HIGHWAY 800:02 – BELLY RIVER EROSION SITE
REPORT ON JUNE 26, 2009 SITE INSPECTION

Submitted to:

Alberta Transportation
Calgary, Alberta

Submitted by:

AMEC Earth & Environmental,
a division of AMEC Americas Limited
Calgary, Alberta

July 2009

CG25309.D

July 2, 2009
CG25309.D

Mr. Ross Dickson
Alberta Transportation
2nd Floor - 803 Manning Road NE
Calgary, AB T2E 7M8

Dear Ross:

Re: HIGHWAY 800:02 – BELLY RIVER EROSION SITE
REPORT ON JUNE 26, 2009 SITE INSPECTION

Please find enclosed the report on the June 26, 2009 inspection of the above-noted site.

If you have any questions or require any further information, please do not hesitate to contact the undersigned at (403) 387-1565.

Yours truly,
AMEC Earth & Environmental,
a division of AMEC Americas Limited

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Associate Geological Engineer

c: Neil Kjelland – AT

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1.0 INTRODUCTION

AMEC Earth and Environmental (AMEC), a division of AMEC Americas Limited, attended a call-out request to an erosion/landslide site along the Belly River and adjacent to Highway 800:02 on June 26, 2009. The call-out request was made by Mr. Ross Dickson of Alberta Transportation (AT). The site inspection was performed by Mr. Andrew Bidwell, P.Eng. of AMEC.

The purpose of the site inspection was to:

- Inspect erosion along a segment of the right bank of the Belly River that has led to landsliding of the adjacent valley slope with the headscarp of the landslide encroaching towards Highway 800.

- Provide a preliminary assessment of the hazard conditions and associated risk to the highway.

- Provide preliminary recommendations for mitigative measures, along with recommendations for further investigation and assessment of the hazard conditions.

The call-out site inspection was authorized under AT Consulting Services Agreement CE061/08.

2.0 SITE LOCATION AND GENERAL DESCRIPTION

The site is located in 18-3-27 W4M, around Km 9 northbound along Highway 800 from the junction of Highway 5 and Highway 800, approximately 17 km westbound along Highway 5 from Cardston, AB. The site is located on the eastern side of the transition zone between the Rocky Mountain Foothills to the west and rolling/plains terrain to the east. The site is located within the boundaries of the Blood Indian Reserve 148, with the Belly River forming the west boundary of the reserve.

This segment of Highway 800:02 is a paved, two lane undivided roadway. The site is located in the area where the highway begins to descend to the south approach to the bridge over the Belly River, approximately 500 m northbound from the site. The highway is located on the upland area east of the Belly River channel, with an approximately 15 to 20 m high valley slope above the right (east) bank of the river between the highway right-of-way and the river channel. Figure 1, attached, shows the overall site layout and the relative location of the highway and the river channel.

This site has not previously been reviewed under AT's Geohazard Risk Management Program.

It is understood from AT that erosion of the slope between the highway and the river has been ongoing for many years, and that slope crest retrogression towards the highway has been

noted and informally observed by AT since around 2002. The slope crest in this area has reportedly retrogressed in the order of 3 to 5 m towards the highway since 2007, however more detailed observations of the timing and amount of retrogression have not been recorded. AT provided a photo of the site taken from a 2006 videolog inspection of Highway 800 (see Photo 7, attached), which shows the 2006 slope crest position relative to the fenceline along the west side of the highway. A comparison of the 2006 videolog to the June 2009 site observations shows that the slope crest has retrogressed eastwards towards the highway in the order of 10 to 15 m or possibly even more from 2006 to 2009. Currently, the minimum offset from the toe of the road embankment to the edge of the pavement is approximately 11 to 12 m.

3.0 JUNE 26, 2009 SITE OBSERVATIONS

A site plan along with a slope cross-section through the landslide area are attached as Figures 1 and 2.

Key observations from the site inspection are outlined below and shown in the attached photographs:

- There is active landsliding of the approximately 15 to 20 m high slope between the right bank of the river and the highway. Photos 1 to 3, attached, show views of the landsliding.
    - The mode of movement appears to be slumping in the lower and mid-slope triggered by river erosion along the toe of the slope. The downdrop of the slumping areas appears to create a near-vertical soil face in the uppermost portion of the slope. This in turn leads to separation and toppling/downdrop of metre-scale blocks of soil with an intact turf cover. The surface width of currently separating and recently fallen blocks is typically around 3 to 4 m (i.e. each block that falls away causes the slope crest to retrogress in the order of 3 to 4 m.)
    - The height of the near-vertical scarp above the colluvial mass on the slope varies from around 2 m or slightly less around the point of maximum retrogression towards the highway (i.e. the point of minimum offset form the highway) to 3 to 5 m or slightly greater in other areas at greater offset from the highway.
    - The near-vertical scarps expose a variable thickness (typically 1 m or less) of sandy, low plastic silt with fine gravel inclusions underlain by till consisting of sandy silt with trace amounts of sub-rounded to sub-angular, fine gravel inclusions and of low to medium plasticity. The colluvium slope below the scarp consists of metre-scale blocks of the silt till (some with intact turf covers still in place), transitioning to completely reworked and broken-up till blocks further downslope. The lowermost portions of the landslide area consist of colluvium derived from the till with a slight “flowed” appearance and numerous toe thrusts/bulges into the river channel.

- No areas of groundwater seepage were noted in the landslide area at the time of the site inspection. Some portions of the colluvium slope as well as areas still identifiable as back-rotated tops of slump blocks showed evidence of having ponded water earlier in 2009 (all were dry at the time of the site inspection), but overall it did not appear that groundwater seepage was significant at this site.

- The landsliding has caused the slope crest to retrogress eastwards towards the highway. At the time of the June 26, 2009 site inspection, the minimum offset of the slope crest from the fenceline west of the highway was 3.4 m (roughly 11 to 12 m from the edge of pavement), with an approximately 15 m segment of the slope crest offset 5 m or less from the fenceline. Photo 4 and Figures 1 and 2, attached, illustrate the minimum offset of the slope crest from the highway.

    - Seven pairs of reference stakes were placed at 0 and 1 m offset from the June 26, 2009 slope crest position, at the locations shown on Figure 1 and in Photo 4. A third stake, at 2 m offset from the slope crest, was also placed at the point where the slope crest was closest to the fenceline.

- The landsliding extends for approximately 200 to 300 m upstream from the point of minimum offset between the slope crest and the highway. The landsliding further upstream appeared to be slightly less active, however there were treed landslide blocks on the slope that appeared to have moved in recent years. Due to the meander bend curvature upstream of the site, these areas are at approximately 20 m or greater offset from the fenceline (see Figure 1). Tension cracks adjacent to the crest of the slope in this area delineated 2 to 3 m wide blocks that are about to break away and slide downslope.

- The site is located along the outside of a meander bend in the river channel and the landsliding is due to river erosion along the toe of the slope. As shown on the site plan on Figure 1, the river channel makes a sharp turn (greater than 90° change in bearing along less than approximately 200 m channel length) immediately upstream of the site, resulting in a tight meander bend along the toe of the slope adjacent to the highway. The flow along the toe of the slope was rapid and there were back-eddies present downstream of the numerous toe thrusts of landslide blocks into the channel at the time of the June 26, 2009 inspection.

- The maximum flow depth on June 26, 2009 was visually estimated from shore to be in the order of 2 to 2.5 m, with the majority of the channel adjacent to the landslide area around 1.5 m or less depth. It should be noted that these are very approximate estimates only, however the base of the channel was generally visible from the right bank and showed clean, cobble-sized bedload.

- Immediately downstream of the most active landslide area, the meander bend appears to be eroding into a terrace and gravel bar along the right bank of the river as the apex of the tight meander bend shifts downriver over time. As shown on Figure 1 and Photo 5, the 2 to 3 m high face of this terrace along the right bank is armored with boulder-sized rock riprap. The armored area is largely overgrown. Where the meander bend is eroding into the gravel bar and terrace there were some rapids along the channel which suggests that several metres of the armored bank has been outflanked and recently eroded with the boulder-sized material distributed a short distance downstream.

- A weir and canal headworks were noted approximately 500 m upstream from the landslide area (Photo 6).

- During the latter part of the site inspection, Mr. Ben Scout Jr. drove by the site and stopped to discuss the site conditions with the AMEC field engineer. Mr. Scout identified himself as the owner of the land at this site, and provided the following information:

    - The weir and canal headworks upstream of the site were constructed approximately 15 years ago as a replacement to similar facilities around the same location. Mr. Scout contends that the current weir has altered the flow pattern of the river channel which has led to the current landsliding and encroachment towards the highway.

    - Mr. Scout expressed dissatisfaction with a lack of compensation to him by the provincial government for the loss or alteration of productive land along the river channel since the construction of the current weir, along with the recent landsliding that has reduced the amount of pasture land in the area around the landslide headscarp.

4.0 DISCUSSION AND ASSESSMENT

A comparison of the site photo from the 2006 videolog of this segment of Highway 800 to the observations from the June 26, 2009 inspection shows that a significant length of the slope crest has retrogressed several metres towards the highway since 2006. There are no measurements of the offset of the slope crest from the fenceline along the west side of the right-of-way, therefore the following items are approximations at this time:

- The rate of retrogression in recent years, including confirmation that the retrogression occurs in 2 to 4 m increments as suggested by the surface width of the visible landslide blocks that topple away from the slope crest.

- The timing of landslide activity is related to peak river flows. Large floods result in greater attack at the toe of the slope causing more landsliding.

Also, the degree to which the weir upstream of the site influences conditions at the toe of the landslide area is currently unknown, as are any changes to the site conditions that can be attributed to the replacement of a previous weir with the current one.

Regardless of the above-noted uncertainties, it is apparent that the landsliding has caused significant loss of ground adjacent the highway in recent years. Without mitigative measures, the slope crest will retrogress even closer to the highway because the near-vertical scarp above the landslide area will not be stable over the long-term and ongoing river channel erosion and landsliding on the lower slope will likely further destabilize the uppermost portion of the slope. The timing and rate of such retrogression is unclear at present, but if the apparent recent level of landslide activity in the upper slope continues during 2009 or again during peak river flows in early 2010, the slope crest could very well retrogress east of the fenceline and to within 8 to 9 m of the west edge of the pavement. Furthermore, a worst-case scenario of extrapolating the angle of the lower portion of the landslide slope upwards suggests that the slope crest could ultimately retrogress into the southbound lane of the highway, if not further. This needs to be confirmed with a site survey to confirm the topography and extent of the landslide area and its position relative to the highway along with a hydrotechnical analysis to estimate the future river erosion conditions.

Conceptually, a repair similar in approach to the Fall 2008 repair at the S4 – Willow Creek site on Highway 2 would appear appropriate for this site. The details of such a repair would need to be determined through further assessment and design, but in summary would consist of:

- Erosion protection along the right bank of the river through the landslide area and extending both upstream and downstream. The erosion protection could consist of conventional rip-rap armouring without any channel training measures, or perhaps Longitudinal Peak Stone Toe Protection (LPSTP) along with vanes to attempt to direct erosive flows away from the right bank. Either method could be supplemented with willow plantings and bioengineering measures to increase the long-term effect of the erosion protection and also reduce the environmental impact to the river channel and bank. A hydrotechnical assessment of the site is required to determine which measure(s) would be appropriate and optimize their design.

- Stabilizing the oversteepened uppermost portion of the slope in the landslide area using launched soil nails or equivalent measures. It may also be prudent to trim back the near-vertical slope face to 1H:1V prior to soil nailing so that it can more easily be revegetated, albeit with even less offset from the highway than current conditions.

- Grading/shaping of the colluvium slope in the landslide area so that surface runoff will not pond on the slope, along with revegetation measures in selected areas where beneficial. The revegetation measures could be selected based on the results of the trail methods at the Willow Creek site.

Other repair options, such as earthworks to try to buttress and stabilize the landslide area or shifting the highway to the east, appear to be technically unsuitable and/or impractical for this site.

5.0 RISK LEVEL

AMEC recommends the following Risk Level for this site, based on AT's general geohazard risk matrix:

- Probability Factor of 13, based on a "high rate of movement,……steady or increasing" due to the apparent, but unquantified, significant slope crest retrogression towards the highway since the 2006 videolog.

- Consequence Factor of 3, reflecting the potential for loss of service of a portion of the roadway and potentially partial closure of the road (e.g. closure of the southbound lane).

Therefore, the recommended Risk Level is 39 (i.e. 13 x 3). This Risk Level may be somewhat conservative if the rate of slope crest retrogression and the ultimate slope crest position are more favorable than assessed based on the single site inspection to date. This will need to be clarified with the recommended further assessment and site investigation work.

6.0 RECOMMENDATIONS

Repair work is recommended as soon as possible in order to minimize additional loss of ground between the highway and the slope. The recommended short term measures along with further assessment and site investigation work to provide a basis for a repair design are listed in the following subsections.

6.1 SHORT TERM MEASURES

- The offset of the slope crest from the fenceline should be checked weekly in order to provide an early indication of unexpectedly rapid crest retrogression that may trigger the need for a guardrail or possibly even the proactive construction of a detour lane on the east side of the highway. The reference stakes that were placed along the crest can be used for this monitoring. It would be most efficient and cost-effective if measurements of the offset could be taken by locally-based maintenance contractor personnel, with the data sent to AMEC for review and compilation.

- Preliminary discussions should be held with the Department of Fisheries and Oceans, Navigable Waters and other regulators as required in order to facilitate regulatory approvals for the repair work without delay. The details of the repair design will not be available at the time, however the repair concept could be discussed and the successful application at the Willow Creek may streamline the approvals for this site.

- AT should confirm the ownership and status of the land at this site (e.g. privately owned, or perhaps within the Blood Indian Reserve 148). Representatives from AT and possibly also Alberta Environment should contact the landowner in order to start the process of securing permission to access the site for repair construction. AMEC could provide input on the geohazard conditions to support these discussions, as appropriate.

- Discussions with Alberta Environment regarding the site history of the weir upstream of the landslide site, including the basis for the construction of the current weir and any past assessments of the river channel conditions that would be relevant to the repair design for the erosion/landslide site.

6.2 FURTHER ASSESSMENT / SITE INVESTIGATION WORK

If AT wishes to proceed with a repair for this site, the following tasks should be started as soon as possible to take advantage of lower flow conditions later in the summer of 2009:

- Site survey to produce a topographic site plan that can be used in the site assessment and design of repair measures. The survey will need to include a survey of the river channel thalweg and selected channel cross-sections to support the hydrotechnical assessment. It may be possible to use existing LiDAR survey coverage of the site (either already obtained by AT or from a commercial provider) to reduce the cost of the site survey, however LiDAR data from prior to the spring of 2009 may not be applicable given the apparent significant landslide activity in recent years.

- Hydrotechnical assessment of the site, including consideration of the effects of the weir on the flow conditions at the site. This assessment will provide a basis for selecting and designing appropriate erosion protection works for the river bank.

- A environmental assessment, consisting of:

    - An aquatic environmental (fisheries) assessment to support the permitting process.

    - Fish habitat compensation plan, if required to support the DFO approval.

    - The preparation and submission of permitting applications under the federal Fisheries Act, Navigable Waters Protection Act, provincial Water Act and Public Lands Act.

AMEC will submit a proposal and cost estimate for the recommended further assessment and site investigation work under separate cover after discussion with AT to confirm the path forward for this site.

6.3 LONG TERM / ONGOING

Annual site inspections by AT and AMEC personnel under the Southern Region GRMP, starting in 2010.

7.0 CLOSURE

This report has been prepared for the exclusive use of Alberta Transportation for the specific project described herein. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it are the responsibility of such third parties. AMEC Earth & Environmental, a division of AMEC Americas Limited, cannot accept responsibility for such damages, if any, suffered by any third party as a result of decisions made or actions based on this report. This report has been prepared in accordance with accepted geotechnical engineering practices. No other warranty, expressed or implied, is made.

We trust that this meets your needs at this time. Please contact the undersigned if you have any questions or require any further information.

Respectfully Submitted,
AMEC Earth & Environmental,
a division of AMEC Americas Limited

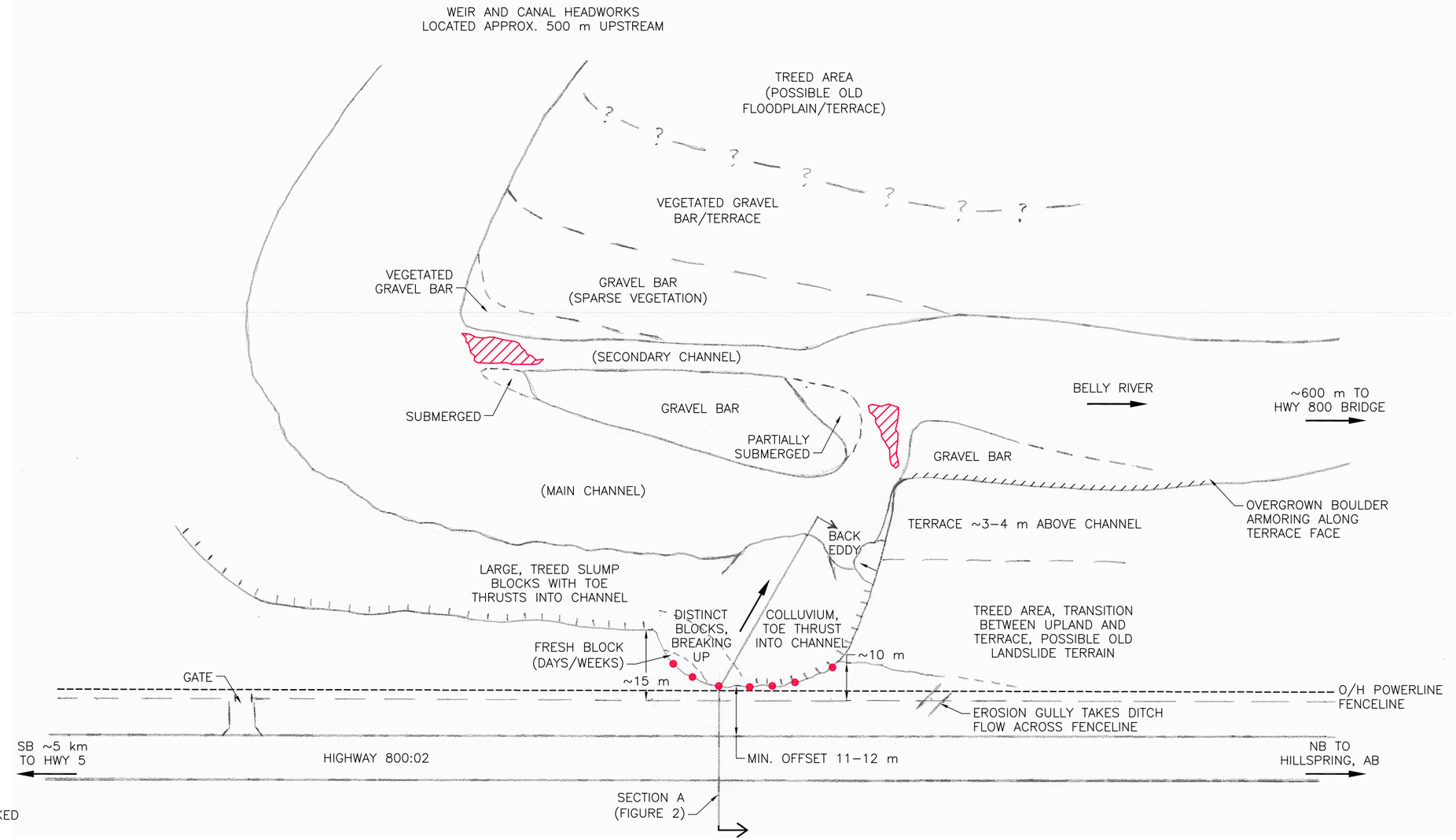
Andrew Bidwell, M.Eng., P.Eng.
Associate Geological Engineer

Reviewed by:

APEGGA Permit to Practice No. P-04546

L.S. Hundal, M.Eng., P.Eng.
Senior Water Resources Engineer

Attachments: Figures 1 and 2
Photos 1 to 7



LEGEND:

RAPIDS/TURBULENT FLOW

JUNE 26/09 CREST + 1 m OFFSET STAKED

NOTES:

1. ALL DIMENSIONS ARE APPROXIMATE.
2. SITE FEATURES AS OF JUNE 26/09.

APPROXIMATE SCALE
1:1000
0 10 20 m

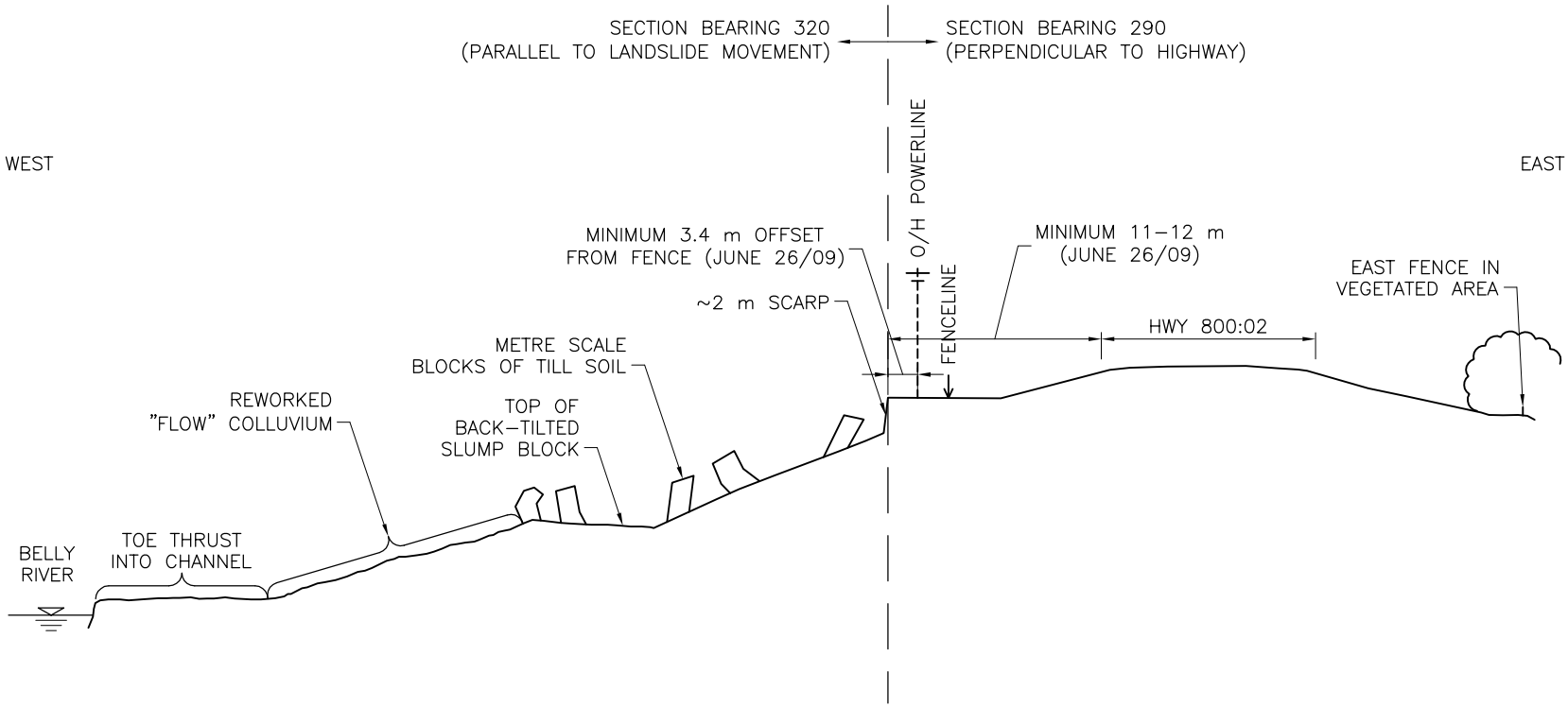
amec Earth & Environmental

CLIENT: Alberta Transportation

PROJECT: SOUTHERN REGION GEOHAZARD ASSESSMENT

TITLE: HWY 800:02 BELLY RIVER EROSION SITE
SITE PLAN

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
JUNE 2009	CG25309.D	25309N20.dwg	FIGURE 1	A



NOTES:

1. ALL DIMENSIONS ARE APPROXIMATE.
2. SITE FEATURES AS OF JUNE 26/09.

APPROXIMATE SCALE
1: 400
0 2 4 6 8 m

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CLIENT: Alberta Transportation

PROJECT: SOUTHERN REGION GEOHAZARD ASSESSMENT

TITLE: HIGHWAY 800:02 BELLY RIVER EROSION SITE
SECTION A

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
JUNE 2009	CG25309.D	25309N20.dwg	FIGURE 2	A

Photo 1 – View from the crest of the slope above the landslide area, a short distance south/upstream from the area of significant retrogression towards the highway in recent years. The sharp bend in the river channel immediately upstream of the site is evident, along with the meander in the channel that directly attacks the toe of the slope in the landslide area. Figure 1 contains further annotations illustrating the site features shown above.

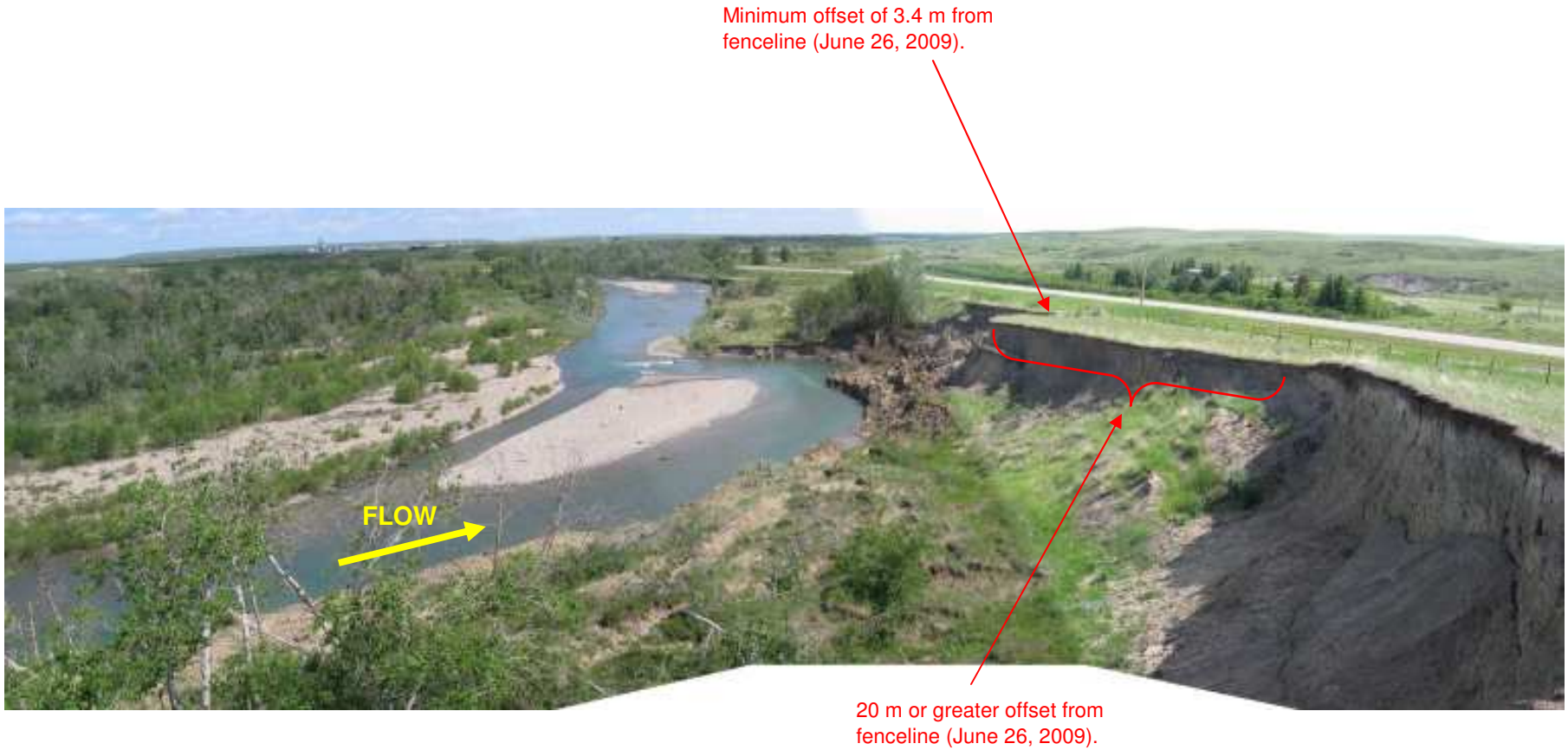

Photo 2 – View downstream/northbound towards the landslide area, with Highway 800 on the right. Note the active landsliding due to river erosion along the toe of the slope, which is located on the outside of a meander bend.

Photo 3 (top) – View upstream towards the toe of the landslide area. Photo is taken from the downstream end of the meander loop and on top of the armored right bank downstream of the landslide area that is being outflanked and eroded. Note the significant toe bulge/thrust from the recent landsliding.

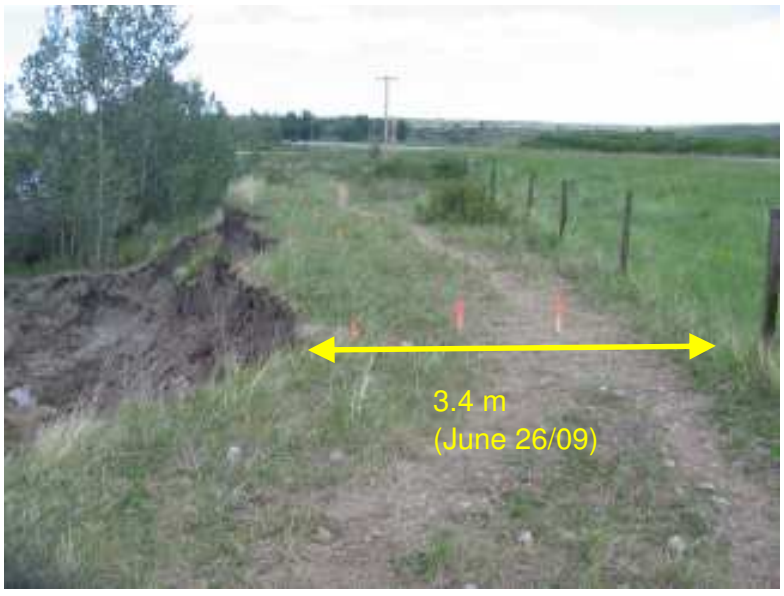

Photo 4 (bottom) – View north along the slope crest, at the point of maximum retrogression towards the highway (offset 3.4 m from the fenceline). Reference stakes were placed at selected locations along the slope crest, at 0 and 1 m offset along with a third stake at 2 m offset at the location shown.

Photo 5 (top) – View downstream of the armored right bank, which is located downstream of the meander bend and landslide area. The upstream end of this armored segment of the bank is being outflanked and eroded by the meander bend.

Photo 6 (bottom) – View upstream from the site towards the weir and canal headworks (approximately 500 m upstream from the site).

Photo 7 (top) – Photo from 2006 videolog provided by AT, facing southbound along the highway adjacent to the landslide area. Note the significantly greater offset between the crest of the slope and the highway compared to the June 2009 photos.