

**PLANS AND DOCUMENTS
referred to in the PDA
DEVELOPMENT APPROVAL**

Approval no: DEV2018/988

Date: 30 July 2019



FEBRUARY, 2019

JOB NO. GE19/017

PACIFIQ PTY LTD

**GLOBAL STABILITY ASSESSMENT OF PROPOSED
EARTHWORKS ADJACENT TO RAILWAY CORRIDOR
WYATT ROAD AND BUSHMAN DRIVE
FLINDERS LAKES**



**MORRISON
GEOTECHNIC**

Job No. GE19/017
Ref: 18928
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4th February, 2019

Pacifiq Pty Ltd
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ATTENTION MR MATTHEW MCLAREN

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Dear Sir,

RE: GLOBAL STABILITY ASSESSMENT OF PROPOSED EARTHWORKS ADJACENT TO RAILWAY CORRIDOR – WYATT ROAD AND BUSHMAN DRIVE, FLINDERS LAKES

1.0 INTRODUCTION

This report is a global stability assessment of the proposed earthworks adjacent to the railway corridor at Wyatt Road and Bushman Drive, Finders Lakes (The 'Site'). The purpose of the assessment is to assess if the proposed development including all proposed earthworks associated with the proposed development will or has the potential to impact on the stability of the existing railway corridor. The works were requested by Mr Matthew McLaren from Mortons Urban Solutions on behalf of the Client, Pacifiq Pty Ltd.

This report includes a review of the attached Mortons Urban Solutions earthworks drawings adjacent to the railway corridor and assesses if the proposed earthworks will achieve a long term factor of safety of at least 1.5 against geotechnical instability for all cut and fill batters and retaining structures and that the proposed development including the proposed earthworks will not have a detrimental impact on the stability of the adjacent railway corridor.

It should be noted that this report only assesses the stability of the proposed earthworks and associated development adjacent to or within a close vicinity of the railway corridor. It does not assess the stability of the proposed earthworks including all cut and fill batters and retaining structures throughout the remaining areas of the proposed development site or the local geotechnical stability within the rail corridor.

2.0 METHODOLOGY

A desk study of the available aerial photos, contour maps, geological survey maps, previous reports and the earthworks drawings was initially carried out to identify the site geology, topography, proposed development area and major site features such as unstable areas, drainage features, seepage zones, filled areas and sloping terrain.

Following this desk study, a walk over survey of the site was carried out by a Senior Engineering Geologist from our Gold Coast office on the 29th January 2019 to identify the main geological and surface features, which would impact on the planning and design of the project. This included identifying major site features of significance to slope stability such as slope angles and direction, erosion features, surface and subsurface drainage, wet zones, vegetation density, rock outcrop, cut and fill areas and the presence of any irregular surface features such as curved trees, slips, slumps, debris slides or any associated features.

Several boreholes were drilled as part of previous investigations at the site for the proposed development including a proposed new bridge over the railway corridor. This borehole information as well as observations of the exposed cuts within the rail corridor and outcropping bedrock at the surface were used to assess soil profiles and depths to bedrock where the proposed development and proposed earthworks are to be carried out and to assist with the global stability assessment.

To analyse the global stability of the proposed earthworks including all cut/fill batters and retaining structures, computer generated stability analysis models of the most significant batters and retaining wall sections were created using the software GSLOPE.

The Earthworks drawings are attached in Appendix A. Site photographs are contained in Appendix B to this report. The stability analysis output plots are attached in Appendix C whilst the Guidelines for Hillside Construction are presented in Appendix D.

3.0 SITE DESCRIPTION

The rail corridor adjacent to the proposed development area is approximately 600m long and approximately 25m wide. The proposed development is to back onto the north-south trending rail corridor which has been cut into relatively flat or gentle sloping terrain to form the rail formation with steep cut batters ranging up to approximately 40° in slope gradient at the far southern end adjacent to large Lot 401. These cut batters range between approximately 7.0m and 8.0m in height and expose interbedded layers of extremely weathered (XW) sandstone and siltstone rock within the face. At the base of the cut where the existing railway track is located, the corridor is approximately 8.0m to 9.0m wide.

Adjacent to Lot 900 at the central western boundary of the proposed development site, the rail corridor is typically ongrade with the natural terrain. To the north of this, the rail corridor has been filled adjacent to large Lots 400 and 902 and small Lots 142 and 143 to form fill batters ranging up to approximately 7.0m to 8.0m in height which have been battered to an angle of approximately 2(H):1(V). To the north of this and adjacent to small Lots 140 and 141, the rail corridor is ongrade with the natural terrain. At the far northern end of the development, the rail corridor adjacent to small Lots 138 and 139 has been cut to form cut batters ranging up to approximately 2.0m in height on a slope angle of approximately 2(H):1(V).

The natural terrain within the proposed development area and immediately behind the crest of the cut batters flanking the rail corridor is typically flat or gentle sloping with surface gradients of typically 5° or less. This flat or gentle sloping terrain slopes downwards from both the north and south towards to large Lot 902 in the central portion of the western boundary of the site. At this location the terrain is typically flat and forms an underpass below the railway line. Rock armour has been placed around the fill batters on each side of the underpass in this area.

Based on the attached Mortons Urban Solution earthworks drawings, the ground surface level directly behind the crest of the cut batter at the far southern end of the rail corridor is approximately RL47.0m AHD. The ground surface level directly behind the crest of the cut batter at the far northern end of the rail corridor is approximately RL46.0m whilst the ground surface level reduces to approximately RL31.0m AHD adjacent to the underpass below the railway line on Lot 902.

No major drainage features are evident adjacent to the rail corridor, however several small eroded areas are evident along the boundary between the rail corridor and the proposed development adjacent to small Lots 142 and 143. The low lying area on Lot 902 where the underpass below the railway line is located does form a large flat drainage swale.

The proposed development area to the east of the rail corridor supports moderate native bush vegetation with grass and localised areas which have been cleared of vegetation.

4.0 SUBSURFACE CONDITIONS

The site geology forms part of the Marburg Formation and is thought to have been formed in the Jurassic Geological Time Period. It comprises sandstone, siltstone, shale, conglomerate, coal, oolitic ironstone (Moreton Geology 1:500 000 Geological Series, 1980).

Based on the results of borehole drilling from previous investigations at the site, the subsurface conditions are typically expected to comprise residual soil comprising hard, sandy clay of low plasticity extending to a depth of approximately 1.0m overlying interbedded layers of extremely weathered (XW) sandstone and siltstone rock of extremely low, very low and low strength. The sandstone and siltstone rock sequence becomes distinctly to slightly weathered (DW-SW) and of medium and medium to high strength below a depth of approximately 7.0m.

On average the typical defect spacing within the weathered sandstone and siltstone rock ranges between 30mm and 300mm.

Based on observations of the siltstone and sandstone rock observed in the cuttings and the cored boreholes, the interbedded layers of XW sandstone and siltstone rock typically dip at angles of approximately 20° to 30°.

5.0 SLOPE STABILITY ASSESSMENT

The proposed development areas of the site adjacent to the railway corridor display no evidence of recent past slope instability involving small-scale or large-scale movements of significant quantities of soil or rock in a short duration event such as slips, slumps, debris slides or a landslide. There are, however, localised areas within the cuts along the railway corridor which have been eroded from surface water flows. Some minor localised areas where small sections of rock have dislodged are also evident within these cut batters.

This instability is typically limited to the cuts within rail corridor and there does not appear to be any evidence of existing instability within the proposed development area which would impact on the stability of the existing rail corridor.

To assess the impact that the proposed earthworks for the proposed development will have on the stability of the existing rail corridor, a global stability assessment of the proposed earthworks including all cut/fill batters and retaining structures has been carried out. The results of the global stability assessment are presented in Sub-Section 5.1 below

5.1 Global Stability Assessment

As part of the global stability assessment the following drawings were reviewed:

- Preliminary Overall Earthworks Plan (Drawing No.23305-PRE-S040-A) dated 19/11/18;
- Preliminary Earthworks Detail Sheet 01 (Drawing No.23305-PRE-S041-A) dated 19/11/18;
- Preliminary Earthworks Detail Sheet 02 (Drawing No.23305-PRE-S042-A) dated 19/11/18;
- Preliminary Earthworks Detail Sheet 03 (Drawing No.23305-PRE-S043-A) dated 19/11/18;
- Preliminary Earthworks Detail Sheet 04 (Drawing No.23305-PRE-S044-A) dated 19/11/18;
- Section Plan A-G;
- Section Plan H-K;
- Sections A-C;
- Sections D-G; and
- Sections H-K.

Based on the earthworks drawings provided by Mortons Urban Solutions, the bulk earthworks adjacent to or within a close vicinity to the railway corridor comprise fills ranging up to approximately 1.0m in thickness and cuts ranging up to approximately 1.5m in depth to form batter heights no higher than approximately 1.5m when battered to the maximum allowable safe batter angle of 2(H):1(V) or 26°. Retaining walls are proposed along the boundary with the rail corridor with most walls being no higher than 1.0m. The exception is the retaining wall at the rear of Lots 142 and 143 which typically ranges between approximately 1.0m and 1.5m in height.

All earthworks batters involving cutting and filling are limited to a slope angle of no steeper than 2(H):1(V) or 26°, which is usually considered to be the maximum slope angle for cut or fill batters to achieve a factor of safety in excess of 1.5.

This report includes a global stability assessment of the cut and fill batters and associated retaining walls adjacent to the rail corridor to assess if a long term factor of safety of at least 1.5 can be achieved and that the proposed earthworks will not impact on the railway corridor. To analyse the global stability of the batter and associated retaining wall sections, two (2) computer generated stability analysis models of the batter and associated retaining wall sections was created using the software GSLOPE. Section A (adjacent Lot 401) and Section H (adjacent Lot 143) was established for a global stability analysis and are shown on the attached earthworks drawing.

The geometry of the batter and associated retaining wall cross sections was derived from the attached Mortons Urban Solutions design drawings. Surcharges have been applied behind the batter and associated retaining walls sections to simulate loads imposed by buildings and or vehicles. Based on our experience, testing and the Morrison Geotechnic borehole logs from the area, the following parameters have been adopted for analysis of the batter and associated retaining wall sections.

Table 1 – Estimated Strength Parameters

Material	Bulk Density (kN/m ³)	c' (kPa)	Ø (degrees)
Structural Fill	20	2	25
Natural Clay Soil	21	5	26
XW Bedrock	23	8	33

Calculations of the global stability of the batter and associated retaining wall sections using the above parameters for the fill, natural clay soil and XW sandstone and siltstone bedrock, result in a minimum Factor of Safety which is in excess of 1.5, which is usually considered to be the minimum design target value for similar developments.

On this basis, the proposed development including all cut/fill batters and associated retaining walls adjacent to the existing railway corridor are considered to be satisfactory and will achieve a long term factor of safety in excess of 1.5 and will not have a detrimental impact on the stability of the railway corridor providing the recommendations stated below are followed:-

- The fill used in the construction of batters is placed and compacted to at least 95% Standard Maximum Dry Density and is "Controlled Fill" in accordance with A.S. 2870 (Clause 6.4.2 (a)) – "Residential Slabs and Footings" and A.S. 3798.
- The fill slopes are over-constructed and trimmed back to the design geometry to ensure compaction in the outer zones.
- Where the ground surface slopes at 8° or more, the foundation is benched prior to filling, in accordance with our recommendations.
- All surficial water flows must be directed away from the railway corridor to limit the ingress of surface water over the batters within the railway corridor which can create stability problems.
- Batters are to be stabilised using techniques such as vegetation and mulching or similar to minimise erosion. Properly maintained vegetation should reduce the occurrence of surface erosion by impinging rainfall.
- All retaining walls are to be founded in structural fill, natural soil or bedrock with an allowable bearing pressure of at least 100kPa.
- No dwellings or structures are permitted within 3m of the crest of any batters constructed on site. If dwellings or structures are to be constructed within 3m of the crest of the batter slopes, further analyses will be required or foundations must extend below the toe of the batter.
- No additional earthworks including cuts, fills or retaining walls that are not shown on the attached Mortons Urban Solutions design drawings are permitted without approval from a suitably qualified geotechnical engineer or engineering geologist.

It should be noted that the exposed fill material and batters must be constantly maintained and repaired during the early stages of mulching and vegetation, as erosion may be expected until vegetation is fully established.

If the recommendations described above are followed, the proposed development including all proposed cut and fill batter and retaining structures will not have a detrimental impact on the stability of the existing railway corridor.

The Mortons Urban Solutions earthworks drawings showing the cut and fill batters and retaining walls are attached as Appendix A to this report. Stability output plots are presented as Appendix C to this report.

Please do not hesitate to contact this office if you require any further information.

Yours faithfully



L. BEXLEY BAppSc-App(Geology) AffillEAust
for and on behalf of
MORRISON GEOTECHNIC PTY LTD



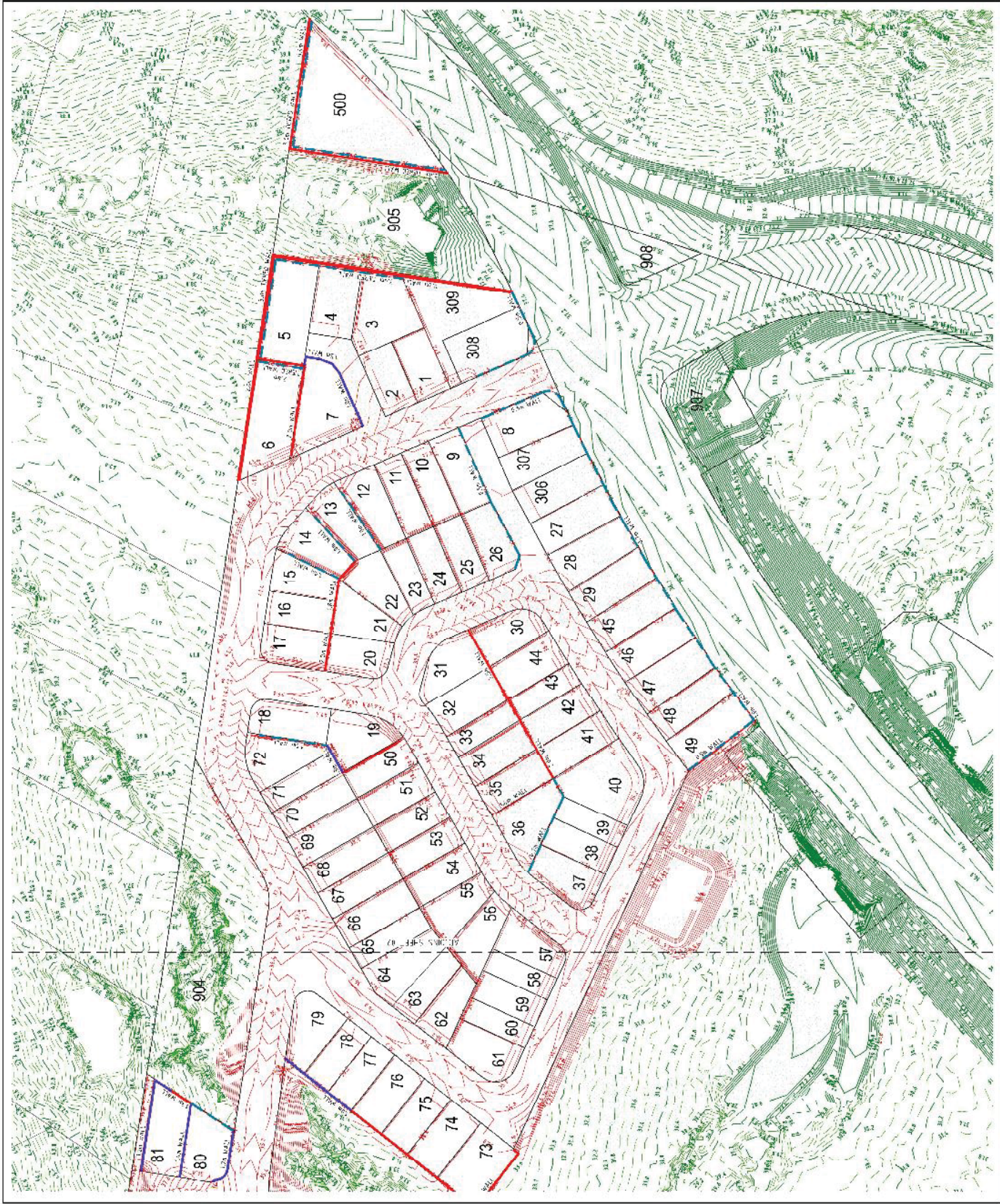
B. M. ELSMORE (RPEQ 19656)
for and on behalf of
MORRISON GEOTECHNIC PTY LTD

Encl Appendix A - Mortons Urban Solutions Earthworks Drawings
 Appendix B - Site Photographs
 Appendix C - Stability Output Plots (Figures 1A, 1B & 2)
 Appendix D - Guidelines for Hillside Engineering
 Important Information About Your Geotechnical Engineering Report

APPENDIX 'A'

MORTONS URBAN SOLUTIONS EARTHWORKS DRAWINGS





PROJECT NAME

Bushman + Wyatt

PRELIM ENGINEERING

CENT

PACIFIQ

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PROJECT NAME
Bushman + Wyatt
PRELIM ENGINEERING
CITY
PACIFIQ



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Scale: 1" = 100' 1:12,500 AS

REVISION	DATE	BY	CHKD
1	10/15/10	WYATT	BUSHMAN

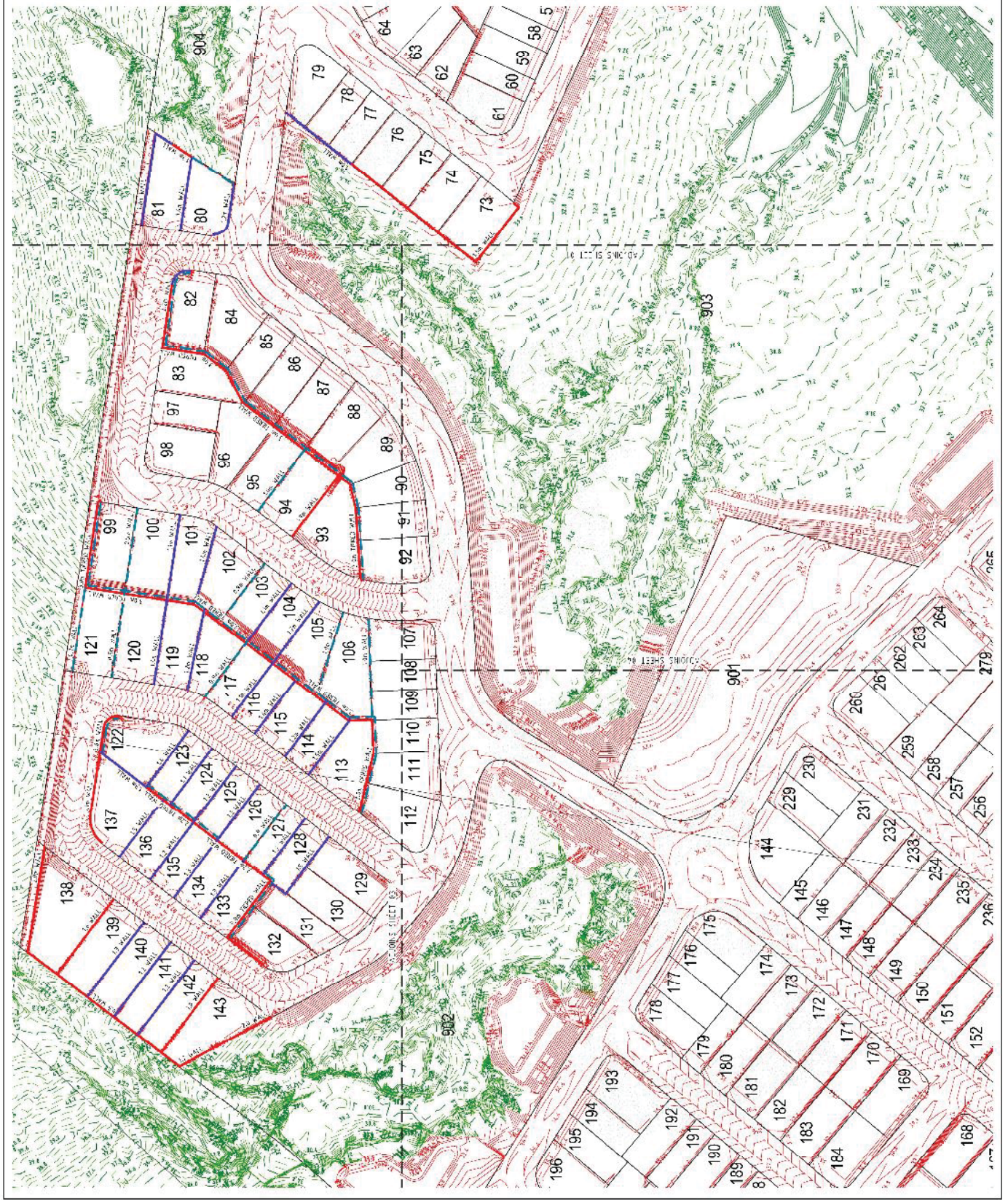
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BMT BENTLEY
Cardno SHAW GROUP
CRACKS CONSULTANTS

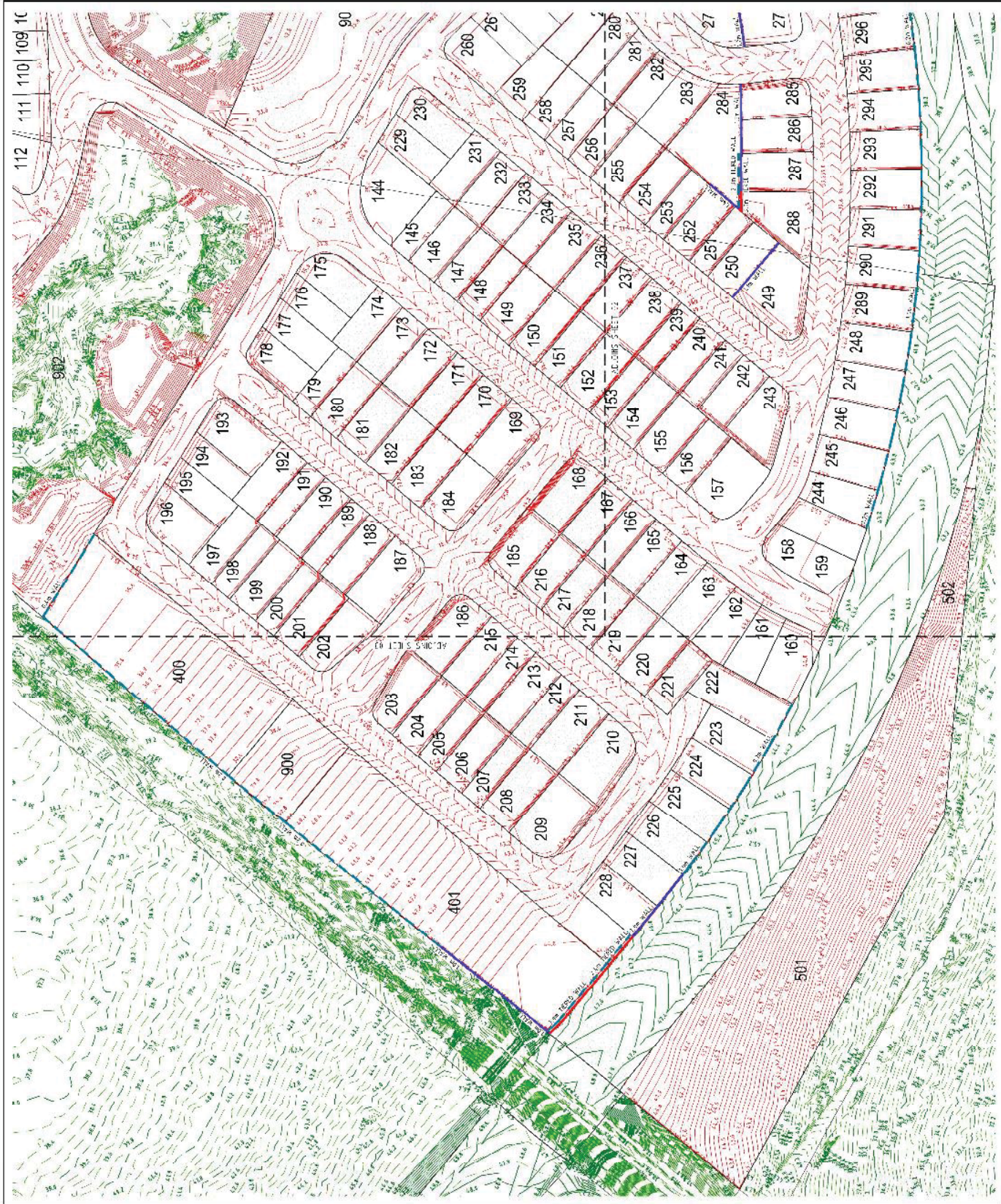
MORTONS urban solutions
Urban & Regional Planning
Civil Engineering
Coordination

PRELIMINARY
EARTHWORKS DETAIL
SHEET 02

23305-PRE-S042

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PROJECT NAME

Bushman + Wyatt

PRELIM ENGINEERING

CENT

PACIFIQ

0 15 30 45 60 75 90

Scale: 1" = 150'

Scale: 1" = 150'

DATE: 10/10/2018

BY: J. BUSHMAN

DATE: 10/10/2018

BY: J. BUSHMAN

ASSOCIATED CONSULTANTS

HOG robertsday

BMV

Cardno

ST

PRELIMINARY

EARTHWORKS DETAIL

SHEET 04

MORTONS

Urban & Regional Planning

Civil Engineering

Coordination

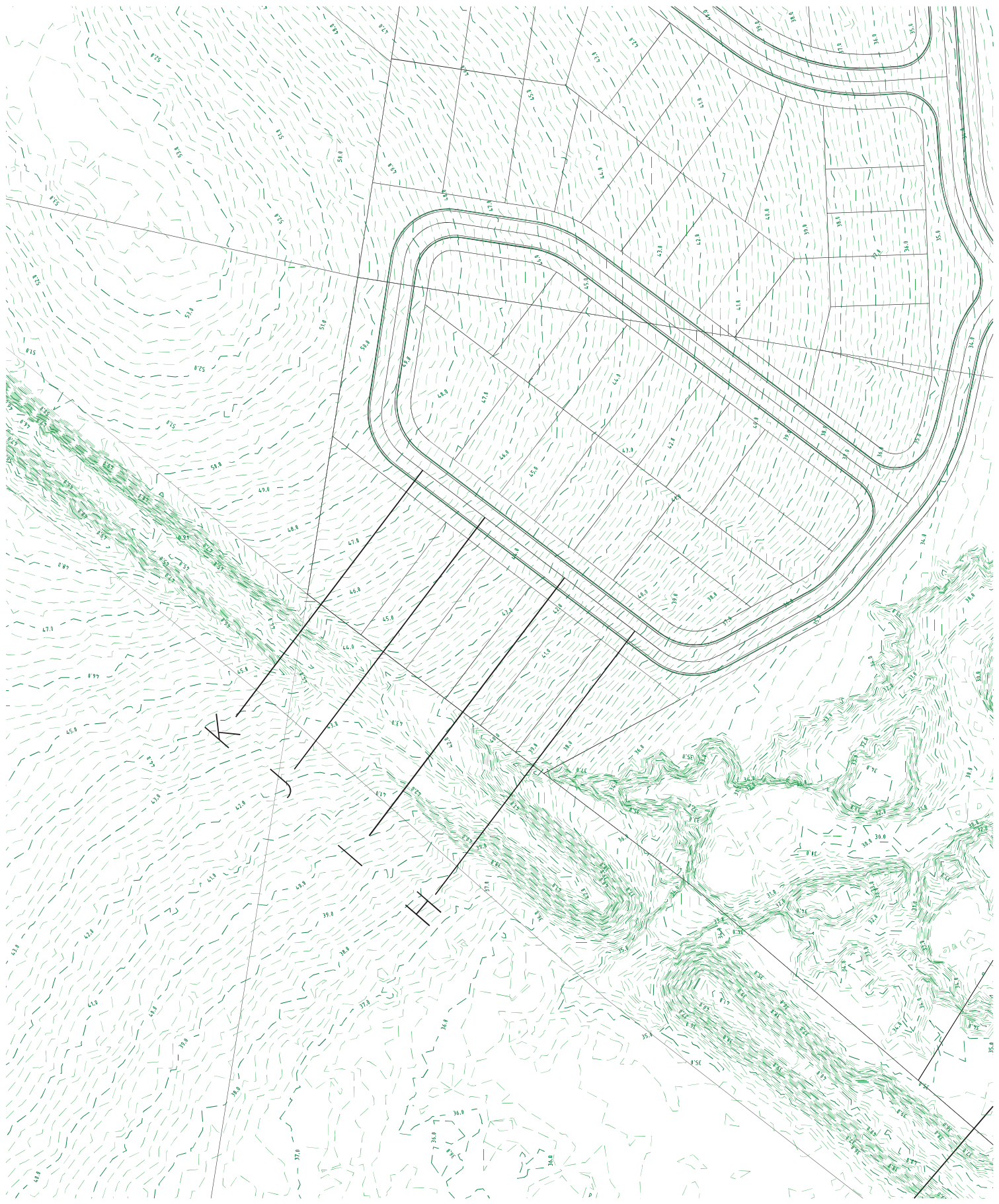
1000 West 1st Ave., Suite 100
Portland, OR 97204
Phone: 503.228.1111
Fax: 503.228.1112
Email: info@mortonsolutions.com

23305-PRE-S04

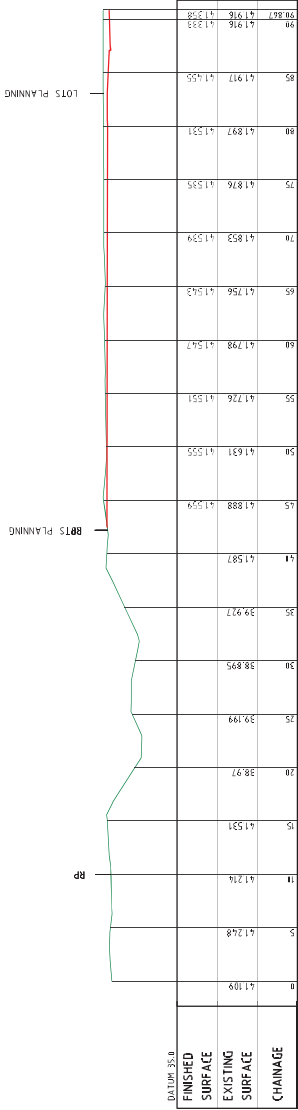
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A topographic map of a mountainous region. The map features brown contour lines indicating elevation, with labels such as 3000, 3100, 3200, 3300, 3400, 3500, 3600, 3700, 3800, 3900, 4000, 4100, 4200, 4300, 4400, 4500, 4600, 4700, 4800, 4900, 5000, 5100, 5200, 5300, 5400, 5500, 5600, 5700, 5800, 5900, 6000, 6100, 6200, 6300, 6400, 6500, 6600, 6700, 6800, 6900, 7000, 7100, 7200, 7300, 7400, 7500, 7600, 7700, 7800, 7900, 8000, 8100, 8200, 8300, 8400, 8500, 8600, 8700, 8800, 8900, 9000, 9100, 9200, 9300, 9400, 9500, 9600, 9700, 9800, 9900, 10000. A network of roads is shown, including a main road running diagonally from the top left to the bottom right, and several smaller roads branching off. A proposed development area is outlined in black and labeled with letters A through G. The area is divided into several rectangular sections. The map also shows a river or stream flowing through the lower right portion. The overall terrain is rugged and mountainous.

SECTION PLAN H-K

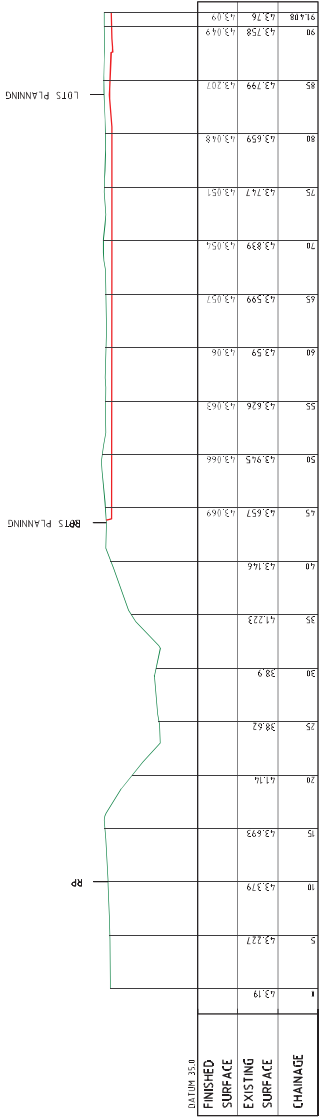


SECTIONS A-C



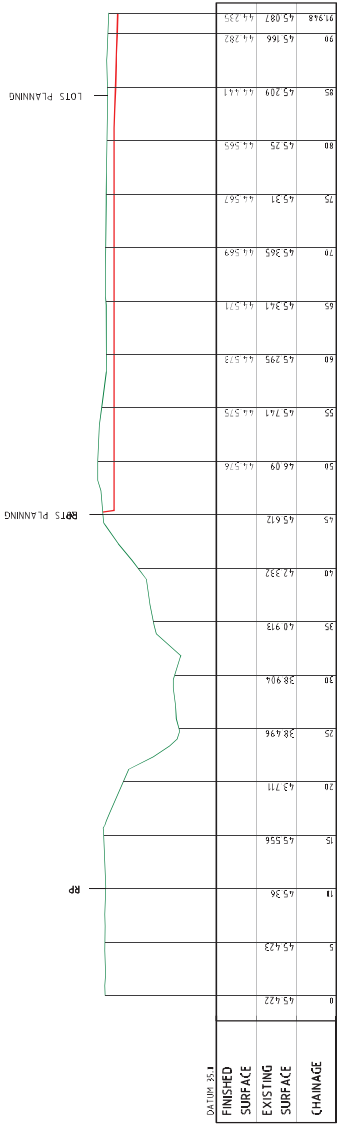
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Vertical scale 1:250



LONGITUDINAL SECTION RAIL B

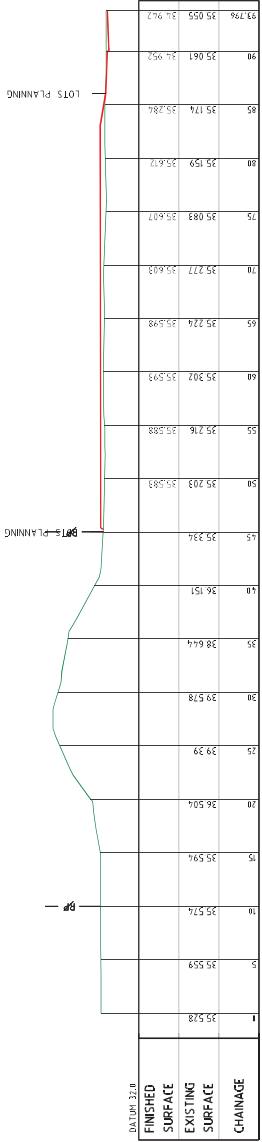
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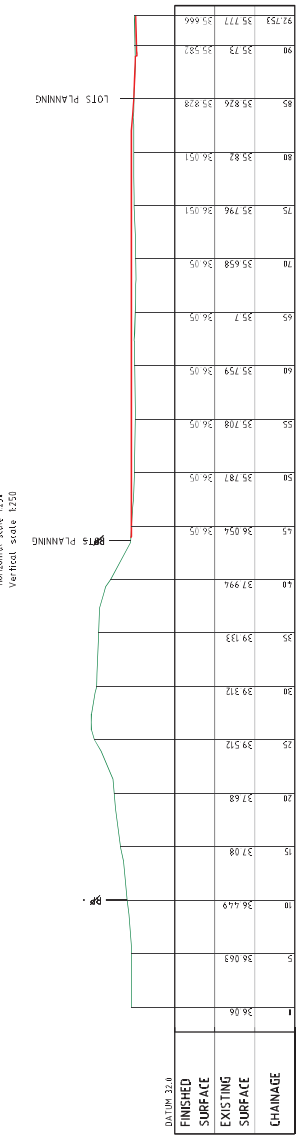
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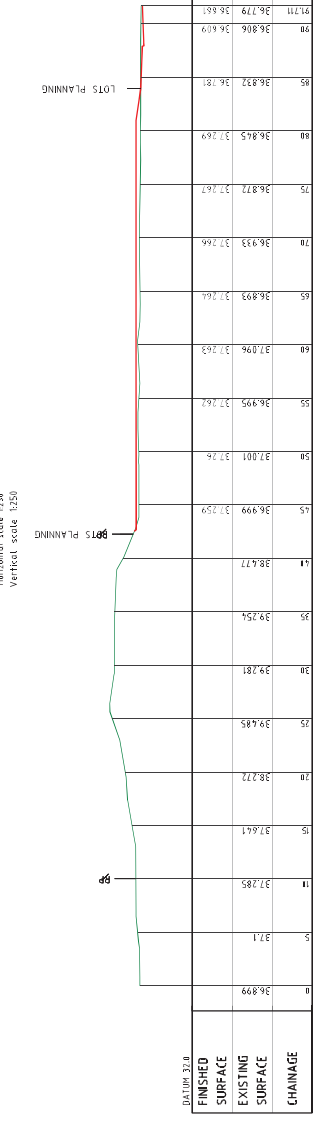
SECTIONS D-G



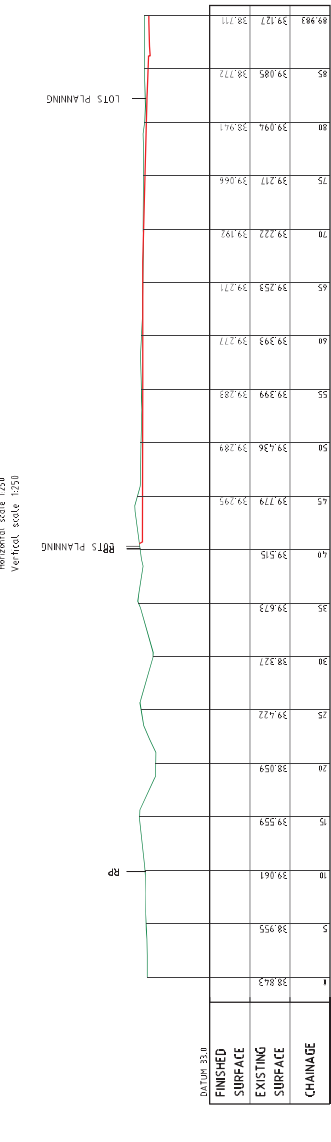
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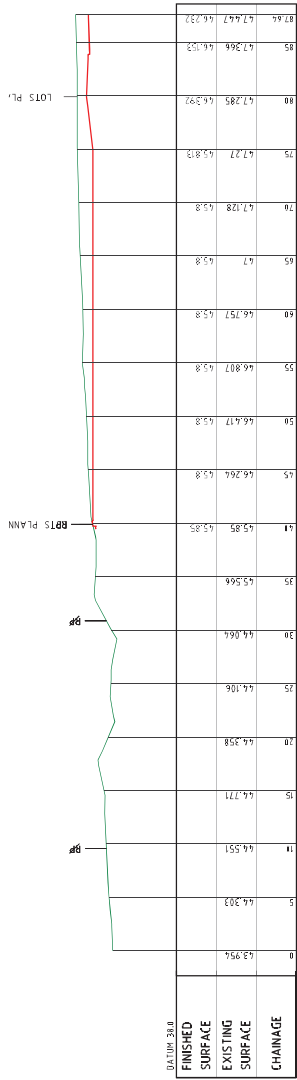
LONGITUDINAL SECTION RAIL E



LONGITUDINAL SECTION RAIL D

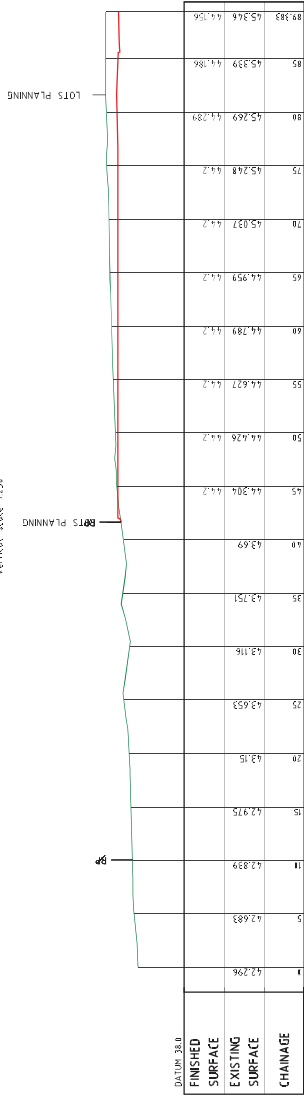


SECTIONS H-K



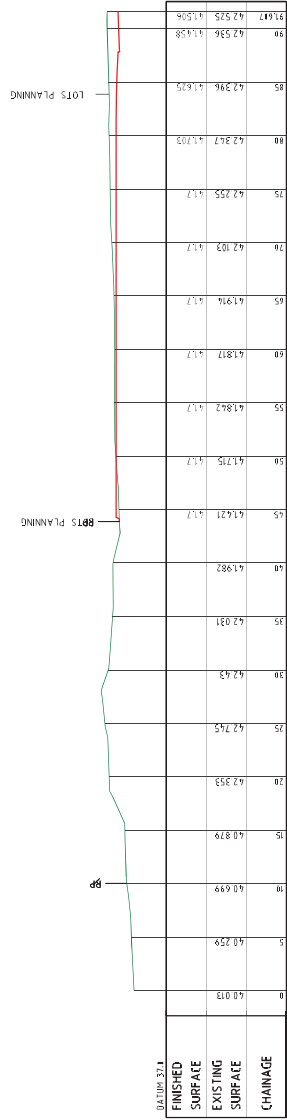
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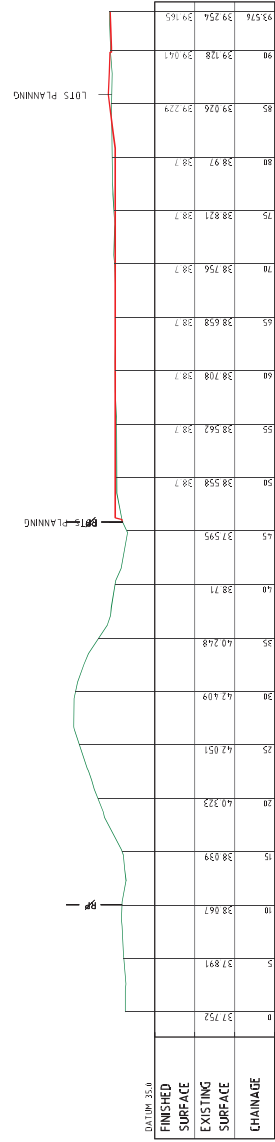
LONGITUDINAL SECTION J

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Vertical scale 1:250



LONGITUDINAL SECTION I

Horizontal scale 1:250
Vertical scale 1:250



LONGITUDINAL SECTION H

Horizontal scale 1:250
Vertical scale 1:250

APPENDIX 'B'

SITE PHOTOGRAPHS





Plate 1 - XW bedrock exposed in railway cutting adjacent to far southern end of proposed development area.



Plate 2 - Proposed development area behind railway cutting at far southern end of the site. Topography is typically flat or gentle sloping.



Plate 3 - Underpass below railway line adjacent to Lot 902. Rock armour has been placed over the fill on right side of photo.



Plate 4 - Fill batter on southern side of underpass below railway line adjacent to Lot 902.



Plate 5 - Fill material associated with the railway line adjacent to Lot 400.



Plate 6 - Gentle sloping terrain forming part of the proposed development area at far northern end. XW bedrock exposed in cutting to the right of photo within rail corridor.

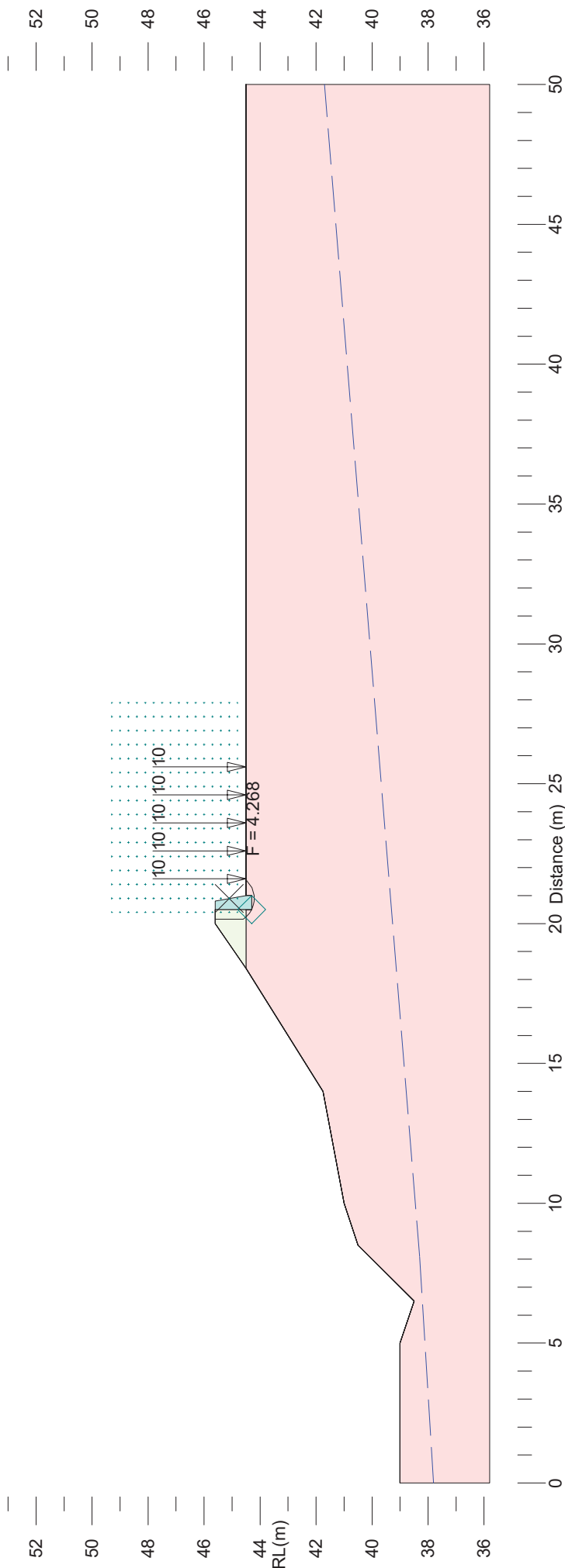
APPENDIX 'C'

STABILITY OUTPUT PLOTS

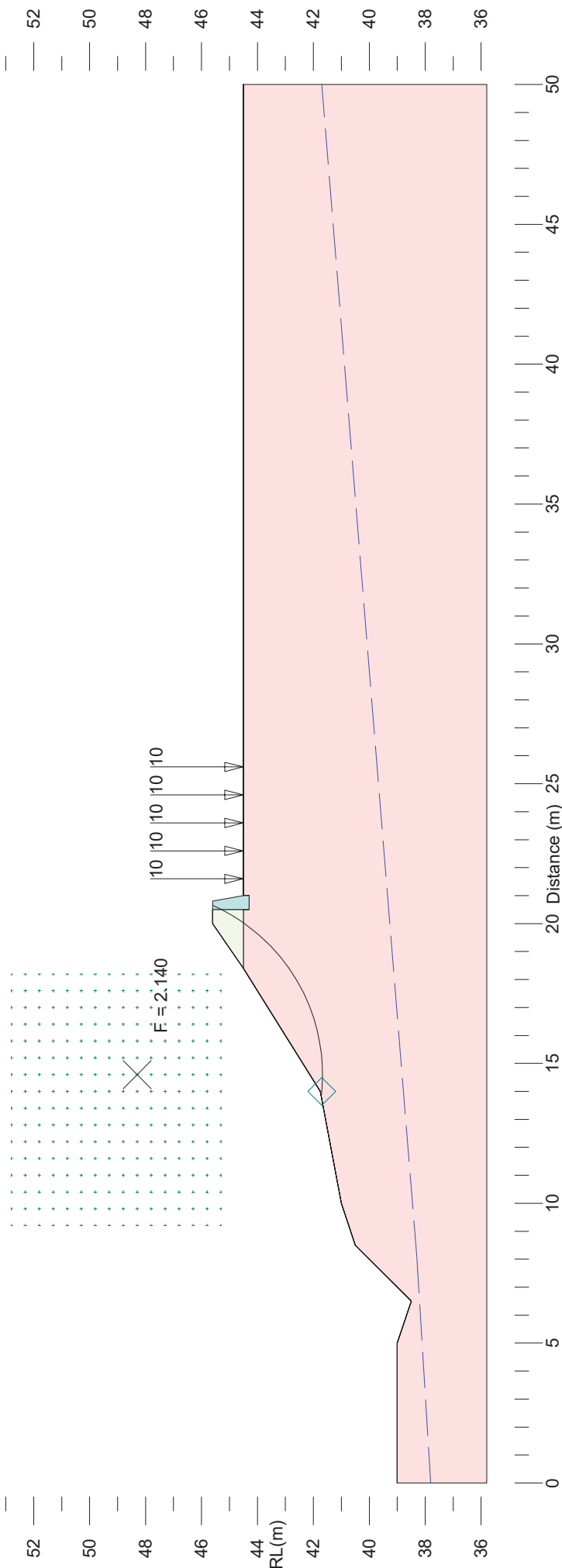
(FIGURES 1A, 1B & 2)



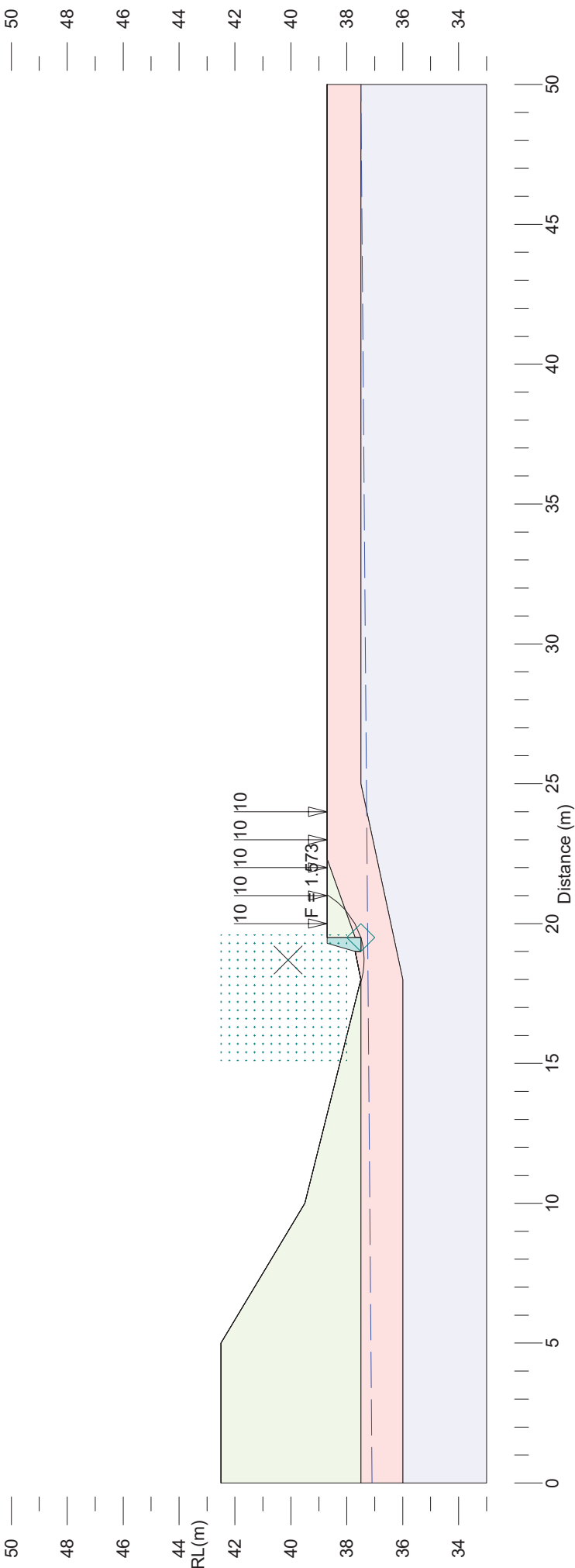
	Gamma C kN/m3	Phi deg	Plezo Surf.
Retaining Wall	23	15	50
Natural Clay Soil	21	5	26
XW Bedrock	23	8	33



	Gamma C kN/m3	Phi deg	Plezo Surf.
Retaining Wall	23	15	50
Natural Clay Soil	21	5	26
XW Bedrock	23	8	33



	Gamma kN/m3	C kPa	Phi deg	Piezo Surf.
Retaining Wall	23	15	50	1
Structural Fill	20	2	25	1
Natural Clay Soil	21	5	26	1
XW Bedrock	23	8	33	1



APPENDIX 'D'

GUIDELINES FOR HILLSIDE ENGINEERING



PRACTICE NOTE GUIDELINES FOR LANDSLIDE RISK MANAGEMENT 2007

SOME GUIDELINES FOR HILLSIDE CONSTRUCTION

GOOD ENGINEERING PRACTICE

POOR ENGINEERING PRACTICE

ADVICE

GEOTECHNICAL ASSESSMENT	Obtain advice from a qualified, experienced geotechnical practitioner at early stage of planning and before site works.	Prepare detailed plan and start site works before geotechnical advice.
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PLANNING

SITE PLANNING	Having obtained geotechnical advice, plan the development with the risk arising from the identified hazards and consequences in mind.	Plan development without regard for the Risk.
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DESIGN AND CONSTRUCTION

HOUSE DESIGN	Use flexible structures which incorporate properly designed brickwork, timber or steel frames, timber or panel cladding. Consider use of split levels. Use decks for recreational areas where appropriate.	Floor plans which require extensive cutting and filling. Movement intolerant structures.
SITE CLEARING	Retain natural vegetation wherever practicable.	Indiscriminately clear the site.
ACCESS & DRIVEWAYS	Satisfy requirements below for cuts, fills, retaining walls and drainage. Council specifications for grades may need to be modified. Driveways and parking areas may need to be fully supported on piers.	Excavate and fill for site access before geotechnical advice.
EARTHWORKS	Retain natural contours wherever possible.	Indiscriminatory bulk earthworks.
CUTS	Minimise depth. Support with engineered retaining walls or batter to appropriate slope. Provide drainage measures and erosion control.	Large scale cuts and benching. Unsupported cuts. Ignore drainage requirements
FILLS	Minimise height. Strip vegetation and topsoil and key into natural slopes prior to filling. Use clean fill materials and compact to engineering standards. Batter to appropriate slope or support with engineered retaining wall. Provide surface drainage and appropriate subsurface drainage.	Loose or poorly compacted fill, which if it fails, may flow a considerable distance including onto property below. Block natural drainage lines. Fill over existing vegetation and topsoil. Include stumps, trees, vegetation, topsoil, boulders, building rubble etc in fill.
ROCK OUTCROPS & BOULDERS	Remove or stabilise boulders which may have unacceptable risk. Support rock faces where necessary.	Disturb or undercut detached blocks or boulders.
RETAINING WALLS	Engineer design to resist applied soil and water forces. Found on rock where practicable. Provide subsurface drainage within wall backfill and surface drainage on slope above. Construct wall as soon as possible after cut/fill operation.	Construct a structurally inadequate wall such as sandstone flagging, brick or unreinforced blockwork. Lack of subsurface drains and weepholes.
FOOTINGS	Found within rock where practicable. Use rows of piers or strip footings oriented up and down slope. Design for lateral creep pressures if necessary. Backfill footing excavations to exclude ingress of surface water.	Found on topsoil, loose fill, detached boulders or undercut cliffs.
SWIMMING POOLS	Engineer designed. Support on piers to rock where practicable. Provide with under-drainage and gravity drain outlet where practicable. Design for high soil pressures which may develop on uphill side whilst there may be little or no lateral support on downhill side.	
DRAINAGE		
SURFACE	Provide at tops of cut and fill slopes. Discharge to street drainage or natural water courses. Provide general falls to prevent blockage by siltation and incorporate silt traps. Line to minimise infiltration and make flexible where possible. Special structures to dissipate energy at changes of slope and/or direction.	Discharge at top of fills and cuts. Allow water to pond on bench areas.
SUBSURFACE	Provide filter around subsurface drain. Provide drain behind retaining walls. Use flexible pipelines with access for maintenance. Prevent inflow of surface water.	Discharge roof runoff into absorption trenches.
SEPTIC & SULLAGE	Usually requires pump-out or mains sewer systems; absorption trenches may be possible in some areas if risk is acceptable. Storage tanks should be water-tight and adequately founded.	Discharge sullage directly onto and into slopes. Use absorption trenches without consideration of landslide risk.
EROSION CONTROL & LANDSCAPING	Control erosion as this may lead to instability. Revegetate cleared area.	Failure to observe earthworks and drainage recommendations when landscaping.

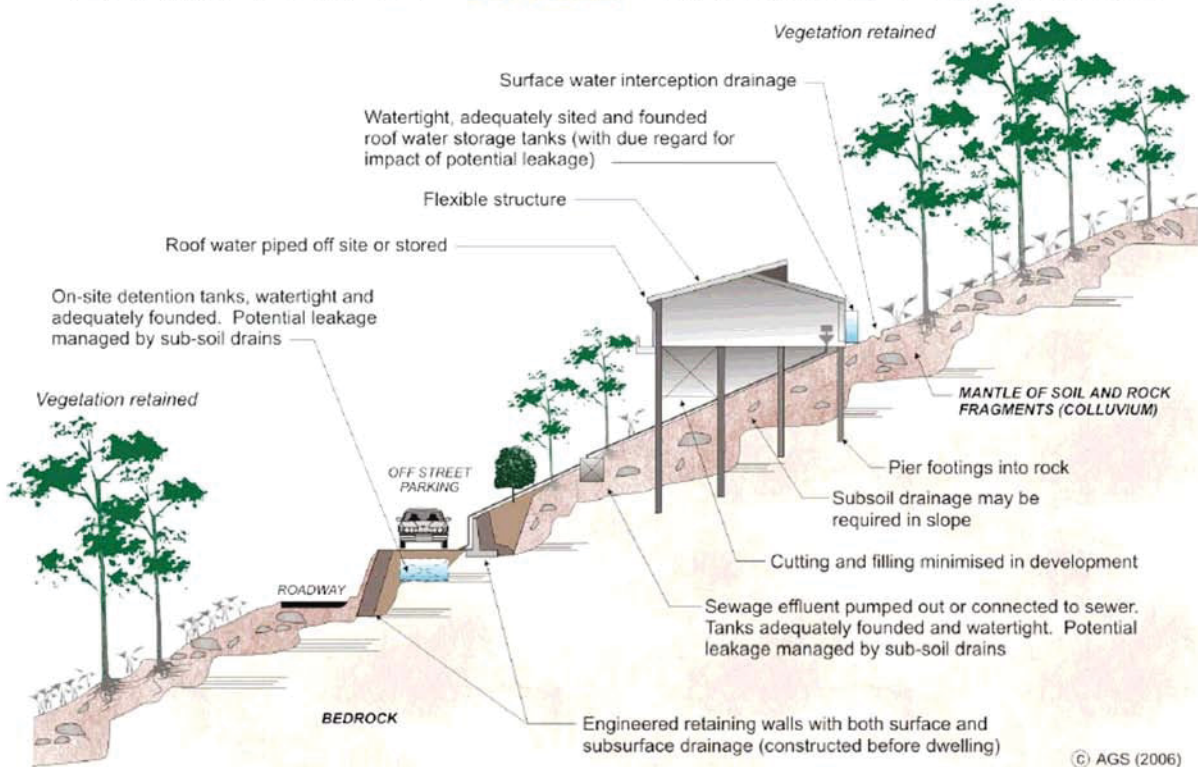
DRAWINGS AND SITE VISITS DURING CONSTRUCTION

DRAWINGS	Building Application drawings should be viewed by geotechnical consultant	
SITE VISITS	Site Visits by consultant may be appropriate during construction/	

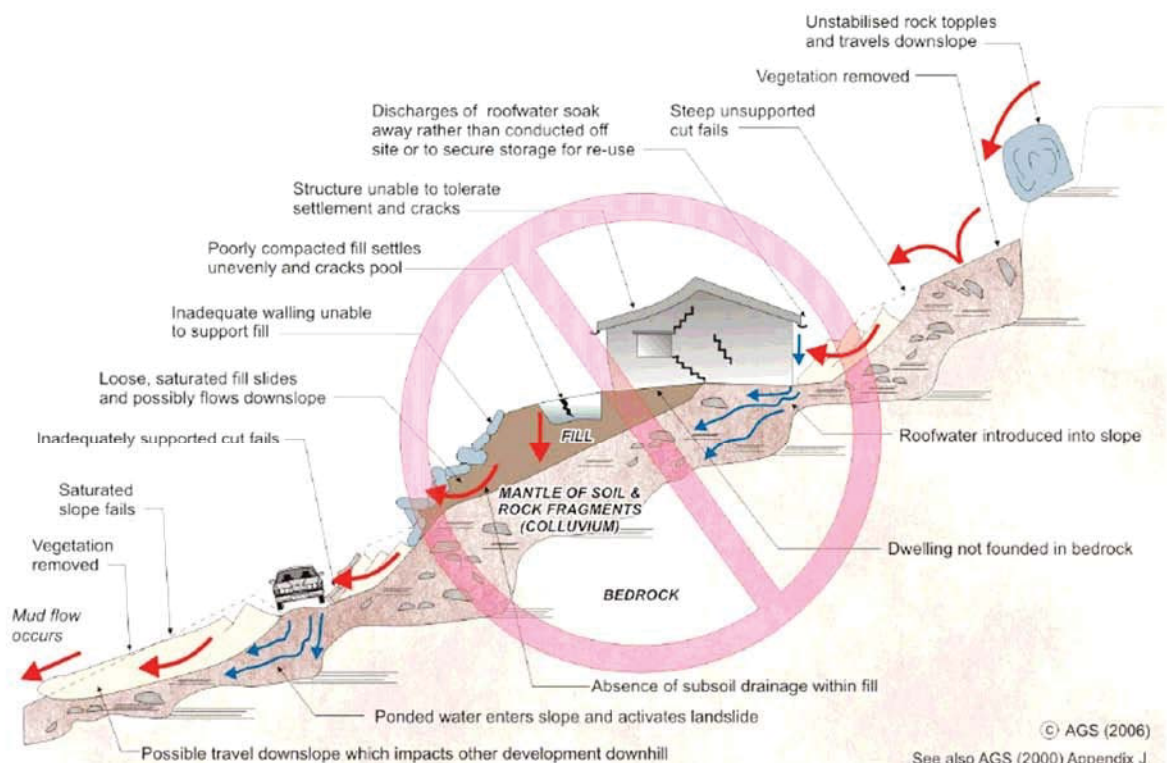
INSPECTION AND MAINTENANCE BY OWNER

OWNER'S RESPONSIBILITY	Clean drainage systems; repair broken joints in drains and leaks in supply pipes. Where structural distress is evident see advice. If seepage observed, determine causes or seek advice on consequences.	
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EXAMPLES OF **GOOD** HILLSIDE PRACTICE



EXAMPLES OF **POOR** HILLSIDE PRACTICE



Important Information about Your Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time to perform additional study.* Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely on Your ASFE-Member Geotechnical Engineer for Additional Assistance

Membership in ASFE/THE BEST PEOPLE ON EARTH exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.



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