GEOCRES No: 30M5-140-1

memorandum

Ontario

To: Mr. G. C. E. Burkhardt
Head, Structural Section
Central Region
5000 Yonge Street, Willowdale

Date: 84 01 05

Attn: Mr. F. Chan

From: Foundation Design Section
Room 315, Central Building
Downsview

Re: Foundation Investigation
GO-ALRT, West Extension, Oakville Project
- Oakville Creek Bridge (Piers 1 to 6, Dwg. No. P-001)
- Elevated Structure (Dwg. No. P-003)
-Oakville Creek West Bridge (Piers 1 to 4, Dwg. No. P-003)
W.O. 82-26025-R
District 4, Hamilton

Fieldwork for the above-noted project has been completed.

This memo contains recommendations pertaining to the design and construction of the foundations for the proposed structures. These recommendations are intended to be sufficient to allow the design of the structures to proceed to completion. Our complete foundation investigation and design report will be submitted in the near future. If there are any questions, please contact this office.

SUBSURFACE CONDITIONS

Refer to Drawings P-001 and P-003 (prepared by Parker Consultants).

Outside the Oakville Creek Valley, 1.5 to 3.7 m of stiff to hard silty clay overlies the sedimentary bedrock at the borehole locations. At the east bank, the bedrock is Georgian Bay Formation shale containing limestone layers up to 30 cm thick - the upper 1.5 ± m being weathered. At the west bank and along the south bank slope of Oakville Creek, the Queenston Formation shale grades into the Georgian Bay Formation at 97 ± m. Here, the weathered bedrock zone varies from 0.7 to 3.7 m at the borehole locations. However, the weathered bedrock is generally 1.5 ± m thick.

At Oakville Creek, the existing valley slopes are approximately 1.6 horizontal to 1 vertical, with 1.5 ± m of overburden cover. At Oakville Creek West, south bank slope, the existing valley slopes are approximately 1 horizontal to 1 vertical, with 1 ± m of overburden cover.

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Subsurface conditions along valley slopes are illustrated in;

- Figure A for Oakville Creek
- Figure B for Oakville Creek West, South Bank Slope

Within Oakville Creek Valley, the overburden material is variable (fill, alluvium, till), although for the most part cohesive. In the previous and existing stream channels, the overburden is composed of a large proportion of boulders, and limestone slabs up to 0.5 m in thickness. These conditions will affect Oakville Creek Piers 3, 4, and 5. The overburden thickness at the proposed pier locations ranges from 4.4 to 13.0 m. The bedrock is Georgian Bay Formation shale containing occasional limestone layers. Upstream of the proposed GO-ALRT alignment, Oakville Creek has been realigned from its previous course along the east bank of the valley, to its present course through the central-west part of the valley. Cross Avenue has been constructed on a fill along the east bank of the valley.

Stabilized groundwater conditions were difficult to establish because of the impermeable nature of the overburden and the generally intact nature of the bedrock. The groundwater elevation at the time of the investigation was estimated at elevation 99 m ± m at the east bank; between the surface and elev. 77.5 (creek level) in Oakville Creek Valley; at elevation 102 m at the west bank and west along the GO-ALRT alignment towards Kerr Street.

DISCUSSION AND RECOMMENDATIONS

It is proposed to construct a 5-span bridge to carry the proposed GO-ALRT over Oakville Creek at a grade of 107.5 ± m.

General Recommendations (Applicable to all proposed structures)

- Earth pressure acting on abutments and retaining walls should be computed as per Subsection 6.6.1.2.2 of the O.H.B.D.C. assuming a non-yielding foundation with K_o = 0.43 and
  γ = 22.0 kN/m^3 for Granular A backfill; K_o = 0.5 and
  γ = 21.2 kN/m^3 for Granular C backfill.

- For frost protection, cover should be greater than 1.2 m.

- The minimum cover required for scour protection should be determined from hydrological data.

- No stability problems are anticipated for embankments or cuts with slopes of 2:1 or flatter. If steeper slopes are required please contact this section for recommended slope angles and erosion protection.

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- The existing valley slopes at Oakville Creek Bridge are acceptable provided that any disturbance during construction is restored and erosion protection is provided. However, at Oakville Creek West Bridge, active undercutting and erosion is occurring. At this location, suitable protection should be provided to control erosion. As a minimum requirement, it is recommended that erosion protection be provided for at least 10 m on each side of the centre line of Pier 2 (Sta.10 + 648±) and Pier 3 (Sta.10 + 690±).

- Differential settlements in the structures will be negligible.

- Outside of the valley and on the valley slopes, dewatering is not anticipated to be a major problem because of the impermeable nature of the overburden and the generally intact nature of the bedrock. In most cases, it is believed that groundwater entering excavations can be controlled by conventional pumping techniques. However, due to the variable nature of the sediments within the valley, a dewatering scheme will be required if piers are to be constructed in the dry.

- Excavations in bedrock may be accomplished without blasting techniques although the limestone layers (up to 30 cm thick) in the Georgian Bay Formation will present some difficulties.

- At all spread footing locations, all soft or loose material should be removed, and the foundation surface should be covered, within 12 hours of exposure, with a 15 cm pad of mass concrete. Where trenches (e.g. underground utilities) are encountered within the footing areas, they should be excavated to bedrock and backfilled, within 12 hours of exposure, with mass concrete.

- For resistance to lateral forces,

  a) key footing into bedrock a minimum of 0.5 m and use a friction coefficient of 0.25 between the bedrock and the footing,

or b) dowel into bedrock a minimum of 1.5 m (as a design example a 5 cm diameter dowel installed as recommended will provide a safe shearing resistance of approximately 20 kN per dowel).

Design Details

Five foundation proposals have been recommended at various pier locations at this site;

i) spread footings in Zone 1
ii) spread footings in Zone 2
iii) spread footings in Zone 3
iv) steel H-piles (310 x 110) equipped with reinforced tips and driven to bedrock
v) concrete caissons in Zone 3

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Design details for these foundation proposals are provided below, followed by specific design details for each proposed pier location. The proposals which lead to the least expensive design should be adopted.

SPREAD FOOTINGS (PROPOSALS i, ii, iii)

For the spread footing proposals, the following design values are recommended for foundations within the indicated zones;

- net safe bearing pressure

  for Zone 1 = 400 kPa
  for Zone 2 = 670 kPa
  for Zone 3 = 1000 kPa

and for the purposes of the O.H.B.D.C.;

- Factored Bearing Capacity at U.L.S.

  for Zone 1 = 600 kPa
  for Zone 2 = 1000 kPa
  for Zone 3 = 1500 kPa

- Bearing Capacity at S.L.S. Type II

  for Zone 1 = 400 kPa
  for Zone 2 will not govern design
  for Zone 3 will not govern design

STEEL H - PILES (PROPOSAL iv)

For 310 x 110 steel H - piles equipped with reinforced tips in accordance with structural standard DD-3301, and driven to bedrock, the following design values are recommended;

- safe capacity = 1150 kN

and for the purposes of the O.H.B.D.C.;

- Factored Capacity at U.L.S. = 1600 kN
- Capacity at S.L.S. Type II = 1150 kN

The load on the pile should at no time exceed 1150 kN.

CONCRETE CAISSONS (PROPOSAL v)

For 1 m diameter concrete caissons founded as recommended on sound bedrock the following design values are recommended;

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- safe capacity = 5.0 MN

and for the purposes of the O.H.B.D.C.;

- Factored Capacity at U.L.S. = 7.5 MN
- Capacity at S.L.S. Type II = 5.0 MN

The load on the caisson should at no time exceed 5.0 MN.

Larger capacities are possible for caissons with diameters larger than 1.0 m.

Specific Design Details

Refer to the Bore Hole Locations and Soil Strata drawings and the Record of Borehole Sheets for subsurface conditions at the proposed pier locations.

OAKVILLE CREEK BRIDGE

It is recommended that consideration be given to altering the spans of Oakville Creek Bridge to avoid anticipated difficulties associated with construction for proposed Piers 1 and 6 on the valley slopes and proposed Pier 4 in the creek.

PIER 1, STA. 10 + 370 ±

Pier 1 should be founded on a spread footing on sound bedrock with the entire footing located within Zone 3 as shown on Figure A-2.

PIER 2, STA. 10 + 400 ±

Pier 2 may be founded on;

a) a spread footing on weathered bedrock within Zone 2, at or below elev. 76.5 m.

or b) steel H - piles (size 310 x 110) equipped with reinforced tips and driven to bedrock. The bedrock elevation at the borehole location at this pier is 76.5 ± m.

PIER 3, STA. 10 + 430 ±

Pier 3 may be founded on steel H - piles (size 310 x 110) equipped with reinforced tips and driven to bedrock. The bedrock elevation at the borehole location at this location is 69.7 ± m.

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PIER 4, STA. 10 + 460 ±

Pier 4 may be founded on;

a) a spread footing on overburden within Zone 1, at or below elev. 73.6 m.

or b) a spread footing on weathered bedrock at or below elev. 70.2 m. For this option, Zone 3 recommendations apply.

The selection of foundation type for this pier will be influenced by the size and footing elevation of the adjacent CNR pier. A scheme to protect the CNR pier may be required.

A de-watering scheme will be required if the footing is to be constructed in the dry. For this purpose, a cofferdam may be constructed using either sheeting or a prefabricated box. However, due to the subsurface conditions at this location, developing a seal will be difficult. Therefore, it would be advantageous to construct a portion (i.e. at least enough to balance the hydrostatic head) of the footing by employing tremie concrete techniques. The remainder of the footing and pier should be constructed in the dry.

PIER 5, STA. 10 + 490 ±

Pier 5 may be founded on;

a) a spread footing on overburden within Zone 1, at or below elev. 77.2 m

or b) a spread footing on weathered bedrock at or below elev. 75.8 m. For this option, Zone 3 recommendations apply.

or c) steel H - piles (size 310 x 110) equipped with reinforced tips and driven to bedrock. The bedrock elevation at the borehole location at this pier is elev. 75.8 ± m.

PIER 6, STA. 10 + 520 ±

Pier 6 should be founded on a spread footing on sound bedrock with the entire footing located within Zone 3 as shown on Figure A-1.

Oakville Creek Elevated Section - Special Structure

PIER AT STA. 10 + 549 ±

This pier may be founded on;

a) a spread footing on overburden within Zone 1, at or below elev. 101.5 m (estimated)

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or b) a spread footing on weathered bedrock within Zone 2, at or below elev. 100.1 m (estimated)

or c) a spread footing on sound bedrock within Zone 3, at or below elev. 98.1 m (estimated)

Note that due to utility constraints, the borehole for this pier was located some 18m right of the GO-ALRT centre line. Subsurface conditions, specifically bedrock elevation, may vary at the proposed pier location.

PIER AT STA. 10 + 579 ±

This pier may be founded on;

a) a spread footing on overburden within Zone 1, at or below elev. 100.5 m.

or b) a spread footing on weathered bedrock within Zone 2, at or below elev. 99.1 m

or c) a spread footing on sound bedrock within Zone 3, at or below elev. 97.2 m

Oakville Creek West Bridge

PIER 1, STA. 10 + 609 ±

This pier may be founded on;

a) a spread footing on weathered bedrock at or below elev. 99.5 m. - For this option Zone 3 recommendations apply.

or b) concrete caissons (1 m diameter) on sound bedrock at or below elev. 95 m.

PIER 2, STA. 10 + 648 ±

This pier may be founded on concrete caissons (1 m diameter) on sound bedrock at or below elev. 94 m.

PIER 3, STA. 10 + 690 ±

This pier may be founded on concrete caissons (1 m diameter) on sound bedrock at or below elev. 94 m.

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PIER 4, STA. 10 + 729 ±

This pier may be founded on;

a) a spread footing on sound bedrock within Zone 3, at or below elev. 100.5 m

or b) concrete caissons (1 m diameter) on sound bedrock at or below elev. 95 m

D. H. Dundas

D. H. Dundas, P. Eng.
Foundations Engineer

FIGURE A
FOOTING ZONES AND SUBSURFACE CONDITIONS

GO-ALRT WEST EXTENSION
OAKVILLE PROJECT - OAKVILLE CREEK
W.O. 82-260025-A

horiz. scale 1:500
vert. scale 1:100

→ CONSTRUCTION EAST

METRIC

FIGURE A-1
WEST BANK

FIGURE A-2
EAST BANK

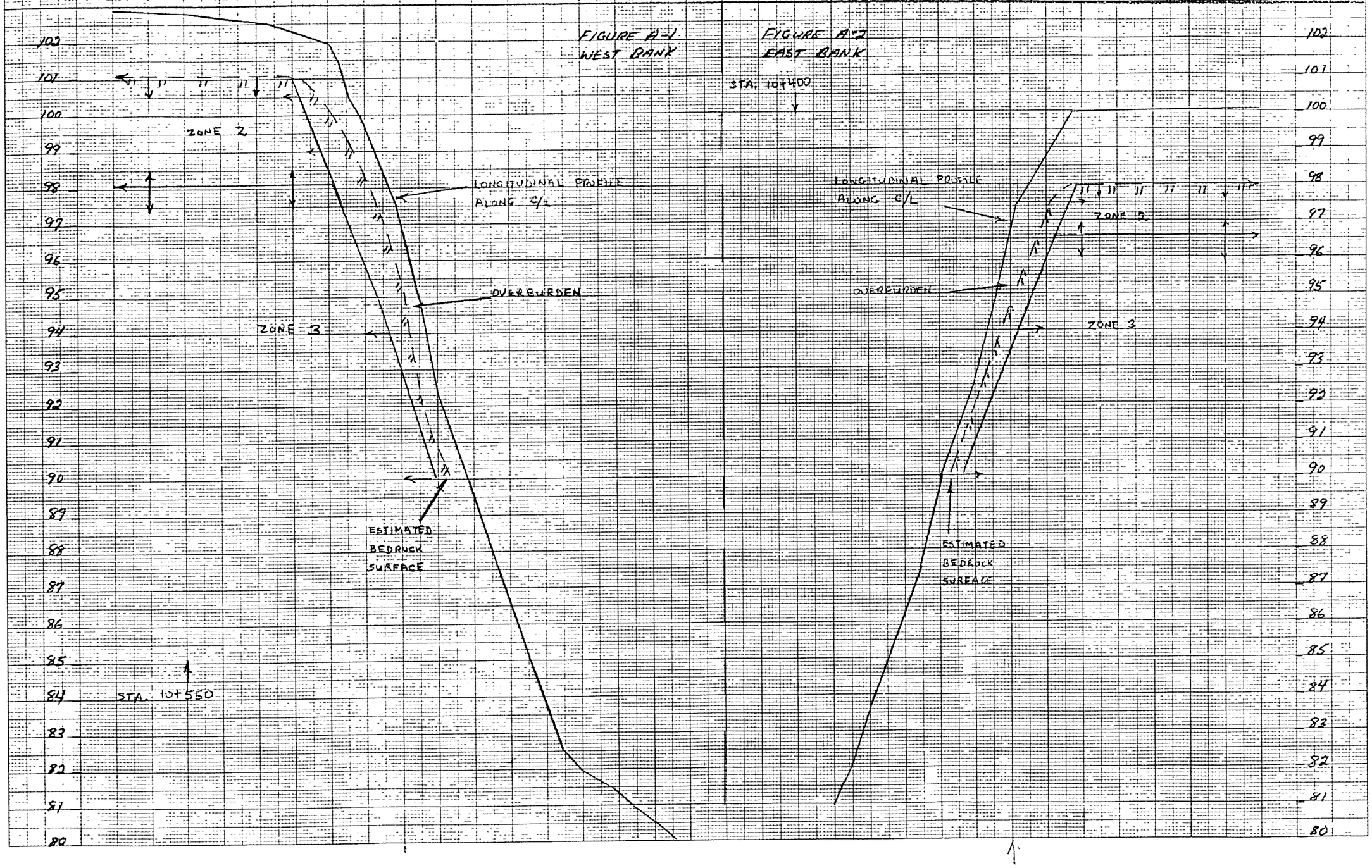

FIGURE B
SUBSURFACE CONDITIONS

GO-ALRT WEST EXTENSION
OAKVILLE PROJECT - OAKVILLE CREEK WEST
SOUTH SLOPE W.O. 82-26025-R

horiz scale 1:500
vert scale 1:100

→ CONSTRUCTION NORTH

METRIC

FIGURE B-1
STA. 10+648±

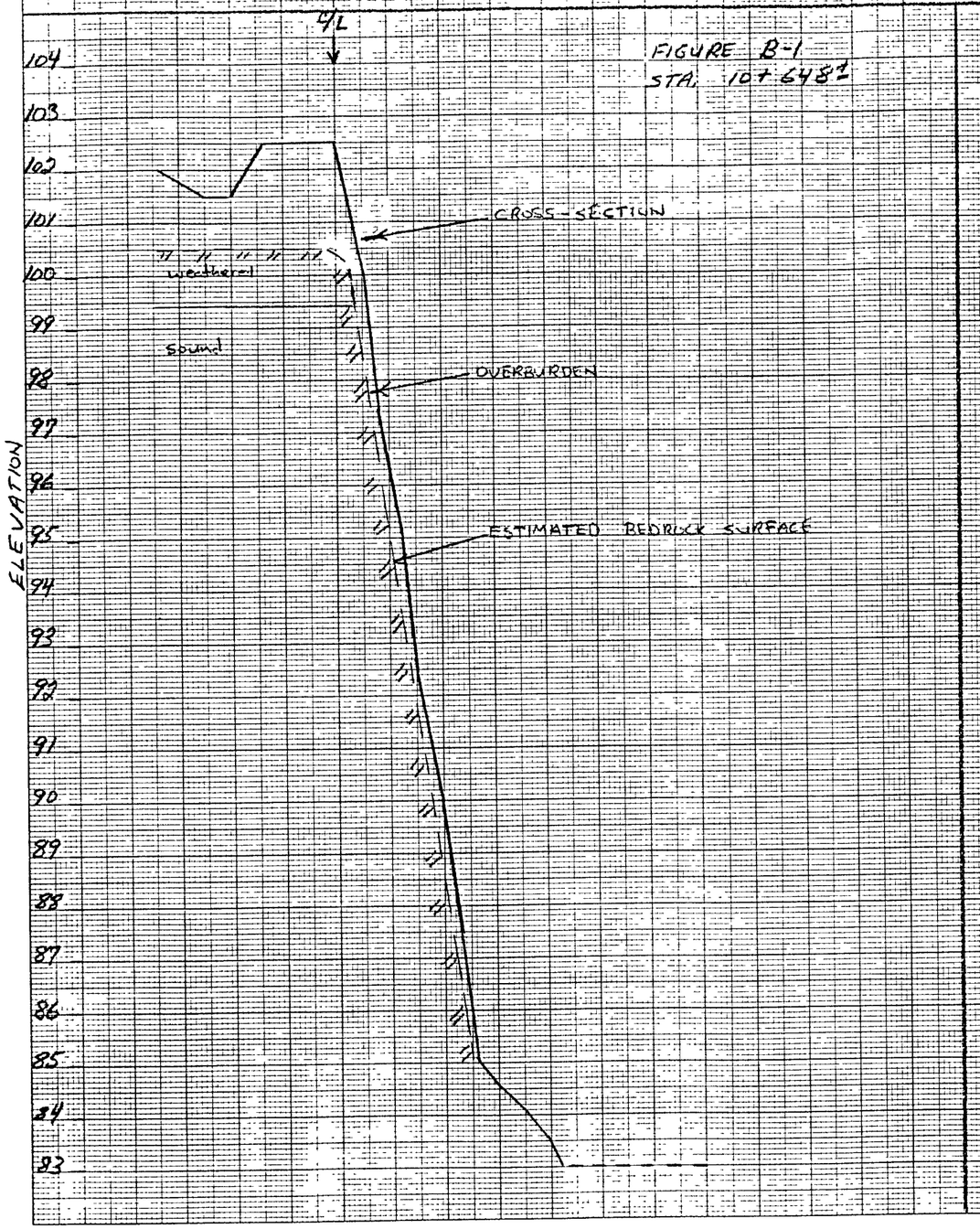

FIGURE B-2
STA. 10+690±