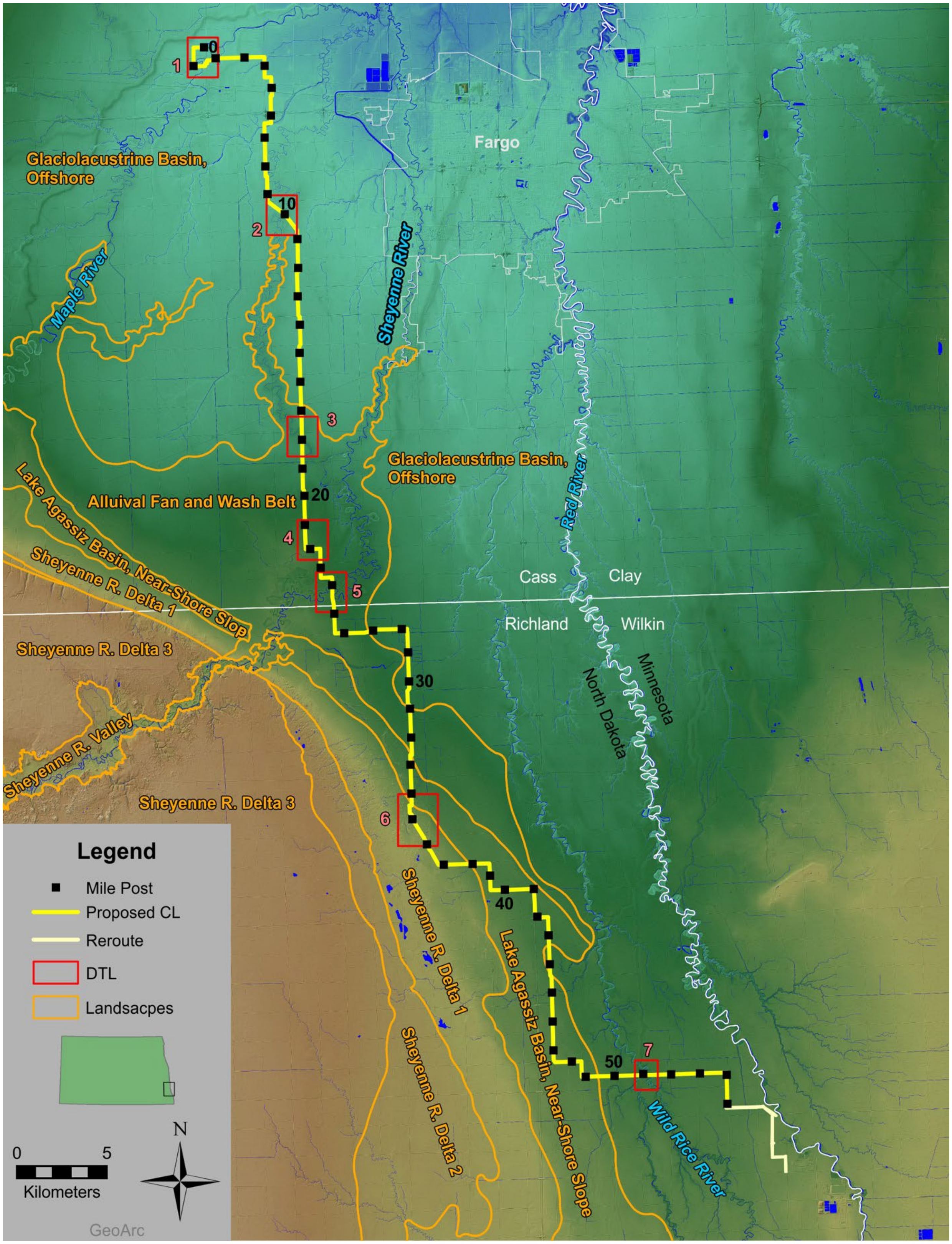

Figure 1. Project pipeline centerline, macro-geomorphology and potential deep test locations. (pDTLs) on the Lake Agassiz Glaciolacustrine Plain, on a color shaded relief digital elevation model, southeast North Dakota.

glacial Lake Agassiz in the basin (Clayton and Moran, 1982; Teller and Clayton, 1983; Lepper et al., 2007).

Morphology of the plain resulted from Glacial Lake Agassiz, an extremely large and deep proglacial lake that occupied the basin between about 11,800 and 9200 ^{14}C yrBP. Lake Agassiz was a massive inland lake during Paleoindian occupation of the continent. The latter age represents abandonment of the southern outlet (down the Minnesota River Valley) for lower outlets to the northeast for the final time (Fisher, 2005). Given the size of the basin, lacustrine depositional environments were dominated by nearshore shallow water and offshore deep-water conditions (Harris, 2007). More important to the archaeology of the basin were the more spatially discrete shoreline depositional environments marked by various forms of beach ridges, often with back-beach basins, and deltaic depositional environments where rivers and creeks entered the lake (Lepper et al, 2011).

During its existence, lake level fluctuated, sometimes rapidly and greatly, as it was controlled largely by opening and closing of northern and northeastern outlets as the ice front advanced or retreated and the region underwent isostatic rebound with retreat of glacial ice. Sill elevation at the southern outlet that at times routed lake water down the Minnesota River Valley was also a controlling factor during closure of lower more northerly outlets (Thorleifson, 1992; Fisher et al., 2008). The fluctuations in lake level through time resulted in spatial shifts in shorelines, depositional environments and depositional foci. Among the archaeologically significant results of this, in general to the basin, are multiple beach ridges across a range of elevations; very deeply buried alluvial deposits of the Poplar River Formation deposited during a period when Lake Agassiz was drained at least to the international border (Harris et al., 1995); river valley reaches with different ages; and, relict deltaic or fan deltaic distributary channels. Depositional environments with a high and / or moderate geological potential are represented within each of these groups of landforms.

During the prolonged very low stand of Lake Agassiz, higher parts of the basin were subaerially exposed. Rivers coursed down and incised the exposed lake plain. Alluvium of the Poplar River Formation deposited during the low stand is of appropriate age to host buried Paleoindian cultural deposits. Alluvial depositional environments at least in part would have been conducive to burial and preservation of any such cultural deposits. Subsequent transgression of the lake and lacustrine sedimentation has buried the Poplar River Formation, for the most part deeply below depths of concern in pipeline trenching.

Beach ridges and associated foreshore, slopes, and back-beach swales with or without intermittent drainageways occur in the shallow water facies part of the Lake Agassiz plain. In some landform positions, these environments have a high and/or moderate geological potential for hosting buried cultural deposits. Natural Resources Conservation Service (NRCS) mapping of the Hecla loamy fine sand with a recognized buried soil supports this potential. Although the beach ridge itself is often considered to fall on the low end of this spectrum, the Hecla series is sometimes mapped on the ridges as well as in back-beach basins. Entrainment and local redeposition of beach sand also can lead to burial of cultural deposits in this environment. Beach ridges were not recognized in the geomorphological assessment of the Project. However, it is possible that the margin of the Sheyenne River Delta (see below) could have been wave-modified.

During and following final drainage of Glacial Lake Agassiz, the Maple River and Sheyenne River deposited significant alluvial fans beyond the Sheyenne River Delta (Figure 1). Earliest increments of associated sediment assemblages may have accumulated in a fan-deltaic, or even deltaic environment. Paleomeander and active meander belts of main river courses, as well as relict potential distributary courses flanked by natural levees, deposited secondary fan lobes, often elongated, with some extending well beyond main fan limits. In addition to the fans and natural levees, crevasse splays and associated channels are common features. These alluvial deposits tend to have a greater silt content than the silty clay of the glaciolacustrine deposits. The contrast stands out on the main fan bodies, but the influence becomes less obvious with distance into the basin. Nevertheless, subtle changes in described soil textures can reflect the influence of post-lake alluvial contributions of silt into the upper parts of soil profiles in these more distal positions.

Farther into the basin, these and other valleys, such as that of the Wild Rice River, become progressively more deeply incised into the glaciolacustrine plain with distance from fan edges, although overall still relatively shallowly incised. Within these shallow valleys of both active and relict courses, creek and river channels are largely meandering; youngest channel belts, if present, are narrow and discontinuous; floodplains and terraces, if present, are subtly multi-story, with some indications (via NRCS mapped soil series) of one or more buried soils; and, natural levees diminish and give way to very thin overwash on the glaciolacustrine plain with distance from fan edges. Within adjacent sub-basins, mostly atrophied paleochannel courses are few.

Both ends of the Project cross the Lake Agassiz Basin where relief is extremely low in what was an offshore position (Figure 1). In between, as the Project corridor angles toward the southeast in Richland County, it just skirts the northeastern edge of a massive relict delta that resulted from potentially catastrophic deglacial discharge down the Sheyenne River Valley into Glacial Lake Agassiz. The highest, oldest and most expansive surface of the delta (Figure 1, Sheyenne R. Delta 3) is relatively level and of very low relief. The outer edge of the delta is characterized by a series of broad, shallow steps that descend gently to moderately sloping risers on the order of a couple of meters high and less toward the lake basin. Two of these, defined by some of the taller risers (Figure 1, Sheyenne R. Delta 2, 1), are mapped, but additional steps are present and unmapped. The Project corridor ascends and descends the lower of these surfaces between about MPs 34.2 and 37.8, respectively. They may have been modified by post-delta shoreline processes during certain higher stands or the final lowering of Lake Agassiz. The Project crosses this surface between about MP 34.5 and 36 where dunes occur discontinuously. The lowest surface above the glaciolacustrine basin, the near-shore slope, gently slopes to the east-northeast along the Project crossing.

Beyond the lower steps of the Sheyenne River Delta and near-shore slope of the basin in Richland County, to the southeast, the Project crosses at about MP 51 Antelope Creek immediately upvalley of its confluence with Wild Rice River (Figure 1). In this position, both meandering water courses and associated landforms are incised into the glaciolacustrine plain.

Geological Potential for Intact Buried Pre-Euroamerican Cultural Deposits

Given this landscape and its geological history and ages, buried, intact, prehistoric cultural deposits along the Project, if present, would likely be limited to alluvial sediment assemblages atop the glaciolacustrine plain that post-date final lake drainage. This would include within incised valley segments as well as atop the low relief plain itself. The sandy aeolian sediment assemblages that form scattered to few short continuous lines of low dunes on the eastern margin of the Sheyenne River Delta also are possible hosts to buried cultural deposits.

In the Holocene alluvial environment of the Sheyenne River, the greatest geological potential for intact burial and preservation of cultural deposits of pre-Euroamerican age is where the Project crosses natural levee, crevasse splay, alluvial fan, and floodplain and terrace overbank sediment assemblages, with or without terrace veneers. Within paleomeander belts, deposits of the point bar bar-top depositional environment also are of concern, whereas underlying point bar sand, if present, was deposited by traction currents in a subaqueous environment and are unlikely to contain intact buried cultural deposits. Similarly, the paleogeomorphic surface of the glaciolacustrine plain was buried beneath these sediment assemblages to a depth greater than the depth of shovel testing would be of concern, but not the underlying glaciolacustrine deposits.

Farther into the basin, where water courses such as the Maple River, Wild Rice River, and its tributary Antelope Creek are incised more deeply (yet still relatively shallowly) into the glaciolacustrine plain, there are sediment assemblages with similar geological potential. Water courses are more confined, and actively incising. As a result, floodplains and terraces with fine grain alluvial sediment assemblages usually occur at multiple levels, again with or without younger veneers. Natural levees, however, are very limited or absent and crevasse splays are absent.

METHODS

Desktop Assessment of Geological Potential

The desktop assessment of the Project for the geological potential for buried pre-Euroamerican contact cultural deposits consists of several steps at different levels of examination. Initially, a literature review was conducted for relevant information about the landscape setting, age and late Pleistocene and Holocene history of landscape evolution, that together have a foremost bearing on the geological potential.

GIS layers obtained and/or developed and utilized in the assessment are listed in Table 1. With these resources for reference, location of the Project corridor was systematically examined and evaluated for type and distribution of landscapes and landforms, likely underlying materials, and apparent soil-geomorphic relationships to the extent possible with the generalized NRCS soil mapping, ultimately to interpret likely depositional environments and their extents. Versions of color shaded relief digital elevation models (DEMs) served as proxies for interpreting glaciolacustrine basin landforms of intermediate to fine scale, and LiDAR-derived DEMs and 0.25 m contours provided more detail to interpret landforms at pDTL locations. All DEM background imagery utilize a vertical exaggeration of 3x. Notes were entered into a log and pegged to centerline milepost intervals (MPs) (Appendix A).

Table 1. Project GIS layers developed or acquired for and utilized in evaluation of geological potential.

Layer	Date	Comments
Cass and Richland County Soil Maps	various	Two shape files, from USDA NRCS SSURGO program.
Potential Deep Test Location (pDTL) ratio polygons	2021	Shape file developed for Project.
Detailed landform geomorphology maps for DTLs	2021	Shape file developed for Project; based on interpretations from LiDAR-derived DEMS and contour lines, and aerial imagery.
Landscape geomorphology	2021	Shape file developed for Project; based on interpretations from LiDAR-derived DEMS and contour lines, and NED 3 m relief & hydrology.
Project route and reroute center lines, mileposts, and archaeological survey corridors	2021, 2022	Three groups of shape files provided by ERM for original route and two reroutes. (Mileposts not provided for latest reroute.)
NED 30-cm contours	2021	Shape file developed for Project; based on NED 3 m relief.
LiDAR 25-cm contours	2021	Shape file developed for Project covering pDTLs; based on LiDAR point cloud data
North Dakota Counties 1:24,000 topographic maps	2021 various	ND DOT DRG mosaic covering the extent of the Project and adjacent areas; developed for the Project; based on USGS Digital Raster Graphics of 7.5’ quadrangles.
LiDAR color shaded relief DEMs	2021	Five shaded relief color DEMs; based on LiDAR point cloud data.
Black and white aerial imagery mosaics		Five orthorectified and georeferenced DOQ mosaic image files developed from USGS NAPP black and white imagery.
Color shaded relief digital elevation model	2021	Image file developed for Project; based on National Elevation Dataset (NED) 1/3 arc-second and 1/9 arc-second.
Color shaded relief digital elevation model	2021	Image file developed for Project; based on SRTM 60 m relief.
Two color shaded relief digital elevation models	2021	Two image files developed for Project; based on 3DEP10m relief and hydrology
Color aerial imagery	2018	USDA NAIP color imagery.

As part of the evaluation, official NRCS soil information was entered into a spreadsheet for easy reference, profile comparison and likely genetic grouping. Their spatial distributions were examined relative to the different landforms of the glaciolacustrine plain in the GIS along the Project and beyond. Mapped soils were also examined particularly for any noted buried soils and other clues pertaining to landscape evolution and depositional environments. In general, NRCS descriptions of soil series can be important for textural information, and thus potentially provide some general clues to underlying landform sediment assemblages, as well as the thinking at the time of original mapping about the soil parent material origin. They are, however, not a reliable basis for identifying or describing the project area landforms, stratigraphy or detailed sedimentology. The original NRCS soil mapping was conducted for reasons and at scales far different from the specific and detailed needs of archaeologists and geoarchaeologists. Aerial photo map bases utilized for mapping at the time were rarely orthorectified or georeferenced, so positioning of intended boundaries must be considered generalized at best. For example, in pDTLs for this project, NRCS mapping of river channels are consistently shifted to the east of the actual river channel location. The aforementioned differences need to be respected; nothing beyond NRCS soil series texture, other lab data, and horizonation at the series type location should be taken at face value for archaeological or geoarchaeological assessment.

RESULTS

Lake Agassiz Glaciolacustrine Plain

Except for alluvial courses, narrow valleys, basin margin alluvial fans and compression ridges, the glaciolacustrine plain in the Project area is nearly featureless along the Project route (Figure 1; Appendix A). The plain does have some local basins in places that exhibit relief on the order of up to 20-30 centimeters. Alluvial fan and crevasse splay limits locally in part define limits of such basins. Sediment assemblages underlying the general plain consist of glaciolacustrine silty clay and silty clay loam.

Mapped soils on the plain where unmodified by alluvial activity are described as having formed in silty clay and silty clay loam glaciolacustrine sediments. Fargo silty clay is the most commonly mapped soil series, but Hegne, Kindred, Bearden and Lindaas are also mapped on the plain (Appendix A). Isolated intermittent water courses and atrophied low-order paleochannels are sometimes mapped with the Dovray silty clay. In subtle depressional areas, A horizons of some of these series can be over-thickened by up to about 30%, or on the order of about seven centimeters. Compression ridges often are mapped with the Beardon silty clay loam.

This glaciolacustrine sediment body represents a depositional environment highly favorable for the burial and preservation of any discarded artifacts. However, while these deposits have the potential to host significant artifacts, such as canoes, these would be extremely rare. Historically, such finds have been encountered only through happenstance. Thus, no pDTLs covering the glaciolacustrine depositional environment were defined for more detailed assessment.

Alluvial Valleys, Related Overwash and Soil Geomorphology

Following final drainage of Lake Agassiz, rivers and creeks that fed into the lake now make their way across the glaciolacustrine plain, with waters ultimately joining the Red River to flow northward into Canada. These water courses locally include the Maple, Sheyenne and Wild Rice Rivers, and Antelope Creek. The proposed Project crosses these streams, some relict courses of these streams, as well a few unnamed creeks (Figure 1).

Alluvial landforms recorded in detailed geomorphic mapping of these streams and related features where the Project crosses them reflect that a range of alluvial depositional environments are represented (Table 2). Among them, natural levee, crevasse splay, alluvial fan, floodplain and terrace (and any associated veneers) are of particular interest because they have components of their sediment assemblages that were deposited by settlement from suspension, overland sheetflood and other low-energy depositional processes conducive to burial and preservation of cultural deposits.

NRCS-mapped soils only crudely reflect the differentiation of alluvial landforms of water courses on, or very slightly cut into, the plain, from the glaciolacustrine basin beyond, whereas somewhat more deeply incised valleys make such distinctions more obvious. Overly and Bearden series, with silty clay loam and silt loam textures that reflect a greater silt content than the underlying glaciolacustrine sediment, are often associated with proximal and medial natural levee positions and thin overwash onto the plain. The Wahpeton silty clay to silty clay loam is mapped on floodplains and terraces, with silt content tending to be higher in entrenched and less basin-ward positions of streams. This soil is significant in that it can have at least two buried soils within the upper 1.5 m (5.0 ft). In some cases, the lower, or lone, buried soil may represent the original glaciolacustrine plane.

Soil textures have a greater silt content on the Sheyenne River alluvial fan, and the channel belts that cross it. Along the relict paleomeander belt, Overly-Bearden silt loams are generally mapped on proximal to medial natural levees on the medial and distal fan, and along crevasse splay paleochannels on the medial fan. Distal natural levee flanks, as well as some crevasse splay lobes, with silty clay loam textures, are mapped with Kindred-Bearden and Fargo series. Other, presumably thinner, crevasse splay lobes are mapped with the Fargo-Hegne, or Fargo, silty clay series.

On the proximal alluvial fan, where there is semblance of a valley inset into the fan, proximal to medial natural levees are mapped with the LaDelle silty clay loam, and more discontinuously in proximal positions, Fairdale silt loam series. In more distal positions, thin crevasse splays and the fan surface are mapped with Fargo silty clay loam and silty clay series. The LaDelle series has a buried soil at its type location at a depth of 0.9-1.1 m (2.9-3.6 ft). The Fairdale series also has a buried soil, but the depth at the series type location is deeper, at 1.2-1.7 m (4.0-5.6 ft), than the buried soil found within the LaDelle series. Incidentally, depths of buried soils can vary greatly from those at the type location, and it is likely that at least some of the Fairdale mapping is in sediment of post-Euroamerican settlement age. In these cases, the buried soil likely is the pre-Euroamerican settlement soil. Within the Sheyenne River valley on the proximal fan, mapped soils of the floodplain that do not discriminate the array of landforms present are mostly the LaDelle and Fairdale series.

Table 2. Summary of geomorphology map units in the vicinity of subsurface testing.

Landscapes	Landform Label [1]	Landform Description
Floodplain		
	Fr	river or creek channel
	Fb	flood basin
	Fcb	channel belt
	Fch	small channel or paleochannel; often inherited
	Fnl	natural levee
	Fnlu	Natural levee, undifferentiated
	Fcs	crevasse splay
	Fcspc	crevasse splay paleochannel
	Ff1	floodplain, youngest
	Ff2	floodplain, next-to-youngest
	Ff3	floodplain, second next-to-youngest
	Ff4	floodplain, third next-to-youngest
	Ff4u	Floodplain, third next-to-youngest undiff.
	Ff5	floodplain, forth next-to-youngest
	Fpc2	paleochannel, next-to-youngest
	Fpc3	paleochannel, second next-to-youngest
	Fpc4	paleochannel, third next-to-youngest
	Fpcu	paleochannel, undifferentiated
Terrace		
	Tt1	terrace, youngest
	Tt2	terrace, next-to-youngest
	Tt3	terrace, second next-to-youngest
Valley Margin		
	Maf	alluvial or fluvial fan (Sheyenne R.)
Glaciolacustrine Plain		
	GPp	plain
	GPpw	plain, with overwash veneer
	GPr	compression ridge
Aeolian		
	Ed	aeolian dune

1. Capital letter refers to landscape. lower case letters following a capital letter refer to landforms. Numbers and following lower case letter, if present, reflect relative age relationships internal to each DTL only. Numbers increase and letters progress with increasing relative age.

On the proximal alluvial fan, where there is semblance of a valley inset into the fan, proximal to medial natural levees are mapped with the LaDelle silty clay loam, and more discontinuously in proximal positions, Fairdale silt loam series. In more distal positions, thin crevasse splays and the fan surface are mapped with Fargo silty clay loam and silty clay series. The LaDelle series has a buried soil at its type location at a depth of 0.9-1.1 m (2.9-3.6 ft). The Fairdale series also has a buried soil, but the depth at the series type location is deeper, at 1.2-1.7 m (4.0-5.6 ft), than the buried soil found within the LaDelle series. Incidentally, depths of buried soils can vary greatly from those at the type location, and it is likely that at least some of the Fairdale mapping is in sediment of post-Euroamerican settlement age. In these cases, the buried soil likely is the pre-Euroamerican settlement soil. Within the Sheyenne River valley on the proximal fan, mapped soils of the floodplain that do not discriminate the array of landforms present are mostly the LaDelle and Fairdale series.

To the southeast, well beyond the Sheyenne River alluvial fan, where the Project crosses valleys incised into the glaciofluvial plain, rivers and creeks are meandering, with multiple (subtle) floodplain and terraces levels. The highest terraces are mapped with the same soil series as the surrounding offshore glaciolacustrine plain, suggesting they are terraces cut into the glaciolacustrine sediments with little, if any alluvial mantle. Inset into the higher terrace levels, however, floodplain levels and lower terrace levels are mapped with the Fairdale silt loam and LaDelle silty clay loam series. Buried soils are likely present at highly variable depths.

Alluvial Depositional Environment Potential Deep Test Locations

Seven potential deep test locations (pDTLs) were identified where the Project crosses an area interpreted to have a moderate to high geological potential for hosting buried cultural deposits, and thus targeted for further consideration (Figure 1). pDTLs are numbered from north to south-southeast. Six pDTLs have alluvial landform sediment assemblages, associated with one of the rivers or creeks that post-date final drainage of Lake Agassiz, that are likely to have untested components deeper than the depth of shovel testing. The water course crossings, however, vary in character depending on position within the glaciolacustrine basin landscape. The seventh pDTL is a location with aeolian dunes. The pDTL figures that follow have DEM bases, upon which geomorphic mapping was conducted, that have a vertical exaggeration of 3x. For the most part then, some of the mapped distinctions as viewed on the landscape are very subtle.

The northwestern-most pDTL-01 is located over the Maple River where it is slightly incised into an offshore part of the glaciolacustrine plain (Figure 1). It is situated about 30.0 km (18.6 mi) as the crow flies northeast of the head of its related alluvial fan at the northeastern limit of the main level (3) of the Sheyenne River Delta. Furthermore, ERM documented substantial archaeological deposits at prehistoric site 32CS4676 less than 225 meters to the north from pDTL-01 within a bend of the Maple River.

pDTL-02 and -03 are located over a paleomeander belt of the Sheyenne River which the Project crosses in two locations (Figure 1). The paleomeander belt most likely represents a former course of the Sheyenne River. Alternatively, it could represent a substantial relict distributary of the Sheyenne River alluvial fan. An unnamed creek that originates within the upper reach of the meandering paleochannel currently occupies this former course. pDTL-2 and -03 are about 22.9 km (14.2 mi) and 10.5 km (6.5 mi), respectively, north of where the Sheyenne River fan abuts the near-shore slope of the Lake Agassiz basin margin. This places pDTL-02 well beyond the alluvial fan limits, and pDTL-03 on the distal fan position.

To the south, pDTL-04 covers what is mapped as the eastern flank of a massive relict crevasse splay of the Sheyenne River in the medial alluvial fan position (Figure 1). It is located about 5.2 km (3.2 mi) north of the Sheyenne River Delta front. pDTL-05 overlies the active Sheyenne River meander belt where parts of at least four related paleomeander belts flank the active meander belt, which through time visually exhibit first decreases, then increases, in meander wavelength and amplitude. This location on the proximal fan is about 4.0 km (2.5 mi) northeast of the near-shore slope.

pDTL-06 covers parts of the lowest level of the Sheyenne River Delta (1) and a small part of the near-shore slope of the Lake Agassiz basin where there is field of discontinuous aeolian dunes (Figure 1).

pDTL-07 lies about 32 km (19.9 mi) to the south-southeast of pDTL-05, and only about 2.7 km (1.7 mi) east of the Lake Agassiz Basin near-shore slope margin (Figure 1). Here, the Project crosses both the Wild Rice River and its tributary, Antelope Creek, just above their confluence. In this location, the stream valleys are incised into the offshore glaciolacustrine plain landscape.

pDTL-01

In this position the, the Maple River (Fr) exhibits a meandering pattern where it flows within a narrow channel belt (Fcb) inset only slightly into the glaciolacustrine plain (GPp) (Figure 2). It flows between two semi-parallel compression ridges (GPr), each captured in opposing corners of the pDTL. Relatively small, discontinuous remnants of two floodplain levels (Ff1, Ff2) are preserved within meander bends of the river. The lowest (Ff1) floodplain level is inset into the glaciofluvial plain on the order of about 1.0 m (3.3 ft). The next higher alluvial surface is mapped as a low terrace (Tt1); discontinuous remnants typically larger than the floodplain remnants are preserved on the insides of meander arcs and abut the glaciofluvial plain where they are inset on the order of 0.5 m (1.6 ft).

The Project crosses the Maple River heading eastward where the river is nearly against the western valley wall (Figure 2). A sliver of the lowest floodplain (Ff1) lies between the river cutbank and the western valley wall. Soil mapping suggests the possibility of a thin (< 0.5 m [1.6 ft]) veneer of overwash on the plain to the immediate west only. East of the river, the Project ascends to cross a high floodplain (Ff2) remnant. Based on NRCS soil mapping of the Wahpeton silty clay loam soil series, there could be a buried soil in the associated Ff2 sediment assemblage. The Project then ascends slightly more to a terrace (Tt1) remnant that apparently has been cut into the glaciolacustrine clay before heading onto the glaciolacustrine plain.

pDTL-02

The paleomeander channel (Fr) of the Sheyenne River at this location (Figure 3), inherited by an unnamed creek, exhibits a large sinuosity with cut-off paleomeanders (Fpcu), all flanked with natural levees (Fnl) that rise on the order of 1.3-1.5 m (4.3-4.9 ft) above the glaciolacustrine plain (GPpw). Several localized minor flood basins (Fb) occur within the natural levees as a result of the relationships of the main channel to older cutoff meander levees. Only the main paleomeander channel (Fr) is inset into the plain, and then only on the order of 0.3 m (1.0 ft). There is only one small segment of floodplain (Ff1) on the inside of one meander (Figure 3); it is likely related to activity of the inheritor stream. Essentially the glaciolacustrine plain functioned as the main floodplain when the Sheyenne River occupied the channel.

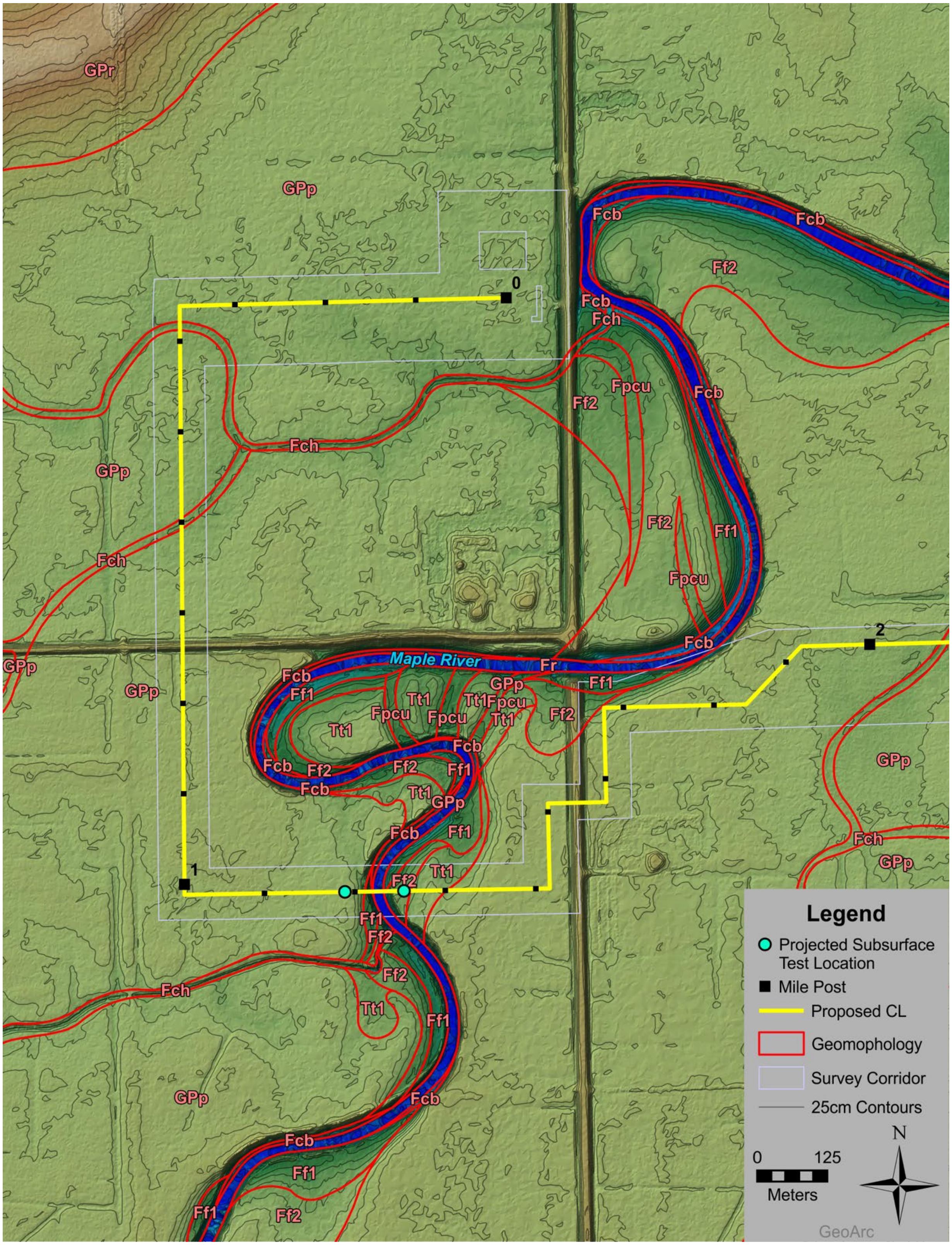

Figure 2. Project pipeline centerline, work corridor and geomorphology at the Maple River Valley crossing (pDTL-01), on a LiDAR-based color shaded relief digital elevation model with 0.25 m contours.

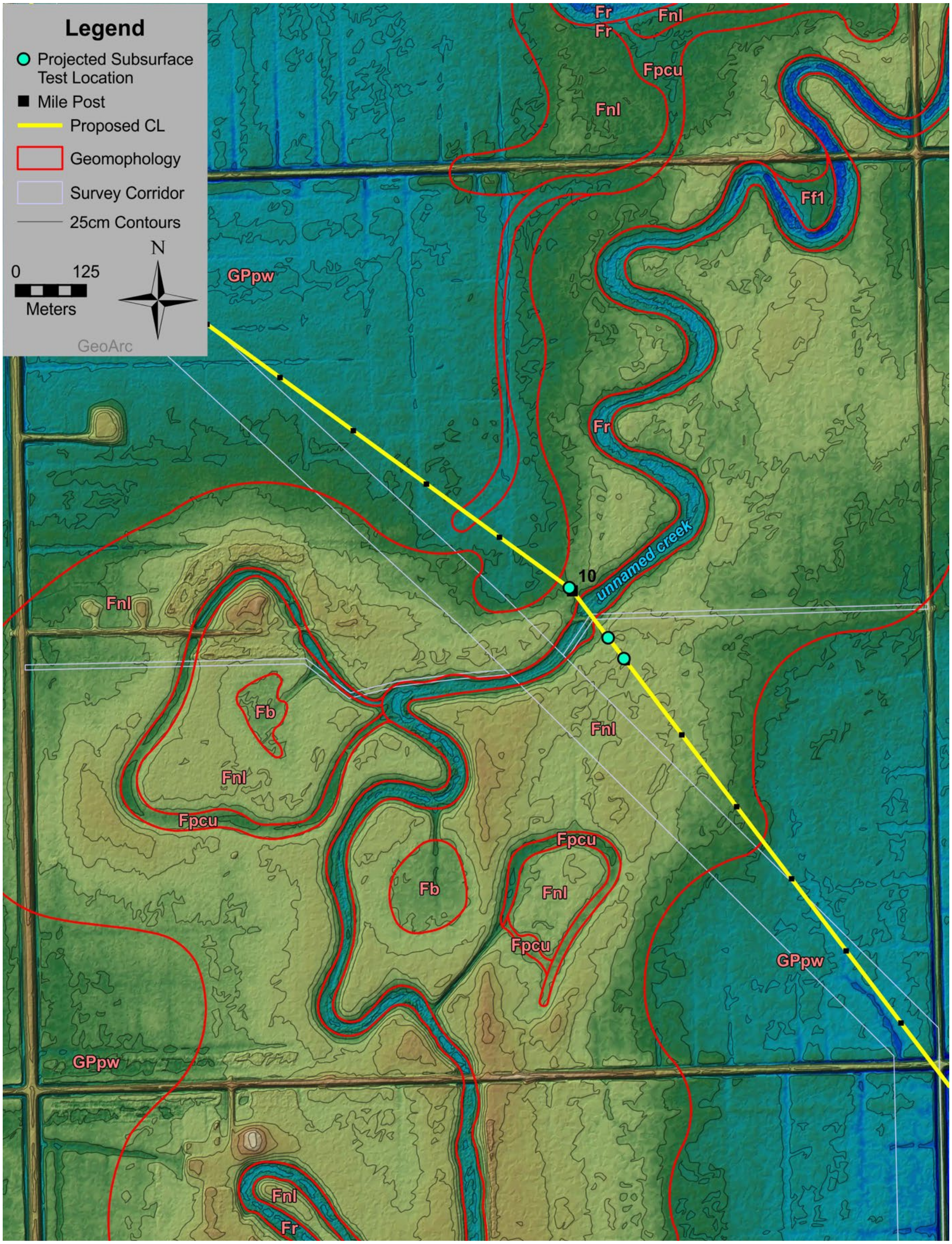

Figure 3. Project pipeline centerline, work corridor and geomorphology at Sheyenne River paleochannel belt crossing 1 (pDTL-02), on a LiDAR-based color shaded relief digital elevation model with 0.25 m contours.

The Project crosses the paleomeander channel (Fr) on the NW-SE diagonal where the northwest flanking levee is relatively narrow and less than 0.9 m (3.0 ft) thick. The southeast flanking levee is considerably broader, but with only a slightly greater thickness range (1.2 m [3.9 ft]). Its breadth is comparatively augmented because an older course of the Sheyenne River deposited the southeastern-most two-thirds or more of the levee at this location. Overly – Bearden silt loams are mapped on the thicker and younger parts of the natural levee, whereas the Fargo series is mapped where it has a silty clay loam texture in the more distal position where presumably it has a somewhat older base.

pDTL-03

As at the previous pDTL-02, pDTL-03 has a similar paleomeander channel (Fr) with a set of flanking natural levees (Fnl) that are deposited on the glaciolacustrine plain (GPpw) (Figure 4). Levees rise above the plain on the order of up to 1.5 m (4.9 ft). A floodplain is lacking between the levees as the plain must have served that function. East of the channel, a crevasse splay paleochannel channel (Fcspc) leads eastward through the natural levee (Fnl) to a crevasse splay (Fcs), also deposited on the plain. In the southwestern part of pDTL-03, there is a low, broad natural levee west of the natural levee adjacent to the channel. An atrophied paleochannel (Fpcu), with a single elongated smaller basin (Fb), likely part of the paleochannel, lies between the two natural levees.

The Project crosses this pDTL north to south, running along a considerable length of first the eastern levee where it is relatively thick, then along the western natural levee where it is thick, then thins considerable, and finally thickens again toward the southern limit of the pDTL (Figure 4). Overly-Bearden soils are mapped on the main part of the levees, with the Fargo series, both silty clay loam and silty clay, on more distal, thinner parts of the levee.

pDTL-04

In the medial alluvial fan position, pDTL-04 encompasses two narrow relict paleochannels (Figure 5). The southern, more prominent, of the two is interpreted as a massive crevasse splay (Fcs) and associated paleochannel(s) (Fcspc). Given their setting on the fan, however, it could represent a failed attempt at Sheyenne River avulsion. In either case, the paleochannel (Fcspc) lies atop a linear rise that it deposited, with slopes descending at first away from the paleochannel, and then with distance from the source, in the direction of paleochannel orientation. Minimally, the rise upon which the paleochannel runs is 2.5 m (8.2 ft) above the glaciolacustrine plain. Some of this thickness at depth may represent the underlying alluvial fan sediment assemblage. The northern paleochannel is probably older, and seemingly coalesces two crevasse splay paleochannels into one. Beyond the DTL to the east, this paleochannel joined a Sheyenne River paleochannel east of the pDTL that flowed northward.

The Project enters pDTL-04 from the north, crosses the northern paleochannel (Fcspc), angles due eastward far enough to avoid the southern paleochannel (Fcspc), then turns to continue southward. In so doing, it avoids some areas of the thickest combined crevasse splay and underlying alluvial fan sediment assemblages, although throughout pDTL-04, the sediment cover atop the glaciolacustrine plain is likely thicker than the depth of shovel testing. At its thickest point where crossed, located at the eastern end of the west-east leg, the crevasse splay (Fcs, plus alluvial fan),

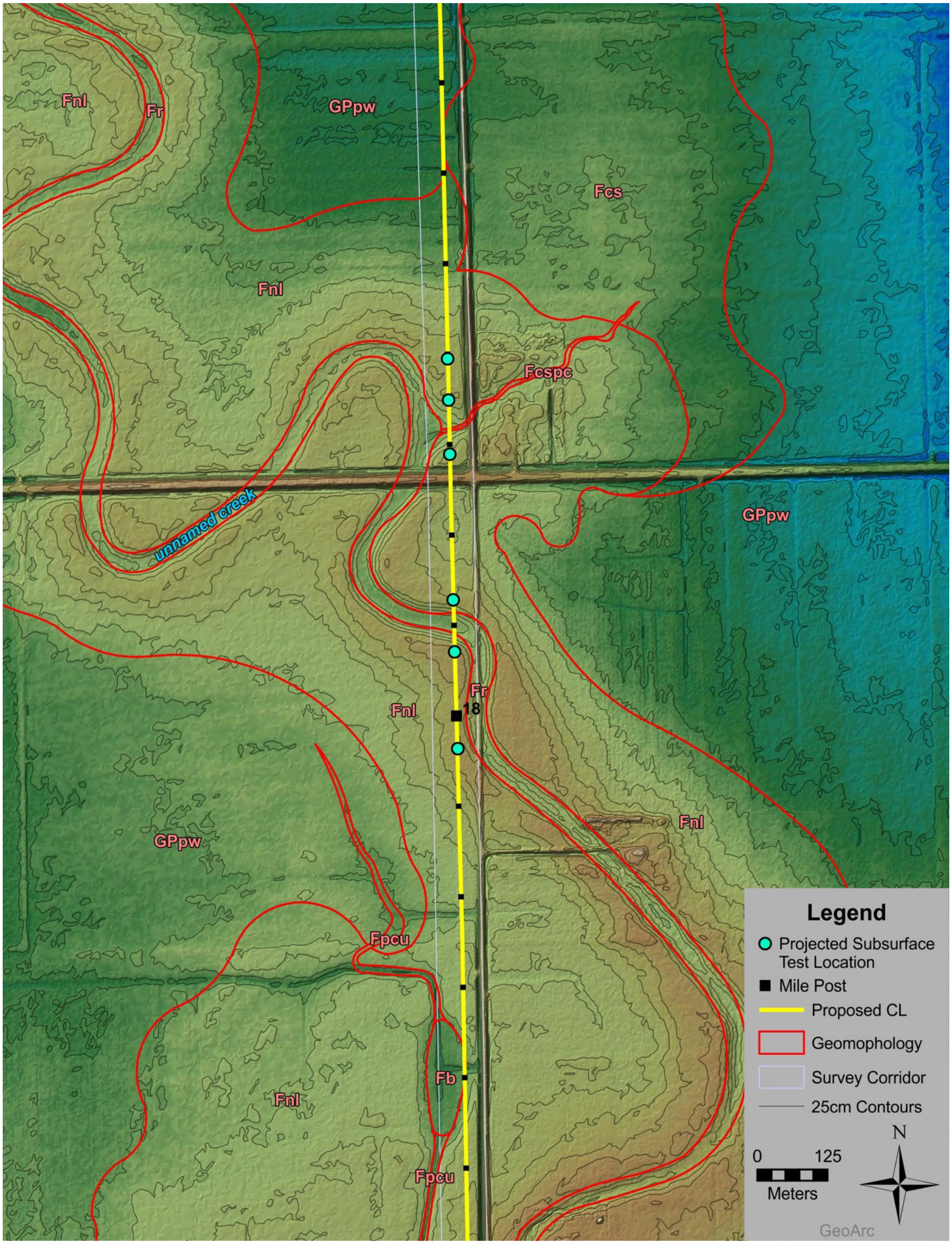

Figure 4. Project pipeline centerline, work corridor and geomorphology at Sheyenne River paleochannel belt crossing 2 (pDTL-03), on a LiDAR-based color shaded relief digital elevation model with 0.25 m contours.

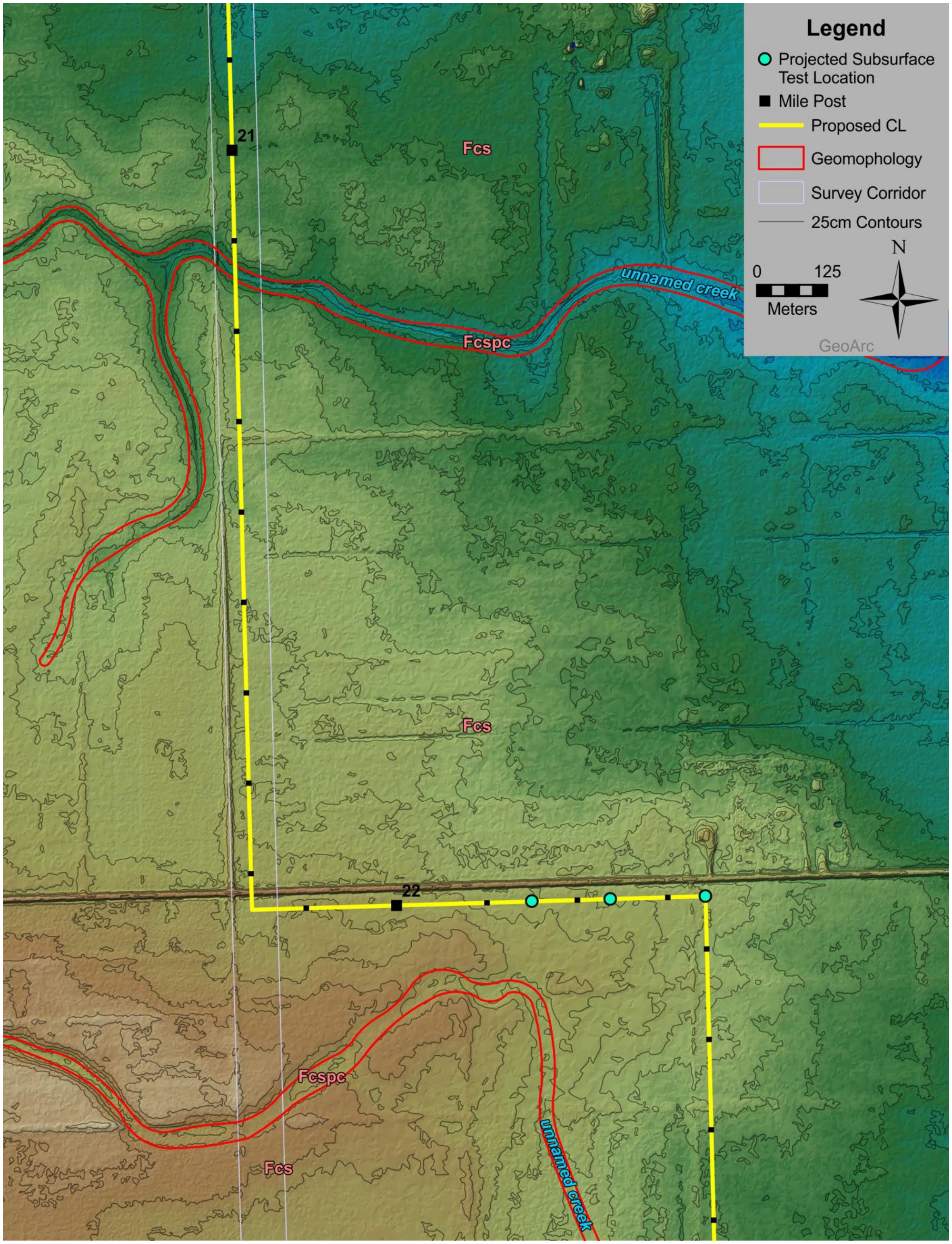

Figure 5. Project pipeline centerline, work corridor and geomorphology at crossings of crevasse splays of Sheyenne River paleochannel (pDTL-04), on a LiDAR-based color shaded relief digital elevation model with 0.25 m contours.

is minimally at least 1.5-1.8 m (4.9-5.9 ft) thick. In this location, mapped soils are the Overly-Bearden silt loams.

pDTL-05

pDTL-05 is where the Project crosses the modern Sheyenne River (Fr) and associated meander belts (Figure 6). In this proximal fan position, the channel is cut into its underlying fan (Maf) about 3.2 m (10.5 ft), but the nearby alluvial fan surface is about 2.2 m (7.2 ft) below the crest of a very low natural levee (Fnlu). Furthermore, there is less than about 0.7 m (2.3 ft) difference between the youngest floodplain level (Ff1) and the crests of the natural levee (Fnlu) immediately adjacent to the meander belts. Also, there is less than about 0.7 m (2.3 ft) difference among the various floodplain segments (Ff1, Ff2, Ff4). Effectively, this has been an aggrading system. The most recent and active channel belt (Fcb) consists of few very narrow segments within pDTL-05, but the youngest floodplain (Ff1) exhibits a youthful morphology with hints of underlying point bar ridge and swale morphology. Cutoff and partially infilled paleomeanders of at least three different paleochannel systems (Fpc2, Fpc3 and Fpc4) are common.

The Project enters pDTL-05 from the north to cross part of the crevasse splay upon which it left pDTL-04 to the north (Figure 6). It jogs to the east, then to the south where it crosses the Sheyenne River alluvial fan (Maf) and ascends the low natural levee north of the paleomeander belts. After crossing the active channel, the Project crosses various segments of low natural levees associated with a number of the abandoned paleochannel segments within the paleomeander belts. It then crosses a narrow crevasse splay paleochannel (with low natural levees) before continuing southward across the Sheyenne River fan.

pDTL-07

On the offshore glaciolacustrine plain (GPp) at pDTL-07, the Wild Rice River and its tributary, Antelope Creek, meander within valleys that incise the plain on the order of 4.0 m (13.1 ft), with channels (Fr) inset another 1.0 m (3.3 ft) or so (Figure 7). The Wild Rice River exhibits a moderately large sinuosity while Antelope Creek has a relatively moderate sinuosity. Because of the meandering, incised valley widths below terrace levels vary greatly. Five floodplain levels are mapped, and the youngest three occur in both valleys, but the oldest two are only mapped within the Wild Rice River valley. The lowest floodplain remnants (Ff1), which might also be considered as part of a narrow channel belt, rise on the order of 0.5-0.8 m (1.6-2.6 ft) above the channels. They are few in number and this low floodplain is highly discontinuous. Far more numerous but still discontinuous, remnants of next older low floodplain (Ff2) primarily occur on the insides of meanders, but there are a small number that occur on the outsides of meander bends as well. While still discontinuous, they are present within far more meander bends than not. They rise about 1.8 m (5.9 ft) above the creek channel. Remnants of the intermediate floodplain (Ff3) are limited to the Wild Rice River valley where they occur almost exclusively within the meander bends, thus discontinuously, usually as a relatively narrow bench cut into the next higher floodplain level. They rise on the order of 2.8 m (9.2 ft) above the channel. Relatively major areas within the meander bends are occupied with the high floodplain (Ff4). Remnants of this surface slope generally toward the water course. In general, they rise about 3.3 m (10.8 ft) and more above the channel. In the central to southern half of the Wild Rice River Valley only, there are three remnants of a still slightly higher floodplain (Ff5). These also slope very gently toward the creek.

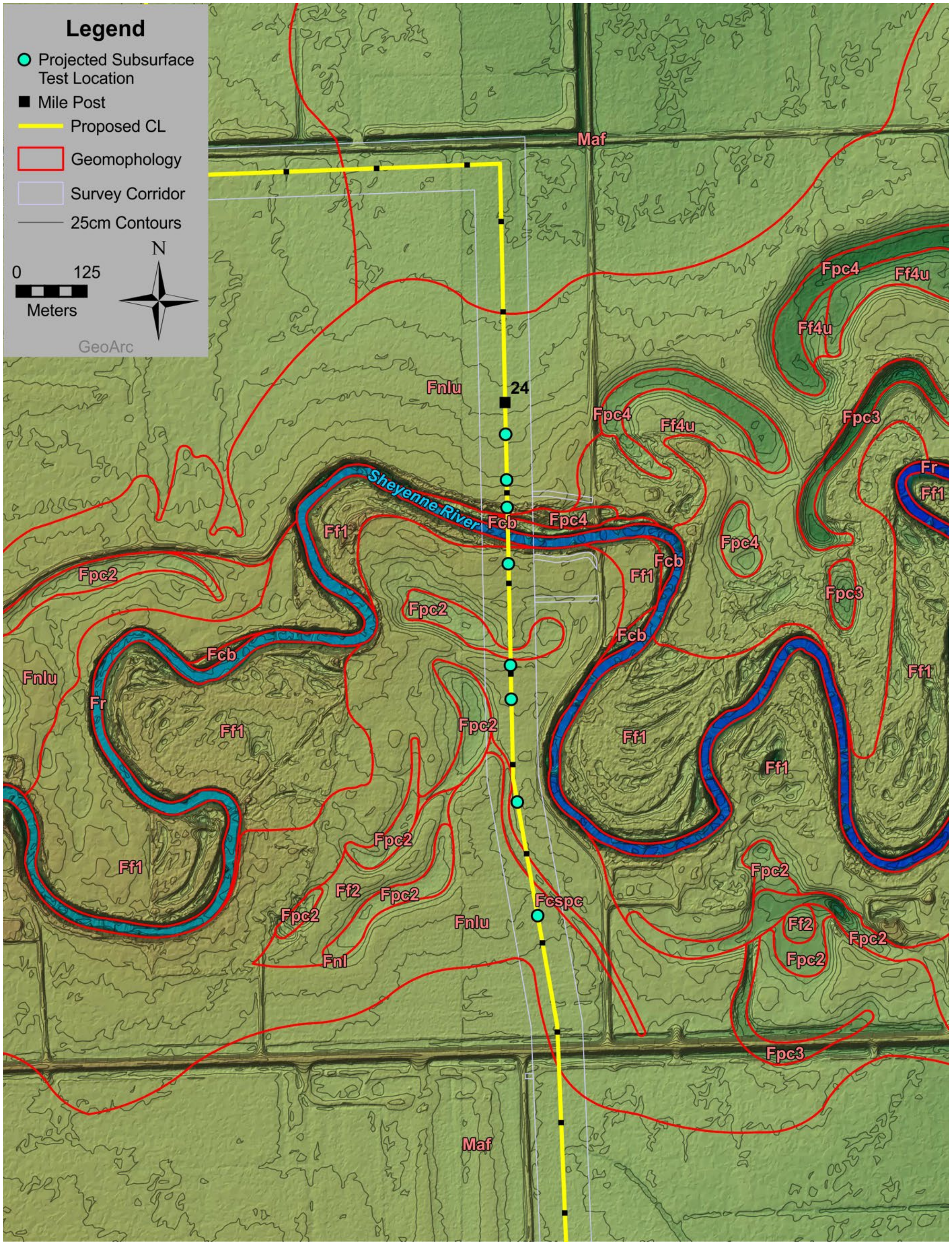

Figure 6. Project pipeline centerline, work corridor and geomorphology at Sheyenne River channel belt crossing (pDTL-05), on a LiDAR-based color shaded relief digital elevation model with 0.25 m contours.

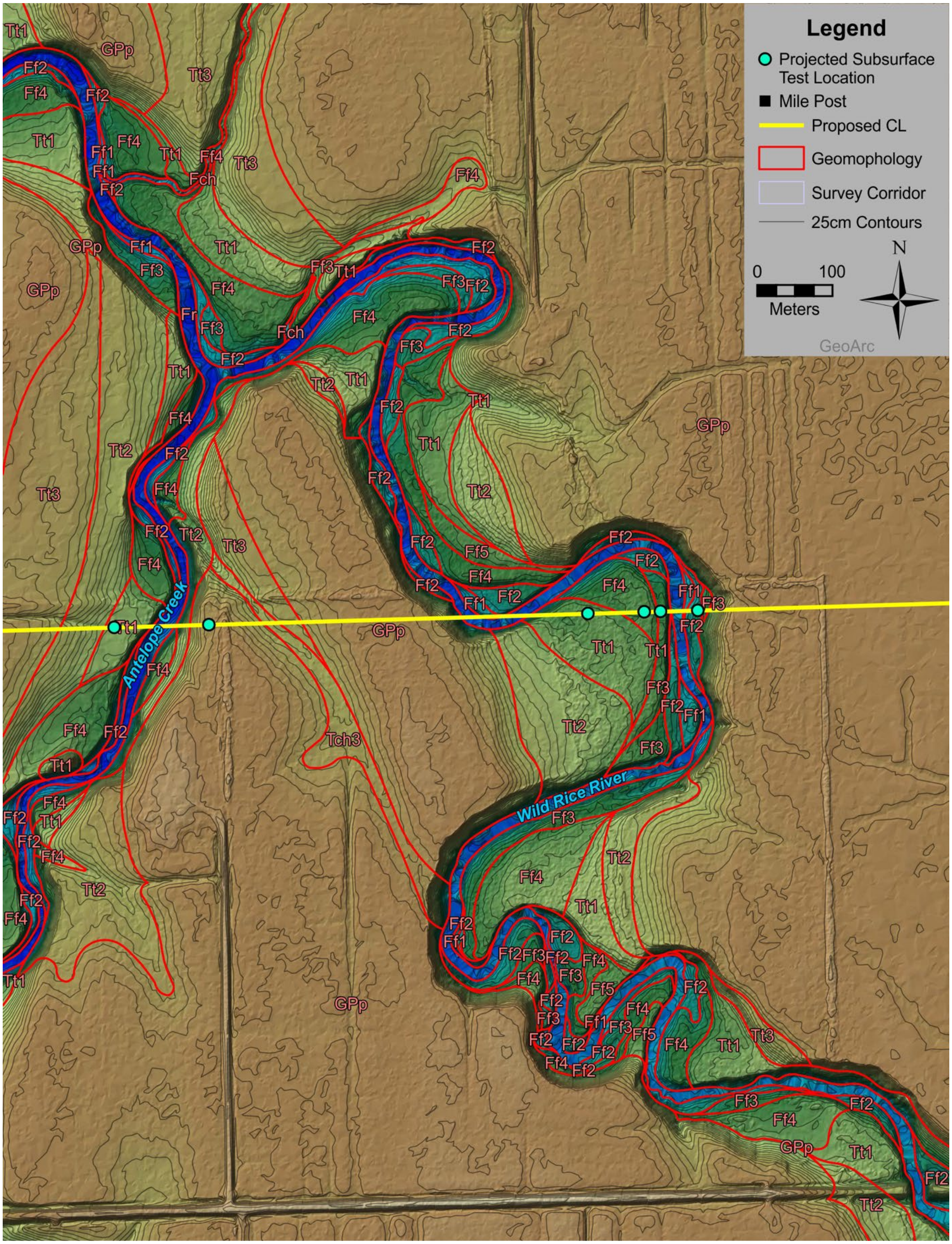

Figure 7. Project pipeline centerline, work corridor and geomorphology at Antelope Creek and Wild Rice River valley crossings (pDTL-07), on a LiDAR-based color shaded relief digital elevation model with 0.25 m contours.

Three terraces were mapped, with remnants of each terrace level preserved in both valleys (Figure 7). The low terrace (Tt1) is a major surface within the central to back parts of the area within meander bends. It is usually very gently sloping, but can approach a moderate slope when close to a steep slope developed in the glaciolacustrine plain sediment assemblage. The intermediate terrace (Tt2) is usually a moderately to somewhat steeply sloping surface where it most commonly fronts and abuts steep valley wall slopes developed in the glaciolacustrine plain sediment assemblage at the backs of the inside of meander bends. In two instances, Tt2 remnants directly front Tt3 terrace remnants. The high terrace remnants (Tt3) form very gently sloping benches that are shallowly cut into the glaciolacustrine plain (GPp) on the order of about 0.3-0.6 m (1.0-2.0 ft). In the area just above the confluence of the two valleys, there is a Wild Rice River paleochannel (Tch3) associated with one of these few high terrace remnants.

At pDTL-07, the Project approaches Antelope Creek Valley from the west and descends into it while crossing remnants of all three terrace levels (Tt1, Tt2, Tt3; Figure 7). On the other side of the creek, it ascends a relatively steep slope to the glaciolacustrine plain (GPp) where it forms a relatively narrow (300 m [980 ft]-wide) interfluve, diagonally bisected by a narrow and early paleochannel of the Wild Rice River (Tch3). The Project descends a steep slope into the Wild Rice River Valley where it immediately crosses the river on either side of a meander bend while just traversing the river-edge of the youngest floodplain (Ff1) within the bend. On the east side of the river, the Project ascends and crosses the inside of the next, much broader, meander upstream. Within this bend, the Project descends in a stepped manner from the low (Tt1) terrace, to the high (Ff4), then intermediate (Ff3) floodplain before crossing the river a third time at pDTL-07 (Figure 7). East of the river, the Project crosses the three youngest floodplain sequences, where the youngest (Ff1) and second-next-to youngest (Ff3) are extremely narrow, before ascending a steep slope out of the valley and back onto the glaciolacustrine plain (GPp).

APPENDIX A

LOG OF LANDSCAPES, LANDFORMS AND NRCS MAPPED SOILS ALONG THE WAHPETON EXPANSION PROJECT

Landscape / Landform	Mile Post Range	Mapped NRCS Soil Series [1]
Lake Agassiz Glaciolacustrine Plain		
Glaciolacustrine Plain, Offshore		
plain (GPp)	0.00 – 1.21	Fargo sicl; Fargo sic
floodplain (Ff1)	1.21 – 1.23	Wahpeton sic
Maple River (Fr)	1.23 – 1.24	water
plain (GPp)	1.24 – 2.08	Fargo sic
atrophied *Maple River* paleochannel (Fch)	2.08 – 2.09	Fargo sic
plain (GPp)	2.09 – 2.71	Hegne-Fargo sicl; Fargo sic;
compression ridge	2.71 – 2.88	Beardon sicl
plain	2.88 – 3.83	Fargo-Hegne sicl; Fargo sic; Bearden-Kindred sicl
intermittent water course in atrophied paleochannel	3.83 – 3.87	Bearden-Kindred sicl
plain	3.87 – 4.86	Bearden-Lindaas sicl; Fargo-Hegne sic
atrophied paleochannel	4.86 – 4.96	Dovray sic
plain	4.96 – 6.62	Bearden sicl; Fargo sicl, sic; Fargo-Hegne sic
intermittent water course in atrophied paleochannel	6.62 – 6.64	Dovray sic
plain	6.64 – 8.78	Fargo-Hegne sic; Fargo sic
paleomeander (2x) and relict natural levee (<0.6 m)	8.78 – 9.03	Overly-Bearden sil
plain (GPp)	9.03 – 9.98	Fargo sic
natural levee (<1.0 m) (Fnl)	9.98 – 10.01	Fargo sic; Overly-Bearden sil
unnamed low order watercourse in paleochannel (Fr)	10.01 – 10.04	Dovray sic
natural levee (<1.0 m) (Fnl)	10.04 – 10.35	Overly-Bearden sil; Fargo-Hegne sic; Fargo sicl
plain (GPp)	10.35 – 16.78	Fargo sicl, sic; Fargo-Hegne sic
Alluvial Fan and Wash Belt		
plain, with overwash veneer (GPpw), and possibly distal crevasse splay	16.78 – 17.23	Fargo sic; Hegne-Fargo sicl

plain, with overwash veneer (GPpw)	17.23 – 17.39	Kindred-Bearden sicl
natural levee (Fnl)	17.39 – 17.68	Kindred-Bearden sicl; Fargo sicl; Overly-Bearden sil
crevasse splay paleochannel (Fcspc)	17.68 – 17.69	Overly-Bearden sil
natural levee (Fnl)	17.69 – 17.89	Overly-Bearden sil
water course in atrophied paleochannel (Fr)	17.89 – 17.91	Overly-Bearden sil
natural levee (Fnl)	17.891– 18.83	Fargo sicl, sic; Fargo-Hegne sic

1. sic=silty clay; sicl=silty clay loam; sil=silt loam; scl=sandy clay loam; fsl=fine sandy loam; lfs=loamy fine sand; fs=fine sand

Landscape / Landform	Mile Post Range	Mapped NRCS Soil Series [1]
medial alluvial fan, undifferentiated	18.83 – 21.12	Fargo sicl, sic; Fargo-Hegne sic; Bearden-Kindred sicl; Kindred-Bearden sicl; Bearden sicl; Fargo sicl
undifferentiated relict crevasse splay paleochannel	21.12 – 21.14	Bearden sicl
crevasse splay	21.14 – 22.05	Hegne-Fargo sicl; Fargo sic; Kindred-Bearden sicl; Overly-Bearden sil
crevasse splay natural levee	22.05 – 22.53	Overly-Bearden sil
crevasse splay	22.53 – 22.68	Overly-Bearden sil
crevasse splay natural levee	22.68 – 23.10	Overly-Bearden sil; Fargo-Ryan thick solum
crevasse splay channel belt, distal	23.10 – 23.17	Fargo-Ryansic thick solum
crevasse splay	23.17 – 23.56	Fargo-Ryan sic thick solum
Sheyenne River alluvial fan (Maf)	23.56 – 23.90	Fargo-Ryan sic thick solum; Fargo-Ryan sic
Sheyenne River natural levee (Fnlu)	23.90 – 24.13	Fargo sicl (distal); LaDelle sicl (medial); Fairdale sil (proximal)
Sheyenne River (Fr), channel belt (Fcb), and floodplain (Ff1)	24.30 – 24.15	Fairdale sil - Fluvaquents
Sheyenne River natural levee (Fnlu)	24.15 – 24.27	Fairdale sil; LaDelle sicl
Sheyenne River paleochannel (Fpc2)	24.27 – 24.28	LaDelle sicl
Sheyenne River natural levee (Fnlu)	24.28 – 24.50	LaDelle sicl; Fairdale sil; Fargo sicl, sic
crevasse splay paleochannel (Fcspc)	24.50 – 24.53	Fargo sicl
Sheyenne River / crevasse splay natural levee (Fnlu)	24.53 – 24.71	Fargo sicl; sic
Cass / Richland County line	24.71	
Sheyenne River / crevasse splay natural levee (Fnlu)	24.71 – 24.73	Fargo sic
medial to distal alluvial fan, (Maf)	24.73 – 26.84	Fargo sic
Glaciolacustrine Plain, Offshore		
plain	26.84 – 30.98	Fargo sic

Alluvial Fan and Wash Belt		
distal to proximal slope	30.98 – 32.64	Fargo sicl, sic; Bearden sil; Overly sicl; Aberdeen-Ryan sicl
Glaciolacustrine Plain, Near-Shore Slope		
	32.64 – 34.35	Overly sicl; Hilaire-Espelie lfs; Galchutt-Wheatville sil; Fargo sic; Aberdeen fsl; Aylmer-Thiefriver – Serden complex

1. sic=silty clay; sicl=silty clay loam; sil=silt loam; scl=sandy clay loam; fsl=fine sandy loam; lfs=loamy fine sand; fs=fine sand

Landscape / Landform	Mile Post Range	Mapped NRCS Soil Series [1]
Sheyenne River Delta 1		
	34.35 – 37.90	Aberdeen fsl; Tiffany loam; Hilaire-Espelie lfs; Aylmer-Bantry fs; Thiefriver fsl; Maddock-Hilaire-Espelie lfs; Perella loam; Mantador-Delamere-Elmville fsl; Wheatville sil; Galchutt sil; Galchutt-Wheatville sil; Aberdeen-Galchutt-Fargo complex
Glaciolacustrine Plain, Near-Shore Slope		
	37.90 – 43.33	Aberdeen-Galchutt-Fargo complex; Bearden sil; Fargo-Enloe complex; Wheatville-Mantador-Delamere sil; Mantador-Delamere-Elmville loam; Ryan-Fargo sic; Wheatville sil
Glaciolacustrine Plain, Offshore		
plain	43.33 – 44.32	Ryan-Fargo sic; Aberdeen-Galchutt-Fargo complex; Fargo-Enloe complex
Glaciolacustrine Plain, Near-Shore Slope		
near-shore slope	44.32 – 44.94	Fargo-Enloe complex; Aberdeen-Galchutt-Fargo complex; Aberdeen-Ryan sicl
Pitcairn Creek	44.94 – 44.96	Overly-Nutley scl
near-shore slope	44.96 – 49.43	Overly sicl; Bearden sil; Aberdeen-Galchutt-Fargo complex; Gardena sil; Mantador-Delamere-Elmville

		loams; Galchutt-Wheatville sil; Fargo-Enloe complex
Glaciolacustrine Plain, Offshore	49.43 – 50.73	Aberdeen-Galchutt-Fargo complex; Fargo-Ryan sic, thick solum

1. sic=silty clay; sicl=silty clay loam; sil=silt loam; scl=sandy clay loam; fsl=fine sandy loam; lfs=loamy fine sand; fs=fine sand

Landscape / Landform	Mile Post Range [2]	Mapped NRCS Soil Series [1]
terrace flat (Tt3)	50.73 – 50.77	Fargo sic
terrace slope (Tt2&Tt3 slope)	50.77 – 50.83	Nutly-Fargo sic
high floodplain (Ff4)	50.83 – 50.85	LaDelle sicl
intermediate floodplain (Ff2)	50.85 – 50.86	Cashel - Fluvaquents
Antelope Creek	50.86 – 50.87	water
terrace slope and flat (Tt2)	50.87 – 50.89	Cashel – Fluvaquents (unlikely)
high paleochannel, undifferentiated	50.89 – 50.91	Fargo-Ryan sic, thick solum
terrace flat (Tt3)	50.91 – 50.94	Fargo sic
plain (GPp); valley wall scarp	50.94 – 51.05	Fargo sic; Cashel – Fluvaquents
Wild Rice River	51.05 – 51.06	Water
intermediate floodplain (Ff2)	51.06 – 51.07	Cashel-Fluvaquents
high floodplain (Ff4)	51.07 – 51.08	Wahpeton sic
high floodplain (Ff5)	51.08 – 51.11	Wahpeton sic
low terrace (Tt1)	51.11 – 51.12	Wahpeton sic
intermediate terrace (Tt2)	51.12 – 51.14	Wahpeton sic
plain (GPp)	51.14 – 51.47	Fargo sic; Fargo-Ryan sic, thick solum
plain (GPp), w/ few s-n oriented narrow paleochannels	51.47 – 54.22	Ryan-Fargo sic; Fargo sic; Dovray sic (local paleochannel, swale segments); Fargo-Ryan sic, thick solum; Fargo-Enloe complex (local)
distal crevasse splay	54.22 – 55.75	Fargo-Ryan sic, thick solum
plain (GPp)	55.75 – 56.67	Ryan-Fargo sic
plain (GPp) and upper valley sideslope	56.67 – 56.97	Fargo-Ryan sic, thick solum, Nutley-Fargo sic (upper valley slope and immediately adjacent plain)
low terrace (Tt1) and terrace scarp	56.97 – 56.99	Nutley-Fargo sic; Cashel-fluvaquents (terrace scarp)
Wild Rice River	56.99 – 57.01	Water

plain (GPp)	57.06 – 57.48	Nutley-Fargo sic (upper valley slope), Fargo-Ryan sic, thick solum
plain (GPp)	57.06 – 57.48	Nutley-Fargo sic (upper valley slope), Fargo-Ryan sic, thick solum
floodplain (Ff4)	57.48 – 57.53	Nutley-Fargo sic
floodplain (Ff3)	57.53 – 57.54	Wahpeton sic
floodplain (Ff3)	57.01 – 57.02	Cashel-fluvaquents (terrace scarp); Wahpeton sic (floodplain flat)
floodplain (Ff4)	57.02 – 57.06	Wahpeton sic

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2. Mileposts after 50.73 not precise due to two reroutes lacking mileposts.

Landscape / Landform	**Mile Post Range [2]**	**Mapped NRCS Soil Series [1]**
floodplain (Ff2)	57.54 – 57.56	Cashel-fluvaquents
Wild Rice River	57.56 – 57.57	Water
floodplain (Ff3)	57.57 – 57.58	Cashel-fluvaquents
plain (GPp), with ephemeral drainageway	57.58 – 57.91	Fargo sic; Fargo-Nutley sic (ephemeral drainage)
plain	57.91 – 58.52	Fargo sic; Fargo-Ryan sic, thick solum
low natural levee	58.52 – 58.63	Fargo sic
intermittent water course in atrophied paleochannel	58.63 – 58.64	Fargo sic
low natural levee	58.64 – 58.74	Fargo sic
plain	58.74 – 60.56	Fargo-Enloe complex sic; Fargo sic; Antler-Mustinka complex; Clearwater-Reis sic, loamy substratum; Doran cl

1. sic=silty clay; sicl=silty clay loam; sil=silt loam; scl=sandy clay loam; fsl=fine sandy loam; lfs=loamy fine sand; fs=fine sand
2. Mileposts after 50.73 not precise due to two reroutes lacking mileposts.