KLOHN CRIPPEN

July 18, 2005

Alberta Infrastructure & Transportation
Central Region
#401, 4902 – 51 Street
Red Deer, Alberta
T4N 6K8

Mr. Alain Momedi, P.Eng.
Project Engineer

Dear Mr. Momedi:

Central Region GeoHazard Assessment
Site C30 H734:12 Slide
Geotechnical Callout Report

This geotechnical callout report was prepared by Klohn Crippen Consultants Ltd. (Klohn Crippen) for Alberta Transportation Central Region under the Geohazard Assessment Agreement CE 045/2004. The site inspection was undertaken on June 29, 2005 by Mr. Darren Ratcliffe, P.Eng., of Klohn Crippen Consultants Ltd. Mr. Ratcliffe was accompanied by Mr. Alain Momedi and Mr. Fred Cheng of Alberta Infrastructure & Transportation. A second inspection was conducted on July 12, 2005 following remedial work to re-open the highway.

1. PROJECT BACKGROUND

The project site is located on Highway 734:12, about 3 km south of the junction with Highway 584, approximately 45 km west of Sundre, Alberta. At this location, the highway is located at the crest of the James River Valley orientated in a east-west alignment (Figure A). The legal description of the site is NE 19-33-08-W5M with approximate NAD83 coordinates of E629,740 and N5,745,805.

The highway is a gravel road and would appear to service logging and oil field operations and a number of recreational campsites in the area. Traffic volume on the road is low with an AADT of 100 vehicles per day (TIMS data).

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Prior to the October 2004 repair work, two slides about 20 m apart were present on the south side along this stretch of highway. For descriptive purposes, the east slide is termed "Slide 1" and the west slide is termed "Slide 2".

Slide 1 had a total width of about 30 m and extended back into the highway surface by about 2.5 m over a length of about 10 m. The slide was semi-circular in plan with a main backscarp of about 1.5 m. In general, the slide area was soft and wet and comprised gravelly clay. A 600 mm diameter CSP culvert was located under the road at this location and the downstream end had been displaced downwards by the slope movement. Despite the culvert break, water was still flowing from the outlet. However, the source of the water was from within the slope as the upstream end of the culvert and ditch was dry. The flow of water from the culvert flowed initially eastwards along tension cracks and then southwards down the slope towards the James River, located about 50 m away with a vertical drop of about 20 m. A second culvert was located about 25 m east of the broken culvert. A spring flow was observed from the slope below the culvert.

Slide 2 was located about 20 m west of the first slide and was about 20 m wide. The slide was semi-circular in plan with a 1.5 m high scarp about 3 m from the edge of the road. The slide extended for a length of about 10 m down the valley side and seepage flows were also observed exiting from the slide area. Similarly, the ditch on the north side of the road was dry. The extent of the vegetation in the slide areas was generally poor in terms of both grass and trees. In contrast, the vegetation was much thicker outside the slide areas.

It was considered that this length of highway was constructed very close to the edge of the river valley and was built over natural springs in the area. The spring flows had softened the clayey soil and this resulted in a slope movement towards the river. The rate of slide progression had increased significantly in the previous six to nine months, possibly due to gravel placed at the top of the slide or increased pore pressures within the slope although some groundwater was exiting the slide area. The groundwater flow had also been softening the area below the slide.

Due to the slide encroaching well into the road and creating a significant hazard, it was considered that this site warranted remedial action. The October 2004 remedial work comprised the following and is shown on Figure 1:

(1) Replacement of the damaged culvert and controlling groundwater flows with pipes carrying the flow further down the slope.
(2) Rebuilding the edge of the highway using reinforced gravel, limiting the load placed at the crest of the slide.

(3) Extending the highway width away from the valley edge for a length of about 50 m.
(4) Vegetating the downslope area.

For Slide 1, the damaged 600 mm diameter culvert was replaced with a new 600 mm diameter CSP culvert over the full width of the highway. Equally spaced across the slide area, five 150 mm diameter perforated HDPE ("Big-O") pipes in filter socks were provided at a depth of about 2 m below the highway surface and extending to the centerline of the highway. The discharge ends of the HDPE pipes were to be connected to flexible corrugated HDPE pipes placed on the surface of the slope to discharge water away from the crest. For Slide 2, three similar perforated pipe drains were installed. Slide 1 was excavated to a depth of about 2 m below road level (about 0.5 m below invert of culvert on the east side of road). At this depth, the base material was dry, and so the proposed drains were installed at a lower elevation. Five drains were installed by digging trenches about 0.5 m below the base of the excavation.

The soft, wet soil excavated to install the drains was considered unsuitable for re-use. To reconstruct the embankment, pit run gravel obtained from a local AIT source was placed and compacted. The gravel was reinforced with LP20X geo-grid material, extending the grid for the full width of the highway in the culvert replacement zone and to at least the centerline of the highway in the other drain locations. Geo-grid sheets were placed at about 0.5 m vertical spacing as the gravel fill was raised. Filter fabric was placed at all soil-gravel interfaces.

Space was available to the west of the highway to permit local widening of the road by a distance of about 3 m over a length of about 50 m. Any organics were stripped and the shoulder grade raised with compacted fill to match the highway. A layer of road gravel surfacing was placed to create the highway surface.

It was considered that live staking the area downslope of the slide with willow and poplar would help to increase the stability of the area. The stakes were installed on an approx. 1 m by 1 m grid.

The total cost of the October 2004 work was $50,600.

2. JUNE 2005 INSPECTION

Heavy rain in Southern Alberta in June 2005 caused significant flood events and subsequent damage to infrastructure. Flooding and erosion occurred at the H734:12 slide site closing the highway as shown on the attached photographs and illustrated on

Figure 2. An erosion channel about 10 m wide by about 3 m deep was formed at the east end of the "Slide 1" repaired area as ditch flows bypassed the culvert and flowed around the reinforced gravel area and down the slope. At the time of the inspection, the ditch was still flowing. A temporary vehicle access had been developed to the north of the erosion site.

The following observations were noted for the two identified sites:

"Slide 1"

- Seepage was observed from the steep north side of the erosion channel at a number of locations.

- Old culverts and previously buried perforated pipes were exposed by the flood and erosion. The 400 mm diameter CSP at the east end of the site has been washed away.

- The downstream end of the new 600 mm diameter CSP has been eroded leaving about 5 m of pipe exposed. The erosion of the slope area has also exposed the geo-grid reinforcement. It was noted that the reinforcement was not extended a sufficient distance downslope. However, it was also noted that the majority of the reinforced gravel section is remaining and erosion occurred to the east.

- Due to the loss of ground downslope, cracks in the highway surface have reappeared in a similar location to those observed previously.

- The HDPE off-take drain pipes have been displaced downslope by the flows.

- Most of the planted live stakes were washed away in the central part of the slope.

"Slide 2"

- No damage due to the flood flows occurred in this area, except for a minor ditch erosion feature at the west end.

- A slight settlement of the new slope fill had occurred

- Good growth was observed on the live stakes planted in this area. It is estimated that at least 90% of the stakes are showing new shoots with green leaves. Grass is also growing well in the flatter portion of the slope.

The source of the ditch flow was traced back to a stream flowing from the north about 100 m west of the erosion site. The area to the north of the highway appears to be a marsh-like wetland that could have a considerable catchment area.

3. JULY 2005 INSPECTION

A second inspection of the site was undertaken on July 12, 2005 following the placement of gravel fill around the north section of the site to reopen the road as shown on Figure 3 and in the attached photographs. In general, there was no significant change or deterioration in the site conditions from the previous inspection. The following observations were noted:

- Ditch flows (slightly reduced from the previous inspection) were directed into the new 600 mm diameter CSP and the culvert is discharging onto the slope face. Some seepage was observed under the culvert.

- Some seepage was observed at the base of the new fill. Due to the new fill placement some upward seepage flow and ponding was observed in the base of the erosion channel.

- An old buried culvert was exposed by the excavation work to obtain material for the new highway fill.

4. SITE ASSESSMENT

The required remediation in 2004 was related to slope instability and groundwater issues. Following construction and observations in May 2005, some cracking and settlement was observed in the downslope area. However, as the gravel material was reinforced and the planted vegetation was beginning to grow, no further work was planned for this site this year.

The observed damage to the site in June 2005 can be directly attributed to erosion from flood flows. The area of reinforced fill was largely undamaged and the flood eroded a section of highway to the east due to road overtopping due to the inadequate capacity of the culverts. For this reason, it is considered that the required repair work should be funded based on damage caused by the flood.

To reduce the potential for road overtopping, it is considered that future flood flows are split at the source upstream of the site. By providing a culvert at the stream location

about 100 m to the west, a significant portion of the flow could cross the highway at this location where stability issues are not a concern.

It is considered that the new alignment of the highway offers significant advantages over the old alignment in keeping the road away from the edge of the valley. The new fill appears stable and there should be no need to remove. Internal drainage should be provided to control groundwater flows and the fill can be widened to the required highway width.

Based on the risk level criteria provided by Alberta Infrastructure & Transportation relating to safety, a risk rating of 36 was assigned to this site. This is based on a probability factor of 9 for an active erosion feature and instability, and a consequence factor of 4 due to the potential for further loss of the highway.

5. PROPOSED REMEDIATION

The following remediation is recommended for the site and is illustrated on the attached figures. Figure 4 provides details of the internal drainage requirements and Figure 5 illustrates the overall site requirements.

- Extend the existing 600 mm diameter CSP culvert downslope with an approx. 30 m long, 600 mm diameter corrugated HDPE pipe (Big-O) to prevent further erosion in the upper slope area. The HDPE pipe should be clamped to the end of the CSP and tied to suitable trees down the slope for anchorage.
- Place a 300 mm diameter perforated and filter sock wrapped HDPE pipe about 15 m long in the lowest point of erosion channel across the highway. The 300 mm HDPE pipe should be extended with a 20 m long corrugated HDPE pipe to carry seepage flows down slope to the river.
- Place three 150 mm diameter perforated and wrapped HDPE pipes in the low area to collect seepage from the backslope and direct into the 300 mm HDPE pipe. Reconnect existing damaged 150 mm diameter HDPE pipes and add additional 150 mm diameter HDPE pipes as required to collect seepage flows prior to backfilling.
- Backfill highway area with compacted pitrun gravel. Filter fabric is to be provided at all soil/gravel interfaces. Provide LP20X geo-grid reinforcement for compacted gravel placed under the road area and extend downslope to the south. Geo-grid sheets are to be placed at about 0.5 m vertical spacing as the gravel fill is raised. Overlap new reinforcement with existing reinforcement by at least 600 mm. Care should be taken to not damage the existing exposed ends of the geo-grid. Upper exposed existing reinforcement sheets should be lifted up and

restrained above the work area until the fill extends vertically to the elevation of the existing reinforcement. The appropriate existing geo-grid sheet can then be placed down on the new fill and overlapped with the new geo-grid sheet. The slope down from the new highway edge should be as flat as possible based on the required final highway width. Complete highway gravel fill to grade and finish with a layer of road gravel.

- The downslope area should be replanted with live stakes as before. About 100 stakes are proposed.
- The inlet area of the 600 mm diameter CSP culvert should be protected with a layer of Class 1 riprap over a distance of at least 3 m. The riprap should be underlain by a layer of filter fabric.
- Provide a 600 mm diameter CSP culvert at the stream location to the west. Excavate the south ditch to suit the culvert invert extending to the west "Slide 2" area. A typical ditch section is provided on Figure 5. The ditch should be seeded and straw matting provided as erosion protection. Provide synthetic permeable barriers at 20 m spacing. Construct a ditch block at least 1.5 m high with a 600 mm diameter CSP culvert at the invert. Armour the ditch block on both sides with Class 1 riprap on filter fabric to guard against overtopping damage. Extend with a corrugated HDPE pipe 30 m long as before. The HDPE pipe should be clamped to the end of the CSP and tied to suitable trees down the slope for anchorage.

Estimated costs for the repair are provided in Table 1.

Table 1 Estimated Material Quantities and Costs

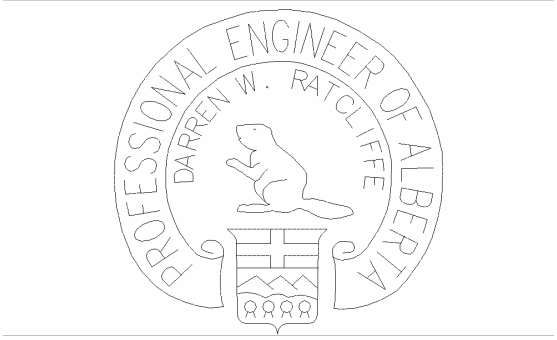
Item	Quantity	Unit	Rate	Total
Mob/Demob	LS	LS	-	$15,000
Common Excavation	500	m^3	$10	$5,000
Common Fill	50	m^3	$10	$500
Pitrun Gravel	750	m^3	$20	$15,000
Road Gravel	10	m^3	$25	$250
Geo-Grid	2000	m^2	$10	$20,000
Filter Fabric	1000	m^2	$5	$5,000
150 mm Perforated HDPE Pipe	50	m	$20	$1,000
300 mm Perforated HDPE Pipe	15	m	$30	$450
150 mm Corrugated HDPE Pipe	50	m	$20	$1,000
300 mm Corrugated HDPE Pipe	20	m	$30	$600
600 mm Corrugated HDPE Pipe	60	m	$80	$4,800
600 mm CSP	20	m	$200	$4,000
Class 1 Rip Rap	5	m^3	$300	$1,500
Live Stakes	100	No.	$20	$2,000
Seeding and Straw Matting	500	m^2	$5	$2,500
Permeable Barriers	20	m	$20	$400
Total				**$79,000**

6. CLOSURE

Please contact the undersigned at (403) 730-6811 if you have any questions regarding this report.

Yours truly,

KLOHN CRIPPEN CONSULTANTS LTD.



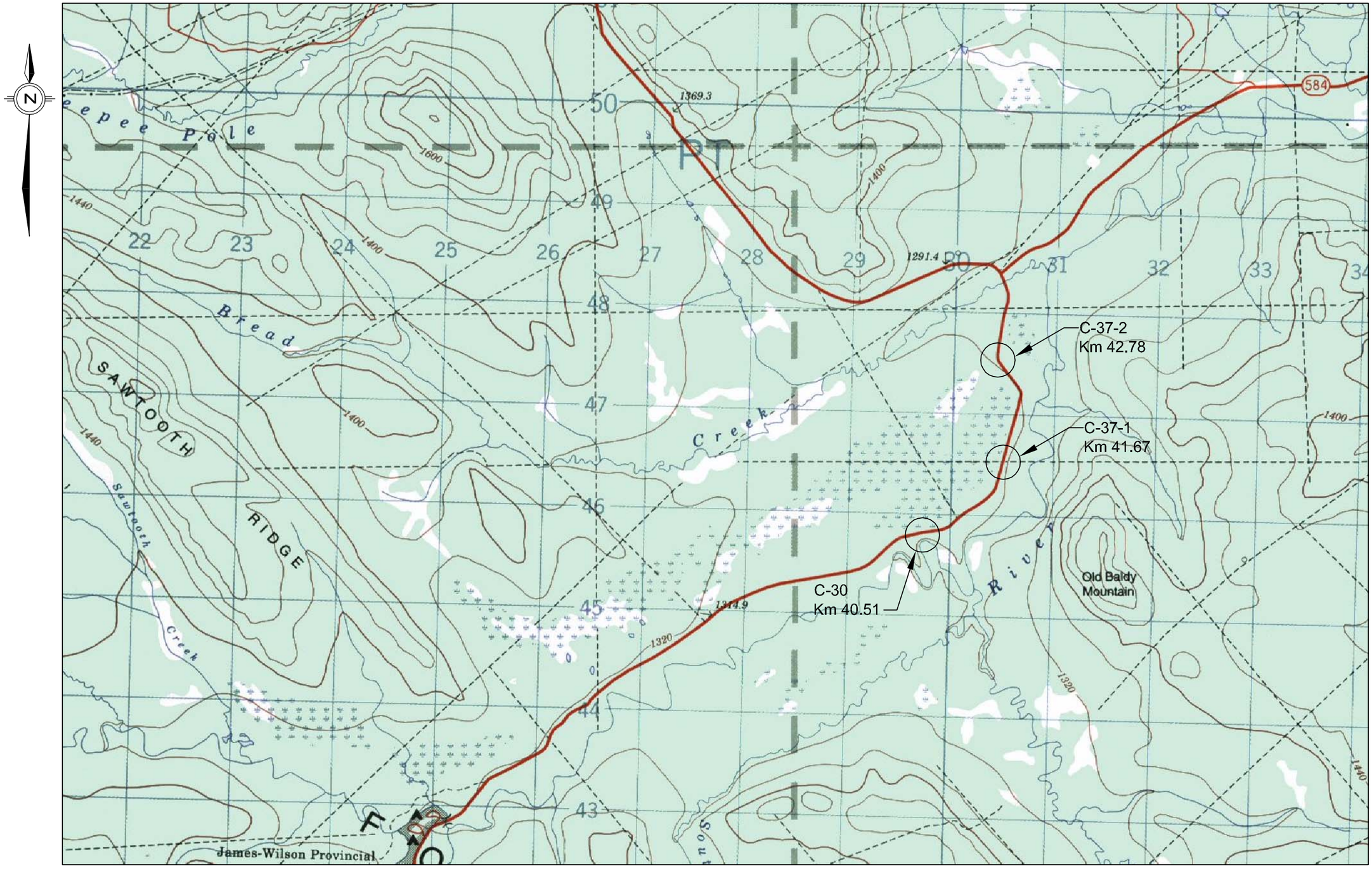
Darren Ratcliffe, P.Eng.
Project Manager

APEGGA Permit to Practice No. 433

cc. Mr. Roger Skirrow, Alberta Transportation

Attachments

FIGURES



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PWSS PLAN No.
MICROFILM DATE

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CONSULTANT
KLOHN CRIPPEN

Alberta
INFRASTRUCTURE AND TRANSPORTATION

PROJECT: CENTRAL REGION
GEOHAZARD RISK ASSESSMENT
TITLE: SITE C30 & C37 : H734 : 12
LOCATION PLAN

DATE	SHEET	DRAWING No.	REV.
JULY 2005		FIGURE A	

MICROFILM DATE

PWSS PLAN No.

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PROJECT FILE No. 3038A01.C30.Fig-1.dwg

EXTENDED ROAD WIDTH

50.0

23.0

4.0

1.5

H734:12

600 mm DIA. CULVERT

(6) 150 mm DIA. PERFORATED HDPE PIPE IN FILTER SOCK

EXISTING 400 mm DIA. CULVERT

10.0

(3) 150 mm DIA. PERFORATED HDPE PIPE IN FILTER SOCK

15.0

1.0

EXTENT OF GEO-GRID REINFORCEMENT

12.0

20.0

8.0

9.0

9.0

10.0

6.0

6.0

5.0

6.0

5.0

9.0

4.0

45°

4.0

3.0

2.5

4.5

3.5

LIVE STAKES (APPROX. 200 STAKES PER SLIDE)

(3) 150 mm DIA. CORRUGATED HDPE PIPE EXTENSIONS 12 m LONG

(2) 150 mm DIA. CORRUGATED HDPE PIPE EXTENSIONS 18 m LONG

(4) 150 mm DIA. CORRUGATED HDPE PIPE EXTENSIONS 12 m LONG

LIVE STAKES (APPROX. 200 STAKES PER SLIDE)

JAMES RIVER

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D.W.R.	D.W.R.
DRAWN BY	CHECKED BY
M.D.	D.W.R.

SCALE 1:200 0 2 4 m

CONSULTANT KLOHN CRIPPEN

Alberta INFRASTRUCTURE AND TRANSPORTATION

PROJECT CENTRAL REGION

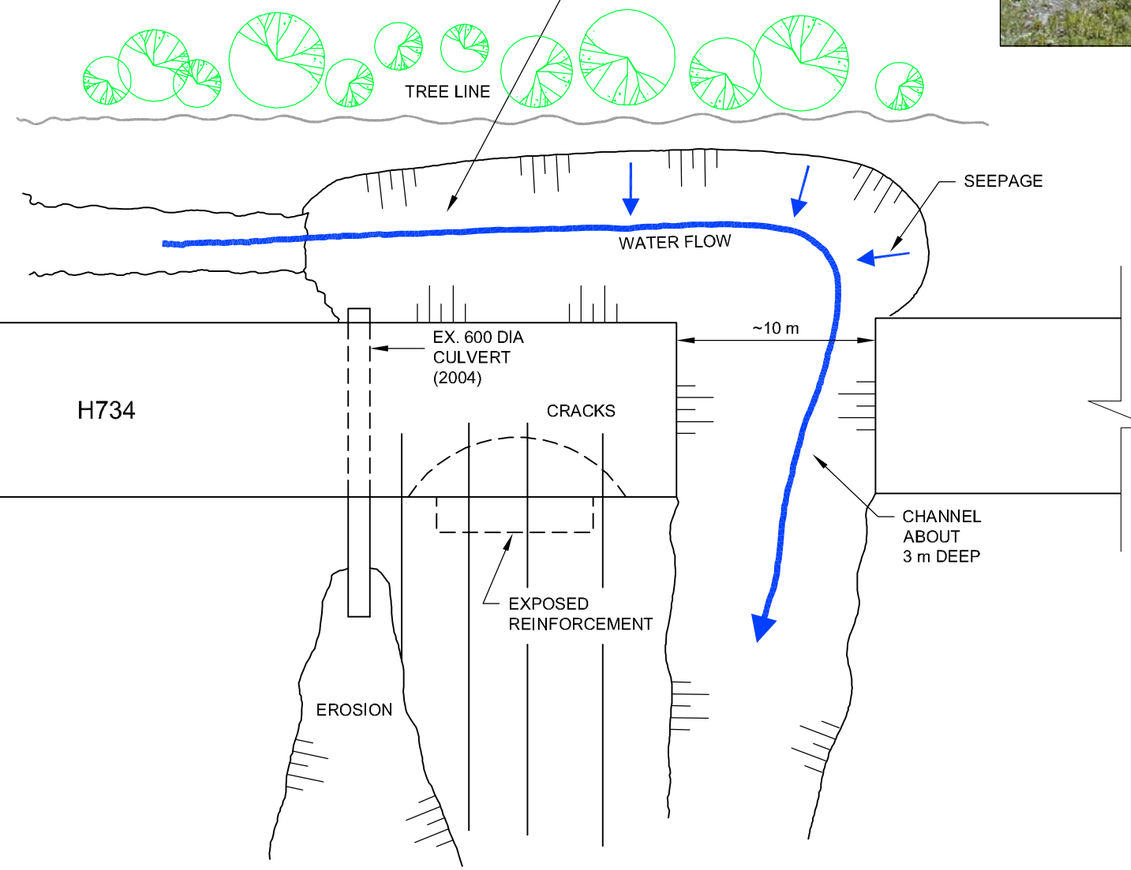
GEOHAZARD RISK ASSESSMENT

TITLE

SITE C30 : H734 : 12

OCT 2004 AS-BUILT REMEDIATION PLAN

DATE	SHEET	DRAWING No.	REV.
JULY 2005	1 OF 5	FIGURE 1	



NOTE:
1. PHOTOS TAKEN
JUNE 29, 2005

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PWSS PLAN No.
MICROFILM DATE

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DRAWN BY	CHECKED BY
M.D.	D.W.R.

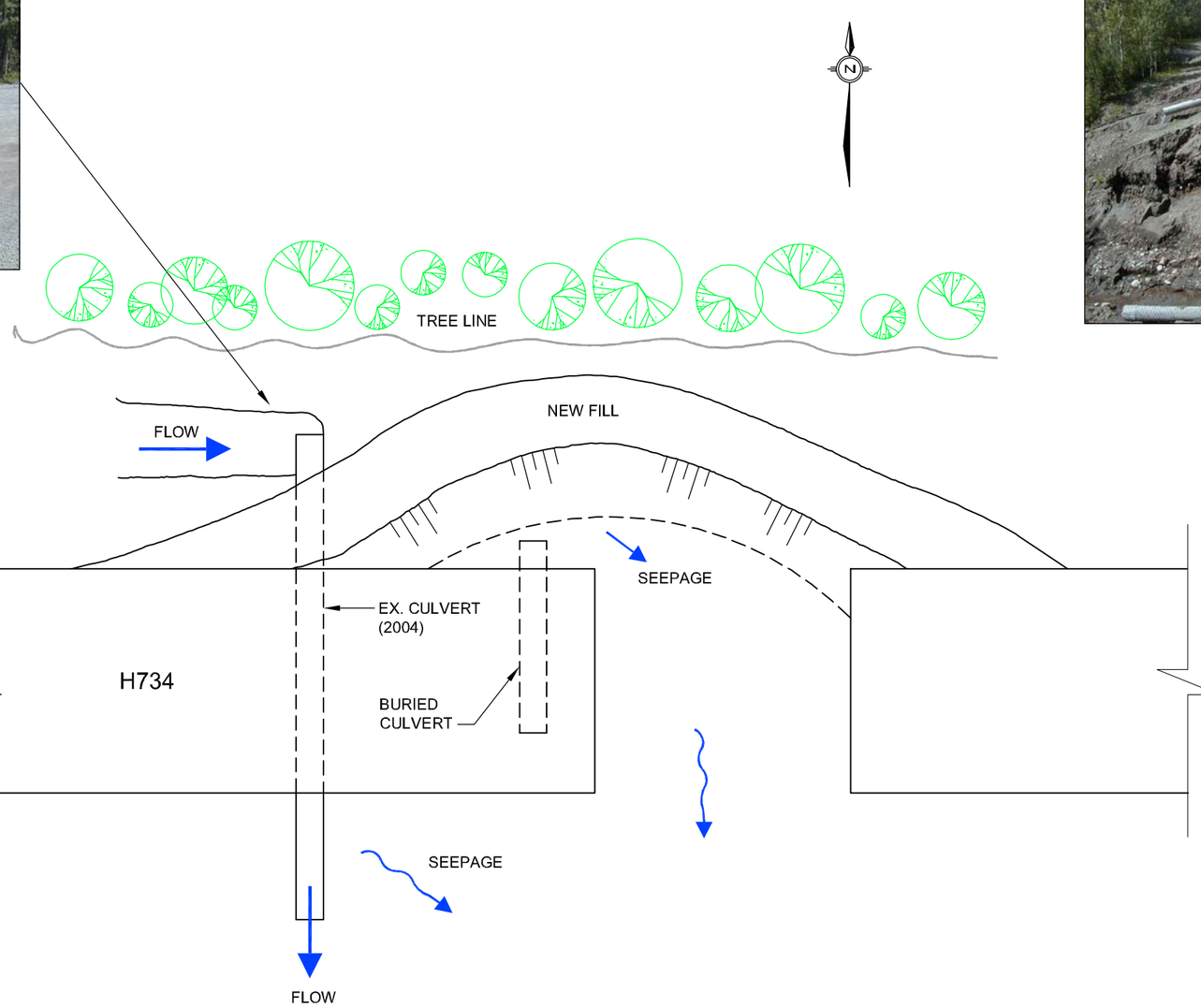
SCALE 1:250 0 2.5 5 m

CONSULTANT
KLOHN CRIPPEN

Alberta
INFRASTRUCTURE AND TRANSPORTATION

PROJECT: CENTRAL REGION
GEOHAZARD RISK ASSESSMENT
TITLE: SITE C30 H734 : 12
POST FLOOD CONDITIONS

DATE	SHEET	DRAWING No.	REV.
JULY 2005	2 OF 5	FIGURE 2	



NOTE:
1. PHOTOS TAKEN
JULY 12, 2005

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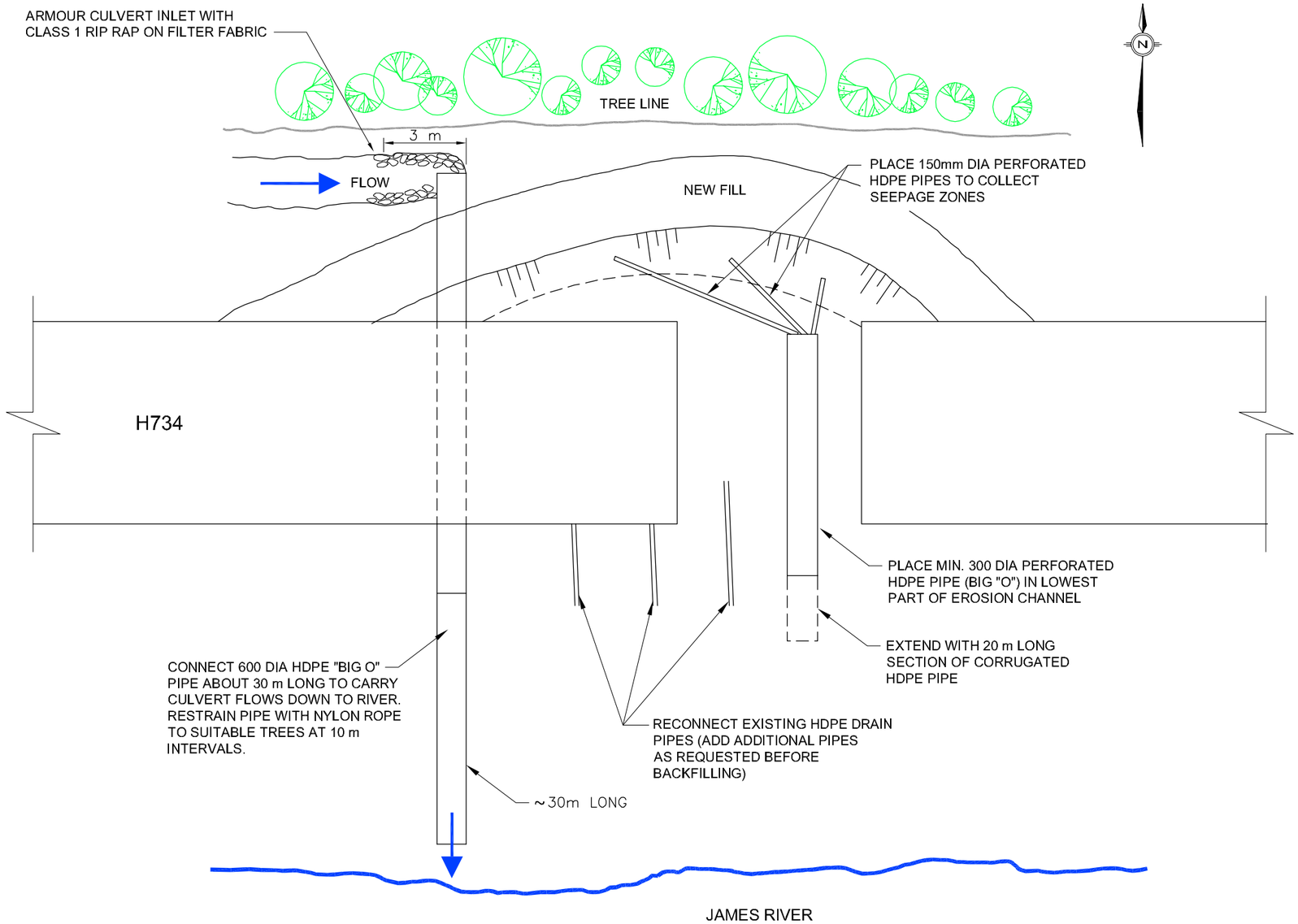
CONSULTANT
KLOHN CRIPPEN

Alberta
INFRASTRUCTURE AND TRANSPORTATION

PROJECT CENTRAL REGION
GEOHAZARD RISK ASSESSMENT
TITLE
SITE C30 H734 : 12
JULY 2005 CONDITIONS

DATE	SHEET	DRAWING No.	REV.
JULY 2005	3 OF 5	FIGURE 3	



NOTES

1. ALL PERFORATED HDPE PIPES TO HAVE FILTER SOCKS.
2. FILTER FABRIC TO BE PROVIDED AT ALL SOIL/GRAVEL INTERFACES.

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CONSULTANT KLOHN CRIPPEN

Alberta INFRASTRUCTURE AND TRANSPORTATION

PROJECT CENTRAL REGION

GEOHAZARD RISK ASSESSMENT

TITLE SITE C30 H734 : 12
INTERNAL DRAINAGE DETAILS

DATE	SHEET	DRAWING No.	REV.
JULY 2005	4 OF 5	FIGURE 4	

PROJECT FILE No. 3038A01.C30.Fig-2.dwg

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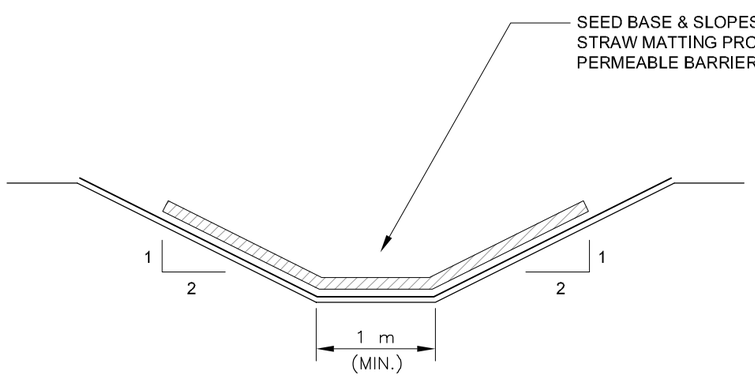
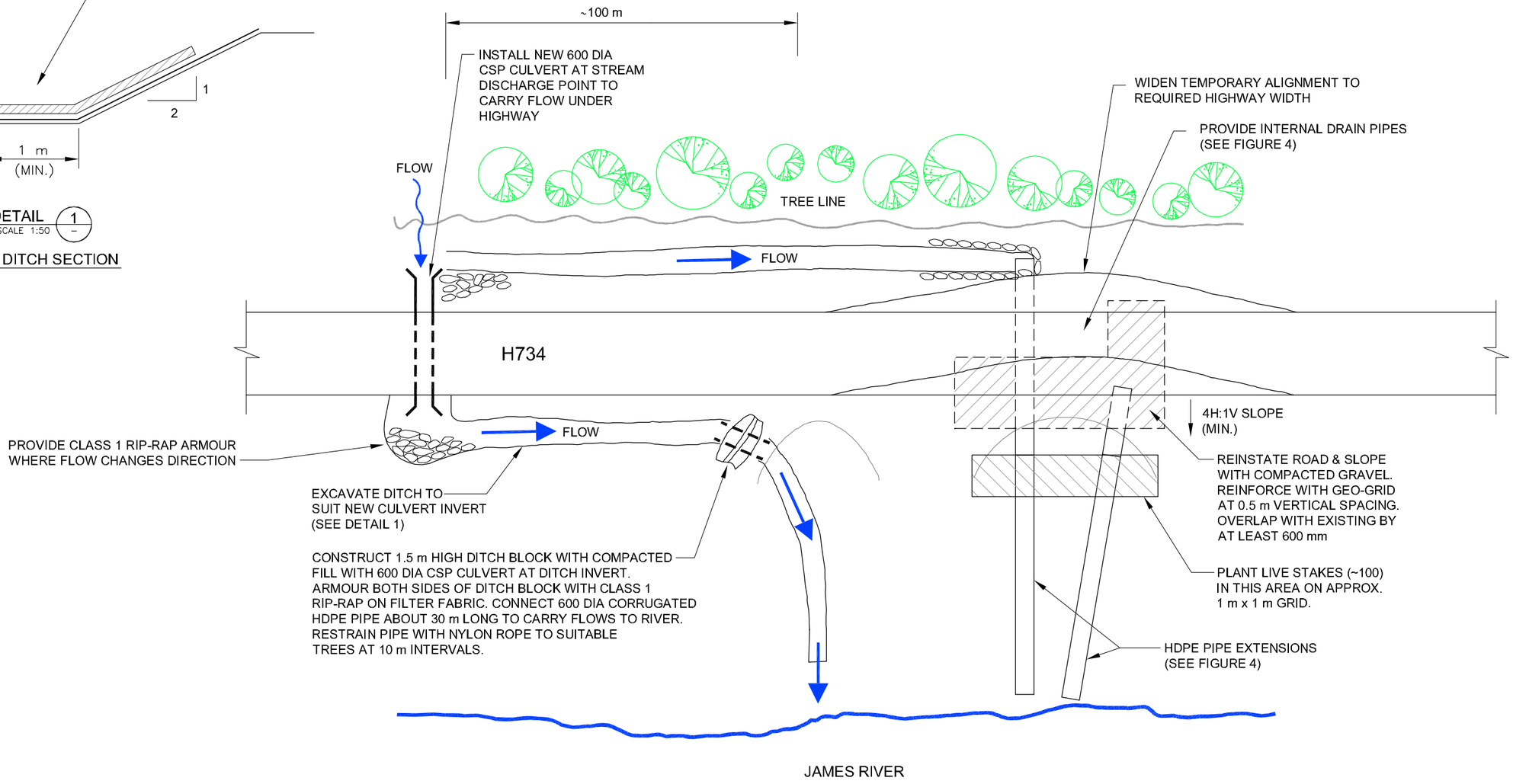
PWSS PLAN No.

MICROFILM DATE



DETAIL 1 – SCALE 1:50

SOUTH DITCH SECTION



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CONSULTANT
KLOHN CRIPPEN

Alberta INFRASTRUCTURE AND TRANSPORTATION

PROJECT
CENTRAL REGION
GEOHAZARD RISK ASSESSMENT

TITLE
SITE C30 H734 : 12
PROPOSED REMEDIATION PLAN

DATE	SHEET	DRAWING No.	REV.
JULY 2005	5 OF 5	FIGURE 5	