APPENDIX D SNH STATUTORY DESIGNATION LOCATIONS, URS DRAWING NO. 47065084/4004

N

ALLT NAN CARNAN
SLUMBAY ISLAND
ATTADALE

ON3
ON3, N2.6
N2
N2.6
N6
O6
O1,4,5,7
O2
O3
O1,04
S4
O1,4
S5
S6
S1
S1, 3
S3

Strathcarron Junction
Strathcarron
Achintee
Kirkton
Maman Hill
Attadale
River Attadale Valley
Cuddies Point
Lochcarron
Strome Wood
Loch Carron
Cnoc Nam Mult
Ardnarff
Ardarroch
Achinstraid
Stromemore
Leacanasigh
Ardaneaskan
Strome Narrows
Strome Islands
Stromeferry
Creag Mhaol
Loch nam Breac Mora
Plockton
Achmore
Craig
Braeintra
Glen Udalain Valley

Drawing for information purposes only | Drawing for information purposes only | Drawing for information purposes only

CONSTRUCTION RISKS | MAINTENANCE / CLEANING RISK | DEMOLITION RISKS

In addition to the hazard/risks normally associated with the types of work detailed on this drawing take note of above.
It is assumed that all works on this drawing will be carried out by a competent contractor working, where appropriate, to an appropriate method statement.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

Key:

- Outer North Corridor Route Option Prefix ON
- North Shore Corridor Route Option Prefix N
- Online Corridor Route Option Prefix O
- Southern Corridor Route Option Prefix S
- Discounted Routes
- Approximate Site of Special Scientific Interest (SSSI) with site reference.

Notes:
Preliminary Route Options following STAG Pre-Appraisal sifting.
Refer to Route Option Summary.
Retains original Route Option numbering convention adopted on drawing 47065084-602a
Refer to URS Report Stromeferry Options Appraisal Geotechnical Desk Study Report for full details on entries

This drawing is for preliminary purposes only and is subject to amendment during design development. UNDER NO CIRCUMSTANCES MUST THIS DRAWING BE USED FOR CONSTRUCTION PURPOSES

Revision Details	By / Check	Date	Suffix
--	-- / --	-.-.-	-

Purpose of issue: FOR INFORMATION

Client: The Highland Council / Comhairle na Gàidhealtachd

Project Title: Stromeferry Options Appraisal

Drawing Title: LOCATION OF SNH STATUTORY DESIGNATIONS

Drawn	Checked	Approved	Date
HM	AP	PLM	MAR 2013

URS Internal Project No.	Suitability
47065084	-
Scale @ A1	Zone / Mileage
1:2500	-

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Drawing Number: 47065084 - 4004
Rev: 0

APPENDIX E RCAHMS ENTRIES AND LOCATION PLAN, URS DRAWING NOS. 47065084/4002 & 47065084/4003

N

ON3
N2.6
N2
N6
O6
O1,4
O1,4,5,7
O2
O3
S4
S5
S6
S7
S1, 3
S3

Ardarroch
Achinstraid
Strome Wood
Strome Narrows
Strome Islands
Ardaneaskan
Stromemore
Leacanasigh
Ardnarff
Lochcarron
Cuddies Point
Strathcarron Junction
Strathcarron
Achintee
Maman Hill
Attadale
River Attadale Valley
Cnoc Nam Mult
Stromeferry
Creag Mhaol
Achmore
Braeintra
Plockton
Craig
Loch nam Breac Mora
Glen Udalain Valley

NG84SE.10
NG84SE.2
NG84SE.3
NG84SE.8
NG84SE.9
NG94SW.11
NG94SW.12
NG83NE.24
NG83NW.11
NG83NE.5
NG83NE.7
NG83NE.18
NG83NE.23
NG83NE.4
NG83NE.3
NG83NE.17
NG83NE.8
NG83NE.16
NG83NE.12
NG83NE.29
NG83NE.15
NG83NE.19
NG83NE.2
NG83NE.11
NG83NE.28
NG83NE.8001
NG83NE.27
NG83SE.12
NG83SE.24
NG83SE.11
NG93SW.7
NG83NE.20
NG94SW.16
NG94SW.26
NG94SW.18
NG94SW.25
NG94SW.24
NG94SW.13
NG94SW.22
NG94SW.8001
NG93NW.8
NG93NW.6
NG93NW.1

LB: 7264
NMRS: NG94SW.17.2
NG94SW.17.3

LB: 7262
7263
NMRS: NG94SW.17.0
NG94SW.17.1

NG94SW.7.0
NG94SW.20
NG94SW.7.2
NG94SW.7.3
NG94SW.7.1

LB: 7258
NMRS: NG94SW.15

SM: 8867

LB: 49299
NMRS: NG83NE.21.0
NG83NE.21.1

LB: 7259
NMRS: NG83NE.22
NG83NE.23

LB: 7260
NMRS: NG92SW.14

LB: 7261
NMRS: NG92SW.23

LB: 7254
NMRS: NG93NW.6

SM: 8481
NMRS: NG83NE.1
NG83NE.6
NG83NE.25
NG83NE.8002

LB: 48207
6938
NMRS: NG83SE.14
NG83SE.18
NG83SE.15.0
NG83SE.15.1
NG83SE.15.2
NG83SE.15.3
NG83SE.13
NG83SE.16
NG83SE.23
NG83SE.25
MG83SE.3

LB:6995

LB: 6997
6996
NMRS: NG83SE.17
NG83SE.1.1
NG83SE.22
NG83SE.1.2
NG83SE.26
NG83SE.1.0

Drawing for information purposes only	Drawing for information purposes only	Drawing for information purposes only
CONSTRUCTION RISKS	MAINTENANCE / CLEANING RISK	DEMOLITION RISKS

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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

Key:

- Outer North Corridor Route Option Prefix ON
- North Shore Corridor Route Option Prefix N
- Online Corridor Route Option Prefix O
- Southern Corridor Route Option Prefix S
- Discounted Routes
- Approximate Location National Monuments Record of Scotland (NMRS)
- Approximate location Listed Building (LB)
- Approximate Location Scheduled Monument (SM)

Notes:
Preliminary Route Options following STAG Pre-Appraisal sifting.
Refer to Route Option Summary.
Retains original Route Option numbering convention adopted on drawing 47065084-602a
Refer to URS Report Stromeferry Options Appraisal Geotechnical Desk Study Report for full details on entries

This drawing is for preliminary purposes only and is subject to amendment during design development. UNDER NO CIRCUMSTANCES MUST THIS DRAWING BE USED FOR CONSTRUCTION PURPOSES

--	-- / --	-.-.-	-
Revision Details	By / Check	Date	Suffix

Purpose of issue: FOR INFORMATION

Client: The Highland Council / Comhairle na Gàidhealtachd

Project Title: Stromeferry Options Appraisal

Drawing Title: RCAHMS DATABASE ENTRY LOCATION PLAN SHEET 1 OF 2

Drawn	Checked	Approved	Date
HM	AP	PLM	MAR 2013

URS Internal Project No.: 47065084
Suitability: -
Scale @ A1: 1:2500
Zone / Mileage: -

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Drawing Number: 47065084 - 4002
Rev: 0

N

Ardarroch
MHG24630
MHG40958
MHG22277
MHG35920
MHG51350
MHG22271
MHG43713
MHG47704
MHG51310
MHG22272
MHG7656
MHG7941
MHG7942
MHG8399
MHG17464
MHG22541
MHG51312
MHG31251
MHG23791
MHG22223
MHG31252
MHG31253
MHG42872
MHG42873
MHG51354
MHG51346
MHG51347
MHG51348
MHG51349
ON3
Achinstraid
MHG27079
MHG45075
MHG22479
MHG27078
MHG41591
MHG27077
MHG43403
MHG76481
MHG43404
MHG30669
MHG43405
MHG22280
MHG43892
MHG32958
MHG46067
MHG41528
MHG43691
MHG32877
MHG14810
MHG32879
MHG24131
MHG43402
MHG14046
MHG38859
MHG46066
MHG46080
Leacanasigh
N2
Ardaneaskan
Strome Narrows
Strome Islands
MHG9237
MHG16904
MHG25526
MHG22618
MHG28000
MHG25523
MHG25524
MHG25525
MHG25522
MHG4635
MHG36933
ON3
N2
Plockton
MHG17569
MHG22274
MHG30348
MHG36284
MHG36280
MHG46065
Craig
MHG29495
MHG16819
MHG9287
MHG16837
MHG25521
MHG28416
MHG34235
MHG44049
MHG47745
MHG49967
MHG9236
MHG45312
Achmore
MHG25521
MHG22474
Braeintra
MHG22278
MHG29929
MHG53523
MHG46064
MHG25589
S3
S1
S1, 3
S4
Glen Udalain Valley
MHG45874
MHG7655
MHG45874
MHG33089
MHG29497
MHG22513
MHG51150
MHG7646
MHG7667
MHG14042
MHG33087
MHG33088
MHG32724
MHG41305
Lochcarron
N2
N6
MHG22484
MHG7520
Strome Wood
MHG22483
MHG24893
MHG24893
MHG46068
MHG22480
MHG14041
MHG51353
Loch Carron
MHG22481
MHG22482
MHG7647
MHG30669
Stromemore
MHG7665
MHG32958
MHG32877
MHG43692
N6
Stromeferry
Creag Mhaol
MHG52555
MHG51355
MHG45874
MHG33084
MHG32226
MHG7943
MHG22520
MHG31392
MHG33085
MHG51300
MHG45873
MHG32883
MHG38970
MHG39295
MHG18023
MHG16309
Strathcarron Junction
ON3, N2.6
Kirkton
ON3
MHG7656
MHG45874
MHG54875
MHG51355
MHG48653
MHG24919
MHG45874
MHG51412
MHG16698
MHG52507
MHG25508
MHG7750
MHG16390
MHG43981
MHG46081
O6
Cuddies Point
01,4,5,7
MHG22514
02
03
MHG26628
02
01, 04
Ardnarff
MHG22476
Cnoc Nam Mult
MHG51300
MHG51299
MHG16172
MHG23652
MHG46785
MHG16227
MHG51299
MHG7763
MHG22575
MHG24918
MHG85917
MHG40331
Strathcarron
MHG32858
MHG51299
Achintee
MHG22575
MHG32889
MHG46083
MHG39296
MHG46082
S4
01,4
MHG22543
MHG51311
Maman Hill
MHG24216
Attadale
River Attadale Valley
S5B
MHG22514
S4
Loch nam Breac Mora
MHG22547
MHG22544
MHG22546
S4

Key:

- Outer North Corridor Route Option Prefix ON
- North Shore Corridor Route Option Prefix N
- Online Corridor Route Option Prefix O
- Southern Corridor Route Option Prefix S
- Discounted Routes
- Approximate Location Scottish Sites and Monuments Records

Notes:
Preliminary Route Options following STAG Pre-Appraisal sifting.
Refer to Route Option Summary.
Retains original Route Option numbering convention adopted on drawing 47065084-602a
Refer to URS Report Stromeferry Options Appraisal Geotechnical Desk Study Report for full details on entries

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Drawing for information purposes only	Drawing for information purposes only	Drawing for information purposes only
CONSTRUCTION RISKS	MAINTENANCE / CLEANING RISK	DEMOLITION RISKS

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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION BOX

Revision Details	By / Check	Date	Suffix
--	-- / --	-.-.-	-

Purpose of issue: FOR INFORMATION

Client: The Highland Council / Comhairle na Gàidhealtachd

Project Title: Stromeferry Options Appraisal

Drawing Title: RCHAMS DATABASE ENTRY LOCATION PLAN SHEET 2 OF 2

Drawn	Checked	Approved	Date
HM	AP	PLM	MAR 2013

URS Internal Project No.: 47065084
Suitability: -
Scale @ A1: 1:2500
Zone / Mileage: -

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Drawing Number: 47065084 - 4003
Rev: 0

RCAHMS ENTRY DETAILS

Scottish Sites and Monuments Records

Site Number	Site Name	Site Type	Council
MHG9237	South Strome	Pier	Highland Council
MHG16904	Stromeferry Former Church of Scotland Mission Church	Mission church, house	Highland Council
MHG25526	Stromeferry Hotel, laundry	Laundry	Highland Council
MHG22618	Stromeferry	Settlement	Highland Council
MHG28000	Stromeferry Station	Railway station	Highland Council
MHG25523	Stromeferry Hotel	Hotel	Highland Council
MHG25524	Stromeferry Hotel, stable	Stable	Highland Council
MHG25525	Stromeferry Hotel, offices	Office	Highland Council
MHG25522	Stromeferry, Former Free Church Mission Hall	Church, mission hall	Highland Council
MHG46351	Stromeferry	Site, round house (domestic)	Highland Council
MHG17569	Fernaig	Cruck house	Highland Council
MHG22274	Fernaig	Farmstead	Highland Council
MHG30348	Barn, Fernaig, Achmore	Barn	Highland Council
MHG36284	Fernaig, Farm Barn	Barn, site	Highland Council
MHG36280	Fernaig Farm	Farm	Highland Council
MHG46065	Fernaig	Lithic scatter	Highland Council
MHG36933	Stornoway: Stromeferry, Loch Carron	Wreck	Highland Council
MHG29495	Achmore	Findspot	Highland Council
MHG16819	Farmhouse and Steading, Achmore Farm	Farmstead	Highland Council
MHG9287	Achmore	Cruck house	Highland Council
MHG16837	Barn, Achmore Farm	Barn	Highland Council
MHG25521	Stromeferry	Settlement	Highland Council
MHG28416	Achmore	Settlement	Highland Council
MHG34235	Achmore Farm, Cruck-Framed Barn	Barn	Highland Council
MHG44049	Farmhouse and Steading, Achmore Farm	House	Highland Council

Site Number	Site Name	Site Type	Council
MHG47745	Achmore Farm, Farmsteading	Farmstead	Highland Council
MHG49967	Achmore Water Mains	Site	Highland Council
MHG9236	Achmore	Cemetery	Highland Council
MHG45312	Achmore	Mound, mound	Highland Council
MHG25521	Stromeferry	Settlement	Highland Council
MHG22278	Allt Cadh an Eas	Township	Highland Council
MHG25589	Unknown: Plockton, Loch Carron	Wreck	Highland Council
MHG29928	Achmore	Cairn	Highland Council
MHG53523	Possible henge, Achmore	Homestead?, henge?, ring ditch?, circular enclosure	Highland Council
MHG46064	Allt Cadh An Eas	Lithic scatter	Highland Council
MHG22474	Allt Cadh an Eas	Shieling hut	Highland Council
MHG25521	Stromeferry	Settlement	Highland Council
MHG22546	Possible Shieling Hut, Allt Loch Innis Nan Seangan	Shieling hut	Highland Council
MHG22544	Allt Loch Innis Nan Seangan	Township	Highland Council
MHG22547	Allt Loch Innis Nan Seangan	Field system	Highland Council
MHG22476	Imair	Farmstead	Highland Council
MHG26628	Loch Carron	Shelter	Highland Council
MHG22514	Cuddies Point	Farmstead	Highland Council
MHG7750	Attadale Station	Railway station	Highland Council
MHG22536	Strathan, Attadale	Enclosure	Highland Council
MHG16390	Attadale House	House	Highland Council
MHG43981	Attadale House	Garden	Highland Council
MHG46081	An Maman	Cave	Highland Council
MHG32858	Strath Carron	Ford	Highland Council
MHG51299	Track way through Glen Carron to New Kelso	Trackway, road	Highland Council
MHG16227	New Kelso, Estate Cottages	House	Highland Council
MHG51299	Trackway through Glen Carron to New Kelso	Trackway, road	Highland Council

Site Number	Site Name	Site Type	Council
MHG46785	New Kelso, 3 Kelso Lodge Cottages	Site, estate cottage	Highland Council
MHG16172	New Kelso	House	Highland Council
MHG23652	New Kelso, Steading	Farmstead	Highland Council
MHG51299	Trackway through Glen Carron to New Kelso	Trackway, road	Highland Council
MHG51299	Trackway through Glen Carron to New Kelso	Trackway, road	Highland Council
MHG51299	Trackway through Glen Carron to New Kelso	Road, trackway	Highland Council
MHG51300	Trackway from Ribhuachan to Coulags	Trackway	Highland Council
MHG24216	Loch Carron	Wreck	Highland Council
MHG51311	Possible fish trap at Cam-allt, Lochcarron	Coastal Fish Weir, Fish Trap	Highland Council
MHG22575	Strathcarron, General	Settlement	Highland Council
MHG32889	Achinlee	Township	Highland Council
MHG46083	Achintree	Lithic Scatter	Highland Council
MHG52555	Possible site of St Maelrubha's Chapel	Cell, Chapel, Church	Highland Council
MHG7763	Strathcarron Station	Railway Station	Highland Council
MHG22575	Strathcarron, General	Settlement	Highland Council
MHG24918	Strathcarron Hotel	Hotel	Highland Council
MHG35917	STRATHCARRON STATION, SIGNAL BOX	Signal Box	Highland Council
MHG40331	Strathcarron Station	Railway Station	Highland Council
MHG45873	Site of former settlement of Ribhuachan, Lochcarron	Settlement, Enclosure	Highland Council
MHG32883	Smithy (Mue), Lochcarron	Museum	Highland Council
MHG38970	Smithy (Mue), Lochcarron	Smithy	Highland Council
MHG39295	Ribhuachan, Peat Cutting Banks	Peat Hag	Highland Council
MHG51300	Trackway from Ribhuachan to Coulags	Trackway	Highland Council
MHG16309	Tullich Farm Square	Farmstead	Highland Council

Site Number	Site Name	Site Type	Council
MHG18023	Tullich	House	Highland Council
MHG45875	Site of Druim na Faille, cattle market and fair near Lochcarron	Livestock Market, Fair	Highland Council
MHG51355	Route of Kishorn to Kirkton drove road extension, Lochcarron	Drove Road	Highland Council
MHG48653	Strathcarron Water Mains	Smithy, Building	Highland Council
MHG7943	Lochcarron Kirkton (Old Church)	Church	Highland Council
MHG22520	Allt a' Chlachain	Enclosure	Highland Council
MHG31392	Lochcarron Kirkton (Old Church), graveyard	Cemetery	Highland Council
MHG33085	Sheepfold at East Church	Fank, Sheep Fold	Highland Council
MHG22225	Lochcarron Parish Church	Church	Highland Council
MHG22226	Lochcarron Parish Manse	Manse	Highland Council
MHG33084	Hut circles north-west of Kirkton	Hut Circle Settlement?, Hut Circle	Highland Council
MHG45874	Kishorn to Kirkton drove and coffin road, Lochcarron	Corpse Road, Drove Road	Highland Council
MHG51355	Route of Kishorn to Kirkton drove road extension, Lochcarron	Drove Road	Highland Council
MHG52555	Possible site of St Maelrubha's Chapel	Cell, Chapel, Church	Highland Council
MHG7656	Hut circle, Torra Fionn	Hut Circle	Highland Council
MHG7941	Battle Site, Aldy Charrish	Battle Site	Highland Council
MHG7942	Cist, Cladh Nan Druineach	Cist	Highland Council
MHG8399	Strathcarron	Cruck House	Highland Council
MHG17464	Possible Dun, Lochcarron	Dun	Highland Council
MHG22541	Lochcarron	Building	Highland Council
MHG51312	Shieling hut set into head dyke above Lochcarron (A)	Shieling Hut	Highland Council
MHG31251	Corn Mill, Lochcarron	Grain Mill	Highland Council
MHG23791	Lochcarron, Old Police Station	Police Station	Highland Council

Site Number	Site Name	Site Type	Council
MHG22223	Caledonian Bank, Lochcarron	Bank (Financial)	Highland Council
MHG31252	Poorhouse, Lochcarron	Poor House	Highland Council
MHG31253	Battery and Rifle Range, Lochcarron	Battery	Highland Council
MHG42872	Battery and Rifle Range, Lochcarron	Magazine	Highland Council
MHG42873	Battery and Rifle Range, Lochcarron	Firing Range	Highland Council
MHG51354	Possible shieling hut set into head dyke above Lochcarron	Shieling Hut, Pen?	Highland Council
MHG51346	Shieling hut set into head dyke above Lochcarron (B)	Shieling Hut	Highland Council
MHG51347	Shieling hut set into head dyke above Lochcarron (C)	Shieling Hut	Highland Council
MHG51348	Shieling hut set into head dyke above Lochcarron (D)	Shieling Hut	Highland Council
MHG51349	Shieling hut set into head dyke above Lochcarron (E)	Shieling Hut	Highland Council
MHG51350	Shieling hut set into head dyke above Lochcarron (F)	Shieling Hut	Highland Council
MHG22271	Lochcarron	Building	Highland Council
MHG43713	Site of building attached to head dyke, Lochcarron	Building	Highland Council
MHG47704	Lochcarron, Main Street, Caledonian Bank, Stables	Garage, Stable	Highland Council
MHG51310	Causeway at Kirkton Moor	Causeway, Peat Extraction Site	Highland Council
MHG22272	Head dyke, Lochcarron	Head Dyke	Highland Council
MHG52507	Fernbank, Lochcarron	House	Highland Council
MHG52508	Site of house adjacent to Fernbank, Lochcarron	House	Highland Council
MHG22513	Lochcarron	Crofting Township	Highland Council
MHG51150	Buildings on Croft 415, Lochcarron	Building	Highland Council
MHG24919	Lochcarron School	School	Highland Council

Site Number	Site Name	Site Type	Council
MHG45874	Kishorn to Kirkton drove and coffin road, Lochcarron	Corpse Road, Drove Road	Highland Council
MHG51412	Tobar Suthainn (The Everlasting Well), Lochcarron	Well	Highland Council
MHG16698	Lochcarron Hotel	Hotel	Highland Council
MHG7520	Slumbay Island	Promontory Fort	Highland Council
MHG22484	Lochcarron	Crofting Township	Highland Council
MHG7646	Hut circle, The Black Mare's Rock	Hut Circle	Highland Council
MHG7667	Boat shaped burial? Portnacrich	Ship Burial	Highland Council
MHG14042	Lochcarron	Hut Circle	Highland Council
MHG33087	The Black Mare's Rock	Clearance Cairn	Highland Council
MHG33088	Slumbay	Fank	Highland Council
MHG32724	Possible Cairn, Slumbay	Cairn	Highland Council
MHG41305	Hut circle, The Black Mare's Rock	Clearance Cairn	Highland Council
MHG29497	Lochcarron	Findspot	Highland Council
MHG33089	Allt a' Bheatha	Long Barrow	Highland Council
MHG7656	Hut circle, Torra Fionn	Hut Circle	Highland Council
MHG45874	Kishorn to Kirkton drove and coffin road, Lochcarron	Corpse Road, Drove Road	Highland Council
MHG35920	GLENBEG, BRIDGE	Bridge	Highland Council
MHG22277	Achintraid	Enclosure	Highland Council
MHG24630	Achintraid	Township	Highland Council
MHG40958	Achintraid	Head Dyke	Highland Council
MHG27079	Achintraid	Dyke	Highland Council
MHG22479	Allt Ribeig	Enclosure	Highland Council
MHG27078	Allt Ribeig	Clearance Cairn	Highland Council
MHG41591	Allt Ribeig	Clearance Cairn	Highland Council
MHG45075	Allt Ribeig	Dyke	Highland Council

Site Number	Site Name	Site Type	Council
MHG27077	Reraig	Dyke	Highland Council
MHG27074	Reraig	Structure	Highland Council
MHG27075	Reraig	Dyke	Highland Council
MHG27076	Reraig	Path	Highland Council
MHG45134	Reraig	Coffin Cairn	Highland Council
MHG45135	Reraig	Culvert	Highland Council
MHG7647	Township, Strome Meanach	Township	Highland Council
MHG7648	Strome Castle	Castle, Hall House	Highland Council
MHG30669	Cemetery, Mid Strome	Cemetery	Highland Council
MHG22280	Stromemore	Township	Highland Council
MHG32958	Stromemore	Township	Highland Council
MHG41528	Township, Strome Meanach	Corn Drying Kiln	Highland Council
MHG32877	Ruined building, E of Stromemore	Croft	Highland Council
MHG32879	Ruined building, E of Stromemore	Croft	Highland Council
MHG43402	Stromemore	Head Dyke	Highland Council
MHG43403	Stromemore	School	Highland Council
MHG43404	Stromemore	Inn	Highland Council
MHG43692	Former Strome Inn, North Strome	Inn	Highland Council
MHG43405	Stromemore	Sheep Fold	Highland Council
MHG46067	Mid Strome	Rock Shelter	Highland Council
MHG43691	Landing place, North Strome	Slipway	Highland Council
MHG14810	'Pride of Strome', Stromemore	Wreck	Highland Council
MHG24131	Wreck of 'Strome Castle' ferry, Strome (former location)	Wreck, Findspot	Highland Council
MHG7665	Landing place, North Strome	Landing Point	Highland Council
MHG32958	Stromemore	Township	Highland Council

Site Number	Site Name	Site Type	Council
MHG32877	Ruined building, E of Stromemore	Croft	Highland Council
MHG43692	Former Strome Inn, North Strome	Inn	Highland Council
MHG14046	Port a' Mheirlich	Cist	Highland Council
MHG38859	Shore Cottage (site of), Leacanashie	House	Highland Council
MHG46066	Port A' Mheirlich	Rock Shelter	Highland Council
MHG46080	Loch Carron, Ardneaskan	Cave	Highland Council
MHG24893	Strome Carronach	Landing Point	Highland Council
MHG51353	Wreck of 'Strome Castle' ferry, Strome	Wreck	Highland Council
MHG22481	Strome Wood	Enclosure	Highland Council
MHG22480	Allt Camas Na Fearna	Enclosure	Highland Council
MHG22483	Rhunamone	Farmstead	Highland Council
MHG24893	Strome Carronach	Landing Point	Highland Council
MHG46068	Rhunamone	Rock Shelter	Highland Council
MHG22482	Stromemeanach	Building	Highland Council
MHG7647	Township, Strome Meanach	Township	Highland Council

National Monuments Record of Scotland (NMRS)

Site Number	NMRS Name	Class
NG83SE.1.0	Achmore Farm. Alternative: Achmore Farm, Fernaig	Farmhouse
NG83SE.17.-	Stromeferry. Alternative: -	Term Pending
NG83SE.1.1	Achmore Farm, Cruck-Framed Barn. Alternative: Hay Barn	Cruck Framed Barn
NG83SE.22-	Achmore. Alternative: -	Village
NG83SE.1.2	Achmore Farm, Farmsteading. Alternative: -	Farmstead
NG83SE.26.-	Achmore Water Mains. Alternative: -	No Class (Event)

Site Number	NMRS Name	Class
NG83SE.3.-	South Strome, Pier. Alternative: Strome Ferry/Loch Carron	Pier
NG83SE.14.-	Stromeferry, Church Of Scotland. Alternative: -	Church
NG83SE.18.-	Stromeferry, Free Church Mission Hall. Alternative: -	Church
NG83SE.15.0	Stromeferry Hotel. Alternative: -	Hotel
NG83SE.15.1	Stromeferry Hotel, Stable. Alternative: -	Stable
NG83SE.15.2	Stromeferry Hotel, Offices. Alternative: -	Office(S)
NG83SE.15.3	Stromeferry Hotel, Laundry. Alternative: -	Laundry
NG83SE.13.-	Stromeferry, General. Alternative: -	Village
NG83SE.16.-	Stromeferry Station. Alternative: Strome Ferry Station	Railway Station
NG83SE.23.-	Stromeferry, Free Church. Alternative: -	Church
NG83SE.25.-	Stromeferry. Alternative: -	Roundhouse (Possible)
NG83NE.27.-	Port A' Mheirlich. Alternative: -	Rock Shelter
NG83NE.1.-	Strome Castle. Alternative: Stromeferry Castle	Hall House
NG83NE.6.-	North Strome, Pier. Alternative: Strome Ferry	Landing Point, Pier
NG83NE.25.-	Strome Castle. Alternative: -	Castle
NG83NE.8002.-	Unknown: North Strome Slipway, Loch Carron. Alternative: Strome Castle, Stromeferry, Inner Sound	Boat
NG83NE.2.-	Stromemeanach. Alternative: -	Township
NG83NE.8001.-	Unknown: Strome Castle, Loch Carron. Alternative: Strome Ferry, Stromeferry, Inner Sound	Ferry (20th Century)
NG83NE.19.-	Strome Wood. Alternative: -	Building, Enclosure
NG83NE.11.-	Stromemeanach. Alternative: -	Building
NG83NE.28.-	Mid Strome. Alternative: -	Rock Shelter
NG83NE.3.-	Lochcarron. Alternative: -	Hut Circle(S)
NG83NE.4.-	Lochcarron. Alternative: -	Grave(S) (Viking)(Possible)
NG83NE.7.-	Lochcarron. Alternative: -	Platform
NG83NE.15.-	Allt Camas Na Fearna. Alternative: -	Enclosure
NG83NE.12.-	Strome Carronach. Alternative: -	Township

Site Number	NMRS Name	Class
NG83NE.16.-	Rhunamone. Alternative: -	Farmstead
NG83NE.17.-	Lochcarron. Alternative: Wester Slumbay	Township
NG83NE.29.-	Rhunamone. Alternative: -	Rock Shelter
NG83NE.20.-	Imair. Alternative: Immer	Farmstead
NG93NW.7.-	Loch Carron. Alternative: -	Avalanche Shelter
NG93NW.6.-	Attadale House. Alternative: -	House
NG93NW.1.-	Attadale Station. Alternative: Attadale Halt	Railway Station
NG93NW.8.-	An Maman. Alternative: Attadale	Cave
NG94SW.8001.-	Unknown: Loch Carron. Alternative: Attadale, Strathcarron	Pontoon (20th Century)
NG94SW.13.-	Cnoc Ban. Alternative: -	Building
NG94SW.24.-	Teanga Fhiadhaich. Alternative: -	Lithic Scatter
NG94SW.25.-	Achintree. Alternative: -	Lithic Scatter
NG94SW.18.-	Strathcarron, General. Alternative: -	Village
NG94SW.7.0	Strathcarron Station. Alternative: -	Railway Station
NG94SW.20.-	Strathcarron Hotel. Alternative: -	Hotel
NG94SW.7.2	Strathcarron Station, Signal Box. Alternative: -	Signal Box
NG94SW.7.3	Strathcarron Station, Footbridge. Alternative: -	Footbridge
NG94SW.7.1	Strathcarron Station, Signal Box. Alternative: -	Signal Box
NG94SW.17.2	New Kelso, 1 Kelso Lodge Cottages. Alternative: Kelso House, Estate Cottages	Estate Cottage
NG94SW.17.3	New Kelso, 3 Kelso Lodge Cottages. Alternative: Kelso House, Estate Cottages	Estate Cottage
NG94SW.17.0	New Kelso. Alternative: Former Linen Factory, New Kelso Lodge, New Kelso House	Farmhouse
NG94SW.17.1	New Kelso, Steading. Alternative: Cart Shed, Stables And Byre, Kelso House, Steading	Byre, Farmstead, Stable
NG94SW.26.-	Strathcarron Water Mains. Alternative: -	Building(S), Smithy
NG94SW.15.-	Kirkton, Lochcarron Parish Church. Alternative: -	Church
NG94SW.16.-	Lochcarron Parish Manse. Alternative: -	Manse

Site Number	NMRS Name	Class
NG94SW.22.-	Lochcarron, School. Alternative: -	School
NG94SW.14.-	Lochcarron Hotel. Alternative: -	Hotel
NG94SW.23.-	Lochcarron, Police Station. Alternative: -	Police Station
NG83NE.21.0	Lochcarron, Main Street, Caledonian Bank. Alternative: Bank Of Scotland, Halifax Bank Of Scotland	Bank (Financial)
NG83NE.21.1	Lochcarron, Main Street, Caledonian Bank, Stables. Alternative: Garage	Garage, Stable(S)
NG83NE.22.-	Lochcarron, Free Church Of Scotland Church. Alternative: Lochcarron Free Church	Church
NG83NE.23.-	Lochcarron, Free Church Of Scotland Manse. Alternative: Lochcarron Free Church Manse	Manse
NG83NE.18.-	Lochcarron. Alternative: Easter Slumbay	Township
NG94SW.12.-	Lochcarron. Alternative: -	Building
NG94SW.11.-	Lochcarron. Alternative: -	Building
NG84SE.9.-	Lochcarron. Alternative: -	Building
NG84SE.8.-	Lochcarron. Alternative: -	Building
NG84SE.2.-	Allt Nan Carnan. Alternative: -	Hut Circle
NG84SE.10.-	Glenbeg, Bridge. Alternative: -	Bridge
NG83NE.24.-	Achintraid. Alternative: -	Enclosure
NG83NW.11.-	Achintraid. Alternative: -	Head Dyke, Township
NG83SE.12.-	Allt Cadh An Eas. Alternative: -	Shieling Hut(S) (Possible)
NG83SE.24.-	Allt Cadh An Eas. Alternative: -	Lithic Scatter
NG83SE.11.-	Allt Cadh An Eas. Alternative: -	Township
NG93SW.7.-	Allt Loch Innis Nan Seangan. Alternative: -	Shieling Hut (Possible)

Listed Buildings

Hbnum	Details	Address	Categories	List Dates
6995	Council: HIGHLAND Parish/Burgh: LOCHALSH Item No: 1	ACHMORE FERNAIG FARM BARN (FERNAIG, BARN)	B	08-SEP-1982

Hbnum	Details	Address	Categories	List Dates
6997	Council: HIGHLAND Parish/Burgh: LOCHALSH Item No: 3	Achmore Farm Barn (Achmore Farm, Cruck-Framed Barn)	B	08-SEP-1982
6996	Council: Highland Parish/Burgh: Lochalsh Item No: 2	Achmore Farm Farmhouse And Steading (Achmore Farm, Farmsteading)	C(S)	08-SEP-1982
6996	Council: Highland Parish/Burgh: Lochalsh Item No: 2	Achmore Farm Farmhouse And Steading (Achmore Farm)	C(S)	08-SEP-1982
48207	Council: Highland Parish/Burgh: Lochalsh Item No: 86	Stromeferry, Former Free Church (Stromeferry, Free Church)	C(S)	08-OCT-2001
6933	Council: Highland Parish/Burgh: Lochalsh Item No: 85	Stromeferry, Former Church Of Scotland Mission Church (Stromeferry, Church Of Scotland)	C(S)	05-MAR-1990
7254	Council: Highland Parish/Burgh: Lochcarron Item No: 2	Attadale House	C(S)	25-MAR-1971
7262	Council: Highland Parish/Burgh: Lochcarron Item No: 10	New Kelso House (New Kelso)	A	25-MAR-1971
7263	Council: Highland Parish/Burgh: Lochcarron Item No: 11	New Kelso Farm Square (New Kelso, Steading)	B	25-MAR-1971
7264	Council: Highland Parish/Burgh: Lochcarron Item No: 12	New Kelso Driveway Pair Estate Cottages (New Kelso, 1 Kelso Lodge Cottages)	C(S)	31-AUG-1983
7264	Council: Highland Parish/Burgh: Lochcarron Item No: 12	New Kelso Driveway Pair Estate Cottages (New Kelso, 3 Kelso Lodge Cottages)	C(S)	31-AUG-1983
7258	Council: Highland Parish/Burgh: Lochcarron Item No: 6	Lochcarron Old Parish Church (Kirkton, Lochcarron Parish Church)	B	25-MAR-1971
7260	Council: Highland Parish/Burgh: Lochcarron Item No: 8	Lochcarron Hotel	C(S)	25-MAR-1971
7261	Council: Highland Parish/Burgh: Lochcarron Item No: 9	Lochcarron Old Police Station (Lochcarron, Police Station)	C(S)	31-AUG-1983

Hbnum	Details	Address	Categories	List Dates
49299	Council: Highland Parish/Burgh: Lochcarron Item No: 16	Lochcarron, Main Street, Bank House (Halifax Royal Bank Of Scotland) Including Former Stables, Boundary Walls, Gatepiers And Railings (Lochcarron, Main Street, Caledonian Bank)	B	02-JUL-2003
49299	Council: Highland Parish/Burgh: Lochcarron Item No: 16	Lochcarron, Main Street, Bank House (Halifax Royal Bank Of Scotland) Including Former Stables, Boundary Walls, Gatepiers And Railings (Lochcarron, Main Street, Caledonian Bank, Stables)	B	02-JUL-2003
7259	Council: Highland Parish/Burgh: Lochcarron Item No: 7	Lochcarron Free Church (Lochcarron, Free Church Of Scotland Church)	B	31-AUG-1983

Scheduled Monuments

INDEX NUMBER	NAME	LOCAL AUTHORITY	NGRs
8481	Strome Castle	Highland	NG862354
8867	Lochcarron Old Parish Church, 160m SSW of Lochcarron Parish Church	Highland	NG914412

APPENDIX F HISTORICAL REPORTS

DIRECTORS:
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ROSS AND CROMARTY COUNTY COUNCIL

MESSRS. BABTIE SHAW AND MORTON

REPORT ON SITE INVESTIGATION

FOR

A890 SOUTH STROME TO AUCHTERTYRE ROAD IMPROVEMENT

WESTER ROSS

Messrs. Babtie Shaw and Morton,
95 Bothwell Street,
Glasgow,
G2 7HX.

March, 1974

ADR/DRC/aj/1190

Registered Office
Minster House, Arthur Street, London, EC4R 9BH

Registered in England No. 630626

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ROSS AND CROMARTY COUNTY COUNCIL

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REPORT ON SITE INVESTIGATION

FOR

A890 SOUTH STROME TO AUCHTERTYRE ROAD IMPROVEMENT

WESTER ROSS

Ref: 1190

March, 1974

INTRODUCTION

Ross and Cromarty County Council proposes to upgrade and re-route some 10 km. of the existing single track A890 road between South Strome and Auchtertyre to two lane single carriageway trunk road standard. The planned development was understood to include the re-grading and re-alignment generally clear of the existing road and the construction of a by-pass on the east side of the village of Achmore including the provision of two new culverts at Hangman's Burn and Srath Ascaig.

At the request of Messrs. Babtie Shaw and Morton, Consulting Engineers for the work, a site investigation was undertaken to their requirements to provide information on ground conditions prevailing along the route of the proposed new road and to enable recommendations to be made pertinent to the design of foundations for the culverts; stability of embankments and cuttings; and the suitability for re-use, with special regard to settlements problems, of excavated material for fill in embankments.

This report is based on information established by observation, boring, sampling and testing. It should be noted that natural strata vary from point to point and groundwater conditions are dependent on seasonal and other factors. Whilst an attempt is made in comprehensive reporting to assess the likelihood at the site, it should be recognised that there may be conditions obtaining which are not disclosed by the investigation. Comments and recommendation are based on analysis of the conditions as they appear to affect the proposed development, but presuppose that these will be interpreted by qualified personnel in the overall engineering design of the works.

TOPOGRAPHY AND GEOLOGY OF SITE

The area under investigation for the proposed new road extends for a distance of approximately 10 km. from the village of Auchtertyre in the south, to the village of South Strome on the shores of Loch Carron in the north. From Auchtertyre the new road turns east and follows approximately the route of the existing single track A890 road, which initially/

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initially climbs steeply for some 3 km. from Auchtertyre with tight bends, and gradients up to 1 in 7 in places, to Lochalsh Dam at an elevation of 160 metres above Ordnance Datum. The road thereafter continues northwards along a broad glen over more gentle undulating moorland reaching a maximum elevation of 224 metres above Ordnance Datum to the north of the Lochalsh Reservoir, from where it descends into Srath Ascaig.

Approximately 2 km. to the north of this pass, the proposed new road is shown to diverge from the existing road and run through Forestry Commission land, (which was occupied at the time of the investigation, by a forest of mature timber), to the floor of Srath Ascaig where it is shown to swing west and run along the route of an existing forestry road parallel to the edge of the forested slopes on the north side of the valley, rejoining the existing A890 north of the village of Achmore. From Achmore the proposed new road is shown to follow approximately the route of the existing A890 to South Strome.

The proposed route from Auchtertyre to Achmore traverses three main topographic regions from south to north. The first region which includes the section of the road from Auchtertyre to the Lochalsh Dam consists of steep and locally near precipitous concave south and east facing slopes frequently cut by a steep-sided gullies and craggy outcrops of rock. This rugged topography gives rise to the pass, generally covered with peat bog and glacial drift with few outcrops of rock.

One noticeable gully is located at chainage 20^{00}m. and is apparently infilled with an unusually large thickness of drift, associated with morainic deposits observed in the region, part of which shows indications of active erosion. The glacial drift adjacent to this erosion forms a steep though apparently stable slope possibly produced by ancient landslipping of the soil during the extreme climatic conditions of the immediate past glacial period. No water was observed issuing from the base of the old landslips.

The third topographic region occurs to the north of the pass and includes Srath Ascaig and the adjacent hillsides to Achmore. The hillsides over which the proposed new road is shown descending to the floor of Srath Ascaig are steep and forested with few gullies and crags. The floor of Srath Ascaig slopes gently towards the Ascraig burn at an elevation of approximately 20 metres above Ordnance Datum and is well drained and cultivated in places with the exception of the area adjacent to the burn which is extremely boggy and appears to be prone to periodic flooding. From Achmore to South Strome, the proposed road is shown to climb steadily over gently sloping moorland and bog reaching an elevation of approximately 90 metres about 1 kilometre north of Achmore.

Published geological information indicates that in the low lying regions at Srath Ascaig freshwater alluvial deposits overlie deposits of the Upper Raised Beach below which is the schist and gneiss of the Moine and Lewisian series of the Precambrian. Some raised beach deposits are also shown overlying rock at Auchtertyre. Over the remainder of the site, with the exception of some isolated pockets of peat and alluvium shown infilling poorly drained hollows, shallow deposits of soil described as/

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as undifferentiated drift are indicated through which numerous outcrops of the underlying metamorphic rocks of Precambrian age are shown, especially in the upland areas and regions of rugged topography.

Of the two principle rock types present in the area, the uppermost and youngest series consist mainly of highly folded schist of the Moine Series of the Precambrian which are present only in the central and northern sections of the site. This series is followed by the older highly folded hornblende gneiss of the Lewisian series of the Precambrian which is present predominantly in the southern section of the site and interbanded with the Moine Series over the remainder of the site.

Several dykes and irregular intrusions of metamorphosed gabbro described as hornblende schist and amphibolite are shown to cut the gneiss. The contact between the Moine series and the Lewisian series is shown as a highly complex zone of structural disturbance called the Moine Thrust which runs from northeast to southwest across the site. The rocks are also dissected by a number of small approximately east west trending faults and cut by numberous largely east west trending basalt dykes apparently of Tertiary age.

SITE WORK

Site work extended over the period 1st September to 27th November, 1973, during which several phases of site investigation were undertaken with some further work during March 1974. Initially a total of 45 boreholes number 1 to 44 and 11A were to be sunk by shell and auger methods and 19 test pits were to be dug at locations indicated by the Engineer and shown on the Site Plans, Drawing Nos. R2857/137 - 142 and SI/1190. As site work progressed, a further 8 boreholes were required, also shown in the Site Plans in the Appendix, these being given the suffix A or B where appropriate. When it was realised that boring by shell and auger methods was not satisfactory at some of the borehole positions the programme was revised and of the above total of boreholes indicated, a total of 38 boreholes were finally sunk by shell and auger methods at 200, 150 and 125 mm diameter, the remainder being replaced by pits, as indicated in the Borehole Records in the Appendix. though still indicated as boreholes on the Site Plans. Of the above 38 boreholes, a total of 12 were sunk by mechanical methods using a Pilcon Wayfarer shell and auger boring rig. The use of this equipment was limited by difficulty of access and soft ground at borehole positions and the remaining boreholes were sunk by hand methods at 125 mm. Boreholes 5, 6, 7 and 12B were continued into rock by rotary drilling methods at 86 and 76 mm diameter to produce 72 and 62 mm diameter rock cores respectively. Borehole 12B was sunk through overburden to rockhead using rotary openhole methods at 113 and 98 mm diameter and was subsequently continued into rock for 1 metre using rotary diamond drilling methods at 86 mm diameter. This borehole was sunk to prove bedrock and the depth of overburden present in in area of suspected landslipping where shell and auger methods of boring had failed. Boreholes 5, 6, 7, 28 and 28A were cored to depths of between 6.4 and 8.4 metres to establish information on the nature of the rock strata in the region of the proposed large bench cut between chainage 400 and 750m.

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In addition to these boreholes a total of 19 test pits were excavated as planned to supplement borehole information at positions indicated by the Engineer and shown in the Site Plans. Pits 7 to 19 inclusive were excavated by Hy-mac, while the remainder were excavated by hand.

A further series of 42 pits designated as trial holes, were dug by Hy-mac to provide further information on the soils occurring at the site and to establish, where possible, the level of rockhead along trenches at positions indicated by the Engineer and shown on the Site Plans. Trial holes were numbered 1 to 42 and were given the prefix (TH). Trial hole 42 was excavated in the form of an elongated trench in the presence of the Engineer's representative in an attempt to establish rockhead level and to investigate the soil for indications of possible active landslipping in the region of chainage 20^{00}m.

Dynamic penetration tests were carried out during shell and auger boring and representative disturbed and undisturbed samples of the soils and rocks encountered in boreholes and pits were taken, all as described in the Notes in the Appendix.

The investigation was discontinued on account of weather conditiosn and resulting access difficulties in November when almost complete. Two additional boreholes numbered 27A and B were subsequently sunk by rotary methods at 86 mm diameter in the forest section, ch. 62^{00} in an area where geological conditions indicated broken rock. No core was recovered from any hole and trial holes 43 and 46 were then excavated by others, to assess the condition of the rock, and logged by Messrs. Whatlings (Found.) Ltd.

Standpipes were inserted also at this time in boreholes 12B, 27A and B to monitor groundwater levels.

Details of all boreholes including daily progress of hole and casing, descriptions of soils and rock encountered, records of sampling and in-situ testing carried out, observations of groundwater conditions during boring and levels of ground surface and of changes of strata related to Ordnance Darum are given in the Borehole Records in the Appendix. Details of test pits and trial holes including descriptions of the soils and rock encountered, records of sampling, observations of groundwater conditions during excavations and levels of ground surface related to Ordnance Datum are given in the Records of Test Pits and of Trial Holes in the Appendix.

LABORATORY WORK

Testing was carried out on the samples of soil indicated by the Engineer by procedures referred to in the Notes in the Appendix.

The results of natural moisture content and density determinations and immediate undrained triaxial compression tests are given in Figure 1 and the results are summarised in Table 1 in the Appendix.

The results of moisture content and density determinations and of drained triaxial compression tests on remoulded samples are given in Figures 2 and 3.

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The results of British Standard compaction tests are given in Figure 4.

The results of particle size distribution determinations are shown on Figures 5 to 8.

The results of sulphate content and pH value determinations are given in Table 2.

C.B.R. tests were carried out on single samples of soil compacted by dynamic methods at moisture contents approximately to the highest value assessed as likely to obtain after construction of the pavement and the results are given in Table 3.

The results of large shear box tests carried out on a sample of soil are indicated in a report by the Department of Civil Engineering of Portsmouth Polytechnic, Portsmouth in the Appendix, which also gives details of the laboratory procedures involved in the carrying out of these tests.

GROUND CONDITIONS

Ground conditions were found to be broadly similar to those indicated by available published geological information in that superficial deposits of peat and local pockets of alluvium overlay a rather thin and discontinuous layer of glacial drift through which numerous outcrops of the underlying bedrock were observed. No raised beach deposits were positively identified along the route of the proposed new road.

Extensive fairly shallow deposits of soft peat were encountered at surface from chainage 15^{00}m to 72^{00}m and 92^{50} to 100^{00}m which extended to a maximum depth of 5.6 metres in local poorly drained hollows along the route but which generally showed thicknesses considerably less than this along the greater part of the route. In such poorly drained hollows, the peat was frequently laminated and contained a considerable proportion of silt and sand of alluvial origin.

In the vicinity of chainage 27^{50} the peat was followed by a thick layer of alluvium predominantly consisting of grey and grey brown sand, gravel and cobbles in which the cobbles become more abundant and coarser with increasing penetration, apparently reaching over 50% in places. Within this deposit, several discontinuous bands and lenses of fine grained material varying between silty sand and silty clay were encountered which appeared to occur in a zone around a level of 148 m O.D. and showed a relative density within the medium dense range. The relative density of the coarse alluvial deposits appeared to increase with increasing penetration varying between medium dense and dense. Alluvial deposits were also encountered at chainage 75^{00}m apparently associated with the Ascaig Burn. These deposits consisted of an upper layer of medium dense grey brown silty sand followed by a thick zone of dense and very dense sand and gravel and cobbles.

Between chainage 15^{00} and 100^{00}m extensive deposits of glacial drift were encountered below deposits of alluvium, where present, and below the superficial organic deposits over the remainder of the section./

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section. The depth of the drift appeared to be strongly influenced by topography with up to 9 metres of the deposit being encountered in local hollows, though over the greater part of the route, the deposit did not generally exceed 3 metres in thickness. The glacial drift was associated with morainic deposits in the vicinity of chainage 20^{00}m and consisted of brown and blue grey clayey and silty sand and sandy clay which contained abundant gravel, cobbles and boulders of assorted rock types including frequent fragments of the underlying bedrock.

The soil was generally highly porous, slightly or non cohesive, and showed a relative density varying between dense and very dense. Where trial pits were excavated below groundwater level in these deposits, water was observed flowing rapidly into the pits with rapid deterioration of the soil and collapse of the sides of the excavations. The highly variable nature of the drift and its close association with morainic deposits observed along the route of the proposed road, is consistent with its description as undifferentiated drift as in published geological information.

Between chainage 0^{00} and 15^{00}m rock was encountered close to ground surface covered largely by a thin layer of topsoil. Pockets of deeper soil were encountered which also resembled topsoil and consisted of brown and orange brown silty sand containing roots, gravel and boulders.

These pockets of deep soils were commonly associated with breaks in slope and may represent local accumulations of topsoil produced by old landslips.

Rock was encountered in the majority of boreholes, test pits and trial holes at shallow depth and was exposed in craggy outcrops in numerous localities. It consisted of various types of metamorphic strata from which three major divisions were identified on the basis of hardness, rock type and structure. The youngest strata were described as schist of the Moine Series by published geological information and shown on site location plan SI/1190, in the Appendix, and consisted of highly folded and foliated hard and very hard grey quartz mica schist. The dip of the strata generally appeared to be to the east. The oldest stratum indicated as Lewisian Gneiss by published geological information was encountered predominantly between chainage 0^{00} and 30^{00}m but also at other localities along the route of the proposed road. This rock was highly folded and in places highly foliated with thin highly micaceous bands alternating with very hard massive coarse grained horizons. The rock varied in compositon from grey and dark grey banded hornblende gneiss to red grey and light grey biotite gneiss which resembled a foliated granite in places and was cut by numberous veins of quartz. The general dip of foliations in the rock was between 40^{0} and 70^{0} to the east. Several large irregular intrusions and small dykes of dark grey hornblende schist and amphibolite; rock types derived from metamorphic alteration of basalt and related rock types, were found to cut the schist and gneiss, the amphibolite generally occurring in dyke form producing sharp topographic features and consisting of very hard dark green grey massive, coarse grained and well jointed rock virtually devoid of any preferred planes of foliation.

In the vicinity of chainage 37^{00}m a broad zone of structural disturbance/

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turbance was encountered which coincided with the indicated outcrop of the Moine Thrust. This zone appeared to be somewhat discontinuous apparently producing alternating bands of crushed, sheared and broken rock and hard unaltered rock, and appeared to affect strata for a considerable distance from the indicated outcrop of the thrust.

Both the Lewisian gneiss and the Moine schists were present in this region though frequently somewhat modified in places apparently as a result of the severe crushing and shearing present within this zone. The rocks were highly foliated and appeared to be less hard and more prone to surface weathering than the rocks in undisturbed regions in that no surface outcrops of rock were observed along the sections of the route where the boreholes encountered severely foliated and crushed strata. No small faults or basalt dykes as referred to in the published geology were encountered or identified in any of the boreholes, test pits or trial holes.

Groundwater was encountered in many of the holes at high levels in poorly drained sections of the route and in the vicinity of rivers and streams. Where the ground was well drained as in the section between chainage 0^{00} and 15^{00} boreholes and pits were generally dry.

D. R. Christison.

D.R. CHRISTISON
B.Sc.
GEOLOGIST

A890 South Strome to Auchtertyre Road Ref: 1190

COMMENTS ON GROUND CONDITIONS IN RELATION TO FOUNDATION DESIGN

The investigation has revealed conditions which indicate rockhead level at or near ground surface over most of the route of the proposed new road covered by rather thin though extensive glacial deposits and occasional isolated and relatively deep pockets of alluvial soils. An assessment of the topography along the route has revealed that, as expected, much of the proposed road will be required to run in cut much of which is expected to involve the removal of considerable quantities of bedrock. It is expected that most of the excavated rock and the soil is to be re-used as fill in the construction of embankments and comments on the suitability of rock and soil as fill material are included in this report. Special measures for control of groundwater may be necessary in areas where natural drainage is poor and liable to be impeded by the proposed works.

STRUCTURES

Assessments of allowable bearing capacities of the soils at the site of the proposed structures are based on analysis of dynamic penetration tests taken in the granular soils and on the assumption of an allowable settlement of the order of 25 mm.

Bases of foundation excavations should be inspected to ensure that conditions comply with those assumed in design. Any pockets of soft material should be removed and replaced by well compacted hardcore or lean concrete, or the depth or width of foundation suitably adjusted. Loose pockets of granular material, particularly where these are found in proximity to the standing water level may be more appropriately treated by compaction and the addition of further hardcore.

Large Culvert ch. 35^{00}m - Hangman's Burn

At this point, the proposed new road crosses a narrow, incised burn which flows through a narrow gully approximately 4 metres deep into the adjacent Lochalsh Reservoir.

The two boreholes sunk at this site indicated deposits of overburden consisting of clayey and silty sand, gravel and boulders of up to 1.5 metres in thickness overlying medium hard schist which showed a dip to the east, approximately parallel to the burn.

It appears that the culvert can be conveniently founded on rock which would be expected to withstand loadings of at least 2.5 MN/m^2 (25 tons/sq.ft.) which appears more than adequate for the design. The bases of foundation excavations should be thoroughly inspected after completion and the direction of dip of foliation and other planes of weakness measured. Any foliation with a component of dip towards the river may provide potential surfaces of slipping in that direction and keys into rock behind such surfaces may require to be installed.

Ascaig Burn Culvert ch. 75^{50}m.

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A890 South Strome to Auchtertyre Road Ref: 1190

The proposed road is shown to run across Ascaig Burn on an embankment some 3 metres in height.

The boreholes at this location showed over 5.7 metres of overburden which consisted of soft peat and sandy silt followed by dense sandy gravel below a depth of 1 and 2 metres below ground level (approximately 19 m O.D.). Rock was not encountered at the site of the proposed culvert.

The upper soft largely organic deposits consisted of up to 2 metres of peat frequently including layers and lenses of soft brown sandy silt of alluvial origin which gave rise to very soft surafce conditions which prevented the access of mechanical boring equipment.

The underlying dense sandy gravel consisted of slightly silty sand with abundant rounded gravel and cobbles of alluvial origin.

It would appear most suitable to found the culvert on strip or pad foundations placed at a depth of 2 metres below ground surface within the dense sandy gravel. Assessments of allowable bearing capacity in this layer are based on dynamic penetration test results in saturated soil and indicate values of the order of 150 to 200 kN/m^2 ($1\frac{1}{2}$ - 2 tons/sq.ft.) at a depth of 2 metres. The overlying peat and soft alluvial deposits might be removed and replaced with well compacted fill material.

A high level of standing groundwater was observed in all boreholes and would appear to be subject to rapid fluctuations related to the regime of the adjacent stream and a system of dewatering therefore appears to be required to control groundwater level during construction of foundations. The excavations of drainage sumps adjacent to foundation excavations may prove sufficient but it must be appreciated that pumping of groundwater can result in irreversible loosening of the deposits and large associated settlements. It therefore appears preferable to install a system of well points or drainage sumps adjacent to excavations. It would be undesirable for foundation excavations themselves to be used as dewatering sumps as this would be liable to result in deterioration of the formation. Some form of stream control may also be necessary to prevent access of floodwater from the adjacent burn into foundation excavations.

In the event of slab foundations being suitable for the proposed culvert, piled foundations may be necessary and in view of the highly porous non-cohesive nature of the foundation horizon driven systems such as steel 'H' piles driven to refusal would appear to be most suitable for this purpose.

The concentration of sulphates present in samples of groundwater were such that no special precautions should be required to ensure the durability of normal good quality Portland Cement products. Groundwater in the vicinity of borehole 33A was slightly acidic, possibly derived from the adjacent peat deposits, and it would appear worthwhile to protect concrete foundations with oversite paper of polythene membrane during construction and to provide adequate cover for steel reinforcement. Some protective measures such as bitumen coating of steel piles to prevent corrosion by groundwater may also be necessary.

EARTHWORKS AND ROCK CUTTINGS

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A890 South Strome to Auchtertyre Road Ref: 1190

The proposed new road is shown to traverse a region of rugged topography with the result that much of the route is expected to run in cut or on embankment some of which will be of considerable proportions. Soils encountered during the investigation, were found to be relatively thin and the cuttings proposed are expected to involve the excavation of considerable quantities of rock which will be used as fill material in embankments where possible. Rock encountered during the investigation was found to be predominantly hard and largely resistant to deterioration by weathering, and allowable slopes of cuttings will be dependent on the attitude of planes of weakness such as bedding planes, joints, and foliations within the rock strata rather than on rock strength. Where considerable depth of overburden was encountered above rock strata, the allowable slopes would be expected to be largely dependent on the moisture content of the soil which was found to vary considerably from place to place and be subject to extreme local variations. Soils encountered over the site were found to be highly porous and susceptible to rapid deterioration when subject to unbalanced water pressure. Measures necessary for drainage of rock cuts may become apparent only after excavation.

Excavated materials from rock cuttings are expected to produce high quality fill for embankments which should be durable and easily drained, and could sustain slopes of the order of 1 in 1 if required, dependent on the subgrade. Where the use of rock fill is not possible for one reason or another the soils of glacial origin may be considered for use as fill material.

Embankments of moderate height constructed of this material could if desired have side slopes of up to 1 in 1½, which is steeper than normally used where considerations of maintenance are paramount. It is assumed that adequate permanent drainage will be provided to slopes and formations. It should be observed, however, that these indications assume that soil can be excavated, and placed, spread and compacted in embankment with little increase in moisture content or alternatively that it is rapidly free draining as placed.

Cuttings

A total of 19 cuts varying in depth from 3 to 13 metres in depth are shown along the route of the proposed new road, the majority of which are indicated between Auchtertyre and chainage 40^{00}m. There is also a large rock cut between chainage 62^{00} and 64^{00}.

The cuts were predominantly in rock and of box type in profile where the gradients of the sides could be readily altered in accordance with the depth and rock structures encountered to ensure adequate slope stability and are not considered further in this report.

Two large bench cuts are indicated which involve excavations of 10 and 13 metres respectively into steep hillsides which allow little or no margin for alteration of side slope gradients to ensure adequate slope stability and if problems in slope stability arise these may require to be overcome by specialised methods such as bolting of critical rock masses. Such work would require to be carried out under the directions of an experienced engineering geologist.

Chainage/

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A890 South Strome to Auchtertyre Road Ref: 1190

Chainage 4^{00} to 6^{00} m.

To the north of Auchtertyre, the proposed new road will run in a large bench cut along the steep south facing hillside above Lochalsh. It appeared that the depth of the cut could be of the order of 10 metres on the centreline of the road and that due to the steep gradients of around 1 in 2 of the natrual ground in the area, the north side of the cut would require to stand at an angle near vertical.

The investigation revealed that the cutting would be in rock covered by up to 4 metres of overburden which consisted of sandy soil with gravel, boulders and fragments of bedrock.

The rock indicated an apparent dip of between 40^{o} to 70^{o} to the east, approximately parallel to the line of the cut and it would appear likely that the sides of the cut should be relatively stable at a slope of the order of 8 in 1. However, in the event of a component of dip to the south being present which was not indicated by the investigation, the risk of failure along planes of foliation in the rock would be increased. This should be ascertained during construction of the works and if such potential slip surfaces are encountered rock bolts may require to be installed to minimise the risk of slip failure of the rock. It is probable that the strongly banded gneiss will be susceptible to spalling due to weathering of the exposed rock and measures may be required to control this.

The soils encountered above the rock in this section had apparently attained stability on gradients of approximately 1 in 2. It therefore appears likely that this soil may become unstable if required to stand at steeper slopes and may therefore require to be retained above the cut. The soil was also found to deteriorate considerably in the presence of percolating water, which will require that an adequate system of drainage be provided.

Chainage 61^{00} to 63^{50} m.

A second large cut is proposed in this section and is expected to be of the order of 18 metres deep in ground which slopes to the north west at gradients of approximately 1 in 2.

The investigation revealed that less than 1 metre of soil was present above rockhead and no problems of slope stability therefore arise in the superficial deposits.

The rock was not exposed in the vicinity of the site but evidence from trial pits and boreholes showed it to be badly fractured and consisting of strongly foliated schist. This condition is consistent with shattering and subsequent weathering caused by the Moine Thrust which runs parallel to the route along this section and a short distance to the west. The condition of the rocks might be expected to be similar to that visible in a quarry excavation in comparable geological conditions at ch. approximately 75^{00} on the northern side of Srath Ascaig. The dip of the rock could not be precisely determined, but appeared to be relatively flat and approximately in an easterly direction in accordance with the regional dip of the strata.

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The stability of this cutting gives some cause for concern in view of the apparently shattered nature of the rock and of the groundwater conditions. On the west side, these appear to require and permit the use of a side slope, as for a soil formation, at about 1 in 1½.

On the eastern side, such a slope would entail a major cutting or alternatively a retaining structure, but it may be observed that the dip of the rocks appears to favour the cutting on this side. Near vertical slopes are apparently stable in such conditions in the quarry referred to above. It appears likely therefore that a steep slope - say 8 to 1 - with provision for benching as required, should be stable on this side, provided always that adequate provision is made for drainage.

Embankments

It was understood that it was intended to re-use material excavated from cuttings as fill for embankments. In view of the frequency and depths of the cuttings, of which the majority will involve excavation of considerable quantities of rock, an abundance of high quality fill should be available especially along the southern section of the route. In the northern section between Srath Ascaig and South Strome the depth of overburden was generally greater and cuttings into rock less frequent. It will, therefore be necessary to use excavated overburden as fill material.

Of the rocks encountered during the investigation, the very hard gneiss and intrusive rocks would be expected to yield the best quality fill which, owing to the high quartz content of the rock, would be expected to be extremely resistant to deterioration by weathering. The less hard schist and crushed gneiss of the central section between chainage 35^{00} and 100^{00}m would also yield high quality fill but would be expected to be prone to slight deterioration by weathering over a considerable number of years.

Settlements occurring in this fill should be small and would be expected to occur during the construction period, provided that it is spread and compacted by normal good practice.

Soils consisting of non cohesive and poorly cohesive silty and clayey sand and gravel similar to those encountered widely over the site would also appear capable of producing high quality fill when used in suitable weather conditions and spread and compacted by normal good practice designed to preclude the opportunity for increase of moisture content. Care would have to be taken to prevent the inclusion of peat or cohesive soil in significant quantity in the fill material. The latter soil type should be excluded as far as practicable to maintain the free draining characteristics of the granular soils. Compaction tests carried out on these soils indicated optimum moisture content of 10 to 12% and maximum dry density of 1980 - 2020 kg/m^3 when tested by British Standard 2.5 kg. procedure. Shear box tests carried out at Portsmouth Polytechnic on a sample of similar soil from chainage 20^{00}m showed that the soil behaved as a granular material under direct shear stress with no cohesive intercept and an apparent residual angle of shearing resistance of 37^{0} at maximum compacted density of the material. These values appear to confirm that the material is suitable as fill subject/

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subject to the conditions indicated and to the achieving of a high degree of compaction to exclude air from the interior of the embankments.

The majority of the proposed embankments were shown to be constructed over areas where rockhead was encountered at depths of less than 2 metres below ground level and where settlement in the overburden was expected to be within tolerable limits. These proposed embankments are not considered further in this report. Two embankments were proposed in areas where soils were of greater thickness.

Chainage 26^{00} to 29^{00}m.

At this section, the road was expected to run in up to 10 metres of fill across flat boggy ground which lay immediately west of the existing Lochalsh Reservoir.

The investigation indicated up to 5.5 metres of very soft peat in this area followed by thick laminated alluvial deposits of silty sand, and sand and gravel with occasional thin bands of clayey silt. The alluvial deposits are undoubtedly capable of withstanding the loadings exerted on them by the proposed fill while restricting settlements to a tolerable amount, but such loadings on the overlying peat deposits would result in large and continuing amounts of total and differential settlements unless certain restrictions and controls on the implacement of fill materials are observed. Such problems of settlement could be overcome by several methods: including controlled compaction of the peat by surcharging; removal of the peat by displacement methods or by excavation; or re-routing the relvant section of the proposed new road to an adjacent site where ground conditions are more favourable. In view of the high standing groundwater levels observed in the area, removal of the peat deposits prior to fill emplacement would be expected to result in serious drainage problems during construction.

Srath Ascaig Culvert Chainage 74^{00} to 76^{50}m.

The proposed new road is shown to run on an embankment up to 6 metres in height, crossing the Ascaig burn which will be accommodated in a large culvert.

The investigation indicated deep alluvial soils adjacent to the Ascaig burn at chainage 75^{00}m which consisted largely of thin silty sand followed by coarse sand and gravel, which should provide an adequate foundation for the proposed embankment after removal of little more than the organic topsoil.

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A P P E N D I X

NOTE ON METRICATION

In keeping with the programme of the Construction Industry this report is expressed in S.I. Metric Units.

To assist with interpretation during the changeover period, leading dimensions may also be shown in Imperial units to normal civil engineering standards of accuracy. The following conversion factors are given as applicable to the quantities used in the report.

Length	1 m	=	3.28 ft.
Mass	1 kg	=	2.20 lb.
Force	1 kN	=	225 lb. f. 0.10 ton f.
Density	1000 kg/m^3	=	62.4 lb./cu.ft.
	1 Mg/m^3	=	
Pressure, stress strength			
	1000 kN/m^2	=	145.0 lb./sq.in.
	1 MN/m^2	=	20,890 lb./sq.ft. 9.32 ton/sq.ft.

T69
ADR/AJ/S.I.

NOTES ON FIELD PROCEDURES

Boring

Boreholes are sunk by shell and auger methods to permit representative sampling in soft formations; or by rotary drilling for fast penetration of soils, or to permit recovery of cores from indurate soils and rock strata. Sampling and in-situ testing are carried out generally to the requirements of BS CP 2001 and BS 1337 : 1967.

Sampling

In shell and auger boreholes, representative disturbed soil samples are taken in glass jars from the tools and in-situ testing equipment at frequent intervals and these may be supplemented when required by large bulk samples.

Undisturbed samples 100mm. diameter are taken in open drive tubes 450mm. long normally on first recognising a cohesive stratum and subsequently at intervals within the stratum. The number of blows of the rods and jarring tool required to drive a sample are recorded as a guide to the consistency of the soil. These results are dependent also on depth, on soil type and on personal factors. There is no relationship with the results of Standard Penetration Tests.

Samples of groundwater are taken in clean glass jars when sufficient water has collected in a borehole.

In-Situ Testing

The degree of compactness of predominantly granular soils is assessed by in-situ penetration tests. Standard Penetration Tests and dynamic Cone Penetration Test are carried out according to Test 18 of BS 1377 and on the basis of the results, the relative density of a deposit is described after Terzaghi & Peck as follows:-

Very Loose	Loose	Medium Dense	Dense	Very Dense
0-4	4-10	10-30	30-50	Over 50 - Blows for 300mm.

Where no reliable test results are available, the deposit is assessed as Loose or Compact.

Static cone penetration tests are used to provide a continuous record of penetration resistance at varying depths; and plate bearing tests are occasionally appropriate to allow a more accurate estimate to be made of the allowable bearing pressure of shallow cohesionless soils than is possible by penetration tests.

In-situ Vane tests are carried out in extensive soft cohesive deposits whose sensitivity to sampling disturbance may result in unrealistically low safe bearing capacities being indicated by laboratory tests. Procedure is to Test 17 of BS 1377. The vane used is normally 150mm. long and 75mm. across. Tests are carried out on the undisturbed condition and also on the remoulded soil some five minutes after the vane has been rotated through one complete revolution.

T70
ADR/AP/Site Investigations.

NOTES ON LABORATORY PROCEDURES

The samples of soil and rock taken during the site work are examined in the laboratory and assessments of their characteristics used to supplement field observations, and in-situ and laboratory test results in the preparation of the Borehole Records.

Testing is carried out to the requirements of British Standards where applicable, or otherwise in accordance with good practice as follows. The results are presented in Summary, and in detailed Tables and Figures.

Compression Tests. Specimens 38mm. diameter and 76mm. long are normally prepared by extrusion of undisturbed samples into thin wall tubes as described in Test 20 of BS 1377. When testing cohesive soils containing a substantial proportion of gravel, the use of a larger test specimen is frequently desirable and single 100mm. diameter specimens 200mm. long are then prepared directly from the undisturbed sample. The densities of the specimens are recorded and determination made of their moisture contents after testing.

Unconfined compression tests are carried out on single specimens to Test 19 of BS 1377 and the maximum stress measured over the average cross-section area. In soils exhibiting a zero angle of shearing resistance, the shear strength is half the unconfined compression strength. This is normally the case in 'quick' tests of saturated clays.

Immediate undrained triaxial compression tests are carried out on sets of 38mm. diameter specimens at varying cell pressures, as described in Test 20 of BS 1377. Tests on 100mm. diameter specimens are commenced at a low cell pressure, and provided that deformation is sufficiently small when observations indicate that the rate of increase of compressive stress has reduced, so that the compressive stress registered is unlikely to be significantly exceeded in any continuation of the test, the cell pressure is quickly increased and the procedure repeated to provide results at a range of cell pressures similar to that used for the small specimens. The states of stress attained at failure are represented in Figures as Mohr circles, and the derivation of shear strength parameters is indicated in appropriate cases.

The results of strength tests are interpreted within the range of consistencies defined by section 1.6 of the Civil Engineering Code of Practice No. 4 - Foundations.

Laboratory vane tests are carried out using an apparatus based on that used for the in-situ test (BS 1377 Test 17). The vane size is 13mm. by 13mm.

Consolidation tests are carried out according to Test 16 of BS 1377.

California Bearing Ratio Tests are performed in accordance with the Test 15 of BS 1377, and more specifically by the procedure laid down in Road Note No. 29 published by the Road Research Laboratory of the Ministry of Transport, London.

Sulphate Content and Reaction Determinations. The concentrations of soluble sulphates present in samples of soil and groundwater are estimated by chemical analysis to Test 9 of BS 1377. The results are expressed as the percentage of sulphur trioxide (SO_3) in soil, or as the number of parts of SO_3 per 100,000 in groundwater. 1 p.p.m. th = 0.01 g/litre.

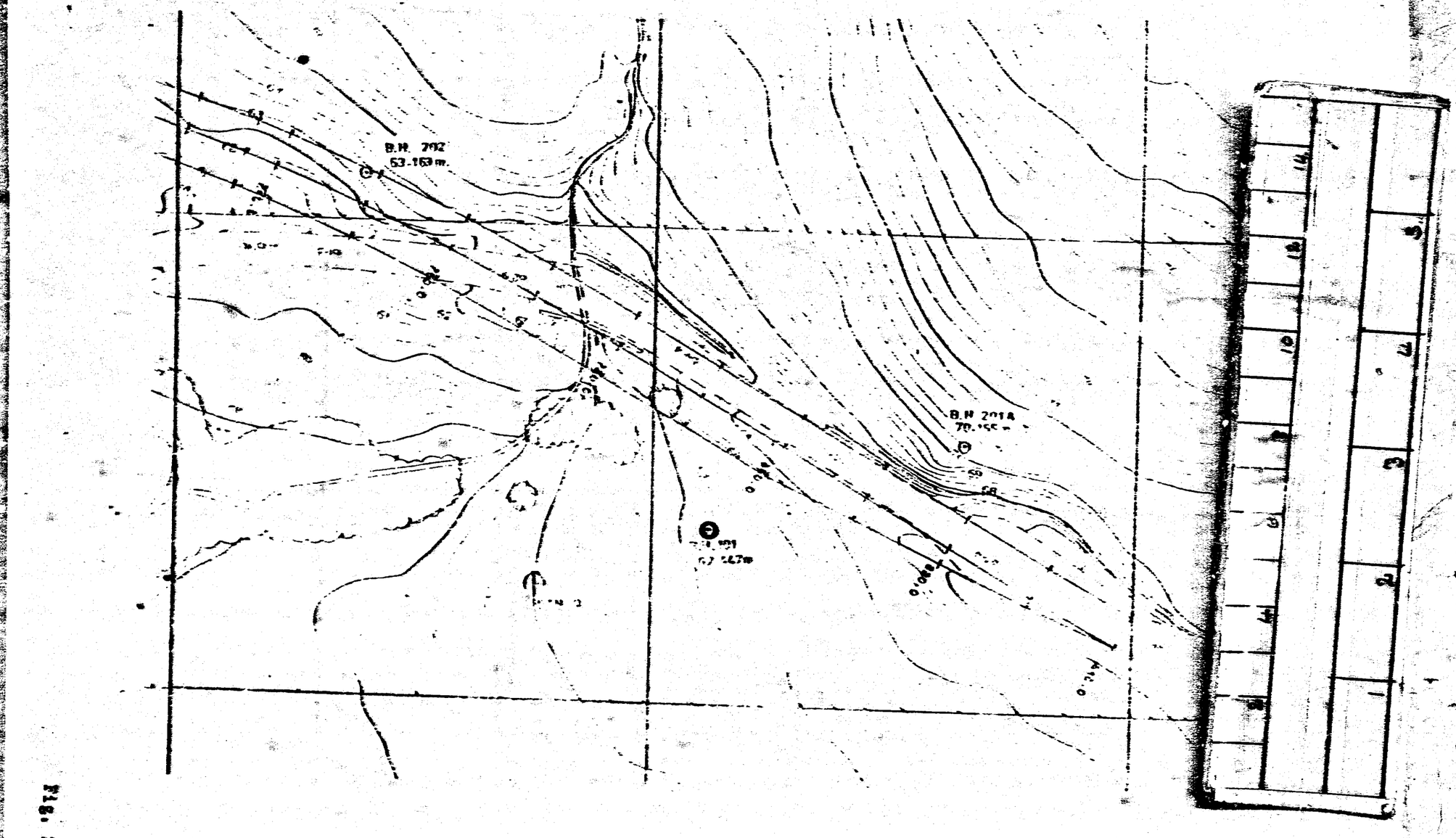

Fig. 20

A896 Lochcarron Village Phase II

Borehole Locations

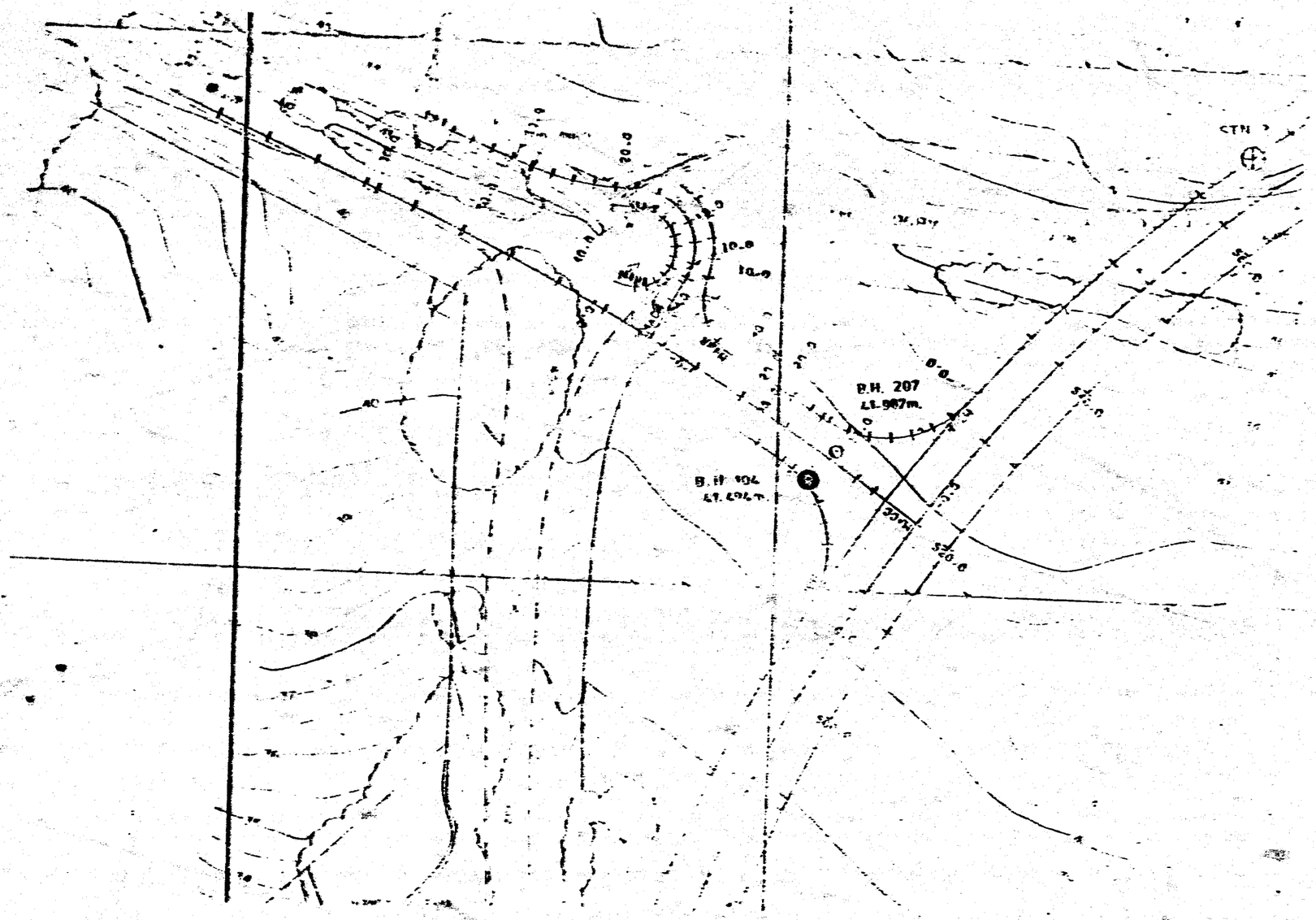

Fig. 21

A896 Lochcarron Village Phase II

Borehole Locations

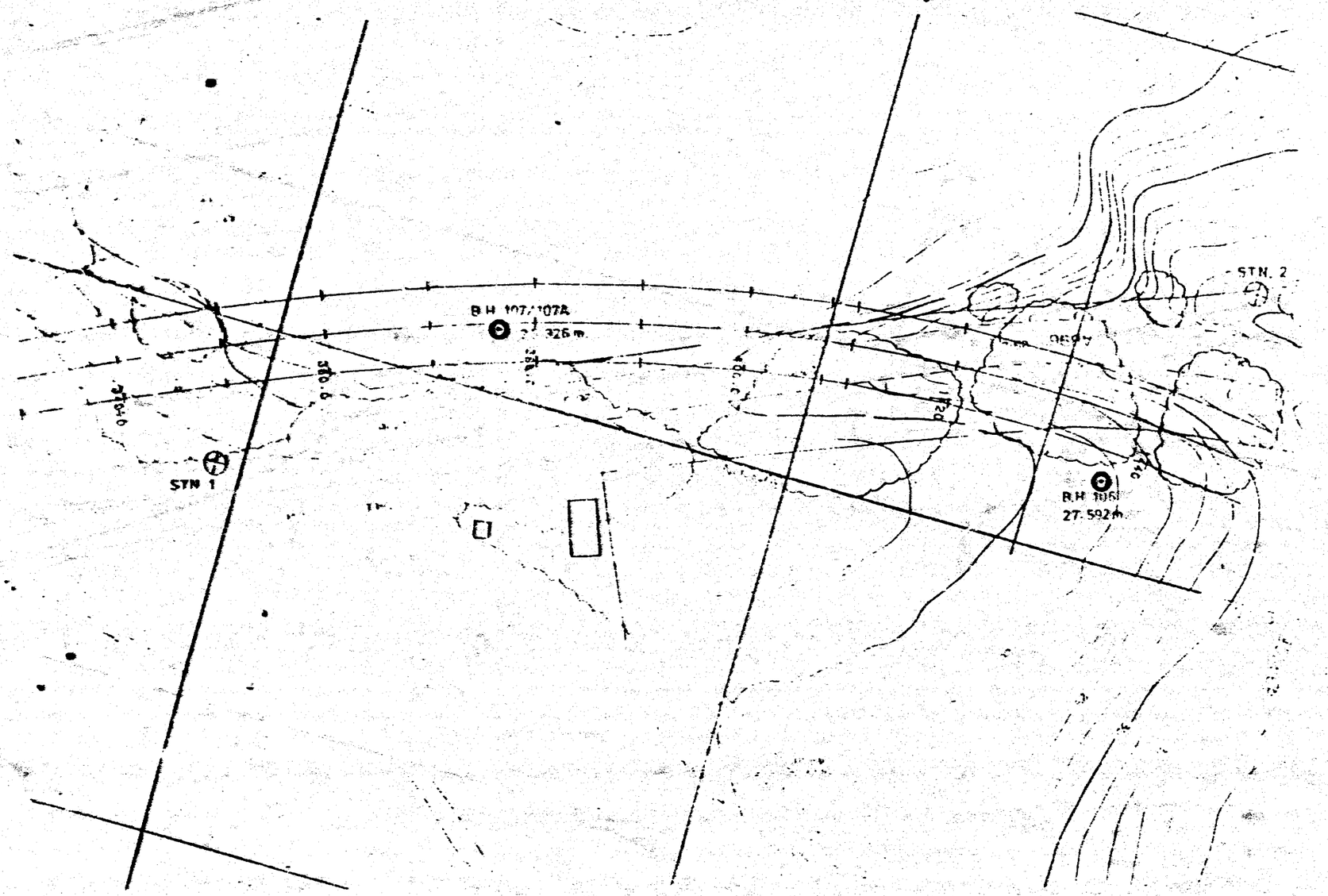

Fig. 22

A896 Lochcarron Village Phase II

Borehole Locations

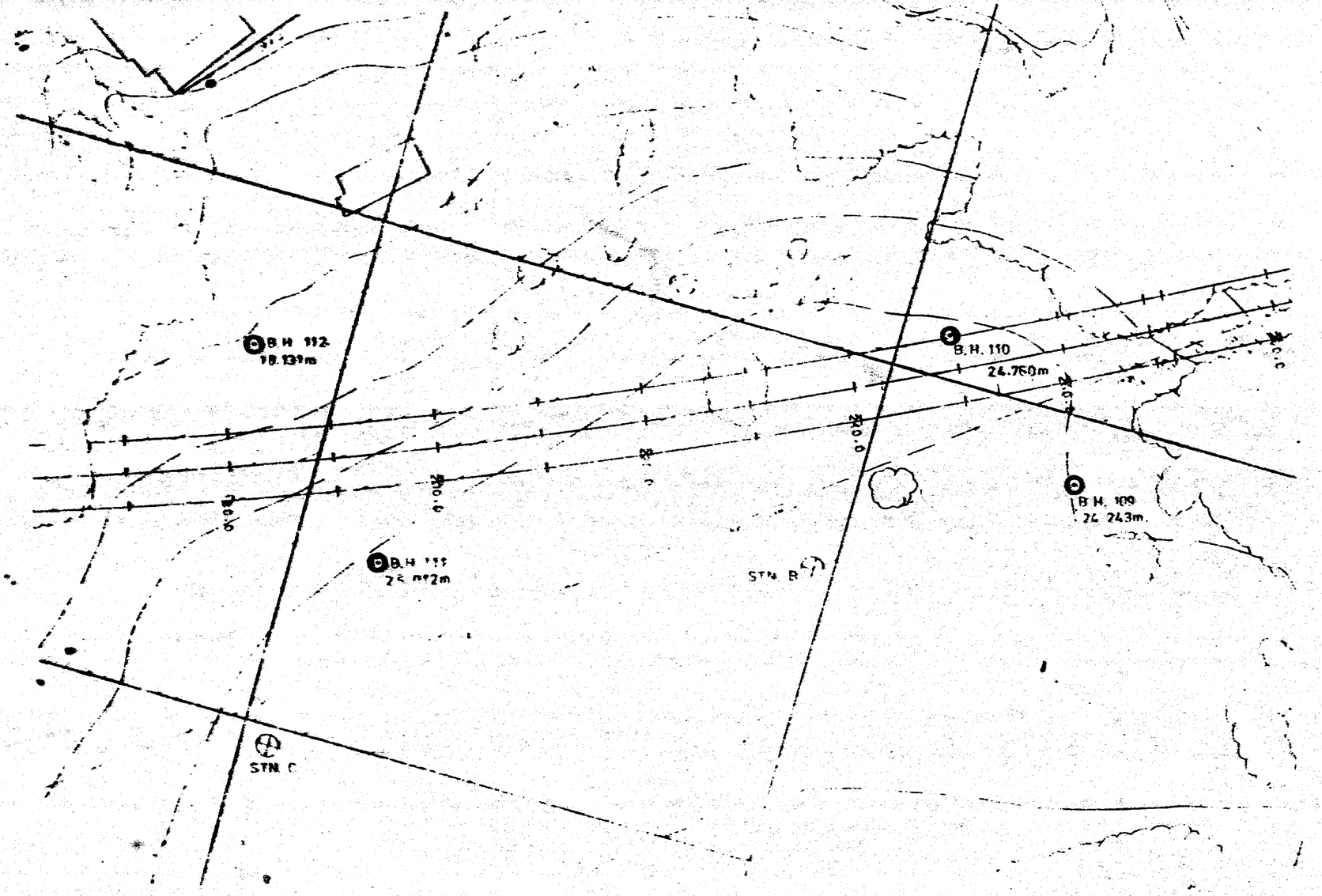

Fig. 23

A896 Lochcarron Village Phase II

Borehole Locations

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 1

Ref. No. 1190 Dia. of Boring PIT TO 1.00 M

Ground Level 29.05 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
26/5/73			0.20 - 0.60	B1		0.20	28.85	LOOSE BROWN TOPSOIL
								SOFT BROWN AND DARK BROWN PEATY SANDY SOIL
			0.60 - 1.00	B2		0.60	28.45	WITH GRAVEL
								COMPACT RED BROWN SILTY SAND WITH FRAGMENTS
1.00		DRY				1.00	28.05	OF WEATHERED GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U/70	Undisturbed Sample - no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 2

Ref. No. 1190
Ground Level 38.09 M O. D.

Dia. of Boring PIT TO 1.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
26/9/73			0.20 - 0.55	B1		0.20	37.89	LOOSE BROWN TOPSOIL
			0.55 - 1.00	B2		0.55	37.54	COMPACT RED BROWN SANDY SOIL WITH GRAVEL, COBBLES AND BOULDERS
1.00						1.00	37.09	COMPACT LIGHT BROWN SILTY SAND AND FRAGMENTS OF HORNBLENDE GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 3

Ref. No. 1190
Ground Level 29.13 M O. D.
Dia. of Boring 1.25 M To 0.30 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
13/2/73 0.30						0.17	28.96	LOOSE BROWN SAND OF SOIL
						0.30	22.83	HARD GREY GNEISS

REMARKS :

SCALE: 1/50

KEY:

b	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450 mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Sheer Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 4

Ref. No. 1190 — Dia. of Boring PIT — To 0.80 M

Ground Level 20.01 O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
26/3/73			0.20 - 0.80	B1		0.20	19.91	LOOSE BROWN SANDY TOPSOIL
								LOOSE BROWN PEATY CLAYEY SAND
						0.80	19.21	
0.80		DRY				1.00	19.01	HARD GREY GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water . do	(27)	No Blows for 310mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

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A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 5

Ref. No. 1190
Ground Level 55.54 M. O. D.
Dia. of Boring 113 MM TO 2.30 M
98 MM TO 8.40 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
8.10.73								COMPACT BROWN SANDY SOIL AND ABUNDANT FRAGMENTS OF BROKEN ROCK
						1.50	54.04	
								MEDIUM HARD WEATHERED AND BROKEN GNEISS
2.30	1.60	DRY				2.30	53.24	
9.10.73		DRY						HARD AND VERY HARD LIGHT GREY BANDED GNEISS, BROKEN IN PLACES
			4.00 - 5.00	0.40				
3.30	3.00							
10.10.73		DRY	5.00 - 5.30	0.30				
			5.30 - 5.75	0.30				
			5.80 - 6.30	0.50				
5.30	3.00							
11.10.73		DRY	6.30 - 7.00	0.70				
5.79	3.00	DRY						
12.10.73		DRY	7.00 - 7.30	0.30				
			7.30 - 8.40	1.10				
7.30		DRY						
13.10.73		DRY						
8.40	3.80	DRY				8.40	47.14	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test
B	Bulk do do	C(27)	Cone do do
W	Water do	(27)	No Blows for 300mm Penetration
*	Core Recovery	V	In - situ Vane Shear Test

U1/70	Undisturbed Sample 100mm dia
/70	No of Blows to drive sample 450mm
U4/70	Undisturbed Sample - no recovery

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 6

Ref. No. 1190
Ground Level O.D.

Dia. of Boring 98 MM TO 7.25 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
10.10.73						0.30	47.53	SOFT DARK BROWN PEATY TOPSOIL
								COMPACT BROWN SANDY SOIL WITH GRAVEL, COBBLES AND LARGE BOULDERS
			1.75 - 3.00	0.45		1.75	46.08	
								COMPACT BROWN SANDY SOIL WITH ABUNDANT LARGE BOULDERS AND BROKEN ROCK FRAGMENTS
3.00	1.75	DRY						
17.10.73			3.00 - 4.00	NIL				
4.00	3.70		4.00 - 4.30	0.30		4.00	48.83	
18.10.73	3.70	DRY						
4.30	3.70	DRY	4.30 - 4.95	0.60		4.30	43.53	MEDIUM HARD RED GREY GNEISS
19.10.73	3.70	DRY						
								HARD BECOMING VERY HARD LIGHT RED GREY BANDED GRANITISED GNEISS
			4.95 - 5.70	0.60				
5.70	3.70	DRY						
20.10.73		DRY	5.70 - 6.60	0.90				
6.60	3.70	DRY						
21.10.73		DRY	6.60 - 7.25	0.65				
7.25						7.25	40.58	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
✳	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 7

Ref. No. 1190
Ground Level O. D.
Dia. of Boring 98 MM TO 4.70 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
25.10.73			0.00 - 0.30	B1		0.30	42.80	LOOSE RED CLAYEY SOIL
			0.30 - 0.60	B2				COMPACT RED BROWN SANDY SOIL WITH GRAVEL, COBBLES AND BOULDERS
2.20	2.20	DRY						
30.10.73								
3.40	2.90	DRY	3.40 - 4.70	1.30		3.40	39.70	
31.10.73		DRY						HARD BECOMING VERY HARD LIGHT RED GREY BANDED HORNBLENDE GNEISS
4.20	2.90	DRY						
1.11.73		DRY	4.70 - 6.40	1.30				
6.40	2.90	DRY				6.40	36.70	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 8

Ref. No. 1190
Ground Level 156.36 M O. D.

Dia. of Boring 125 MM TO 0.60 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
11/9/73			0.20	D1		0.30	156.06	LOOSE BROWN SANDY TOPSOIL
0.60		DRY	0.60	D2		0.60	155.76	MEDIUM HARD LIGHT RED GREY GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Core do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Sheet Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 9

Ref. No. 1190
Ground Level 163.96 M O. D.
Dia. of Boring 125 MM to 1.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
			0.15	D1		0.25	163.71	SOFT DARK GREY FIBROUS PEAT
			0.50 - 0.90	U1/100				MEDIUM HARD LIGHT BROWN WEATHERED QUARTZ FELDSPAR GNEISS
1.00		DRY	1.00	D2		1.00	162.96	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 10

Ref. No. 1190
Ground Level 165.55 M O. D.
Dia. of Boring 125 MM to 1.30 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
11/9/73		NET AT 0.60	0.10	D1				SOFT BROWN SILTY FIBROUS PEAT
			0.15 - 0.60	U1/70		0.60	164.95	
			0.65	D2		1.00	164.55	FIRM MOTTLED BROWN AND GREY ORGANIC SANDY CLAY CONTAINING GRAVEL AND COBBLES
1.30	1.00	0.80	0.60 - 1.00	B		1.30	164.25	SOFT LIGHT GREY WEATHERED PHYLLITE
			1.30	D3				
			0.80	W				

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450 mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — 40 recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 11

Ref. No. 1190
Ground Level 162.30 M O. D.

Dia. of Boring 125 MM to 2.30 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
11/9/73			0.10	D1				SOFT DARK RED BROWN FIBROUS PEAT
			0.20 - 0.65	U1/50		0.60	161.70	
		WET AT 0.65	0.70	D2				LOOSE LIGHT BROWN CLAYEY AND SILTY SAND AND SCHIST AND GNEISS GRAVEL
			0.80	D3				
			0.95 - 1.25	C(8)				
			1.25 - 1.55	C(9)		2.00	160.30	
2.30			2.30	D4		2.30	160.00	SOFT LIGHT BROWN WEATHERED PHYLLITE
			0.80	W				
			0.60 - 2.00	B				

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample - 4" recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 11A

Ref. No. 1130
Ground Level 141.45 M O. D.

Dia. of Boring 125 MM to 0.80 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
12/9/73			0.30	D1				LOOSE BROWN MICACEOUS CLAYEY SAND AND FRAGMENTS OF PHYLLITE
			0.70	D2		0.60	140.85	
0.90		DRY				0.70	140.75	SOFT LIGHT GREEN CHLORITE
			0.80	D3		0.80	140.65	HARD LIGHT GREY HORNBLENDE GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test
B	Bulk do do	C(27)	Cone do do
W	Water do	(27)	No Blows for 300mm Penetration
✱	Core Recovery	V	In - situ Vane Shear Test

U1/70	Undisturbed Sample 100mm dia
/70	No of Blows to drive sample 450mm
U-/70	Undisturbed Sample — no recovery

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 – SOUTH STROME – AUCHTERTYRE ROAD

RECORD OF BOREHOLE 11B

Ref. No. 1190 — Dia. of Boring PIT 1.00 M

Ground Level 159.14 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
2.10.73.			0.00 – 0.60	B1				SOFT DARK BROWN FIBROUS PEAT
			0.60 – 1.00	B 2		0.60	158.54	
1.00			1.00	D1		1.00	158.14	COMPACT BROWN CLAYEY SAND WITH FRAGMENTS OF DECOMPOSED ROCK
								MEDIUM HARD GREY SCHIST (BOULDER)

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample – no recovery
✱	Core Recovery	V	In – situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 12

Ref. No. 1190
Ground Level 165.74 M O.D.

Dia. of Boring 125 MM TO 1.80 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
12/9/73			0.10	D1		0.20	165.54	LOOSE LIGHT BROWN SANDY TOPSOIL
			0.20 - 0.65	U1/75				DENSE LIGHT BROWN CLAYEY SAND AND GRAVEL (UNDIFFERENTIATED DRIFT)
			0.70	D2				
			1.07	D3		1.50	164.24	
1.80	1.50	DRY	1.22 - 1.52	C(47)		1.80	163.94	SOFT TO MEDIUM HARD LIGHT GREY FOLIATED PHYLLITE
			1.80	D4				

REMARKS :

SCALE 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450 mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 12A

Ref. No. 1150 Dia. of Boring PIT to 0.20 M

Ground Level 164.84 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
0.20	NIL	DRY				0.20	164.64	LOOSE BROWN SANDY TOPSOIL

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 12B

Ref. No. 1190
Ground Level 162.61 M O.D.

Dia. of Boring PIT 0.60 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
0.60			0.60	D1		0.60	162.01	LIGHT BROWN SANDY SOIL WITH GRAVEL

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 – SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 13

Ref. No. 1190 Dia. of Boring 125 MM to 2.50 M

Ground Level 165.50 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
12/3/73			0.20	D1				SOFT DARK BROWN FIBROUS PEAT
			0.30 - 0.75	U1/40				
			0.80	D2				
			1.60	D3		1.50	164.00	
			1.75 - 2.05	C(28)				MEDIUM DENSE DARK GREEN GREY MICACEOUS SILTY SAND AND GRAVEL
			2.50	D4		2.25	163.25	
2.50	2.27	0.60	1.50 - 2.27	B		2.00	163.00	MEDIUM HARD LIGHT RED GREY BANDED HORNBLENDE GNEISS
			0.30	W				

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample – no recovery
*	Core Recovery	V	In – situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 13A

Ref. No. 1190
Ground Level 169.99 M O. D.
Dia. of Boring 150 MM TO 2.30 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
1.10.73		NET AT 0.30	G.L. 0.65	B1				SOFT DARK BROWN FIBROUS PEAT
			0.65 - 2.20	B2		0.65	169.34	SOFT GREY BROWN MICACEOUS SILTY SAND
						2.20	161.79	
2.30	DRAIN	G L	2.20 - 2.30	D1		2.30	161.69	MEDIUM HARD GREY SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E2

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 14

Ref. No. 1190 — Dia. of Boring 125 MM TO 1.90 M

Ground Level 172.79 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
12.3.78.			0.15	D1		0.90	172.19	SOFT DARK RED BROWN FIBROUS PEAT
			0.25 - 0.70	U1/04				FIRM MOTTLED LIGHT GREY AND BROWN SANDY CLAY
			0.75	D2				CONTAINING ABUNDANT SCHIST GRAVEL AND BANDS
			1.00	D3				OF CLAYEY SAND
			1.15 - 1.45	C(14)				
						1.67	171.11	
1.90	1.67	DRY	1.90	D4		1.90	170.89	HARD LIGHT RED GREY HORNBLENDE GNEISS
			0.75 - 1.67	B				

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 15

Ref. No. 1190
Ground Level 156.41 M O. D.
Dia. of Boring 200 MM TO 3.80 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
12.9.72.			0.00 - 0.50	B1				SOFT DARK BROWN FIBROUS PEAT
			0.50 - 1.50	B2		0.50	155.91	
								LOOSE BECOMING COMPACT LIGHT GREY BROWN CLAYEY SILTY SAND AND ASSORTED GNEISS SCHIST AND QUARTZ GRAVEL AND BOULDERS
			2.00	D1				
			2.15 - 2.45	S(4)				(UNDIFFERENTIATED DRIFT)
			3.35	D2				
			3.50 - 3.80	C(45)				
3.00	2.45	DRY						
13.9.72.		DRY						
3.80						3.80	152.61	

REMARKS :

SCALE: 1/50

KEY:
- D Disturbed Sample
- B Bulk do do
- W Water do
- ✱ Core Recovery
- S(30) Standard Penetration Test
- C(27) Core do do
- (27) No Blows for 300mm Penetration
- V In - situ Vane Shear Test
- U1/70 Undisturbed Sample 100mm dia
- /70 No of Blows to drive sample 450mm
- U-/70 Undisturbed Sample - no recovery

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 16

Ref. No. 1190
Ground Level 154.59 M O.D.

Dia. of Boring 200 MM TO 7.26 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
11.9.73.			0.00 - 0.50	B1				SOFT DARK GREY FIBROUS PEAT WITH ROOTS
			0.50 - 1.00	B2		0.50	154.09	
			1.50	D1				VERY SOFT AND SOFT GREY PEATY SILTY MICACEOUS SAND CONTAINING BANDS OF FIBROUS PEAT
			1.65 - 1.95	S(5)				
		SET AT 3.00	3.00	U				
			3.00	B2				
			3.15 - 3.45	S(4)				
						3.50	151.09	
								SOFT DARK BROWN SILTY FIBROUS AND LIGNEOUS PEAT
			4.00 - 4.50	B3				
			4.60	B2				
			4.75 - 5.05	S(5)				
						5.10	149.49	
			5.30	B4				MEDIUM DENSE LIGHT GREY BROWN SANDY FINE AND MEDIUM GRAVEL
			5.45 - 5.75	S(10)				
			6.40 - 6.70	B4				
6.40	6.40	2.50						
12.9.73.		G.L.						
						6.70	147.89	
			6.90	D5				VERY DENSE LIGHT GREY SAND AND FINE AND MEDIUM GRAVEL
7.26	6.70	2.00	6.95 - 7.26	C(59)		7.26	147.33	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample - 4" recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 17

Ref. No. 1190
Ground Level 153.41 M O. D.

Dia. of Boring 200 MM TO 6.35 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
10.9.73.			0.50	B1				SOFT DARK GREY AND BROWN SANDY AND MICACEOUS FIBROUS PEAT
			0.50	U				
			1.00	D1				
			1.15 - 1.45	c(5)				
			2.75	D2				
			2.90 - 3.15	c(6)				
						4.50	148.91	
			4.80	B2		4.85	148.56	LOOSE DARK GREY ORGANIC SILTY MICACEOUS SAND AND GRAVEL
								MEDIUM DENSE LIGHT GREY SANDY SILT
			5.00	D3				
			5.15 - 5.45	s(16)				
						5.97	147.44	
6.25	6.25	3.00	6.25 - 6.30	B3		6.29	147.12	DENSE GREY MEDIUM AND COARSE GRAVEL AND COBBLES
11.9.73		G.L.						HARD LIGHT RED GREY BANDED HORNBLENDE GNEISS
6.35	2.35	2.00	6.35	D4		6.35	147.06	

REMARKS :

SCALE: 1/50

KEY:
- D Disturbed Sample
- B Bulk do do
- W Water do
- ✱ Core Recovery
- S(30) Standard Penetration Test
- C(27) Core do do
- (27) No Blows for 300mm Penetration
- V In - situ Vane Shear Test
- U1/70 Undisturbed Sample 100mm dia
- /70 No of Blows to drive sample 450mm
- U-/70 Undisturbed Sample - no recovery

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 18

Ref. No. 1190
Ground Level 154.21 M O. D.

Dia. of Boring 200 MM TO 8.05 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
7.5.73.			0.50	D1				SOFT DARK RED BROWN FIBROUS PEAT WITH OCCASIONAL SILTY BANDS AND FINE SCHIST GRAVEL
			1.00 - 2.00	B1				
			1.50	D2				
		WET AT 1.00	1.50	W				
			2.50	D3				
			3.50	D4		4.90	149.31	
			5.00 - 6.00	B2				MEDIUM DENSE LIGHT GREY BROWN COARSE SAND AND ROUNDED GRAVEL
			5.00	D5				
			5.15 - 5.45	C(19)				
			6.40	D6		6.30	147.91	
			6.50	D7		6.50	147.71	COMPACT LIGHT GREY SANDY SILT
			6.65 - 6.95	C(35)				DENSE LIGHT BROWN COARSE SAND AND ROUNDED GNEISS GRAVEL
			7.60	D8				
			7.75 - 8.05	C(40)				
8.05	8.00	1.50	8.00 - 8.05	B3		8.05	146.16	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Core do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 – SOUTH STROME – AUCHTERTYRE ROAD

RECORD OF BOREHOLE 19

Ref. No. 1190
Ground Level 153.25 M O.D.

Dia. of Boring 200 MM TO 11.50 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
3.3.78.			0.10 – 1.10	B1				SOFT DARK BROWN CLAYEY AND SANDY PEAT WITH BANDS OF SOFT SILTY CLAY AND LOOSE PEATY SAND AND GRAVEL
			0.50	D1				
		WET AT 1.00	0.80 – 1.25	U/-				
			1.30 – 1.75	U/-				
2.00	2.00	1.20	2.10	B2		2.15	151.10	
3.3.78.		G.L.	2.60 – 3.05	U/-				SOFT DARK RED BROWN SILTY FIBROUS PEAT
			2.60 – 3.60	B2				
			3.65	D3				
			3.80 – 4.10	S(5)				
			5.00 – 5.60	B3				
			5.30	D4		5.60	147.65	
			5.30	D5				MEDIUM DENSE LIGHT GREY BROWN SILTY SAND AND OCCASIONAL FINE GRAVEL
			6.05 – 6.35	S(10)				
			7.30	D6				
			7.45 – 7.75	S(11)		8.00	145.25	
			8.90	D7				SOFT TO FIRM LIGHT GREY SILTY CLAY
			9.05 – 9.35	S(10)				
			9.80 – 10.00	B4		9.90	144.25	
			10.20	D8				MEDIUM DENSE GREY BROWN SAND AND FINE AND MEDIUM ROUNDED GRAVEL
			10.35 – 10.50	C(57)		10.10	143.15	
			10.90 – 11.05	U/-				VERY STIFF LIGHT GREY BROWN VERY SANDY CLAY
11.50	11.00	0.50	11.10	D9		11.50	140.75	CONTAINING FINE AND MEDIUM GRAVEL (BOULDER CLAY)

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample – no recovery
✱	Core Recovery	V	In – situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 20

Ref. No. 1190 — Dia. of Boring 200 MM TO 7.15 M

Ground Level 154.98 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
2.9.73.			0.40 - 0.85	U-/17				SOFT DARK GREY BROWN SANDY PEAT WITH BANDS OF GREY BROWN SILTY SAND AND OCCASIONAL FINE GRAVEL
			0.40 - 1.00	BULK 1				
			0.50	D1				
			1.40 - 1.95	U1/19				
			1.50	W				
			1.90	D2				
			2.90	D3				
			3.00 - 3.45	U-/16				
			3.00 - 3.60	BULK 2				
			3.40	D4				
			3.90	D5				
			3.95 - 4.25	C(7)				
4.50	4.50	4.00						
2.9.73.		G.L.						
						5.20	149.78	
			5.50	D6				
			5.55 - 5.95	C(15)				MEDIUM DENSE LIGHT GREY COARSE SANDY GRAVEL
			5.50 - 6.00	B3		5.80	149.18	
			6.00	D7				DENSE LIGHT GREY SAND AND GRAVEL AND COBBLES
			6.15 - 6.45	C(30)				
						6.86	148.12	
			6.90	D8				
7.15	6.87	1.00				7.15	147.83	HARD LIGHT GREY BANDED HORNBLENDE GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 21

Ref. No. 1190
Ground Level 175.19 M O. D.

Dia. of Boring 200 MM TO 3.60 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
19/9/73			0.00 - 0.50	B1				SOFT DARK BROWN FIBROUS PEAT
						0.50	174.69	
			1.00	D1				
			1.15 - 1.45	C(52)				VERY DENSE LIGHT BROWN CLAYEY SAND AND ABUNDANT GRAVEL WITH OCCASIONAL BOULDERS
2.00	2.00	DRY	2.00 - 4.00	B2				(UNDIFFERENTIATED DRIFT)
20/9/73		DRY	2.40	D2				
			2.55 - 2.85	C(60)				
						3.10	172.09	
			3.32	D3				SOFT LIGHT GREY GREEN DECOMPOSED BIOTITE SCHIST
3.60	3.00	DRY				3.60	171.59	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450 mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In – situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 – SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 22

Ref. No. 1190
Ground Level 171.61 M O. D.

Dia. of Boring 200 MM TO 9.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
14.3.73.			0.00 - 0.50	B1				SOFT DARK GREY FIBROUS PEAT
						0.50	171.11	
								VERY DENSE LIGHT GREY BROWN CLAYEY SAND AND GRAVEL AND COBBLES
			1.60	D1				(UNDIFFERENTIATED DRIFT)
1.50	1.50	DRY	1.75 - 2.05	C(58)				
15.3.73.		DRY	2.05 - 2.30	B2				
2.05	2.05	DRY	2.30	D2				
16.3.73.			2.45 - 2.75	C(60)				
						3.00	168.61	
								COMPACT LIGHT GREY GREEN MICACEOUS CLAYEY SILT
			3.50	D3				(DECOMPOSED CHLORITE SCHIST)
4.00	4.00	DRY						
17.3.73.		DRY						
						4.50	167.11	
			4.75	D4				MEDIUM HARD DARK GREEN GREY HORNBLENDE SCHIST
5.00	4.50	DRY				5.00	166.61	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample – no recovery
*	Core Recovery	V	In – situ Vane Sheer Test		

A890 – SOUTH STROME – AUCHTERTYRE ROAD

RECORD OF BOREHOLE 23

Ref. No. 1190
Ground Level 160.15 M O. D.

Dia. of Boring 125 MM TO 1.50 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
~~13/5/75~~			0.10	D1				SOFT DARK BROWN SILTY PEAT
			0.20 -0.65	U1/6B		0.60	159.55	
			0.70	D2				COMPACT LIGHT GREY SILTY SAND AND SCHIST GRAVEL
			0.60 -1.30	B1		1.30	158.85	
1.60	1.30	DRY	1.60	D3		1.60	158.55	MEDIUM HARD GREY FOLIATED CHLORITE SCHIST

REMARKS :

SCALE: 1 /50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450 mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample – no recovery
✱	Core Recovery	V	In – situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

RECORD OF BOREHOLE 24

Ref. No. 1190 — Dia. of Boring 125MM TO 1.86 M

Ground Level 162.05 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
18/9/73			0.20	D1		0.30	161.75	LOOSE BROWN SANDY TOPSOIL
			0.20 - 0.40	U1/80				COMPACT LIGHT ORANGE BROWN CLAYEY SAND AND GRAVEL AND BOULDERS
			0.45	D2				
			0.20 - 1.30	B1				
						1.54	160.51	
1.86	1.54	DRY	1.80	D3		1.86	160.19	MEDIUM HARD GREY FOLIATED QUARTZ MICA SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

...SOUTH STROME AUCHENTYRE ROAD

RECORD OF BOREHOLE 25

Ref. No. 1190
Ground Level 179.50 M O. D.

Dia. of Boring PIT TO 3.10 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
30.9.73.								VERY LOOSE LIGHT GREY BROWN SILTY SAND AND FINE TO MEDIUM ROUNDED GRAVEL
			2.80	B2				
						2.95	176.55	
3.10			3.10	D1		3.10	176.40	MEDIUM HARD LIGHT GREY SHEARED QUARTZ MICA GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 26

Ref. No. 1190
Ground Level 149.67 O.D.

Dia. of Boring PIT TO 1.30 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
19.9.73.			0.30	D1				SOFT DARK BROWN FIBROUS SILTY PEAT
			0.30 - 1.00	B1				
						1.00	148.67	
1.30			1.30	B2		1.30	148.37	MEDIUM HARD DARK GREY GREEN SHEARED HORNBLENDE SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 27

Ref. No. 1190
Ground Level 124.93 M O. D.

Dia. of Boring PIT TO * 1.40 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
19.9.73			0.10	D1		0.20	124.73	SOFT RED BROWN FIBROUS MOSSY PEAT
			0.30	D2				SOFT ORANGE BROWN CLAYEY SAND WITH FRAGMENTS OF DECOMPOSED SCHIST
			0.50 - 0.95	U1/60		0.90	124.03	
			1.00	D3				SOFT TO MEDIUM HARD LIGHT GREY DECOMPOSED AND WEATHERED SCHIST
1.40			1.40	D4		1.40	123.53	

REMARKS :

SCALE: 1/50

KEY:
- D Disturbed Sample
- B Bulk do do
- W Water do
- * Core Recovery
- S(30) Standard Penetration Test
- C(27) Cone do do
- (27) No Blows for 300mm Penetration
- V In - situ Vane Shear Test
- U1/70 Undisturbed Sample 100mm dia
- /70 No of Blows to drive sample 450 mm
- U*/70 Undisturbed Sample — no recovery

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 28

Ref. No. 1190
Ground Level 132.03 N O. D.

Dia. of Boring PIT TO 0.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
13.5.78.			0.10	D1		0.20	131.83	SOFT DARK RED BROWN PEAT
			0.30	D2		0.35	131.68	FIRM GREY BROWN ORGANIC SILT
			0.20 - 0.75	1		0.40	131.63	FIRM BLACK PEAT
0.50			0.50	D3				SOFT TO MEDIUM HARD LIGHT GREY WEATHERED
			0.80	D4				CHLORITE SCHIST
						0.90	131.13	

REMARKS :

SCALE: 1/50

KEY:

b	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 28A

Ref. No. 1190
Ground Level 131.49 M O. D.

Dia. of Boring 86 & 58 MM TO 2.00 M
86 & 38 MM TO 7.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
15/8/74			0.50	DR				GREY BROKEN QUARTZ MICA SCHIST
				DR/1.50				
2.00	2.00	DRY	2.00 - 3.50	0.15		2.00	129.49	
16/8/74								GREY BANDED SEVERELY CRUSHED AND BROKEN QUARTZ MICA SCHIST
				DR/1.50				
			3.50 - 5.00	NIL				
				DR/0.90				
		WET AT 5.10	5.00 - 5.90	NIL				
				DR/1.10				
			5.90 - 7.00	NIL				
7.00	2.00					7.00	124.49	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U4/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 29

Ref. No. [illegible]0
Ground Level 118.93 M. O. D.
Dia. of Boring PIT TO 1.20 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
0.5.78.			0.05	D1		0.20	118.73	SOFT DARK RED BROWN PEAT
			0.30 - 1.00	D1				VERY DENSE BROWN CLAYEY SAND AND GRAVEL
			0.50	D2				COBBLES AND BOULDERS
			1.00	D3		1.00	117.93	
1.20						1.20	117.73	MEDIUM HARD GREY CHLORITE SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 30

Ref. No. 1130
Ground Level 125.64 M O. D.

Dia. of Boring PIT TO 0.55 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
18.5.72.			0.10	D1		0.16	125.48	SOFT RED BROWN FIBROUS PEAT
			0.16 - 0.45	D1		0.45	125.19	COMPACT LIGHT BROWN ORGANIC SANDY SILT
0.55			0.30	D2				MEDIUM HARD GREY WEATHERED SCHIST
			0.50	D3		0.55	125.09	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 31

Ref. No. 1190
Ground Level 29.01 ft O.D.

Dia. of Boring 150 MM TO 1.53 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
7.9.78.			0.10	D1				SOFT DARK BROWN SILTY FIBROUS PEAT
			0.20 - 0.65	U1/10				
			0.70	D2		0.75	28.26	
		WATER USED	1.00	D3				DENSE COARSE SAND AND GRAVEL
			1.00 - 1.10	S(60)		0.89	28.21	
								VERY LENSE BROKEN LIGHT RED GREY BIOTITE FELDSPAR GNEISS
1.53	0.40	DRY				1.53	27.48	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 32

Ref. No. 1190
Ground Level 27.87 M O.D.

Dia. of Boring 150 mm TO 2.20 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
8/9/73			0.10	D1				SOFT DARK RED BROWN FIBROUS PEAT
			0.30 - 0.75	U1/12				
			0.80	D2				
						1.30	26.07	
			1.40 - 1.80	U2/72				SOFT BROWN SANDY CLAY AND GRAVEL
						1.80	25.57	
			1.85	D3				SOFT LIGHT GREY WEATHERED HORNBLENDE
2.20	1.80	DRY	1.90 2.05 - 2.20	D4 C(46)		2.20	25.17	GNEISS

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 33

Ref. No. 1190
Ground Level 20.13 M O. D.

Dia. of Boring 125 MM TO 2.30 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
9.3.73.			0.20	D1				LOOSE BECOMING COMPACT LIGHT BROWN CLAYEY SAND WITH PEAT TRACES.
			0.20 - 1.40	B1				
			0.20	W				
						1.40	18.73	
			2.00	D2				VERY DENSE BROKEN FRAGMENTS OF GREY QUARTZ MICA SCHIST
			2.15 - 2.30	S(50)				
2.30	2.00	G.L.				2.30	17.83	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 33A

Ref. No. 1190
Ground Level 20.44 m O.D.

Dia. of Boring 125 MM TO 5.75 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
12.3.72.			0.20	D1				SOFT BROWN CLAYEY PEATY TOPSOIL
			0.30 - 0.75	U1/12		0.50	19.94	
								COMPACT MOTTLED BROWN AND GREY SILTY SAND
			0.90	D2				
			1.20	W				
			1.30 - 2.90	B1		1.90	19.14	
								DENSE AND VERY DENSE GREY AND BROWN SILTY SAND AND ABUNDANT ROUNDED GRAVEL AND COBBLES
								(UNDIFFERENTIATED DRIFT)
			2.76	D3				
			2.91 - 3.21	C(34)				
3.21	2.95	1.90	3.70	D4				
14.3.72.		1.00	3.85 - 4.15	C(63)				
			3.21 - 5.30	B2				
			5.30	D5				
5.75	5.40	1.40	5.45 - 5.75	C(41)		5.75	14.69	

REMARKS :

SCALE: 1/50

KEY:
- D Disturbed Sample
- B Bulk do do
- W Water do
- * Core Recovery
- S(30) Standard Penetration Test
- C(27) Cone do do
- (27) No Blows for 300mm Penetration
- V In - situ Vane Shear test
- U1/70 Undisturbed Sample 100mm dia
- /70 No of Blows to drive sample 450mm
- U4/70 Undisturbed Sample - no recovery

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 34

Ref. No. 1190 — Dia. of Boring 125 MM TO 2.80 M

Ground Level 19.98 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
9.9.78.			0.10	D1				SOFT BROWN CLAYEY AND SANDY FIBROUS PEAT WITH OCCASIONAL SAND LAYERS
			0.10 - 1.50	B1				
			0.25	W				
			0.90	D2				
						1.50	18.48	
			2.00	D3				DENSE LIGHT GREY BROWN SANDY SCHIST GRAVEL
			2.25	D4				
			2.50 - 2.80	C(25)				
2.50	2.35	G.L.				2.80	17.18	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 34A

Ref. No. 1190
Ground Level 19.92 M O.D.

Dia. of Boring 125 MM TO 5.65 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
15.9.72			0.10	D1		0.30	19.62	SOFT BROWN PEATY CLAYEY SOIL
			0.20 - 0.75	U1/27				FIRM BROWN SANDY SILT
			0.90	D2				
			1.00	W				
		WET AT	1.20	D3		1.01	18.91	--
		1.00	1.35 - 1.65	C(35)				DENSE AND LOCALLY VERY DENSE LIGHT BROWN
			1.80 - 3.50	B1				SILTY SAND AND MAINLY SCHIST GRAVEL
								(UNDIFFERENTIATED DRIFT)
			2.30	D4				
			2.45 - 2.75	C(58)				
			3.50	D5				
			3.65 - 3.95	C(46)				
			4.00 - 5.00	B2				
			5.20	D6				
			5.35 - 5.65	C(41)				
5.65	5.20	1.00				5.65	14.27	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample -- no recovery
⅓	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 35

Ref. No. 1150 — Dia. of Boring 125 MM TO 2.60 M

Ground Level 19.53 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
9.9.78.		G.L.	0.20	D1				SOFT DARK BROWN FIBROUS PEAT
			0.20 - 1.94	B1				
			0.10	W				
						1.94	17.59	
			2.15	D2				DENSE LIGHT BROWN SANDY SCHIST GRAVEL
2.60	2.15	G.L.	2.30 - 2.60	C(42)		2.60	16.93	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 150 mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In — situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 36

Ref. No. 1190
Ground Level 54.95 M O. D.

Dia. of Boring 125 MM TO 1.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
11.3.78.			0.10	D1		0.30	54.75	SOFT LIGHT BROWN SANDY TOPSOIL
			0.20 - 0.70	B1				VERY DENSE LIGHT YELLOW BROWN SILTY SAND
			0.50	B2				CONTAINING FRAGMENTS OF WEATHERED SCHIST
			0.65 - 0.72	C(50)		0.70	54.25	
1.00	0.70	DRY	0.80	B3		1.00	53.95	MEDIUM HARD LIGHT GREY BROWN QUARTZ MICA SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 37

Ref. No. 1190 — Dia. of Boring 125 MM TO 2.00 M

Ground Level 43.81 O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
1.9.78.		G.L.	0.10	D1		0.20	43.61	LOOSE LIGHT BROWN SANDY TOPSOIL
			0.20	B				MEDIUM DENSE BECOMING DENSE LIGHT GREY BROWN SILTY SAND AND QUARTZ MICA SCHIST GRAVEL AND COBBLES
			0.50	D2				
			0.65 - 0.95	C(27)				
			0.50 - 1.50	B1				
			1.50	B3				
			1.65 - 1.35	C(32)				
2.00	2.00	G.L.				2.00	41.81	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✳	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 38

Ref. No. 1190
Ground Level 44.82 M O.D.

Dia. of Boring 125 MM TO 1.95 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
11.9.72		G.L.	0.10	D1				SOFT LIGHT BROWN PEATY TOPSOIL
			0.10 - 0.75	U1/90		0.50	44.32	
			0.30	W				DENSE BECOMING VERY DENSE LIGHT BROWN SAND AND
			0.90	D2				ABUNDANT SUBROUNDED GRAVEL
			0.50 - 1.50	B1				
			1.40	D3				
			1.55 -1.85	C(58)				
1.85	1.40	G.L.				1.95	42.97	

REMARKS :

SCALE: 1/50

KEY:
- D Disturbed Sample
- B Bulk do do
- W Water do
- ✱ Core Recovery
- S(30) Standard Penetration Test
- C(27) Cone do do
- (27) No Blows for 300mm Penetration
- V In - situ Vane Shear Test
- U1/70 Undisturbed Sample 100mm dia
- /70 No of Blows to drive sample 450mm
- U-/70 Undisturbed Sample - no recovery

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 39

Ref. No. 1199
Ground Level 70.90 M O.D.

Dia. of Boring 125 MM To 1.10 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
0.3.72			0.10	D1		0.15	70.75	LOOSE LIGHT GREY PEATY SANDY TOPSOIL
			0.30 - 0.60	U1/150				VERY DENSE LIGHT GREY BROWN CLAYEY SILTY SAND AND FINE GRAVEL
			0.65	D2				
			1.00	D3				
1.10		DRY	1.00 - 1.10	S(50)		1.10	69.80	(DECOMPOSED CHLORITE SCHIST)

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm.
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 39A

Ref. No. 1130 — Dia. of Boring 125 MM TO 3.00 M

Ground Level 72.14 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
17.3.76			0.10	D1		0.17	71.97	SOFT BROWN SANDY PEATY TOPSOIL
			0.30	D2		0.40	71.74	COMPACT ORANGE BROWN SILTY SAND AND GRAVEL
			0.50	D3		0.58	71.56	SOFT DARK GREY SANDY PEAT
			0.60	D4				
			0.70 - 0.91	C(50)				VERY DENSE LIGHT GREY BROWN CLAYEY SILTY SAND
			0.60 - 2.00	B1				AND QUARTZ MICA SCHIST GRAVEL AND COBBLES
			1.60	D5				
			1.75 - 1.92	C(50)				(POSSIBLY DECOMPOSED QUARTZ MICA SCHIST)
			2.00	W				
			2.60	D6				
			2.60 - 2.72	C(50)		2.70	69.44	
			2.80	D7				MEDIUM HARD GREY WEATHERED QUARTZ MICA SCHIST
3.00	2.70	1.30				3.00	69.14	

REMARKS : SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 40

Ref. No. 1190

Ground Level 82.50 M O.D.

Dia. of Boring 125 MM TO 1.40 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
10/9/73			0.10	D1		0.15	82.35	SOFT DARK BROWN SANDY PEAT
			0.30 - 0.60	U1/140				VERY LOOSE LIGHT BROWN CLAYEY SILTY SAND AND
			0.65	D2				FINE AND MEDIUM SCHIST GRAVEL
			1.10	D3				(POSSIBLY DECOMPOSED SCHIST)
			1.25 - 1.40	c(50)				
1.40		DRY				1.40	81.10	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 40A

Ref. No. 1100
Ground Level 82.30 M O.D.

Dia. of Boring 125 MM TO 2130 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
16.3.78			0.10	D1		0.15	82.15	SOFT LIGHT BROWN SANDY PEAT
			0.30	D2				MEDIUM DENSE ORANGE BROWN SILTY SAND AND GRAVE
			0.45 - 0.75	C(25)		0.45	81.85	
								COMPACT BROWN AND YELLOW CLAYEY SAND AND GRAVEL WITH SCHIST FRAGMENTS
			1.00	D3				
			0.50 - 1.50	B1				(DECOMPOSED CHLORITE SCHIST)
			2.10	D4		2.00	80.30	
2.30	2.00	DRY				2.30	80.00	SOFT TO MEDIUM HARD LIGHT GREY FOLIATED CHLORITE SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 41

Ref. No. 1199
Ground Level 99.12 O.D.

Dia. of Boring 125 MM TO 3.50 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
19/3/73			0.10 0.60 - 1.05	D1 U1/-				SOFT DARK GREY FIBROUS PEAT
			1.10 1.10	D2 W		1.20	81.32	
			2.00 2.15 - 2.45	D3 C(50)				STIFF BLUE GREY VERY SANDY CLAY CONTAINING FRAGMENTS OF WEATHERED CHLORITE SCHIST
			3.00 3.15 - 3.45	D4 C(43)				
3.50	3.50	0.60				3.50	79.62	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 41A

Ref. No. 1190
Ground Level 81.60 M O. D.
Dia. of Boring 125 MM TO 2.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
16/3/72			0.10	B1		0.30	81.30	SOFT DARK BROWN PEATY TOPSOIL
			0.50	D2				VERY DENSE LIGHT BROWN SANDY SILT CONTAINING GRAVEL AND FRAGMENTS OF QUARTZ MICA SCHIST
			0.65 - 0.81	S(50)				
			0.50 - 1.50	B1				
			1.50	D3				
			1.65 - 1.70	S(50)		1.70	79.90	
			1.90	D4				SOFT TO MEDIUM HARD DARK GREEN GREY AMPHIBOLITE
2.00	1.70	DRY				2.00	79.60	

REMARKS :

SCALE: 1/50

KEY:
- D Disturbed Sample
- B Bulk do do
- W Water do
- ✱ Core Recovery
- S(30) Standard Penetration Test
- C(27) Cone do do
- (27) No Blows for 300mm Penetration
- V In - situ Vane Shear Test
- U1/70 Undisturbed Sample 100mm dia
- /70 No of Blows to drive sample 450mm
- U-/70 Undisturbed Sample — no recovery

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2.

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 42

Ref. No. 1130 — Dia. of Boring 125 MM TO 4.50 M

Ground Level 94.93 M O. D.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
13/5/73			0.10	D1				SOFT DARK GREY FIBROUS PEAT
			0.60 - 1.05	U1/3				
			1.10	B				
			1.10	S2				
						1.95	82.98	
			2.00	D3				MEDIUM DENSE GREY SILTY SAND AND ANGULAR SCHIST GRAVEL
			2.15 - 2.45	C(11)				
			2.45 - 2.75	(12)				(UNDIFFERENTIATED DRIFT)
			2.00 - 3.00	B1				
			3.00	D4				
			3.15 - 3.45	C(18)		3.20	81.63	
			3.45 - 3.75	(29)				DENSE BECOMING VERY DENSE GREY SANDY SILT AND SCHIST GRAVEL
			4.00	D5				(UNDIFFERENTIATED DRIFT)
			4.15 - 4.45	C(39)				
4.50	4.50	0.45				4.50	90.33	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 43

Ref. No. 1190
Ground Level 86.82 M O. D.

Dia. of Boring 125 MM TO 2.50 M.

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
8/9/76		G.L.	0.10	D1				SOFT DARK RED GREY FIBROUS PEAT.
			0.50 - 1.05	U1/10				
			1.10	D2				
			2.00	D3		2.00	84.82	
								VERY DENSE LIGHT GREY FOLIATED BROKEN QUARTZ MICA SCHIST.
2.50	2.00	0.30	2.15 - 2.33	C(50)		2.50	84.32	

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Core do do	/70	No of Blows to drive sample 450mm
W	Water . do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample — no recovery
*	Core Recovery	V	In - situ Vane Shear Test		

WHATLINGS (FOUNDATIONS) LIMITED, 2410 LONDON ROAD GLASGOW E.2

A890 - SOUTH STROME - AUCHTERTYRE ROAD

RECORD OF BOREHOLE 44

Ref. No. 1190
Ground Level 87.89 M O. D.
Dia. of Boring 200 MM TO 4.00 M

PROGRESS			SAMPLE / TEST		STRATA			
HOLE	CASING	WATER	DEPTH	TYPE	LEGEND	DEPTH	LEVEL	DESCRIPTION
7.6.78			0.10	D1				SOFT DARK RED GREY FIBROUS PEAT
			0.20	W				
			0.30 - 0.75	U1/12				
			0.80	D2				
						1.10	86.79	
			1.50 - 2.50	D1				LOOSE MOTTLED BROWN AND GREY CLAYEY SAND AND ABUNDANT SCHIST GRAVEL
			2.00	D3				
			2.15 - 2.45	S(5)				
			2.45 - 2.75	(9)				
			2.80 - 3.40	B2		2.90	85.09	
			2.90	D4				STIFF TO STIFF MOTTLED BROWN AND GREY SANDY CLAY CONTAINING SCHIST GRAVEL (BOULDER CLAY)
			3.00 - 3.40	U/-				
			3.60	D5		3.60	84.29	
4.00	3.60	DRY				4.00	83.89	MEDIUM HARD FOLIATED QUARTZ MICA SCHIST

REMARKS :

SCALE: 1/50

KEY:

D	Disturbed Sample	S(30)	Standard Penetration Test	U1/70	Undisturbed Sample 100mm dia
B	Bulk do do	C(27)	Cone do do	/70	No of Blows to drive sample 450mm
W	Water do	(27)	No Blows for 300mm Penetration	U-/70	Undisturbed Sample - no recovery
✱	Core Recovery	V	In - situ Vane Shear Test		

RECORD OF TEST PITS

Test Pit 1	G.L. 18.?? m O.D.
Topsoil	to 0.20 m
Brown clayey sand and gravel, cobbles and boulders	0.20 - 2.30 m
Brown medium to coarse sand and gravel, cobbles and boulders	2.30 - 3.50 m

Groundwater met at 2.2 m

Bulk samples taken at 1.0 and 2.6 metres

Test Pit 2	G.L. 82.55 m O.D.
Topsoil	to 0.50 m
Hard grey banded gneiss	at 0.50 m

Pit Dry

Test Pit 3	G.L. 94.6? m O.D.
Topsoil	to 0.60 m
Brown peaty soil	0.60 - 1.00 m
Medium hard decomposed and weathered grey banded gneiss	1.00 - 1.30 m

Pit Dry

Bulk samples taken at 1.0 and 1.? metres

Test Pit 4	G.L. 113.86 m O.D.
Peaty topsoil	to 0.25 m
Compact red brown clayey sand with fragments of decomposed rock	0.?? - 0.?? m
Medium hard green grey banded hornblende schist	0.?? - 1.10 m

Groundwater met at 1.0 m

Bulk samples taken at 0.? and ?.? metres

N30 South Stream to Auchencairn — Ref : 1290

Test Pit 5 — G.L. 122.83 m O.D.

Peaty topsoil	to 0.20 m
Compact red brown clayey sand with fragments of broken rock	0.20 - 0.50 m
Medium hard green grey weathered amphibolite	0.50 - 0.70 m

Pit Dry

Bulk sample taken at 0.3 metres

Test Pit 6 — G.L. 147.54 m O.D.

Topsoil	to 0.20 m
Compact dark brown sandy soil containing fragments of decomposed gneiss	0.20 - 0.80 m

Pit Dry

Bulk sample taken at 0.3 metres

Test Pit 7 — G.L. 166.28 m O.D.

Soft dark brown fibrous peat	to 0.25 m
Compact light brown clayey coarse sand and abundant fragments of gneiss	0.25 - 1.00 m
Very hard dark green and red grey banded hornblende gneiss	at 1.00 m

Surface water entering pit

Bulk samples taken at 0.25, 0.5 and 1.0 metres

Test Pit 8 — G.L. 160.46 m O.D.

Soft [illegible]	[illegible]
Compact brown and grey clayey sand and gravel and fragments of weathered gneiss	0.50 - 1.00 m
Soft to medium hard weathered and decomposed gneiss	1.00 - 2.90 m
Hard grey banded gneiss	at 2.90 m

Surface water entering pit

Bulk samples taken at 0.1, 0.6, 1.0, 2.9 metres

A890 South Strome to Auchtertyre — Ref : 1190

Test Pit 9 — G.L. 163.95 m O.D.

Soft dark grey brown mottled peaty silty sand with decomposed gravel fragments	to 0.25 m
Compact light brown silty coarse sand and gravel with cobbles and boulders of amphibolite	0.25 - 1.20 m
Compact grey brown clayey sand and gravel with broken rock fragments	1.20 - 3.20 m
Compact brown medium and coarse sand and broken rock fragments	3.20 - 4.40 m
Hard grey banded gneiss	at 4.40 m

Groundwater met at 1.3 m

Bulk samples taken at 0.2, 0.8, 2.2, and 4.0 metres

Test Pit 10 — G.L. 161.97 m O.D.

Soft dark brown fibrous peat	to 0.70 m
Compact brown clayey sand and gravel	0.20 - 0.60 m
Compact grey brown silty sand and gravel, cobbles and fragments of granodiorite	0.60 - 3.00 m
Hard dark grey coarse grained amphibolite	at 3.00 m

Pit Dry

Bulk samples taken at 0.3, 1.3 and 3.0 metres

Test Pit 11 — G.L. 159.69 m O.D.

Soft dark brown fibrous peat	to 0.30 m
Compact grey brown sand and [illegible]	0.3 - 2.00 m
Hard dark grey foliated hornblende schist	at 2.00 m

Pit Dry

Bulk samples taken at 1.3 and 2.0 metres

A890 South Strome to Auchtertyre — Ref : 1190

Test Pit 12 — G.L. 174.00 m O.D.

Soft dark brown fibrous peat	to 0.20 m
Soft orange brown sandy silt and silty sand and gravel with layers of peat	0.20 -0.80 m
Compact grey brown sand and gravel with gravel and shattered rock	0.80 - 4.60 m
Hard grey gneiss	at 4.60 m

Pit Dry

Bulk samples taken at 0.3 and 4.0 metres

Test Pit 13 — G.L. 169.08 m O.D.

Soft dark brown fibrous peat	to 0.30 m
Loose orange brown silty sand and gravel containing organic matter	0.30 - 1.00 m
Compact light brown silty sand and schist gravel	1.00 - 3.50 m
Medium hard and hard light red grey foliated gneiss	at 3.50 m

Pit Dry

Bulk samples taken at 1.6, 2.3 and 3.5 metres

Test Pit 13A — G.L. 175.92 m O.D.

Soft dark brown fibrous peat	to 0.30 m
Soft red brown clayey soil containing organic matter	0.30 - 0.70 m
Compact light grey brown clayey sand and gravel and cobbles	0.70 - [illegible] m
Hard light grey foliated gneiss	at [illegible] m

Pit Dry

Bulk samples taken at 0.3, 2.0 and 2.5 metres

Test Pit 14 — G.L. 205.91 m O.D.

Soft dark brown fibrous peat	to 0.50 m
Medium hard dark grey schist	0.50 - 0.56 m

Groundwater met at 0.3 metres

Bulk samples taken at 0.3 metres

A30 South Devon to Architabyre — Ref : 1190

Test Pit 1: — G.L. 204.95 m O.D.

Soft dark brown fibrous peat	to 2.20 m
Compact brown silty sand	2.20 - 2.40 m
Hard grey foliated schist	at 2.40 m

Groundwater met at 0.15 metres

Bulk sample taken at 2.20 metres

Test Pit 10 — G.L. 68.34 m O.D.

Topsoil	to 0.10 m
Compact red brown sand and gravel with occasional cobbles	0.10 - 0.40 m
Compact light brown clayey sand and gravel	0.40 - 0.90 m
Soft to medium hard light grey schist	0.90 - 1.30 m

Pit Dry

Bulk samples taken at 1.0 metres

Test Pit 11 — G.L. 22.03 m O.D.

Topsoil	to 0.30 m
Compact brown silty sand and gravel with broken rock fragments	0.30 - 3.80 m
Soft brown laminated sandy clay	3.80 - 4.20 m
Compact light brown silty sand and gravel and cobbles with frequent broken rock	4.20 - 4.80 m

Groundwater met at 3.50 m

Bulk samples taken at 4.0 m, and 4.6 metres

Test Pit 12 — G.L. 46.27 m O.D.

Topsoil	to 0.25 m
Compact grey brown sand and gravel and boulders	0.25 - 4.50 m

Pit Dry

Bulk samples taken at 2.0 and 4.3 metres

A40 South Stroma to Auchlyne — Ref : 1190

Test Pit 12 — G.L. 51.87 m O.D.

Soft dark brown fibrous peat	to 1.30 m
Compact blue grey clayey sand and gravel	1.30 - 2.00 m
Compact brown sandy clay and gravel	2.00 - 4.80 m

Surface water entering pit

Bulk samples taken at 0.6, 1.6 and 3.3 metres

Bore Hole No. 1 — G.L. 67.50 m

Soft dark brown peat	to 0.80 m
Compact blue grey medium to coarse clayey sand and gravel	0.80 - 2.70 m
Firm brown boulder clay	2.70 - 3.20 m
Dark grey foliated schist	at 3.20 m.

Surface water entering Pit

Bulk samples taken at 2.0, 3.0 and 3.2 metres

Bore Hole No. 2 — G.L. 68.60 m

Soft dark brown peat	to 2.00 m
Compact blue grey medium to coarse sand and gravel, cobbles and boulders	2.00 - 3.50 m

Surface water entering Pit

Bulk samples taken at 1.0 and 2.8 metres.

Bore Hole No. 3 — G.L. 72.20 m

Topsoil	to 0.10 m
Decomposed and shattered rock	0.10 - 1.00 m
Medium hard dark grey amphibolite	at 1.00 m

Pit Dry

Bulk sample taken at 0.75 metres.

Bore Hole No. 4 — G.L. 57.21 m

Topsoil	to 0.10 m
Brown sandy clay and fine to medium gravel	0.10 - 1.00 m
Compact grey brown medium sand and fine to medium gravel and broken rock fragments	1.00 - 4.80 m

Groundwater met at 3.8 m

Bulk samples taken at 0.5 and 4.0 metres.

Contd / ...

A890 South Stromeferry to Auchtertyre — Ref: 1190

Trial Hole No. 5 — G.L. 57.21 m

Dark brown peaty topsoil	to 0.70 m
Brown clayey sand and fine gravel with broken rock fragments	0.70 - 1.30 m
Fine to coarse clayey sand and fine to medium gravel and broken rock fragments	1.30 - 3.00 m

Surface water entering Pit

Bulk samples taken at 0.4, 1.0 and 2.2 metres.

Trial Hole No. 6 — G.L. 47.83 m

Dark brown peaty topsoil	to 0.40 m
Dense brown sand and gravel	0.40 - 2.00 m
Very dense brown sand and gravel	2.00 - 2.20 m

Pit Dry

Bulk samples taken at 0.2, 0.4 and 1.5 metres.

Trial Hole No. 7 — G.L. 43.10 m

Soft to firm brown sandy and peaty topsoil with fine to medium gravel	to 0.90 m
Medium dense brown sand and gravel	0.90 - 3.30 m
Hard dark grey foliated amphibolite Schist	at 3.30 m

Pit Dry

Bulk samples taken at 0.4, 1.0 and 3.3 metres.

Trial Hole No. 8 — G.L. 36.61 m

Loose brown peaty topsoil	to 0.20 m
Very dense brown sand and gravel	0.20 - 1.60 m

Pit Dry

Bulk samples taken at 0.2 and 1.0 metres.

Contd / ...

[illegible] Ref: 1190

Trial Hole No. 9 — G.L. 49.71 m

Loose brown topsoil	to 0.05 m
Mixed red brown clayey soil with fine to medium gravel	0.05 - 0.50 m
Compact red brown clayey soil containing fragments of broken chloritic schist	0.50 - 1.60 m
Leading hard green grey sheared chloritic schist	at 1.60 m

Pit Dry

Bulk samples taken at 0.3 and 1.0 metres.

Trial Hole No. 10 — G.L. 73.61 m

Topsoil	to 0.10 m
Compact brown sandy soil with fine to medium gravel	0.10 - 0.90 m
Compact brown clayey sand with fragments of dark grey chloritic schist	0.90 - 2.40 m
Leading hard dark grey sheared chloritic hornblende schist	at 2.40 m

Pit Dry

Bulk samples taken at 0.6, 1.0 and 2.4 metres.

Trial Hole No. 12 — G.L. 176.72 m

Soft dark brown fibrous peat	to 0.5 m
Compact blue grey weathered and decomposed hornblende gneiss	0.50 - 2.60 m
Leading hard dark grey crushed and [illegible]	at 2.60 m

Surface water entering Pit

Bulk samples taken at 1.1 and 2.6 metres

Trial Hole No. 13 — G.L. 188.57 m

Soft dark brown fibrous peat	to 0.30 m
Compact light brown fine and medium sand and gravel	0.30 - 1.70 m
Very hard light grey amphibolite and quartz mica schist	at 1.70 m

Surface water entering Pit

Bulk samples taken at 1.2 and 1.7 metres.

Contd / ...

A.60 South Stacey to Ambleterne — Ref: 1190

Trial Hole No. 14 — G.L.192.57 m

Soft dark brown fibrous peat	to 0.50 m
See Bulk Sample (61)	0.50 - 2.00 m
Dense brown fine to medium clayey sand and gravel	2.00 - 3.30 m
Base light red grey and dark grey sheared biotite hornblende schist	at 3.30 m

Surface water entering Pit

Bulk samples taken at 1.3, 2.3 and 3.3 metres.

Trial Hole No. 15 — G.L.201.20 m

Soft dark brown fibrous peat	to 0.10 m
Light brown fine and medium sand and gravel	0.10 - 2.20 m
Medium hard light grey and grey crushed and sheared Quartz mica schist	at 2.20 m

Pit Dry

Bulk samples taken at 1.0 and 2.2 metres.

Trial Hole No. 16 — G.L.204.24 m

Soft dark brown fibrous peat	to 0.40 m
Compact brown fine to medium clayey sand with fine shreds of decomposed peat	0.40 - 1.60 m
Compact brown sandy clay with fragments of broken quartz mica schist	1.60 - 2.10 m
Medium hard grey sheared quartz mica schist	at 2.10 m

Surface water entering Pit

Bulk samples taken at 1.1, 1.6 and 2.1 metres.

Trial Hole No. 17 — G.L.207.42 m

Soft brown fibrous peat	to 1.50 m
Dense blue grey silty sand and gravel (undifferentiated drift)	1.50 - 2.30 m
Very dense grey gravel and cobbles of quartz and schist (undifferentiated drift)	at 2.30 m

Surface water entering Pit

Bulk samples taken at 1.0, 1.8 and 2.3 metres.

Contd / ...

[illegible] [illegible] 1190

Trial Hole No. 19 — G.L. 207.42 m

Soft dark brown fibrous peat	to 0.40 m
Compact blue grey silty sand and gravel (undifferentiated drift)	0.40 - 2.00 m
Hard light red and grey banded biotite hornblende gneiss	at 2.00 m

Surface water entering Pit

Bulk samples taken at 1.2 and 2.0 metres.

Trial Hole No. 20 — G.L. 201.49 m

Topsoil	to 0.10 m
Brown sand with fragments of weathered and broken rock	0.10 - 0.80 m
Compact grey brown clayey sand and gravel (undifferentiated drift)	0.80 - 2.30 m
Medium hard dark grey cleaved hornblende biotite schist	at 2.30 m

Pit Dry

Bulk samples taken at 0.5, 1.9 and 2.3 metres.

Trial Hole No. 21 — G.L. 182.13 m

Topsoil	to 0.40 m
Compact grey brown sand and gravel	0.40 - 2.60 m
Very hard grey and red grey banded hornblende gneiss	at 2.60 m

Surface water entering Pit

Bulk samples taken at 1.5 and 2.6 metres.

Trial Hole No. 22 — G.L. 183.93 m

Soft dark brown fibrous peat	to 0.35 m
Compact blue grey clayey sand and gravel (undifferentiated drift)	0.35 - 1.70 m
Brown sandy clay containing fragments of broken rock	1.70 - 2.70 m
Firm light grey and white clay with fragments of decomposed rock (kaolin)	2.70 - 4.00 m
Kaolin and hard light gneiss grey quartz and feldspar pegmatite vein	at 4.00 m

Groundwater met at 1.90 m

Bulk samples taken at 1.0, 2.1, 3.3 and 4.0 metres.

[illegible]

[illegible] to Auchinleck — Ref: 1190

Trial Hole No. 23 — G.L. 169.20 m

Soft dark brown fibrous peat	to 0.40 m
Compact blue grey silty sand and fragments of broken rock (undifferentiated drift)	0.40 - 1.50 m
Compact brown clayey sand with fragments of broken schist	1.50 - 3.00 m
Medium hard light grey brown weathered quartz mica schist	at 3.00 m

Surface water entering Pit

Bulk samples taken at 1.0, 2.1 and 3.0 metres.

Trial Hole No. 24 — G.L. 167.18 m

Soft dark brown fibrous peat	to 0.40 m
Compact blue grey silty sand and gravel (undifferentiated drift)	0.40 - 1.83 m
Compact light brown clayey sand and gravel, cobbles and boulders becoming very coarse near base of stratum (undifferentiated drift)	1.83 - 5.00 m
Medium hard weathered grey hornblende schist	at 5.00 m

Surface water entering Pit

Bulk samples taken at 1.8 and 5.0 metres.

Trial Hole No. 25 — G.L. 170.72 m

Soft dark brown fibrous peat	to 0.40 m
Compact mottled brown and grey silty sand and gravel with fragments of weathered [illegible] (undifferentiated drift)	0.40 - 1.64 m
[illegible]	at 1.64 m

Surface water entering Pit

Bulk samples taken at 0.6 and 1.6 metres.

Contd / ...

A540 South Stoke to Arabberton — Ref: 1190

Trial Hole No. 26 — G.L. 170.00 m

Topsoil	to 0.13 m
Dense red brown bound sand (decomposed rock)	0.13 - 0.33 m
Soft to medium hard brown weathered and foliated hornblende gneiss (Dip of strata 70° to East)	0.33 - 1.60 m

Pit Dry

Bulk sample taken at 0.8 metres.

Trial Hole No. 27 — G.L. 161.23 m

Soft dark brown peaty topsoil	to 0.30 m
Dense brown clayey sand with fragments of weathered rock (undifferentiated drift)	0.30 - 1.26 m
Medium hard grey foliated and weathered gneiss	at 1.26 m

Pit Dry

Bulk samples taken at 0.6 and 1.26 metres.

Trial Hole No. 28 — G.L. 162.23 m

Soft light brown silty peat	to 0.72 m
Compact blue grey silty sand and gravel and cobbles with fragments of weathered rock (undifferentiated drift)	0.72 - 2.60 m
Medium hard grey massive gneiss with quartz veins	at 2.60 m

Groundwater met at 2.5 metres

Bulk samples taken at 1.15 and 2.6 metres.

Trial Hole No. 29 — G.L. 179.43 m

Soft dark brown peat	to 0.30 m
Soft mottled grey and brown weathered and decomposed hornblende schist	0.30 - 0.60 m
Very hard light grey foliated hornblende gneiss	at 0.60 m

Pit Dry

Bulk samples taken at 0.1 and 0.4 metres.

Contd / ...

A890 South Strome to Auchtertyre

Ref: 1190

Trial Hole No. 30

G.L. 102.44 m

Soft brown peat — to 1.49 m

Soft mottled blue grey sandy silt containing gravel and cobbles and fragments of decomposed rock (undifferentiated drift) — 1.49 - 1.97 m

Water entering from sides of pit and surface

Bulk samples taken at 1.05 and 1.88 metres.

Trial Hole No. 31

G.L. 109.95 m

Loose brown topsoil — to 0.23 m

Brown decomposed and weathered in-situ rock — 0.23 - 0.70 m

Very hard light grey foliated gneiss — at 0.70 m

Dip of strata 40° to east

Strike of strata 344°

Pit Dry

Bulk sample taken at 0.7 m

Trial Hole No. 32

G.L. 102.51 m

Loose brown sandy topsoil — to 0.38 m

Brown silty sand containing fragments of weathered rock — 0.38 - 0.96 m

Hard grey banded and foliated gneiss — at 0.96 m

Pit Dry

Bulk sample taken at 0.96 metres.

Trial Hole No. 33

G.L. 79.94 m

Loose brown sandy silt — to 0.23 m

Soft to medium hard dark grey weathered and poorly foliated amphibolite — 0.23 - 0.65 m

Hard dark grey amphibolite — at 0.65 m

Groundwater met at 0.6 metres

Bulk sample taken at 0.3 metres.

Contd / ...

A990 South Shields to Auchtergaven — Ref: 1190

Trial Hole No. 34 — G.L. 76.38 m

Loose brown sandy topsoil	to 0.33 m
Brown bound sand and fine and medium gravel with fragments of weathered rock	0.33 - 0.60 m
Soft light grey decomposed rock	0.60 - 0.86 m
Very hard light grey foliated hornblende gneiss	0.86 - 0.90 m

Pit Dry

Bulk samples taken at 0.45 and 0.9 metres

Trial Hole No. 35 — G.L. 69.23 m

Bound brown slightly silty sand and gravel with cobbles and boulders	to 1.00 m
Mottled brown silty sand, gravel and cobbles	1.00 - 2.04 m
Brown silty sand and gravel with fragments of decomposed rock	at 2.04 m

Groundwater met at -.06 metres

Bulk samples taken at 1.0 and 2.0 metres.

Trial Hole No. 36 — G.L. 71.47 m

Loose dark brown sandy topsoil	to 0.26 m
Mottled brown and grey clayey sandy gravel, cobbles and fragments of decomposed rock (undifferentiated drift)	0.26 - 0.90 m
Medium hard light grey weathered quartz hornblende schist	0.90 - 1.20 m
Hard grey quartz hornblende schist	at 1.20 m

Pit Dry

[illegible] taken at 0.61 metres

Trial Hole No. 37 — G.L. 70.61 m

Light brown sandy topsoil with gravel, cobbles and large boulders	to 1.62 m

Pit Dry

Bulk sample taken at 1.58 metres

Contd / ...

[illegible] South Pimple to Jacksonville [illegible] 1990

Trial Hole No. 38 — G.L. 61.46 m

Topsoil	to 0.68 m
Dense brown sandy soil containing gravel and fragments of weathered rock	0.68 - 1.29 m
Medium hard grey foliated gneiss	at 1.29 m

Pit Dry

Bulk sample taken at 0.6[illegible] metres

Trial Hole No. 39 — G.L. 33.27 m

Topsoil	to 0.30 m
Brown sandy soil with fragments of broken rock	0.30 - 1.50 m
Hard grey gneiss	at 1.50 m

Pit Dry

Bulk samples taken at 1.0 and 1.5 metres

Trial Hole No. 40 — G.L. 18.84 m

Soft dark brown peat	to 0.45 m
Red brown clayey silty sand containing fragments of broken rock	0.45 - 1.30 m
Hard grey banded gneiss	at 1.30 m

Surface water entering pit

Bulk samples taken at 0.8 and 1.3 metres

[illegible] No. 41 — [illegible] m

Topsoil	to 0.20 m
Brown clayey silty sand with fragments of weathered gneiss	0.20 - 0.50 m
Hard grey banded gneiss	at 0.50 m

Pit Dry

Bulk samples taken at 0.2 and 0.5 metres

A82 South Stronie to Auchterbyre — Ref : 1190

Trial Hole No. 42 — G.L. 166.12 m

Topsoil	to 0.80 m
Brown clayey sand with fragments of broken rock	0.80 - 2.20 m
Grey clayey silty sand and gravel with weathered schist boulders	2.20 - 3.60 m

Pit Dry

Bulk samples taken at 1.8 and 3.0 metres

Trial Hole No. 43 — G.L. 129.19m O.D.

Soft dark brown fibrous peaty soil.	to 0.33 m
Compact light grey brown sandy clay containing abundant fragments of weathered quartz-mica schist.	0.33 - 0.83 m
Medium hard to hard light grey laminated crushed and broken quartz mica schist.	at 0.83 m

Groundwater entering pit at 0.7 metres

Trial Hole No. 44 — G.L. 123.66m O.D.

Soft dark brown fibrous peaty soil	to 0.66 m
Compact light grey brown sandy clay containing fragments of badly sheared and weathered quartz mica schist.	0.66 - 1.14 m

Pit Dry

Trial Hole No. 45 — G.L. 120.62

Soft dark brown peaty soil	to 0.10 m
Compact light grey brown sandy clayey silt containing abundant fragments of sheared and weathered quartz mica schist epidote and epidiorite.	0.10 - 0.70
Medium hard grey crushed and broken quartz mica schist	at 0.70

Pit Dry

A890 South Strome to Auchtertyre — Ref : 1190

Trial Pole No. 46 — G.L. 124.10 m O.D.

Soft dark grey brown peaty soil	to 0.35 m
Compact reddish brown clayey sandy soil with abundant fragments of schist, gneiss and epidiorite.	0.35 - 0.55 m
Compact light yellow grey sandy and clayey silt containing abundant fragments of weathered and crushed quartz mica schist.	0.55 - 0.83 m

Dip of strata apparently gentle towards the east

Pit Dry

SUMMARY OF LABORATORY TEST RESULTS

Site: A30 South Stroma to Auchterbyre Road — TABLE I — Ref: 1190

B.H. No.	Sample No.	Sample Depth (m)	Moisture Content	Atterburg Limits LL (%)	Atterburg Limits PL (%)	Atterburg Limits PI (%)	Density Bulk (kg/m³)	Density Dry (kg/m³)	Apparent Cohesion (kN/m²)	Angle of Shearing Resistance (degrees)	Other Tests	Description of Sample
11	B2	0.80									Sieving	Light brown sand and gravel.
12	B1	0.35	27.0	Unsuitable for Compaction Test							Sieving	Light brown clayey sand and gravel.
T.P. 10	B1	0.45		Unsuitable for C.B.R. Test							Sieving and C.B.R.	Compact brown clayey sand and gravel.
13	B2	3.35									Sieving	Compact grey brown clayey sand, gravel and boulders.
14	B4	3.50									Sieving	Grey brown sand and gravel.
17	B2	0.75									Sieving	Brown sandy peat.
18	B5	3.00									Sieving	Brown sandy gravel.
20	B3	3.50									Sieving	Light grey sandy gravel and cobbles.
22	B2	2.05	14.0								Sieving and Compaction	Light grey brown clayey silty sand and gravel.

Cont'd / ...

SUMMARY OF LABORATORY TEST RESULTS

Site: A90 South Street to Auchtertyre Road — TABLE I — Ref: 1100

B.H. No.	Sample No.	Sample Depth (m)	Moisture Content	Atterburg Limits LL (%)	Atterburg Limits PL (%)	Atterburg Limits PI (%)	Density Bulk (kg/m³)	Density Dry (kg/m³)	Apparent Cohesion (kN/m²)	Angle of Shearing Resistance (degrees)	Other Tests	Description of Sample
32	U1	0.65	502.8				900	141	7	0		Dark brown fibrous peat
33A	D3	2.76									Sieving	Grey and brown sand and gravel.
34	D3	1.20									Sieving	Grey and brown sand and gravel.
T.P. 15	B1	2.00	11.9								Sieving and Compaction	Grey and brown sand and gravel.
	B2	4.25									C.B.R.	Grey and brown silty sand and gravel.
TH 2	B2	2.30									C.B.R.	Grey sand and gravel.
TH 15	B1	1.20									C.B.R.	Grey clayey sand gravel and organic matter.

Unsuitable for C.B.R. Test

A090 SOUTH STRONE TO AUCHTERTYRE ROAD

SULPHATE CONTENT AND pH VALUE DETERMINATIONS

ON

GROUNDWATER SAMPLES

TABLE 2

Borehole No.	Depth (m)	SO_3 p.p.m. th.	pH
33	0.20	Trace	7.0
33A	1.20	Trace	5.6
34	0.25	Trace	7.0

DRC/a.j/1190

[illegible]

[illegible] OF CALIFORNIA [illegible] & NUMBER TWELVE

TABLE 2

Borehole No.	Sample No.	Depth Range	Moisture Content	Density Bulk	Density Dry	Loss O.M.H.
BH 13	B1	1.20	12.4	2254	2010	9.4 %
TP 18	B2	4.25	11.9	2311	2060	6.9 %

[illegible]

TRIAXIAL COMPRESSION TEST

FIG. 1

[illegible]

JT: [illegible] REF. 1190

BOREHOLE No. [illegible] SAMPLE No. 1 DEPTH. 6.55 m

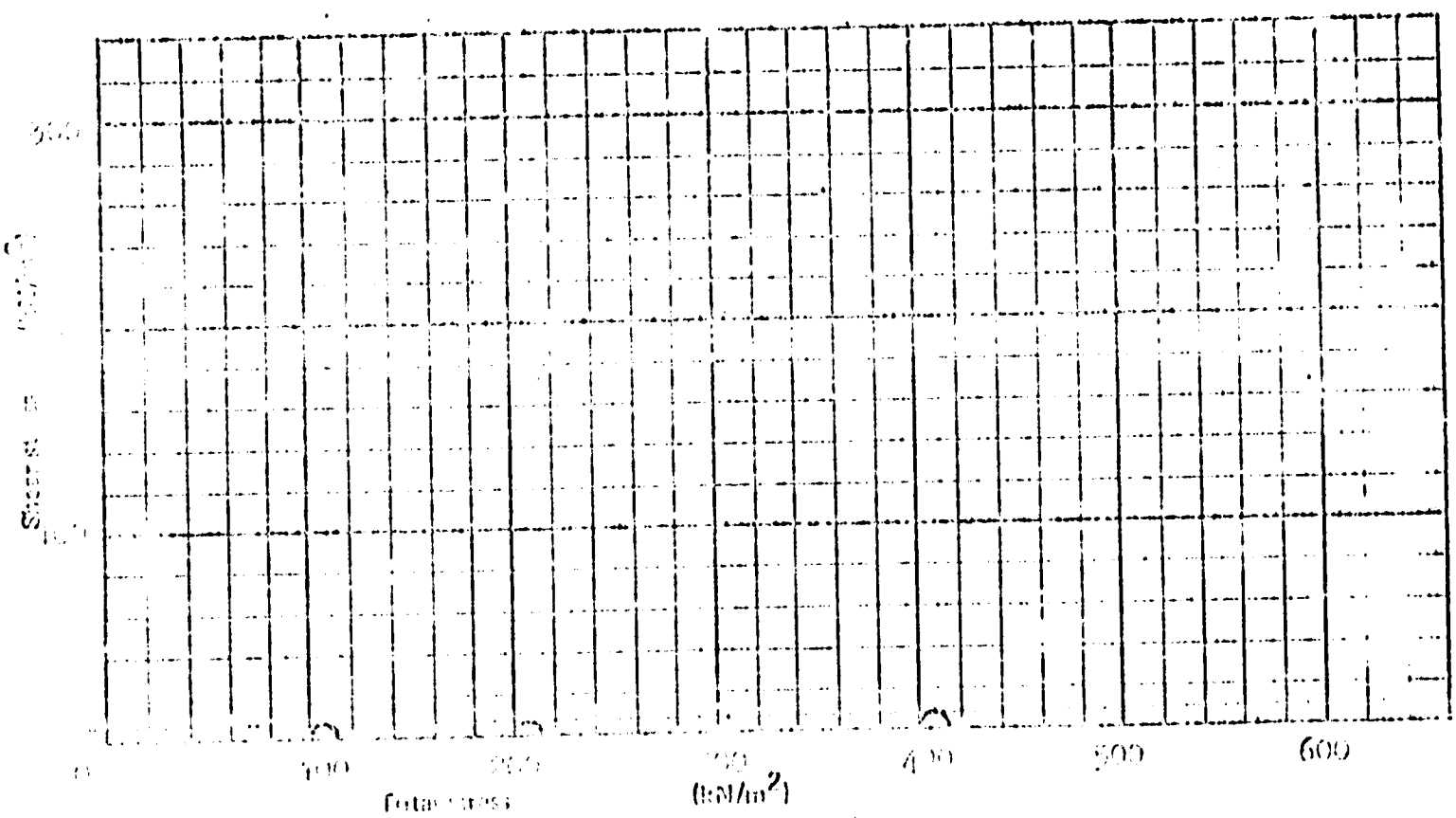
Diameter of specimen [illegible] mm Rate of strain 2 %/min.

Length of specimen [illegible] mm

Moisture content	(%)	[illegible]			
Dry density	(kg/m^3)	141			
Cell pressure	(kN/m^2)	[illegible]	200	[illegible]	
Strain at failure	(%)	6	8	12	
Maximum deviator stress	(kN/m^2)	13	14	16	

Apparent cohesion (c) 7 kN/m^2

Angle of internal friction (ϕ) 0 °



[illegible]

TRIAXIAL COMPRESSION TEST

FIG. 2

IMMEDIATE UNDRAINED

SITE [illegible] to Dockfield Road REF. 1120

BOREHOLE No. 98.49 SAMPLE No. B1 DEPTH. 1.22 m

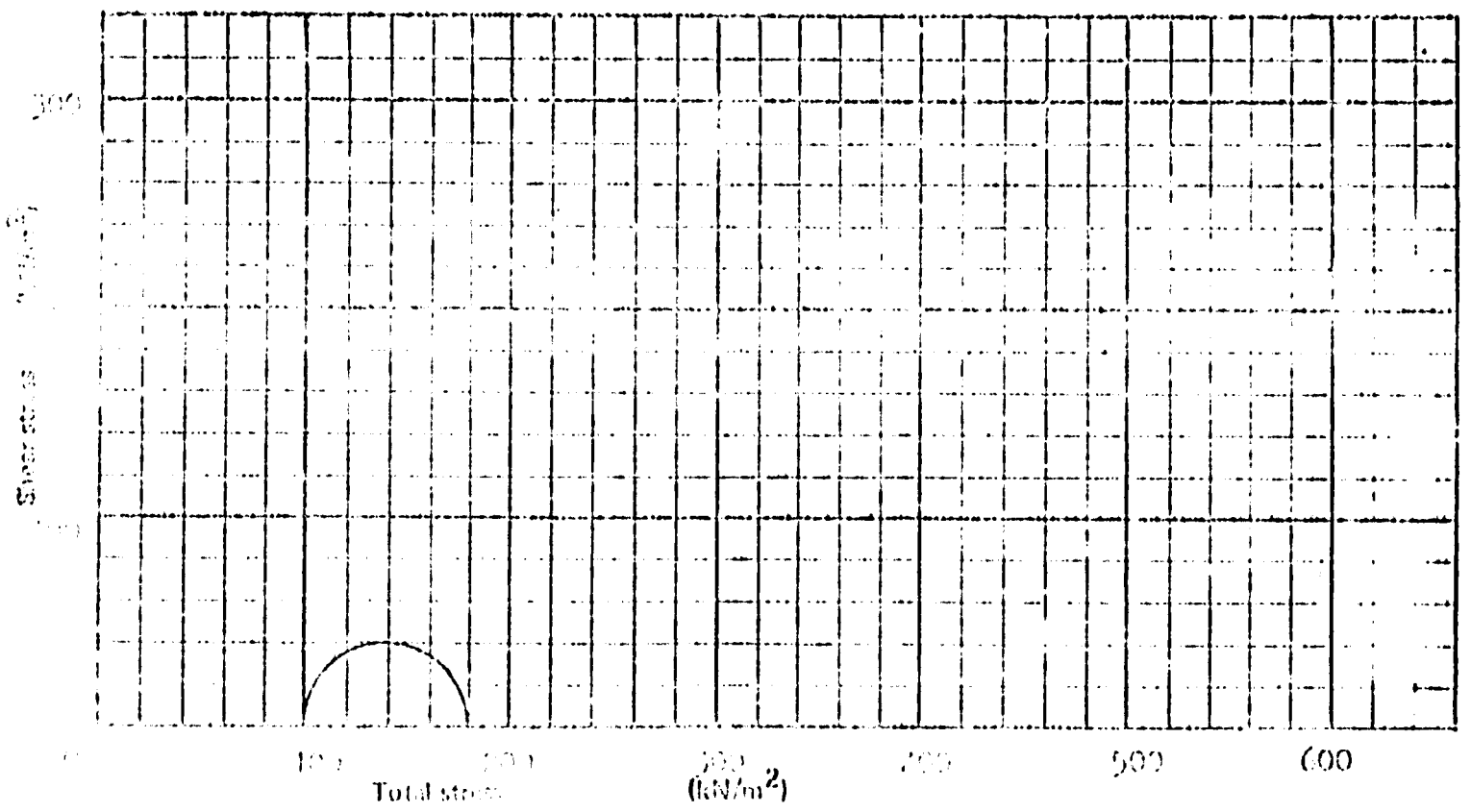
Diameter of specimen 107 mm Rate of strain x %/min.

Length of specimen 223 mm

Moisture content	(%)	28.7			
Dry density	(kg/m^3)	1570			
Cell pressure	(kN/m^2)	100			
Strain at failure	(%)	20			
Maximum deviator stress	(kN/m^2)	70			

Apparent cohesion (c) 30 kN/m^2

Angle of internal friction (ϕ) .. o



TRIAXIAL COMPRESSION TEST

FIG. 5

SITE [illegible] REF. 1150

BOREHOLE No. [illegible] SAMPLE No. [illegible] DEPTH. 5.12 m

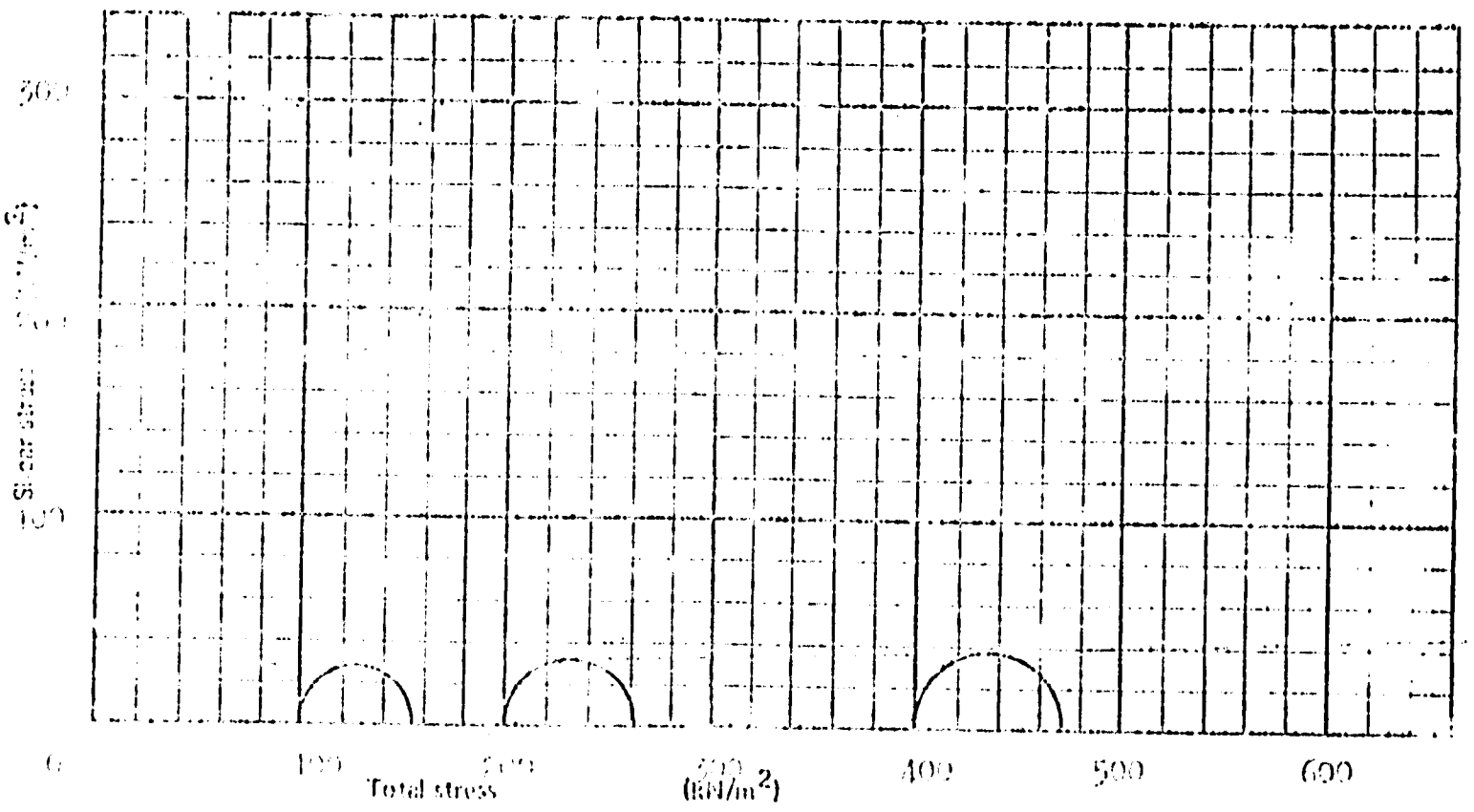
Diameter of specimen [illegible] mm Rate of strain 2 %/min.

Length of specimen [illegible] mm

Moisture content	(%)	15.6			
Dry density	(kg/m^3)	1970			
Cell pressure	(kN/m^2)	100	200	400	
Strain at failure	(%)	11	18	20	
Deviator stress	(kN/m^2)	24	44	72	

Apparent cohesion (c) 25 kN/m^2

Angle of internal friction (φ) [illegible] °



COMPACTION TEST FIG. 4

SOIL MOISTURE/DENSITY RELATIONSHIP

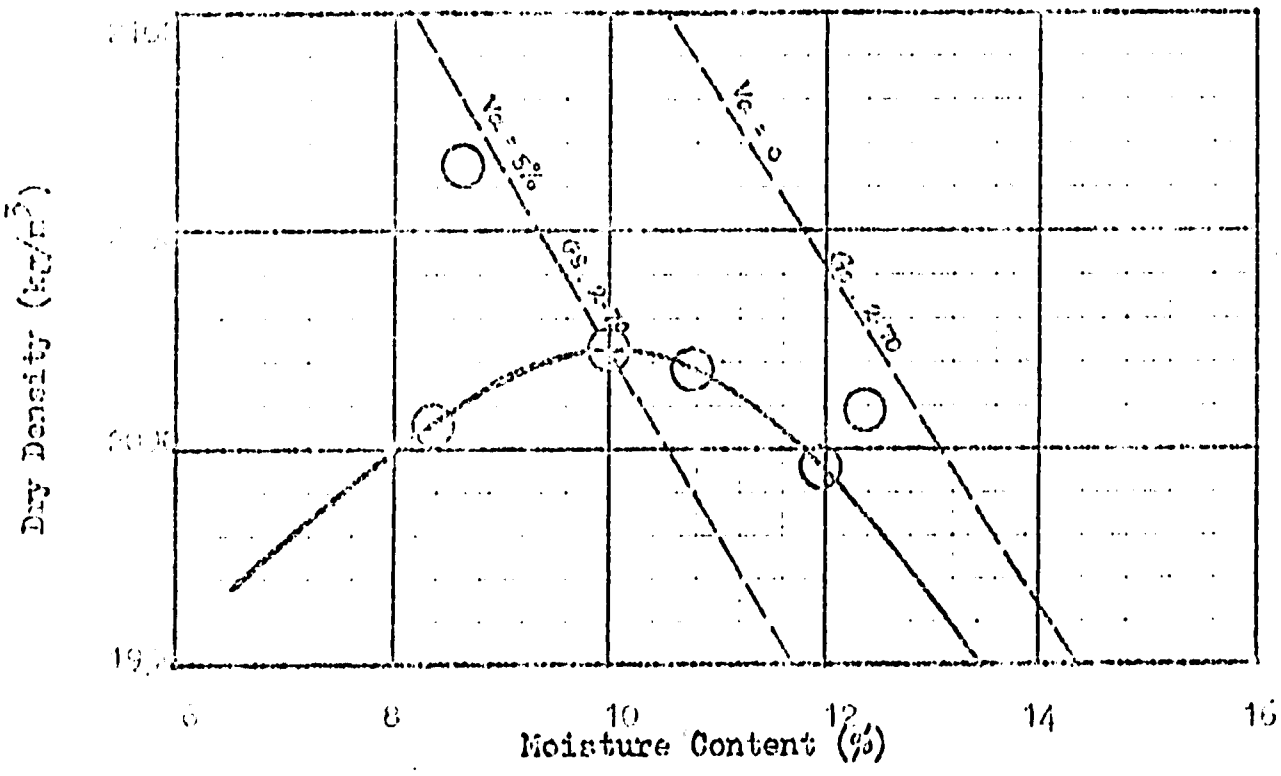
SITE [illegible] REF. 1120

BOREHOLE [illegible] SAMPLE NO. B1 DEPTH 2.15 m

Compaction Standard

Optimum Moisture Content 10 %

Maximum Dry Density 2020 kg/m^3

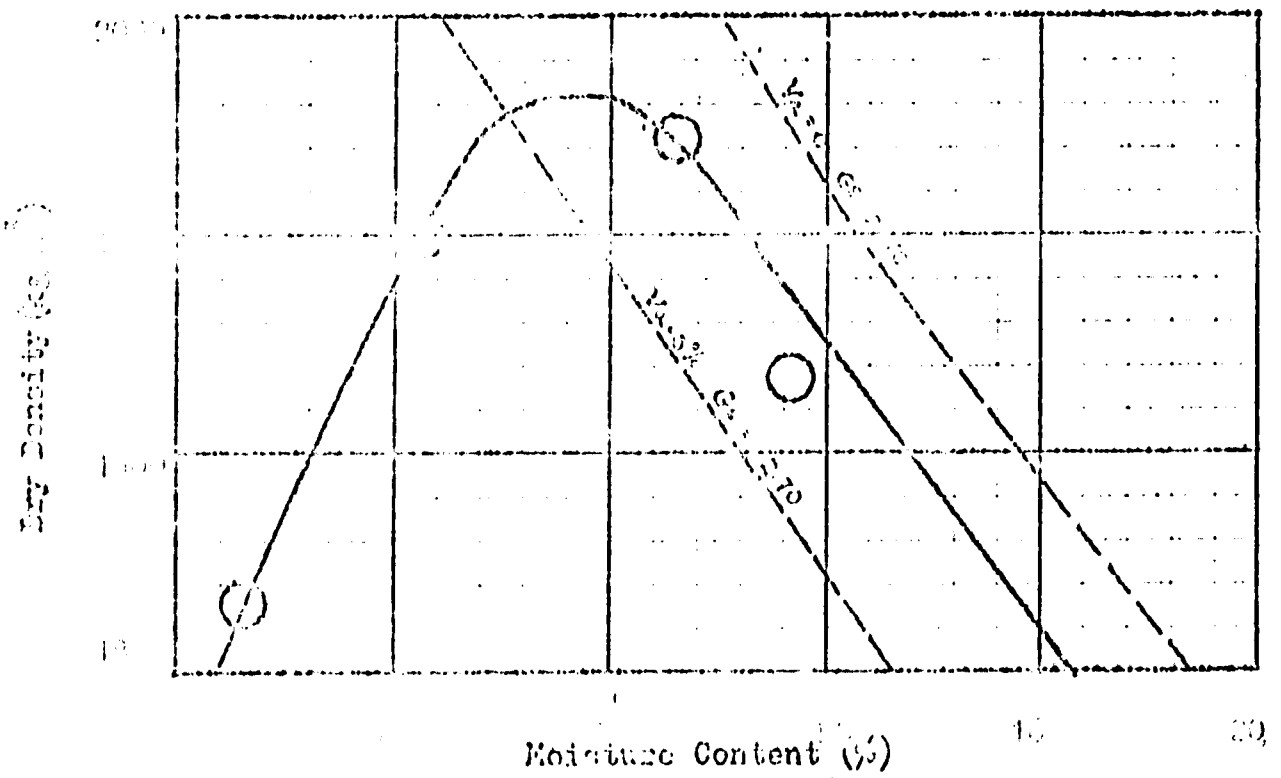


BOREHOLE 22 SAMPLE NO. B2 DEPTH 2.05 m

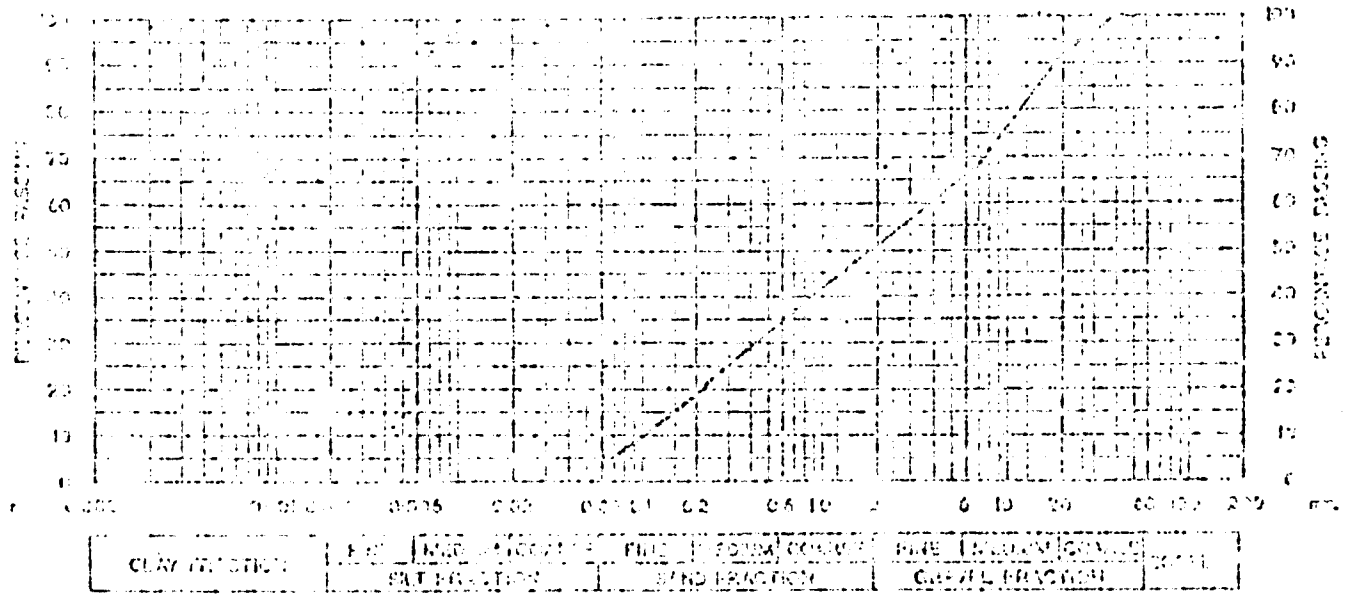
Compaction Standard

Optimum Moisture Content 12 %

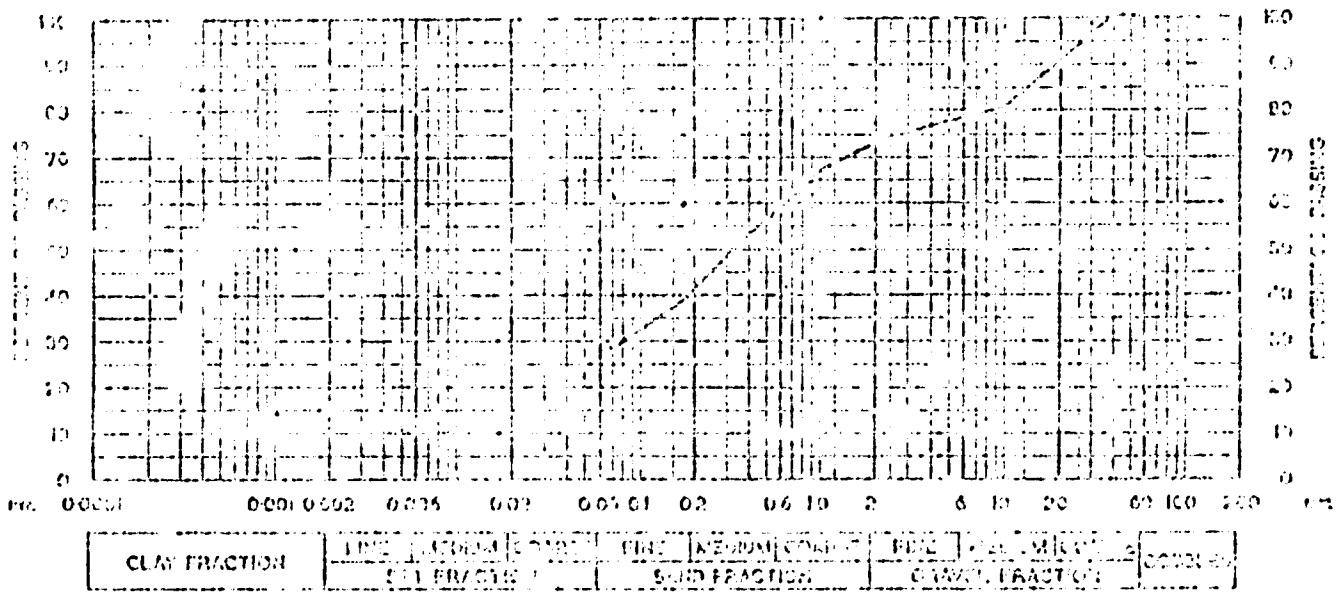
Maximum Dry Density 1980 kg/m^3



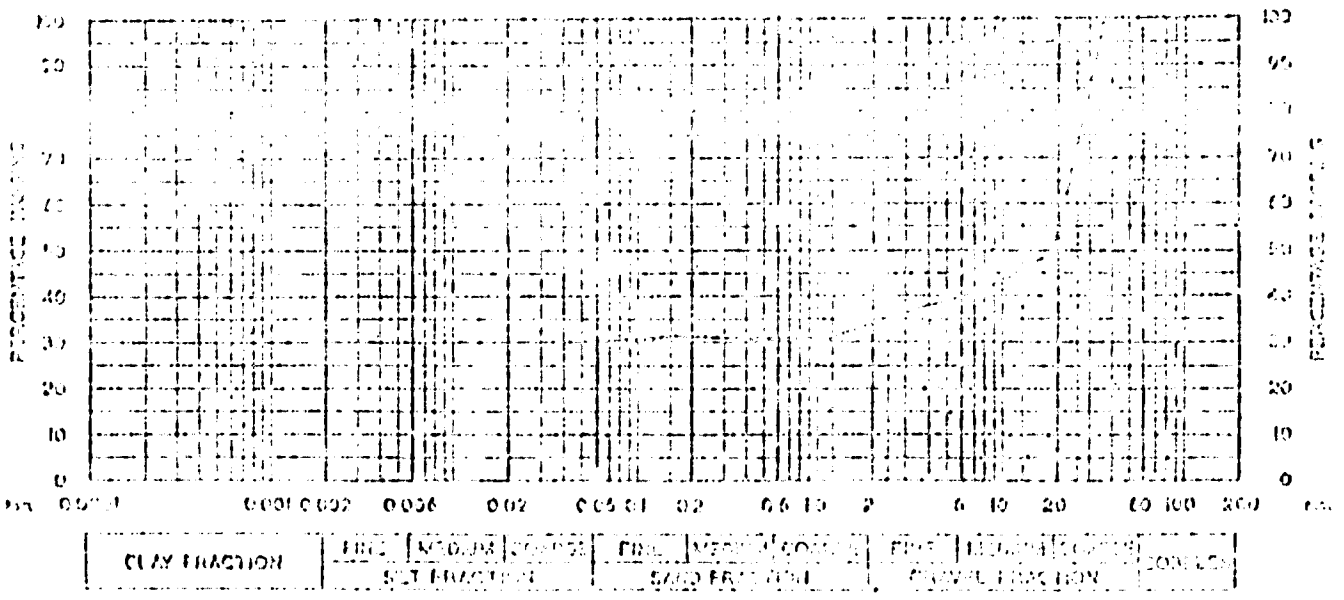
PARTICLE SIZE DISTRIBUTION



BOREHOLE No 11 SAMPLE No D5 DEPTH 1.25 m



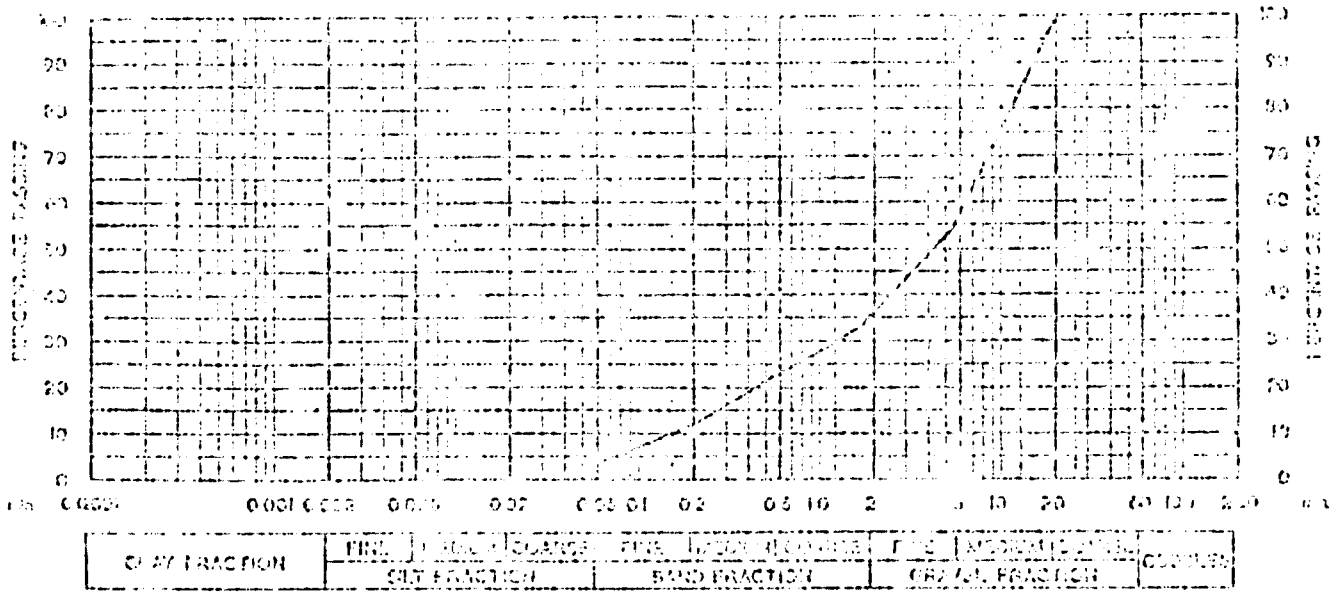
BOREHOLE No 12 SAMPLE No D1 DEPTH 0.45 m



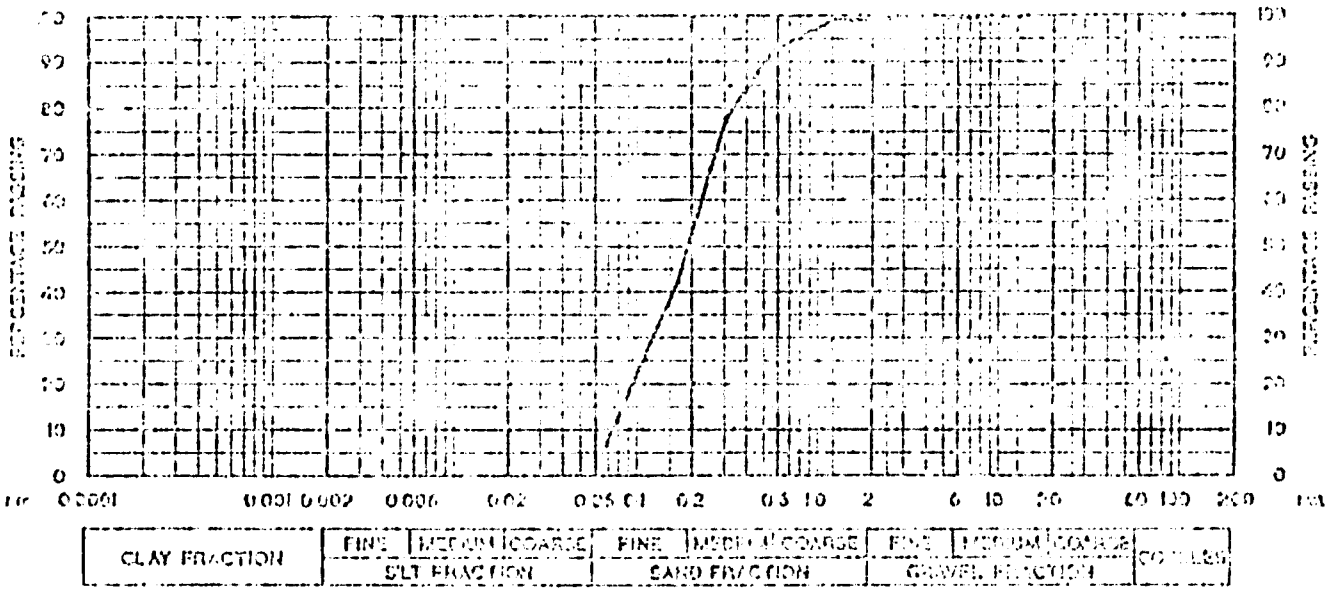
BOREHOLE No 15 SAMPLE No D2 DEPTH 3.50-3.95 m

PARTICLE SIZE DISTRIBUTION

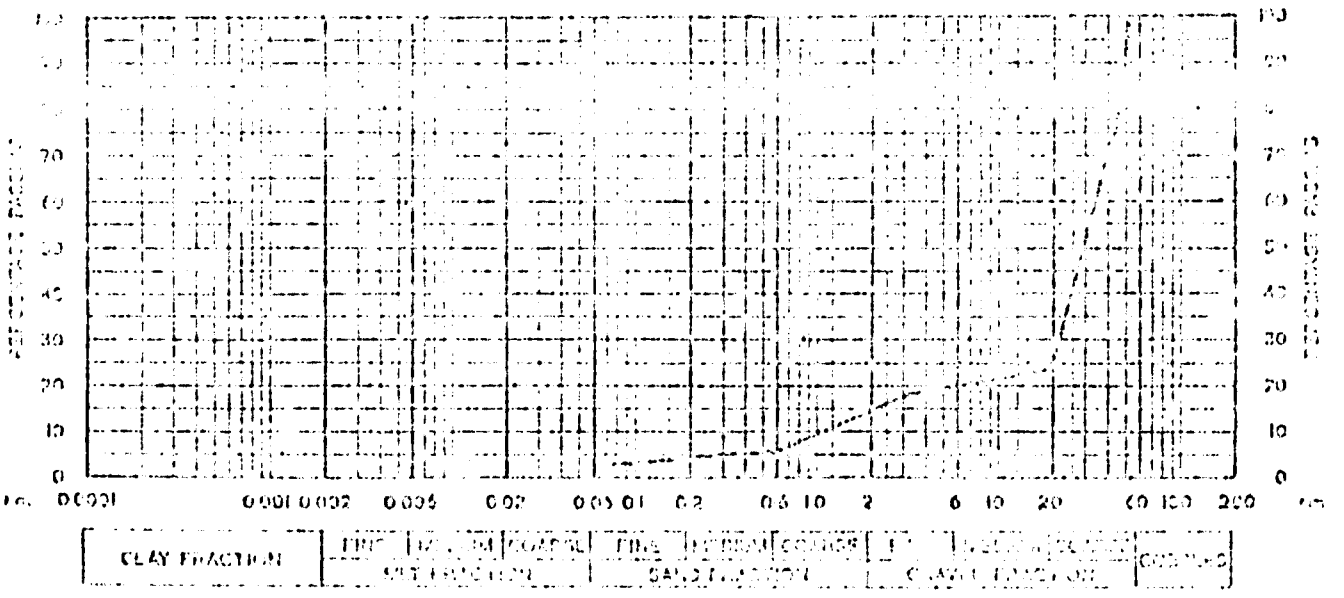
FIG 5



BOREHOLE No. 16 SAMPLE No. [illegible] DEPTH 5.30-5.7[illegible] m



BOREHOLE No. 17 SAMPLE No. [illegible] DEPTH [illegible] m

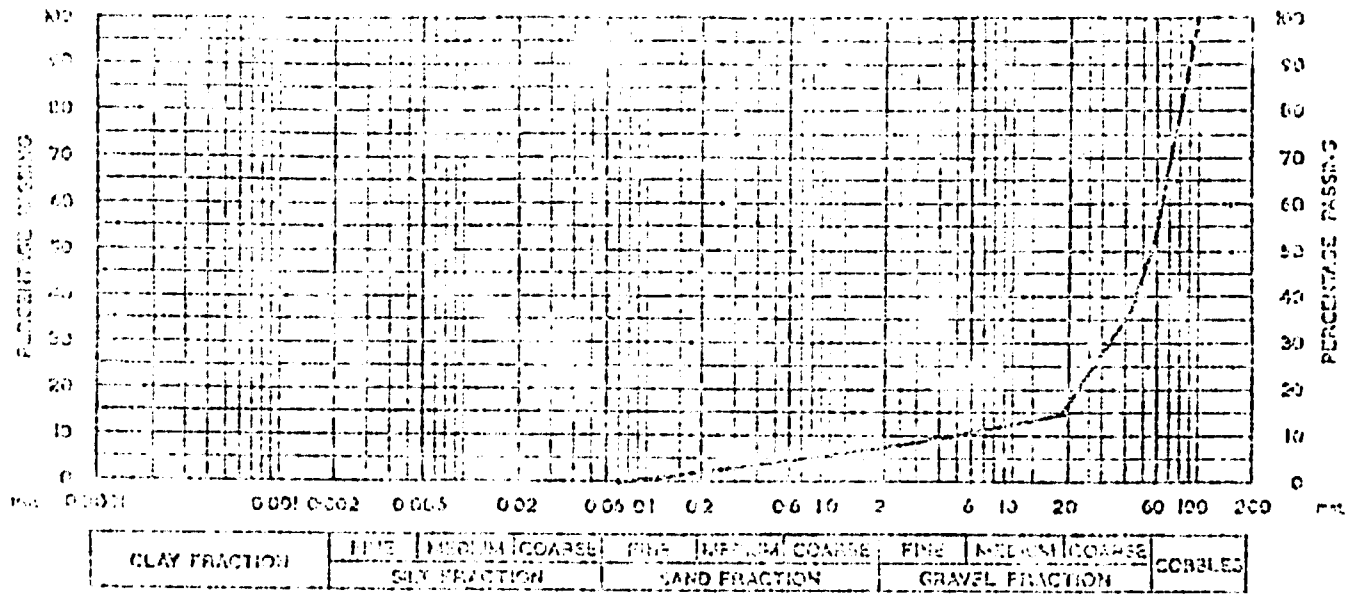


BOREHOLE No. 18 SAMPLE No. [illegible] DEPTH [illegible] m

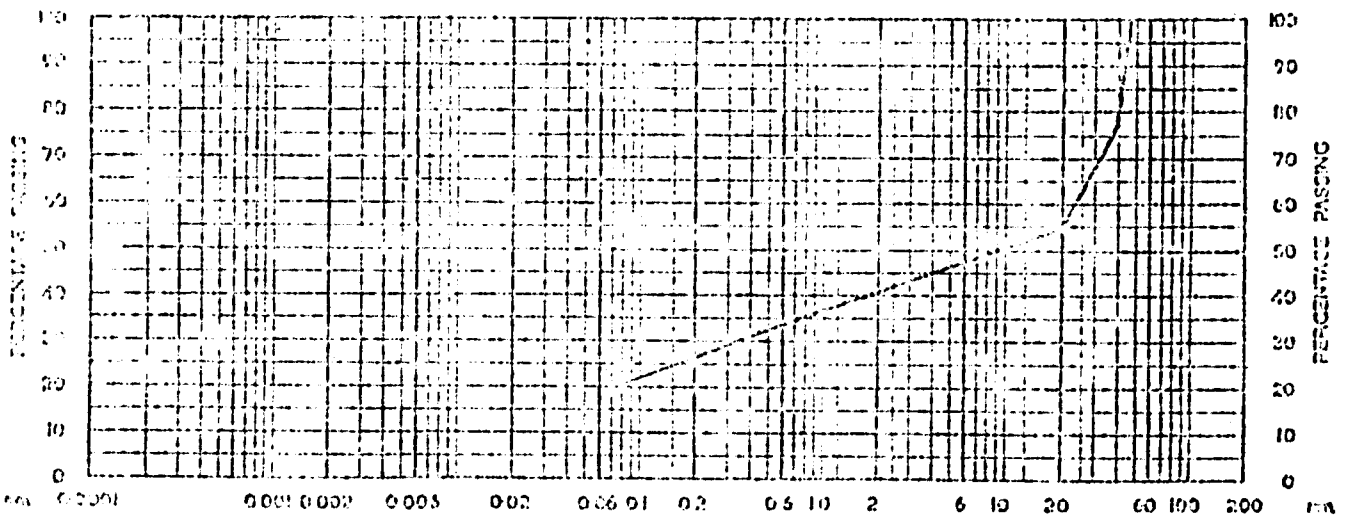
PARTICLE SIZE DISTRIBUTION

FIG. 7

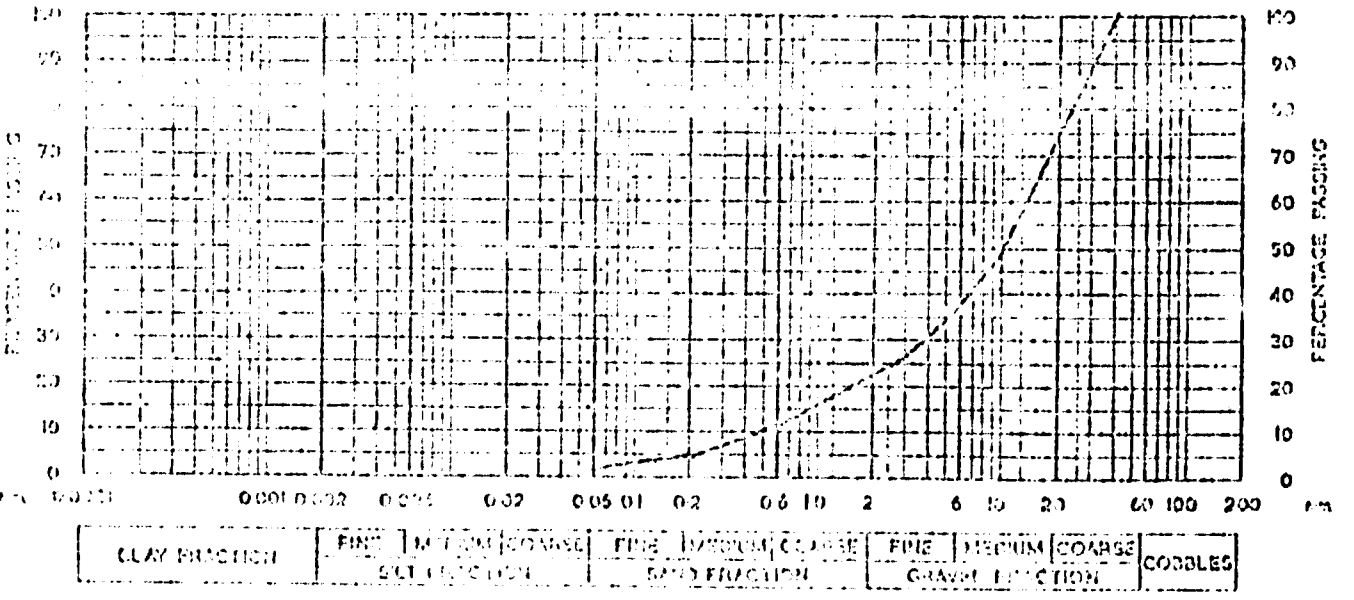
[illegible] FIG. No. 1100



BOREHOLE No. 20 SAMPLE No 23 DEPTH 5.5-6.0 m



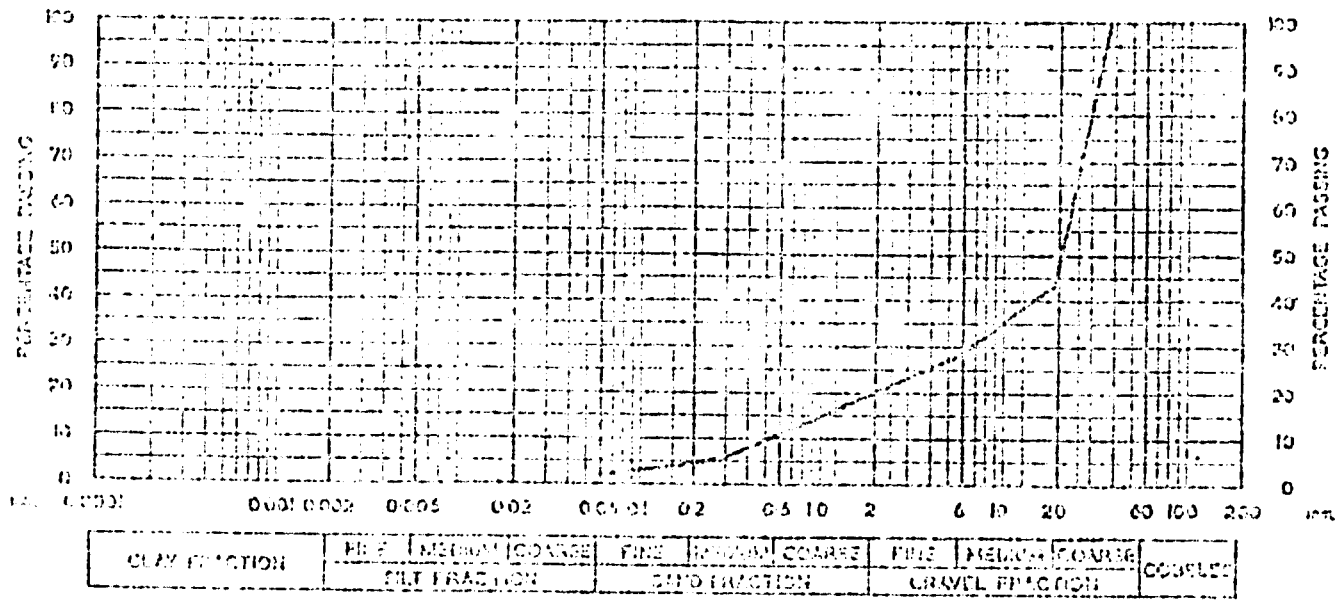
BOREHOLE No 21 SAMPLE No 22 DEPTH 2.20 m



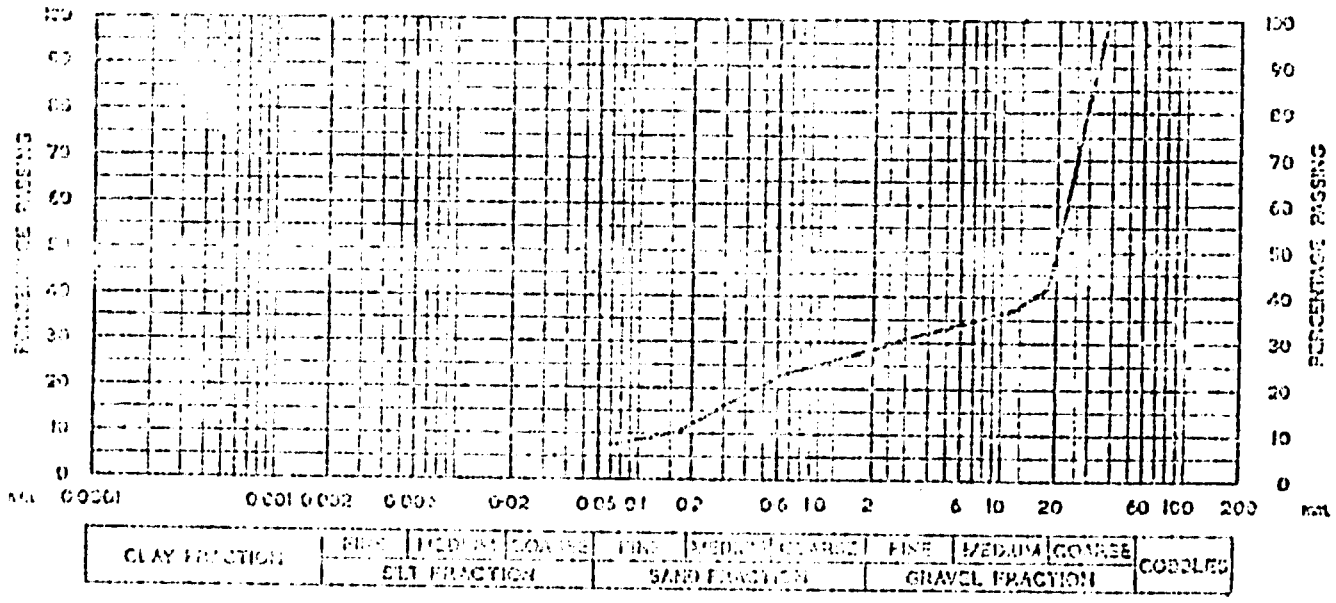
BOREHOLE No 23 SAMPLE No 23 DEPTH 2.76 m

PARTICLE SIZE DISTRIBUTION

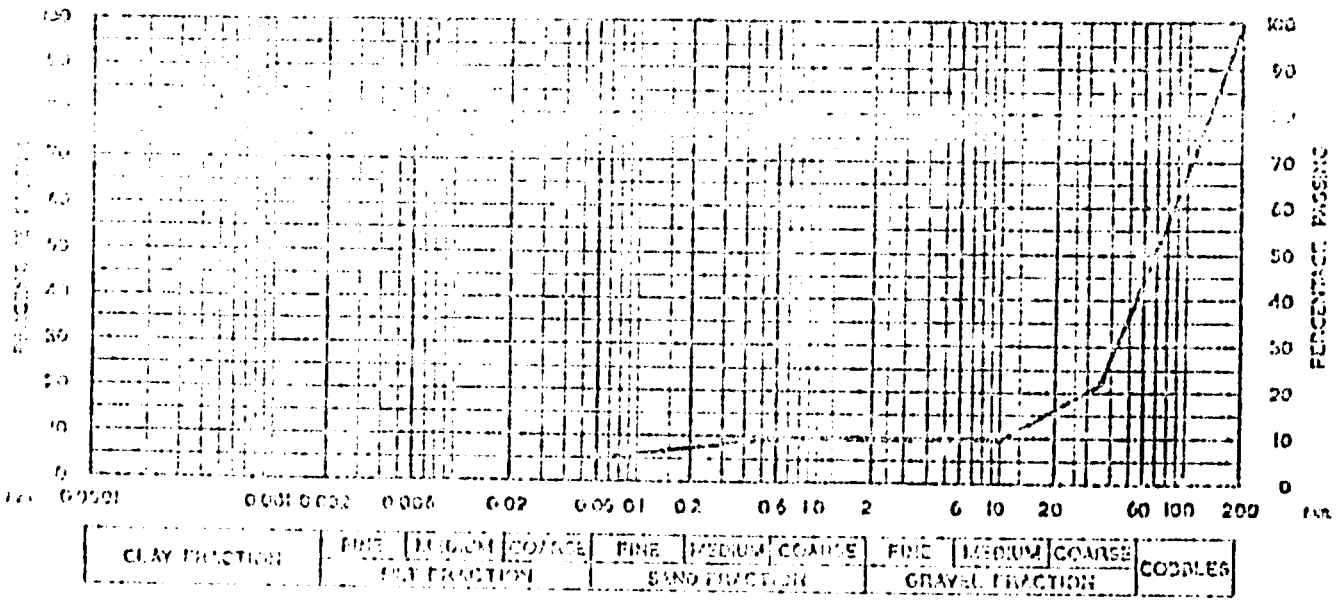
FIG 6



BOREHOLE No 34 SAMPLE No 03 DEPTH 1.20-1.65 m



BOREHOLE No 31 SAMPLE No 02 DEPTH 1.50 m



BOREHOLE No 32, 33 SAMPLE No 31 DEPTH 2.15 m

PARTICLE SIZE DISTRIBUTION

Borehole Number	R101
Depth of Sample	1.4-1.55
Sample Number	
Sample Type	Bulk

Method:- Standard Method by Wet Sieving

Sample Description:- Well graded, sandy, fine to medium GRAVEL.

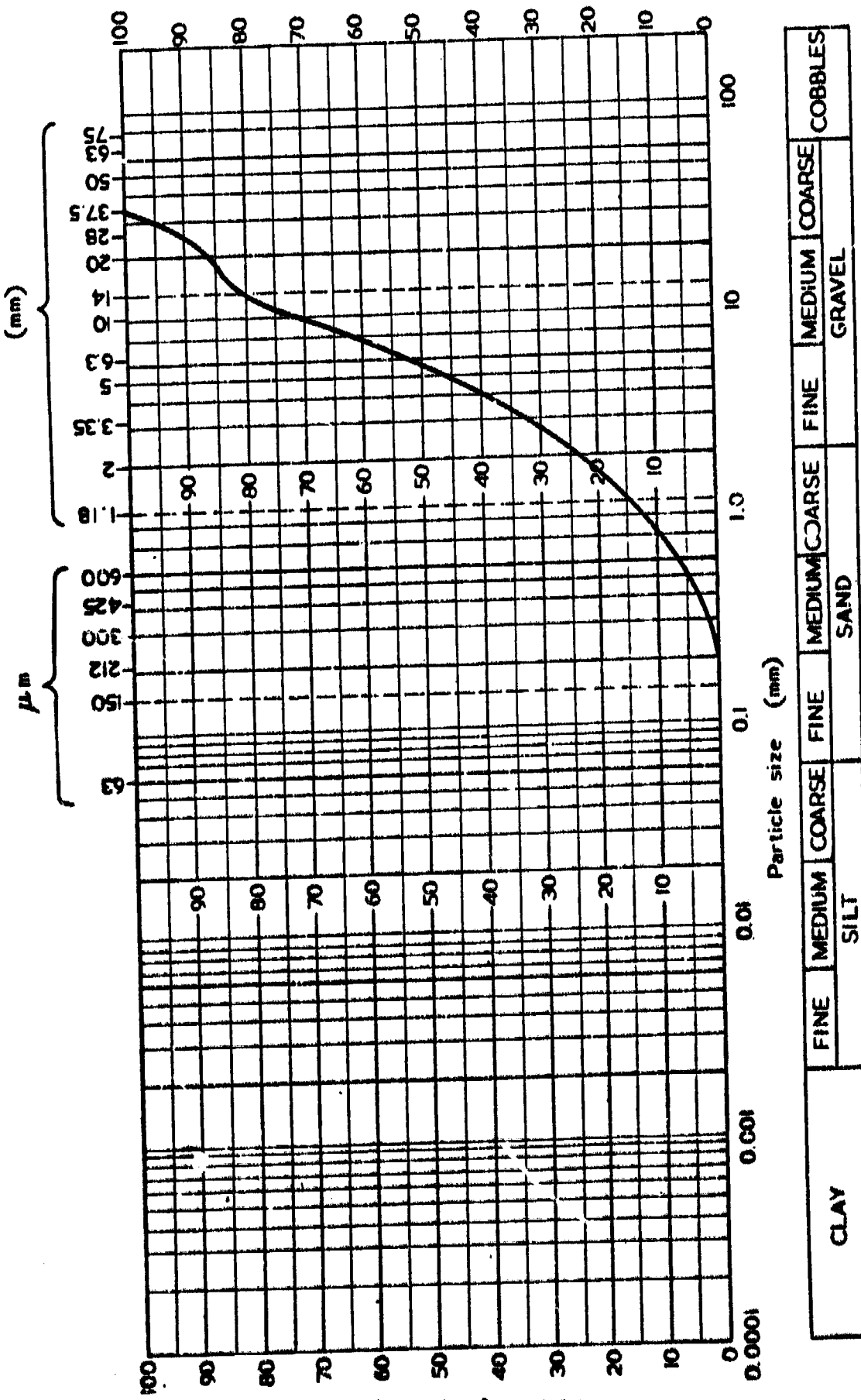


FIG.12

PARTICLE SIZE DISTRIBUTION

Borehole Number	R106
Depth of Sample	1.4-1.7
Sample Number	
Sample Type	Bulk

Method:- Standard Method by Wet Sieving

Sample Description:- Well graded, sandy, fine to medium GRAVEL.

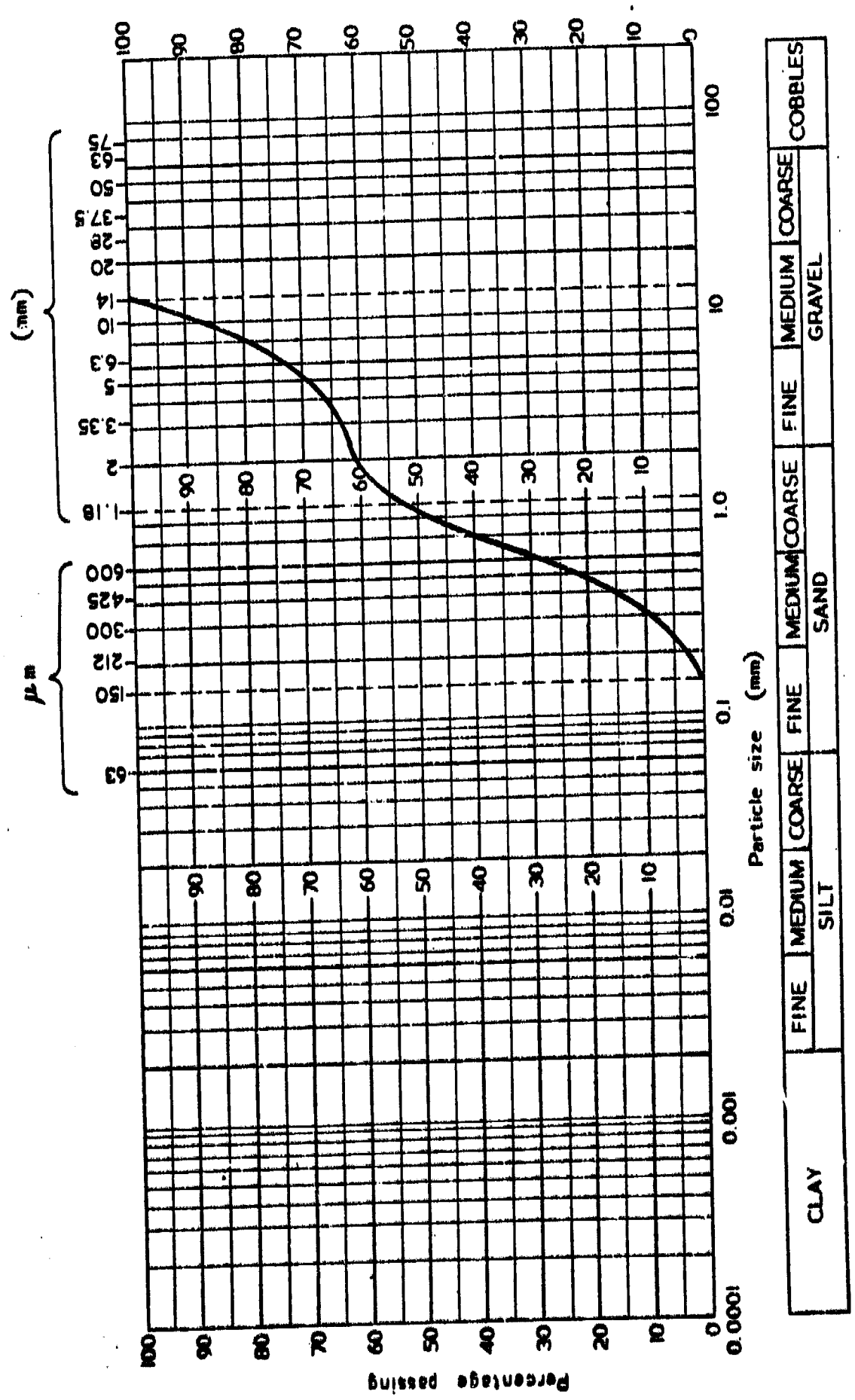


FIG. 13

PARTICLE SIZE DISTRIBUTION

Borehole Number	R107
Depth of Sample	7.0-7.4
Sample Number	
Sample Type	Bulk

Method:- Standard method by wet sieving.

Sample Description:- Well graded, sandy, fine to coarse GRAVEL

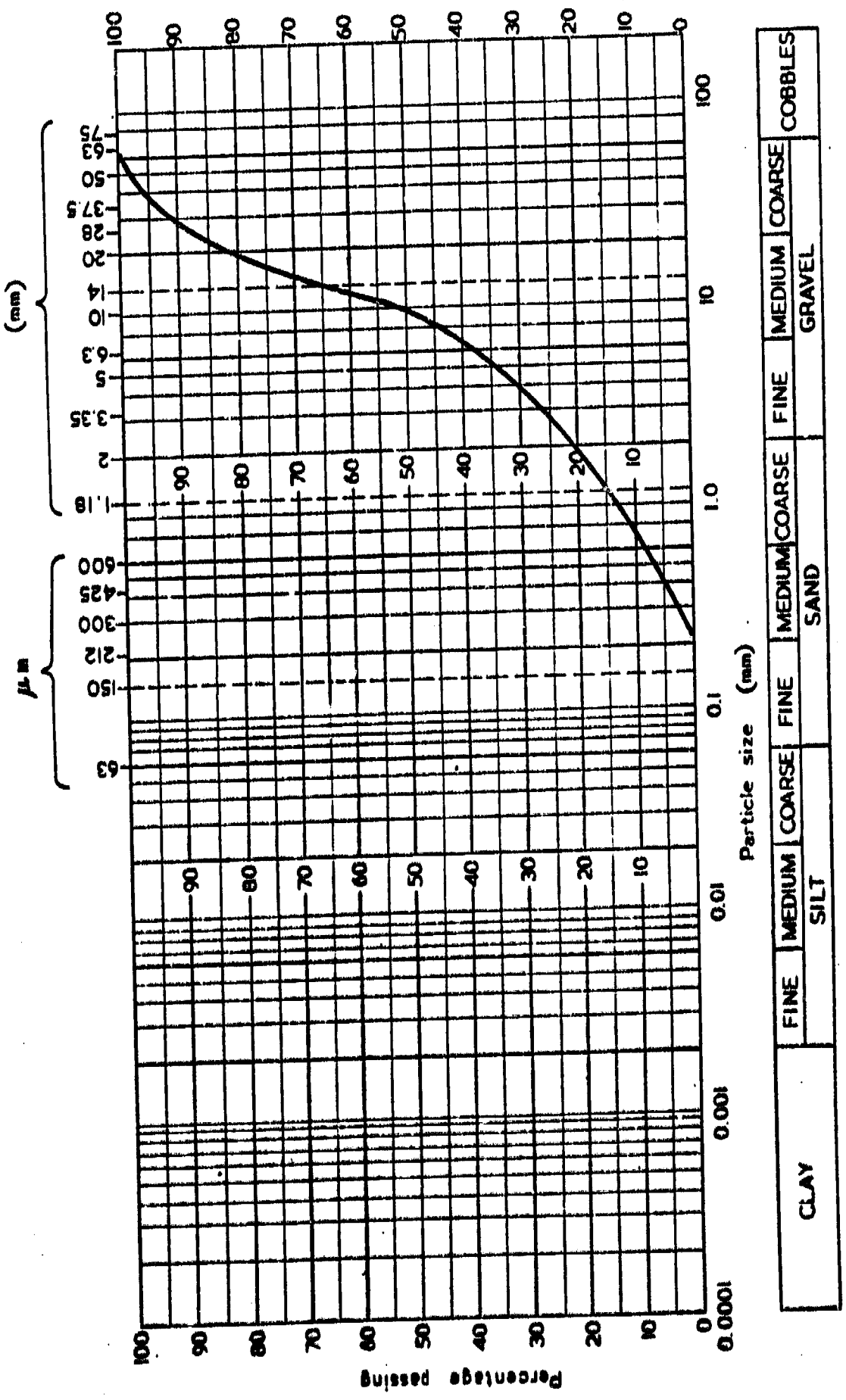


FIG. 14

PARTICLE SIZE DISTRIBUTION

Borehole Number	R109
Depth of Sample	1.5-1.95
Sample Number	
Sample Type	Bulk

Method:- Standard method by wet sieving.

Sample Description:- Well graded, sandy, fine to coarse GRAVEL.

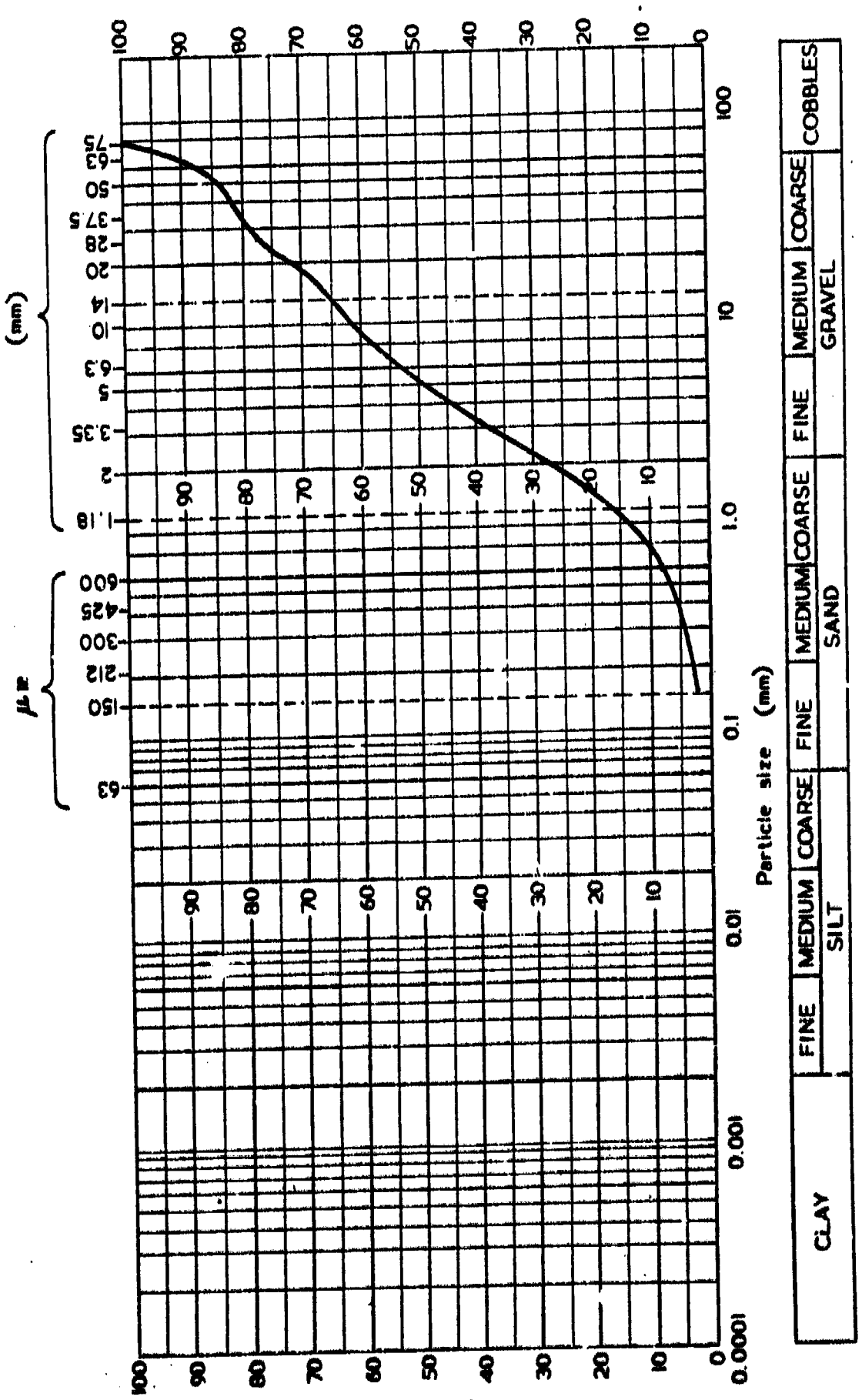


FIG. 15

PARTICLE SIZE DISTRIBUTION

Borehole Number	R109
Depth of Sample	3.0-3.1
Sample Number	
Sample Type	Bulk

Method:- Standard method by wet sieving.

Sample Description:- Well graded, fine to coarse SAND/GRAVEL.

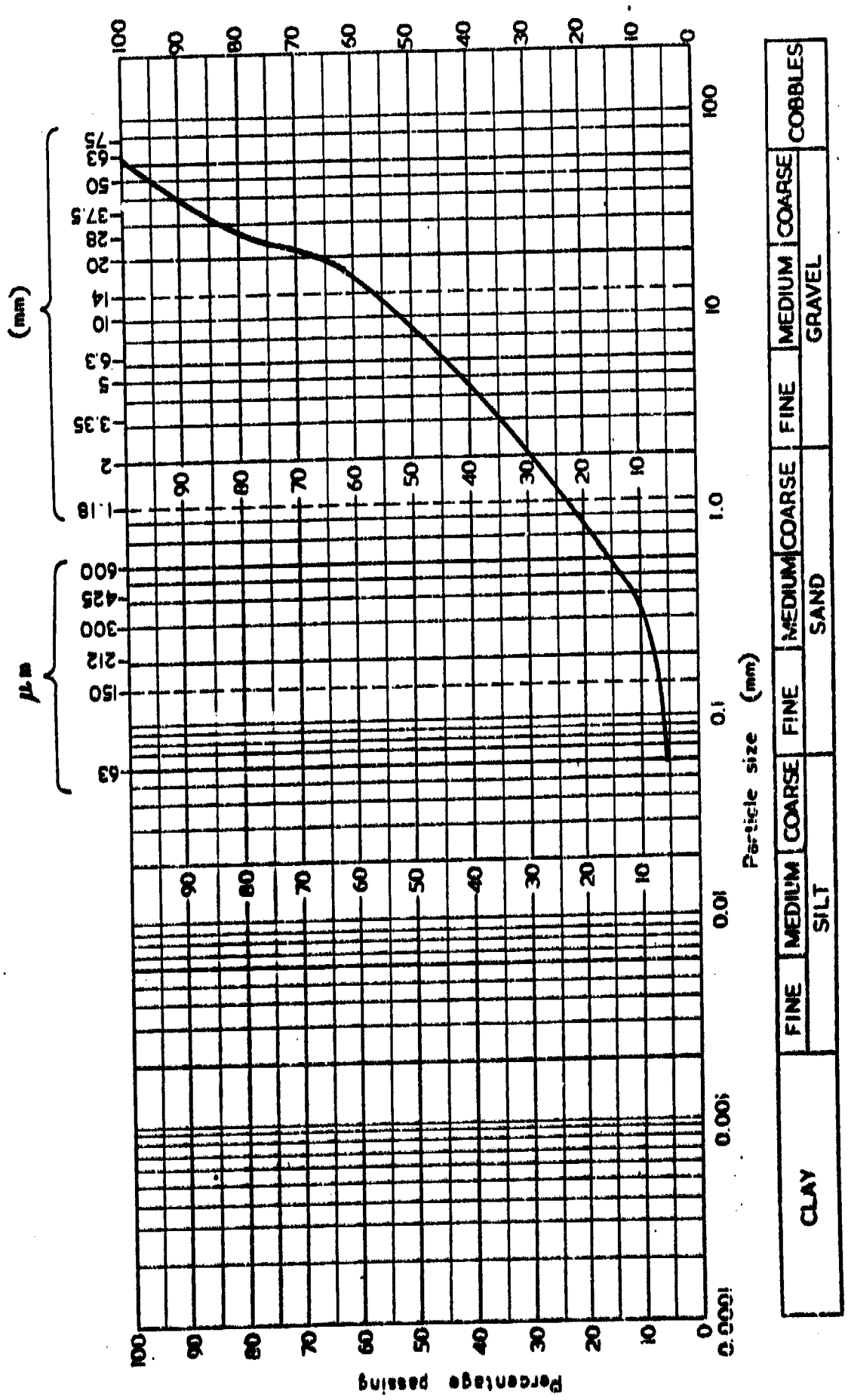


FIG. 16

PARTICLE SIZE DISTRIBUTION

Borehole Number	R110
Depth of Sample	6.0-6.45
Sample Number	
Sample Type	Bulk

Method:- Standard method by wet sieving.

Sample Description:- Well graded sandy, fine to coarse GRAVEL/COBBLES.

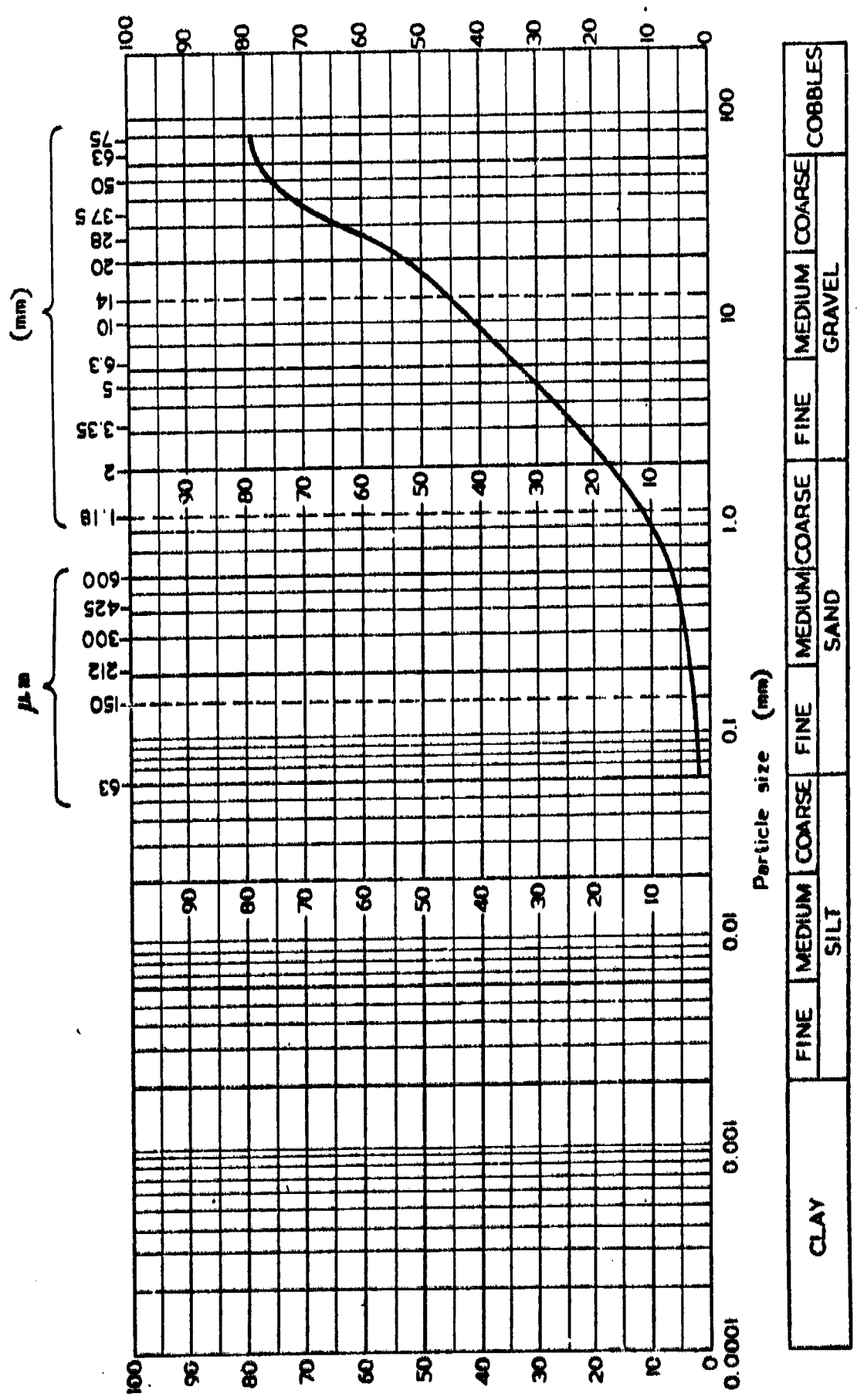


FIG. 17

SOIL CLASSIFICATION

Borehole Number	R111
Depth of Sample	7.5-7.95
Sample Number	
Sample Type	Bulk

Remarks:-

Moisture Content by
Oven Drying: - %

	% Passing BS 425 μm Sieve	Air Dried	Natural State	Unknown	%
Liquid Limit by Cone Penetrometer	46	*			42
Plastic Limit		*			26
Plasticity Index					16
Linear Shrinkage					
Plasticity Chart Symbol MI					

Specific Gravity:-

Fine-, Medium- and
Coarse-Grained Soils

Fine Grained Soils

Fig 18a.

PARTICLE SIZE DISTRIBUTION

Borehole Number	R112
Depth of Sample	1.5-1.95
Sample Number	
Sample Type	Bulk

Method:- Standard method by wet sieving.

Sample Description:- Well graded, sandy, fine to coarse GRAVEL.

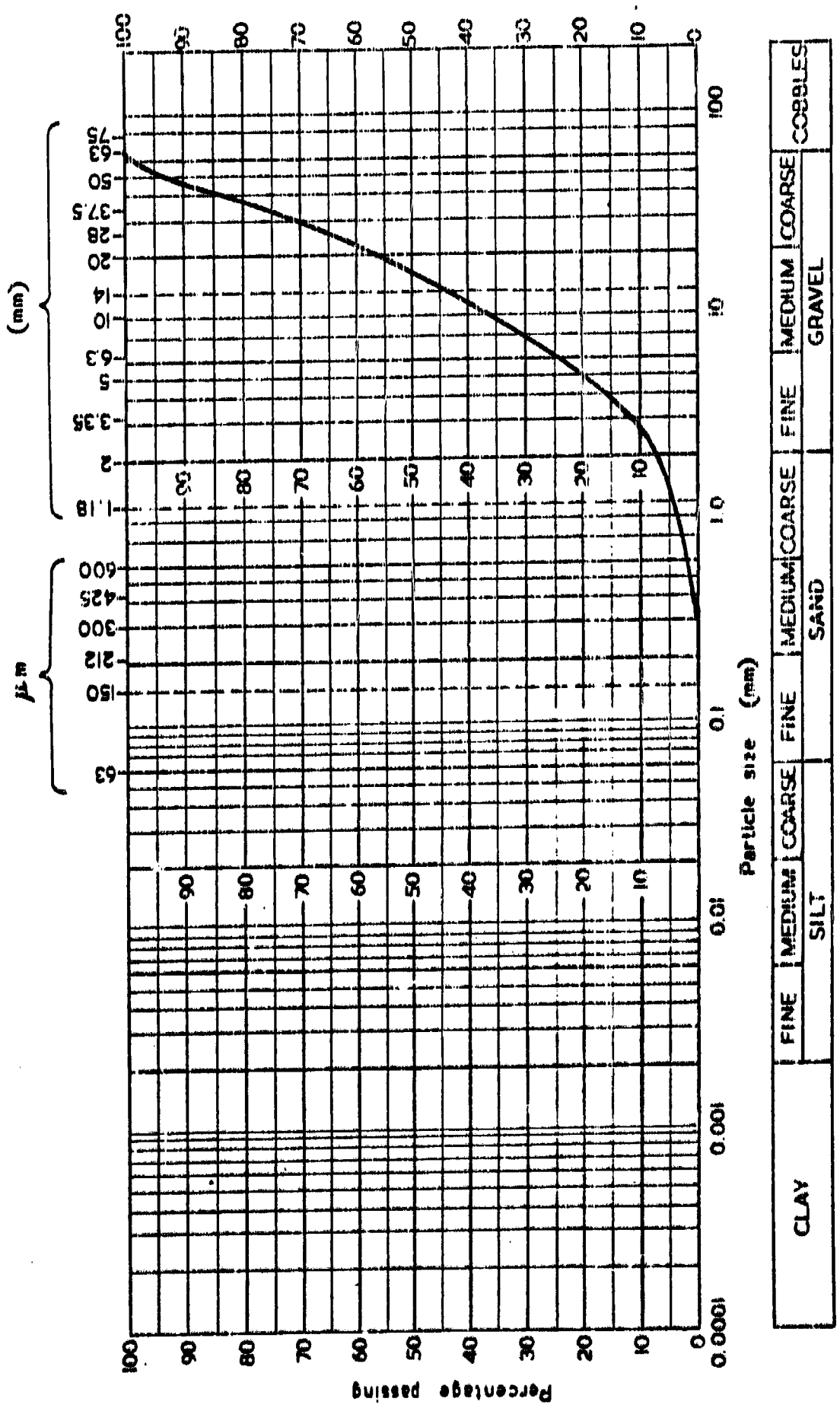


FIG. 19

PARTICLE SIZE DISTRIBUTION

Borehole Number	R112
Depth of Sample	3.0-3.45
Sample Number	
Sample Type	Bulk.

Method:- Standard method by wet sieving.

Sample Description:- Sandy, gravelly CLAY.

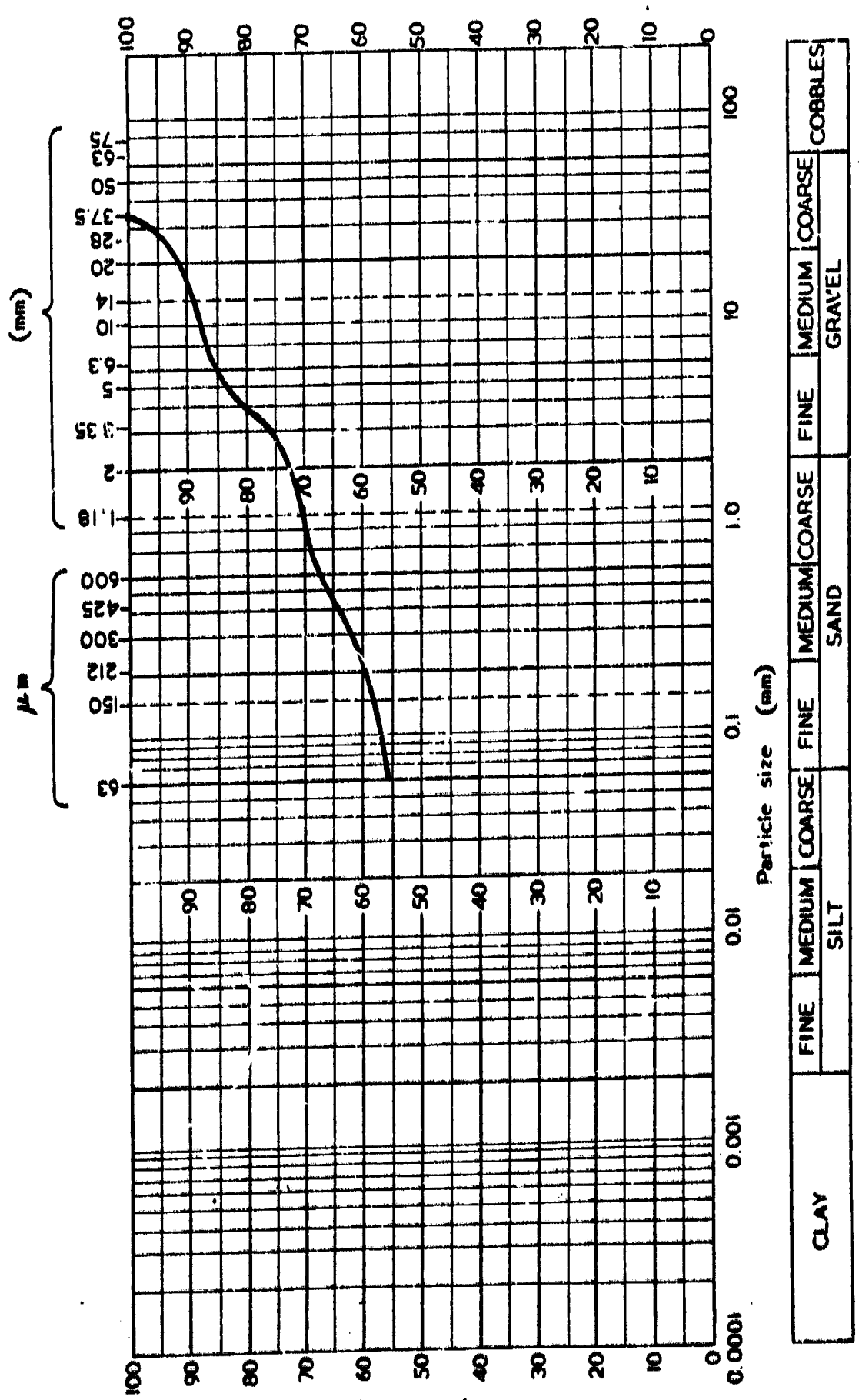


Fig. 19a

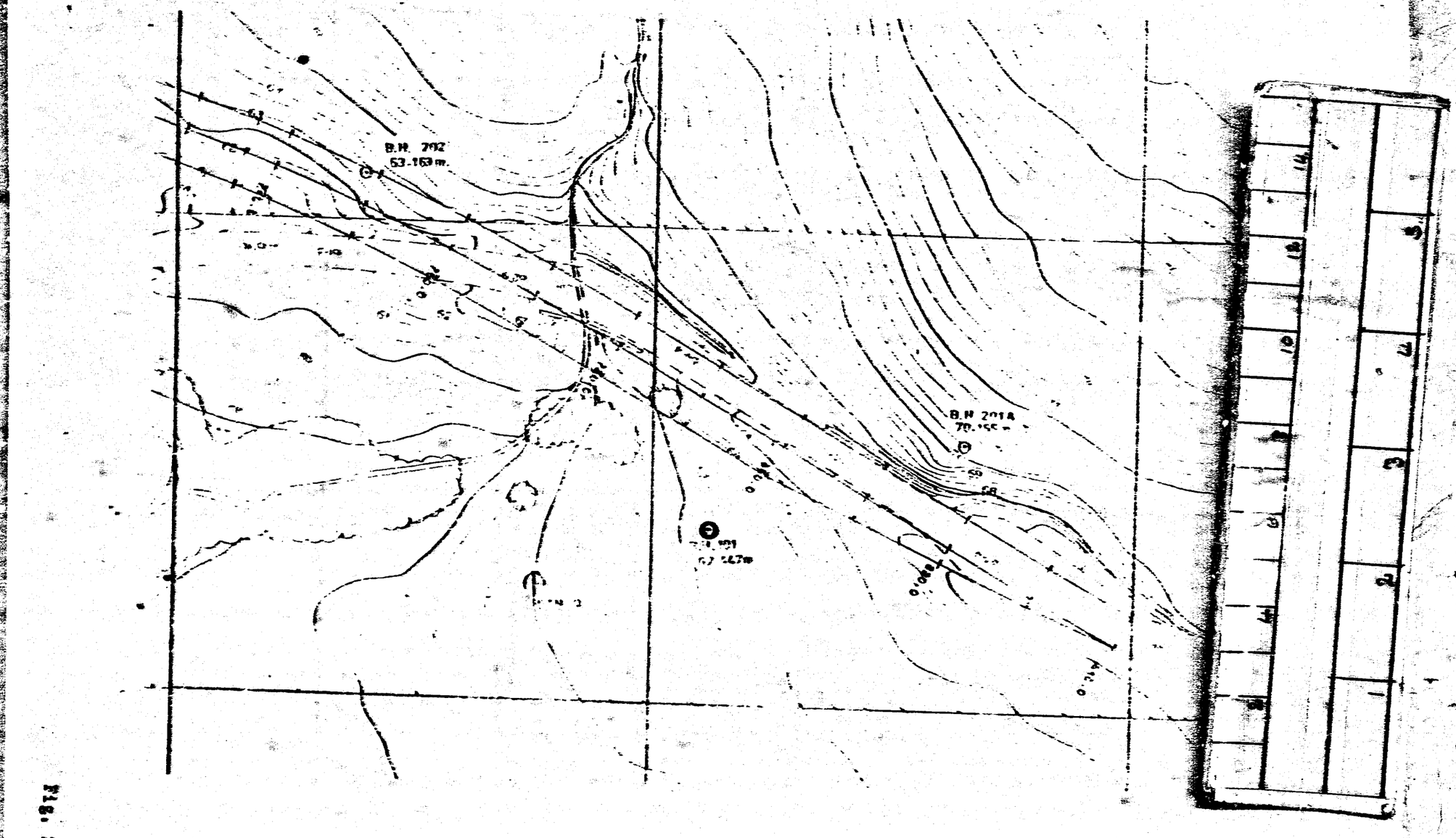


Fig. 20

A896 Lochcarron Village Phase II

Borehole Locations

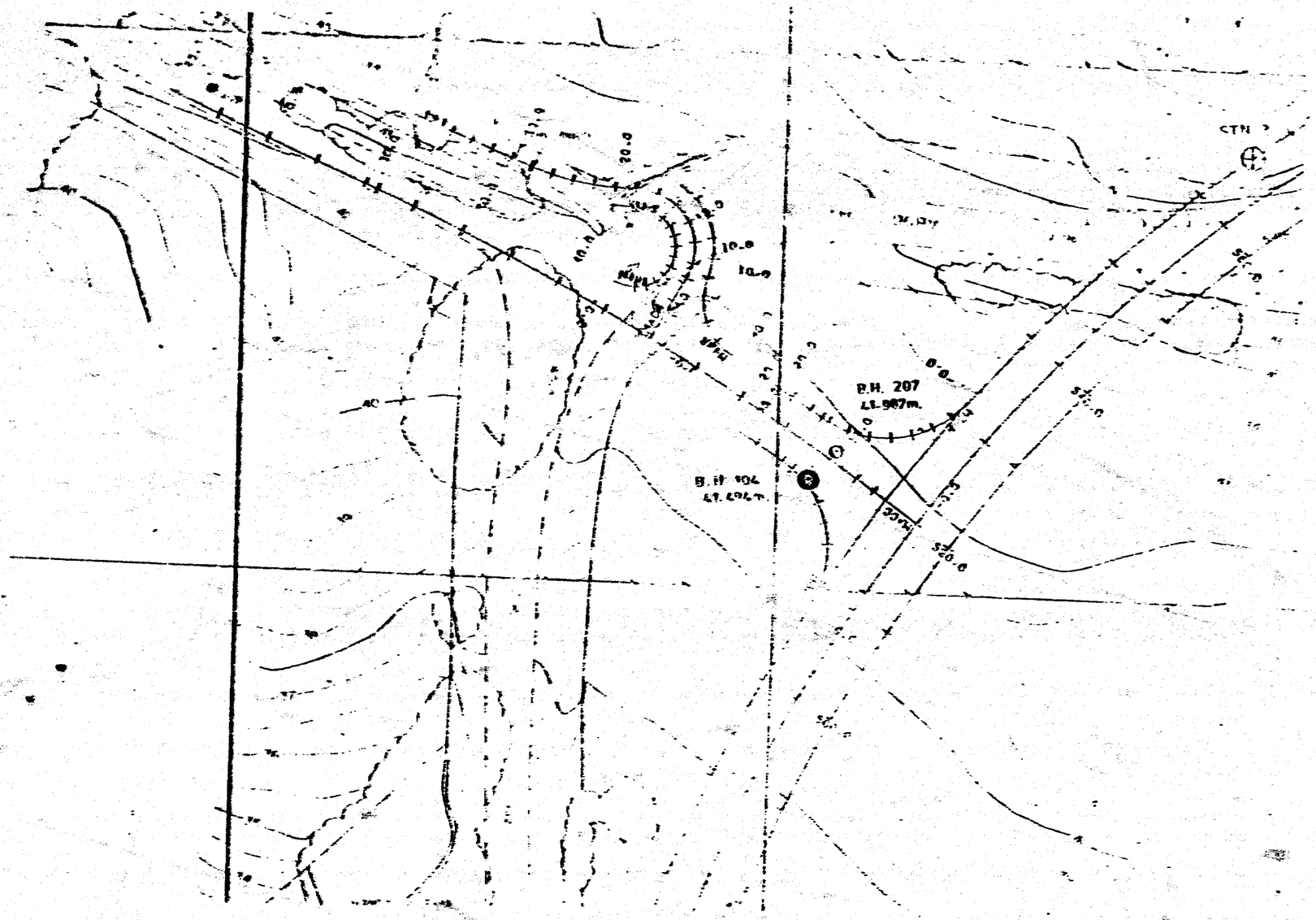


Fig. 21

A896 Lochcarron Village Phase II

Borehole Locations

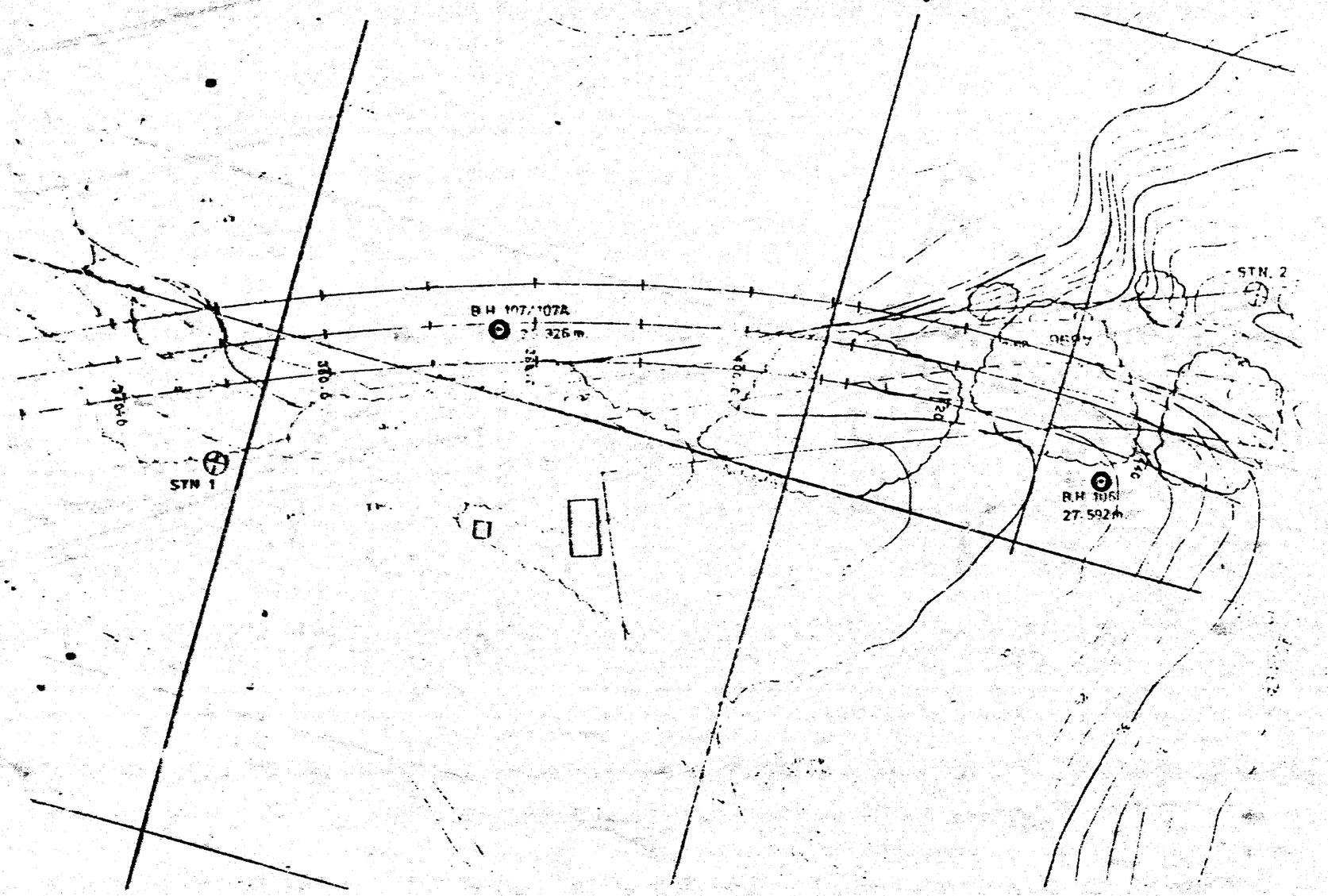


Fig. 22

A896 Lochcarron Village Phase II

Borehole Locations

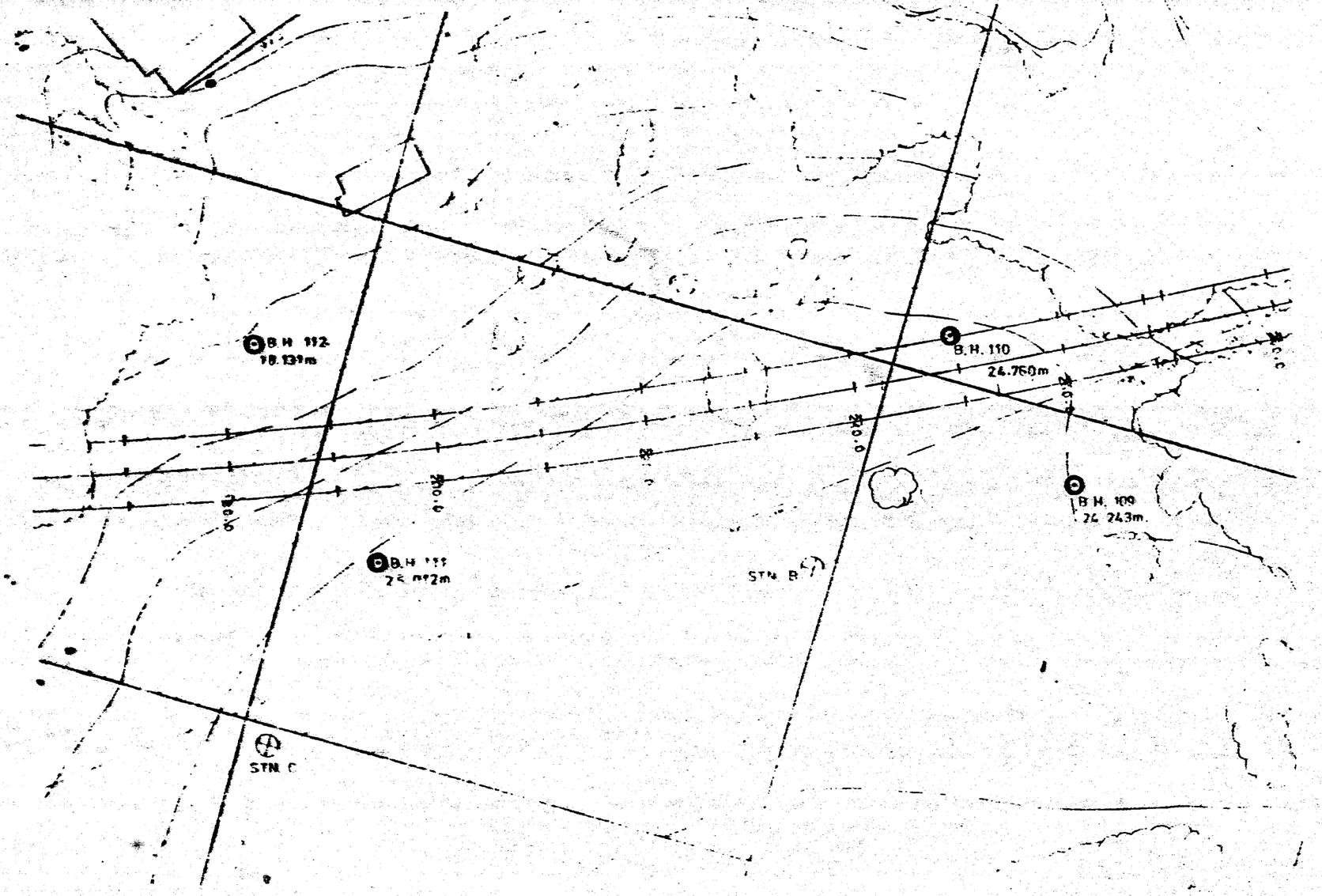


Fig. 23

A896 Lochcarron Village Phase II

Borehole Locations

Portsmouth Polytechnic

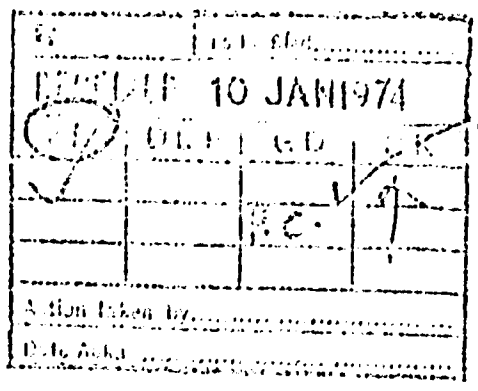
Department of Civil Engineering
Burnaby Road Portsmouth PO1 3QL

Telephone
Portsmouth 27681
Extension

DJP/CM

7th January, 1974

Messrs Babtie, Shaw and Morton,
Consulting Civil and Structural Engineers,
95, Bothwell Street,
GLASGOW, G2 7HX.



For the attention of Mr. P. Carter

Dear Sir,

A890 South Strome-Auchtertyre Road

I am pleased to enclose the results of the tests performed on samples from the above site using the 12 inch square shear box apparatus.

The tests were performed as follows:

1. All material greater than $\frac{1}{2}$ inch diameter was removed.

2. The remaining material was compacted in the shear box, using layers approx. $\frac{3}{4}$ inch thick and compacting each layer until a sample approx. 5.5 inch deep was formed. The sample obtained had a bulk density of 139.5 lb/ft^3 and a water content of 16.4%.

The sample was then saturated.

3. A normal pressure of 15 psi was applied to the sample, and the sample was left to consolidate. The consolidation readings are given in Fig 1.

4. The sample was sheared under a normal pressure of 15 psi, at a rate of strain of .005 in/min. The test was continued using several reversals to define the residual shear strength of the sample at this normal pressure. The results of these shearing stages are given in Fig 2.

5. The normal pressure was increased to 40 psi, and the consolidation results under this normal pressure are given in Fig 3.

6. The sample was sheared at a rate of .005 in/min, using several reversals to define the residual shear strength, see Fig 4.

Contd/.....

7. The normal pressure was increased to 60 psi, and the consolidation results under this normal pressure are given in Fig 5.

8. The sample was sheared at a rate of .005 in/min, using several reversals to define the residual shear strength, see Fig 6.

The above procedure follows that suggested in your letter to me of the 10th December. In view of the presence of a fairly large quantity of mica in the silty matrix, and the possibility that, during shear, the mica might accumulate on the shear surface, the following additional stages were performed.

9. The normal pressure was reduced to 15 psi.

10. The sample was then sheared under a normal pressure of 15 psi at a rate of .005 in/min., using two reversals to confirm that the residual shear strength had been defined (see Fig 7).

11. The normal pressure was increased to 30 psi.

12. The sample was then sheared under a normal pressure of 30 psi at a rate of .005 in/min, using two reversals to define the residual condition (see Fig 8).

A plot of shear strength against normal pressure is given in Fig 9. I hope that you will find the results to be satisfactory, and that the addition of steps 9-12 as described above, meets with your approval.

Please do not hesitate to contact me if you feel that I can be of any further assistance to you.

Yours faithfully,

D. Hoeby.

D. Hoeby

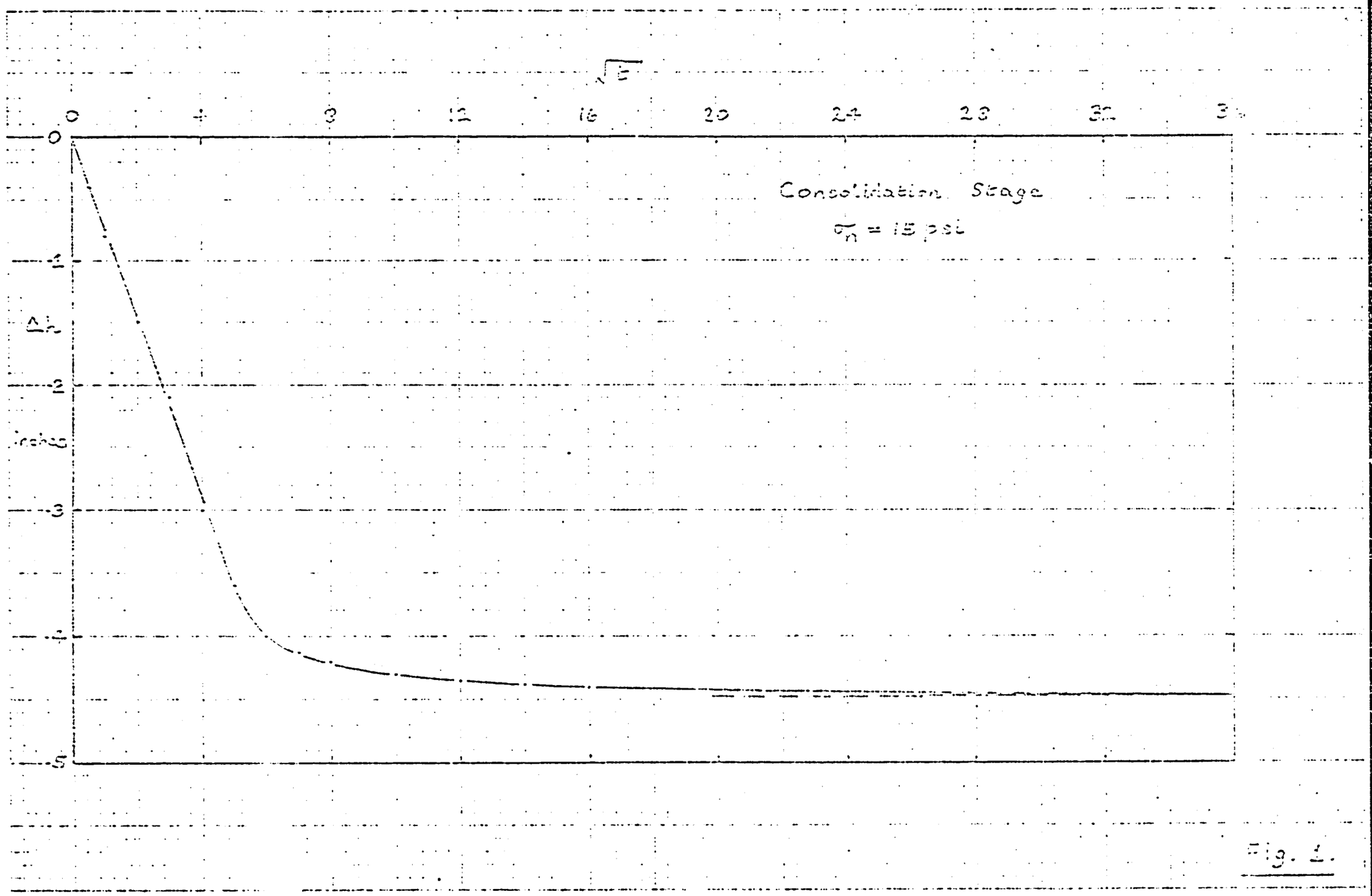

√t
0
4
8
12
16
20
24
28
32
36
Consolidation Stage
σn = 15 psi
Δh
Inches
0
-1
-2
-3
-4
-5

Fig. 1.

Shear Stage $\sigma_c' = 15$ psi

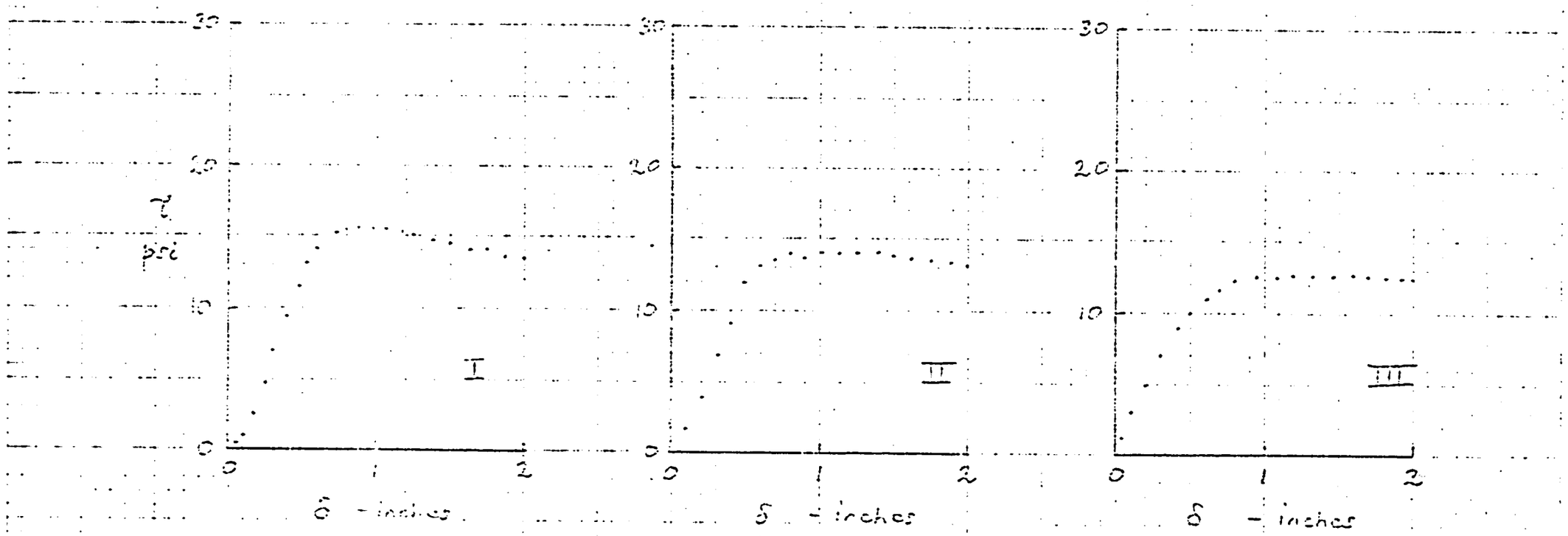


Fig 2 a

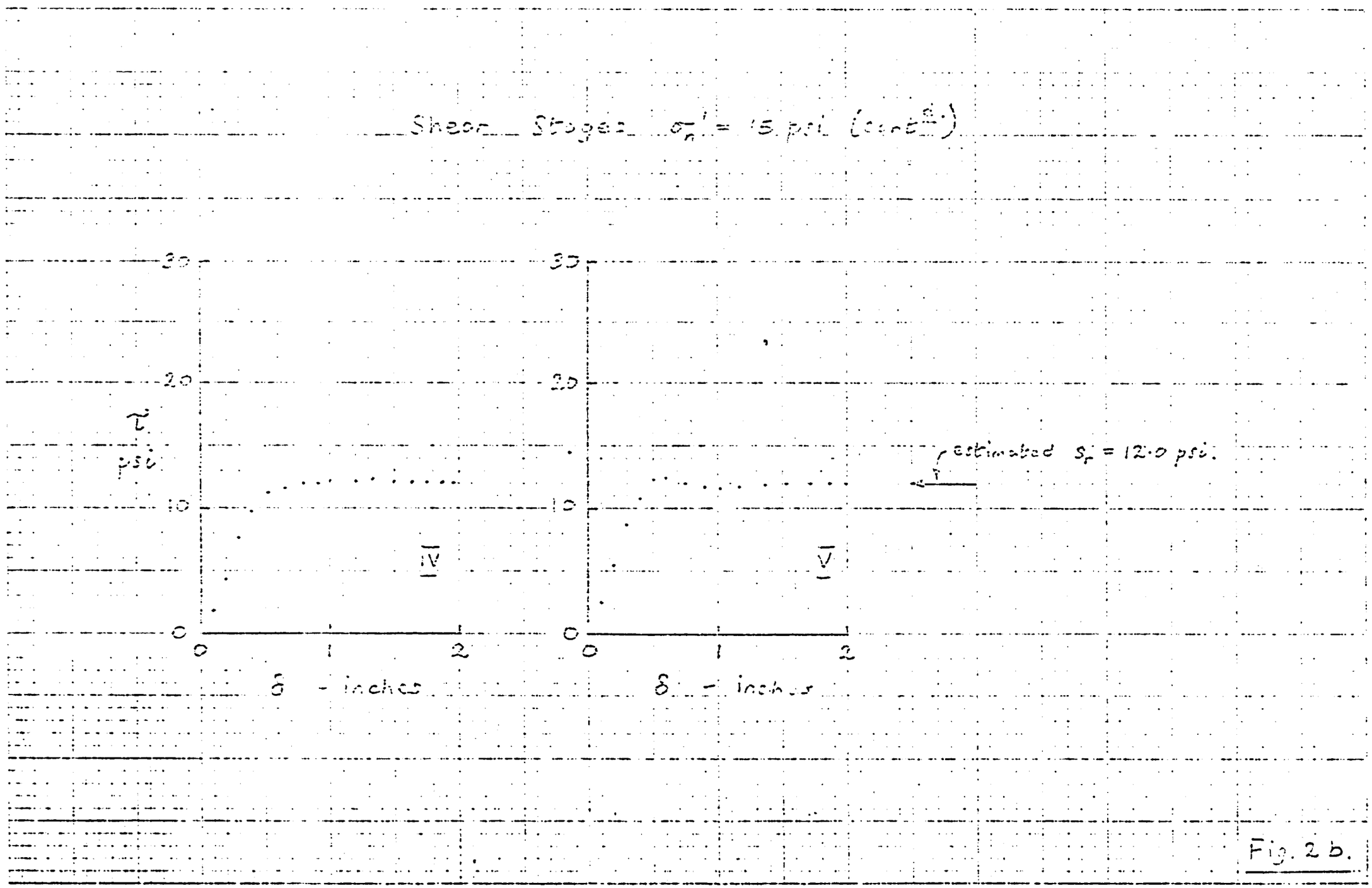

Shear Stages: σ_n' = 15 psi (constant)
30
20
10
0
τ
psi
IV
V
0
1
2
δ - inches
δ - inches
estimated S_i = 12.0 psi.

Fig. 2 b.

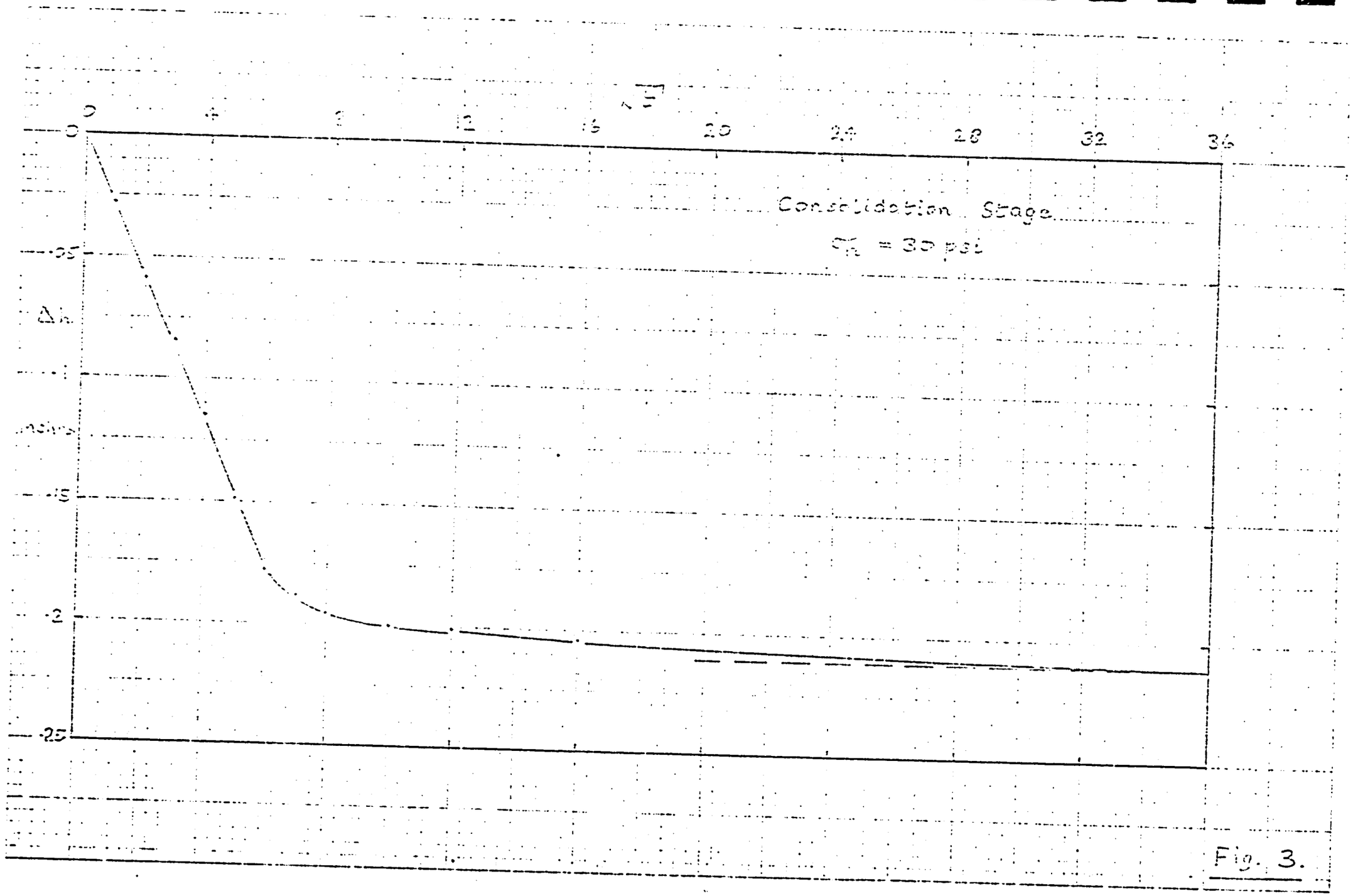

0
4
8
12
16
20
24
28
32
36
0
.05
Δh
inches
.15
.2
.25
Consolidation Stage
σ_h = 30 psi

Fig. 3.

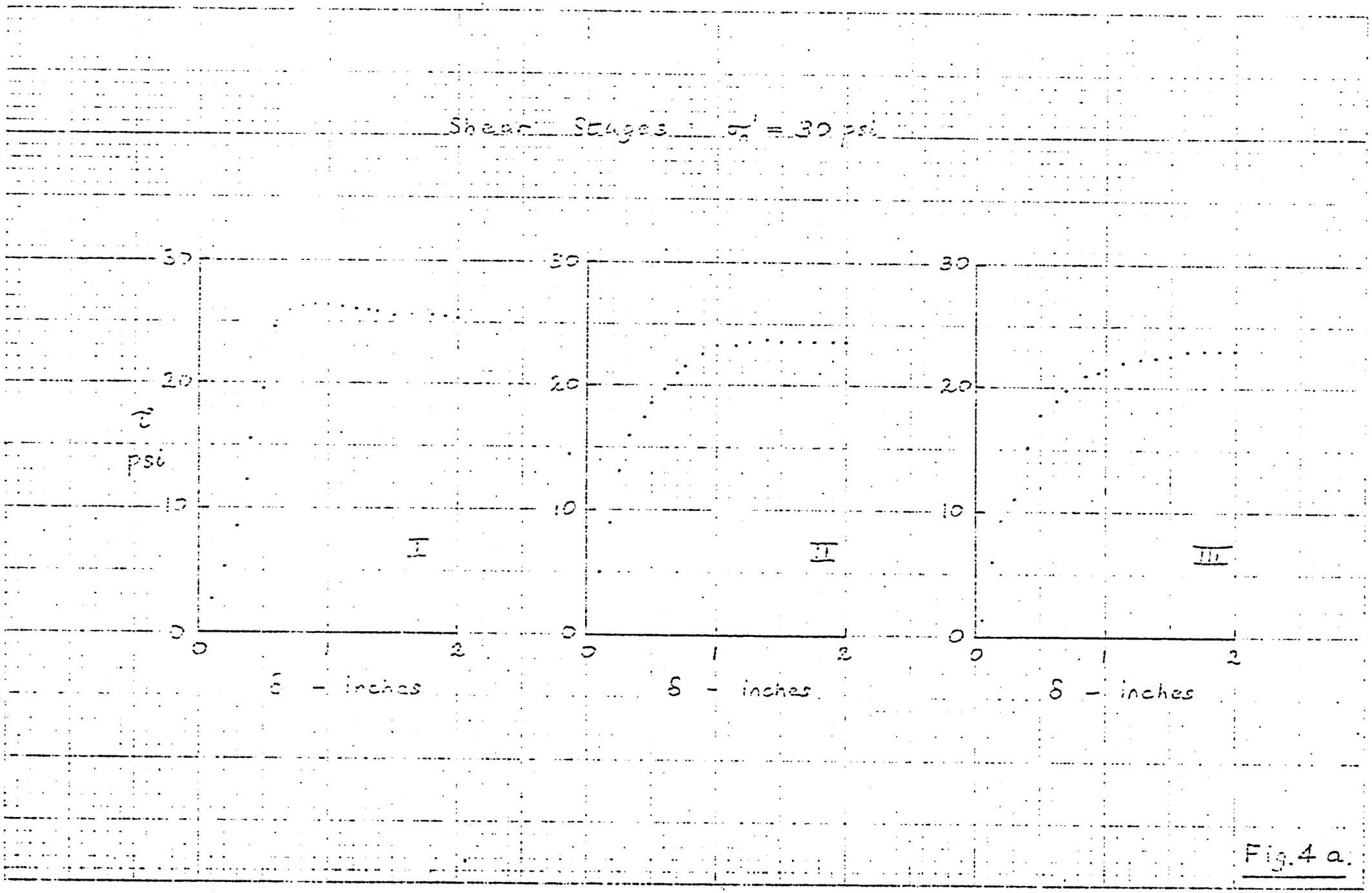

Shear Stages $\sigma_n' = 30$ psi
30
20
10
0
τ
psi
I
II
III
0
1
2
δ - inches
δ - inches
δ - inches

Fig. 4 a.

Shear Stages: $\sigma_n' = 30$ psi (const.)

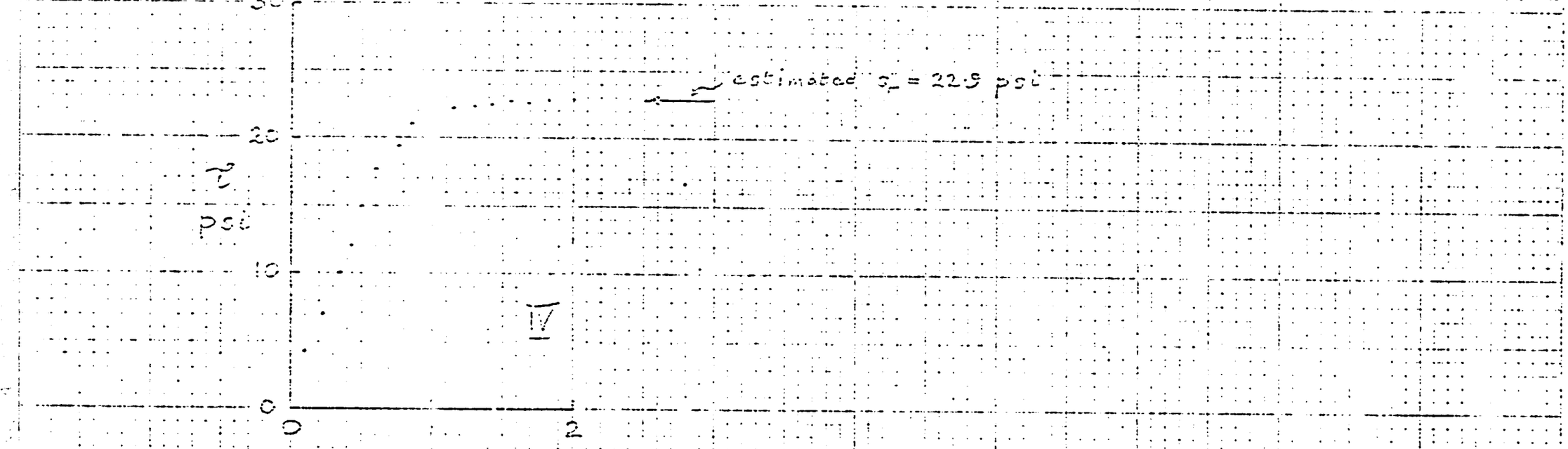


Fig 4-b

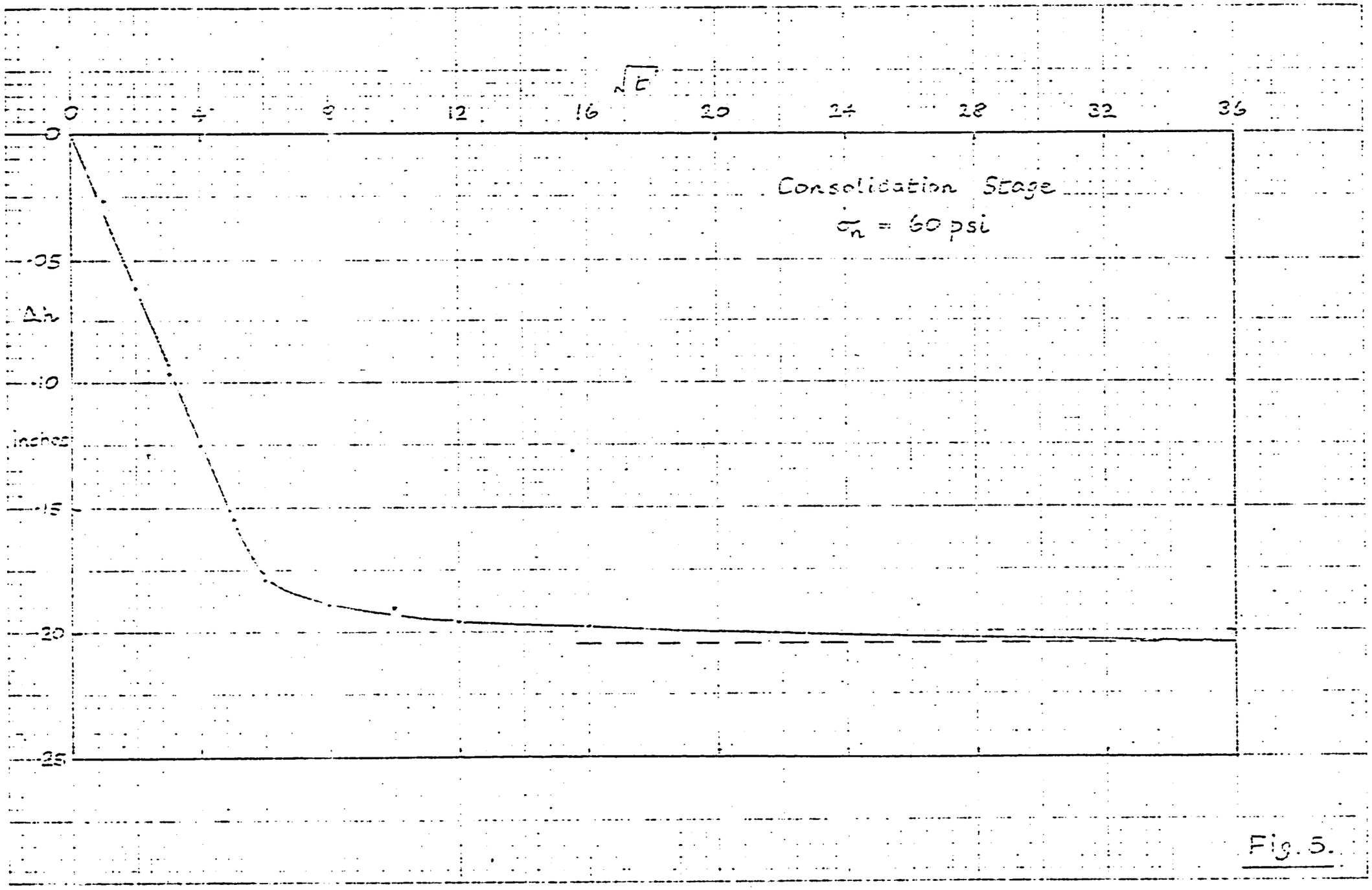

$\sqrt{t}$
0
4
8
12
16
20
24
28
32
36
0
.05
Δh
.10
inches
.15
.20
.25
Consolidation Stage
σ_n = 60 psi

Fig. 5.

Shear Stages — $\sigma_n' = 60$ psi

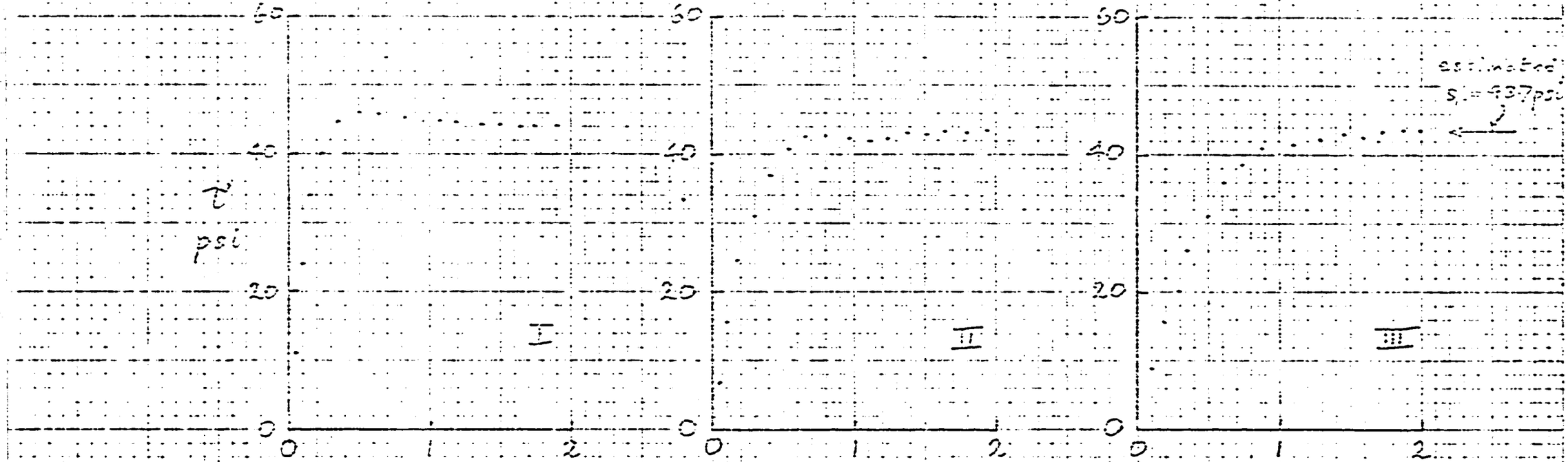


Fig. 6.

Shear Stages - $\sigma_n' = 15$ psi

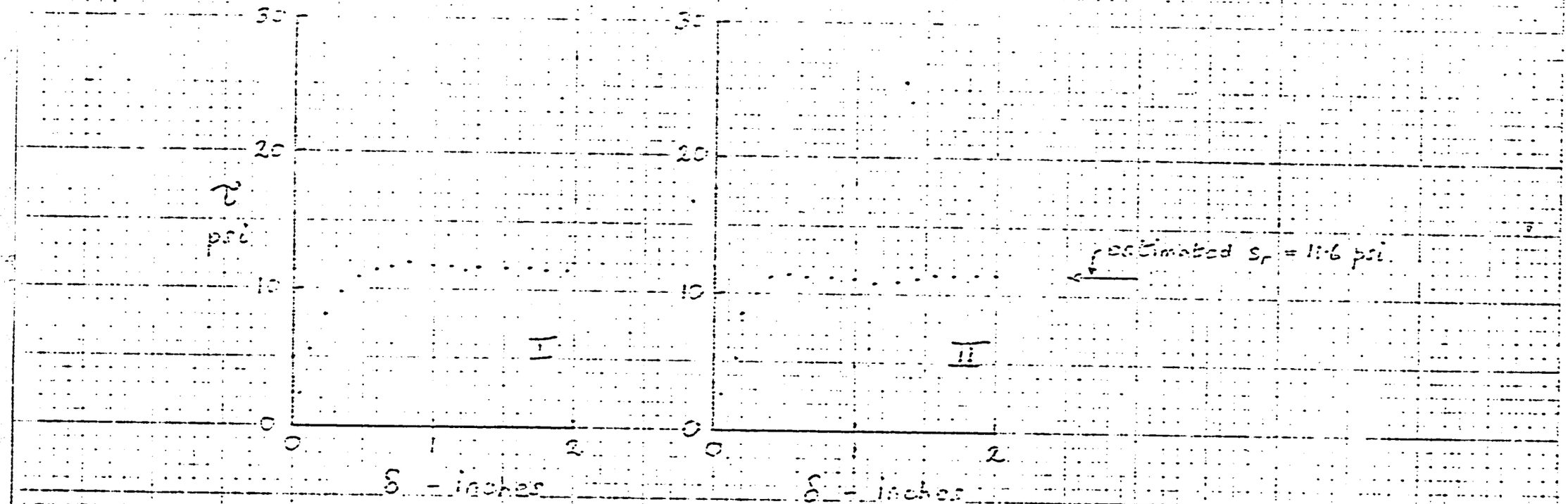


Fig. 7.

Shear Stages $\sigma_n' = 30$ psi

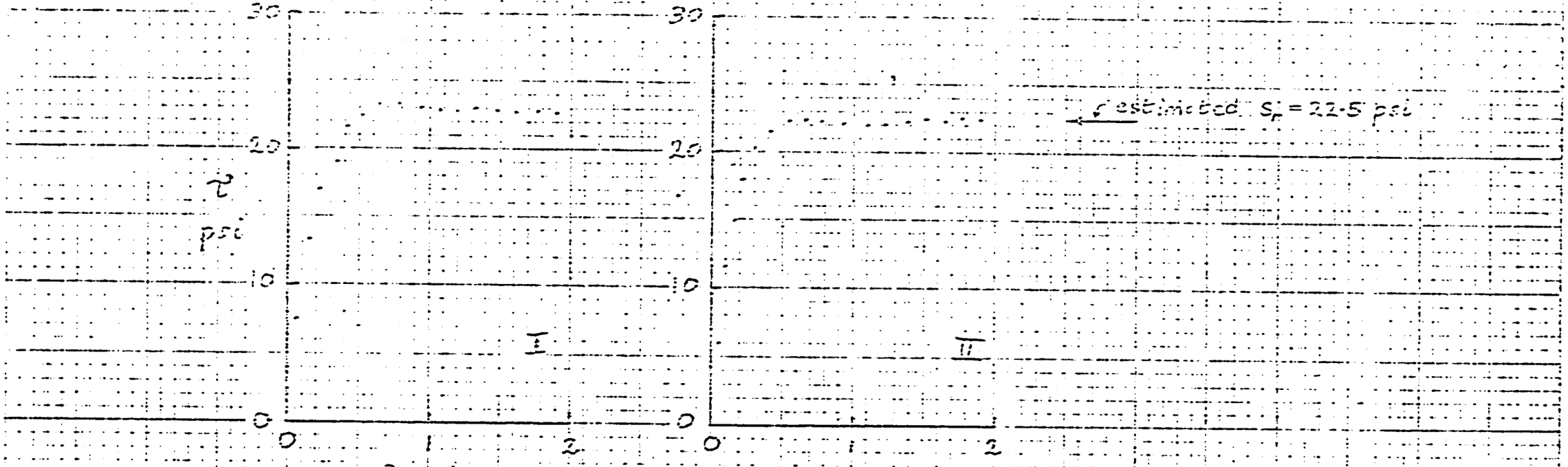
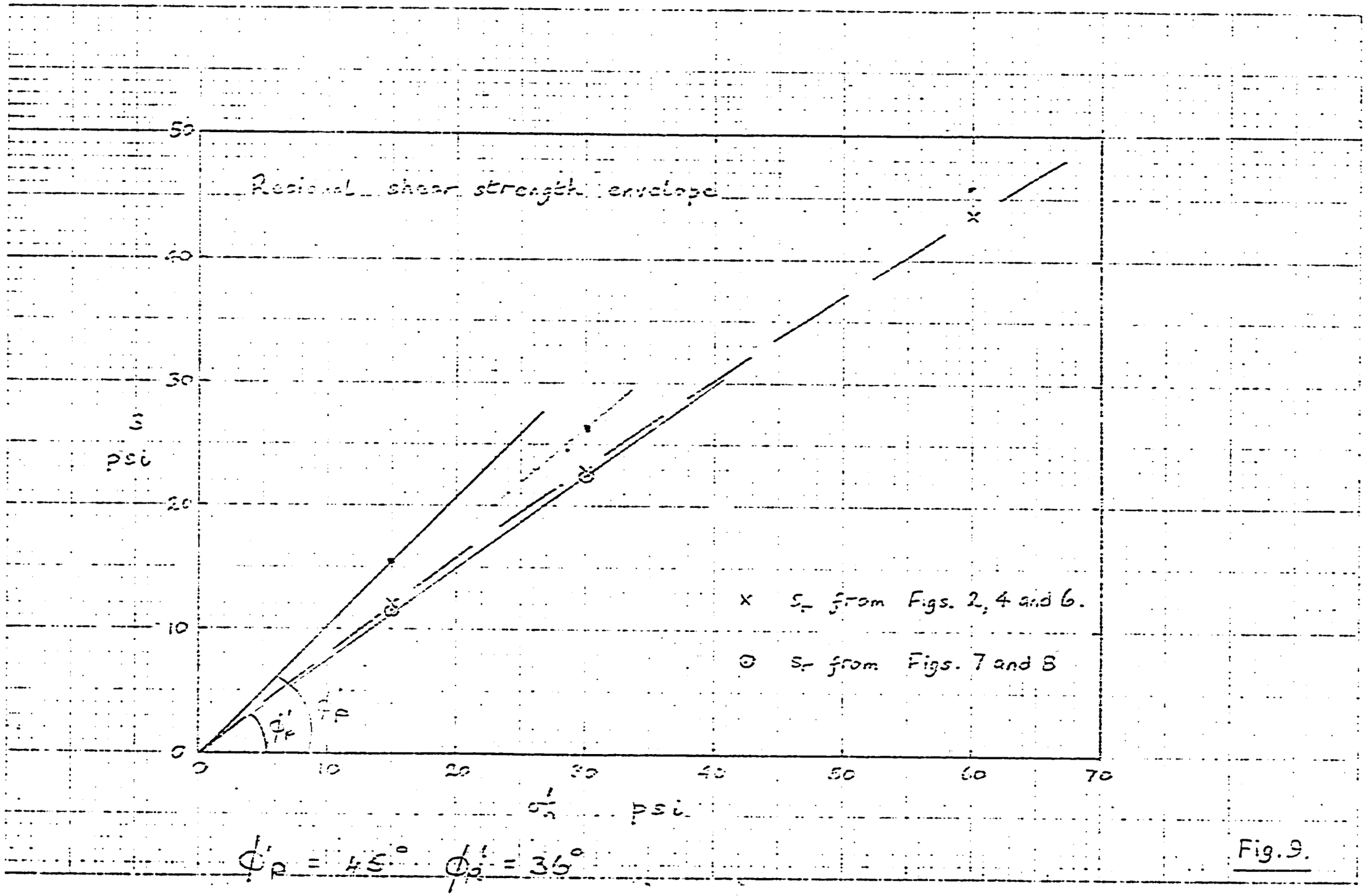
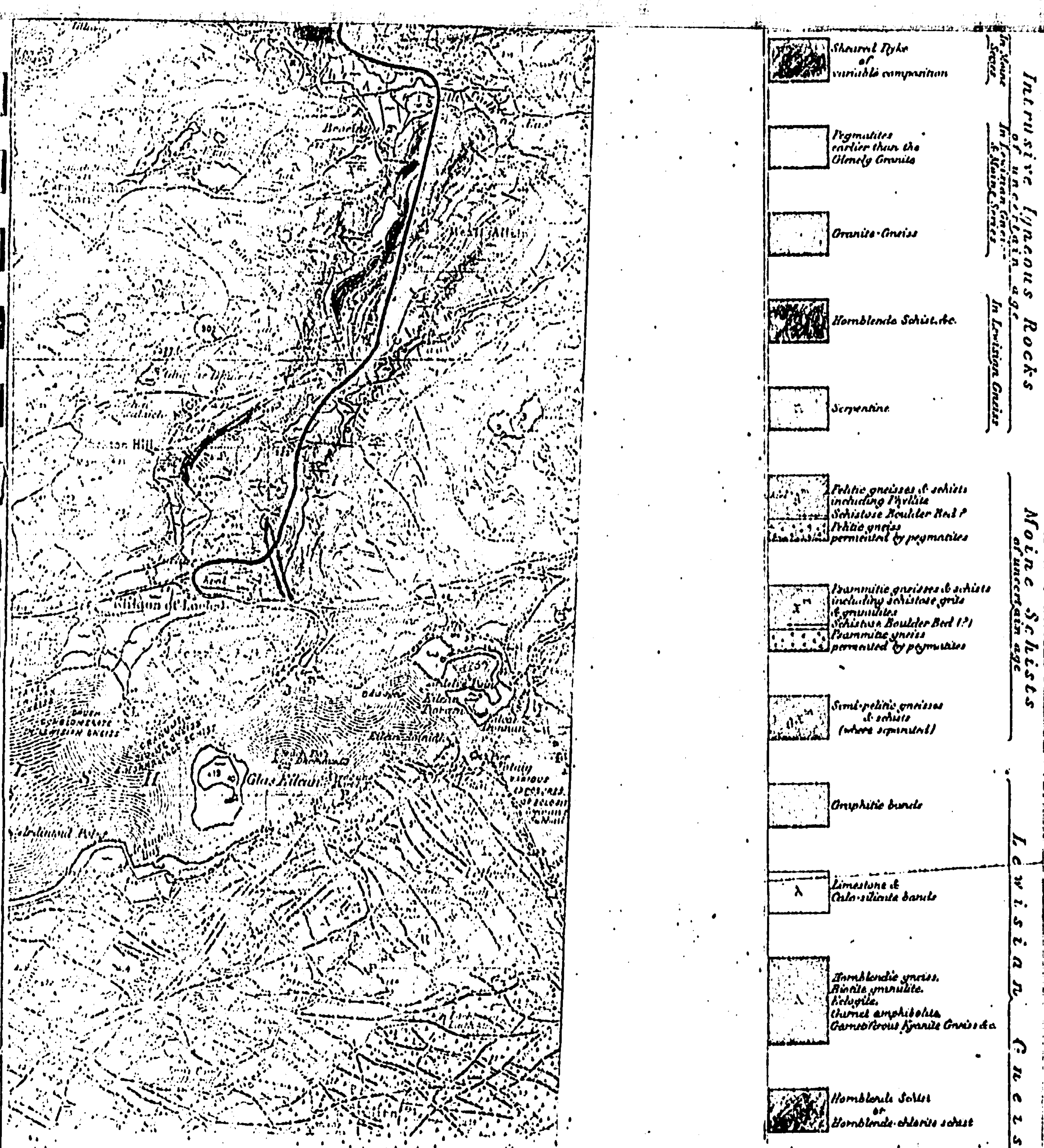


Fig. 8



$\phi'_R = 45°$ $\phi'_r = 36°$

Fig. 9.



Road Shown thus :— ———

A890 SOUTH STROME TO AUCHTERTYRE ROAD

SITE LOCATION PLAN

DRG No SI/ 1190	PREPARED BY:— A.G.D.	SCALE :— 1" To 1 Mile

WHATLINGS (FOUNDATIONS) LTD

2410 LONDON ROAD GLASGOW E.2.

SE/945

ROSS and CROMARTY COUNTY COUNCIL

A890 SOUTH STROME - AUCHTERTYRE ROAD IMPROVEMENT

HORIZONTAL ALIGNMENT Ch. 000 ~ 1550

SITE INVESTIGATION

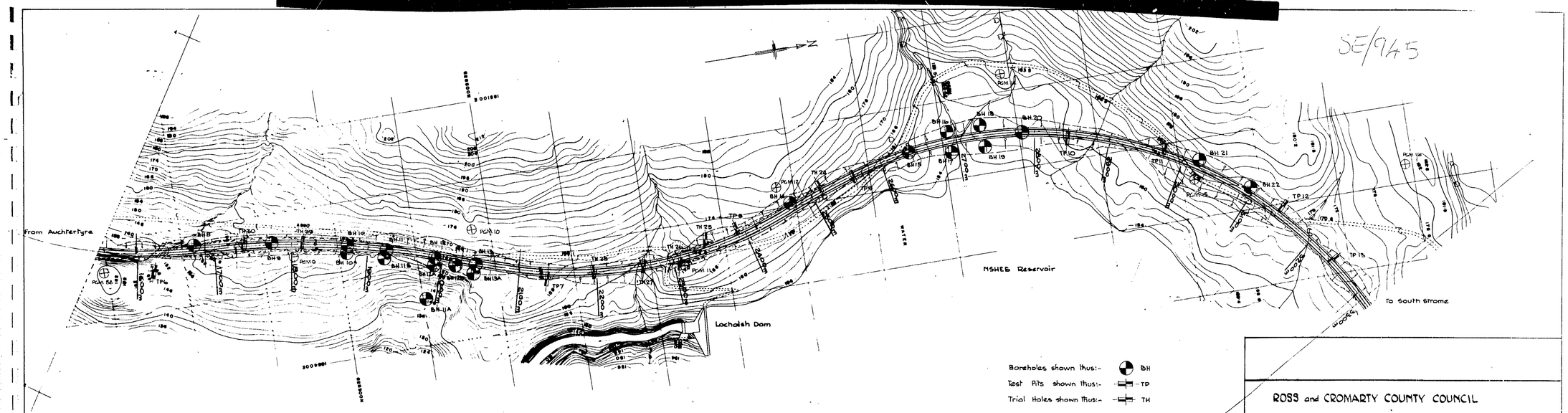
LOCATIONS OF BOREHOLES, TEST PITS and TRIAL HOLES

Scale: 1/2500

DRAWN BY	JMM	BABTIE, SHAW and MORTON
APPROVED		CONSULTING CIVIL & STRUCTURAL ENGINEERS
DATE	FEB.'74	Head Office: 95 BOTHWELL STREET GLASGOW. G2 7HX

R2857/137

SE/945



ROSS and CROMARTY COUNTY COUNCIL

A890 SOUTH STROME - AUCHTERTYRE ROAD IMPROVEMENT

HORIZONTAL ALIGNMENT Ch 1550 - 3300

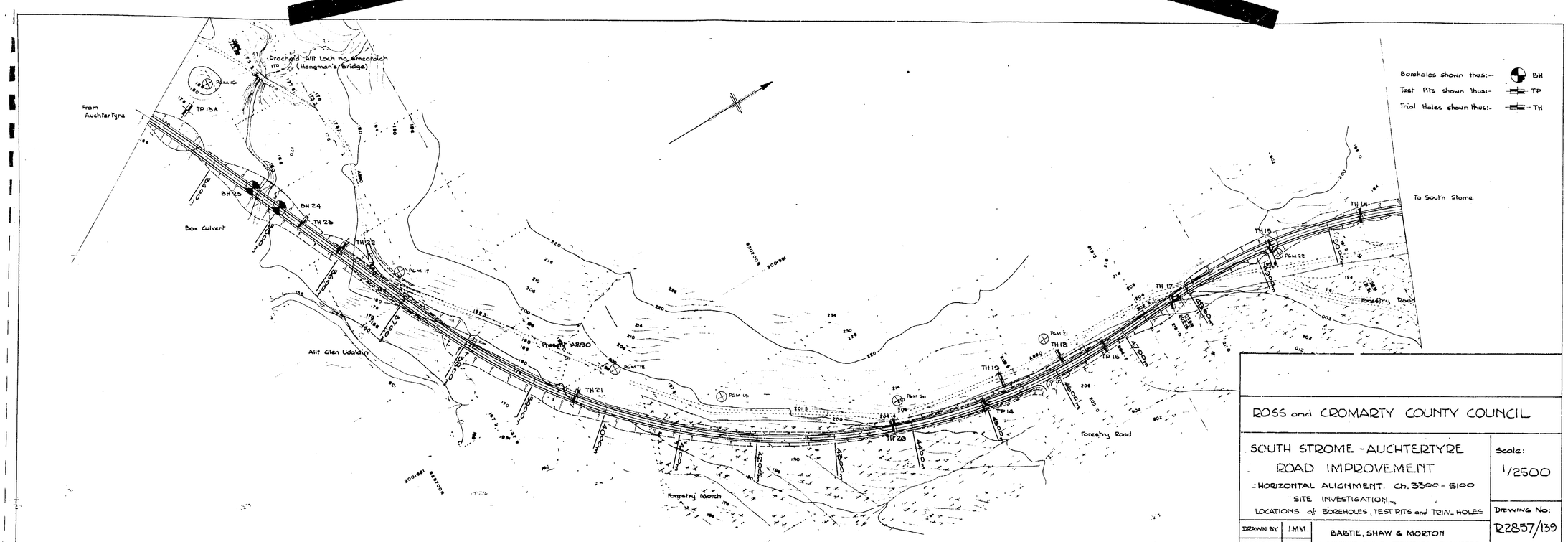
SITE INVESTIGATION

LOCATIONS of BOREHOLES, TEST PITS and TRIAL HOLES

SCALE 1/2500

DRAWN BY	J.MM	BABTIE, SHAW and MORTON
APPROVED		CONSULTING CIVIL & STRUCTURAL ENGINEERS
DATE	FEB.'74	Head Office: 95 BOTHWELL STREET GLASGOW. G2 7HX

DRAWING NO R2857/138



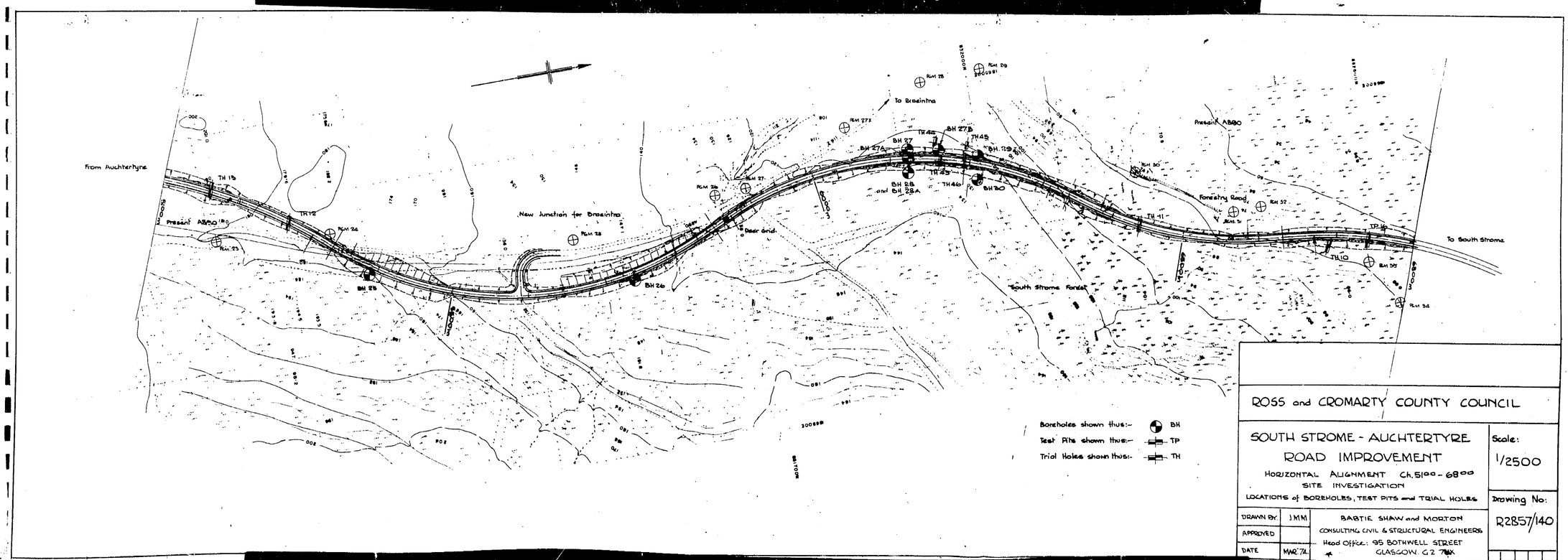
ROSS and CROMARTY COUNTY COUNCIL

SOUTH STROME - AUCHTERTYRE
ROAD IMPROVEMENT
HORIZONTAL ALIGNMENT. Ch. 3300 - 5100
SITE INVESTIGATION
LOCATIONS of BOREHOLES, TEST PITS and TRIAL HOLES

Scale: 1/2500

Drawing No: R2857/139

DRAWN BY	J.MM.	BABTIE, SHAW & MORTON
APPROVED		CHARTERED CIVIL & STRUCTURAL ENGINEERS
DATE	MAR.'74	Head Office: 95 BOTHWELL STREET GLASGOW. G2. 7HX



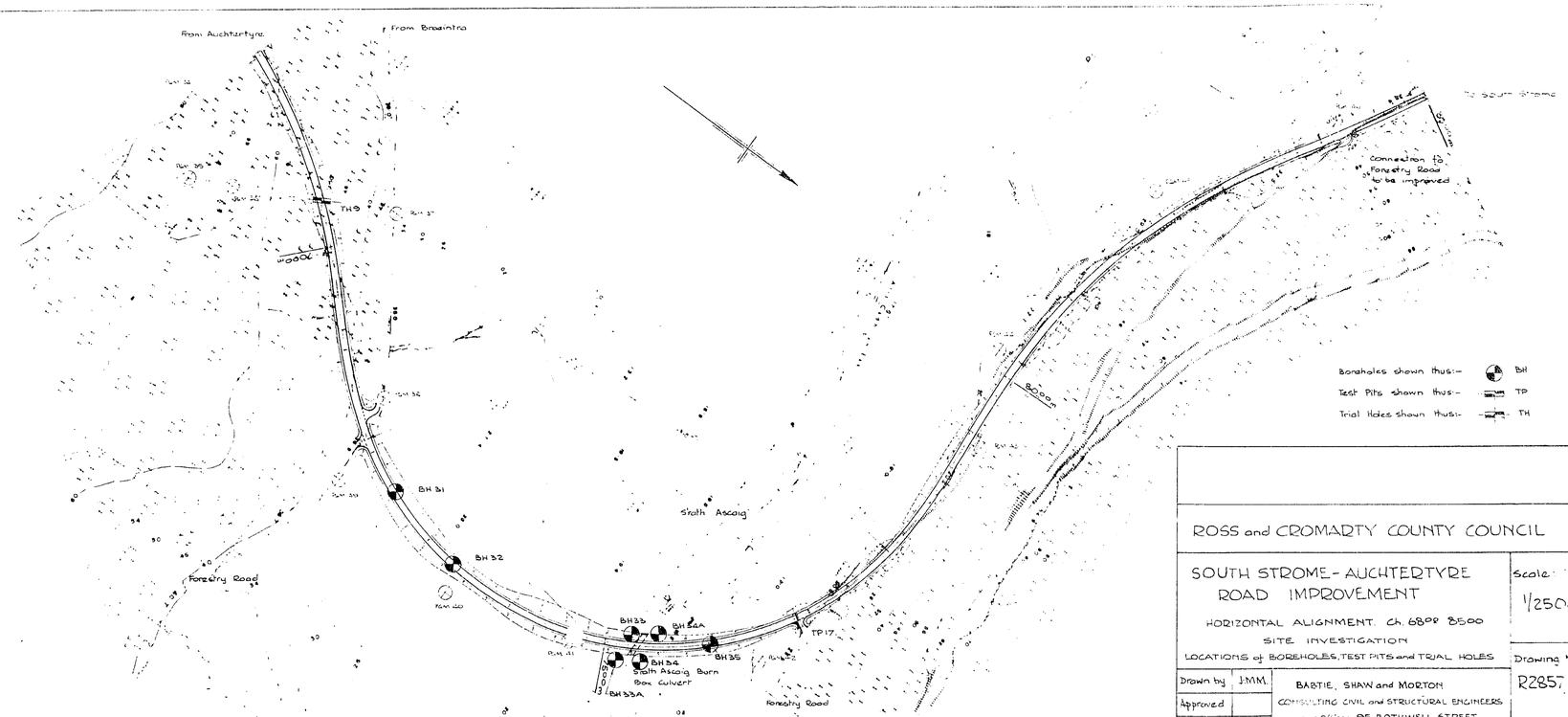
ROSS and CROMARTY COUNTY COUNCIL

SOUTH STROME - AUCHTERTYRE
ROAD IMPROVEMENT
HORIZONTAL ALIGNMENT Ch. 5100 - 6800
SITE INVESTIGATION
LOCATIONS of BOREHOLES, TEST PITS and TRIAL HOLES

Scale: 1/2500

Drawing No: R2857/140

DRAWN BY	J.MM.	BABTIE SHAW and MORTON
APPROVED		CONSULTING CIVIL & STRUCTURAL ENGINEERS
DATE	MAR.'74	Head Office: 95 BOTHWELL STREET GLASGOW. G2 7HX



ROSS and CROMARTY COUNTY COUNCIL

SOUTH STROME - AUCHTERTYRE ROAD IMPROVEMENT

HORIZONTAL ALIGNMENT. Ch. 6800 8500

SITE INVESTIGATION

LOCATIONS of BOREHOLES, TEST PITS and TRIAL HOLES

Scale: 1/2500

Drawing No R2857/141

Drawn by	J.M.M.
Approved	
Date	Mar. '74

BABTIE, SHAW and MORTON
CONSULTING CIVIL and STRUCTURAL ENGINEERS
Head Office: 95 BOTHWELL STREET GLASGOW. G2 7HX.

Boreholes shown thus:- BH
Test Pits shown thus:- TP
Trial Holes shown thus:- TH

ROSS and CROMARTY COUNTY COUNCIL

SOUTH STROME - AUCHTERTYRE ROAD IMPROVEMENT

HORIZONTAL ALIGNMENT. Ch. 8500 - 10000

SITE INVESTIGATION

LOCATIONS of BOREHOLES, TEST PITS and TRIAL HOLES

SCALE: 1/2500

DRAWING No: R2857/142

DRAWN BY	J.M.M.
APPROVED	
DATE	MAR. '74

BABTIE SHAW AND MORTON
CONSULTING CIVIL & STRUCTURAL ENGINEERS
Head Office: 95 BOTHWELL STREET GLASGOW. G2 7HX.

SITE INVESTIGATION

AT

LOCH CARRON

FOR

HIGHLAND REGIONAL COUNCIL

TRIAX (SITE INVESTIGATION) LTD.
SITE 1,
ALMONDBANK.
PERTHSHIRE.

TEL: ALMONDBANK (073 883) 661

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R101

SHEET 1 OF 1

EQUIPMENT AND METHODS: Shell and Auger Percussive.

SITE: Loch Carron.

CARRIED OUT FOR: Highland Regional Council.

GROUND LEVEL: 62.447

CO-ORDINATES: -

DATE: 4:5:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil.			0.35						
Dense grey fine to medium SAND/GRAVEL some cobbles.			(2.35)		0.7 0.8			S	30 blows for 150 mm.
					1.4 1.55	B		S	28 blows for 150 mm.
			2.7						
Weathered rock.			3.0						
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS:

LOGGED BY IF.

SCALE 1:50

FIG. 1

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R104

SHEET 1 OF 1

EQUIPMENT AND METHODS: 150 mm Shell and Auger Percussive.

SITE: Loch Carron.

CARRIED OUT FOR: Highland Regional Council.

GROUND LEVEL: 41.494

CO-ORDINATES: -

DATE: 28:4:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil.			(0.35) 0.35						
Firm to stiff grey-brown sandy CLAY.			(0.75) 1.1		0.6 - 0.7			S	40 blows for 100 mm.
Dense brown slightly gravelly fine to medium SAND.			(0.3) 1.4		1.1-1.4	B			
Rock MICA SCHIST QUARTZ SCHIST.			(0.15) 1.55						
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS:

LOGGED BY IF

SCALE 1:10

FIG. 2

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R106

SHEET 1 OF 1

EQUIPMENT AND METHODS
150 mm Shell and Auger Percussive.

SITE
Loch Carron.

CARRIED OUT FOR
Highland Regional Council.

GROUND LEVEL
27.592

CO-ORDINATES
-

DATE
24:4:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil (peaty).			(0.45) 0.45						
Very dense grey-brown SAND.			(1.15) 1.6		1.4-1.7	B			
					1.5-1.6	S			50 blows for 100 mm.
Rock MICA SCHIST QUARTZ SCHIST.			(0.15) 1.75						
End - bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key
- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS:

LOGGED BY FF.

SCALE 1:10

FIG. 3

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R107

SHEET 1 OF 1

EQUIPMENT AND METHODS
150 mm Shell and Auger Percussive, and Rotary (NX).

SITE
Loch Carron.

CARRIED OUT FOR
Highland Regional Council.

GROUND LEVEL
25.326

CO-ORDINATES
-

DATE
27:5:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil.			0.3						
Dense grey sandy fine to coarse GRAVEL some cobbles.			(3.2)		1.3 | 1.45	B		S	29 blows for 150 mm.
					2.9 | 3.0			S	50 blows for 100 mm.
			3.5	3.3					
Dense grey slightly sandy fine to coarse GRAVEL numerous cobbles.			(4.7)		4.4 | 4.5-5.5	B		S	50 blows for 100 mm.
					7.0-7.7	B			
					7.3 | 7.45			S	42 blows for 150 mm.
			8.2						
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key
- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS:
Extensive chiselling requiring resiting of borehole position.

LOGGED BY B.McG.

SCALE 1:50

FIG. 4

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R109

SHEET 1 OF 2

EQUIPMENT AND METHODS
200 mm Shell and Auger Percussive and Rotary (NX)

SITE
Loch Carron.

CARRIED OUT FOR
Highland Regional Council.

GROUND LEVEL 24.243

CO-ORDINATES -

DATE 9:6:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil (peaty)			0.3						
Firm light-dark brown sandy CLAY some fine to coarse gravels.			0.7						
			(0.8)						
Medium dense grey fine to coarse SAND/GRAVEL occasional cobbles.			1.5		1.5 – 1.95	B		S	(5)8,7,10,13.
				2.3					
Dense grey fine to coarse SAND and medium to coarse gravel some cobbles.			(4.3)		3.0 – 3.1	B		S	20 blows for 100 mm.
					4.5 – 4.95	B		S	(15)20,22,25,27.
			5.8						
Stiff light brown sandy CLAY.			6.0		6.0 – 6.45	B		S	(22)32 obstruction.
Dense grey fine SAND weathered rock.			6.3		cored runs 6.5-7.2				
Rock MICA SCHIST QUARTZ SCHIST.			(4.5)		7.2-8.2				
					8.2-9.0				
					9.0-9.8				
					9.8-10.8				

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key
- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS:

LOGGED BY G.MCG.

SCALE 1:50

FIG. 5

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R109

SHEET 2 OF 2

EQUIPMENT AND METHODS
200 mm. Shell and Auger Percussive and Rotary (NX).

SITE
Loch Carron.

CARRIED OUT FOR
Highland Regional Council.

GROUND LEVEL
24.243

CO-ORDINATES
-

DATE
9:6:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Rock MICA SCHIST QUARTZ SCHIST.			10.8						
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

D Disturbed Sample
B Bulk Sample
W Water Sample
U 0·1m. Undisturbed Sample
V Vane Test
S Standard Penetration Test
c Core Recovery (%)
r R.Q.D. (%)

REMARKS:

LOGGED BY G.McG.

SCALE 1:50

FIG. 6

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R110

SHEET 1 OF 2

EQUIPMENT AND METHODS: Rotary (NX) and 200 mm. Shell and Auger Percussive.

SITE: Loch Carron.

CARRIED OUT FOR: Highland Regional Council.

GROUND LEVEL: 24.760

CO-ORDINATES: -

DATE: 31:6:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil.			0.1						
Firm mottled brown sandy CLAY some fine gravel.			0.3						
Dense brown fine to coarse SAND/GRAVEL.			(2.7) 3.0		1.5 – 1.95	B		S	(6)10,12,12,13.
Dense light grey fine to coarse slightly silty SAND fine to coarse gravels occasional cobbles.			(6.4) 9.4		4.5 – 4.7	B		S	(3)20 blows for 75 mm.
					6.0 – 6.45	B		S	(8) 6,9,10,12.
					7.5 – 7.95	B		S	(20)8,8,10,10.

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS: Water in casing, soaked away each morning.

LOGGED BY G.H.G.

SCALE 1:50

FIG. 7

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R110

SHEET 2 OF 2

EQUIPMENT AND METHODS Rotary (NX) and 200 mm. Shell and Auger Percussive.

SITE Loch Carron.

CARRIED OUT FOR Highland Regional Council.

GROUND LEVEL 24.760

CO-ORDINATES -

DATE 31:6:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Rock MICA SCHIST QUARTZ SCHIST.			(1.3) 10.7		cored run 9.4-10.7				
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

D Disturbed Sample
B Bulk Sample
W Water Sample
U 0·1m. Undisturbed Sample
V Vane Test
S Standard Penetration Test
c Core Recovery (%)
r R.Q.D. (%)

REMARKS:

LOGGED BY G.McG.

SCALE 1:50

FIG. 8

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R111

SHEET 1 OF 2

EQUIPMENT AND METHODS: Rotary (NX) and 200 mm. Shell and Auger Percussive.

SITE: Loch Carron.

CARRIED OUT FOR: Highland Regional Council

GROUND LEVEL: 25.012

CO-ORDINATES: -

DATE: 22:6:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil.			0.3						
Stiff light brown gravelly CLAY.			0.5						
Medium dense grey fine to coarse SAND/GRAVEL occasional cobbles.			(2.5) 3.0		1.5 / 1.65	B		S	(12)obstruction.
					3.0 / 3.45	B		S	(15)12,12,14,15.
Dense light grey fine to coarse slightly silty SAND fine to coarse gravels occasional cobbles.			(4.7) 7.7		4.5 / 4.95	B		S	(12)10,11,14,14.
					6.0 / 6.45	B		S	(19)12,14,14,15.
					7.5 / 7.95	B		S	(15)11,12,12,16.
Stiff brown sandy CLAY fine to coarse gravels.			9.6						

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- C Core Recovery (%)
- r R.Q.D. (%)

REMARKS:

LOGGED BY GMCG.

SCALE 1:50

FIG. 9

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R111

SHEET 2 OF 2

EQUIPMENT AND METHODS Rotary (NX) and 200 mm. Shell and Auger Percussive.

SITE Loch Carron.

CARRIED OUT FOR Highland Regional Council.

GROUND LEVEL 25.012

CO-ORDINATES -

DATE 22:6:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS: DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Rock MICA SCHIST QUARTZ SCHIST.			9.6		cored runs 9.6-10.5				
					10.5-11.9				
					11.9-13.4				
					13.4-14.7				
			(7.6)		14.7-15.3				
			15.3						
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key

D Disturbed Sample
B Bulk Sample
W Water Sample
U 0·1m. Undisturbed Sample
V Vane Test
S Standard Penetration Test
c Core Recovery (%)
r R.Q.D. (%)

REMARKS:

LOGGED BY GHG.

SCALE 1:50

FIG 10

TRIAX SITE INVESTIGATION LTD.

BOREHOLE NO. R112

SHEET 1 OF 1

EQUIPMENT AND METHODS
200 mm Shell and Auger Percussive and Rotary (NX).

SITE
Loch Carron.

CARRIED OUT FOR
Highland Regional Council.

GROUND LEVEL
18.131

CO-ORDINATES
-

DATE
9:7:82

DESCRIPTION	REDUCED LEVEL	LEGEND	DEPTH AND THICKNESS	GROUND WATER	SAMPLES/TESTS DEPTH	SAMPLE Type	SAMPLE No.	TEST	FIELD RECORDS
Top soil.			0.1						
Very soft brown peaty sandy CLAY.			(0.9) 1.0	0.5					
Medium dense brown clayey SAND some fine gravels.			(0.8) 1.8		1.5 / 1.95	B		S	(2)2,4,3,4.
Firm light grey laminated CLAY.			(1.2) 3.0		3.0 / 3.45	B		S	(5)6,6,6,6.
Dense brown clayey SAND/ GRAVEL.			(1.7) 4.7		Cored run. 4.7-5.5				
Rock MICA SCHIST QUARTZ SCHIST.			(0.8) 5.5						
End of bore.									

SPT: Where full 0·3m. penetration has not been achieved the number of blows for the quoted penetration is given.

DEPTHS: All depths and reduced levels in metres. Thicknesses given in brackets in depth column.

Sample/Test Key
- D Disturbed Sample
- B Bulk Sample
- W Water Sample
- U 0·1m. Undisturbed Sample
- V Vane Test
- S Standard Penetration Test
- c Core Recovery (%)
- r R.Q.D. (%)

REMARKS:

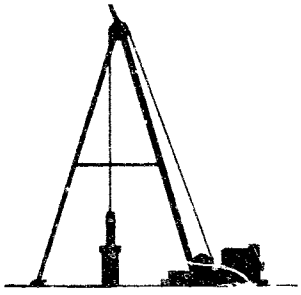
LOGGED BY GMG.

SCALE 1:50

FIG. 11

349

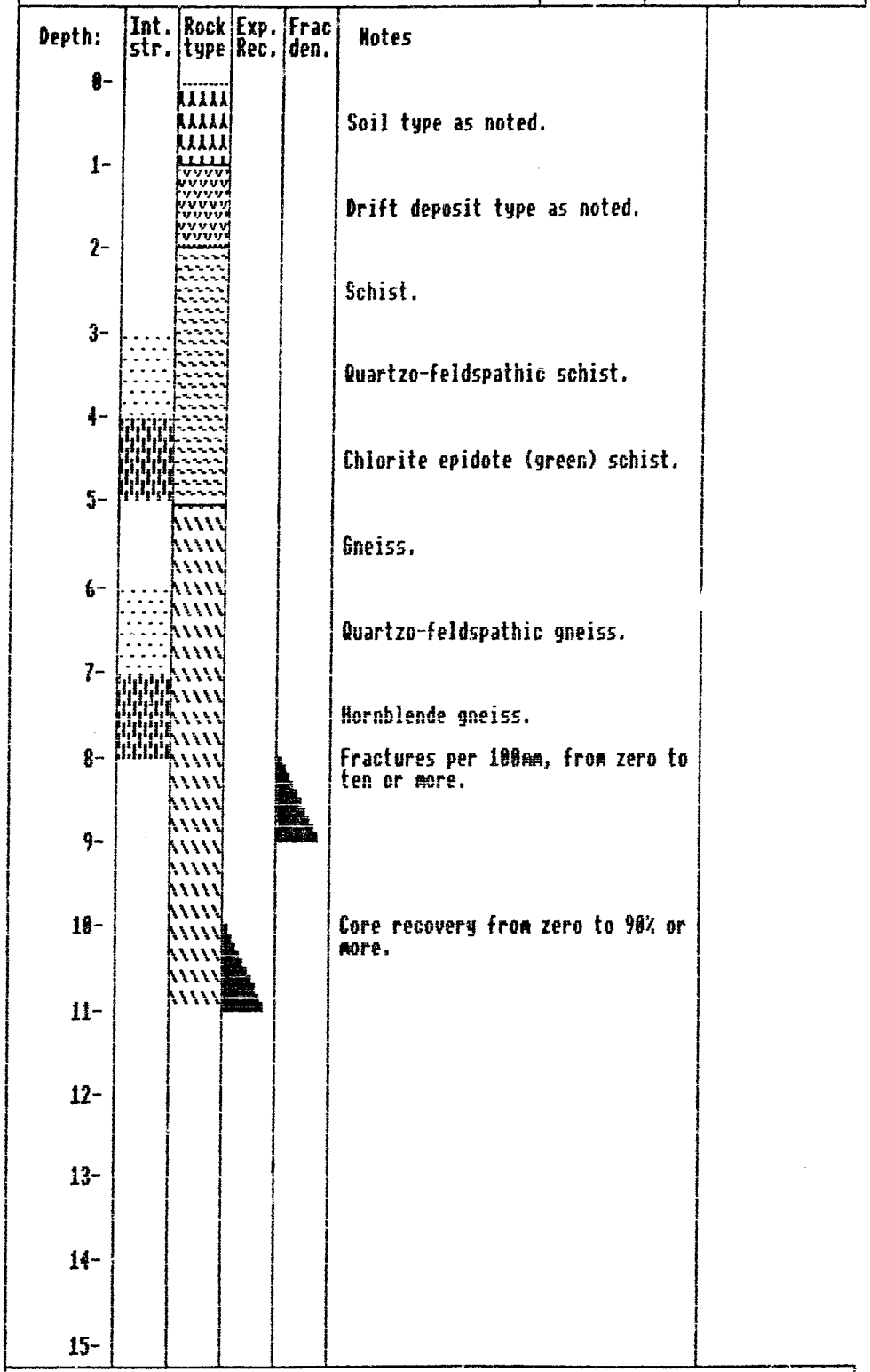
HOLEQUEST LTD



SITE INVESTIGATION REPORT

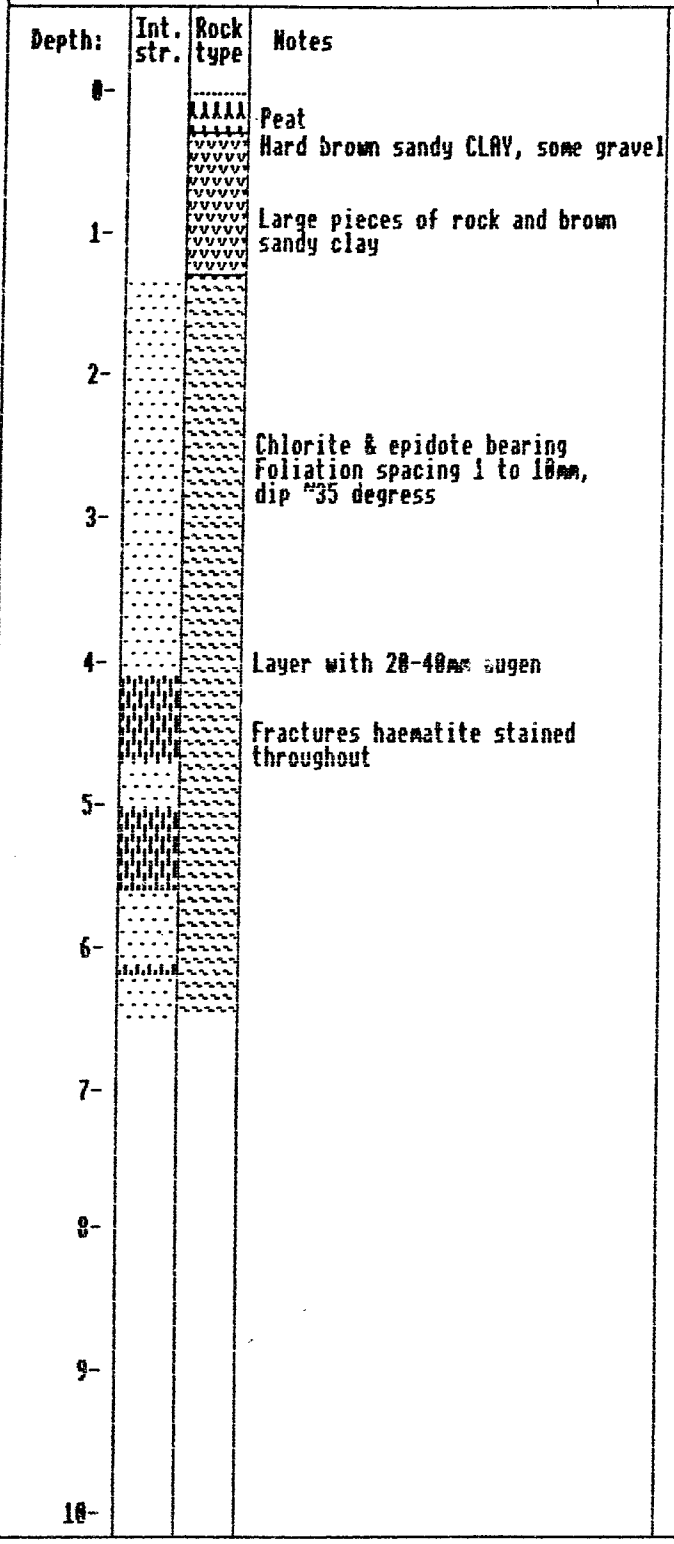
PROJECT	GEOLOGICAL SURVEY & BOREHOLE LOGS LOCH A'CHOIRE LEITH, by LOCHCARRON	
	R.H. CUTHBERTSON & PARTNERS CONSULTING ENGINEERS 13 EGLINTON CRESCENT EDINBURGH	
DATE	OCTOBER 1986	**No.**

PROJECT TITLE: Index section	Scale 1:75	Page 1 of 1	Section ref:Index



Explanation of graphic log conventions.	autoLOG.2 by Cheeney 1986 Sept

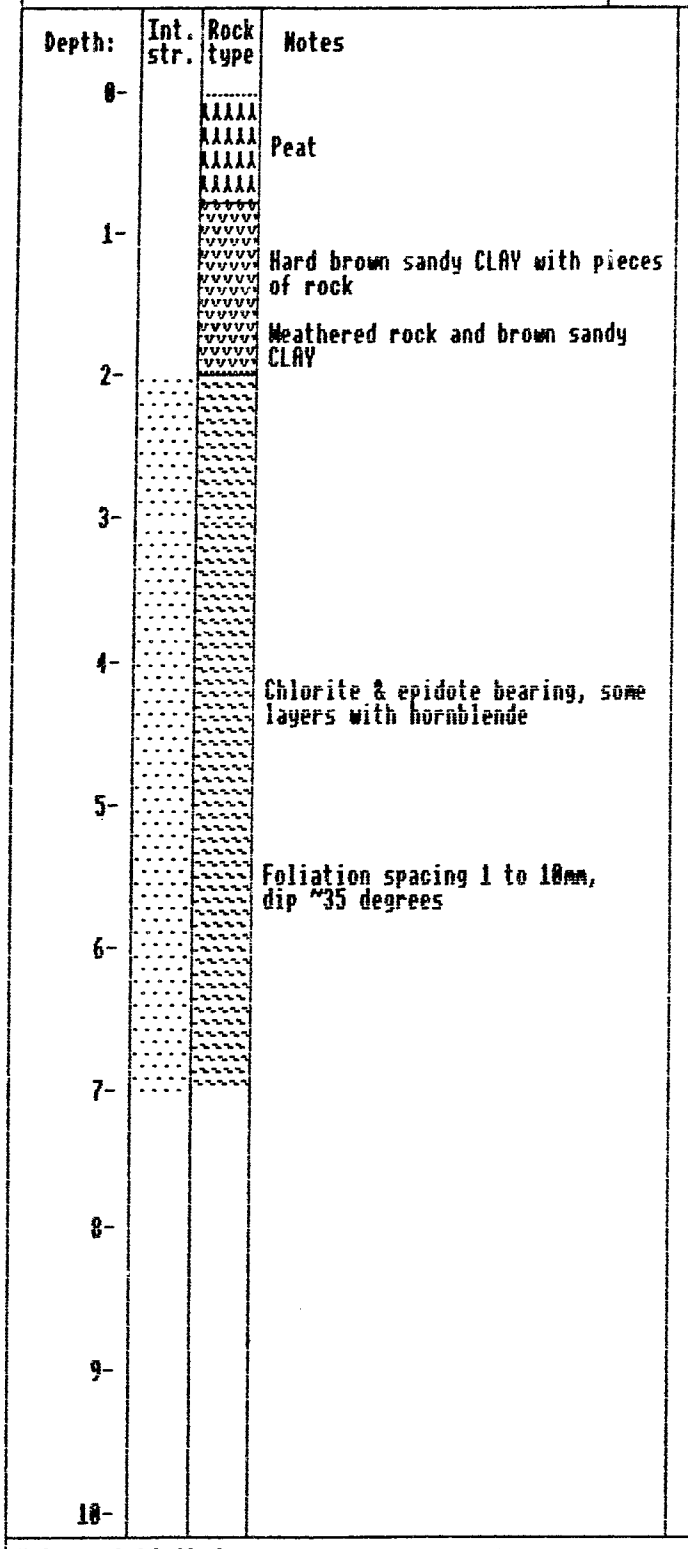
PROJECT TITLE: Loch a'Choire Leith, part 2	Scale 1:50	Page 1 of 1	Section ref:BH 1



Holequest Limited
Winston Road, Galashiels
Selkirkshire TD1 2DA. Phone 2295

autoLOG.2
by Cheeney
1986 Sept

PROJECT TITLE: Loch a'Choire Leith, part 2	Scale 1:50	Page 1 of 1	Section ref:BH 12



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Selkirkshire TD1 2DR. Phone 2295

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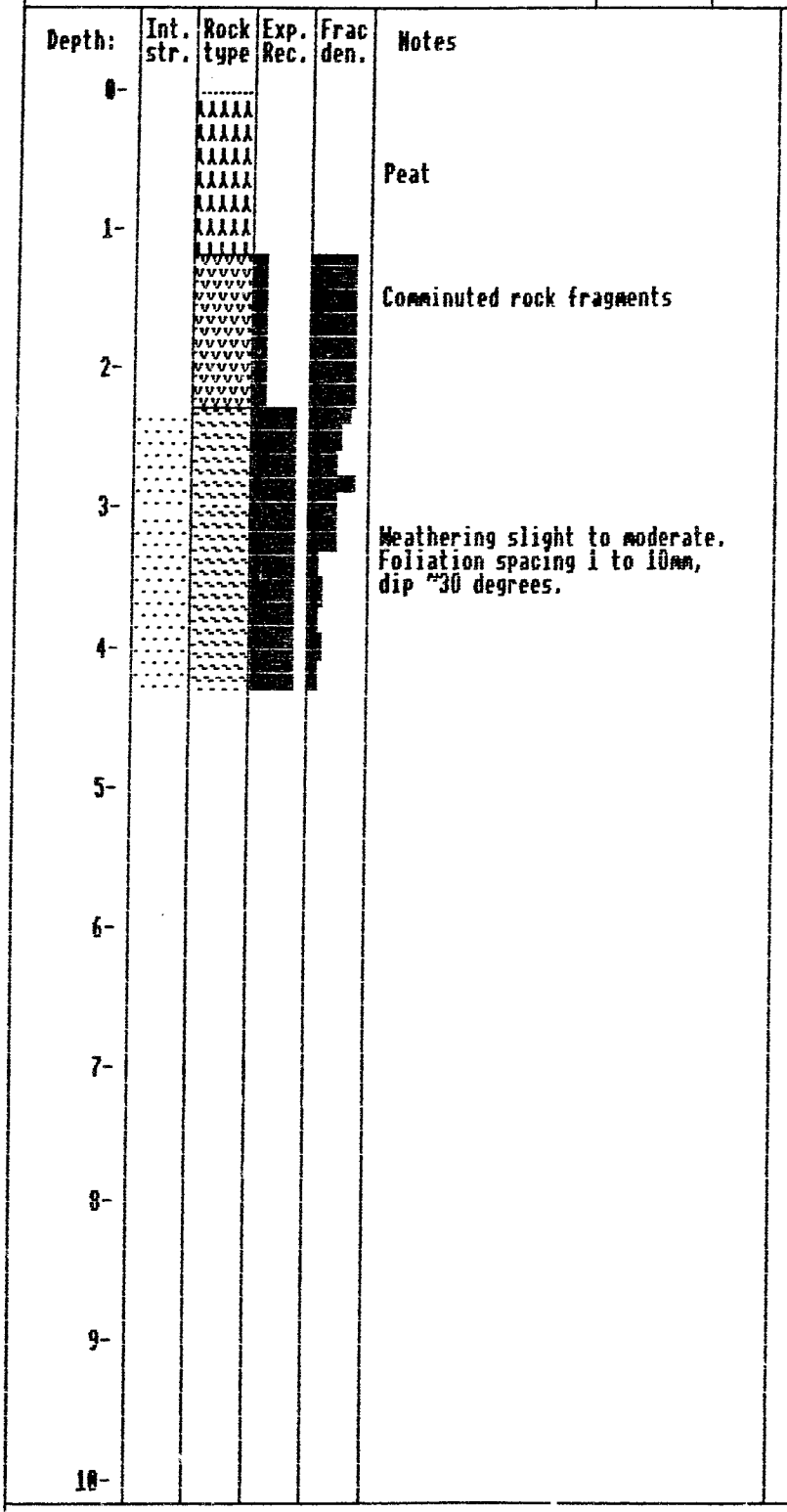
by Cheeney
1986 Sept

PROJECT TITLE: Loch a'Choire Leith, part 2	Scale 1:50	Page 1 of 1	Section ref:BH 12A



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Minston Road, Galashiels
Selkirkshire TD1 2DA. Phone 2295

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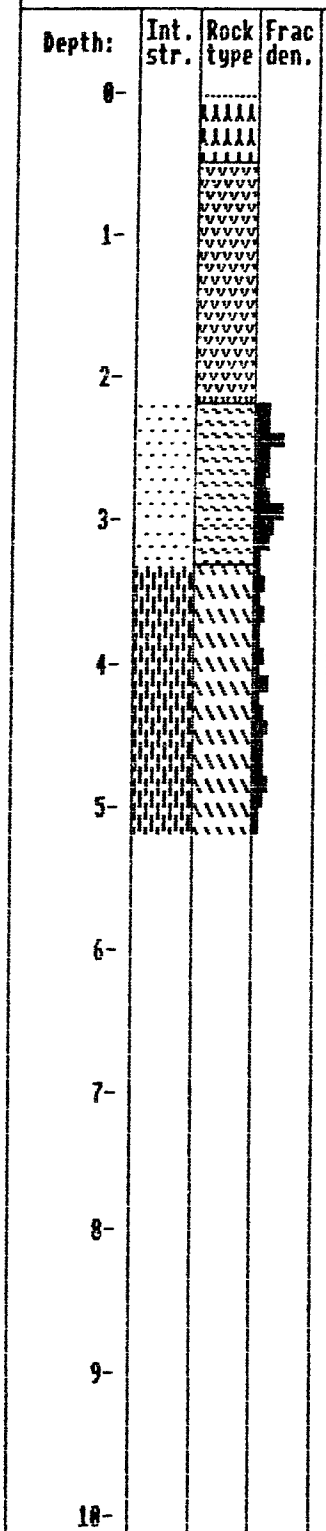
by Cheeney
1986 Sept

PROJECT TITLE: Loch a'Choire Leith, part 2	Scale 1:50	Page 1 of 1	Section ref:BH 13



Notes

Peat

Hard brown sandy CLAY with some gravel & pieces of rock

Weathered rock

Rocks & boulders in brown sandy CLAY

Traces of horneblende
Foliation spacing 1 to 10mm, dip ~45 degrees

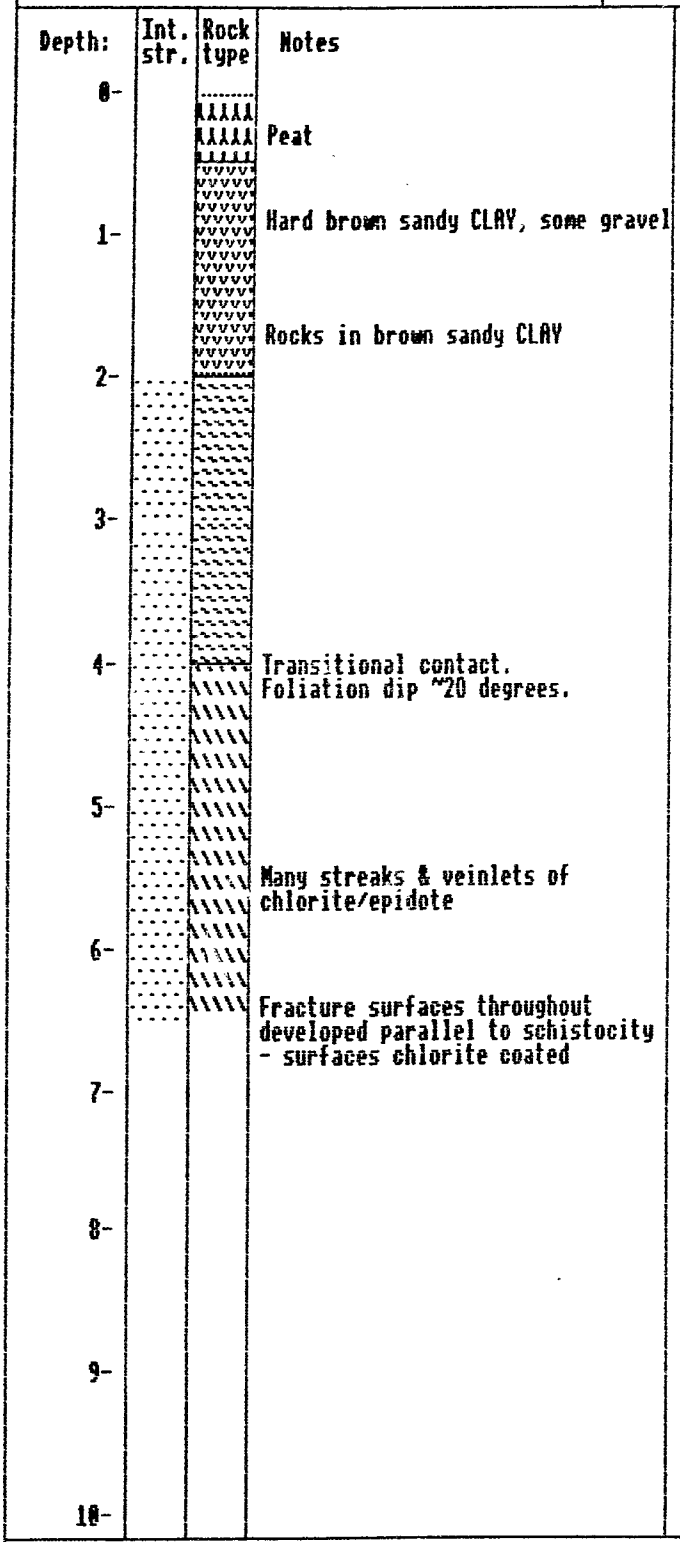
Foliation dip ~60 degrees.

Homogeneous gneiss with grain size ~2mm & quartz/feldspar in irregular patches

Holequest Limited
Winston Road, Galashiels
Selkirkshire TD1 2DA. Phone 2295

autoLOG.2
by Cheeney
1986 Sept

PROJECT TITLE: Loch a'Choire Leith, part 2	Scale 1:50	Page 1 of 1	Section ref:BH 14



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Minston Road, Galashiels
Selkirkshire TD1 2DA. Phone 2295

autoLOG.2
by Cheeney
1986 Sept

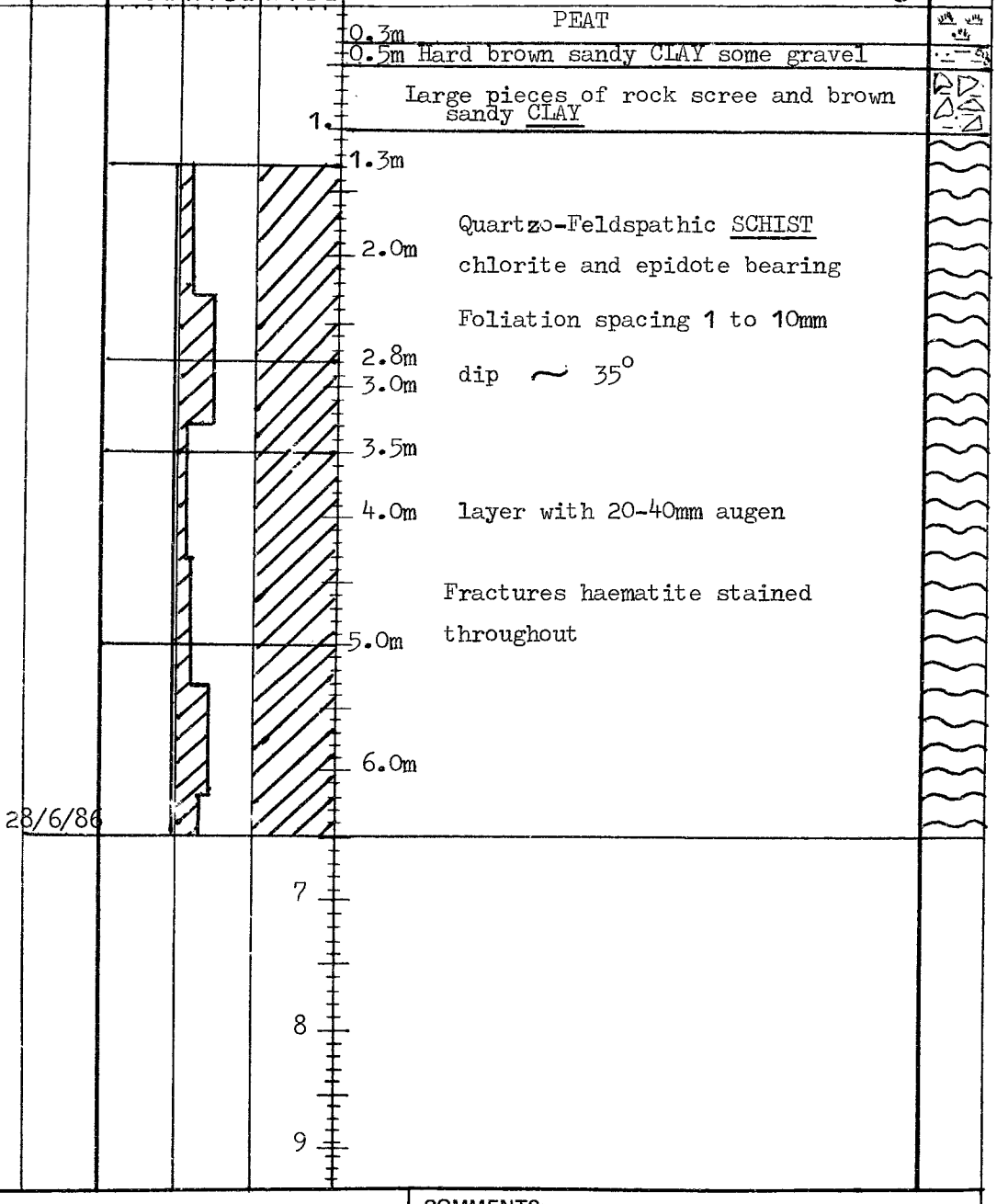
APPENDIX I

BOREHOLE RECORDS

DRILLING METHOD	GROUND LEVEL	CO-ORDINATES	BOREHOLE No.
ROTARY DIAMOND CORE			11

MACHINE	CORE BARREL AND BIT DESIGN	ORIENTATION	SITE
EDECO 20	TNX	VERTICAL	LOCHCARRON

SOIL SAMPLES DEPTH & TYPE	DRILLING AND CASING PROGRESS	WATER RECOV. % & A.M. LEVEL (20 40 60 80)	RQD (20 40 60 80)	CORE RECOV. % & SIZE (20 40 60 80)	DESCRIPTION OF STRATA	O.D. LEVEL	SYMBOLIC LOG



KEY:

U4 –4 in. dia. Undisturbed sample
D –Disturbed sample
W –Water sample
* –Sample not recovered
▽ –Ground - water depth first encountered
▼ –Morning water level
S( ) –Standard penetration test
C( ) –Cone penetration test
No. in brackets is no of blows for 12 in. penetration.

COMMENTS:

Packer Test 4.5 - 5.0 mtrs

31ltrs over 15 mins with a 10mtr head at Ground level

HOLEQUEST LTD.

69 Island Street, Galashiels, Selkirkshire

Telephone: Galashiels 2383, Earlston 465

CLIENT

REF.

DRILLING METHOD	GROUND LEVEL	CO-ORDINATES	BOREHOLE No.
ROTARY DIAMOND CORE			12

MACHINE	CORE BARREL AND BIT DESIGN	ORIENTATION	SITE
EDECO 20	TNX	VERTICAL	LOCHCARRON

SOIL SAMPLES DEPTH & TYPE	DRILLING AND CASING PROGRESS	WATER RECOV. % & A.M. LEVEL (20 40 60 80)	RQD (20 40 60 80)	CORE RECOV. % & SIZE (20 40 60 80)	DESCRIPTION OF STRATA	O.D. LEVEL	SYMBOLIC LOG

PEAT

0.7m

1.

Hard brown sandy CLAY with pieces of rock

1.6m

Weathered Rock and brown sandy CLAY

2.0m

3.0m

Chlorite and epidote bearing Quartzo feldspathic SCHIST some layers with hornblende

4.0m

4.5m

5.0m

5.6m

Foliation spacing 1 to 10mm dip ~ 35°

6.0m

27/6/86

7.0m

8

9

KEY:

U4 –4 in. dia. Undisturbed sample
D –Disturbed sample
W –Water sample
* –Sample not recovered
▽ –Ground - water depth first encountered
▼ –Morning water level
S( ) –Standard penetration test
C( ) –Cone penetration test
No. in brackets is no. of blows for 12 in. penetration.

COMMENTS:

Packer test 4 to 4.5m - 2 ltrs over 15mins with a 10m head at G.L.
Packer test 6.5 to 7m - 2 ltrs over 15mins with a 10m head at G.L.

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REF.

DRILLING METHOD	GROUND LEVEL	CO-ORDINATES	BOREHOLE No.
ROTARY DIAMOND CORE			12A

MACHINE	CORE BARREL AND BIT DESIGN	ORIENTATION	SITE
EDECO 20	TNX	VERTICAL	LOCHCARRON

SOIL SAMPLES DEPTH & TYPE	DRILLING AND CASING PROGRESS	WATER RECOV. % & A.M. LEVEL (20 40 60 80)	RQD (20 40 60 80)	CORE RECOV. % & SIZE (20 40 60 80)	DESCRIPTION OF STRATA	O.D. LEVEL	SYMBOLIC LOG
					PEAT		
					1.2m Brown sandy CLAY		
					Comminuted rock fragments		
					2.3m		
					2.6m		
					Quartzo feldspathic SCHIST Weathering slight to moderate Foliation spacing 1 to 10mm dip ~ 30°		
					3.0m		
					4.0m		
29/6/86							

1 2 3 4 5 6 7 8 9

KEY:
U4 —4 in. dia. Undisturbed sample
D —Disturbed sample
W —Water sample
* —Sample not recovered
▽ —Ground - water depth first encountered
▼ —Morning water level
S( ) —Standard penetration test
C( ) —Cone penetration test
No. in brackets is no. of blows for 12 in. penetration.

COMMENTS:
Packer test 3.8-4.3m - 4 ltrs over 15mins with 10mtr head at G.L.

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REF.

DRILLING METHOD	GROUND LEVEL	CO-ORDINATES	BOREHOLE No.
ROTARY DIAMOND CORE			13

MACHINE	CORE BARREL AND BIT DESIGN	ORIENTATION	SITE
EDECO 20	TNX	VERTICAL	LOCHCARRON

SOIL SAMPLES DEPTH & TYPE	DRILLING AND CASING PROGRESS	WATER RECOV % & A.M. LEVEL (20 40 60 80)	RQD (20 40 60 80)	CORE RECOV. % & SIZE (20 40 60 80)	DESCRIPTION OF STRATA — O.D. LEVEL	SYMBOLIC LOG
					PEAT 0.5m Hard brown sandy CLAY with some gravel and pieces of rock 1.2m Weathered ROCK	
					Rock scree and boulders in brown sandy CLAY	
					Quartzo feldspathic SCHIST with traces of hornblende Foliation 1 to 10mm dip ~ 45° 3.0m 3.2m	
					Homogeneous GNEISS with grain size ~ 2mm and quartz/feldspar in irregular patches 4.0m 5.0m 5.2m	

KEY:

U4 –4 in. dia. Undisturbed sample
D –Disturbed sample
W –Water sample
* –Sample not recovered
▽ –Ground - water depth first encountered
▼ –Morning water level
S( ) –Standard penetration test
C( ) –Cone penetration test
No. in brackets is no. of blows for 12 in. penetration.

COMMENTS:

Packer test 4.7-5.2mtrs nil over 15mins with a 10mtrs head at G.L.

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REF.

DRILLING METHOD	GROUND LEVEL	CO-ORDINATES	BOREHOLE No.
ROTARY DIAMOND CORE			14

MACHINE	CORE BARREL AND BIT DESIGN	ORIENTATION	SITE
EDECO 20	TNX	VERTICAL	LOCH CARRON

SOIL SAMPLES DEPTH & TYPE	DRILLING AND CASING PROGRESS	WATER RECOV. % & A.M. LEVEL (20 40 60 80)	RQD (20 40 60 80)	CORE RECOV. % & SIZE (20 40 60 80)	DESCRIPTION OF STRATA	O.D. LEVEL	SYMBOLIC LOG
					PEAT		
					0.5m		
				1	Hard brown sandy CLAY some gravel		
					1.5m		
					Rock scree in brown sandy CLAY		
					Quartzo feldspathic SCHIST		
					3.0m		
					3.2m		
					3.6m		
					4.0m Transitional contact Foliation dip ~ 20°		
					Quartzo Feldspathic GNEISS with many streaks and veinlets of chlorite/epidote		
					5.0m		
					Fracture surfaces throughout developed parallel to shistocity - surfaces chlorite coated		
					6.0m		
	25/6/86			7			
				8			
				9			

KEY:

U4 – 4 in. dia. Undisturbed sample
D – Disturbed sample
W – Water sample
* – Sample not recovered
▽ – Ground - water depth first encountered
▼ – Morning water level
S( ) – Standard penetration test
C( ) – Cone penetration test
No. in brackets is no. of blows for 12 in. penetration.

COMMENTS:

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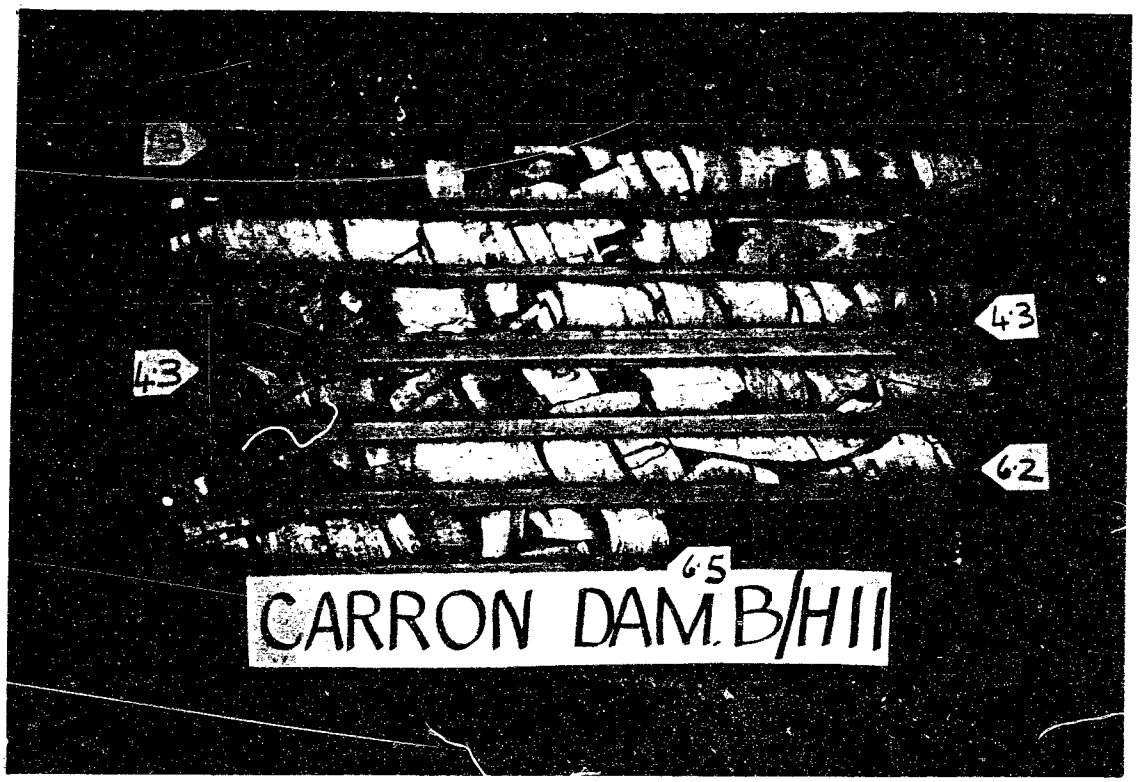
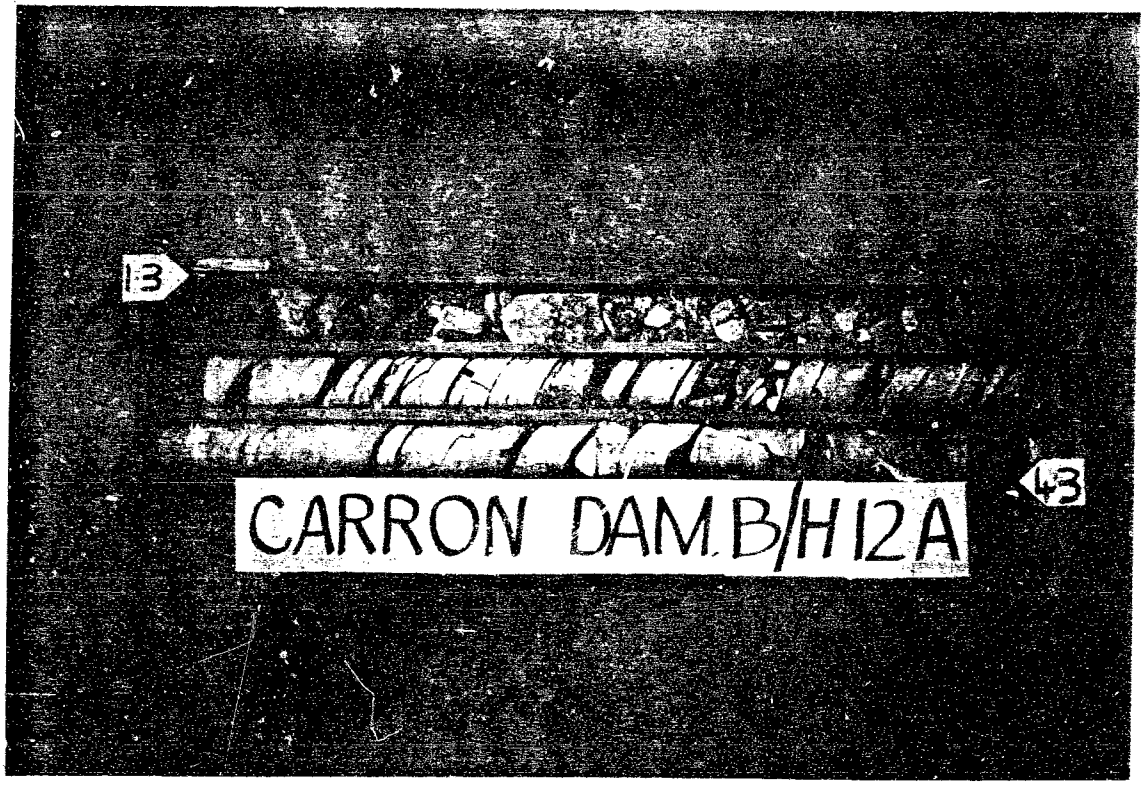
REF.


4·3
4·3
6·2
65
CARRON DAM B/H11


20
50
50
70
CARRON DAM B/H 12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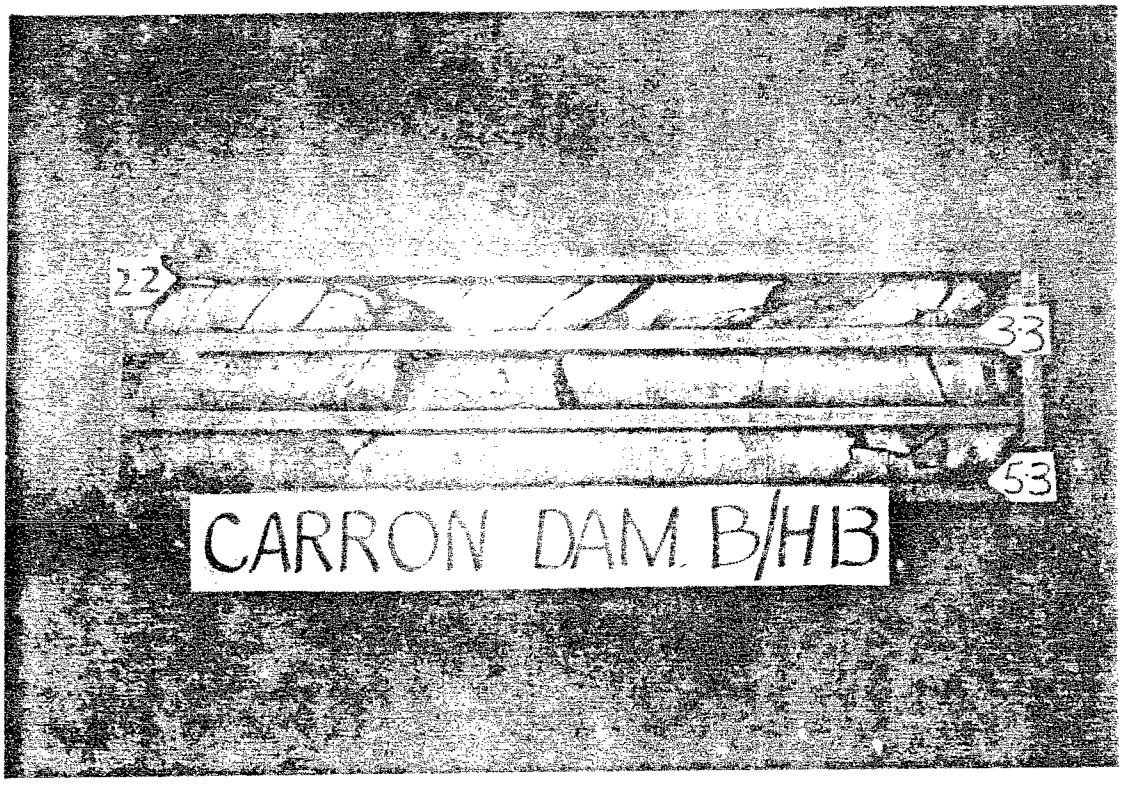
43
CARRON DAM B/H 12A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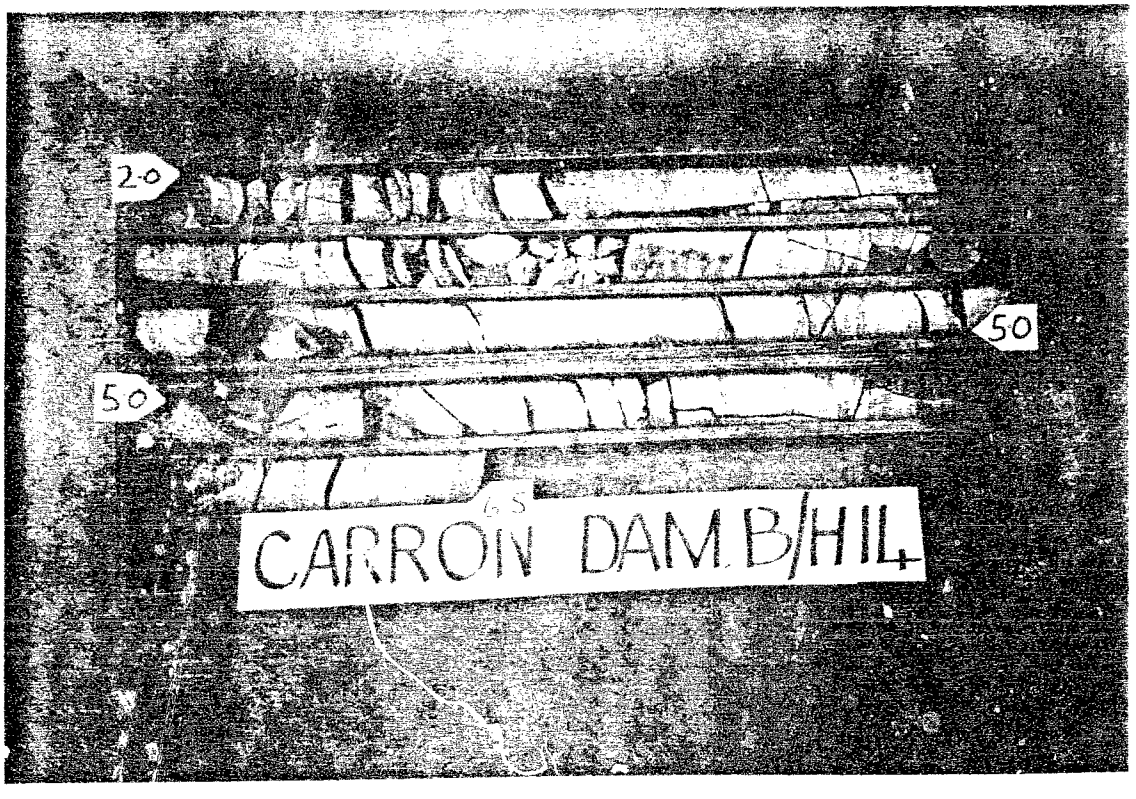
33
53
CARRON DAM B/HB


20
50
50
CARRON DAM B/HIL

APPENDIX II

LABORATORY TEST RESULTS

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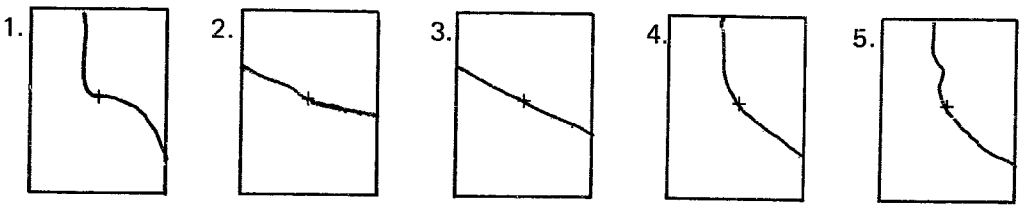
POINT LOAD TEST

Contract: LOCH CARRON

	B/H No.	Depth (m)	Rock Description		Diameter	Failing Load	Is. Value
1.	11	1.3	Quartzo feldspathic SCHIST chlorite and epidote bearing Foliation spacing 1 to 10mm dip ~ 35°		0.06mtrs	10.5KN	2.92_2 MN/m²
2.	11	2.9	Quartzo feldspathic SCHIST chlorite and epidote bearing Foliation spacing 1 to 10mm dip ~ 35°	Min	0.06mtrs	2.5KN	0.69_2 MN/m²
				Max	0.06mtrs	9.0KN	2.5_2 MN/m²
3.	11	4.7	Quartzo feldspathic SCHIST chlorite abd epidote bearing Foliation spacing 1 to 10mm dip ~ 35°	Min	0.06mtrs	4.5KN	1.25_2 MN/m²
				Max	0.06mtrs	13.5KN	3.75_2 MN/m²
4.	11	6.4	Quartzo feldspathic SCHIST chlorite and epidote bearing. Folation spacing 1 to 10mm dip ~ 35°	Min	0.06mtrs	13.5KN	3.75_2 MN/m²
				Max	0.06mtrs	15.0KN	4.17_2 MN/m²
5.	12	3.45	Chlorite and epidote bearing Quartzo feldspathic SCHIST some layers of hornbelende Foliation spacing 1 to 10mm dip ~ 35°	Min	0.06mtrs	10.0KN	2.78_2 MN/m²
				Max	0.06mtrs	15.0KN	4.17_2 MN/m²

Failure Sketches:



Tested by: C. RODGER

Test Date: 22/8/86

\+ Denotes Point of Test

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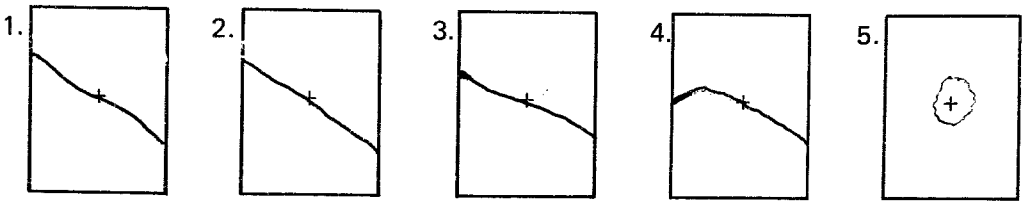
POINT LOAD TEST

Contract: LOCH CARRON

	B/H No.	Depth (m)	Rock Description		Diameter	Failing Load	Is. Value
1.	12	6.2	Chlorite and epidote bearing Quartzo feldspathic SCHIST some layers with hornblende. Foliation spacing 1 -10mm dip ~ 35°	Min	0.06m	27KN	7.5 MN/m^2
				Max	0.06m	31KN	8.61 MN/m^2
2.	12A	3.85	Quartzo feldspathic SCHIST Weathering slight to moderate. Foliation spacing 1 to 10mm dip ~ 30°	Min	0.06m	13KN	3.61 MN/m^2
				Max	0.06m	15KN	4.17 MN/m^2
3.	12A	4.2	Quartzo feldspathic SCHIST Weathering slight to moderate. Foliation spacing 1 to 10mm dip ~ 30°	Min	0.06m	32KN	8.89 MN/m^2
				Max	0.06m	43KN	11.94 MN/m^2
4.	13	3.4	Homogeneous GNEISS with grain size ~ 2mm and quartz/feldspar in irregular patches		0.06m	16KN	4.44 MN/m^2
5.	13	4.4	Homogeneous GNEISS with grain size ~ 2mm and quartz/feldspar in irregular patches		0.06m	26KN	7.22 MN/m^2

Failure Sketches:



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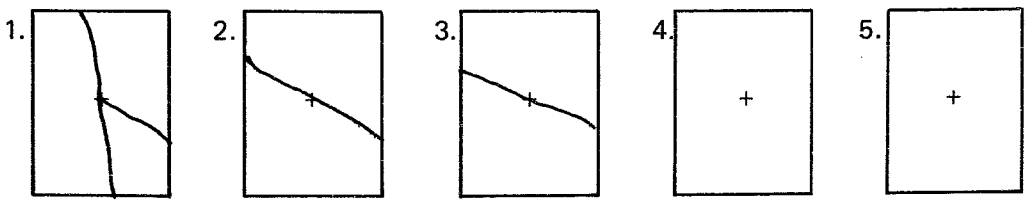
POINT LOAD TEST

Contract: LOCH CARRON

	B/H No.	Depth (m)	Rock Description		Diameter	Failing Load	Is. Value
1.	13	5.2	Homogeneous GNEISS with grain size ~ 2mm and quartz/feldspar in irregular patches		0.06	16KN	4.44 MN/m^2
2.	14	5.0	Quartzo feldspathic GNEISS with many streaks and veinlets of chlorite/epidote	Min	0.06m	19KN	5.28 MN/m^2
				Max	0.06m	43KN	11.94 MN/m^2
3.	14	6.4	Quartzo feldspathic GNEISS with many streaks and veinlets of chlorite/epidote	Min	0.06m	33KN	9.17 MN/m^2
				Max	0.06m	38KN	10.56 MN/m^2
4.							
5.							

Failure Sketches:



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Test Date: 22/8 /86

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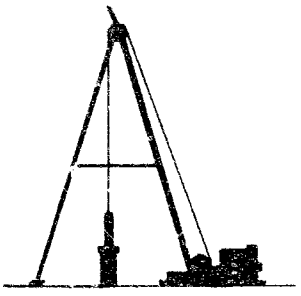

SITE INVESTIGATION REPORT

PROJECT	GEOLOGICAL SURVEY & BOREHOLE LOGS LOCH A'CHOIRE LEITH, by LOCHCARRON	
	R.H. CUTHBERTSON & PARTNERS CONSULTING ENGINEERS 13 EGLINTON CRESCENT EDINBURGH	
DATE	OCTOBER 1986	**No.**

to:
Holequest Limited
Winston Road
Galashiels
Selkirkshire TD1 2DA

Loch a'Choire Leith, by Lochcarron

Further Geological Survey & BH Logs

R F Cheeney PhD, MIGeol
1986 October 4

Space for notes

1. CONTENTS

Continued

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Our Ref:, Your Ref:

Robert H. Cuthbertson & Partners
Consulting Engineers
13 Eglinton Crescent
Edinburgh

Geological Survey & Borehole Logs

Loch a'Choire Leith, by Lochcarron

2. INTRODUCTION & SUMMARY

This report is the third in a series that deals with the geological factors associated with a proposal to raise by 2.7m the level of Loch a'Choire Leith (fig.1), some 2km west of Lochcarron, Ross-shire. The loch lies in a basin, the northern rim of which contains two low points or 'saddles' (fig. 2). The present outlet from the loch is via one of these, the western. The other low point is little higher and the results from a previous preliminary geological survey [2] suggested that the security of this eastern 'saddle' or 'col' was not obvious. This report adds some detail to the geological knowledge of this second 'saddle', arising from further drilling, and concludes that some remedial work may be necessary if the raised loch is to be secure during its designed life.

3. PREVIOUS INVESTIGATIONS

Earlier reports ([1], [2]) focussed on the western col, the present outlet, with only a preliminary inspection of the eastern col. The western col, shown longitudinally in fig. 3, appeared to be developed in relatively uniform and sound bedrock (hornblende gneiss) and was not seen to pose any unusual geological problems.

A preliminary survey of the eastern col was insufficient to reveal the likely nature of its core, indeed, suggesting that less secure geological conditions might obtain. On this basis, a recommendation for further site investigation was made; the subject of this report.

4. DESCRIPTION OF SITE

Fig. 4 presents a profile of the eastern col and some detail from the earlier investigation [2] is repeated here as fig. 5.

Continued

The left, westernmost, two thirds of the col carries several exposures of bedrock in one place or another, as indicated. However, the right, easternmost, one third exposes no bedrock at all.

Fig. 6 is an east-looking longitudinal view of the eastern col that shows more clearly the narrowing of this barrier at its eastern end. Wave action on the loch during SW gales seems to have eroded a beach on the right (south) and the ground slopes steeply down to the left (north) into the valley that drains the loch. The material of the beach is shown in fig. 7. Please refer to the figure captions for further details.

5. BOREHOLE LOGS

The detailed logs are presented in the appendix. All boreholes have penetrated peaty soil 0.2 to 1.2m deep, underlain by brown sandy clay that contains increasing proportions of rock fragments with depth. The thickness of this clay - rock blanket is 1.0 to 1.5m.

The bedrocks consist of schists and gneisses, principally pale and quartzofeldspathic, but with variable proportions of hornblende and other dark minerals, commonly chlorite and epidote. Their state of weathering may be described as 'slight' to 'moderate' [3].

Gneisses are generally coarsely crystalline metamorphic rocks that may or may not be foliated, ie. showing colour layering due to differentiaion of the constituent minerals. Gneisses grade into schists in a manner that has defied definition and the rocks at this location display this transition very nicely. Typically, the schists are rocks in which the foliation is more prominent,

Continued

individual foliae are thinner and amongst which, certain layers are rich in minerals that cleave easily. Thus schists display some of the properties of roofing slate in splitting readily, although generally less regularly.

BH 11 penetrated schists of a somewhat more variegated type, containing alternating layers, some unusually rich in the minerals chlorite and epidote.

A routine logging of fracture density has not been undertaken here for reasons given below. However, cores from boreholes BH 12A and BH 13 have been logged in this way to demonstrate the difference in present fracture density between the two rock types.

6. INTERPRETATION

The data arising from the boreholes have been amalgamated with the results of the field survey to provide the synopsis given in fig. 8. This geological profile is sketched along the line of the colinear boreholes and shows a blanket of superficial deposits (drift) ca. 1.5m thick. This blanket is composed of sandy clay with rock fragments whose density increases towards the rockhead. It is likely that the rockhead is not the crisp line as indicated, more a transition through a zone of shattered rock perhaps 0.5m thick or thereabouts. Bedrocks consist of interlayered gneisses and schists with angles of dip from 20 to 60° directed eastwards.

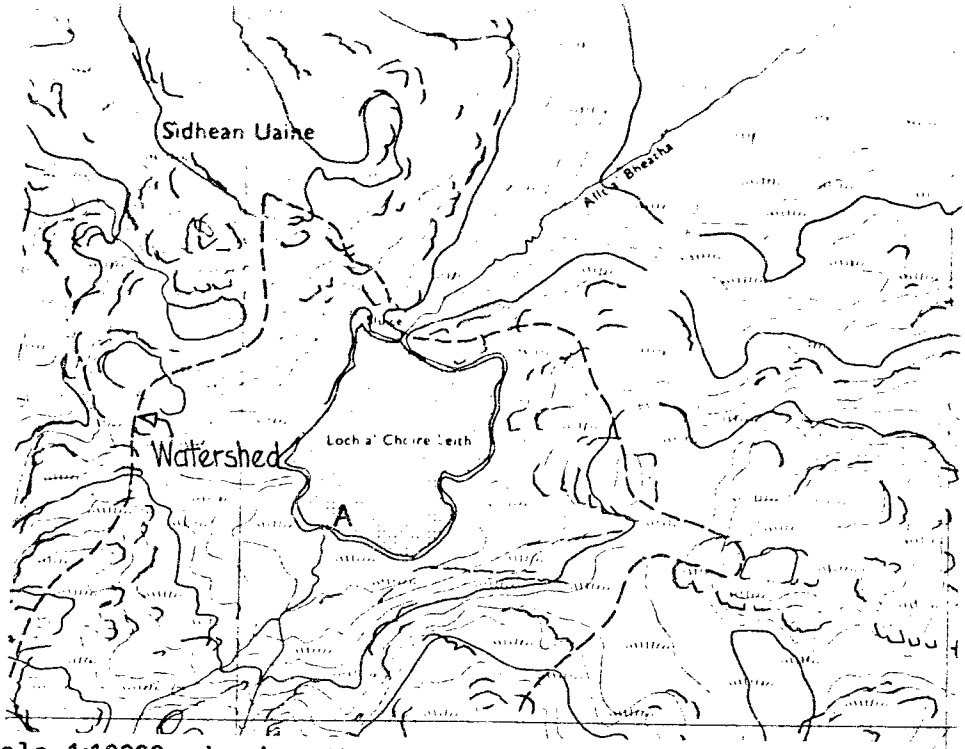
The whole area is overlain by peaty soil whose thickness is variable, from zero to 1.5m. Over the westernmost two thirds of the profile, rockhead rises northwards from the line of the boreholes and reaches the ground surface in many places as noted above. The east

Continued

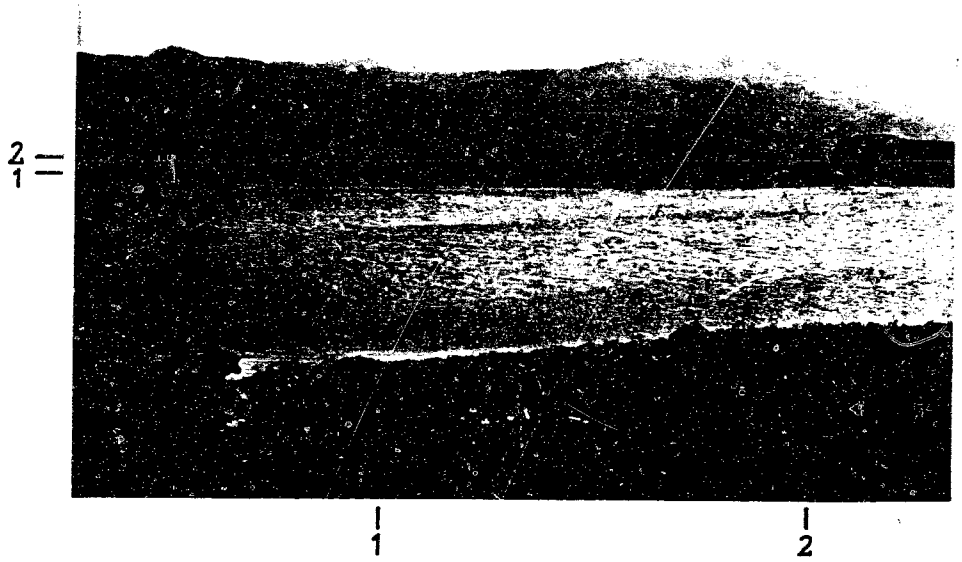
Space for notes

9. FIGURES

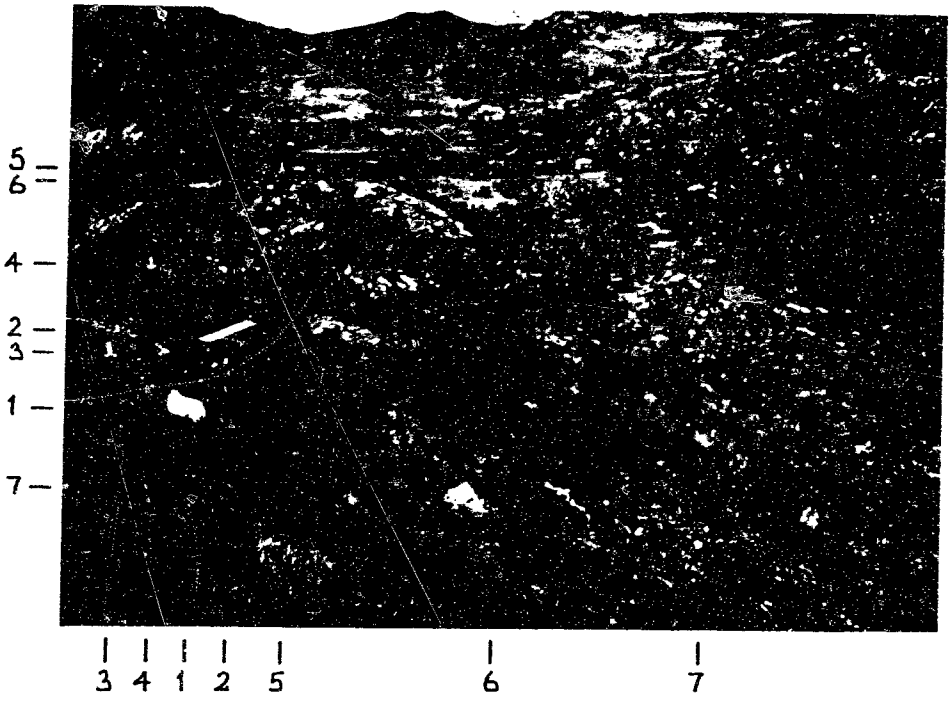
Continued



1. Map, scale 1:10000, showing the watershed of Loch a'Choire Leith. The view north from point A on the southern shore is shown in fig. 2.

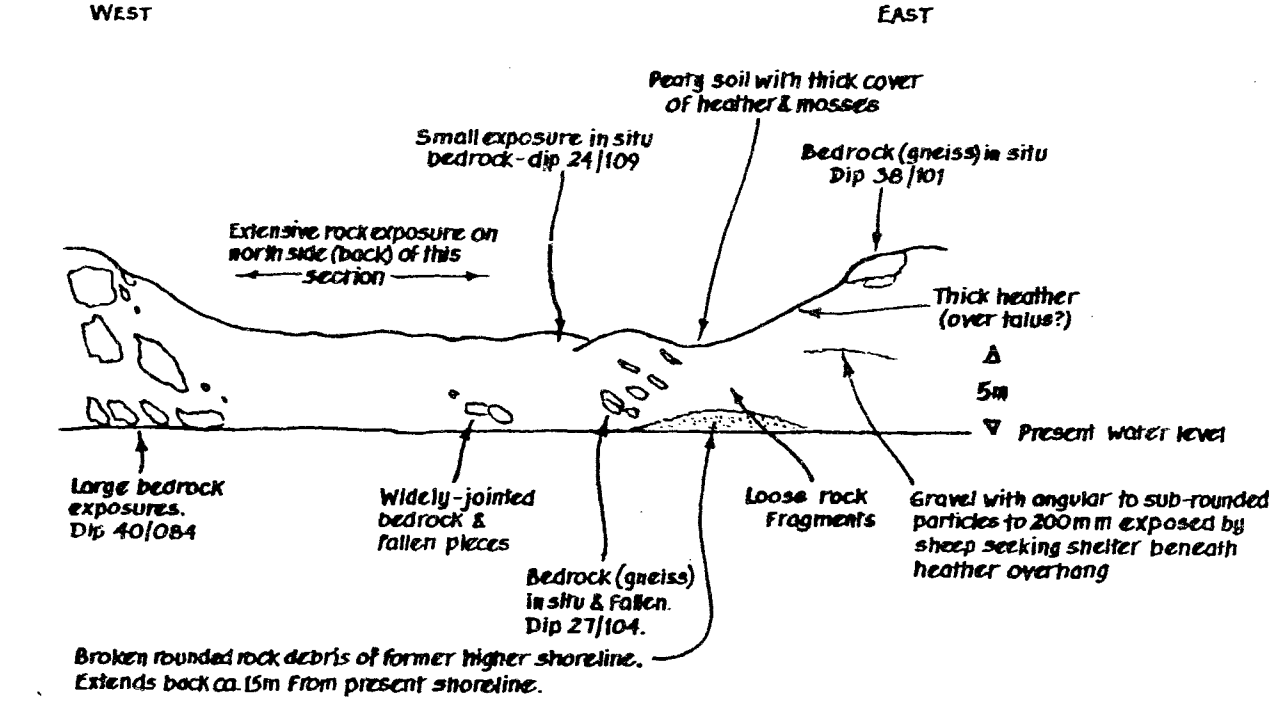


2. View north from the southern shore of the loch (point A in fig. 1). The loch is pounded by a barrier with two low points or 'cols' separated by a long low hill. The present outlet is the western of these, left in the picture and labelled (1). Here, the outlet stream flows over a rock barrier that seems substantially sound. The eastern col, near the right margin of the picture (2), appears to be in part of degraded rock and may need remedial work if the water level is raised by 2.7m, as proposed.

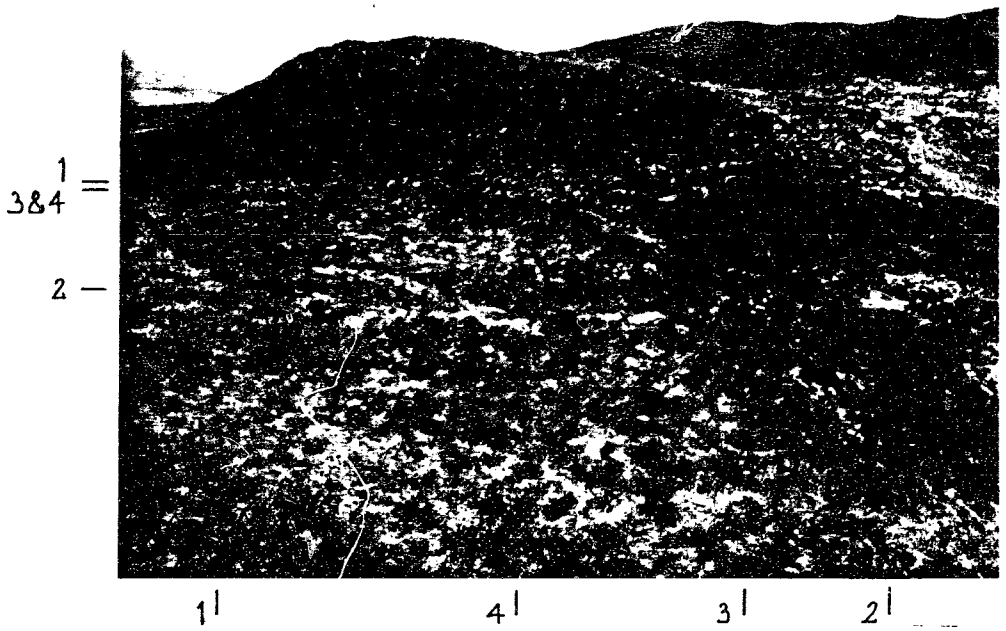


3. A longitudinal view of the western col from a viewpoint on the hill at its eastern end. A sheep (1) gives approximate perspective and the present artificial cut of the outlet stream is bridged by a plank at (2). Cappings to previous boreholes are seen at (3), (4) and (5), and with some difficulty at (6), midway along the pale-toned earth & rock embankment. Marshy ground developed along the former watercourse approaches the viewpoint from the embankment as far as a rock ledge at (7).

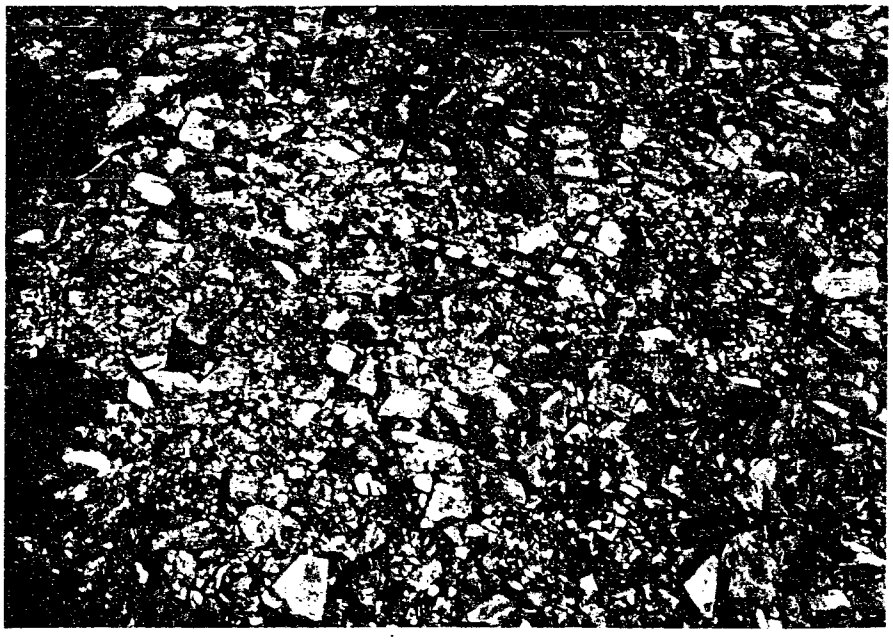
4. View of the eastern col from a point on the shore ca. 50m distant. The altitude of the col is sensibly constant over a distance west to east of ca. 60m, although the view here is confused by a low, flat-topped hill lying some distance behind. The section of greatest concern is that immediately behind the two low promontories in the foreground. Fig. 5 adds some details of surface geology.



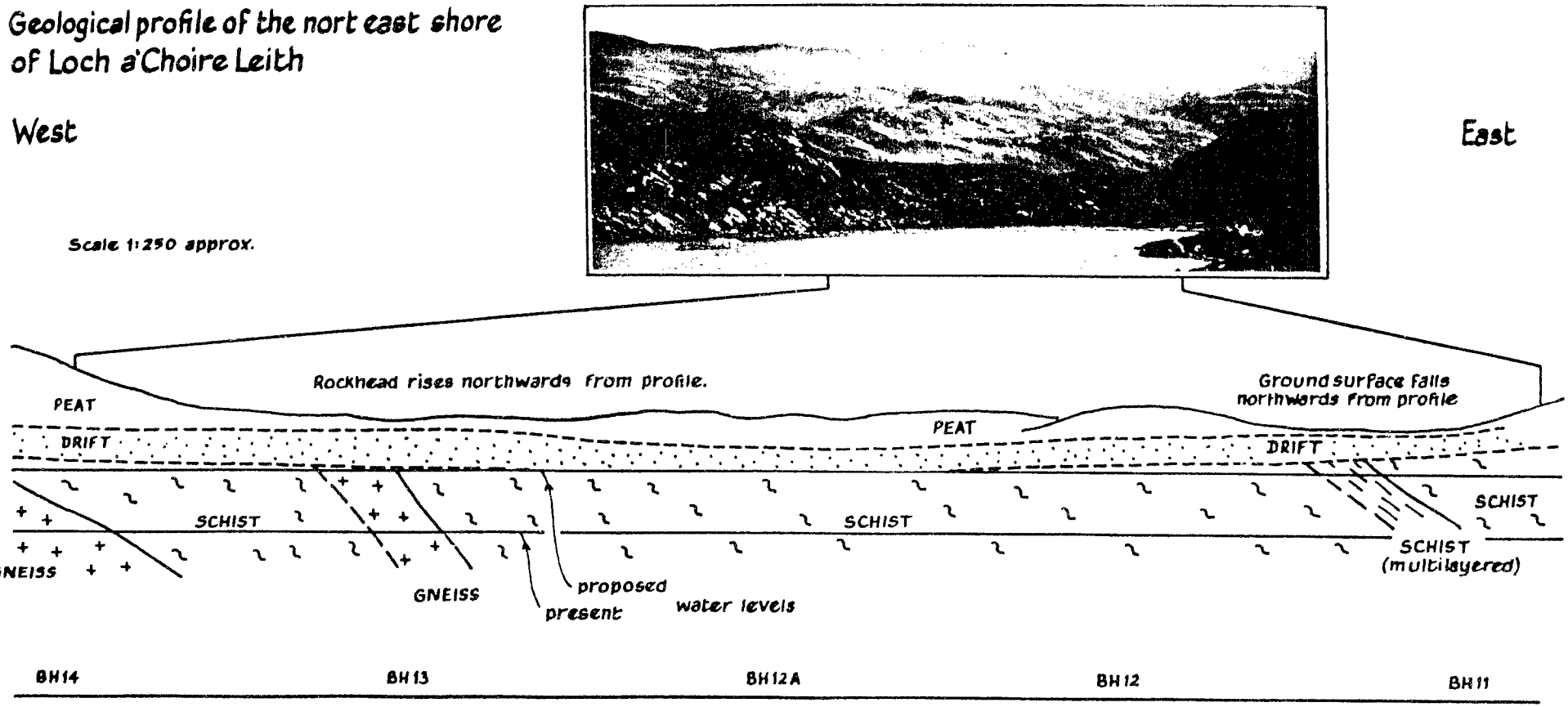
5. Sketch of the eastern col from the same viewpoint as fig. 4, with some surface geological detail added.



6. Longitudinal view of the eastern col, looking east. The narrowest part of the col is in the middle distance. To its left (north), the ground slopes steeply (1) into the valley of Allt a'Bheatha (fig. 1), the stream that drains the loch. To the right (south), can be seen the head of a beach (2), eroded by wave action on the loch during SW gales, perhaps in the very distant past when the water level may have been higher. Sheep have excavated shallow shelters (3) that expose gravelly subsoil and there are numerous soil terraces accentuated by sheep slightly higher on the col (4). Material that constitutes the beach is shown in fig. 7.



7. Fragments of schistose rocks that form a small beach near the NE extremity of the loch, immediately adjacent to the eastern col (scale units are inches).

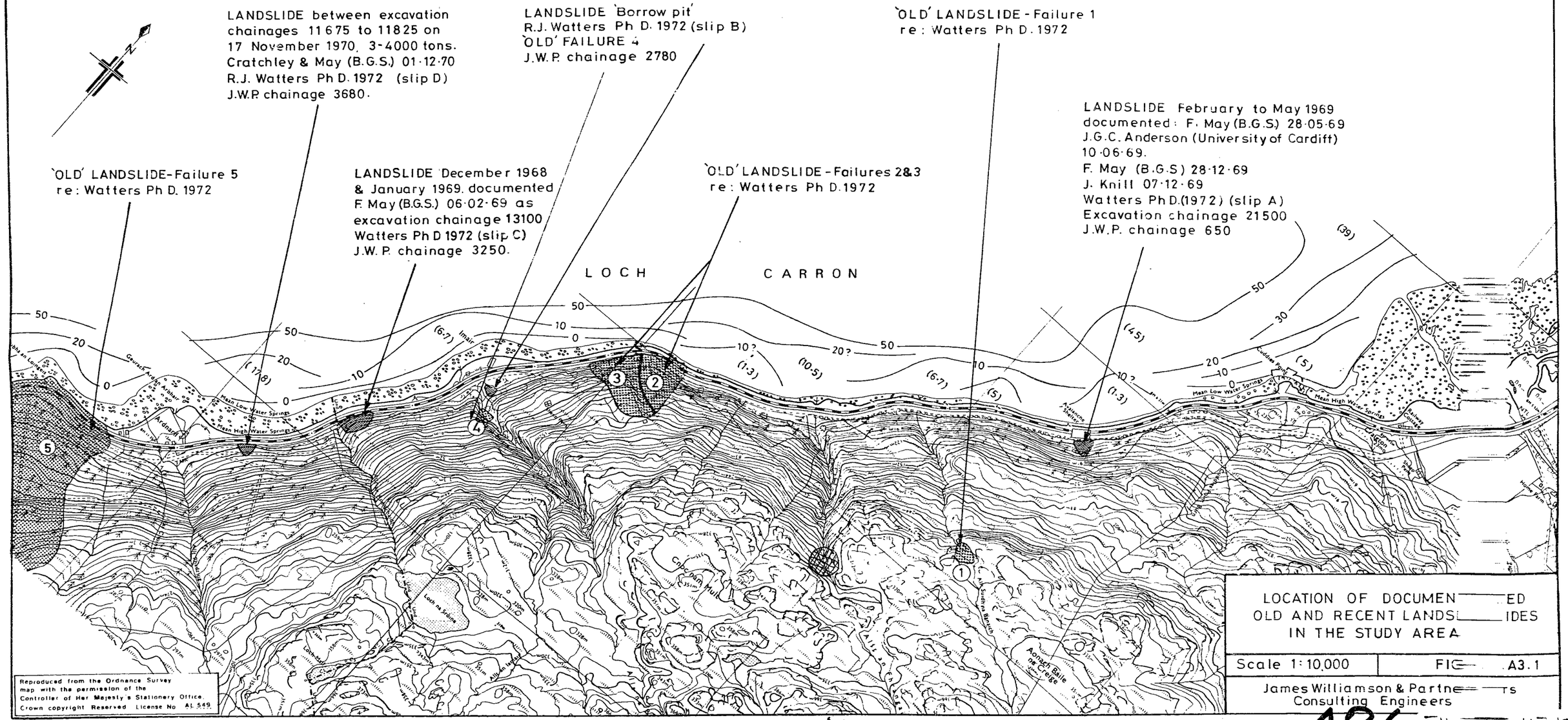


8. Geological profile of the north-east shore of Loch a'Choire Leith. Please see text for description and discussion.

10. APPENDIX: Detailed borehole logs

The first log serves as an index to ornamentations used and a key to the rates of core recovery (column headed 'Exp/Rec') and fracture density (column headed 'Frac den.').

Concluded


'OLD' LANDSLIDE-Failure 5
re: Watters Ph D. 1972
LANDSLIDE between excavation chainages 11675 to 11825 on 17 November 1970, 3-4000 tons.
Cratchley & May (B.G.S.) 01-12-70
R.J. Watters Ph D. 1972 (slip D)
J.W.P chainage 3680.
LANDSLIDE 'Borrow pit'
R.J. Watters Ph D. 1972 (slip B)
'OLD' FAILURE 4
J.W.P. chainage 2780
LANDSLIDE December 1968 & January 1969. documented
F. May (B.G.S.) 06-02-69 as excavation chainage 13100
Watters Ph D 1972 (slip C)
J.W.P. chainage 3250.
'OLD' LANDSLIDE-Failures 2&3
re: Watters Ph D. 1972
'OLD' LANDSLIDE-Failure 1
re: Watters Ph D. 1972
LANDSLIDE February to May 1969
documented: F. May (B.G.S.) 28-05-69
J.G.C. Anderson (University of Cardiff)
10-06-69.
F. May (B.G.S) 28-12-69
J. Knill 07-12-69
Watters Ph D.(1972) (slip A)
Excavation chainage 21500
J.W.P. chainage 650
LOCH
CARRON
Mean Low Water Springs
Mean High Water Springs
Ardslignish
Glenuach
Ardslignish Point
Imair
Cnoc Dam Mullt
Loch na Seilne
Allan Island
Aonach Baile an t-Sneig
Duddon Point
Caolas Glas
Reproduced from the Ordnance Survey map with the permission of the Controller of Her Majesty's Stationery Office. Crown copyright Reserved License No AL 549.
LOCATION OF DOCUMENTED OLD AND RECENT LANDSLIDES IN THE STUDY AREA
Scale 1:10,000
FIG A3.1
James Williamson & Partners
Consulting Engineers
March 87
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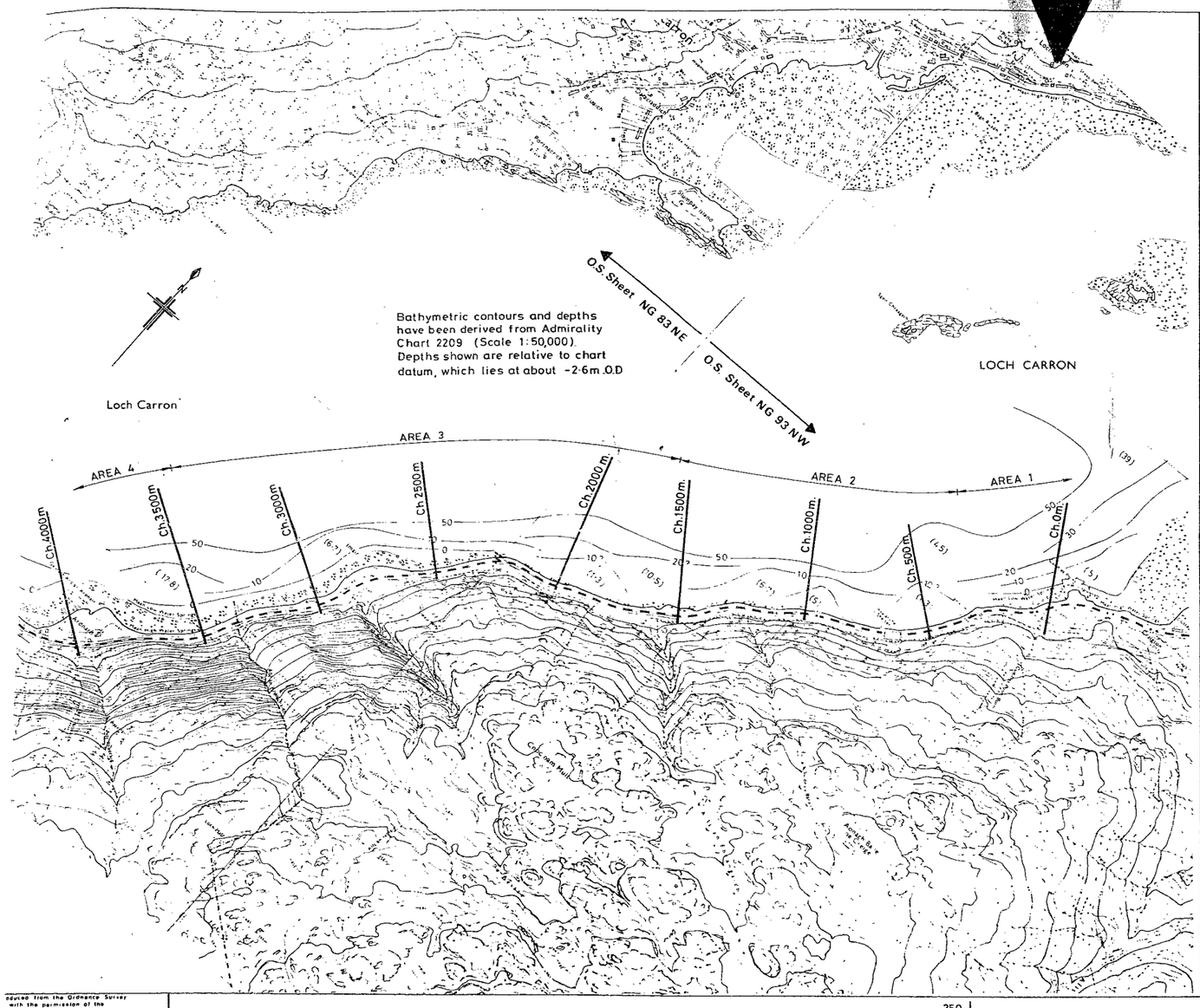
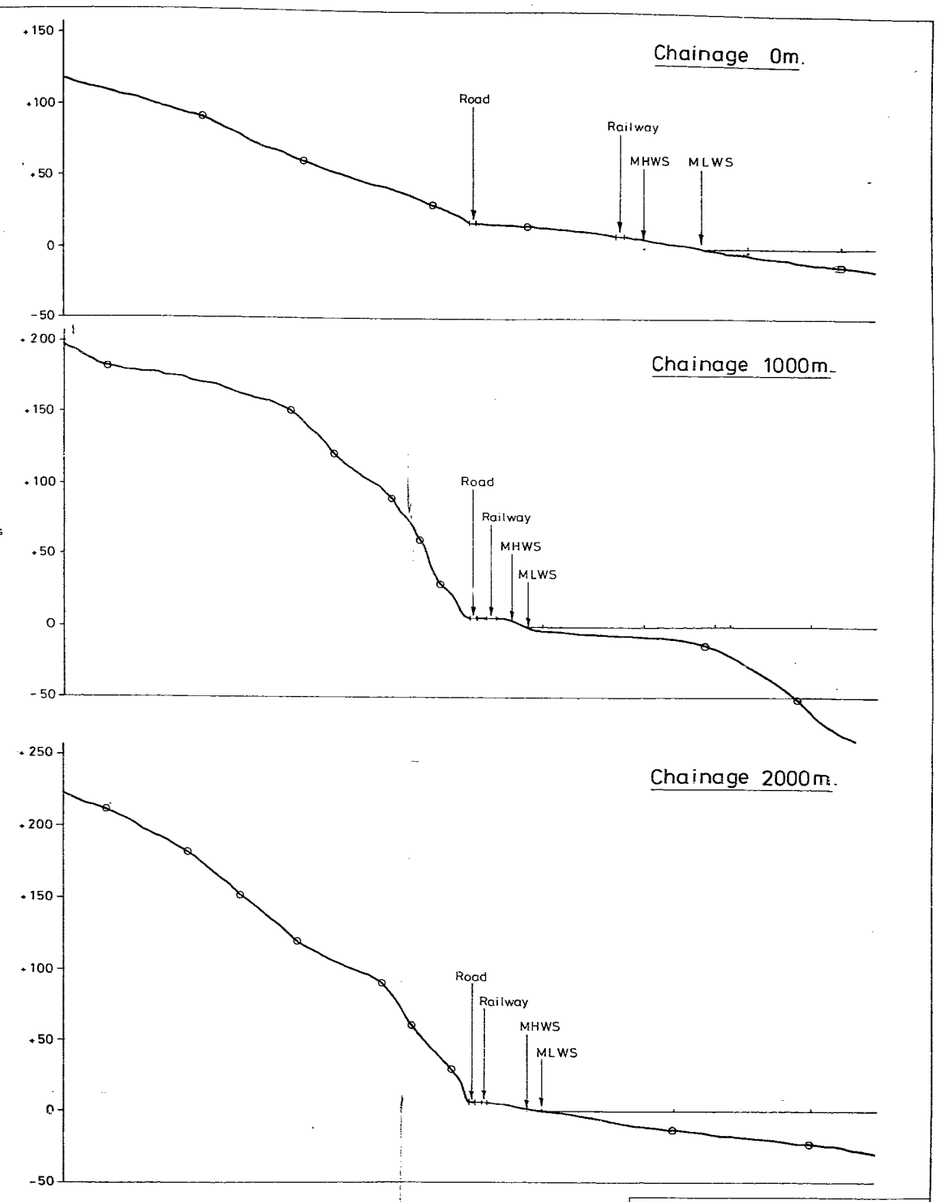
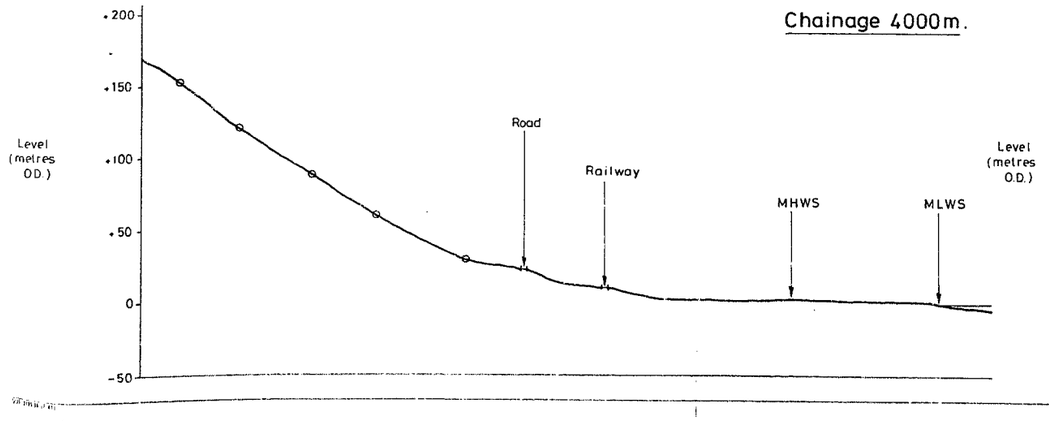
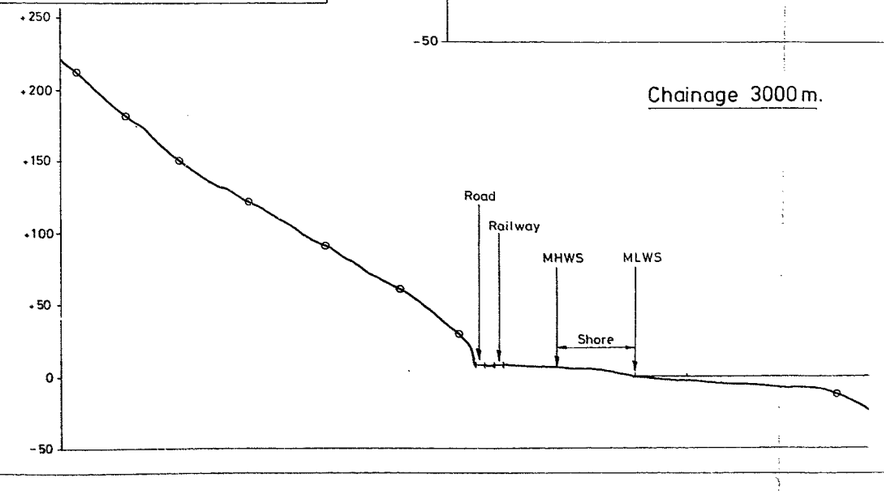








Client

HIGHLAND REGIONAL COUNCIL
DEPARTMENT OF ROADS
AND TRANSPORT

Title

STROME FERRY BY-PASS
PLAN & SECTIONS

James Williamson & Partners
231 St. Vincent Street
Glasgow G2 5QZ
Telephone 041-204 2131 Telex 77425 Telefax 041-248 4102

426

Drawn by	Scales	Drawing No.
M.A.	1:2000 1:10000	2583/1
Checked by T.P.D.	Date DEC. 1986	

FILE 426

HIGHLAND REGIONAL COUNCIL

DEPARTMENT OF ROADS AND TRANSPORT

Stromeferry Bypass
A890

SLOPE STABILITY
(CUDDIES POINT TO ARDNARFF)

Appraisal
Volume 1 : Report

James Williamson & Partners
Chartered Civil Engineers
231 St. Vincent Street
Glasgow G2 5QZ

JANUARY 1987

File

Highland

Department of Roads and Transport
Director G. K. M. MacFarlane
Chartered Civil and Structural Engineer

Highland Regional Council
Regional Buildings
Glenurquhart Road
Inverness IV3 5NX

Telephone (0463) 234121
Telex 75313

Please ask for

Our ref 085-67-426

Extension No

Your ref

Date 22nd April 1986

James Williamson & Partners
Consulting Engineers
231 St. Vincent Street,
GLASCOW G2 5QZ

Soils Laboratory
Diriebught Rd
INVERNESS IV2 3QN

Dear Sirs,

A 890 STROMEFERRY BY-PASS

ROCK FACE APPRAISAL

BRIEF

1. Objective

To investigate the state of instability and degree of risk inherent in the rock faces between Ardnarff and Craigton on A890, Stromeferry By-Pass.

To analyse the modes of failure.

To evaluate alternative methods of remedial works.

2. Means

A preliminary feasibility study report giving an overview of the problem, with recommendations and costs for additional studies, together with a programme.

The overview will consider where minor roadworks improvements may be able to avoid costly and extensive remedial works.

3. Conditions of Engagement

ACE Conditions of Engagement Agreement No 1 for Reports and Advisory Work will apply to the Works.

Payment will be on a time basis, for which schedules of rates

/must

must be supplied.

4. Progress

The Consulting Engineer will submit monthly progress reports with details of current expenditure to the Divisional Engineer and the Principal Engineer (Soils).

Progress meetings may be called for by either party at mutually convenient times.

5. Reports

Four copies of the Reports should be submitted to the Principal Engineer (Soils).

6. Liaison

Details to be discussed at the briefing meeting to be held on Wednesday 23rd April at Divisional Engineer's Office, Loch Carron at 10.30 a.m.

Any queries relating to this brief should be addressed to the Director of Roads and Transport at the address given above.

I am pleased to be able to offer you this brief and look forward to working with you,

Yours Faithfully

pp Director of Roads and Transport.

enc. Details of Briefing Meeting

cc Divisional Engineer (Wester Ross and Lochalsh)
Principal Engineer (Soils)

JW will reply about 2nd May

JT
AGM
WW
P.D.

A890 STROMEFERRY BY-PASS

ROCK FACE APPRAISAL

Briefing meeting to be held on Wednesday 23rd April 1986 in the offices of the Divisional Engineer at 10.30.a.m.

1. Discuss the brief and agree details.
2. Visit the site and define limits.
3. Discuss and agree support required from HRC
4. Agree reporting dates.
5. Agree reporting and liaison channels.

drainage
old digs, bathymetry
climber – JT
Lighting –

mid-end June

Eventual 6m c'way

Aronaff hill bottom → 6m. — poss this year

CONTENTS

A890 STROMEFERRY BY-PASS

ROCK FACE APPRAISAL

SYNOPSIS

During 1986 James Williamson & Partners carried out a stability appraisal of the slopes adjacent to the A890 road over a 4km length along the south-eastern shore of Loch Carron, between Cuddies Point and Ardnarff. Inspections were carried out both from road level and from a lighting cradle. Photographs were taken from a boat on the loch and from a radio controlled aeroplane.

Numerous serious slope hazards have been identified, the majority occurring within the 1.5km length which includes an existing avalanche shelter. Whilst some recommendations for short term security improvements are made, many of the potential stability hazards will require major work. Given the severe space limitations, various alternative long term strategies are considered. The use of a rockfill embankment at the loch edge is discussed in some detail, since this has the advantage of both permitting road widening and increasing the clearance between the road and the hazardous slopes. *

Suggestions are made regarding the possible phasing of the recommended remedial measures which consider the degree of hazard the potential stability problem has been assessed to represent to the road user, to the practicality of carrying out adjacent remedial measures in a single phase and to the speed with which the number of hazards can be reduced as quickly as possible.

* See Conclusions p. 44.

Note: possible long term liability to maintain slopes against failure onto railway. (Liability limited to blasted slopes?). It is reported that HRC has ownership of trees (and natural hillside?). If so, then possible long term liability for whole hillside V12 a V12 railway.

10/2/87

A890 STROMEFERRY BY-PASS

ROCK FACE APPRAISAL

1.0 INTRODUCTION

1.1 Appointment and Layout of Report

In a letter dated 1 April 1986, reference 085-67-426 ANM/AM/S James Williamson & Partners (JWP) were invited by Highland Regional Council (HRC) to undertake a preliminary investigation into, and overview of the state of instability of slopes adjacent to the A890 Stromeferry Bypass and to consider where minor road improvements may be able to avoid extensive remedial measures. The brief for this work was contained in a letter reference 085-67-426, from HRC to JWP dated 22 April 1986. A meeting was held at the office of the HRC Divisional Roads Engineer for Kyle and Wester Ross at Lochcarron on 23 April 1986 to discuss this project and was followed by a brief joint HRC/JWP site inspection. As a result of the meeting and site inspection the JWP proposals for carrying out the work were forwarded to HRC under cover of letter reference WW/EP/2538, dated 8 May 1986, and were accepted by HRC in their letter reference 085/67/426 ANM/LI/S, dated 1 May 1986.

The fieldwork was carried out during Summer/Autumn 1986, and included inspections from road level, from a high reach lighting cradle and from a boat on the loch, which was used to obtain "front elevation" photographs.

The typical forms of potential instability observed on the rock faces and hillside are detailed in Section 3 and, as proposed by JWP, Section 3 also subjectively splits the rock face immediately adjacent to the road into large scale areas based upon the visually assessed differences in their stability characteristics. The large scale areas have been sub-divided into rock faces based upon the subjectively and visually assessed degrees of hazard the potential stability problems represent to the road user.

The appraisal of hazards in the rock faces immediately adjacent to the road is presented in Chainage order in Appendix A1 and is summarised Section 4. The form of remedial measures considered suitable when the potential stability problems are examined as a whole, are considerd in Section 5 in terms of possible forms of long term remedial measures to reduce/remove the hazard to the road user. Section 5 outlines a range of possible approaches for providing the required hazard reduction including widening the existing road and adopting a new road or alignment, and these options are discussed in general terms. Recommendations are made regarding the nature and phasing of further surveys, studies and investigations later in the report.

As the process of determining long term works is likely to occupy a considerable period of time, short term remedial measures to the rock faces and hillside are considered in Section 6 in order to reduce the hazard to the road user by as much as possible and as quickly as possible. These are listed in Appendix A2 and are discussed in Section 6, in terms of the type of measures considered to be appropriate and their phasing.

Finally, Section 7 summarises the proposed scope and phasing of future work including the phasing of short term remedial measures and the phasing of work towards identifying the most economic form of long term measures to reduce the hazard to the road user.

Throughout the report reference is made to photographs to illustrate the potential problem being discussed and to allow it to be located in the field. These are contained in Appendix B which forms Volume 2 of the Report.

1.2 Current Inspection and Remedial Measures

At present, HRC staff routinely inspect the road in the study area to check for rock falls. Small falls are reported to be frequent, and substantial failures are experienced on an annual basis. Immediate remedial works entail clearance of debris from the road and verge. Refurbishment of the rockfall mesh system in place is carried out from time to time.

Annual slope inspections are carried out by staff of Edgar Morton and Partners. The reports from such inspections record any observed deterioration of individual features since the previous visit and make recommendations for remedial measures. HRC implement the recommendations made by Edgar Morton, these generally involving meshing and rock clearance, as well as carrying out their own routine independent in operations and maintenance.

Apart from the use of mesh draped over the rock face referred to above, other works carried out are "buttressing" or infilling undercut areas, displacement monitoring by means of "tell-tales" and general clearance of debris including fallen trees from the hillsides above the road.

1.3 Historical Background

The road by-passing the Strome ferry crossing was completed in 1971. Babtie, Shaw and Morton were the Consulting Engineers.

In 1969, during road construction a major landslip occurred at the site of the subsequently constructed avalanche shelter. The avalanche closed the railway line for several months and was the subject of litigation. A number of geological reports were prepared following this failure, copies of which are held by BGS, Edinburgh. The contents of these reports are summarised in Appendix A3, which also includes an outlie of research work prior to the failure. A PhD report prepared by Watters in 1972 outlines three other lesser failures which also occurred within the study area during road construction.

Major falls involving around 80 tonnes of rock are reported to be ocurring approximately at 1 or 2 yearly intervals and often spill over onto the railway line. BR claim the cost of managing such falls from HRC and carry out daily line inspections. Although BR have not been approached during this study, it is reported that they are satisfied with the current arrangement.

As noted in the report, there are numerous areas of fallen tress over the hillside slopes above the rock faces. It is reported that these were part of a programme of tree planting carried out at the beginning of this century. A few trees fell from the slope approximately 10 years ago, and in around 1980 a programme of tree felling was commenced in order to remove potentially dangerous trees from the slope, leaving only the stumps to about 1.5 m height. However, fallen trees due to storms are a regular problem and in January 1984 a major storm caused an estimated 30 percent of the trees to fall, some to road level, causing temporary closure of both the road and the railway. Most of the fallen trees still lie on the hillside slopes, access for their removal being difficult. Forestry Commission tree removal techniques such as aerial cable ways for drag lines are required if the bulk of the fallen trees are to be removed. Trees have been cleared to a distance of some 20 m back from the crest of the rock slopes in the Ardnarff area. Phocographs of the hillside slopes, including felled tree areas, are included in Appendix B, pages B25 to B30.

The remaining trees are owned by HRC, having been purchased for a nominal sum. However, the legal liability for the trees is believed to still lie with the landowner.

Removal of the trees, whilst advantageous from the view point of the danger of wind fallen trees reaching the road, will expose the soil to erosion and the consequent transport of soil and rock debris down the slope, over the rock slopes and onto the road both in stream channels and between these channels. This is reported to be a particular problem in the area immediately to the S.W. of the avalanche shelter. It is reported that the scale of the erosion is such that the catch pit area formed by the retaining wall adjacent to the shelter can be filled completely in one day.

There are a number of boulders at rest on the hillside slope. These are affected by erosion and eventually slide downwards, a 4 tonne boulder having been reported to have gathered sufficient momentum to have slid over the crest of the rock face, cleared the road and landed on the railway line.

HRC are combatting surface erosion by a programme of planting birch, willow and rhododendron. The first phase of this planting was completed in spring 1985. It is understood that further phases of planting are planned.

2.0 DESCRIPTION OF THE STUDY AREA

2.1 Layout and geomorphology

The A890 road in the study area, shown in drawing 2583/1, accompanying this report runs approximately 4 km south west from Cuddies Point to Ardnarff along the south eastern shore of Loch Carron. The road is of single lane width with passing places over this section and is bounded to the north west by the Kyle of Lochalsh railway line which is located close to the loch shore. The railway was reportedly completed in 1897, and the road, which was completed in 1971, was constructed in the narrow strip of land between the railway and the hillside, with slope excavation being necessary at the narrowest points.

A reinforced concrete avalanche shelter has been built 0.7 km from Cuddies Point at the site of a major landslip which originated in the higher natural hillside slopes during slope excavation for the road.

Steep natural and blasted rock slopes, up to 25 m to 30 m in height, lie immediately adjacent to the road on the south eastern side over much of the study length.

The road surface lies at a level between +5 and +10 m O.D. and the "crest" of the steep slopes immediately adjacent to the road is generally at about +30 m O.D. over much of the area under consideration. Above this 'crest' the hillside slopes continue to rise rapidly in most areas, often at overall angles of about 40 to 45 degress, but generally flattening out to 20 or 30 degress above, about +100 m O.D. Above the +300 m O.D. contour, the ground flattens further, and the hilltop level is generally in the range +300 to +350 m O.D. at a distance of some 900 m from the road. Simplified cross-sections through the hillsides are shown in drawing 2583/1. These are based on the Ordnance Survey 1:10,000 scale maps. The contour interval is such that the steep slopes immediately adjacent to the road cannot adequately be shown in these sections.

The near vertical natural slopes adjacent to the road are interpreted as "raised" natural sea cliffs and although the road and railway are to some extent constructed on fill materials in this area, they are considered to be located substantially on a raised beach. This is described as the "20 foot" raised beach in a landslip report prepared by F. May in 1969. However, part of the material present at or just above the present sea level represents alluvial fan deposits from a number of streams whose courses run directly north west down these hillside slopes to the loch, passing in culverts beneath the road and the railway. The stream gullies are very pronounced features with steep sides.

A number of 'old' landslips have been recorded in the study area, these having occurred within the roughly 10,000 year interval since the last glaciation. These are discussed further in Appendix A3.

2.2 General Geology

The solid (bedrock) geology of the slopes adjacent to the road consists of complex Precambrian strata. Inspection of the Geological Survey "One Inch" sheet 82 indicates that all but the northernmost part of the area under consideration lies within "granulitic schists" of the Moine Series at road level, this being overlain by "pelitic schist" which is in turn overlain by ancient Lewisian gneisses. Lewisian strata occupy much of the high ground south east of the Loch, and are shown to extend down to road level near Cuddies Point. The map indicates a consistent south-easterly dip of metamorphic foliation and bedding.

The main dislocation of the well known Moine Thrust is considered by the BGS to intersect the coast near Stromeferry pier and then run beneath Loch Carron. It does not, therefore, enter the study area, although it may run roughly parallel to the shore in the Ardnarff area. However, other flat-lying thrust structures may be present in the hillsides of the study area.

The severity of tectonic events in this area is indicated by the presence of the substantial mass of older Lewisian lying above the relatively younger Moinian. This inversion may be due to folding or

thrusting. Road level inspections confirm the presence of metamorphic strata dipping towards the south-east, the slopes being formed roughly parallel to the strike of the foliation. Tight, flat lying folds are present. In the slopes near Ardnarff, the lithology changes to "sandstones" resembling those of the Torridonian Series.

More detailed geological mapping information is available from manuscript "6 inch" maps held by BGS Edinburgh. These were prepared by Hinxman and others and form the basis of the "1 inch" sheets published in 1913. More recent geological mapping has been carried out by F. May. A copy of his 1959 PhD report is also held by BGS Edinburgh. This is briefly outlined in Appendix A3 of this report.

2.3 Chainage system

A local chainage system was established by HRC for the purpose of this study. Chainage zero is located near the car park at Cuddies Point (Photograph 1/1, Appendix B) and the end of the section of slope under consideration lies at chainage 3850 m near Ardnarff (Photograph 4/29). Painted marks at 100 m intervals have been provided on the road surface and on the rock face itself. Chainage marks on the loch side of the road should be ignored.

3.0 LARGE SCALE AREAS OF DIFFERING ASSESSED INSTABILITY

3.1 General

The area under study has been divided into four large scale zones based upon the assessed differences in their stability characteristics. The detailed stability appraisal of the rock faces immediately adjacent to the road is presented in Appendix A1. This is summarised in Section 4, which also includes preliminary observations on the stability problems presented by the "hillside" slopes.

The large scale zones are:-

Area 1. Chainage 0 to 324 m

Area 2 : Chainage 324 to 1522 m

Area 3 : Chainage 1522 to 3494 m

and Area 4: Chainage 3494 to 3850 m

The stability assessment of each of these areas is summarised below in terms of four generalised types of instability which have been observed. These are:

i) Type 1. Rockfalls from the steep rock slopes, both natural and blasted, which lie immediately adjacent to the road.

ii) Type 2. Some of the natural slopes, whilst steep, are largely overgrown and the assessed hazard to the road user from these slopes is less than Type 1.

iii) Type 3 Landslips involving sliding and/or rotational failure of soil/rock from the natural hillside slopes which lie above the crest of the rock slopes immediately adjacent to the road.

iv) Type 4. Fallen trees are widespread over the hillside slopes above crest of the roadside rock slopes. It is understood that this is storm damage and is a continual problem. As well as the fallen trees themselves, soil and rock loosened by the uprooting of the trees also represent a potential hazard to the road user. Also included in this category are the boulders and debris loosened by rain. These tend to be discharged down the stream gulleys.

Type 1 instability is particularly significant between Ch.0 and 1500 and involves both natural and blasted rock faces, whilst Type 2 instability occurs sporadically between Ch. 1500 and 3300. Type 3 (landslip) instability has occurred at the avalanche shelter location. According to the "One Inch" geological map, an ancient slip is present at approximately chainage 2220 m. This area now appears to be well vegetated and lacking in rock exposures. Other "old" failures reported are outlined in Appendix A3. The potential hazard from fallen trees (Type 4) is concentrated in Area 2.

3.2 General Stability Assessment of Large Scale Areas

i) Area 1: Chainage 0 to 324 m (Photographs, pages B1 to B4)

Relatively low rock slopes are present adjacent to the road, locally rising to about 6 m high, and posing a limited "Type 1" stability hazard. The hillside slopes remote from the road are not considered to represent a hazard to the road user. Most failures from the slopes adjacent to the road would be expected to be contained on the verge.

ii) Area 2: Chainage 324 to 1522 m (Photographs, pages B4 to B18)

This area includes the most pronounced stability problems. These are Type 1, 3 and 4 hazards. Over most of the length there is considered to be a severe risk of debris striking and possibly blocking the present road alignment. Certain preventative measures are already in place, including the avalanche shelter and slope meshing. Steel barriers have been erected to improve

security at some points, and masonry clad concrete infill buttresses have been formed at the toe of the slope to support local overhangs. Monitoring "tell tales" have been previously installed at some potentially unsafe blocks.

iii) Area 3: Chainage 1522 to 3494 m (Photographs, pages B19 to B22)

"Type 2" hazard slopes (raised sea cliffs) are present at the following locations:

Chainage 1522 to 2020 m
2365 to 2425 m
3005 to 3115 m
3225 to 3305 m

However, these slopes appear not to show active deterioration, and are partly overgrown. Some dilation is evident, this is considered to represent slow and long term deterioration. The cliffs are thought to have been formed by marine erosion in Neolithic times, at about 4,000 years before the present day. They are therefore considered to represent considerably less risk to the road user than the excavated slopes.

iv) Area 4: Chainage 3494 to 3850 m (Photographs, pages B22 to B24)

Significant "Type 1" hazardous slopes are present within this area. These are often in the range 10 to 15 m in height and merge with steep upper slopes. It is considered that there is a hazard from falling blocks striking the road at these locations. Preventative works in the form of meshing of the slope have previously been carried out.

3.3 Summary of preliminary observations

The most severe stability problems are contained in Area 2 (Chainage 324 to 1522 M) where the road is threatened by falls from the rock slopes immediately adjacent to the road (Type 1), potential landslips from the upper slopes (Type 3) and falls of debris from the upper slopes (Type 4).

At those locations where slope stability problems have been identified, the verge is often narrow and in many places non-existent. Any rock which falls lands on the road. Minor realignment of the road to create a verge/rockfall catchment area is inhibited by the presence of the railway line which lies immediately adjacent to the road.

4.0 SUMMARISED DETAILED APPRAISAL

4.1 General

The potential stability problems which have been identified on the rock face immediately adjacent to the road are detailed in Appendix A1. In addition to identifying the nature of the stability problems, they are classified in terms of the potential hazard they represent to the road user using the classification presented in Table 4.1. Recommendations for future short term remedial action are proposed in Appendix A2. These include measures ranging from further inspection and monitoring through to removal.

Appendix A1 lists the potential hazards identified in Chainage order. This section summarises the more significant potential problems in the order of their assessed hazard rating. This forms the basis of the discussion of both the long term and short term remedial measures and their phasing in Sections 5.0 and 6.0, respectively.

The natural hillside slope above the crest of the rock face has been photographed. General photographic views of the slopes in Areas 1, 2 and 4 are contained in Appendix B, pages B25 to B30. These pictures were obtained from a boat. Insufficient detail is available at this stage to carry out a detailed stability appraisal. However, the hillside slopes are considered in general terms in Section 4.4.

4.2 Hazard Rating

The potential problems which have been identified are the result of a visual assessment and have been subjectively classified in terms of the hazard they represent to the road user. The rating of the hazard in terms of its effect upon the road is detailed in Table 4.1.

The hazard rating of a given area is a function of the slope angle, height and shape, together with the verge width and the presence of a ditch or barrier, and the condition and potential instability of individual features. An area with a high hazard rating is also likely to have the potential for less hazardous failures either from smaller blocks nearby or from partial failure of the main mass.

Hazard Rating	Consequences of Likely Failure
EXTREME HAZARD	Large unstable masses where failure probably will cause entire blockage of the carriageway
MAJOR HAZARD	Likely failure probably will cause severe obstruction or blockage of the carriageway
MODERATE HAZARD	Likely failure probably will not be retained by the verge and will effect part of the carriageway
MINOR HAZARD	The likely failure is either small scale or probably will be retained by the verge but may have effect on the carriageway
NEGLIGIBLE HAZARD	Likely failure is small scale and probably will have an insignificant effect, if any, on carriageway
NO HAZARD	No likely failure mechanisms are present, or if present, they will not affect the road.

Table 4.1 : Description of HAZARD Classification

4.3 Rock Slopes immediately adjacent to the Road

The more significant hazards(i.e. EXTREME and MAJOR) which have been identified on the rock slopes immediately adjacent to the road have been listed in Table 4.2. MODERATE HAZARDS are listed in Table 4.3

The general description of the stability problems on each of the four large scale areas identified in Section 3 are:-

i) AREA 1 - CHAINAGE 0-324M

The rock face is typically 4-6m high but rising to 8m between Chainages 83-167. There are no significant rock slopes adjacent to the road between Chainages 253-300. The faces are generally subvertical with occasional undercut blocks (e.g. Chainages 48, 55, 135-153) associated with the higher rock faces but the 3-6m high faces are generally inclined at 60-75°. The upper slope rises gradually, at approximately 10°, although immediately at the crest of the rock faces it may have an angle of 45°. The upper slope area has an almost complete vegetation cover of grass, bracken, gorse and the occasional tree and shrub, all of which partly conceal outcrops. Verge width is typically 1.5m but between Chainages 83-130 (the higher faces) the maximum width reaches 4m.

Mesh has been installed on the rock face between Chainages 130-163.

No EXTREME HAZARDS are present along this section, but MAJOR HAZARDS occur at ch. 109-120, 130-157. The overall Hazard in this area is thus MAJOR.

ii) AREA 2 - CHAINAGE 324-1522m

This area consists of the steepest, highest and most continuous rock faces within the area of this appraisal which, with a very narrow verge, (often less than 1 metre wide) can be classified as a MAJOR HAZARD overall. However MINOR to EXTREME HAZARDS have been identified at individual locations on the faces.

Remedial and protective measures have previously been applied to the road and rock faces as mentioned in Section 3.2 and their locations will be noted in the description below.

A prominent feature of Area 2 is the existence of a large scale landslip scar in the upper slopes above the avalanche shelter between Chainages 610 and 674m.

Area 2 is characterised by 15-35m high subvertical to vertical rock faces, estimated to rise up to 35metres above the road, and generally in the range 25 to 30m high which have been partially or wholly formed by blasting. The faces have been meshed along approximately 350m (29%) of the length with plastic coated chain link mesh. This has been torn at several locations (e.g. Chainages 833 to 850)due to scaling and the occurence of rockfalls after its installation.

Streams running off from the hillside either flow directly down the rock or have eroded small gullies which contain eroded colluvial material of soil, sand and boulders, and are often partially vegetated. Some of this debris has rested on ledges on the rock face, vegetation has become established, mainly grass and gorse, and in places young conifers are growing out of the near vertical face.

The upper slopes are typically inclined at approximately 45°, and are vegetated with grass, bracken and pine forests through which outcrops of rock may be seen. The 'hillside' slopes are discussed in more detail in Section 5.0.

TABLE 4.2

LOCATIONS OF EXTREME AND MAJOR HAZARDS

CHAINAGE	HAZARD
AREA 1	
109 - 120	MAJ
130 - 135	MAJ
135 - 148	MAJ
148 - 157	MAJ
AREA 2 *	
330 - 336	MAJ
336 - 347	EXT
349 - 363	MAJ
380 - 385	EXT
380 - 390	MAJ
395	EXT
400 - 420	EXT
420 - 426	EXT
432	EXT
433 - 436	EXT
436 - 454	MAJ
454 - 500	MAJ
528 - 533	EXT
533 - 546	EXT
567	MAJ
572 - 580	EXT
590	EXT
596 - 600	EXT
683 - 692	MAJ
706 - 717	MAJ
790	MAJ
833 - 956	MAJ
993 - 1012	EXT
1110 - 1112	MAJ
1160 - 1165	EXT
1174 - 1193	MAJ
1258 - 1265	MAJ
1271	EXT
1284 - 1293	MAJ
1360 - 1370	MAJ
1395 - 1430	MAJ
1414	MAJ
1434 - 1441	MAJ
AREA 3	
(NONE)	
AREA 4	
3676	MAJ
3682	MAJ

* EXTREME and MAJOR HAZARDS are also presented by fallen trees and loosened debris in the hillside slopes within Area 2.

TABLE 4.3

SUMMARY OF MODERATE HAZARDS

Chainage	Nature of Hazard
AREA 1	
158	Undulating "sliding" joint
162-163	Dilated mass above overbroken "pocket"
208	Dilated toppling overhang
213-216	Dilated crest block on "sliding" plane
216-222	Crest overhang
AREA 2	
345-357	Joints dip out of slope face
380-390	2m high potential sliding mass 3m above road
436-530	Loose crest blocks
684	Dilated wedge 3m above road
735-779	"Scree" above gabion wall
810-834	"Scree" erosion
967-980	Undercut outcrop
1026	Undercuts 2m above road
1092-1204	MODERATE and MAJOR hazard undercut masses
1482-1522	Possible ravelling collapses
AREA 3	(None)
AREA 4	
3494-3773	Possible ravelling collapses

AREA 2 (Cont)

Extreme Hazards occur at ch. 336-347, 380-385, 395, 400-426,432,433-436, 578-546, 572-580, 596-600,993-1012, 1160-1165 and at ch. 1271 and Major Hazards at ch. 330-336, 349-363, 380-390, 436-500, 567, 683-692, 706-717, 790, 833-956, 1110-1112, 1174-1193, 1258-1265, 1228-1293, 1360-1383, 1395, 1400, 1407, 1414, 1419, 1430 and at ch. 1434 to 1441.

iii) AREA 3 - CHAINAGE 1522-3494m

This area has a variable nature ranging from nearly vertical old sea cliffs deeply incised with stream gullies, some now dry, to 50° to 60° scree slopes and gently inclined vegetated slopes. Blasting along the line of the road has been identified in this area only between ch. 3220-3300 and the old cliff line is approximately 70% vegetated with deciduous trees. The scree slopes are almost wholly vegetated with grass and trees.

The hazard rating of Area 3 is mainly in the range NO HAZARD to MINOR. Although large blocks are present in some "cliff" areas (Ch. 3220 to 3300, and 3455 to 3465) these are not thought to be in an actively deteriorating condition.

iv) AREA 4 - CHAINAGE 3494-3850m

This area consists of rock faces, some up to 30m high. However between Chainages 3494 and 3585 there is a 15 to 20m high rockslope inclined at approximately 50° to 70°. The rock material here is fractured "sandstones" which appear less affected by metamorphism than elsewhere. A reddish brown mantle of weathered material is present, and active small scale ravelling is occurring. From Chainage 3585 to the end of Area 4 the rock faces are typically subvertical and consist of more resistant bedded rocks (apparently "sandstones") which possess numerous undercut and dilated blocks, as well as evidence of ravelling.

The slopes immediately above these faces are generally inclined at approximately 30° and at the crest of the rock face between Chainages 3600-3700m, that the superificial deposits may be seen to be a thin veneer. The upper slopes are covered in conifers and grass.

No Extreme Hazards have been identified in the slopes above the road in area 4, but Major Hazards are present a ch. 3676 and 3682, in addition to the lesser Hazard ravelling between ch. 3494 and 3585.

This area is generally considered to represent a MODERATE HAZARD to the road user, whilst containing occasional isolated features each of which would represent a MAJOR HAZARD to the road user. Mesh on the face between Chainages 3588 and 3630 and 3662 and 3680 helps in retaining the small blocky failures within the verge.

4.4 Hillside Slopes Above Rock Faces

The information available on the hillside slopes is insufficiently detailed to identify specific problems. It is recommended that consideration be given to more detailed aerial photography to allow the hillside slopes to be appraised in detail. However the hillside stability problems are considered below in general terms on the basis of the information available at the time of writing.

The potentially hazardous areas of the upper "hillside" slopes are mainly concentrated in Area 2, which includes the location of the previous major landslip at the location of the avalanche shelter. However, other problems have been identified, such as the transport of slope failure debris down the stream channels and the felling of trees by strong winds.

For completeness, the upper slopes of the whole study area are described below. These are "preliminary" observations, being based on photographs taken from a boat, "trial" photographs from a radio-controlled aeroplane and inspections from road level. The visibility of the hillside slopes from road level is generally poor, the clarity of the aerial photographs suffered from camera shake due to low light levels and the scale of the photographs from the loch was small.

The following notes concentrate on the area of hillside within approximately 100 metres of the road.

i) Area 1 - CHAINAGE 0 to 324

Area 1 includes gently inclined hillside slopes where no hazards to the road have been identified. The rock outcrops present are considered to be too remote from the road represent a hazard to the road user. NO HAZARD.

ii) Area 2 - CHAINAGE 324-1552

Chainage 324 to 600

The upper slopes are gently inclined and well vegetated from chainage 324 to approximately 400. Beyond chainage 400, the upper slopes steepen to about 40 degrees. Within the afforested area, it is estimated that about 30% of the conifers have been felled by wind. However, whilst the fallen trees appear fairly secure, being "entangled" with the remaining standing trees, they are conisdered to present an EXTREME hazard subject to further study.

The small stream which discharges down the lower slope face near chainage 500 originates in a prounced gully, where some debris transport is suspected.

Steep outcrops are visible within the upper slope area. Active instability has not been identified in these.

Chainage 600 to 700 (Avalanche shelter area)

The scar of the landslip which occurred prior to the construction of the shelter is visible in the slopes directly above the shelter. There is evidence of continued ravelling from the scar area, but this does not appear to constitute a hazard to the road. Within the south-western part of the scar, a failed rock outcrop may be seen. This has the appearance of a major wedge type failure. Given the presence of the shelter, this section is considered to present NO HAZARD.

Chainage 700 to 1522

The steep (over 40 degrees) hillside slopes pose a significant threat to the road over this section. Large numbers of fallen trees are present, particularly between chainages 800 and 1450. It is reported that a proportion of the original total number of felled trees has been cleared. Numerous rock outcrops may be seen in the less vegetated areas. This area is considered to present potential MAJOR and EXTREME HAZARDS.

Areas of actively ravelling colluvial material (including cobbles) are present within depressions near chainages 760 (exposed in lower slope), 820, 960, 980/990. Some of these features may have been initiated by trees being uprooted. Debris is also becoming released from other locations outside the areas identified above, and it tends to be "funnelled" down the stream courses.

One of the most active stream courses is at chainage 730, where accumulated debris is at present contained behind a wall constructed from precast concrete panels. Other stream courses are present near chainages 820, 840, 890, 970, 1050, 1140, 1220 (large stream), and 1430. These have been identified from road level and may be seen in photographs taken from a boat in the loch and which are included in Appendix B.

To summarise, a serious threat is posed by falling rock and tree debris being projected onto the road. The likelihood of further large landslip failures has not been identified, although, clearly the area has the potential for this form of instability.

4.4.3 Area 3 - CHAINAGE 1552 to 3494

Over Area 3, the hillside slopes are generally heavily wooded, but they do not show the storm damage which is evident in Area 2. Whilst the trees may obscure potentially hazardous features, they are also likely to provide a degree of security in binding the surface zone with roots, inhibiting rainwater runoff and possibly acting as a "barrier" to any rockfalls from outcrops.

The possible hazard from debris being channelled down stream courses is most pronounced between chainages 1850 and 2000 m. However, as noted the risk of this is not thought to be as severe as in Area 2. Large rock outcrops are visible within the hillside slopes near Chainage 2300. Whilst active deterioration has not been observed at these outcrops from road level observations, should any rock fail, it may not be contained in the lower (vegetated) slope and would probably strike the road.

4.4.4 Area 4 - CHAINAGE 3494 to 3850

No hazards from the hillside slopes have been identified over this area: the slopes appear less steeply inclined than in the remaining areas. Conifers present near the "crest" above the road have not been storm damaged. NO HAZARD.

5.0 LONG TERM IMPROVEMENT OPTIONS

5.1 General

As indicated in Section 4, numerous EXTREME, MAJOR and MODERATE hazards to the road user have been identified. In Area 2 the problems are particularly severe and widespread. Apart from the limited remedial measures which it is considered can be safely carried out to reduce the hazard to the road user in the short term, which are discussed in Section 6, major works will be necessary to provide a long term improvement in the hazard to the road user. Whilst it is likely that the best solution in terms of the road alone would be to move the road out from the rock face sufficiently far to create a catchpit, this is prevented in many areas by the single track railway line which occupies the available land between the road and the loch. Given that the railway will continue to operate, the cost of moving the road would be increased by the need to cross or reposition the railway. In view of the apparently restricted nature of the utilisation of this railway line, any works which involve temporary closure of the line are likely, it is considered, to seriously prejudice the existence of the line. It is recommended that this be investigated before movement of the road is seriously considered .

It is understood that HRC would wish any improvement in the road to include allowance for the road to be widened. However, as noted previously those sections of road with the more significant hazard rating are at those locations where the road has had to be located close in to the rock face to avoid clashing with the railway line. This is particularly the case in Area 2.

Three options to overcoming the slope stability problems are outlined below.

i) Option 1. The road remains at or near its present alignment and width. Two methods are available to improve security: either very substantial slope works are carried out (reprofiling, anchoring, reinforced concrete, heavy meshing etc.) or a road protection scheme is used.As noted in 5.1 above, the proximity of the railway precludes minor road realignments to provide a "catchpit" or "rockfall zone" in the more hazardous areas. However, where the road is slightly higher than the railway, as within Areas 3 and 4, there may be scope for moving the road onto fill supported by a small retaining structure located adjacent to the railway track. The type of protection works envisaged would be structures such as extended avalanche shelters, avalanche barriers, or an elevated road. These measures would supersede or supplement the 'short term' measures outlined in Section 6, which are only intended to provide a limited reduction in potential hazard.

As an alternative, the 'long term' solution could entail completion of the 'short term' measures followed by indefinite monitoring and maintenance. However, it is considered that this constitutes a partial solution given the likely remaining hazard potential.

ii) Option 2. The present road is abandoned in favour of a new route, perhaps a fixed link near the old ferry crossing or a "high level" road near, say, +300 m OD, along the hills parallel to, and south of, the present route.

iii) Option 3. The road remains at approximately its present route, but widened to two-lanes and separated from the slope by a rockfall zone. This implies an increase in the land space necessary to accommodate the road, the railway and the rockfall

zone (say, 6 m). This widening could be achieved either by excavating into the hillside slopes and using the spoil to form an embankment extending into the present loch or by keeping the present rock faces and creating an embankment into the loch from imported material.

5.2 Option 1: Major slope stabilisation

Major slope stablisation works involving reprofiling, anchoring etc. would follow on from the "short term" works discussed in Section 6. Two possible forms of slope stablisation have been considered. These involve either securing individual areas of slope (Option 1.1) or road protection works similar to the existing avalanche shelter (Option 1.2).

Area 2 has been identified as the area requiring the majority of the remedial works. However, faces have been identified in areas 1, 2 and 4 which require long term remedial measures.

(i) Option 1.1: Major Stability Works

Following the short-term work to the slopes adjacent to the road, supplementary work to the slopes would include the following:

local rock trimming,
rock bolting, anchoring and dowelling,
mass concrete buttresses and "dentition",
sprayed concrete,
heavy mesh.

The nature of these works is outlined below. Specific locations have not yet been determined.

(a) Local rock trimming

This would involve the removal of projecting or unstable masses considered too large for inclusion in the short term works.

(b) Rock bolting, anchoring and dowelling

Some suggested "anchoring" support locations are indicated in Section 6 in the context of short term works. For the long term, more extensive anchoring works would be envisaged, and would include the "trimmed" areas where necessary.

(c) Mass concrete buttresses and "dentition"

The further use of infill concrete may be appropriate to support some undercut areas. This has already been carried out at the toe of the slope at locations within Area 2, and future applications would include cavities on the slope faces themselves. Such structures would normally be dowelled or bolted to the rockmass.

(d) Sprayed concrete

Sprayed concrete may be applied to prevent ravelling. The concrete could be mesh or fibre reinforced where necessary. The long term durability in terms of wet and freezing conditions should, however, be considered. The use of a small test panel would be desireable in order to assess durability. The concrete itself could become a hazard if the bond with the rock deteriorated.

(e) Heavy mesh

This may be suitable to contain the larger size ravelling debris which can damage or burst through lighter meshes such as the chain-link and polyprophene meshes at present in use. Following scaling, the type of mesh installed would be either "double twist galvanized", or "torpedo" mesh for larger potential blocky failures. It would be envisaged that the mesh would be "draped" down the face as at present, rather than fixed at numerous points. The intention would be to channel any falling debris rather than retain it on the face.

These substantial slope works represent an extension of the 'short-term' remedial works.

The hillside slopes within Area 2 would require a number of stabilisation and debris control measures including the following:

clearance of stream channels,
clearance of fallen trees,
felling of conifers,
construction of surface water interceptor channels,
"rockslope" treatment to rock outcrops,
establishment of shrub vegetation,
barriers and/or fences on the slope itself to restrain/impede rolling debris.

Since some debris would still be expected to be transported down the stream channels, catch pits should be formed at road level. These would need routine checking, and probably clearance on a seasonal basis.

Although some slope trimming is included in Option 1.1, more extensive slope reprofiling is considered to be a distinct alternative operation and this is discussed more fully in the context of Option 3.

(ii) Option 1.2 : Road protection works

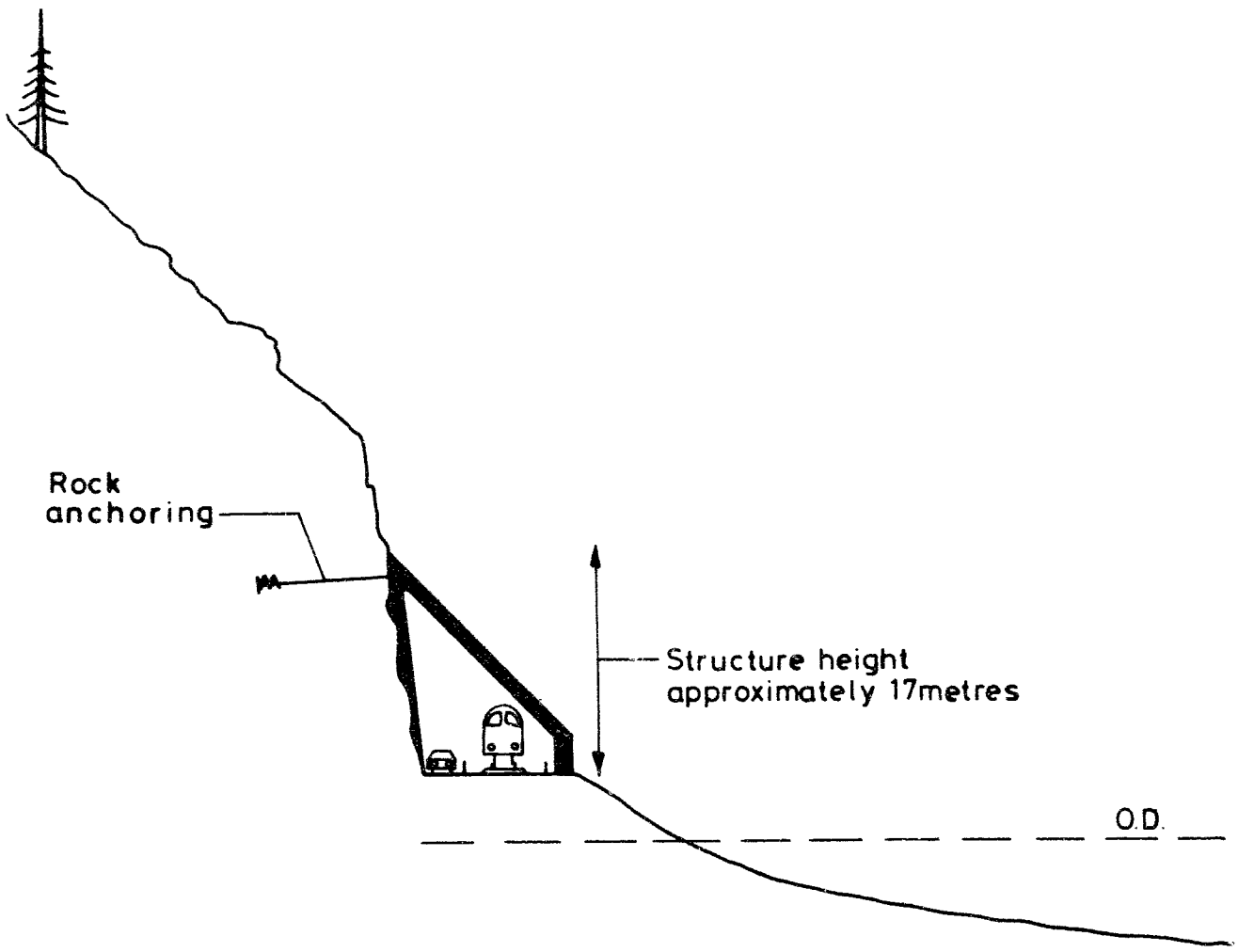
The existing avalanche shelter within Area 2 could be extended, although difficulties could be envisaged with traffic lines of sight, passing places, and illumination.

Without some repositioning of the railway, it would probably be necessary to have the roof of such a structure span both the road and the railway.

An alternative structure could have a steeply inclined roof in order to deflect, rather than retain, falling debris, as showin in Figure 5.1. Stabilisation works would be necessary to prevent rockfalls from the section of slope within the canopy and the structure should probably have to be anchored to the slope. This Option would only locally be applicable, and would have to be used in conjunction with other measures.

✳ Rockfall deflector canopy

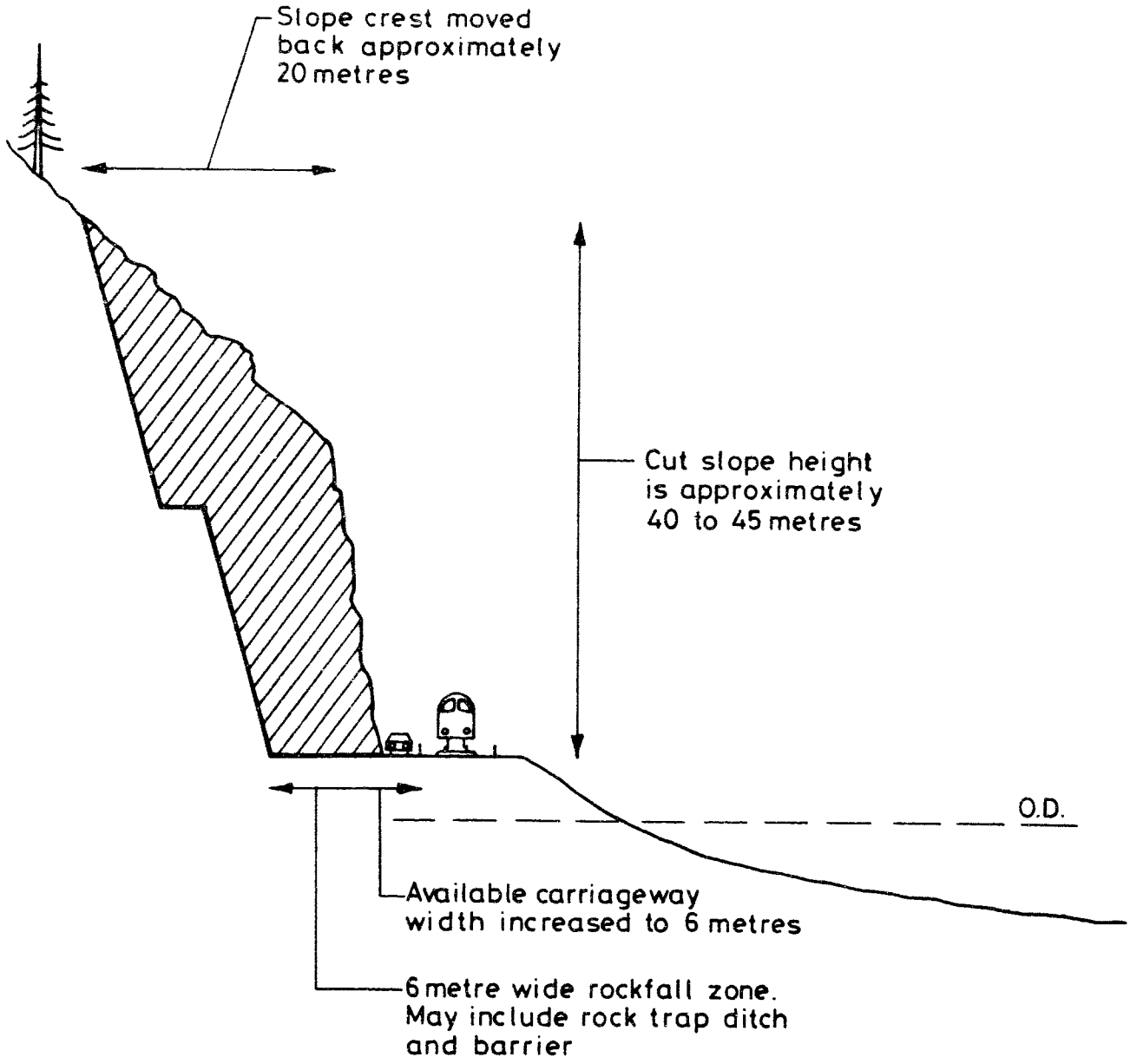
✳ Example assumes no repositioning of road or railway



OPTION 1. 2

FIGURE 5 : 1

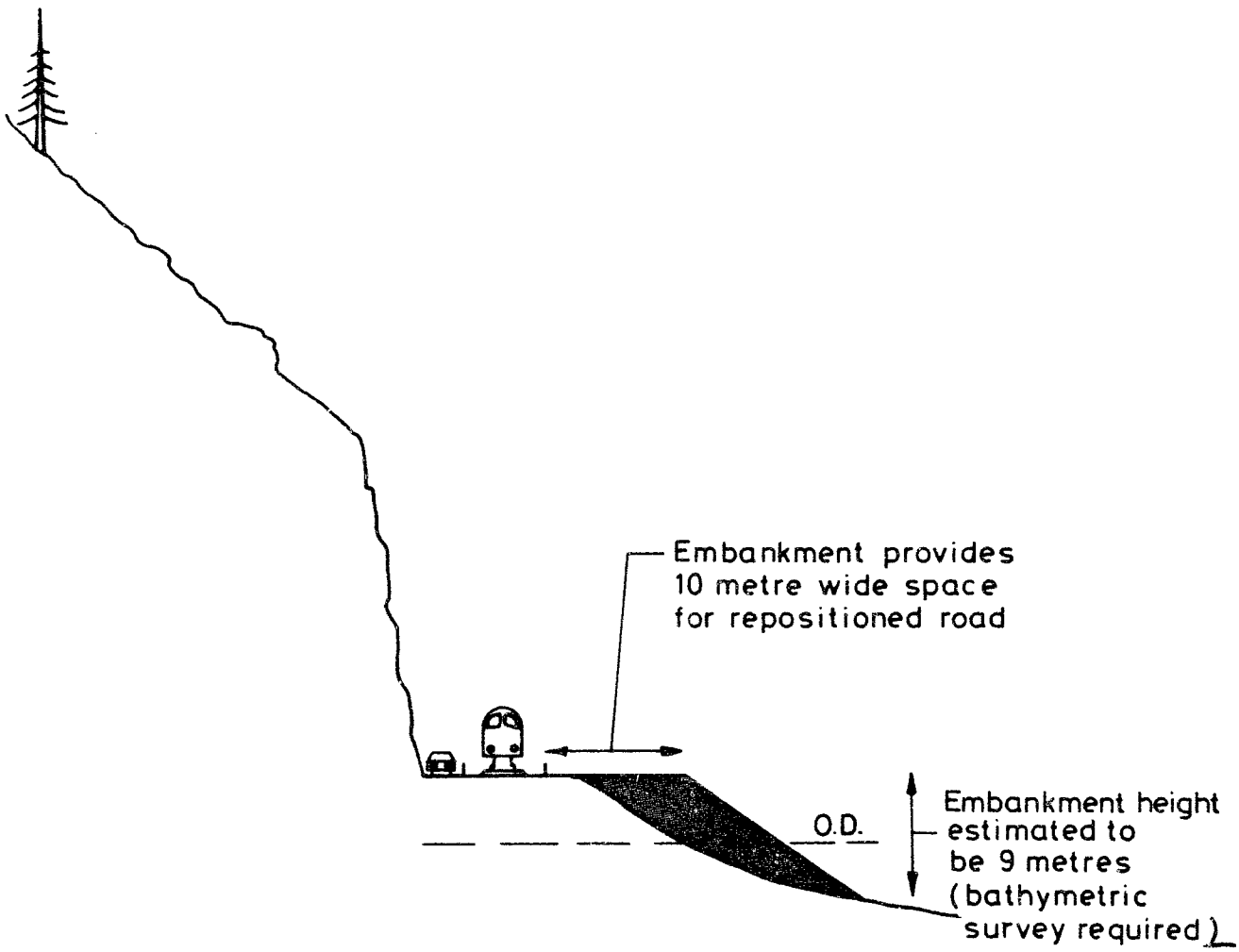
- ✳ Major slope reprofiling
- ✳ Widen road towards slope
- ✳ Provide 6 metre wide rockfall zone
- ✳ Railway alignment remains unchanged



OPTION 3.1

FIGURE 5 : 2

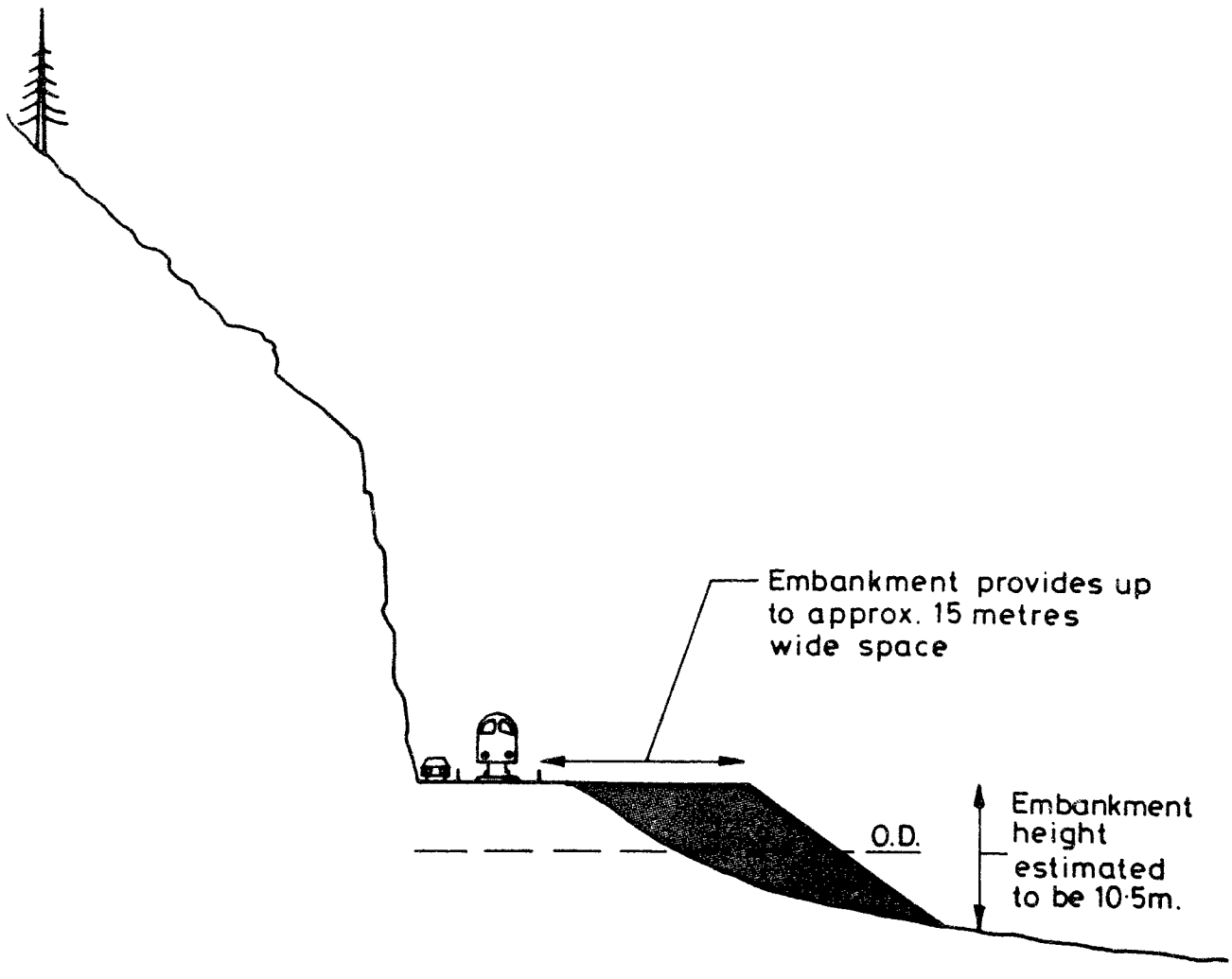
- ✳ Embankment without slope reprofiling
- ✳ Embankment formed from imported fill
- ✳ Road is moved to Loch-side of railway
- ✳ Railway remains in present position



OPTION 3.2

FIGURE 5:3

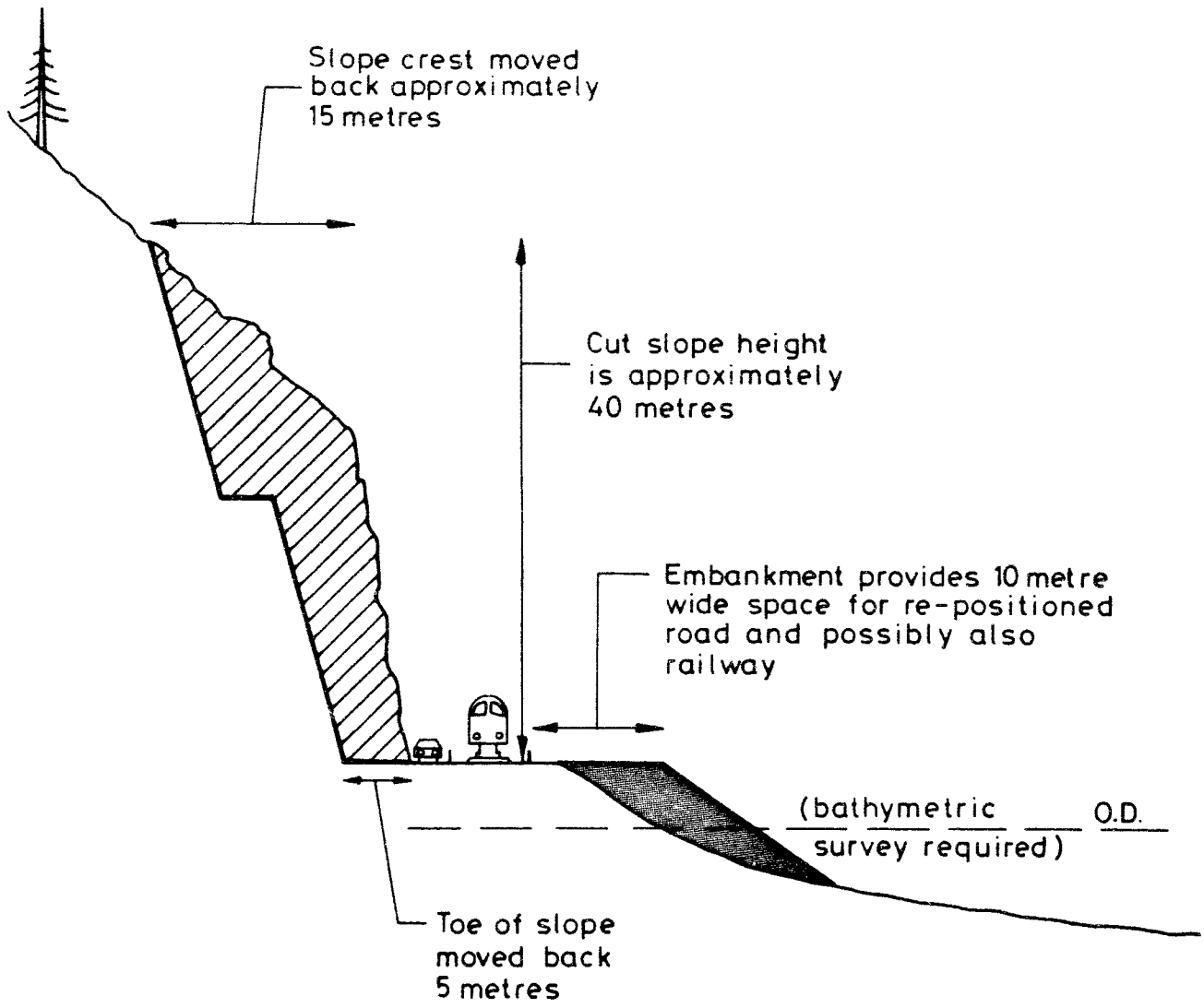
- ✳ Large embankment without slope reprofiling
- ✳ 12 to 15 metres space provided to reposition both road and railway
- ✳ 9 to 12 metres available as rock fall zone



OPTION 3.2

FIGURE 5 : 4

- ✳ Major slope reprofiling and embankment
- ✳ Form embankment from excavated material from slope
- ✳ If road is moved to Loch-side of railway then abandoned road remains as part of total 8 metre wide rockfall zone
- ✳ Railway could be moved to Loch-side edge of embankment, in which case a widened road would be located between the railway and the rockfall zone



OPTION 3.3

FIGURE 5:5

5.3 Option 2: Relocation of road

The option to abandon the present route is not considered in any detail in this report. The road could possibly be radically re-routed. This would involve bypassing of a considerable length of the present road over which there are no serious slope stability problems. Although the possibility of abandoning the present route is not considered in detail in this report, some possible options for such re-routing are briefly outlined below:-

(i) Construct a "high level" road at about +300m OD along the hills parallel to, and south of the present route. Likely diversion points would be near Achmore, about 4km south west of Ardnaff, and near Attadale, suggesting a total length of new road of about 10 km.

(ii) Construct a "fixed link" at Strome Narrows, where the crossing distance varies between 400 and 500 metres. According to the Admiralty Chart the water depth is less than 10 metres over much of this distance, and a composite embankment - bridge - embankment design may be possible. Road traffic would enter Lochcarron from the south-west. An improved road system would be needed at both sides of the crossing.

(iii) Divert the road through rock tunnels either at the "fixed link" described above or to bypass the main unstable slopes at Area 2.

5.4 Option 3: Road improvements along the existing route

Using this Option, the road would be retained approximately along its present route. In Area 2, the slope hazard would be reduced by either excavating into the hillside to form a more stable slope and provide a rockfall zone, or by moving the road away from the slope which would entail the construction of an embankment to accept the road and/or the railway. If such major works are envisaged, it may be appropriate to upgrade the road to two lane width at the same time.

The aim of this Option is to provide a rock fall zone between the road and the slope, and therefore it should reduce the requirement for slope stabilisation works. However, depending on the separation achieved between the slope and the road, some stabilisation works may still be necessary. It is unlikely that a reserve of sufficient width and depth can be provided to contain debris from all conceivable failures. In practice, many of the slope stabilisation measures as outlined for Option 1.1 may also be required. This option is therefore in effect a more secure version of Option 1.1, since it both reduces the risk of debris falling and provides a catch area for any debris which may fall despite the preventive measures.

The increase in land space necessary for this Option may be achieved either by excavation into the hillside slopes, (Option 3.1), or by infilling into ther loch, (Option 3.2.).

(i) Option 3.1 Excavation into Hillside (Figure 5.2)

This can be achieved by various means with or without the formation of an embankment into the loch and the repositioning of either the railway or the realignment of the road onto the embankment on the lochside of the railway. This latter option would require the road to be carried over the railway line at either end of the realignment.

Without an embankment, the rock slope must be excavated to move it away from the loch sufficiently to provide a catchpit 5 to 8 metres, say, in width and, if required, extra road width.

Preliminary observations of the rock structure suggest that reprofiled slopes should be stable at a steep angle if formed using controlled blasting techniques. The actual profile adopted would probably be determined by the 'sliding configuration' joints evident at many locations. A 75 degree slope inclination (roughly 4(V) on 1(H)) is provisonally assumed. It is also assumed that a

substantial (5 metres) wide berm would be required at a height of 20 metres above the slope toe. Given the potential for landslipping already demonstrated within the study area, any reprofiling should be carried out with this possibility in mind. Although the exact mechanism for the major 1969 landslip was not clearly identified (summary reports in Appendix A3), it appears that it may have resulted from the undermining of a zone of fractured rock and thick superficial deposits. Thus site investigations should be carried out to identify areas with thick superficial desposits which should not be undermined by the newly formed slopes. It may be necessary to remove the superficial deposits at such locations, thus extending the 'crest' of the new slopes up the hillside. One area thought to contain such deposits is near Chainage 820 m. Various applications of this method are discussed below.

Although Option 3.1 can be achieved without realigning the railway, it will involve rock excavation. It is unlikely that such excavation could be achieved without damage to, or at least continuous maintenance of the railway. This may well create sufficient disturbance to the line to lead to its temporary closure during the period of the works which may prejudice its continued existence.

Slope reprofiling, Option 3.1, can only bring about a limited improvement in security, rather than the elimination of stability hazards. It may be preferable to avoid such works and concentrate on positioning the road further from the slopes, Option 3.2.

(ii) Option 3.2 Embankment into Loch with No Excavation (Figures 5.3 and 5.4)

The advantage of Option 3.2 is that it can be carried out without severe disruption to road and rail traffic.

The embankment would be formed from imported fill and be of sufficient width to allow a new two-lane road to be constructed upon it. As previously, the road would have to cross the railway line at either end. The alternative is to relign the railway on the embankment and form the road with a catch pit beneath the current rock faces. However, this variant loses the distinct advantage of minimising interference with the railway.

(iii) Option 3.3. Cut/Fill Balance Design (Figure 5.5)

This is an amalgam of Options 3.1 and 3.2, the excavation being balanced against the fill required for the embankment. As with Option 3.2, this option will interfere greatly with the railway.

(iv) Other Options

Finally, particularly if the loch bed plunges steeply away from the shore, there may be merit in replacing the embankment with a backfilled retaining wall or a road deck on piers.

Apart from the two conventional options above, there may be scope for more innovative/imaginative measures such as a two lane road with the road split into single carriageways over isolated sections of the road, the lochside carriageway elevated above the railway line. Such options would still require the rock face to be stabilised.

6.0 RECOMMENDED 'SHORT TERM' REMEDIAL MEASURES

6.1 Introduction

In view of the degree and extent of hazard identified on the rock faces and the delay necessary to carry out the preliminary surveys and study of the possible 'long term' remedial measures discussed in Section 5, it is recommended that 'short term' remedial mesures be carried out to reduce the degree of the hazard to the road user. In many instances the recommended short term works involve removal of unstable rock under controlled conditions. Elsewhere, displacement monitoring is suggested in order to more fully identify any deterioration in progress. The determination of support measures such as rock bolting is included, although the implementation of such a study would probably be completed as a second phase of the short term work or even be deferred until the carrying out of long term measures.

It is considered that Area 3 does not contain any significant hazards to the road user which merit short term action. Areas 1 and 4 are generally a MODERATE HAZARD with occasional sections classed as a MINOR HAZARDS. However, Area 2 is generally classified as a MAJOR HAZARD to the road user, with occasional EXTREME HAZARD areas.

Appendix A2 contains a brief description of the assessed EXTREME and MAJOR hazards identified along the rock faces, together with recommendations concerning the form and two stage phasing of the remedial works. In practice, it would be expected that many of the lesser hazards would be dealt with at the same time as the more severe hazards. It is considered that it would be beneficial to carry out the more straightforward and less costly items of remedial measures which can be carried out rapidly rather than carry out the remedial measures in the described order of Hazard rating. Thus a general lightweight scaling exercise together with mesh refurbishment is recommended for Areas 1, 2 and 4. During this exercise the requirements for the EXTREME and MAJOR HAZARDS described in Appendix A2 would be finalised.

6.2 General Short Term Remedial Measures

The hazard appraisal has identified in Section 4 and Appendix A2 numerous EXTREME and MAJOR hazards within the slopes adjacent to the road, and these should receive short-term attention. Where practicable, the unstable masses should be removed. Appendix A2 identifies locations where removal may not be practicable due to the likelihood of generating larger stability problems. Further study is needed in order to clarify the requirements for this work, and the nature of the work is such that revisions should be expected in the course of the work. Generally, hand scaling is envisaged, using climbers secured by ropes. However, limited blasting could be necessary, which has increased implications for potential damage to the road and the railway. In lower areas (i.e. Area 1), 'machine scaling' may be appropriate. It is important that remedial measures in these areas should be carried out only in a contract which includes for such possible work and with the relevant plant standing by.

In the course of such work, the meshing system already in place should be refurbished. Mesh should be rapidly reinstated after scaling in order to contain any small fragments which may be released later as a result of the disturbance. Other short term works are suggested for the higher hillside slopes. Further clearance of fallen trees in Area 2 would be advisable where it could be envisaged that such trees could ultimately fall to the road. Similarly, clearance of detritus from the stream gulleys is recommended.

At some locations the above works may be too hazardous or disruptive to road and rail traffic to be carried out. This aspect should be considered during the inspection phase prior to executing the 'short term' measures. These measures will offer only a partial and unsatisfactory solution to the slope stability hazards and are only intended to form a short term expedient until more substantial works can be determined and carried out.

Unfortunately, it is in nature of the problem that locations where sufficient space is available to carry out road realignment do not correspond to the hazardous areas, and so this option is not therefore available, on the short term basis.

Generally, trees growing within 3 to 5 metres of the crest and on the rock face should be removed.

6.3 Area 1 Chainage 0-324m

As described in section 4.1, Area 1 typically contains MINOR to MODERATE hazards which should be scaled. Heavy machine scaling could be applied between Chainages 130 to 253 in order to cut back the slope and remove MAJOR HAZARD blocks. Otherwise local removal is recommended (e.g. Chainages 130-135, 135-148, 148-157) with the option to use displacement monitoring (e.g. Chainage 109-120) and anchoring. The upper slopes above this face are gently inclined and there appears to be sufficient space to excavate by blasting if necessary. However a suitable 'design profile' should first be determined for this overhanging face which is estimated to be about 8m high. The blasting method envisaged would involve 'popping off' small individual sections rather than larger scale blasting over the whole slope height.

6.4 Area 2 Chainage 324-1522 m

As mentioned above, the rock slopes in this area generally represent MAJOR and EXTREME HAZARDS because of the steep to overhanging faces, up to about 30 m high, and the insignificant width of verge in comparison to the height of the slope. The 45° to 50° inclination of the upper slope continues up the hillside to about 300 m above Ordnance Datum.

Due to the precarious nature of the slope and rock face, all recommendations should be undertaken with great care so as to avoid undermining the face. Much of the mesh requires replacing, and in so doing the rock faces should be lightly scaled and the overhangs along the crest trimmed back. Before mesh is replaced, any fallen trees lying on the upper slope immediately above the rock face should be removed.

The EXTREME HAZARDS are generally dilated toppling or sliding 'bluffs' or 'noses' which should be removed with great care. In some cases (for example chainages 528-600) it has been suggested that further inspection should be carried out before detailed recommendations can be applied.

Meanwhile such areas (e.g. Ch. 1271, 596-600) should be monitored using tell-tales preferably the graduated plastic type, across the prominent joints.

Due to the narrow verge and nature of the rock it is recommended that this area be inspected regularly, probably daily, with clearance of the verge and ditch as necessary. Immediately after the remedial measures have been undertaken, further small fragments of loosened material may be expected to fall. The mesh will help in channelling such rock.

Rock bolting has been tentatively recommended in some areas (for example chainages 1258-to 1300, 1361, 1370 to 1383, 1430 to 1441) where potential 'sliding' joints could fail, releasing a larger mass of material. Such measures require careful planning, not least to gain access.

6.5 Area 4 Chainage 3494-3850

Detailed short term measures for Area 4 are recommended in Appendix A.2.4. These slopes generally contain MODERATE HAZARDS. However a possible MAJOR HAZARD has been identified at chainages 3668. The potential sliding joints between Chainages 3668 and 3674 should be inspected further with a view to monitoring with tell-tales or installing rock bolting in the near future. Consideration should also be given to the removal of the potential MAJOR HAZARD mass at chainage 3668 by machine scaling.

In general this area would benefit from light scaling, clearance of failed debris resting on the face and removal of the young conifers growing on the face followed by remeshing.

6.6 Hillside slopes

As mentioned previously, the fallen trees lying above the rock faces in Area 2 should be removed.

The heads of the stream channels and gullies at chainages 600, 895 and 1204 have accummulated debris. These should be cleared. If this material should fail it would probably represent an EXTREME HAZARD to the road.

In general, surface water drainage improvements are considered to constitute a long term measure. However, such improvements may also be considered during the short term where it may be practicable to construct cut off channels in the less steeply inclined areas.

7.0 RECOMMENDATIONS FOR FUTURE WORK

Further investigations are needed both to clarify the requirements for short-term improvements and to assess the practicality of the various long-term options.

7.1 Work related to short term improvements

It is considered that more detailed inspections are necessary both prior to, and in the course of, short term remedial works. In particular, supplementary inspection from a lighting cradle should be carried out in order to clarify the type of treatment, if any, that should be applied to MAJOR and EXTREME HAZARD rock masses.

As noted previously, such inspections should include assessment of both the need for and the viability of remedial works. Thus it may become apparent that removal of a particular EXTREME HAZARD mass would involve the risk of damage to the railway, which would preclude removal as a short term option. Thorough record keeping is therefore necessary in the course of these inspections in order to record the conclusions and confirm that action has been taken at each of the suspect blocks.

Such inspections may not be conclusive, particularly where access and visibility are hindered by mesh. Thus the treatment required for individual hazardous masses may in some instances only become apparent in the course of general remedial works, after mesh has been temporarily removed, for example.

Once aerial photographs are available, the hazard potential from the 'hillside' slopes should be more fully assessed. The main area of concern is at stream gulleys and fallen tree areas within Area 2.

7.2 Work related to long-term options

Before embarking on further field investigations related to long term works, preliminary planning and feasibility studies such as those outlined below should be carried out to clarify the types of long-term option likely to be acceptable both to HRC and British Rail. For example, the following points related to the various options outlined in Section 5 should be considered:

(i) The potential problems associated with blasting adjacent to the railway, both in terms of closure periods and potential damage to the railway track.

(ii) The visual impact of any newly cut slopes -

(a) Along the road in Area 2, and

(b) At potential borrow area sites for embankment construction.

(iii) Planning considerations of road re-routing, both using a "high level" route and a fixed link across Strome Narrows.

(iv) The viability of constructing railway crossings, in particular the acceptability of level crossings and the possible need for elevated crossings in the context of an embankment at Area 2.

(v) Possible disturbance to marine life by embankment construction. In addition the disturbance that would be caused by the use of a marine source for fill materials should be considered.

(vi) The possibility of carrying out some railway realignment in the context of the use of a broad embankment with realignment of both the road and the railway.

Assuming that the preferred approach will entail the road remaining at or near its present route, the following operations are recommended.

(i) Carry out a full topographic and bathymetric survey. A "low level" survey should be carried out to show the present road alignment, the railway and the limits of its embankment, the foreshore and the slopes and stream course immediately adjacent to the road. This survey would be drawn upto 1:1000 or 1:500 scale and would be used to clarify the areas where road widening and realignments are necessary and practicable. From the initial investigations it appears that major works would be concentrated in the first 1.5 km (Areas 1 and 2). Further survey work would be concentrated in these identified potential realignment areas. Where practicable, the survey should be extended to over the hillside slopes adjacent to the road. This is particularly the case in Area 1, where slope reprofiling is a viable option both for slope stabilisation and road widening.

A bathymetric survey is recommended for the identified realignment areas, which will cover at least the first 1.5 km. From inspection of Drawing 2583/1 accompanying this report it is apparent that the bathymetry should be established in detail between chainages minus 300 and plus 1800 metres. Over this length the Admiralty Chart suggests an irregular seabed, and this is suspected to include both submerged "gulleys" in rock and "fans" of submerged alluvial material.

It is therefore suggested that initial traverses are made parallel to the shore to cross such features which may trend away from the shore. One traverse should be carried out as close as possible to the shore in order to identify any features of interest which would directly underlie any embankment and which would call for additional survey detail.

Traverses roughly perpendicular to the shore should be carried out at 25 to 50 metre intervals depending on the degree of irregularity identified from the initial surveying, with the option to reduce this interval to 10 metres if very localised features are apparent. The intention would be to establish bathymetric contours at 2 metre intervals to a distance of approximately 50 metres from the present low water mark, and add this information to the 1:1000 or 1:500 scale onshore mapping.

It is suggested that the bathymetric surveying be carried out at an early stage in order to clarify the likely viability (or otherwise) of embankment construction.

Whilst the bathymetric survey is underway, it would be prudent to obtain outline information for the whole potential area of interest. Thus the possibly steeply shelving shore should be investigated up to chainage 2300 metres and the more shallowly shelving shore suggested by the Admiralty Chart should be confirmed as far as chainage 4000 metres. At the same time, the seabed should be surveyed at (say) 200 metre intervals in the range 50 to 100 metres offshore in order to permit correlation with Admiralty information. Levels should be related to Ordnance Datum.

If major hillside slope reprofiling remains an option, then detailed survey work is required. Due to the severe access problems, this would be by aerial photogrammetry. However, as noted elsewhere in the report, major reprofiling does not appear to be an acceptable option from the studies carried out so far.

(ii) Compile a geomorphological plan of the 'hillside slopes'. This would be based on the detailed survey outlined above and include information derived both from aerial photographs and field observations. Immediate hazards (such as erosion at stream gulleys) should be recorded as well as features relevant to possible slope reprofiling, such as suspected thick accumulations of superficial deposits.

(iii) Carry out a geophysical investigtion into seabed deposits. The area of investigation would correspond to the bathymetric surveying outlined above. The presence of granular and cohesive materials and rock seabed should be assessed, since these could affect the viability of the embankment option. The type of survey envisaged would be similar to the exercise carried out in 1985 at Kyle Akin. This entailed both side-scan sonar and seismic ("sparker") surveys.

(iv) Investigate the viability of embankment construction both in terms of design criteria (wave height/armouring requirements) and possible materials sources. Whilst design criteria may be determined theoretically, it is considered worthwhile to establish one or more tide gauges which could also enable wave heights to be assessed. The shore near avalanche shelter would be a suitable location for such monitoring.

The potential for opening a rock fill borrow area quarry should be considered both in terms of environmental acceptability and material suitability. The emphasis should be on the use of the more psammitic metamorphic rocks in the area rather than the more friable and micaceous pelites which may be present. Whilst substantial blocks would probably be required for an armoured revetement, general filling materials such as small broken rock or alluvial cobbles etc. should be suitable for the body of an embankment. The possible use of the extensive alluvial fan deposits present at Attadale should be investigated, together with other granular deposits which are present around the loch shore, being indicated as 'boulders" on the Admiralty Chart.

The above work would form the basis for determining the optimum from of the long term work to improve the security of the road, and following this, further field investigations would probably be needed before a final design could be produced. The survey and mapping work would also have the benefit of clarifying the location of present hazards from the hillside slopes.

APPENDIX A1.1

AREA 1. CHAINAGE 0 TO 324m

Chainage 0-42m (Photograph 1/1)

The rock face is 4-5m high inclined at 60° with a 1.5-2.0m wide verge. The rock is of a blocky nature and appears 'tight'. Any rockfalls are likely to represent a MINOR HAZARD. There is a stream and culvert at Chainage 42.

Chainage 42-130m (Photograph 1/2 to 1/7)

This face gradually rises in height to approximately 8m at Chainage 83m and the verge width increases to 4m. Generally the face is similar to the previous section: undercut blocks at Chainages 48 and 55 represent a NEGLIGIBLE HAZARD. Active failure of the colluvial material containing cobbles and boulders on the crest at Chainages 65 to 83 and 106 to 120 is seen to represent a MINOR HAZARD. Potential sliding configuration planes up to 7m above road level between Chainages 109 and 120 could define a MAJOR HAZARD blocks, although this structure appears 'tight' at present.

Chainage 130-167m (Photographs 1/8 to 1/14)

This 8m high face is a continuation of the previous face but becomes vertical to overhanging. Spalling failure and dilation is evident along this face giving rise to a MAJOR HAZARD area with a 1.2m wide verge. Dilated crest blocks occur between Chainages 130 and 135 and large dilated overhanging masses are present between Chainages 135 and 153 which represent MAJOR HAZARDS. A dilated 'rib' at Chainage 158 and overhangs at Chainage 162 to 167 are considered to represent MODERATE HAZARDS. An old wedge failure scar has been identified at the crest at Chainage 158.

Chainage 167-193m (Photographs 1/14 and 1/15)

The 4-5m high irregular face consists of small rock outcrops (not blasted) and actively degrading colluvium which would be contained by the 1.5 to 2.0m wide verge. This area represents a NEGLIGIBLE HAZARD.

Chainage 193-253m (Photographs 1/15 to 1/19)

The foliation along this section dips into the 6m high rock face and creates overhangs of a MINOR and MODERATE HAZARD rating taking into account the 2-3m wide verge. Large dilated blocks at Chainages 208, and 213 to 216, and crest overhangs at Chainages 216 to 222 all represent MODERATE HAZARDS. The rock face reduces to a height of 2m above road level between Chainages 225 to 253, where it represents a NEGLIGIBLE HAZARD.

Chainage 253-300m (Photograph 1/20)

There are no significant rock slopes in this area and NO HAZARDS are evident.

Chainage 300-324m (Photograph 1/21)

The 60° irregular rock face here gradually increases in height from 3 to 6 metres. The superficial deposits in the crest are failing and releasing cobbles which represent a NEGLIGIBLE hazard.

APPENDIX A1.2

AREA 2. CHAINAGE 324 to 1522m

Chainage 324-361m (Photographs 1/21 to 1/25)

This rock face steadily rises from 6 to 12m in height, is inclined at about 80° and has a 2m wide verge. The meshing commenced at Chainage 334 extends to Chainage 449. The face comprises large potential sliding and toppling masses which typically represent MODERATE and MAJOR HAZARDS, although severe dilation in toppling blocks at Chainage 347 is considered to represent an EXTREME HAZARD. This mass probably became loosened at the time of excavation: remnants of blasting holes are seen in this area of the face. Tell-tales have previously been installed.

Other MODERATE to MAJOR HAZARD dilated masses are seen at Chainages 330 to 336 and 349, 6m above road level. Dilated crest blocks between Chainages 349 and 361 along with failing colluvial material are considered to represent MODERATE and MAJOR HAZARDS.

A 4m high masonry buttress between Chainages 357 and 361 has been constructed to support a very large potential sliding mass which extends to the crest at Chainage 363. The buttress does not show any sign of distress.

Chainage 361-454m (Photographs 1/25 to 1/36)

The meshed rock face described above continues to rise in height to approximately 25m and the upper part of the face appears to be naturally formed. The verge is 1 to 2m wide and a double sided 1 metre high Armco-type barrier has been installed between Chainages 362 and 440. Parts of this face appear to be secure although the combined height, steep angle and proximity of the road result in the unstable masses which are present having the potential for being MAJOR and EXTREME hazards.

The presence of the mesh and barrier does however prevent a proportion of the smaller failed material from affecting the road, but dilated overhanging masses and blocks which occur within 7m above road level (e.g. Chainages 380 to 390, 420 to 426 and 436 to 454) represent MODERATE and MAJOR HAZARDS. Glass tell-tales have been installed to monitor the overhanging mass at Chainage 420 to 426. At Chainages 433 to 436 a dilated overhanging 'nose' rising from about 5 m above the road is considered an EXTREME HAZARD.

Dilated blocks near the crest at Chainages 395 and 432 represent MAJOR and EXTREME HAZARDS. Blocks are seen to be held by the mesh in the crest area at Chainage 374.

Chainage 454-500m (Photographs 1/36, 1/37 and 2/13 to 2/15)

In this zone the near vertical rock face extends to a height of about 30m, the upper 2/3 of which is partially vegetated. Undercut blocks on the face and crest at Chainages 445, 465, 490 and 496 represent MODERATE/MAJOR HAZARDS. It is thought that the lower part of the slope has been excavated by blasting whereas the upper part is naturally formed.

Chainage 500-610m (Photographs 2/1, 2/2, 2/7 and 2/16 to 2/24)

This face is typically 10 to 15m high, inclined at 70 to 80°, and with a verge of 1.5 to 2.0m width, locally reducing to 0.5m. The face is meshed between Chainages 520 and 600. The main stability problems are associated with failure of colluvial material and blocks at the crest and sliding configuration joints in the rock face. From Chainages 500 to 550 and 575 to 610, collapse of colluvial material is seen to represent a MINOR HAZARD to the road user. However undercut and dilated blocks at the crest, for example between Chainages 522 and 550, represent MODERATE to MAJOR HAZARDS depending on block size.

A 4m high masonry buttress at Chainages 528-533 appears to be only partially supporting the potential sliding mass above it which represents an EXTREME HAZARD, as does the sliding masses immediately adjacent to it between Chainages 533 and 546 and that at Chainage 582 to 590. A dilated stack at chainage 567 could pose a MAJOR HAZARD, although this may be "keyed in".

Closely spaced joints in the area of Chainages 572 to 590 dip out of the face and have the potential to define sliding blocks which represent an EXTREME HAZARD. The dilated bluff 5m above the road at Chainage 590 is resting on a sliding joint and is seen as a MAJOR to EXTREME HAZARD.

An undercut dilated wedge 5m above the road near Chainage 596 is seen as an EXTREME HAZARD.

Chainage 610-674m (Photographs 2/3 to 2/6)

The road passes through the avalanche shelter at the toe of the landslip scar. The shelter appears adequate to protect the road from potential future failures over this section.

Chainage 674-735m (Photographs 2/9 and 2/25 to 2/30)

The cut rock face is 6 to 8m high with an irregular profile and with dilated medium to widely spaced joints in grey foliated metamorphic rock. The verge is generally about 1m wide but at one point reduces to only 0.3m. Above the bottom rock face, the slope consists of 60 to 70° poorly exposed and partly vegetated dilated rock outcrops.

The undercut crest area between Chainages 683 and 690 is regarded as providing potential MODERATE and MAJOR HAZARDS, as is the fractured outcrop above the retaining structure, Chainage 706 to 717.

A retaining structure lies between Chainages 702 and 735 to prevent debris transported down the gully by the stream from landing in the road.

Chainage 735-779m (Photographs 2/30 and 2/31)

Along this stretch of the road a 3m high gabion wall is situated at the toe of a mass of colluvial material which is actively failing. Above this, a degrading rock outcrop lies at approximately 12m above road level. Rockfalls have damaged the top row of gabions at Chainage 761. Any further failures may not be contained and are likely to represent a MODERATE HAZARD.

Chainage 779-956m (Photographs 2/32 to 3/2)

This section consists of an 18 to 20m high rock face interrupted by a vegetated colluvium filled depression between Chainages 810 and 834. Storm water run off with scree erosion here could form a MODERATE HAZARD to the road user. The rock faces are subvertical to 80° and meshed between Chainages 779 and 806, 833 and 889, 899 and 932 and 935 and 956. The verge width is 1.0-1.3m and the presence of numerous undercuts associated with foliation and the occasional crest area failure indicates the potential for MAJOR HAZARD failures at numerous locations within this length (Chainage 790 and 833-956).

Chainage 956-1030m (Photographs 3/3 to 3/6)

The faces are typically 15m high, partially blasted at the lower levels and partially covered by a veneer of soil and vegetation. The verge is approximately 2 metres wide, occasionally reaching 3m. Much of this area appears secure, but between Chainages 956 and 1030m the occasional undercut block represents a MODERATE HAZARD. However a severely dilated bluff at Chainage 1000, with a height of 12m and undermined by an old sea cave at the side of it represents an EXTREME HAZARD if it fails en masse. It is composed of individual MODERATE and MAJOR HAZARD blocks which could fail individually or in combination.

Chainage 1030-1092 m (Photographs 3/7 to 3/10)

The face slopes at about 65° between Chainages 1030 and 1092, and in places flattens to about 40°. It is possible that large failures of weathered mantle material have occurred here in the past. The lower faces represent a NEGLIGIBLE HAZARD although a MODERATE/MAJOR HAZARD rating could be applied to the area due to the possibility of falling tree trunks or other debris from the upper slope. The verge width is 2 to 3m.

Chainage 1092-1204m (Photographs 3/11 and 3/14)

The rock face consists of thinly foliated and closely jointed psammites and pelites.

The face height is estimated to be greater than 30m and it is inclined between about 70° and 90°. It comprises mostly natural 'raised sea cliff' faces which are partially vegetated. The verge width varies between 2 and 4m.

Overhanging blocks and bluffs are the main hazard in this section and occur frequently (e.g.Chainages 1110, 1112 and 1174 to 1193 all of which represent MAJOR HAZARDS.) A dilated buff approximately 12 m above road level represents a potential EXTREME HAZARD, Chainage 1160 to 1165.

Between Chainages 1122-1158 the rock face is set back in a 'V' shape which may represent the site of a large wedge failure in the past. Such slips would present an EXTREME HAZARD, and the presence of similar configurations is difficult to predict or assess.

Chainage 1204-1245m (Photograph 3/14)

A major stream cascades down an approximately 20m high rock slope set back some to 5 to 10m from the road.

At the base of the rock face, a vegetated slope 12m high of soil and rock scree rises from road level at approximately 35° and is seen as a NEGLIGIBLE HAZARD. Failure within the rock face behind could, however, lead to a MODERATE/MAJOR HAZARD to the road. The stream culvert is at Chainage 1217m and heavy seepage is seen in the rock face at Chainage 1241.

Chainage 1245-1304m (Photographs 3/13 and 3/15 to 3/19)

The subvertical 15m high rock face is meshed between Chainages 1253m and 1284m. The blocky nature of the rock mass and overhanging blocks form the main hazards from the face. The verge is 0.4 to 1.2m wide, typically less than 1m, and most potential failures are likely to represent MAJOR HAZARDS to the road. Steeply inclined 'sliding' joints lead to potential instability within a dilated stack of blocks at about 25m above road level from Chainage 1258 to 1265. This and the large overhanging masses on 'sliding' joints 4 and 6m above road level between Chainages 1284-1293 are all seen as MAJOR HAZARDS.

A potential EXTREME HAZARD at Chainage 1271 is a large structure with the potential for rising from 2.5m above road level. This appears tight at present, and is therefore thought to be 'keyed in'.

A 2m high masonry buttress fills in an overhang formed on the flat lying foliation between Chainages 1249.5 and 1255.

Chainage 1304-1350m (Photographs 3/19 to 3/22)

This area is thought to represent a NEGLIGIBLE HAZARD even though the rock face is 25m high and near vertical: the verge, which is up to 6m wide, is expected to contain most failure debris, for example the scree material failing between Chainages 1310 and-1320 and the overhanging blocks between Chainages 1325-1350 which may fail from foliation planes and by sliding.

Chainage 1350-1470m (Photographs 3/24 to 3/32)

The irregular rock faces are approximately 20 to 25m high and inclined at an angle of 70 to 75°. The upper section of the face is partly vegetated and lichen covered but sliding and overhanging masses represent MAJOR HAZARDS as seen between Chainages 1361 and 1370 and at the crest at Chainage 1395. A dilated wedge has been identified between Chainages 1434 and 1441 and this is also considered to be a MAJOR HAZARD. Sliding configuration joints running under the crest are also generally considered to form MAJOR HAZARDS and can be seen between Chainages 1373 and 1383, 1400 and 1407, and at chainages 1419 and 1430. Tree root penetration at Chainage 1414 is seen in a 0.1m wide joint at potential MAJOR HAZARD block.

Chainage 1470-1482m (Photograph 3/32)

A stream eroded gully in fractured material discharges at a 4m wide verge area which contains some gravel scree and so this section is classed as a NEGLIGIBLE HAZARD.

Chainage 1482-1522m (Photographs 3/33 to 3/35)

The rock faces are of a similar nature as those described above between Chainages 1350 and 1470. They are typically 12 to 15m high, inclined at 70°, and are meshed between Chainages 1485 and 1523. Blocky failures and ravelling are caused by closely spaced schistosity partings. The mesh is seen to have channelled small failed blocks down to the verge, but some debris has accumulated and needs clearing (Photograph 3/35). The verge is 0.5-1.0m wide along the stretch and individual dilated masses represent a MINOR to MODERATE HAZARD.

A 2m high masonry buttress between Chainages 1496-1508 appears to be in good condition and acts as a toe infill. However at the undercut crest area tree roots have been exposed in the colluvial material resulting a MODERATE HAZARD.

APPENDIX A1.3

AREA 3 - CHAINAGE 1522 TO 3494m

This area has a variable nature ranging from old sea cliffs deeply incised with stream gullies, some now dry, and 50 to 60° scree slopes. No blasting along the line of the road has been identified in this area and the old cliff line is approximately 70% vegetated with deciduous trees. The scree slopes are almost wholly vegetated with grass and trees.

Chainage 1522-2020m (Photogrpahs 3/36 to 4/6)

This section includes natural old sea cliffs, vegetated, 20-30m high, and subvertical. These cliffs appear generally stable but minor ravelling occasionally occurs and is contained within the verge and so represents a NEGLIGIBLE HAZARD to the road user. Some block dilation is evident within the cliffs (e.g. Chainage 1900), but this is thought to be due to very long term deterioration and therefore not an active hazard. Over most of the area there is NO HAZARD and the verges are typically 5-10m wide although occasionally reducing to only 2 to 3m wide, for example at Chainage 1896 to 1965.

Streams may be seen to follow deep narrow gullies as at Chainages 1949, 2005 and 2010, and a small amount of scree has built up at the toe but this represents NO HAZARD.

Chainage 2020-2365m (Photographs 4/7 to 4/9)

This section consists of a 50 to 60° slope with no outcrops present in the area 20 to 30m above the road. The slope has almost 100% vegetation cover of bracken, grass and at the lower levels is partially covered with trees. A coarse scree is seen in the upper part of the slope about 20m above road level, and this originates from the crags in the higher hillside slopes. At Chainage 2230 a massive block is located near the road. Verge width varies from 1 to 10m wide and NO HAZARD is likely from the slopes adjacent to the road.

Chainage 2365-2424m (Photographs 4/9 and 4/10)

The rock face consists of an 80 to 90°, approximately 15m high natural slope with well developed vegetation partially covering it. The occasional heavily jointed areas combined with thin bedding have created small scale ravelling failures which are generally contained within the 1 to 2m wide verge and this is considered to represent a NEGLIGIBLE OR MINOR HAZARD. Occasional seepages occur.

Chainages 2424-2995m (Photographs 4/11 to 4/13)

This section includes 70° natural cliffs, scree slopes and a small disused quarried area which is set back over 30 metres from the road and so represents NO HAZARD.

Chainages 2995-3115m (Photographs 4/14)

This is a variable section of a NEGLIGIBLE to MINOR HAZARD rating. Active soil failure for 6 to 8m above road level, of colluvial material containing boulders occurs between Chainages 2995 and 3005 and represents a NEGLIGIBLE HAZARD.

Towards Chainage 3115 a 2 to 6m high near vertical rock face outcrops along the road with a 2m wide verge. The top part of the face between 4 to 10m high is vegetation covered and small streams and seepages flow down the face between Chainages 3022 and 3070. Active small ravelling occurs which represents a NEGLIGIBLE HAZARD to the road user. Between Chainages 3105 and 3115 the face becomes more blocky due to the laminated and very closely jointed nature of the rock and this represents a NEGLIGIBLE to MINOR HAZARD.

Chainages 3115-3220m

This area includes tree and grass covered slopes. No outcrops are visible from road level and NO HAZARDS are present.

Chainages 3220-3300m (Photograph 4/15)

A 4 to 5m high, 2 to 3m wide berm sloping at 70° is immediately adjacent to the road, behind which is an approximately 15m high, heavily fractured and dilated, blasted face. Large scale failure is likely but this should represent only a MINOR or MODERATE HAZARD to the road user since most material would probably be retained on the bermand verge.

Chainages 3300-3494m (Photographs 4/16 and 4/17)

This section consists of approximately 45° natural slopes, with 100% vegetation including pine trees and conifers down to within 1 to 2m height above road level. The verge is generally greater than 3m wide and NO HAZARDS are apparent. A large boulder lying between Chainages 3455 and 3465 would represent a MODERATE or MAJOR HAZARD if it failed, although this is thought to be unlikely.

APPENDIX A1.4

AREA 4 - CHAINAGE 3494 TO 3850m

Chainages 3494-3585m (Photograph 4/18)

The face has a slope angle of 50 to 70° and consists of steeply dipping, highly fractured fine grained sandstone showing minor faulting. It is largely scrub covered with conifers and grass. However, failure is evident from ravelling debris which has been mainly retained in the verge (which typically has a width of 2 to 3m) and such failures therefore represents NEGLIGIBLE to MINOR HAZARDS.

Between Chainages 3494 and 3512 the rock face is 15 to 20m high and failure of the overhanging crest would represent a MINOR or MODERATE HAZARD.

The face height decreases to 10 to 15m between Chainages 3512 and 3585 and ravelling failure immediately adjacent to the road is a MINOR HAZARD. From Chainage 3567 the rock face 2m above road level has been cut vertically and the verge width reduces to 2m. The limited rockfall space together with heavy seepages in the fractured sandstone has increases the rating for failures to MODERATE HAZARD.

Chainages 3585-3640m (Photographs 4/19 and 4/20)

This face is approximately subvertical for 15 to 20m height and then merges with a vegetated upper slope inclined at approximately 50°. This length of rock face is covered with mesh through which small conifers are growing. Ravelling failure from the fractured sandstone represents a MODERATE HAZARD even though the verge is 3 to 4m wide. At Chainage 3633 a partially dilated bluff is also seen as a MODERATE HAZARD. Debris has accumulated behind the mesh on the rock face and at its toe. Other individual MODERATE HAZARD locations are at Chainages 3595 and 3620.

Chainage 3640-3720m (Photographs 4/21 to 4/25)

In this section the rock face is comprised of two slopes: the lower 10 to 12m high slope inclined at 70 to 75° merges with the upper slope inclined at 40 to 50° up to a height of approximately 30m.

At this height the crest is covered in young conifers and there is evidence of only a thin veneer of superficial deposits (less than 1m thick). The potential for ravelling is apparent, with debris lying in the ditch, and future ravelling represents a MINOR or MODERATE HAZARD. However larger collapses could occur in the steeper lower face where potential sliding configuration joints at Chainages 3676 and 3682 could lead to a MAJOR HAZARD risk to the road user. Dilated, fractured and undercut masses seen along the face represent MODERATE HAZARDS although a severely dilated bluff between Chainages 3685-3688 is a MAJOR HAZARD.

Between Chainages 3710 and 3720, the upper part of the face is overhanging. The overhang appears secure from road level. At Chainage 3673 a small stream discharging down the face runs down a shallow gully.

Along this stretch the verge is 1.5m wide to Chainage 3703 and then broadens to approximately 3.5m - 4.0m to Chainage 3781.

Chainage 3720-3781m (Photographs 4/26 to 4/30)

The rock face is subvertical and reducing in height from 15m at Chainage 3720 to 4m at Chainage 3781.

The verge is 4m wide and provides an adequate catch area for the ravelling failures which can be classified as MINOR HAZARDS. The severely undercut crest at Chainage 3740 is a MODERATE HAZARD.

Chainage 3781-3860m (Photograph 4/29)

The rock face varies between 3 to 6m high and is inclined at 75°. The verge width is at least 2m which ensures that most failures that could be envisaged from this face would present a NEGLIGIBLE or MINOR HAZARD. However most of the face appears secure at present.

NOTE:

Chainage 3860m is taken as end of area under consideration.

RECOMMENDED SHORT TERM ACTION : EXTREME AND MAJOR HAZARDS

AREA 1 : CH. 0 TO 324 m

			RECOMMENDATIONS	
CHAINAGE	HAZARD	FEATURE	PRELIMINARY ACTION	FOLLOW-UP ACTION
109 - 120	MAJ	Large potential "sliding" configuration joints. (Photo 1/7)	Fix "tell-tales" across joints. Assess anchoring requirements. (Stability calcs)	Option to anchor if low factor of safety (*1)
130 - 135	MAJ	Dilated crest blocks. (Photos 1/8 and 1/9)	"Trial" hand scaling. Remove if insecure.	Extend scaling/trimming into zone above to merge if necessary. (*1)
135 - 148	MAJ	Dilated overhang, 4 to 7 m above road. (Photos 1/9 and 1/10)	Option to remove or monitor. Prefer removal.	Possible trimming above to merge (*1)
148 - 157	MAJ	Large dilated overhanging mass. (Photos 1/10, 1/11 and 1/12)	Option to remove or monitor. Prefer removal in conjunction with 135 - 148.	Possible trimming above to merge (*1)
				*1 : Slope reprofiling could be applied, Chainage 130 to 253 m.

RECOMMENDED SHORT TERM ACTION : EXTREME AND MAJOR HAZARDS

AREA 2 : CH. 324 TO 1522 m

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
330 - 336	MAJ	Large dilated mass more than 6 m above road level, "sliding" base. (Photo 1/22)	Inspect. Confirm insecurity and assess viability of removal (heavy scaling or light blasting)	Remove if possible. Otherwise install monitoring. Construct barrier at verge. (*2)
336 - 347	EXT	Large overhanging mass from 6 m above road. Includes apparent "sliding" dilation (4 m below crest) and "toppling" dilation, Ch. 347 (Photo 1.23)	(as above)	as above (*2)
349 - 363	MAJ	Dilated and overhanging blocks in crest area. (Photo 1/24)	(as above)	as above (*2)
				*2 : Ch. 330 - 363. Where blocks are removed, supplementary work including rock bolting may then be necessary. The mesh system should be retained and refurbished.

AREA 2

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
380 - 385	EXT	Large overhanging dilated mass in crest area. (Photo 1/27)	Inspect. Assess viability of removal by blasting.	Remove if possible. Otherwise install monitoring.
380 - 390	MAJ	Dilated "stack" left of MOD. hazard potential sliding mass. (Photo 1/27)	Assess viability of removal without destablizing adjacent area.	Remove if possible. Otherwise monitor
395	EXT	Dilated overhanging block near crest (in "open wedge"). (Photos 1/28 and 1/29)	(as above)	(as above
400 - 420	EXT?	Overhanging masses.	Closer inspection - aim to confirm security.	Possible trimming or monitoring.
420 - 426	EXT	1 to 3 m overhanging approx. 7 m above road, showing severe dilation. (Photos 1/32 and 1/33)	Closer inspection to confirm that tell-tales already installed remain intact. Assess viability of bolting area above and then trimming overhang.	Continued monitoring. Trimming?
432	EXT?	Overhanging crest area.	Closer inspection - aim to confirm security.	Possible trimming or monitoring

AREA 2

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
433 - 436	EXT	Dilated/fractured overhanging "rib" rising from 5 m above road. (Photo 1/34)	Close inspection. Assess viability of light blasting to remove.	Removal preferred. Alternatively monitor.
436 - 454	MAJ?	Numerous undercut blocks.	Trial scaling. Remove where insecure.	
454 - 500	MAJ?	Undercut blocks, particularly Ch. 454, 465, 490 and 496 (Photos 1/36, 1/37, 2/14 and 2/15)	(as above)	Extend mesh into this area
528 - 533	EXT?	Potentially sliding mass supported by buttress. (Photos 2/17 and 2/18)	Detailed examination. Confirm adequacy of buttress. Assess practicality of trimming LHS, where some dilation is evident.	Possible trimming, including crest area to merge. Monitor, including LHS if not removed.
533 - 546	EXT	Very large potentially sliding mass. (Photo 2/19)	Investigate presence of possible side-release joint RHS (Ch. 546 area). Determine anchoring requirements.	Rock anchoring
567	MAJ?	Dilated "stack" from approx. 6 m above road. May be "keyed in". (Photo 2/21)	Close inspection and possible trial scaling. Remove if insecure.	

AREA 2

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
572 - 580	EXT	Joints dipping out of slope near toe and in upper parts give potential sliding configuration. (Photos 2/21 and 2/22)	Assess relative merits of trimming or anchoring. Possibly trimming in crest area and anchoring in lower part.	Anchoring and/or trimming. "Tell-tale" monitoring across "sliding joints" where no other action taken.
590	EXT	Dilated "stack" from 5 m above road. (Photo 2/23)	Assess viability of anchoring above, then removing "stack". Otherwise install monitoring.	Anchor then trim?
596 - 600	EXT?	Wedge structure including dilated blocks. (Photo 2/23)	Close inspection to assess viability of removal, particularly effect on mass to right. Consider possibility of concrete infill and anchoring.	Remove? Otherwise install monitoring.
683 - 692	MAJ	Undercut crest area, very small verge. (Photos 2/25 and 2/26)	Scaling, including removal of wedge at Ch. 684 m.	Meshing
706 - 717	MAJ?	Natural rock bluff extending above retaining structure. (Photos 2/28 and 2/29)	Close examination of pre-existing monitoring points. Supplementary monitoring.	Possibly further concrete infill, and local dowelling/ bolting.

AREA 2

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
790	MAJ?	Dilated irregular "wedge" column below sliding failure "scar". (Photo 2/32)	Close inspection of column Assess potential instability - also other sliding configurations nearby. Possible monitoring of column.	Possibly secure sliding configurations by bolting, and remove column by scaling or light blasting.
833 - 956	MAJ	Discrete section with numerous hazards from planar and wedge sliding, and common undercut blocks. (Photos 2/35, 2/36, 2/37, 3/1 and 3/2)	Close inspection in order to clarify blocks suitable for securing, removing or monitoring. Scaling may be inadvisable. Possible local trial scaling.	Any measures determined suitable for individual blocks. Reinstate mesh.
993 - 1012	EXT	12 m high severely dilated "bluff" cavity RHS. (Photos 3/4 and 3/6)	Trim "bluff" by scaling or light blasting.	Possible need for infill concrete at cavity, Ch. 1012. (*3)
				* 3 : Clearance of fallen trees required in hillside slopes. Ch. 956 - 1092
1110 - 1112	MAJ?	Dilated blocks estimated 20 and 30 m above road.	Inspection. Trial scaling/ removal if blocks appear insecure.	

AREA 2

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
1160 - 1165	EXT	Dilated "bluff" estimated 12 m above road. (Photo 3/11)	Close inspection with view to trimming by light blasting.	Trimming, or other work determined from inspection.
1174 - 1193	MAJ?	Large overhanging outcrop estimated 12 m above road. (Photo 3/11)	(as above)	(as above)
1258 - 1265	MAJ	Dilated "stack" rising from estimated 5m above road. (Photo 3/15)	Inspect, with view to removing blocks underlain by steeply inclined "sliding" joints.	(as above)
1271	EXT?	Large mass 2.5 m above road - appears probably secure (tight).	Close inspection. Install monitoring if security remains questionable.	
1284 - 1293	MAJ	Large undercut potential sliding blocks 4 and 6 m above road. (Photo 3/16)	Monitoring. Assess viability of removing some individual blocks.	Option to secure by bolting/ buttressing.
1360 - 1370 (-1383)	MAJ	Undercut and overhanging potentially sliding blocks. (Photo 3/24)	Examination, monitoring. Consider option to remove least secure blocks (scaling) and then bolt remainder.	Scaling or other work determined from inspection.
1395, 1400, 1407, 1419, 1430	MAJ	Overhanging crest blocks. (Photos 3/25 and 3/26)	Examination. Determine scaling requirements.	(as above)

AREA 2

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
1414	MAJ	Dilated (tree roots) block approx. 15 m above road. (Photo 3/26)	Remove block	
1434 - 1441	MAJ	Apparent "open wedge" structure with overhangs. (Photo 3/31)	Close inspection. Monitoring.	Option to trim and/or support with bolts and/or dowelled concrete infill

RECOMMENDED SHORT TERM ACTION : EXTREME AND MAJOR HAZARDS

AREA 3 : CH. 1522 to 3494 m

CHAINAGE	HAZARD	FEATURE	RECOMMENDATIONS	
			PRELIMINARY ACTION	FOLLOW-UP ACTION
		No extreme or major hazard features requiring short term attention have been identified in Area 3.		

RECOMMENDED SHORT TERM ACTION : EXTREME AND MAJOR HAZARDS

AREA 4 : CH. 3494 TO 3860 m

			RECOMMENDATIONS	
CHAINAGE	HAZARD	FEATURE	PRELIMINARY ACTION	FOLLOW-UP ACTION
3676	MAJ	Potentially unstable block on sliding configuration joint. (Photo 4/23)	Monitoring at joint.	Option to anchor block.
3682	MAJ	Sliding configuration (Photo 4/24)	(as above)	(as above)

APPENDIX 3

SUMMARY OF GEOLOGICAL AND LANDSLIP REPORTS

Introduction

Summaries of the reports listed below are held by the British Geological Society, Edinburgh:-

1. Geological report on the landslip at chainage 13100, May 1969
2. Geological report on the landslip at chainage 21500, May 1969
3. Geological report on the slip at chainage 215, Anderson 1969
4. Blockage of railway line, Knill 1969
5. Supplementary report on landslips at chainages 13100 and 21500, May 1969
6. Report on a visit to the rockslide between chainages 11675 and 11825, Cratchley and May 1969
7. Slope stability in the metamorphic rocks of the Scottish Highlands, Watters 1972
8. The structural geology of the Lewisian and Moinian rocks of the area between Stromeferry and Attadale, May 1959

The locations of the slips as discussed in the above reports are shown in Fig. A3.1

1. Geological Report on landslip at Chainage 13100, Strathcarron - South Strome Road

by Dr. F. May IGS (now BGS) reporting to Babtie, Shaw & Morton
6 February 1969.

This report describes a slip occurring at National Grid reference NG 894362 (Landslide C, Fig. A3.1) during December 1968 and January 196' after the rock face had been excavated and oversteepened at the toe of a steep slope.

Two subvertical joint sets striking north-south and east-west intersect a 10^{o} dipping foliation and the rock tends towards a blocky nature. The joints tend to be open and infilled with clay and a series of cracks and fissures revealed displacements vertically up to 10 feet and horizontally up to 5 feet.

The geometry of the north-south joints and foliation form a stable rock mass which has prevented large scale movement downslope. It is suggested that a fault plane or possible anomalous joint dipping towards the slip maybe responsible for failure, although no evidence of such a feature existed. Downward movement on an inclined plane occurs with a forward component and hence bulging at the toe of the slope is expected. However little evidence of this was seen during a site visit.

No explanation for the exact mechanism of failure was given.

2. Geological report on landslip at Chainage 21500 Stromeferry By-pass

by Dr. F. May (BGS) reporting to Babtie, Shaw & Morton
28 May 1969

The history of the major landslip at National Grid reference NG 914377 (Landslip A in Fig A.3.1, Avalanche Shelter) is recorded as a curved crack developing in March 1969 above the rock face which was monitored on a daily basis until 8 May when failure occurred. Typical daily movement was less than one inch, however immediately prior to failure a movement of 9 inches in 24 hours was recorded. The failed material completely blocked the road and railway and revealed a 20 foot high vertical scar on the south-west and south-east sides.

The slip scar is highly jointed, with a prominent set inclined at 60° to the north-west. The small spacing and open nature of the jointing is attributed to the collapse of the rockface.

It is noted that only a minor amount of scree and moraine was removed from the toe of the slope before signs of failure were observed suggesting the hillside to have been in a critical condition before excavation. The mechanism is suggested to be retrogressive and high rainfall and vibrations from nearby blasting operations were thought to have contributed to the failure. It is stated that if the toe of the debris cone was to be removed, further failures could occur and that it would be preferable to realign the road and railway. Due to the believed considerable depth of water at this location it was considered that it would be difficult to achieve this realignment.

3. Stromeferry by-pass road

Geological report on slip at chainage 215 (Slip No.2)

by J.G.C. Anderson, University College, Cardiff reporting to Babtie, Shaw and Morton.

10 June 1969

The report refers to a previous report by the same author dated 11 march 1969 which has not been viewed by JWP.

The failure produced a horse-shoe shaped scar with a pinnacle of partly shattered rock on the floor of the scar. The strata of Lewisian gneisses have a foliation dip 20° to the ESE and are highly jointed, this being attributed to a fault zone on the east side of the gully. The slip is of the "rock and earth slide" type and shallow in nature. Surface creep is evident above the failure scar. The slip is thought to be attributed to: (a) narrow raised beach at the foot of a high steep hillside; (b) highly jointed nature of rock, (c) excavation at the toe of the hillside.

Anderson warns that further excavation beyond that which is absolutely necessary may trigger further failures and the debris in the eastern gully should not be removed although the heavily jointed rock pinnacle should be removed. During excavation falls should be anticipated under conditions of freeze-thaw and heavy rain and that the long term solution would appear to be protective works and a warning or inspection system.

4. Strome Ferry By-Pass - Blockage of Line

by Dr. J.L. Knill, Imperial College, London

to: British Rail

7 December 1969

Knill reports on the major landslip at construction chainage 21500 and states various measures had been undertaken to remove unstable rock material but one uncontrolled failure had occurred. Knill briefly discusses the reports by May (28-05-69) and the Consulting Engineers and concludes that they offered no explanation for the origin of the slip suggesting a detailed study of the landslip should be undertaken.

Knill suggests the landslip is a small component of a larger 'rock slide' which appears to have a deep-seated rock movement and probably occurred in post glacial times. He notes the creep of superficial material and suggests small scarp like features may indicate old slip scars.

Knill discusses anticipated conditions during construction of the avalanche shelter and states that rockfalls from the exposed slip scars are inevitable. Preventive measures are proposed such as submarine netting and he suggests a warning system should be applied to the rock faces.

The avalanche shelter is said to provide adequate protection of falling rock debris but may be too short if the larger, rockslide is taken into account. He suggests that excavation for the shelter should progress in panels ensuring a minimum length of face is left unsupported at any time.

5. Supplementary report on landslips at chainages 13100 and 21500 Stromeferry By-Pass

by Dr. F. May, BGS

to Babtie, Shaw & Morton

19 February 1970

This report describes the slip mechanism which explains the presence of the two major slips. (Landslides C and A, Fig. A.3.1).

It states that the landslips were attributed to smooth closely spaced near vertical joint planes, steep hillside and natural and artificial excavation at the toe of the slope.

The geological history affecting the hillside and the local artificial excavation is discussed generally before each slip is analysed in detail.

The slip at chainage 13100 is controlled by two joint sets with the main movement towards the NNW controlled by joints striking ENE-WSW which are subvertical and curved. Mineral lineation appears parallel to the jointing and acts as a line of weakness controlling fracturing direction. The mechanism is combined toppling and subsidence resulting in a slight bulging of the rock face.

The slip at chainage 21500 is attributed to a joint set dipping 60° towards WNW which is responsible for bulging and eventual collapse of the slip.

6. Report on a visit to the rockslide between chainages 11675 and 11825 Stromeferry By-Pass
by C.R. Cratchley and F. May BGS
to Babtie Shaw & Morton
1 December 1970

This describes the slip at JWP chainage 3680 which occurred on 17 November 1970, fifteen months after the final excavation was made. The heavy rainfall that fell in the 6 weeks prior to failure is thought to have increased the pore water pressure on the sliding plane which appears to undulate. It is suggested the failure plane is a fault.

Suggested remedial measures include removing adjacent rock buttress to the south west of the slide and grading the slope back to the same angle as the present slide plane.

7. Slope stability in the metamorphic rocks of the Scottish Highlands PhD Thesis
by R.J. Watters, Imperial College
1972

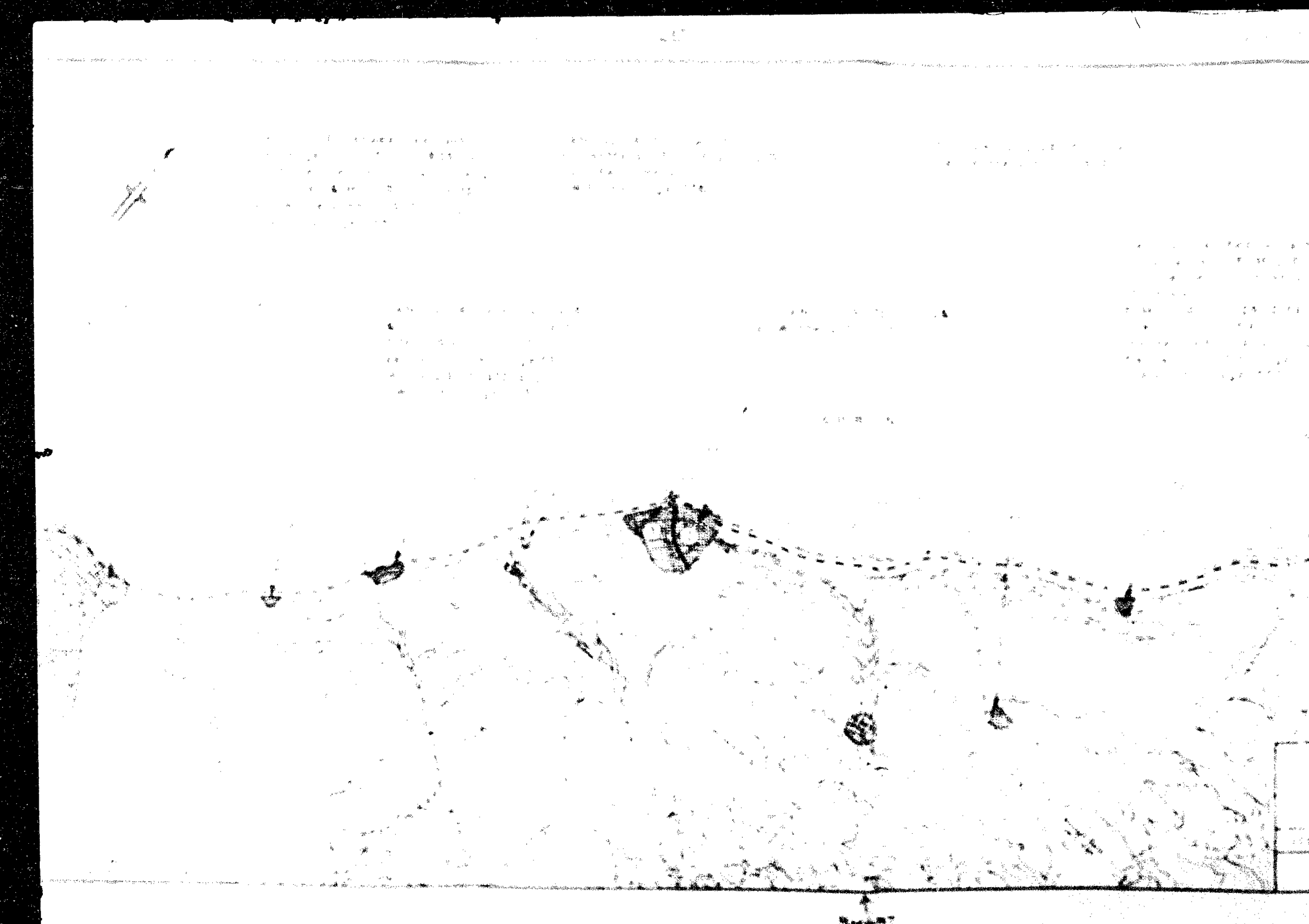
Watters discusses the geology and presence of ancient landslips (Failures 1 to 5 on Fig. A3.1) and recent landslips (Slip A, B, C, & D Fig. A3.1). Analysis of failures have been made and he concludes that recent failures have been caused or reactivated by excavation of road cuts and for borrow materials (Slip B).

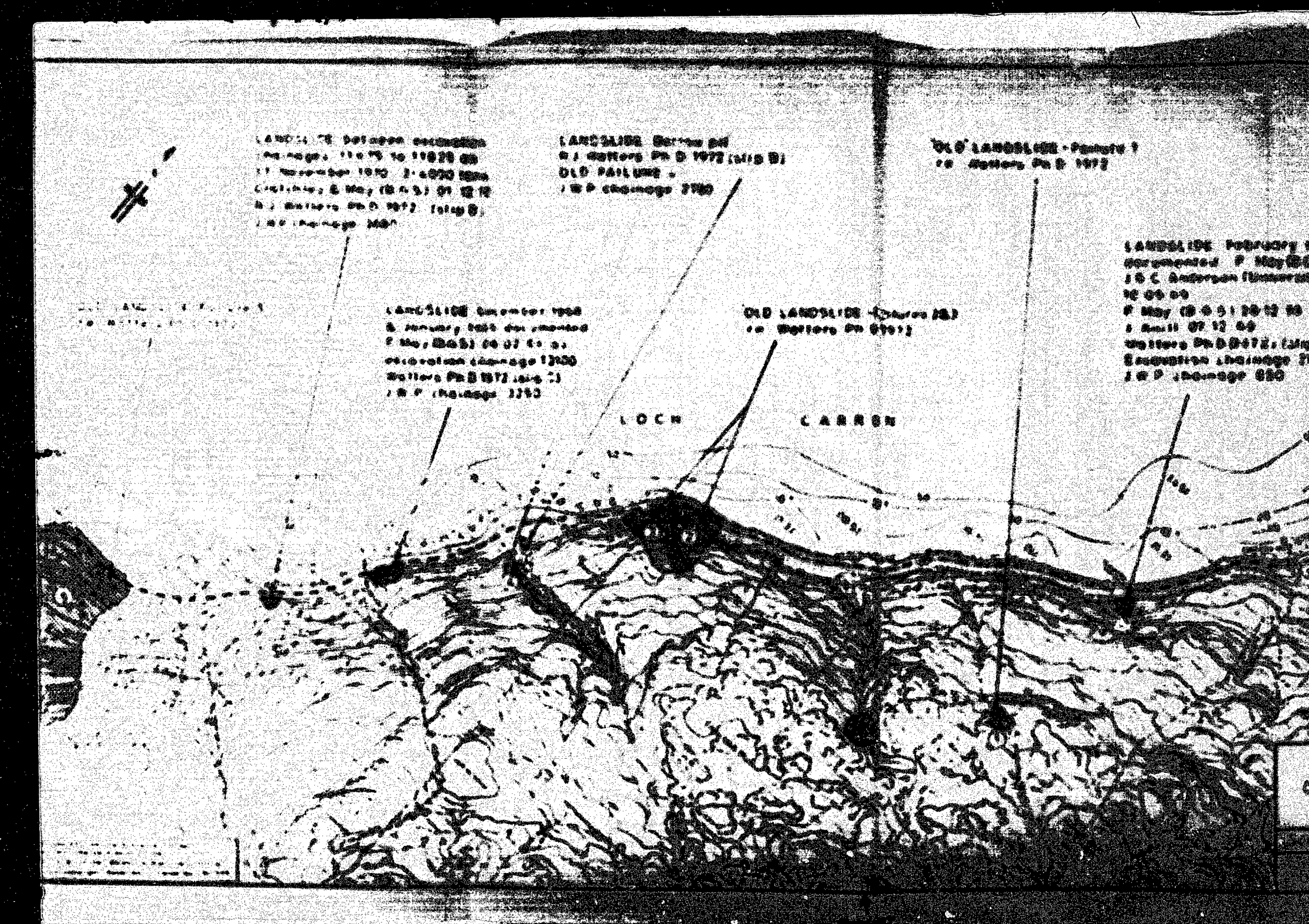
8. The structural geology of the Lewisian & Moinian rocks of the area between Stromeferry and Attadale in Wester Ross, Scotland

PhD Thesis, F. May, Imperial College

1959

This thesis is based on the detailed geological field mapping of the area.

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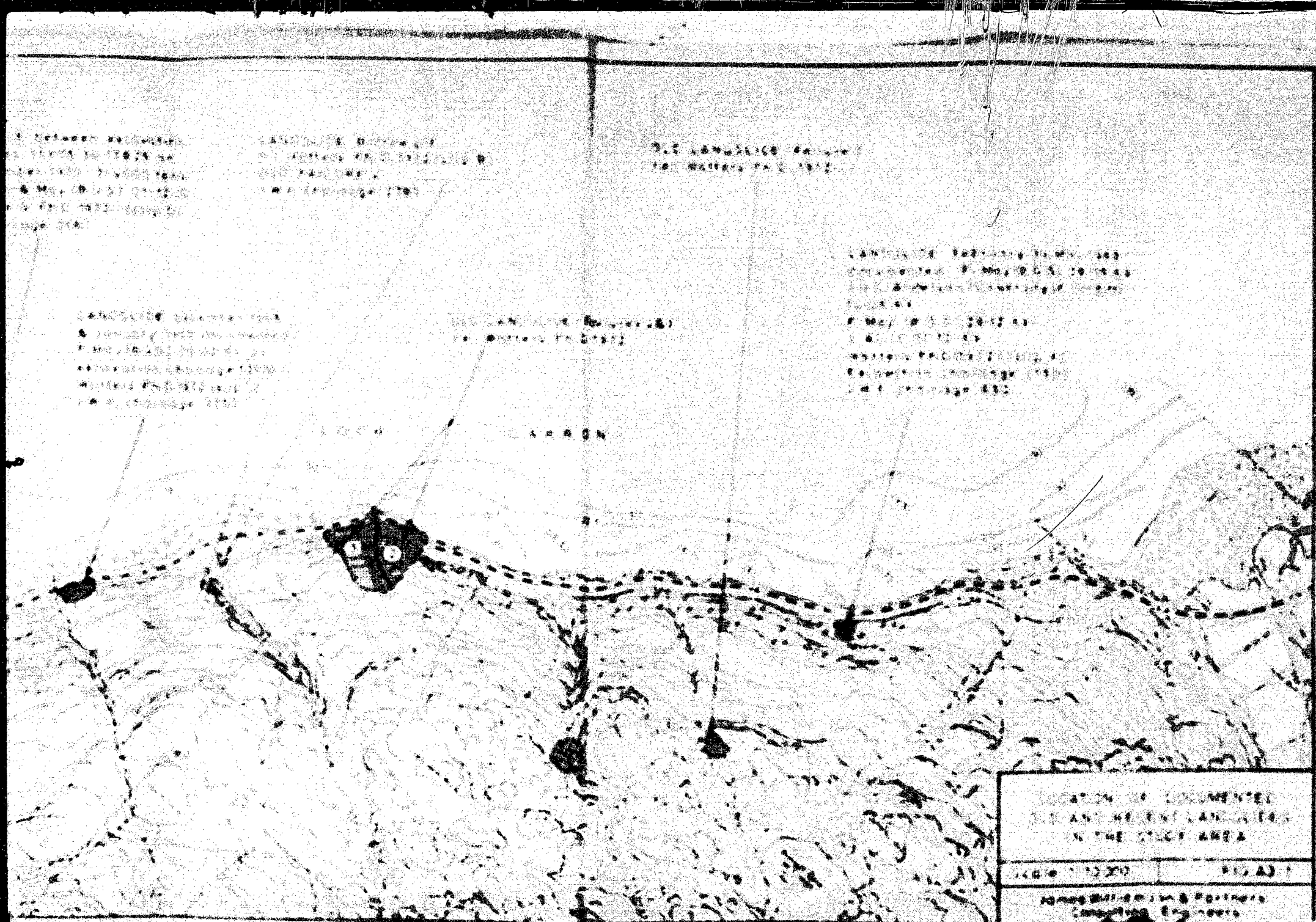

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