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G.I.-30 SEPT. 1976

GEOCRES No. 4012-54

DIST. 2 REGION

W.P. No. 374-94-00

CONT. No. 94-07

W. O. No.

STR. SITE No.

HWY. No. 401

LOCATION Hwy 401, 1 km E of
Culloden Rd. - Slope Failure

No of PAGES -



OVERSIZE DRAWINGS TO BE INCLUDED WITH THIS REPORT.

REMARKS:



Ministry
of
Transportation

FILE No. _____ DATE _____

REMARKS _____

Gord Arthur - District London

1995 Construct

C. Supanin Jim Dennis

Fax 579-644-1496

Office 579-644-1960

Mobile 579-878-8083

Selina Kern - F. Student for WWO

Don Parker - projet aéroport

Quality Assurance Bob McArthur 579 681-1440

579 3298

Whiting Creek

WO 94-11009

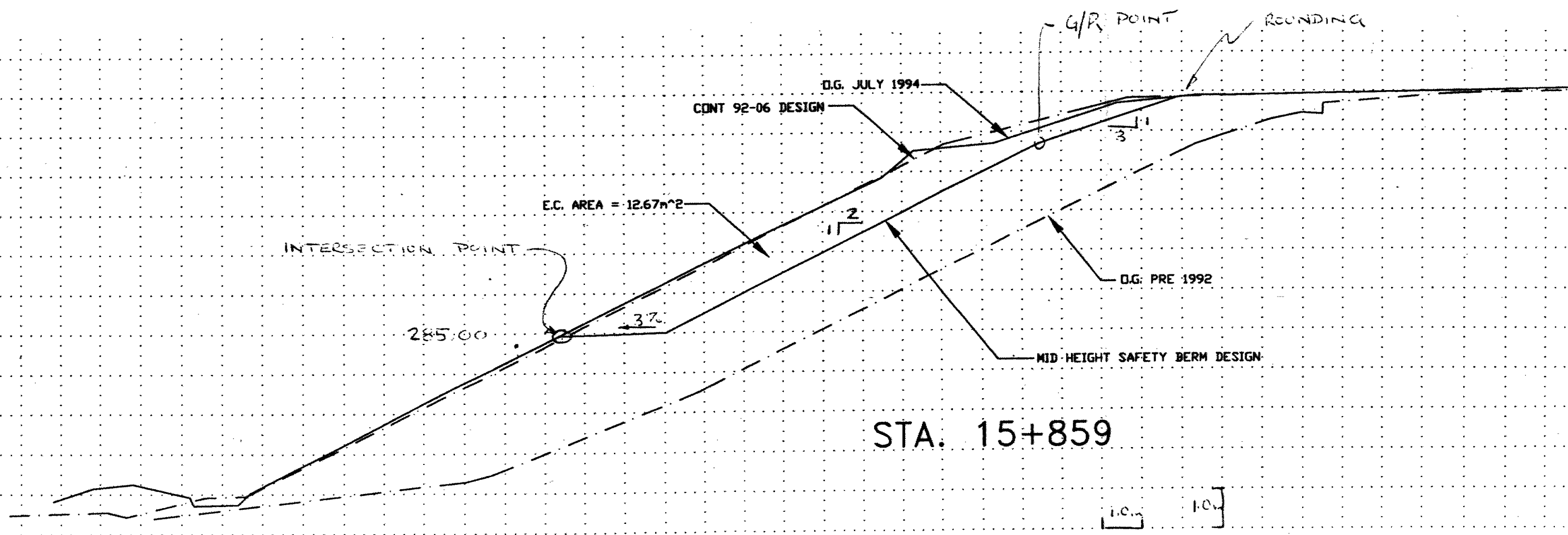
02 WP 370-94-02

recycled
recycle



Cont 52-06

139



18.00

E.C. AREA = 12.28m^2

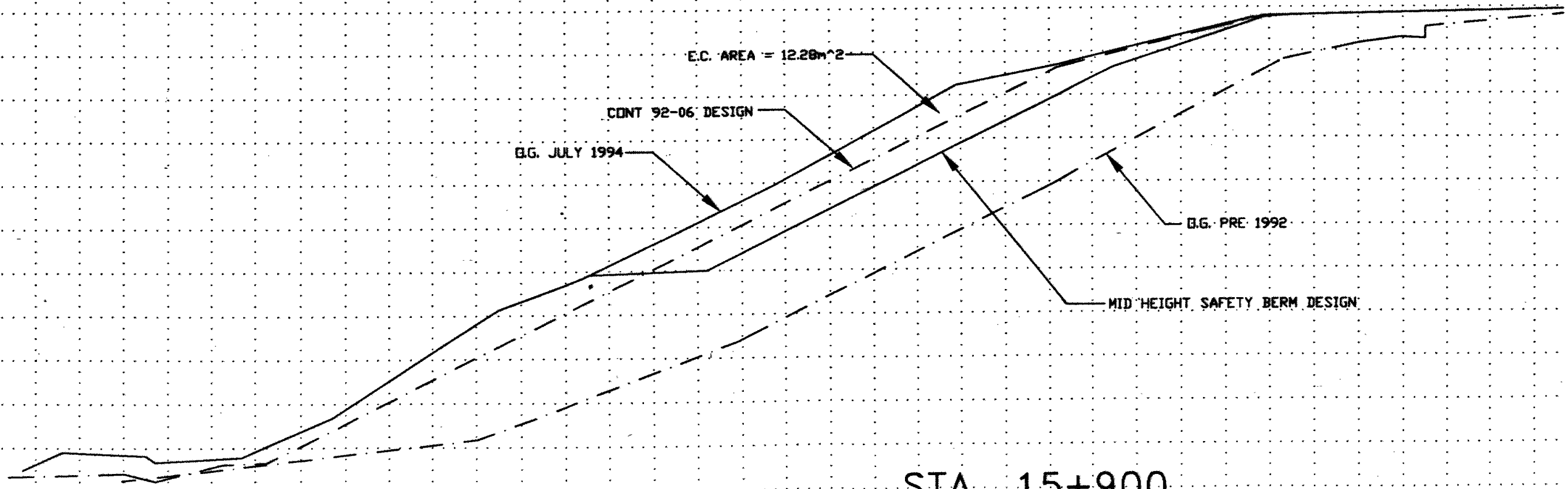
CONT 92-06 DESIGN

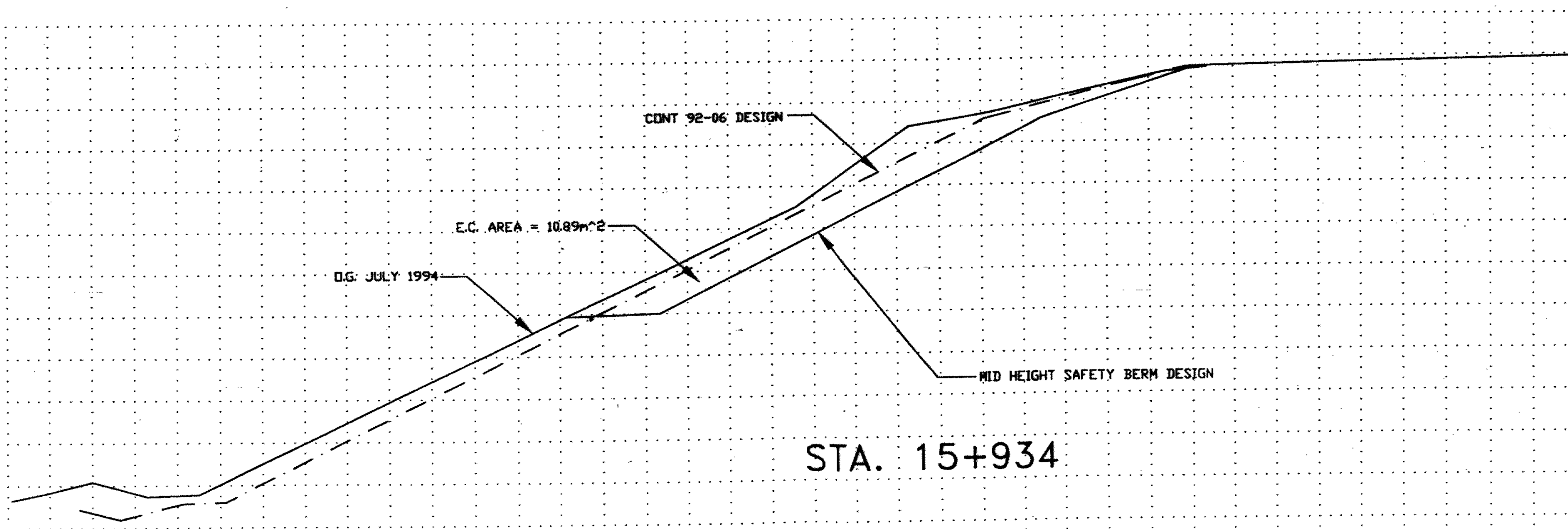
B.G. JULY 1994

B.G. PRE 1992

MID HEIGHT SAFETY BERM DESIGN

STA. 15+900





D.G. JULY 1994

CDNT 92-06 DESIGN

E.C. AREA = 10.89m²

MID HEIGHT SAFETY BERM DESIGN

STA. 15+934

30

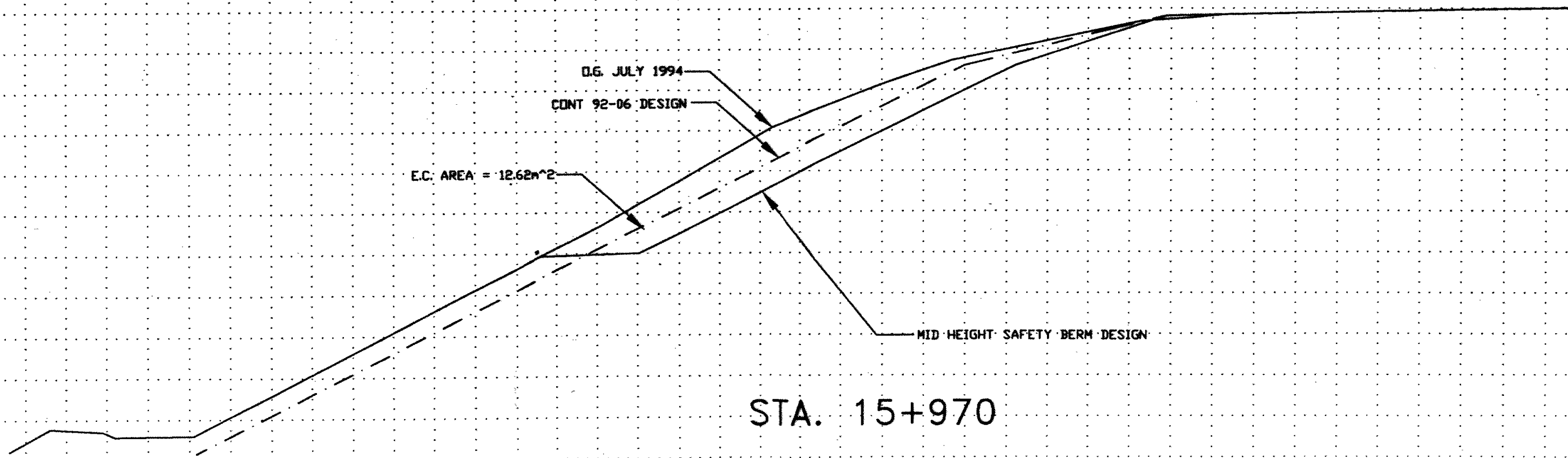
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D.G. JULY 1994
CONT 92-06 DESIGN

E.C. AREA = 12.62m²

MID HEIGHT SAFETY BERM DESIGN

STA. 15+970



0.90

7.00

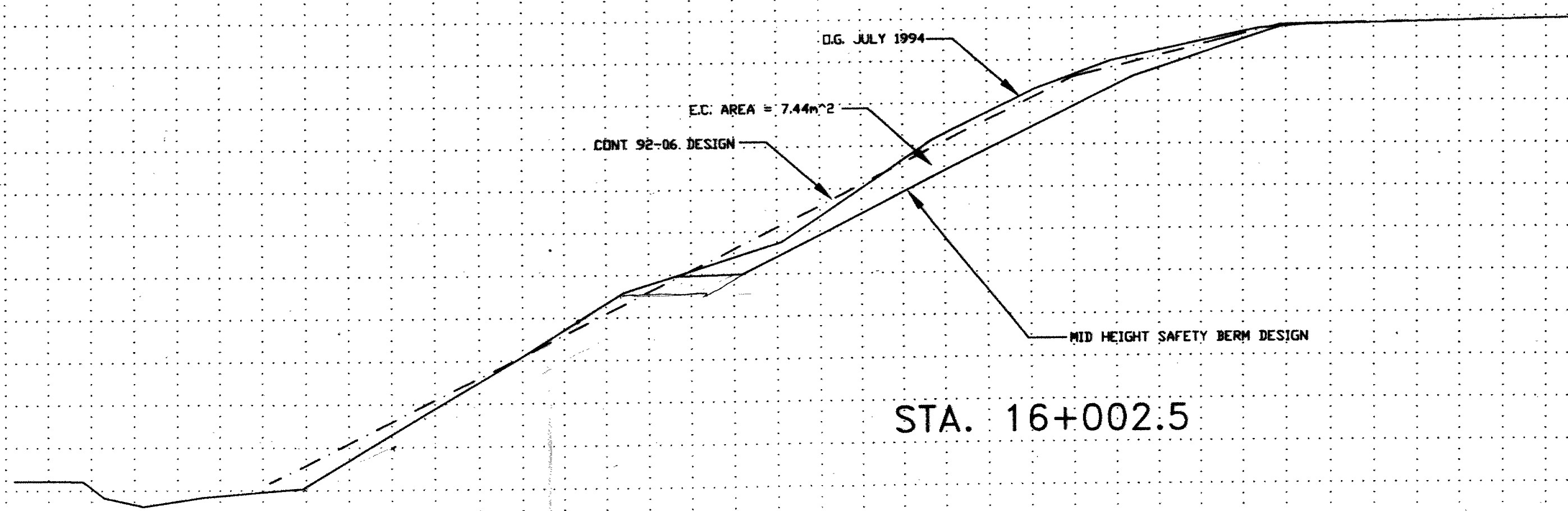
D.G. JULY 1994

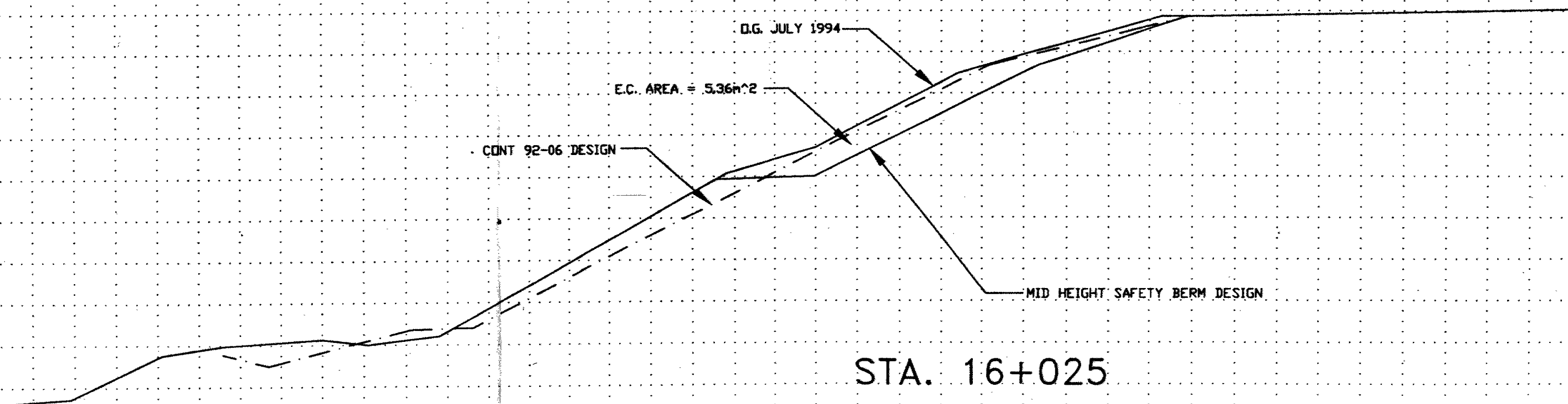
E.C. AREA = 7.44m²

CONT 92-06. DESIGN

MID HEIGHT SAFETY BERM DESIGN

STA. 16+002.5







MEMORANDUM

Engineering Materials Office *Pavements and Foundations*

Room 315, Central Building, Downsview
Tel: (416) 235-3731 Fax: (416) 235-5240

To: T. Rooke
Contract Review Office
Southwestern Region

Date: 95 06 15

From: T.C. Kim

RE: Review of Contract Drawings and Documents
Highway 401 at Whiting Creek
W.P. 374-94-00
District #31, London/Stratford

The final drawings for the above noted project have been reviewed by this Office. Our comments are summarized below.

1. A 3.0 m wide mid-height berm should be indicated on Sheet 8.
2. For the subdrainage ditch at the mid-height berm, the backfill material should be replaced with granular 'O' material or 19 mm clear stone should be wrapped with geotextile in order to prevent the clear stone from direct contact with sandy silt fill between counterfort drains.

We have no further comments. However, if there are any questions, please contact this office.

A handwritten signature in black ink that reads "Tae C. Kim".

Tae C. Kim, P. Eng.
Senior Foundation Engineer

TCK/mmj

c.c. M. Ayton
E. Magni

memorandum



To: E. Magni.
Head, Geotechnical Section
Southwestern Region

March 13, 1995

From: Pavements and Foundations
Room 315, Central Building

Re: Whitings Creek Slope
Highway 401, East of Culloden Road
W.O. 90-11006
District 2, London

Further to your FAX memo dated March 9, 1995, this memo summarizes our comments to your questions.

- 1) The mid height berm can be eliminated for a 2.5H to 1V slope if the slope geometry allows.
- 2) It is our opinion that diagonal counterfort drains should be constructed with a depth of at least 1.5 m since the frost penetration depth in Woodstock is estimated to be 1.3 m.

We believe that this memorandum meets with your present requirements. However, should you have any questions regarding this memo, please do not hesitate to contact this office.

TCK/mmj

A handwritten signature in black ink that reads "Tae C. Kim".
Tae C. Kim, P. Eng.
Sr. Foundation Engineer

MEMORANDUM



To: M. Bond
Head, Geotechnical Section
Southwestern Region

Date: January 17, 1995

Attn: Eric Magni, Soils Supervisor

From: Pavements and Foundations Section
Room 315, Central Bldg.

Tel: (416) 235-3731
Fax: (416) 235-5240

Re: Embankment Slope Failure
Highway 401 at Whiting Creek
East of Culloden Road
W.O. 94-11009 (Cont. 92-06, W.P. 374-94-00)
District 2, London

Further to the meeting held at your office on January 13, 1995, this memo summarizes our further agreement.

As discussed at the meeting, alternatively, Gravel sheeting or Granular blankets can be used where groundwater flow must be controlled to ensure slope stability. However, Granular blankets do not adequately sustain vegetation cover since granular materials promote moisture depletion and do not contain sufficient nutrients.

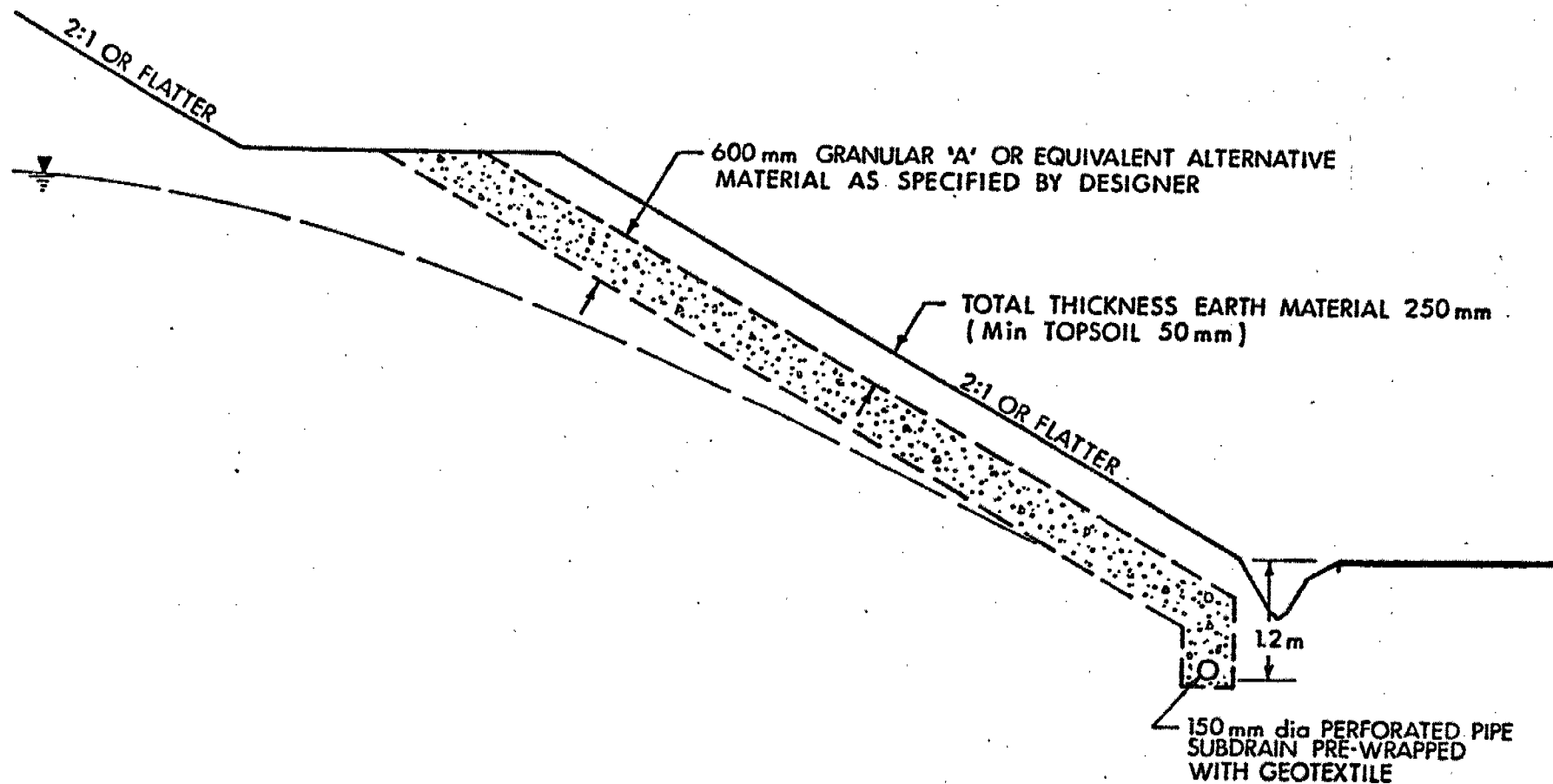
The attached figure is a detail summarizing the consensus reached during the meeting with the landscape unit of the Central Region. It incorporates a sufficient thickness of earth and topsoil (250 mm) to meet architecture requirements while providing drainage to ensure slope stability.

We believe that this memorandum meets with your present requirements. However, should you have any questions regarding this memo, please do not hesitate to contact this office.

TCK/jb

Tae C. Kim
Tae C. Kim, P. Eng.
Sr. Foundation Engineer

cc: M. Ayton - Planning & Design Section
J. Richard - Construction Office



GRANULAR BLANKET

memorandum



Geotechnical Section, Southwestern Region, London

Fax: (519) 649-3108

To: T. Kim
Sr. Foundation Engineer
Pavements and Foundations Section
Engineering Materials Office
3rd Floor, Central Building
Downsview

Date: December 20, 1994



Re: Slope Failures
Highway 401 at Whiting Creek
East of Culloden Road
District 2, London/Stratford
W.P. 374-94-00

*Discussed in January 13, 1995
meeting*

As you are aware, proposed remedial work to these slopes has been delayed until the summer of 1995. The attached cross-sections were surveyed in July 1994 and show the following information.

- Original ground prior to Contract 92-06
- Theoretical widening on the north side of Highway 401 from Contract 92-06 design section rolls
- Ground as determined in July 1994
- Proposed mid height berm design based on maintaining the existing 1.0 m rounding, steepening up the granular side slope behind the guide rail from 4:1 to 3:1, removing the earth fill below the new G/R point at a 2:1 slope, and constructing a safety (mid height) berm at elevation 285.00 m to intersect the original ground

Due to the lateness of the season and the extent of proposed remedial work recommended by the Foundation Section, it was decided to undertake this work in 1995.

In order to prevent potentially harmful sedimentation of the creek, it was decided by the Region to implement some interim remedial measures in the fall of 1994 by a force account.

The repairs involved:

- removal of wet earth material at the G/R point on north slope from Station 15+850± to 16+050 ±,
- reshaping of the north slope with a drag line from Station 15+964 ± and 16+033 ±,
- placement of sandbags on the granular side slope behind the three cable guide rail to channel surface runoff from the west bound driving lanes between Station 15+964 ± and 16+033 ± to the rock chutes,
- placement of gabions on top of Whiting Creek culvert on the north.

In addition, it was decided in the Region to install a subdrain by the end of 1994 between the guide rail and the G/R point on the north and south slopes to drain the granular base. The top of the subdrain backfill will be slightly depressed to encourage surface water into the subdrain. Sand bags will be placed along the top of the down slope edge of the subdrain for the same purpose. This will minimize surface water on the fill slope.

SITE OBSERVATIONS

Cross-sections at Sta 15+900, 15+934, 15+970 and 16+025 show material in excess of the Contract 92-06 design line. Towards the end of construction in 1993, surficial failures occurred on both north and south slopes and equipment was used to pull excess material back up the slope. In many cases the G/R point was covered with earth preventing positive seepage from the granular base.

Hand auger holes put down by the Geotechnical Section indicated approximately 0.5 to 1.0 m of soft, wet material overlying firm to stiff, moist soil. These depths correspond with the 'excess' material shown on the cross-sections. Three trenches through the shoulder granular indicated that the earth in the fill widening was hard.

Because of the soft (uncompacted) nature of this 'excess' material, it is probable that surficial runoff and seepage from the granular saturated and softened it. In some locations small mud slides occurred. Heavy rainfall was recorded in late 1993 and early 1994. This contributed to the softening and subsequent production of deep erosion gullies in this soft upper layer.

On October 27, 1994, subsequent to the fall 1994 interim repairs, sloughing occurred again immediately below the G/R point. Again during interim repairs soil was placed over the G/R point preventing seepage from the granular base. Hand dug trenches showed that the source of the water was the granular and that soil in the slope close to the surface was stiff and at approximately optimum moisture content. Very little rain had fallen in the months preceding the interim repairs, and sandbags had been located along the granular side slopes between the rounding and G/R point to direct surface runoff to rock chutes instead of down the earth fill.

In summary:

- 'Excess' soil pulled up the slope at the end of construction appears to be soft, wet and poorly compacted. It is approximately 0.5 to 1.0 m deep.
- The soil below this excess material appears in general to be well compacted and close to optimum moisture content, i.e. the fill widening placed in Contract 92-06.
- Seepage from granular into the 'excess' soil is the principle cause of softening and mud flows.
- Surface runoff subsequently created deep erosion gullies into this softened soil.

DISCUSSION OF FOUNDATION SECTION RECOMMENDATIONS

Recommendations presented in your memo dated August 26, 1994 have been discussed on several occasions including representation from Planning and Design, Construction, District and Geotechnical. Based on these discussions, we have the following questions and suggestions for your consideration (recommended remedial measures listed on page 2 of your memo are addressed in numerical order):

- OK
- (1) In order to avoid widening the lower half of the slope, relocation of the ditch and possible purchase of property, we recommend that the lower half of the slope with the exception of trimming and compacting remain as it is. The detail on the cross-section indicates this can be achieved by maintaining the existing 1.0 m rounding, steepening up the granular side slope behind the guide rail from 4:1 to 3:1, removing the earth fill below the new G/R point at 2:1 slope, and constructing a safety berm at about elevation 285.00 m to intersect the original ground. This will mean that the mid height berm will vary in width from 1.6 to 2.8 m, whereas the width recommended in your memo is 2.0 m. OK.

Still need to depress ground water level

4 -

NO

still need subdrain

We suggest that a ditch be constructed along the mid-height berm to intercept the runoff water identified in your point 3, therefore eliminating the need for the cutoff trench and subdrain. The ditch would have a longitudinal slope which would outlet to rip-rap lined chutes. Planning and Design proposes to carry out a drainage design to size this mid height ditch and determine whether rip-rap is necessary.

- (2) Surface runoff is to be minimized by ditches, sandbags, subdrains and chutes at top and mid height of slope. Seepage from the granular base appears to be the principle cause of sloughing. The region would therefore prefer not to install concrete curb or asphalt gutter. This will also eliminate the need to replace existing three cable guide rail with steel beam guide rail and channel (or concrete barrier) and possibly eliminate the need for temporary concrete barrier during reconstruction.

yes we need it

- (3) We suggest that this subdrain trench may not be necessary as discussed in (1) above.

OK

- (4) It appears that the proposed 2:1 slope and mid-height berm as described in (1) can be constructed in the vicinity of the culvert. A concrete head wall may not be necessary, subject to confirmation by field survey.

- (5) Given that the poorly compacted, soft 'excess' soil will be removed from the upper slope and that seepage from the granular base will be largely controlled by a subdrain, it is questioned whether counterfort drains are still necessary. If after further consideration the Foundation Section still requires counterfort drains, please provide recommendations on how to achieve the following.

See we backhoe

- a) What method should be employed to excavate 1800 m of 0.5 m wide by 1.5 m deep diagonal trenches on a 2:1 slope? How do we ensure that the soil slope remains compact and undisturbed during this process?

Dumping will achieve >90% compaction

- b) How is the Granular A backfill placed and compacted in these trenches? To obtain the required compaction the granular must be placed in 300 mm lifts; failure to compact will give rise to settlement and erosion by surface water.

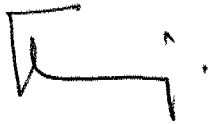
yes. (6) need depress water table

- (6) Why is rip-rap necessary along the toe of the slope? West of Whittings Creek longitudinal flow velocities are low due to flat grades. The steep grades east of the creek are already protected by rip-rap.

- (7) We agree with your recommendation.

We would appreciate meeting with you at your earliest convenience to discuss this project.

Thank you.



E. R. Magni
Soils Supervisor
For C. M. Bond, Head
Geotechnical Section
Southwestern Region London
(519) 681-1441 Ext 3152

EM150/cs

cc: D. Leckie
P. Bryar
J. Richards/L.Pye
H. Welker
A. Irving/N. D'Alessandro
M. Ayton
J. Small
N. Zohorsky

MEMORANDUM



To: M. Bond
Head, Geotechnical Section
Southwestern Region

Date: August 26, 1994

Attn: Eric Magni, Soils Supervisor

From: Foundation Design Section
Room 315, Central Bldg.

Tel: (416) 235-3731

Fax: (416) 235-5240

Re: Embankment Slope Failure
Highway 401, 1 km East of Culloden Road
W.O. 94-11009 (Cont. No. 92-06, W.P. 479-89-00)
Geocres 40P2-54
District 2, London

Further to the official request from the Regional Geotechnical Section (Fax memo, June 30, 1994), site visits have been made by members of the Foundation Design Section and your Geotechnical Section during July 6 and August 5, 1994 at the above mentioned site. This memo will summarize our observations made during the site visits and recommendations pertaining to the remedial measures.

OBSERVATIONS

The following visual observations were made on July 6 and August 5, 1994 by Tae C. Kim.

- 1) Tension cracks and surficial sloughing running parallel to the roadway, were noticed at the north side slope of Hwy. 401 WBL. These failures generally are present along the crest below the asphalt paved shoulder, outside the guide rail, and extend to about 200 m from east to west.
- 2) It was found that localized surficial sloughing was also present on the south side of Hwy 401 EBL slope in the vicinity of the concrete culvert.
- 3) The material within top 3-4 m from the crest was very wet and silty.

DISCUSSION AND RECOMMENDATIONS

Based on our visual observation at the site, the slope instability of the approach embankment of the C.P.R. Overhead structure at Hwy 401 appears to be of a surficial nature within the fill embankment itself rather than a deep-seated one. The primary cause of these surficial sloughing (localized failures) is probably due to the poor compaction of the silty fill material with high water content and the action of surface water seeping through the slopes which resulted in softening of the fill material composed


of the sandy silt.

In view of this, it is recommended that the following remedial measures be carried out as soon as possible in order to control the seepage within the fill and to stabilize the sloughed part of the slopes.

- 1) All of the unstable and/or loosened material in the area where the slippage has occurred should be removed and restored to a slope with a geometry not steeper than 2H:1V with a 2 m mid-height safety berm along the entire length of the fill slope, as shown on Figure 1. The fill should be keyed into the pre-existing slope in accordance with current MTO Standards and practice (OPSD 208.01).
- 2) Concrete curb or asphalt gutter with catch basins should be constructed along the crest of the upper slope on the shoulder of the highway.
- 3) An adequate cut-off trench (base width of 0.6 m) should be constructed along the crest of the mid-height berm in order to intercept the runoff water. A 150 mm diameter perforated subdrain pipe should be installed within the cut-off trench as shown on Figure 1.
- 4) If a new geometry of slope (2H:1V slope with a 2 m safety berm) is not adequate in the vicinity of the existing culvert, a concrete head wall should be constructed in order to accommodate the above proposal.
- 5) Diagonal counterfort drains at least 1.5 m deep and having a minimum base width of 0.5 m should be constructed from the limit of the fill slope to the toe of the slope. The spacing of these drains should be about 10 m from centre to centre at their upper surface. The material used for the drains should consist of free-draining granular material, such as Granular "A". The details of the counterfort drains are shown on Figure 1 attached.
- 6) Toe protection with rip-rap (minimum 0.5 m thick) should be provided in order to prevent it from erosion.
- 7) After completion of the rehabilitation, the slope should be sodded in accordance with OPSD 218.01 to protect the fill slope from erosion.

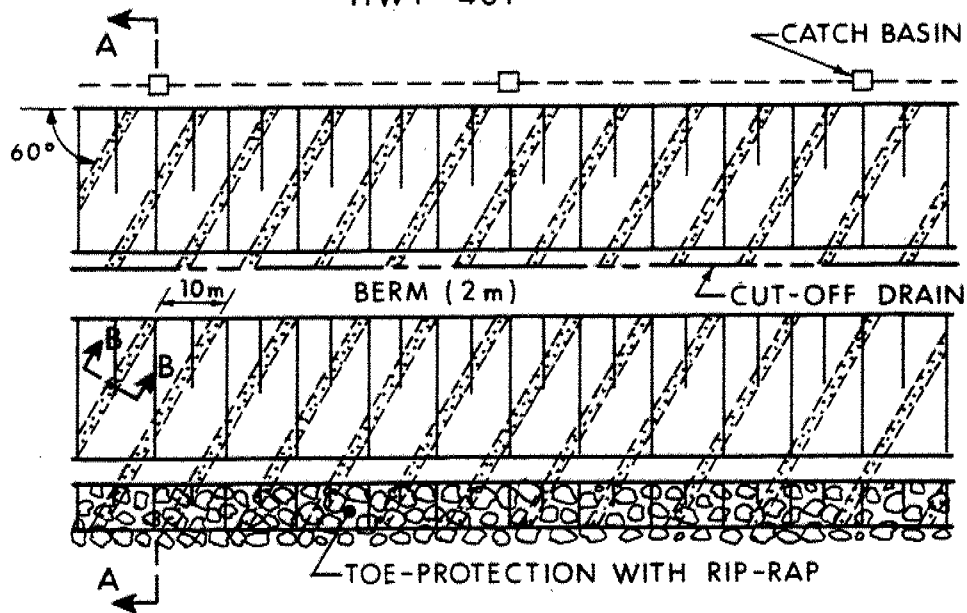
We believe that this memorandum meets with your present requirements. However, should you have any questions regarding this memo, please do not hesitate to contact this office.

TCK/jb

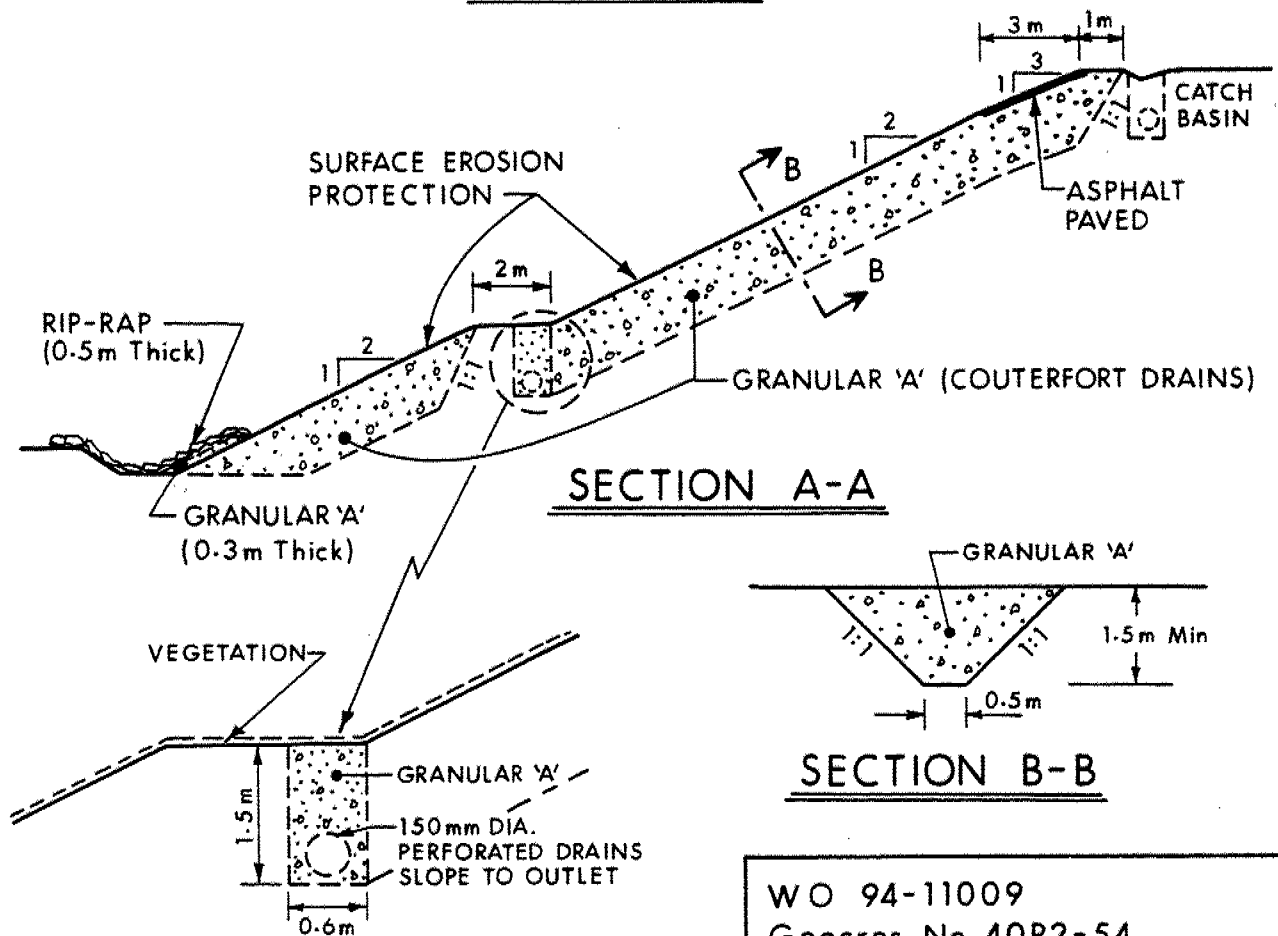

Tae C. Kim, P. Eng.
Sr. Foundation Engineer

RECOMMENDED SLOPE STABILIZATION

HWY 401



PLAN (NTS)



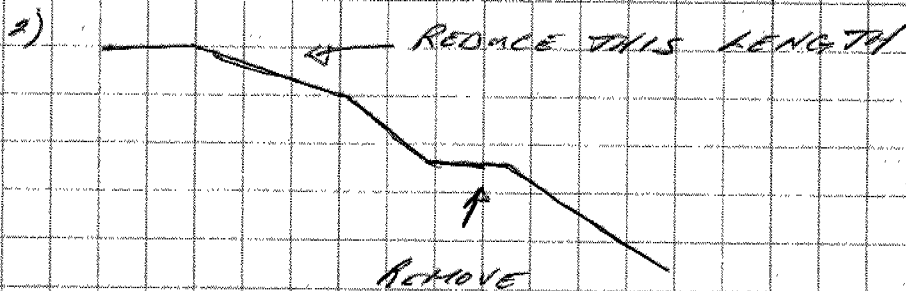
WO 94-11009
Geocres No 40P2-54
Fig. 1

SITE VISIT - AUGUST 5, 1994

TAE C KIM
ERIC MAGNI
TANYA CROSS

SLOPE FAILURE RECOMMENDATIONS:

1) WALL (CONCRETE) OR ASPHALT GUTTER
WITH CATCH BASINS



AND ADD ANGLED DITCHES ALONG
SLOPE LINED WITH RIPRAP.

AUG 5, 94

SITE VISIT

ERIC MAGNI

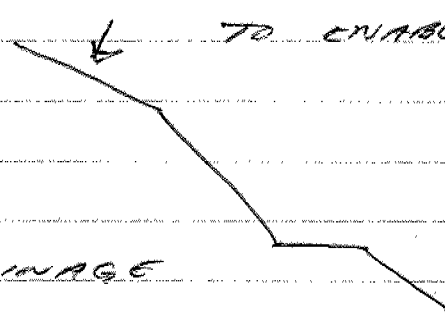
TAE KIM

Tanya Cross

① RECOMMEND SLOPE DRAINS WITH STEP

AT MID POINT.

REDUCING SLOPE AT TOP
A LONGER SLOPE



② CONCRETE WALL WITH DRAINAGE

TAE,

THE SITE AT CALLODEN RD (WHITINGS CRATER)

- ERIC MAGNI CALLED JUNE 11 TO SAY
THAT AT BOTTOM OF GRANULAR BEDS,
THIS AREA WAS WET AT BEGIN. 93 AND
FAILED - SO CONST. PULLED UP THE SLOPE
TO REPAIR IT CREATING THE PROBLEM
FLAT AREA.

ONTARIO MINISTRY OF TRANSPORTATION

SOUTHWESTERN REGION

GEOTECHNICAL SECTION

FAX TRANSMISSION

Date: June 30, 1994

Page 1 of 2

To: Tae Kim
Foundation Design Section
Downsview Head Office

From: Neil Zohorsky
Geotechnical Section
Southwestern Region

Fax: (416) 235-5240



Fax: (519) 649-3108
Tele: (519) 681-1441 X3411

Re: Surficial Slope Failure, Highway 401, 1 km east of Culloden Road, Ingersoll

Tae,

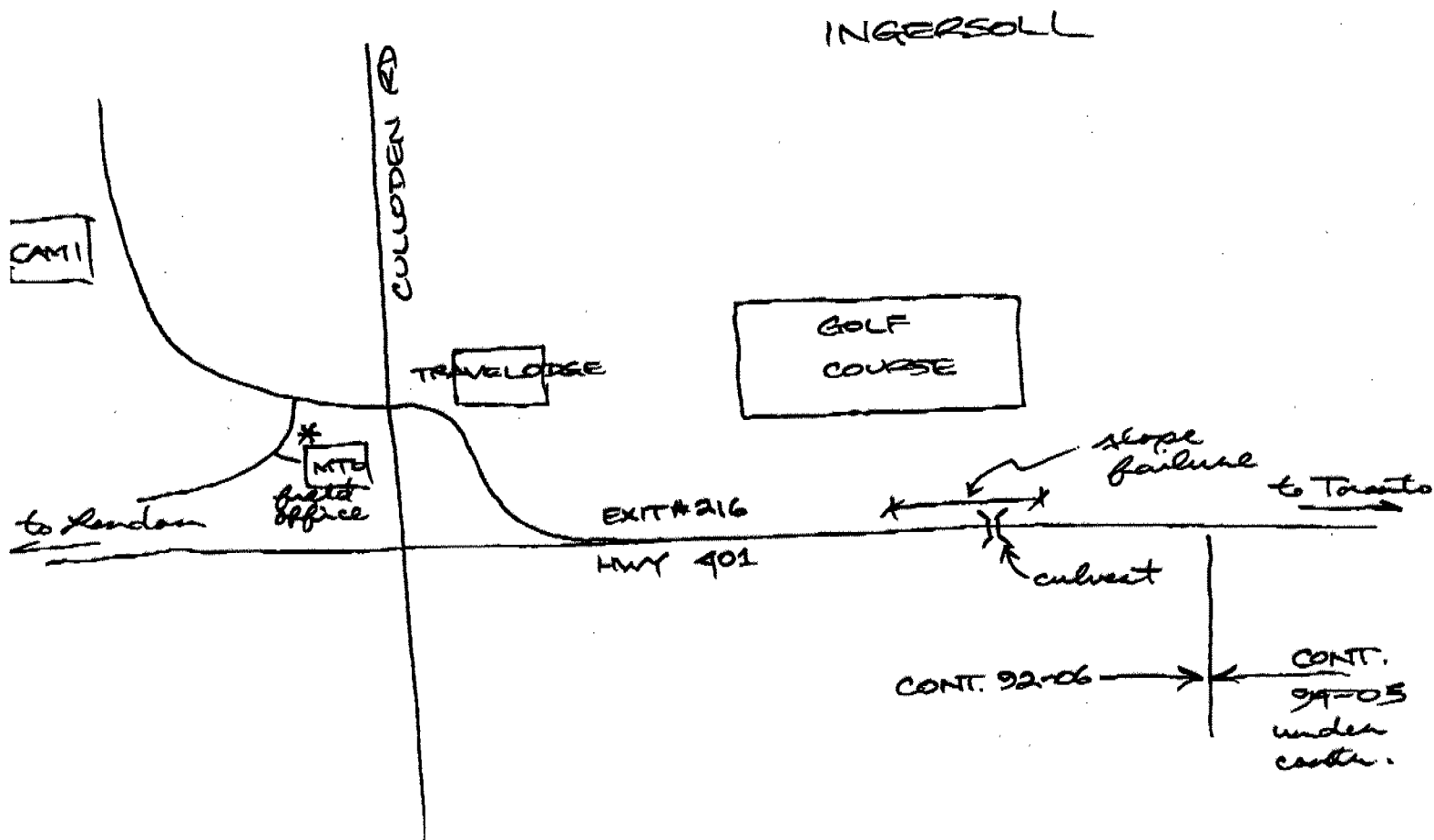
This fax confirms your meeting with Eric Magni on Wednesday, July 6 at 10:00 p.m. The meeting place is at the MTO field office just off Highway 401 at Culloden Road (see map). Thank you for meeting with us on such short notice. A brief description of the problem is provided below:

A surficial slope failure exists on the Highway 401 fill widening placed under MTO Contract 92-06. The fill is about 12 m high. The material on the slope appears to be sandy silt and is clearly erodible. In some locations a considerable amount of material near the top of slope has "sluffed" down the slope. We are particularly concerned with the steepness of the slope at a concrete culvert which crosses Highway 401. At this location the slope appears to be steeper than 2:1.

- ☐ Original to follow by mail
☒ Original will not be mailed

Location of Meeting

77



N.T.S.