

SITE NUMBER AND NAME: NC111 – Hwy 16 Pembina River Bridge Erosion (BF75014)	HIGHWAY AND KM: 16:10, km 28.44	PREVIOUS INSPECTION: November 23, 2023	CURRENT INSPECTION: June 13, 2024
LEGAL DESCRIPTION: SW-20-53-7-W5	NAD83 COORDINATES: UTM11U 5939985 N, 632165 E		RISK ASSESSMENT: PF: 13 CF: 8 Total: 104
AVERAGE ANNUAL DAILY TRAFFIC (AADT): 8,330 (2023)		CONTRACTOR MAINTENANCE AREA (CMA): 508 / 509	

SUMMARY OF INSTRUMENTATION: N/A	INSPECTED BY: Stantec: Leslie Cho, Sonja Pharand TEC: Kristen Tappenden
PRIMARY SITE ISSUE: Erosion and gullying on and adjacent to the west and east bridge abutments.	
APPROXIMATE DIMENSIONS: West abutment: Max. gully size estimated to be about 4 m deep by 8 m wide. East abutment: Max. gully size estimated to be about 2 m deep by 4 m wide.	
DATE OF ANY REMEDIAL ACTION: In 1992 horizontal and vertical tie-backs (rock anchors) were installed on the east riverbank, at Pier 1. In 2003, a new stormwater culvert was installed on the west abutment, replacing the two parallel culverts, located adjacent to the NW and SW corners of Pier 5. A gabion mattress over geotextile was placed to backfill the gully that resulted from the failure of the original stormwater culvert adjacent to the NW corner of Pier 5.	

ITEM	CONDITIONS EXIST		DESCRIPTION AND LOCATION	NOTICEABLE CHANGE FROM LAST INSPECTION	
	YES	NO		YES	NO
Pavement Distress		X			X
Slope Movement		X			X
Erosion	X		Erosion gullies up to 4 m deep on the west abutment, north side of the bridge. Erosion gullies up to 2 m deep on the east abutment, north side of the bridge. Shallow gullies on the east and west abutments below the sandstone outcrops.		X
Seepage		X			X
Bridge/Culvert Distress	X		Erosion and rockfall at Piers 1 and 5, which are supported on footings. Erosion gully encroaching the north side of Pier 3.		X
Rockfall	X		The near vertical exposed rock mass below the east abutment generally contains horizontal bedding with near vertical joints/fractures creating blocks/wedges that detach from the rock face falling below and are undermining the abutment. The exposed rock mass below the west abutment is sloped at approximately 70 degrees and does not have as strong visible bedding/joint pattern as the east rock face. However, displaced blocks are visible on the slope surface.		X

COMMENTS
East Abutment / Bank:

- Erosion is present along the east riverbank (Photos 1 & 2).
 - A deep gully is present at the top of the bank, south from Pier 1. This gully is very close to existing power/telephone poles. The gully appears generally unchanged from the 2023 call out inspection.
 - Significant erosion is present below the sandstone outcropping near the top of the bank, both below the bridge and near the bridge on the north and south sides.
 - The erosion gullies below the east abutment appear to be in a similar state as seen during the call out in 2023. The gullies appear to be about 0.5 m deep and extend downslope to the river.
- The sandstone outcrop was observed to be horizontally bedded and had near vertical joints closely parallel to the valley sides, which result in rockfall and further loosened slabs of rock potentially in unstable conditions below the abutment and potentially undermining the abutment (Photos 2 & 3).
- Sandstone blocks fallen from the outcrop were observed between Piers 1 and 2 (Photo 3). The number of blocks on the slope appears similar to observations during the 2023 call out.
- The pier within the river on the east side (Pier 2) does not appear to be affected by the erosion. Some sediment is collecting against the east side of the pier (Photo 4).

West Abutment / Bank:

- The separated culvert down the west riverbank, on the north side of the abutment, appears to be in similar condition as observed previously in 2023 (Photos 5 & 6). The erosion gully that has resulted from the water exiting the top piece of culvert appeared to be relatively unchanged, with a depth up to around 4 m and width up to around 8 m near the headslope. This gully continues down to the river, where it runs along the side of Pier 3 (Photo 7).
- A second erosion gully is roughly parallel to the gully that resulted from the culvert, and extends below the north corner of Pier 5 to approximately 5 m upslope from Pier 4 (Photo 6). The maximum size of the second gully on the west abutment is about 2.5 m deep and 6 m wide. Geotextiles can be seen in this erosion gully.
- The sandstone outcrop below the west abutment shows erosion and gullying, which continues down along the south side of the piers (Photo 6). These gullies begin at the abutment where they are beginning to undermine the concrete (Photo 8).
- Sandstone rock blocks fallen from the outcrop were observed between Piers 4 and 5 (Photos 6 & 8).

RECOMMENDATIONS

- Regular monitoring through visual inspection and LiDAR change detection at both abutments is recommended.
- In the short term, it is recommended that a topographic and/or LiDAR survey of both abutments and surrounding slopes is performed, including at least 200 m past both sides of the river along the highway to establish catchment areas. With this information, a surface water drainage study should be done to appropriately redesign the highway stormwater discharge on both riverbanks.
- A geotechnical investigation is recommended to characterize the compressive strength of the sandstone and complete rock discontinuity modelling to represent the rock joint patterns and identify wedges most likely to undermine the abutment.
- Long-term repairs may comprise the following:
 - Repair of the erosion gullies under and adjacent to the bridge abutments. The loose material and debris may be excavated, and the area should be backfilled with compacted engineered fill. Given the inclination of the abutments, steep slope safety measures will be required. The high-level cost for repairing the erosion gullies is between \$300,000 and \$600,000, excluding engineering costs.
 - Construction of a new stormwater discharge system on both abutments. Alternatives may comprise an above-ground CSP or HDPE pipe supported on a steel truss resting on footing, or reinforced concrete outfalls, or a system of long reinforced concrete drainage ditches descending the riverbank. The high-level cost for construction of a new stormwater discharge system is between \$900,000 and \$1,500,000, not including engineering and depending on the selected design.
- Site inspections should continue annually.



NORTH CENTRAL REGION GRMP
EDSON / STONY PLAIN
SITE INSPECTION FORM

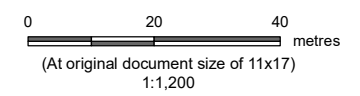


PREPARED BY: Sonja Pharand, P.Eng.	REVIEWED BY: Xiteng Liu, M.Sc., P.Eng., PMP	PERMIT TO PRACTICE:

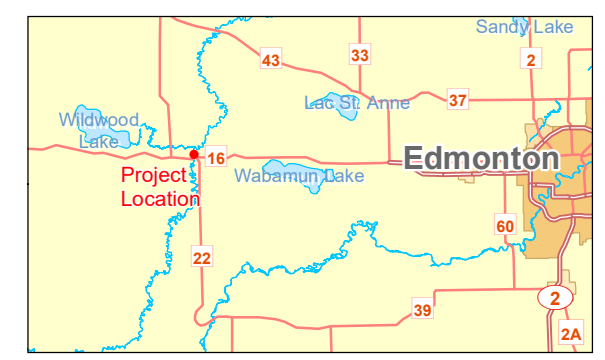


- Previous Observations
- 2024 Observations
- ① Photos and Direction
- Ground Elevation Contours (m AMSL)
- Direction of Waterflow

m AMSL - metres above mean sea level



- Notes**
1. Coordinate System: NAD 1983 UTM Zone 11N
 2. Data Sources: Geogris, ©Department of Natural Resources Canada. All rights reserved.
 3. Background: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community.



Project Location
SW-20-053-07W5,
Entwistle, Alberta

Prepared by SP on 2024-10-02
QR by LC on 2024-10-02
IR by XL on 2024-10-02

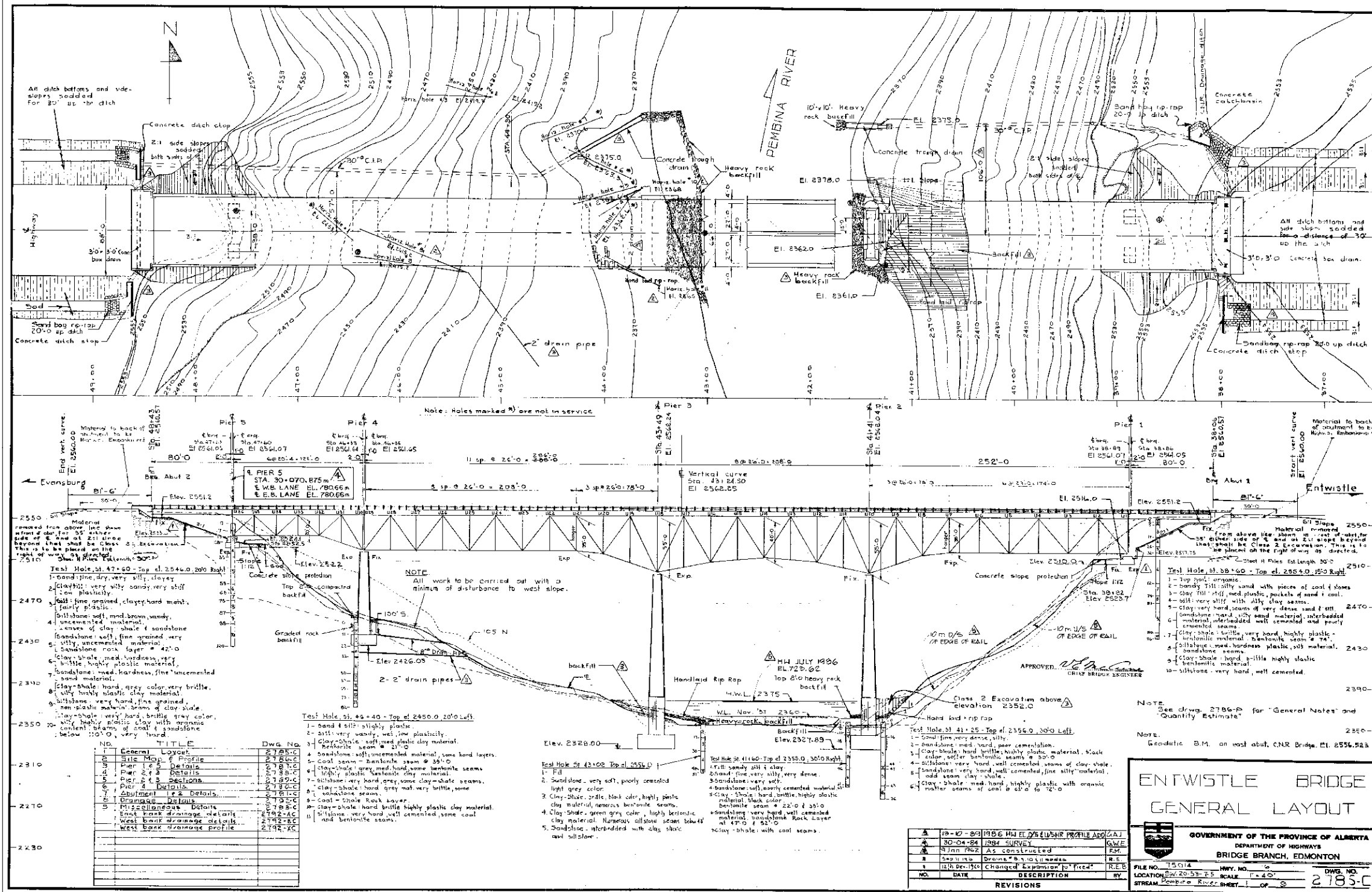
Client/Project
Transportation and Economic Corridors
Geohazard Monitoring Program
NC111 Hwy 16:10, 28.4 km Pembina River Bridge

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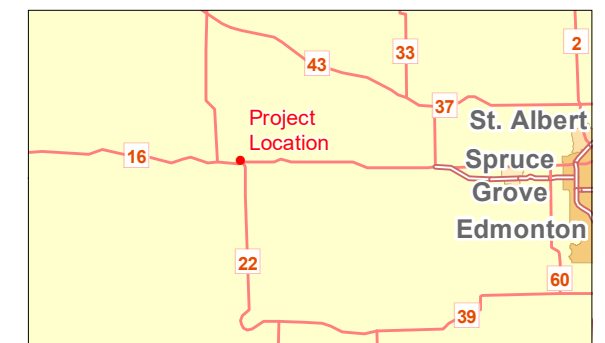
Figure No.
1

Title
Site Plan

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Notes
 1. Coordinate System: NAD 1983 UTM Zone 11N
 2. Inset Data Sources: Geogratis, ©Department of Natural Resources Canada. All rights reserved.



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Client/Project
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 Geohazard Monitoring Program
 NC111 Hwy 16:10, 28.4 km Pembina River Bridge

Figure No.
 2
Title
 BF75014 Pembina River Bridge General Layout

2024 Site Inspection Photos at NC111



Photo 1: Gullies downslope of east abutment and on east slope, facing northeast.



Photo 2: Gullies downslope of east abutment, facing southeast.

2024 Site Inspection Photos at NC111



Photo 3: Sandstone outcrop and gullies downslope of east abutment, facing east.



Photo 4: Lower portion of east river bank near Pier 2. Looking southwest.

2024 Site Inspection Photos at NC111



Photo 5: Overview of west slope, facing west.



Photo 6: Broken culvert and gully on the north side of the west abutment. Looking west.

2024 Site Inspection Photos at NC111



Photo 7: Erosion gully next to west pier at river level, facing southwest.



Photo 8: West abutment and riverbank, facing northwest.