Karl Engineering Consultants Ltd.
KARLENG

File: 2006-1002h

Date: July 8, 2007(prelim)

Sept 28/2007 (final)

Alberta Infrastructure & Transportation
#301, 9621 – 96 Avenue
Bag 900, Box 29
Peace River, AB T8S 1T4

Attention: Mr. Ed Szmata
Sr. Construction Technologist

Re: **Call-out Inspection Report**
Hwy 43:00 (1 mile east of B.C. border)
Embankment Slide at Spring Creek Culvert (BF 73565) ISW 8-75-13-6

As requested, a call-out inspection of the site was carried out on July 7, 2007 by Karl Li, P.Eng. of Karl Engineering Consultants Ltd. (KarlEng) in the company of Messrs. Ed Szmata and Brett McPhedran both of Alberta Infrastructure and Transportation (AIT). A report of this call-out inspection is provided as follows.

1.0 SITE

Hwy 43:00 runs east-west and crosses over Spring Creek (BF 73565) at about 1.7km east of B.C. border. Spring Creek flows from south to north.

The sliding of fill embankment occurred after completion of installation of a replacement bridge-size culvert and the construction of embankment fills at both upstream and downstream ends of the culvert. The construction was carried out from January 2007 to early March 2007 using "Dig and Push" method. Total fill height is about 10m above creek bed and the replacement culvert a SPCSP structure is about 3m in diameter. A sketch showing the culvert and the embankment slides (both upstream and downstream) is presented in Figure 1. Site photos are attached.

It is understood that "Dig and Push" operation was carried out below the centre section of the embankment fill to allow continual flow of traffic during construction. It is understood that, along and connecting to both ends of the "Dig and Push" portion, the culvert replacement was installed by open cut using temporary excavation slopes of 1H:1V. It is understood that the culvert construction, excavation and backfill was carried out within the winter weather conditions of January to March 2007.

From construction records (provided by Brett McPhedran of AIT), it was overviewed that the inspection reports (by MPa Engineering Ltd.) did not contain Q/A-Q/C records on excavation of temporary slopes and placement (and material testing) of fills for the embankment slopes. Only several mentions of inspections of ECO Plan and TAS Plan were recorded within the construction inspection documents. Subsequent to the sliding of embankment fills, a letter report (June 7, 2007 from the material testing consultant) JR Paine & Associates Ltd. (PRP) provided observational comments of the slide inspection and indicated that JRP was not on site during construction of the embankment fills.

2.0 SITE OBSERVATIONS

From Figure 1 and site photos, the following site observations are described.

#201 18327 – 105 Avenue
Edmonton, AB, T5S 2K9
Phone: (780) 481-3898, Cell: (780) 920-6818
Fax: (780) 481-3836 Email: karl.li@karleng.com

Along both upstream and downstream slopes of the 10m high fill embankment, headscarp cracks and slumping cracking movements of fill slopes can be observed. The slopes are about 4H:1V along upper half of slope and about 3H:1V along lower half of slope. The breadth of the slide along its headscarp can be estimated at about 50m in length and is offset 1-3m along the roadway shoulder edge. The headscarp crack started at close to road shoulder edge and possibly coincided with the top of temporary cut slopes excavated for "Dig and Push" installation of the culvert.

Undulation settlement and tension cracking of fill slopes can be noted along slope surface despite contractor's effort to dress back the slope.

- Along downstream slope, obvious slumping (0.5 to 1m) of soil blocks and the opening of wider cracks (30 to 60mm) can be observed to include several wet soil spots of along the slope face. It is understood that the contractor was unsuccessful in redressing the top port of the slide and a 1.5m high steep headscarp still remained at the time of this inspection. At some crack locations, hand probing beneath the dried surface soil crust revealed very wet soft clay beneath. At the headscarp centre area just beside shoulder edge and on top of the culvert installation, a spot of very soft wet clay with oozing wetness (resembling a seepage outflow) can be observed to indicate possible presence of deeper depth of wet and soft soil. It is uncertain whether frozen fill may be present and undergoing thawing and softening to cause the present settlement/sliding movements. This should be the primary concern as cause of sliding of this fill embankment.
- A secondary concern will be the adverse effect of high groundwater and its seepage to affect stability of this fill embankment that was stitched back. As the embankment fill was in-place for a long time before "Dig and Push" replacement of the culvert, the opening up of temporary slope offloaded the overburden surface of wet seepage banks at interface of old fill. (This similar situation was experienced at Hwy 40 S-Curve location when the removal of old fill recreated a release of surcharge allow seepage exit to cause movement of the exposed bank slopes.). Thus, it is uncertain whether, at the centre of d/s slope, the spot of wet clay with oozing wetness (resembling seepage outflow) may be connected to a groundwater seepage exit point at base of the fill to further aggravate movement of the incompetent fills. This groundwater seepage can be probable as the adjacent banks were observed wet with obvious signs of seepage at 4m above creek bed elevations, especially along the upstream banks. This will require further investigation.
- Along the upstream slope, narrow tension cracks can be noted and undulation settlement of fills was obvious. The tension crack extended along the headscarp. It is understood that the contractor attempted to dress and seal the crack but was unsuccessful as cracks of 3-5mm width still persisted. Slide movement of this upstream slope has occurred.
- Along the upstream banks, signs of seepage and wet banks can be noted at an elevation as high as the culvert and top of bank riprap placement. It can be estimated the seepage along the banks can be estimated attempts at 3-5m above creek bank elevation.
- Along the roadway pavement, settlement of fill at centre of culvert seems to persist despite of pavement overlay to patch up the settlement. It maybe possible that a loss of ground might have occurred in the event that excavation advance of the "Dig and Push" operation may have encountered wet seepage soil conditions causing a void out "loss of ground" of a larger annulus area at centre of roadway. It maybe possible that loss of grounds was not completed in filled or grouted back for support of roadway. This possible scenario of presence of seepage and wet ground conditions in conjunction with probable "loss of ground" along the floor of the excavation can invoke settlement of roadway. It will be advantageous to check with the "Dig and Push" contractor if wet ground and seepage conditions and "loss of grounds" were encountered. Future maintenance operation may require more patching to accommodate the settlement before the settlement stabilizes.

3.0 ASSESSMENT

Sliding movement of the fill embankment has obviously occurred along both upstream and downstream slopes. The sliding is related the excavation of steep temporary slopes for this culvert installation and the in-effective reconstruction of the slopes. The ineffective construction and sliding of the fill slopes can be related to the following possible causes.

- The footprint of the fill may not be properly cleaned out for key in the new fill during the winter construction months. This can create a sliding surface along the footprint and base of fill.

- The fill material may be derived from the temporary slope excavations that was stockpiled and was frozen over the winter months, with possibly snow inclusions. As frozen material is not compactable, it will cause a thawing and softening frozen material to result settlement and sliding of fill embankment despite compaction effort inserted.
- Winter construction of fill may not include bench-key in of new fill, moisture conditioning and compaction of fill in layers. This will invoke sliding of fill along the old-new fill interface and settlement of fills.
- The stitching back of fill at the small areas of temporary slopes is a delicate construction process that requires special QA-QC effort during winter freezing temperatures, especially for this site with seepages along the banks. It will require careful control of fill placement operation including quality of non-frozen fill, proper moisture conditioning, clean out and keying of new fill footprint, bench in to key in the new fill. For stitching-in new fill at strong seepage sites, it is advisable to install a gravel drainage blanket at interface between new fill with the creek banks as well as along the footprint of the embankment slopes.

3.1 Risk Assessment

According to AIT risk rating, the following risk rating is assessed.

Risk = Probability Factor (PF) * Consequence Factor (CF)
= 9 * 2
= 18

PF = 9 is assessed because
- The sliding of fill embankment slope is active and steady but with slow movement
- Slide probable causal by use of incompetent fill (Frozen Fill remains to be investigated)
- Possibility of groundwater influence maybe contributory to aggravate sliding as seepage along creeks is observed.

CF = 2 is assessed because
- Slide should not encroach to affect roadway and closure
- Slide should be confined to area of temporary slope areas that was excavated for “Dig and Push” construction of culvert
- Roadway settlement may require patchings (this is causal from possible “loss of ground” from the “Dig and Push” installation of culvert) (this roadway settlement should be not caused by the sliding of fill embankment slopes)

4.0 RECOMMENDATIONS

It is recommended that the following investigation be carried out:
- A testpitting investigation to be carried out to check on the cause of failure. It is important to investigate if the presence of frozen fills as well as any presence of wet seepage conditions prevails along the creek banks.
- In the event that frozen fill be investigated as the cause of sliding of this fill embankment, the slope should be reconstructed using competent fill with proper benching and compaction.
- In the event of presence of wet and seepage banks be confirmed, the use of granular drainage blanket use should be designed and constructed to chimney interface the wet bank and to basal interface the footprint of the fill. The stitching back of new fill over seepage area will require more drainage design and construction attention. The need and requirements for this drainage blanket design should be further discussed after a testpitting investigation. However, this interface drainage design aspect should be considered especially for the stitching back of new fill slopes ontop of a wet seepage creek bank that was previously covered the old fill to surcharge and seal off the seepage exits.

5.0 CLOSURE

We appreciate the opportunity to provide the above information. Should you require further information, please contact the undersigned.

Signed by
Karl Li, P.Eng.
Senior Geotechnical Engineer

cc. Roger Skirrow, P.Eng. AIT Twin Atria

Attachment
- Figure 1
- Site Photos

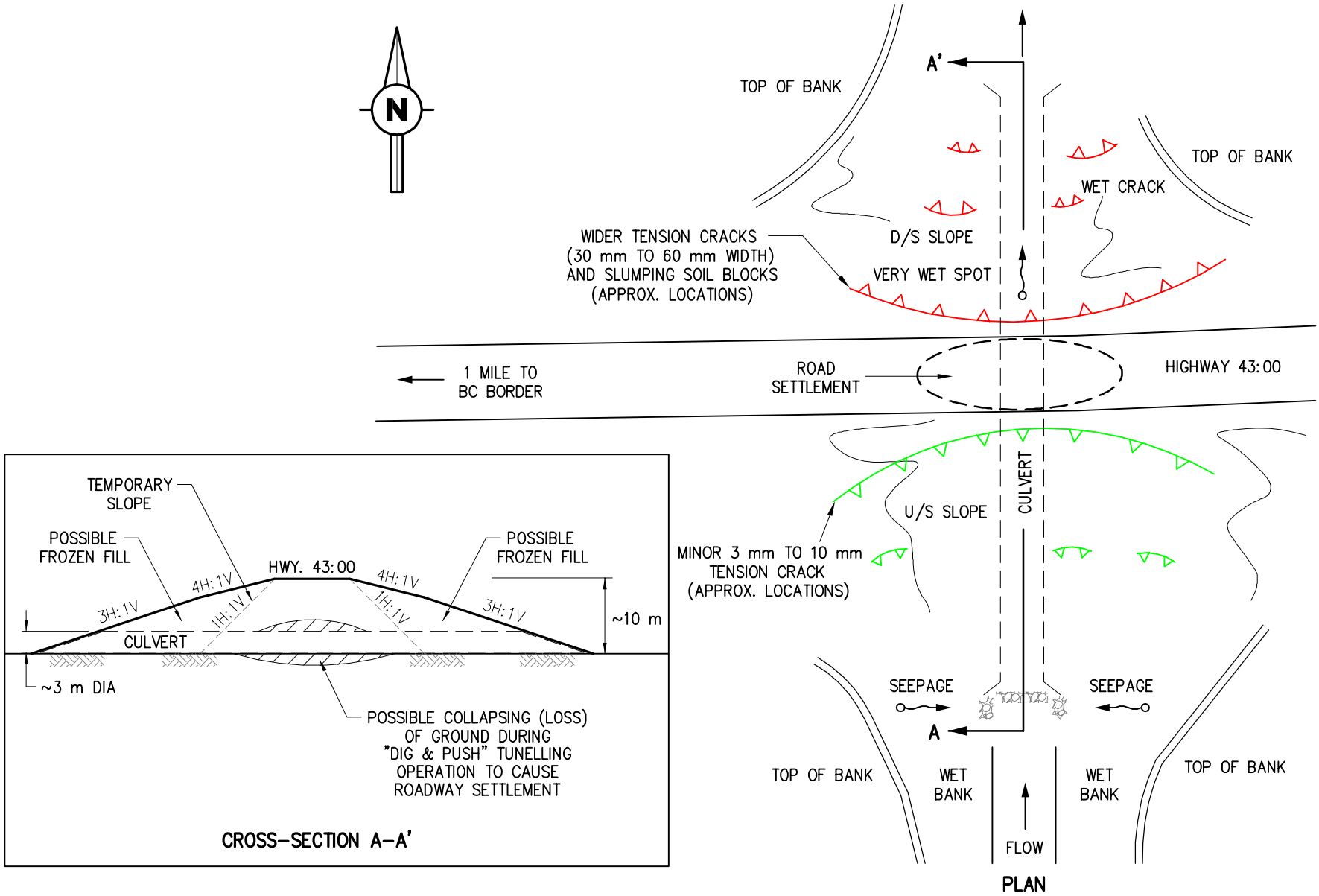

Figure 1
Slide at Embankment Slope u/s & d/s

NOTE: DRAWING NOT TO SCALE

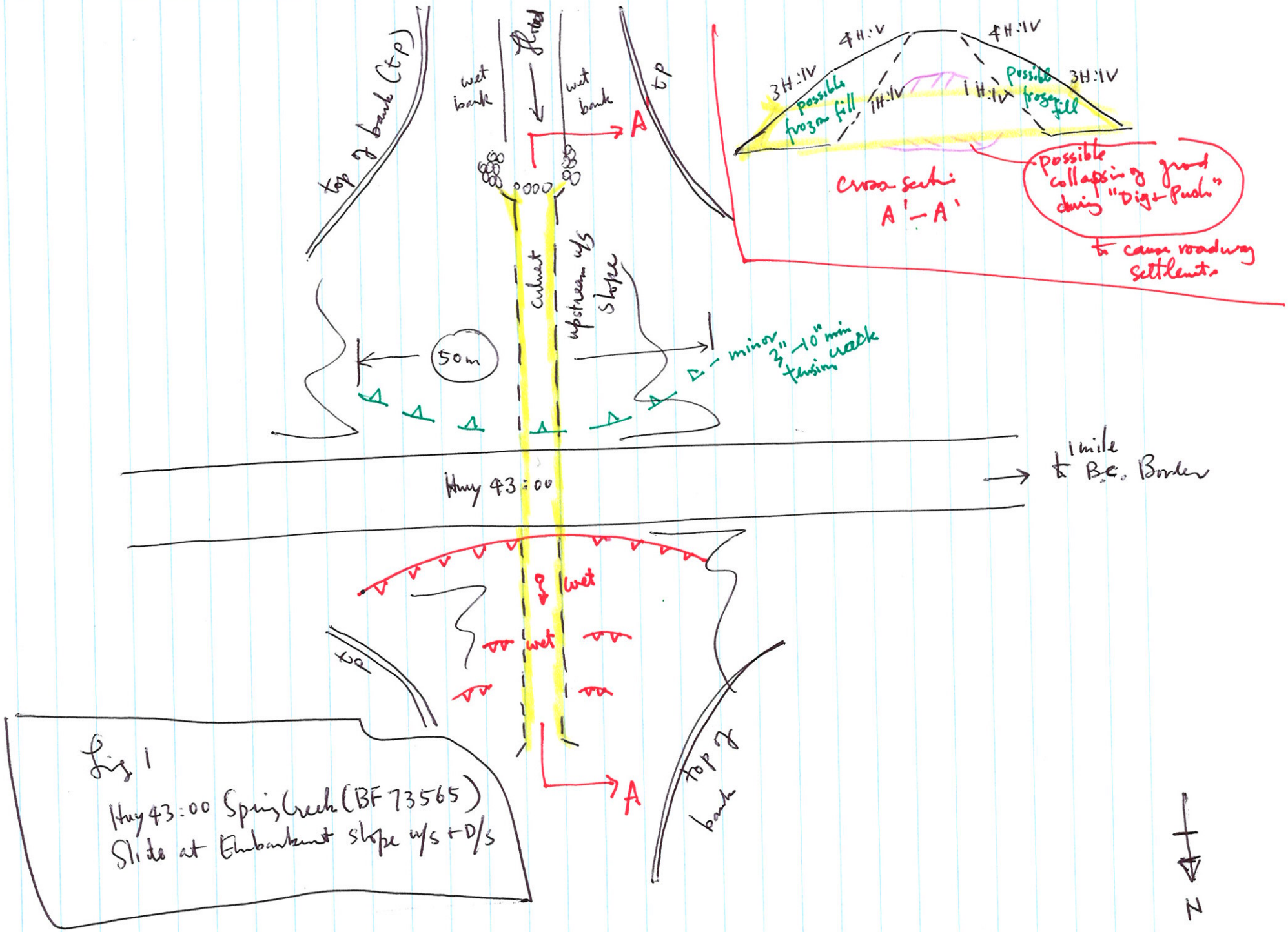

Fig 1

Hwy 43:00 Spring Creek (BF 73565)
Slide at Embankment slope u/s + D/s

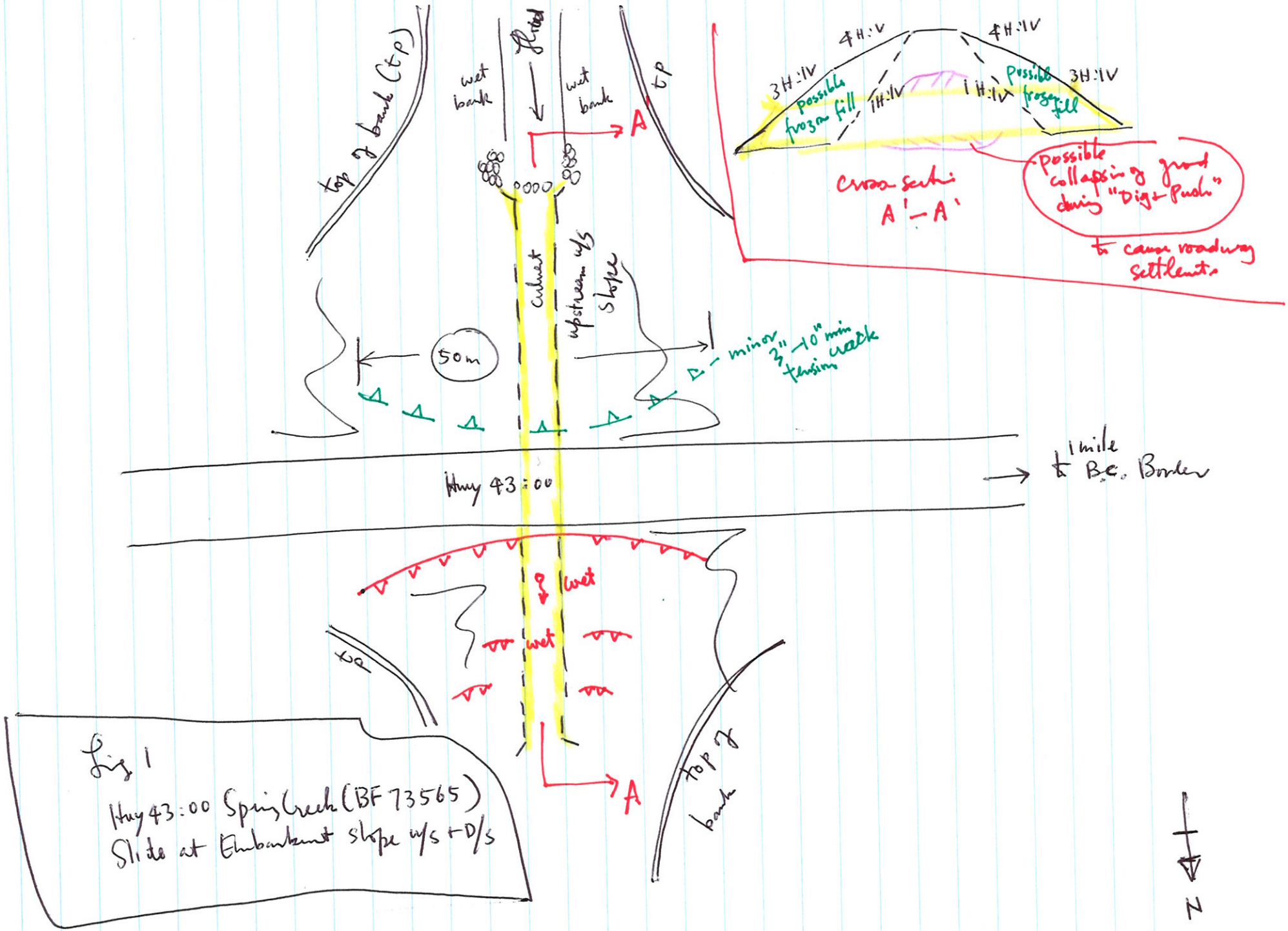

Fig 1

Hwy 43:00 Spring Creek (BF 73565)
Slide at Embankment slope u/s + D/s

Photo 1

Looking west (at B.C. Border) on upstream side of fill embankment
- Cracking and Settlement of fill obvious from the sliding of fills along culvert (centre) alignment
- Contractor attempted to seal off crack; however 3-5mm wide tension crack can be observed along a 50m breadth of slide scarp across the culvert top
- Cracking of fill starting from slope top at 1-2m offset from shoulder edge
- Slumping and undulation settlement of fill extending from shoulder to slope toe despite apparent effort by contractor to dress back the slope
- Apparently, the fill seems fluffy and not in well compacted state. Quality of fill questionable-frozen? Snow? Compaction?
- Seepage and wet banks can be noted at upstream banks (close to top elevations of culvert and riprap) at 3m-4m above creek bed

Photo 2

Looking west (at B.C. Border) on upstream side
- Settlement of road-pavement still obvious from road undulation
- It maybe possible that the “tunneling” (dig and push) culvert installation operation may have experienced loss of ground to incur settlement at top of fill at top of culvert
- It maybe possible that the “tunneling” excavation might have encountered wet and seepage grounds to cause settlement at roadway centreline area

Note: Photos taken on June 2007

Photo 3
Looking south at upstream of Spring Creek Channel
- Wet soils and seepage exit from both banks obvious

Note: Photos taken on June 2007

Photo 4

Looking west (at B.C. Border) on downstream side
- Sliding of fill embankment obvious despite contractor's effort to dress back slide. A drop of headscarp crack (1.5m) at shoulder
- Progressive downslope slumping blocks and wide tension cracks (40mm to 60mm width) obvious
- Wet fill at inside of crack and below fill surface can be indication of frozen material being thawed
- Compaction of fill very questionable, quality of fill very questionable

Photo 5

Looking south (up road) from downstream outlet
- Sliding and settlement of fill obvious

Note: Photos taken on June 2007

Photo 6

Looking west (at B.C. Border) along downstream side
- Drop of fill at headscarp of about (1.5m) despite contractor's effort to dig out and dress back
- slide at deeper depth and possible presence of incompetant fill
(uncompacted, frozen, snowy) to be located at depth
- Wet seepage spot at surface of fill due to melting if frozen wet fill

Photo 7

Another wet fill sign along downstream slope
- Wet soft fill can be located at inside of cracks and beneath dried surface crust of fill

Photo 8

Looking at culvert from downstream outlet
- Culvert structure looks ok

Note: Photos taken on June 2007