From:	[redacted]
To:	IPCN Enquiries Mailbox
Subject:	Hills of Gold Written Submission
Date:	Sunday, 11 February 2024 5:56:15 PM
Attachments:	HillsOfGoldSubmissionIPCSoilLandGAC240211.pdf

Greetings, here, attached, is my submission concerning soil and land issues of the proposed Hills of Gold development. This written submission expands on the presentation I gave on the second morning of the public meeting.

I am very happy to clarify any issues and to answer any further questions that may arise.

I am not sure if all my submission should be public as there are statements which point out shortcomings of PSM and the EIS authors. I am happy to receive the Commision's opinion on that matter.

cheers
Greg

[redacted]

Certified Professional Soil Scientist since 1996
Hon Sec, NSW Soil Knowledge Network.
Hon Science Fellow, then NSW Office of Environment and Heritage
Member NPWS Blue Mountains Regional Advisory Committee
Justice of the Peace

[redacted]

Submission to the NSW Independent Planning Commission.
Hills of Gold Wind Farm (SSD-9679): Land and Soil related concerns.

Prepared by Greg Chapman Certified Practicing Soil Scientist (CPSS, Soil Science Australia), Director Land and Soil Capability.

I am a soil scientist. I have specialised in land resource assessment for forty years. In 1999 I obtained grade 3 certified practicing soil scientist with Soil Science Australia – the highest peer status within the CPSS scheme. My career included establishing and leading soil mapping programs for the NSW Government for 16 years. From 2006 to 2013 I was responsible for leading the team which established methods for NSW base-line monitoring, evaluating and reporting on soil condition and land management within its capability.
My Curriculum Vitae is in appendix A.

 This document expands, and provides further details, pertinent to the presentations I gave (as myself, and also on behalf of Dr Banks) at the public meeting on this matter at Nundle on the 2nd of February 2024. This document addresses concerns and misconceptions relating to soil and land related environmental impacts of the proposed Hills of Gold Wind Farm.

My client is Hills of Gold Preservation Inc (HOGPI), a voluntary group of citizens.
In preparing this review, I made all the inquiries I believe were necessary and appropriate and to my knowledge. I do not believe that there are any matters, relevant to my expertise, omitted from this review. I believe that the facts within my knowledge that have been stated in this document are true.
The opinions I have expressed here are independent and impartial, based on my training, experience and abilities as a soil scientist.

Summary:

Hills of Gold Wind Farm is an attempt to install large scale wind turbine generators (WTG) on terrain which has been mapped by the NSW Government as having an extreme mass movement hazard and an extreme water erosion hazard. The development includes associated infrastructure and roading to allow for installation, maintenance and decommissioning.

- Despite repeated requests there is still no demonstrated on-site soil assessment, nor real understanding of soil and land conditions. Both are necessary to prepare a well-informed Environmental Impact Statement (EIS).
- The disturbance footprint of the development has not been properly assessed, nor has any serious attempt been communicated to match infrastructure to

requirements to limit mass movement (such as landslides, soil creep, land slip, slumping and debris flows etc), effectively curb erosion and prevent entry of high phosphorous soils into catchments.

- Risks and detailed designs are not proposed to be addressed until at least the construction stage. In this case, because aspects of the soil and terrain appear to have been downplayed, a substantial and presumably unallocated budget will be required to ensure slopes are sufficiently stabilised, not only for the life of the development, but for well after it has been decommissioned.
- Risk of accelerated slope failure may be catastrophic for the economic viability of the proposed development and also deteriorate water quality and aquatic habitats.
- Erosion of basalt soils is unusual in that basalt soils are naturally high in phosphorous (P). P is the limiting factor which drives blue green algae blooms – and unless controlled will exacerbate a problem which impacts the Murray Darling. This means control of erosion and sedimentation will require highly specialised and expensive solutions due to slope, hydrological and space constraints. This will in turn increase the footprint, and increase other impacts such as traffic, as well as the expense of the proposal.
- Risk of mass movement is already present and has been recognised by both locals and the NSW government. It is well established that mass movement is exacerbated by extensive cut (basal sapping and toe removal) and fill (extra weighting and drainage changes) operations. These operations are necessary, for example for roading, and for the installation of Wind Turbine Generators (WTGs).
- Multi-million dollar (eg $38m plus) repair bills to rectify disruption to infrastructure through mass movement are known for public roads, on the same geology, crossing the same mountain range. Just one landslip may jeopardise the financial viability of both the project and cause significant environmental impact.

The proposed development is arguably the most extreme and poorly assessed risk to land and water degradation I have encountered.

Table of Contents

Summary: 1

Table of Figures ***3***

Background and timeline 4

Comments concerning the EIS evaluation process and the timeline 5

Comments on Independent Expert Advice: Constructability, Soil and Water 'Assumptions' in Banks 2022, Chapman 2023 and Thoms 2023 by PSM Geotechnical Engineering ***6***

Appendix L or M Confusion in Department's report 6

Examination of PSM's three main summary points 6

1 First conclusion of PSM: Matching soil and land conditions to the footprint of the proposed development ***8***

Misrepresentation of slopes by PSM 8
Mass Movement instability not considered by PSM 9
Roads and slopes 9
Inappropriate erosion controls 10
Footprint and Limitations of local construction materials 11
Achieving soil stability on steep batters with self-mulching cracking clays 11
2 Second conclusion of PSM: Inconsequential characterisation of soil types and land and soil capability 12
The EIS lacks soil data.... 13
Lack of provision of soil and land information and NSW Government Guidelines for EIS preparation.... 13
Government Spatial Information concerning soil erosion and mass movement hazards on site 14
Issues understanding the degree and consequences of soil erosion 16
Impact of erosion of basalt derived soils on water quality 18
Structural instability of basalt landscapes 21
Slope failure of soil and weathered basalt.... 23
Residual risk after investigation 23
Consequences of mass movement 25
Visual impacts of mass movement. 26
3 Third conclusion of PSM: Impacts and the Life of the development 26
Climate change as a second order effect 27
Decommissioning 27
Conclusions 29
Comments on the NSW planning process 29
References....30
Appendix A: Curriculum Vitae: Greg Chapman....32

Table of Figures

Figure 1 Summary of findings by PSM continued in figure 2… 7
Figure 2 Completion of summary points of PSM 7
Figure 3 The footprint of the development 8
Figure 4 Google earth oblique straight line cross section between towers 13 and 20. Maximum slope is 56.5 percent and average slope around 24.5 percent. Location of the cross section is also shown in figure 5 8
Figure 5 A PSM slope map with cross section location. Note red lines indicate the proposed transverse track at 30 percent gradient. 9
Figure 6 Google earth plot and cross section after the transverse road based on PSM mapping towers 14 to 17. 10
Figure 7 Diagram of cut and fill on very steep slopes from the PSM report 12

Figure 8 PSM insufficient and incorrectly characterised soil type and capability is 'inconsequential' 12
Figure 9 Forword of Soil and Landscape Issues in Environmental Impact Assessment DLWC 1997. 14
Figure 10 Land and Soil Capability for Water Erosion showing much of the proposed development area being extreme. This layer has transparency applied over a digital terrain model to help viewers identify pertinent locations. 15
Figure 11 Land and Soil Capability for Mass Movement shown as extreme for much of the development area 15
Figure 12 Summary of soil erosion problems not appreciated in the EIS or by PSM 16
Figure 13 NSW Government Website Espade showing modelled RUSLE soil erosion for undisturbed bare soil 17
Figure 14 Minview (NSW Government geological Survey Web Viewer) showing coincidence of the Liverpool Range with Mount Royal Volcanics. 18
Figure 15 Processes driving blue green algae blooms from basalt soil erosion 19
Figure 16 Some sediment basin requirements 20
Figure 17 Collapsed basalt columns and associated scree. Image by Dave Showalter 21
Figure 18 Columnar basalt collapse mechanisms 22
Figure 19: Landslip cannot always be closely predicted. Prevention is costly and small changes can make a difference 23
Figure 20 Willow Tree Merriwa road crossing the Liverpool Range. Arrow is in the vicinity of closure due to mass movement. Mass movement LSC mapping is class 8 = Extreme. 24
Figure 21 Consequences of mass movement events 25
Figure 22 Example of a debris flow Warrumbungles national park Tulau et al (2019) and photo of a gravel and boulder choked riverbed below the Liverpool Range (photo supplied by B Tomalin HOGPI) 26
Figure 23 Decommissioning and climate change are second order effects according to PSM 28
Figure 24 Concluding remarks 29

Background and timeline

A wind farm was proposed on the Liverpool Range and meetings held in 2018
2018 Hills of Gold Preservation Inc (HOGPI) was established in response to community concerns of the impact of the proposal
2020 the EIS was made available for public comment
2021 HOPPI requested Dr Banks review soil and land aspects of the EIS. He found it lacking appropriate soil information and called for rectification.
The EIS authors responded to Banks concerns by producing a more comprehensive slope map. The updated EIS did not add any on-site soil or geotechnical information
2022 Banks listed ongoing concerns with the EIS. To date no further data updates have been made to the soil and land section of the EIS.
2023 HOGPI commissioned Chapman to respond to further amendments. The Chapman report focused on the extent of disturbance of soil and regolith of the proposal with regard to soil and terrain impacts.
2023 Thoms prepared a report on expected impacts of the proposed development on water issues.

2023 DPE Planning employed an independent expert PSM to review the EIS and issues raised by Banks, Chapman and Thom.
2023 Tamworth Council raises concerns with difficulties of engineering public roads to meet the needs of the development.
2024 Public meeting called by the Indenpendant Planning Commission (IPC) due to Council rejection and large number, and proportion, of negative public responses
2024 The IPC ran a public meeting at Nundle where amongst many others:

- Brian Tomalin spoke of unassessed hydrological impacts the intensity of mountain storms and higher and more intense rainfalls on the summit
- George McDonald, Wallabadah Catchment Community, Wallabadah Community Association and John Sylvester, Sylvester Cattle Co, Head of Peel Rd spoke of concerns erosion and mass movement concerns.
- Chris Eagles, Timor, Crawney and Isis Valley Communities showed a video demonstrating the prevalence of minor spontaneous landslips.
- Chapman and Banks (Chapman representing Banks who could not attend) responded to concerns with the EIS and the PSM report at the public meeting.
- Peter Gill, Retired Civil Engineer, and Steve Brake Civil Engineer with Tamworth Regional Council spoke about construction challenges.

Comments concerning the EIS evaluation process and the timeline

It is understood the Department of Planning asked experts within NSW Government to review biodiversity claims and counter claims. The same process of referrals would also be reasonably expected for other disputed natural resource themes. Soil and land disturbance impacts for the same development could have been send to the Soil and Land Assessment Team, the soil and land assessment experts within the then Department.

However, the Department of Planning and Environment was not aware of the presence of the Soil and Land Assessment Team and so it contracted geotechnical consultant, PSM to prepare a response to the reports provided by Banks and Chapman and Thoms[1]. Various omissions in the PSM response report indicate that the PSM review did not appreciate the nature and implications of the soils or the terrain. Please refer to details provided later in this submission.

It is humbly requested, at least for fairness across specialised disciplines, that the Soil and Land Assessment team, now within the Department of Climate Change, Energy, the Environment and Water be requested to conduct an independent/unbiased review of the Soil and Land components of the EIS and subsequent documents.

Senior Team Leader of the Soil and Land Assessment team

[1] I spoke to NB, Director Energy Resource Assessment for the NSW Department of Planning Housing and Infrastructure, immediately after the public meeting finished and asked if she knew of the Soil and Land Assessment team in the NSW Government. Her answer was no. I encouraged NB to photograph Senior Team Leader's email signature from my phone, and when I asked if she could organise to ask the Senior Team Leader to arrange a review. NB said it was too late. Given the assessment process is over six years and land instability poses a palpable risk, a few weeks to review the documents by government workers does not seem an inordinate delay.

NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW)

Further details on the powerpoint presented by Greg Chapman at the Nundle public meeting on the 3rd of February 2024 are presented below:

Comments on Independent Expert Advice: Constructability, Soil and Water 'Assumptions' in Banks 2022, Chapman 2023 and Thoms 2023 by PSM Geotechnical Engineering

The word 'assumptions' is used in the first slide as the Department of Planning briefing to PSM instructed PSM to assess assumptions by Dr Banks, Mr Chapman and Professor Thoms. According to DPE brief for the scope of work PSM was instructed to, among other things to:
1) Attend meetings with the Department to advise on constructability and impact ***assumptions***. And …
3) Review HOGPI peer review of soil and erodibility ***assumptions****, constructability and impacts to local hydrology.*
Did the Department of Planning stipulate an overly restricted the brief for PSM, by not mentioning assessment of land instability from the construction? Is the Department facing political pressure to fast track the development?
My goal is to draw attention to the overarching theme of assumptions throughout the soil and land assessment component of the EIS - where without presentation of actual onsite soil data, then assumptions must be made.

Appendix L or M Confusion in Department's report

There is confusion concerning Appendixes for the Department of Planning and Environment Report (2023). Some parts of the plan refer to the PSM response as appendix L, others as appendix M. Material concerning what PSM is referring to is missing but sometimes is listed as being in appendix L. Regardless of the reason, the effect is the same - without source material being present, those interested in the assessment of soil and land elements of the development have no alternative but to rely on the opinion of PSM.

Examination of PSM's three main summary points

PSM summary of DPE review. 3 summary points (repeated by DPE)

1 **Interaction of works with steep terrain.** Extent of area of disturbance for WTG, associated works and constrained road geometry

PSM reponse:

- needs more details.
- Increased confidence: proposed approach will allow site specific control measures within **proposed disturbance boundaries** and final location of works **unlikely** to be larger than the EIS footprint
- Details indicating use of standard engineering practices for controlling soil erosion are proposed, including temporary measures within the construction footprint.

Figure 1 Summary of findings by PSM continued in figure 2…

Figure 1 text in red is a shortened quote from the PSM summary. As we shall see it does not inspire confidence.

2 Insufficient and incorrect characterization of soil types and land and soil capability

PSM concludes: '*moderate to high erodibility [sic], depending on slope,* ***considered to be inconsequential***'

3 Future effects of decommissioning and climate change

PSM concludes: 'second order and unlikely to result in significant changes to impact assessment'

If this proposed was on undulating sandstone derived soils I would be inclined to agree. But it is not.

Figure 2 Completion of summary points of PSM

Summary points by PSM in figures 1 and 2, are discussed in more detail below.
I would be inclined to agree with PSM's summaries if the development was on stable terrain with less problematic soil.

As will be detailed below, it appears that PSM has not appreciated the properties of the soils, the nature of the terrain, nor the interaction of soil and terrain with proposed development, nor likely water quality impacts.

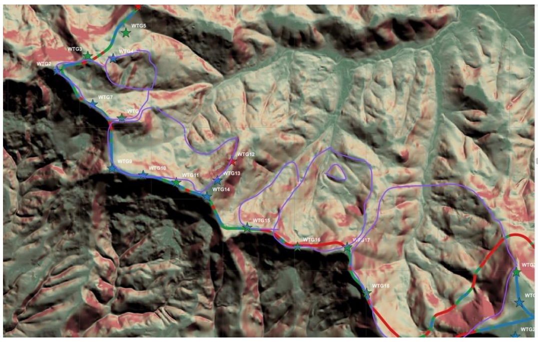
My objection is not to the wind farm as I support the need for societal conversion to renewable energy. It has to be asked: Is there consistent use of presentation gambits to downplay the environmental impacts in the assessment and review process? If so what are the likely consequences for citizens, the environment and the developer?

We know that the development is likely to disturb soils and landforms in a very hazardous environment, with palpable risk of catastrophic landslip and erosion – yet this is not well represented in either the EIS or the PSM report.

In short, I believe the development is being proposed for the wrong place and that there is risk to society, the viability of the development and the environment if it is to proceed.

1 First conclusion of PSM: Matching soil and land conditions to the footprint of the proposed development

My response to 1
The footprint remains unknown



Red lines roads with gradients >30%.
Areas enclosed in purple show signs of previous mass movement [Red hillslope mapping tops out at 30% when the slopes are far steeper]. Road gradients in red are steeper than 30%!

- PSM advocates **inappropriate erosion control** measures (Grassed water-ways and level sills). It leaves addressing specialist measures to the construction phase – without examination of difficulty, by then it will be too late.
- Optomistic suggestions of achieving soil stability on very steep batters of self mulching shrink-swell rocky clays for 30 years. **Good luck**
- Ignores mass movement instability – a huge erosion hazard, especially with cut and fill and changes in runoff!
- Does not include impacts of compound and simultaneous impacts of bends, gradients and gradient changes and required road widths on the amount of rock and soil material to be moved.
- Appears to show road gradients >30% when 15% is considered extreme for trucking turbine blades – so will require far more cut and fill.

Figure 3 The footprint of the development

Misrepresentation of slopes by PSM

In the slope maps presented by PSM, slope tops out with red shading at 30%. Figure 6 shows an obliquely viewed cross section from google earth from tower 13 to tower 20. It indicates maximum slope of 56% - almost double what PSM is portraying. Is this an example of use of GIS colour ramps intended to create a spuriously benign impression?

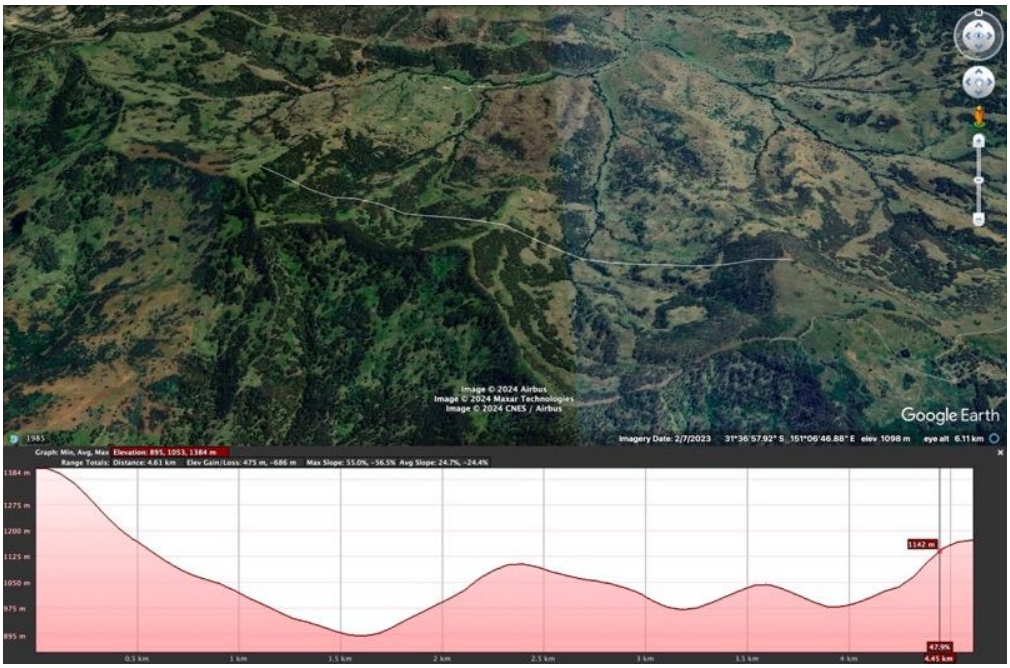


Figure 4 Google earth oblique straight line cross section between towers 13 and 20. Maximum slope is 56.5 percent and average slope around 24.5 percent. Location of the cross section is also shown in figure 5

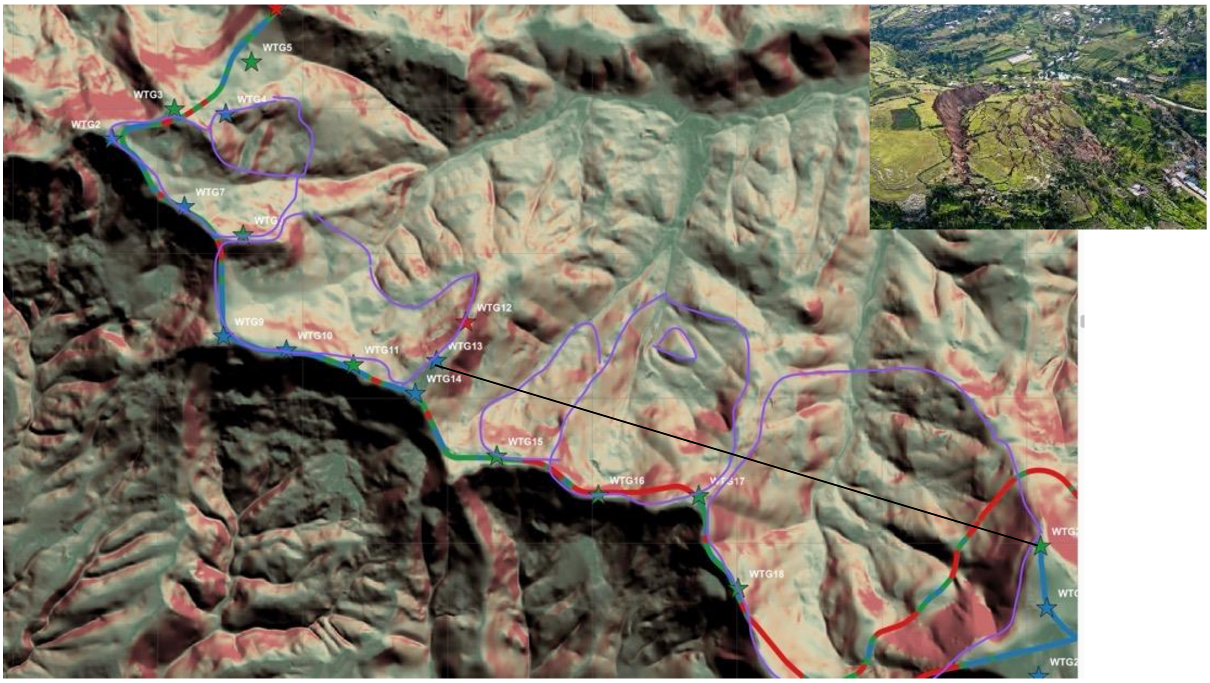


Figure 5 A PSM slope map with cross section location. Note red lines indicate the proposed transverse track at 30 percent gradient.

Mass Movement instability not considered by PSM

Banks 2020 Banks 2022 and Chapman 2023 both warn about land instability on steep basalt mountain ranges. Soil landscape mapping shows that the two main soil landscapes, Cooper Bulga and Langs Neck of the Liverpool Ranges (See the Tamworth and Murrurundi Soil Landscape maps and reports Banks (2001) and McInnes-Clarke (2002)) are essentially dominated by mass movement processes. In figure 5 I have quickly mapped, in purple, based on distinctive terrain patterns, the areas effected by previous terrain altering mass movements. This technique was developed by Jaboyedoff et al (2012) and used by Tulau *et al* (2019) in their study of mass movement in the Warrumbungles.

Two questions:
Firstly, why would an experienced geotechnical firm not consider mass movement in their report? – especially despite Banks 2020, 2022 and Chapman 2023 clearly pointing out evidence of the extremity of the mass movement hazard.

Secondly, assuming consideration of mass movement was not explicitly listed in the Department's brief (asking PSM to '*Review an EIS, including soil and water impact assessment (section 6.9.6 of the EIS)'*, why would mass movement not be considered? It is well established that mass movement debris is a source of disturbed soil and subsequent erosion.

Roads and slopes

The upper (extreme) road gradient for trucks transporting wind turbine blades is 15% according to BOP Wind Farms. They show an example of extreme windfarm gradient roading at *https://www.windfarmbop.com/maximum-road-grade* (see Chapman 2023). However, in figure 5 substantial lengths of road are shown with gradients of 30%, or double what is considered the threshold for 15% extreme gradients[2]. In figure 6 it can be seen that 2.6km of the transverse road between towers 14 and 17 has an on-ground maximum gradient of almost 44%. Taking into account limitations of turning circles, gradients and gradient changes of trucks carrying turbine blades, it can be clearly seen that the proposed route is impractical or will require significant cut and fill – with: subsequent *footprint expansion* of disturbed soils; soil and hydrological disturbance; need for specialist geotech measures to ensure slope stability; and highly specialized soil erosion and sediment control. These factors do not seem to have been taken into account by either PSM or the EIS.

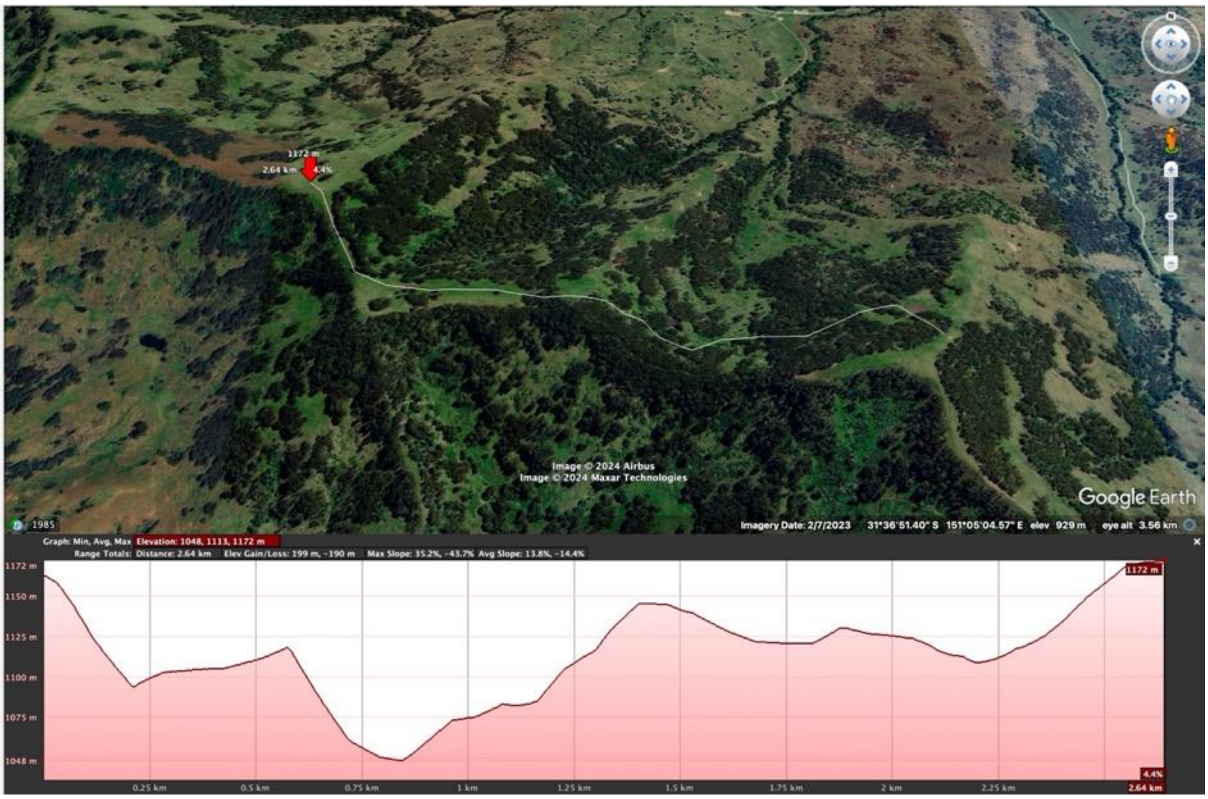


Figure 6 Google earth plot and cross section after the transverse road based on PSM mapping towers 14 to 17.

Inappropriate erosion controls

PSM advocates usual erosion controls (grassed water ways and level sills on slopes of <20% but has ignored the need for sediment control. Sediment control is especially important for maintaining water quality as suspended high phosphorus content sediment from basalt soils can trigger blue green algal blooms. There is an issue of available usable space on steep mountain ridges and spurs- further complicated by simultaneous need to store construction materials, cut soil materials, stockpile topsoil, allow for machinery movements and to turn

[2] Ahern Avenue in Coogee is understood to be the steepest public road in NSW. Its maximum gradient is 30.5 percent slightly greater than 30% mapped by PSM. https://a-z-animals.com/blog/the-steepest-highway-in-new-south-wales-is-a-terrifying-treacherous-path/#:~:text=A%2030.5%20percent%20grade%20over,a%20strong%20sense%20of%20community.

delivery vehicles around. This is expected to greatly reduce scope for erosion control works and scope for other operations.
Given the large amount of soil and regolith disturbance, standard stockpiling of soil materials is not expected to be successful and is likely to highly limited to places where loading of extra weight of (at least of episodically saturated plastic or liquified soil material) does not exacerbate mass movement. If materials are to be stockpiled off-site then where? and how would this be expected to effect traffic? landholder agreements? visual amenity? and other factors which should be included in the EIS?

Footprint and Limitations of local construction materials

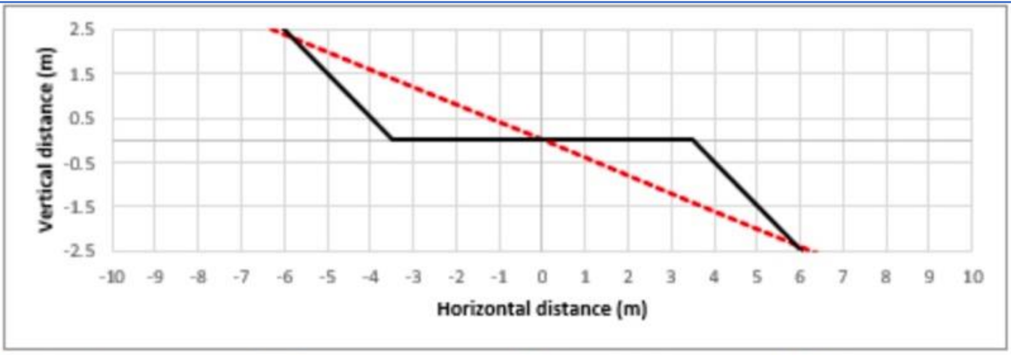
It is usually advantageous and economic to use cut materials for local fill operations such as road foundations. It is noted, from information concerning other basalt subsoils in NSW that most/many are Unified Soil Classification System (USCS) CH class, ie clays with high liquid limits. Such soils are typically poorly suited for construction, and without amelioration generally require more massive construction with lower batter angles (See for example Crouch et al, 2007). This markedly increases the expected footprint of the development, why has this not been considered in the EIS or by PSM?

Using the cross section in figure 6, superimposed on limitations with gradients and gradient changes and very broad turning circles, it can be seen that fill ramp, or bridge of some 30 metres deep/high would be needed to cross the deepest ravine. If the ramp was built from compacted locally cut regolith- likely deeply weathered rocky clays and high liquid limit clays, a detailed design would be expected at EIS stage – particularly with an assessment of how such a construction could be undertaken without landslip – on what is locally known as 'the wet shelf'. This is just one of numerous construction challenges for the development. Like the many other examples, it qualifies as a project on its own. In other words, this component of the development could be expected to require its own EIS. Why has it not been named, not investigated/analysed, included a proposed construction method and environmental impact statement?

Achieving soil stability on steep batters with self-mulching cracking clays

PSM believes it is possible to stabilise 100 percent slopes on the Liverpool Ranges. This is unlikely to be achieved, with typical steep basalt slope conditions, without specialised designs and geotechnical interventions. Leaving such matters to be designed and costed at the construction phase is risky for the environment and likely to imperil the financial viability of the development.
It is noted that some 5km of 'all tracks' are on terrain steeper than 30%. Figure 7 shows a schematic of the degree of cut and fill on what must be a *straight section of track* which has a slope of 40%.
This is in fact spurious as it does not show the extent of disturbance required for long vehicles to deliver turbine blades.   A road far wider than seven metres would be required.
For tight bends: A quick estimate based on transport appendix diagram buried in the EIS, see Chapman 2023, is that a road of some 18 metres width would be required so that the turbine blades do not scrape against rocks on tight bends around spurs. This, once again, is not addressed by PSM or in the EIS. To accommodate the poor turning circle of a truck carrying an 83m blade, by extrapolating from figure 7, the vertical height of the cut and fill

batters expands by 2.57 times to 7.71 metres each and the areal extent of disturbance goes from 12m to 33m wide roads.
An alternative to achieve clearance on spur corners would be to raise the level of the road. This may not involve as high a cut batter but would result in an appreciably longer fill batter – more disturbance and more engineering, but no mention in the EIS and not raised by PSM.



Terrain slope	40%	Maximum cut	1.5 m
Track width	7 m	Maximum fill	1.5 m
Batter slope	1H: 1V	Batter length	3.5 m

Inset 8: Schematics showing details access track cut and fill geometry for varying slope terrains, where roads are constructed at grade (for steep terrain)

Figure 7 Diagram of cut and fill on very steep slopes from the PSM report

The visual impact of bare soil exposed by tall cut and fill batters does not appear to have been included in the EIS. This may well be significant considering the vertical extent of disturbance on prominent hillsides.

2 Second conclusion of PSM: Inconsequential characterisation of soil types and land and soil capability

This statement, as will be detailed below, has not taken into account on site soil and land conditions. See figure 8

2 "Insufficient and incorrect characterization of soil types and 'soil capability' [sic] is considered inconsequential"
Land and Soil Capability includes interaction of land and soil features.

- EIS: Lacks soil info. No holes dug, profiles examined or samples taken – only generalized, unattributed information/assumptions presented.
- No geotechnical data presented, just interpretations. Is it being hidden? Why has PSM **not** considered land instability interactions with erosion?
- But we do have NSW Government information based on fact and science. Why is this information ignored/discounted?

Figure 8 PSM insufficient and incorrectly characterised soil type and capability is 'inconsequential'

The EIS lacks soil data

If there is soil data for the development where is it?
If there is geotechnical data for the development where is it? An ENGIE representative at the public meeting assured the Commissioners that this information exists. If so why has it not been analysed or interpreted? Why is there no statistical or numerical analysis of either Geotechnical data or Soil Profile Data or of laboratory test results?

Banks 2021 pointed out that the first draft of the EIS lacked soil and geotechnical data and pointed out the extreme mass movement and erosion hazards on site. DPE apparently requested further information and when Dr Banks 2022 reviewed the updated EIS only found updated slope mapping data. Dr Banks, by examining the contents of the soil section of the EIS also questioned many elements of the technical soil expertise of the authors. I agree with Dr Banks observations and comments.

Lack of provision of soil and land information and NSW Government Guidelines for EIS preparation

In 1997 the Sustainable Land and Coastal Management (Information and Planning) Directorate of the NSW Department of Land and Water Conservation published *Soil and Landscape Issues in Environmental Impact Assessment* Technical Report 34. (Gray *et al,* 1997). The Director General pointed out the potential impact of developments to cause degradation and the need for problems to be adequately addressed during environmental impact stages of development projects. He added that the technical report also provides guidance on soil and land resource data requirements, evaluation of potential soil and land resource impacts and appropriate mitigating measures. See figure 9.
It seems that the Department is either not aware of the report, or otherwise is not encouraging its use.

FOREWORD

The disturbance of soil and land resources during development or other land use activities has the potential for major impacts on the quality of our environment. Soil erosion, stream sedimentation, mass movement, soil pollution and altered hydrological regimes are just some of the associated environmental problems. In addition to the serious environmental degradation caused, these impacts are also associated with high financial costs to both the project proponent and the community as a whole.

Fortunately, there has been an increased awareness of the potential impacts on soil and land resources and a greater commitment to overcome them in recent years. There is, however, still much room for improvement. In particular, it is essential that these problems be adequately addressed during the environmental impact assessment stages of development projects. This report aids in this process by providing guidance on the soil and land resource data requirements, the evaluation of potential soil and land resource impacts and the appropriate mitigating measures.

Because of the wide variation in the nature and magnitude of the potential impacts on development sites, it is not possible to prepare a prescriptive guideline that will apply to all development situations. It is envisaged, however, that this guide will assist project proponents and government decision makers to better understand the relevant issues and information requirements relating to soil and land resources. This approach should help ensure that these resources receive appropriate environmental impact assessment, thereby helping to improve the decision making process, bringing about time and cost savings to the proponent and community, and ultimately resulting in greater protection and sustainability of our land and water resources.

I commend this report to all development proponents, consent authorities and other parties concerned with the protection of our environment.

[redacted]

Bob Smith
Director-General, DLWC

Figure 9 Forword of Soil and Landscape Issues in Environmental Impact Assessment DLWC 1997.

In an EIS intensity of the development for causing soil disturbance, and the risk of current hazards, should be matched against expected soil data collection requirements. For highly intensive construction such as road building on mountain sides and construction of towers on edges of escarpments, Technical Report 34 indicates a survey scale of 1:1000 would be reasonable. This would be expected, according to the report, to involve 50-100 soil observations and 10 to 20 soil profile descriptions per hectare, with one laboratory tested soil profile per 0.5 to 4 hectares, and each soil type having more than one laboratory analysis (P12).

None of this has been completed, or at least there is no evidence of this having been done.

Government Spatial Information concerning soil erosion and mass movement hazards on-site

Screenshots below (figures 10 and 11) are from Espade the NSW Government spatial soil information portal.
They show land and soil capability mapping for the proposed development area. Both *Mass Movement and Water Erosion are mapped as extreme*. This information is available to the public, including the EIS authors and PSM.

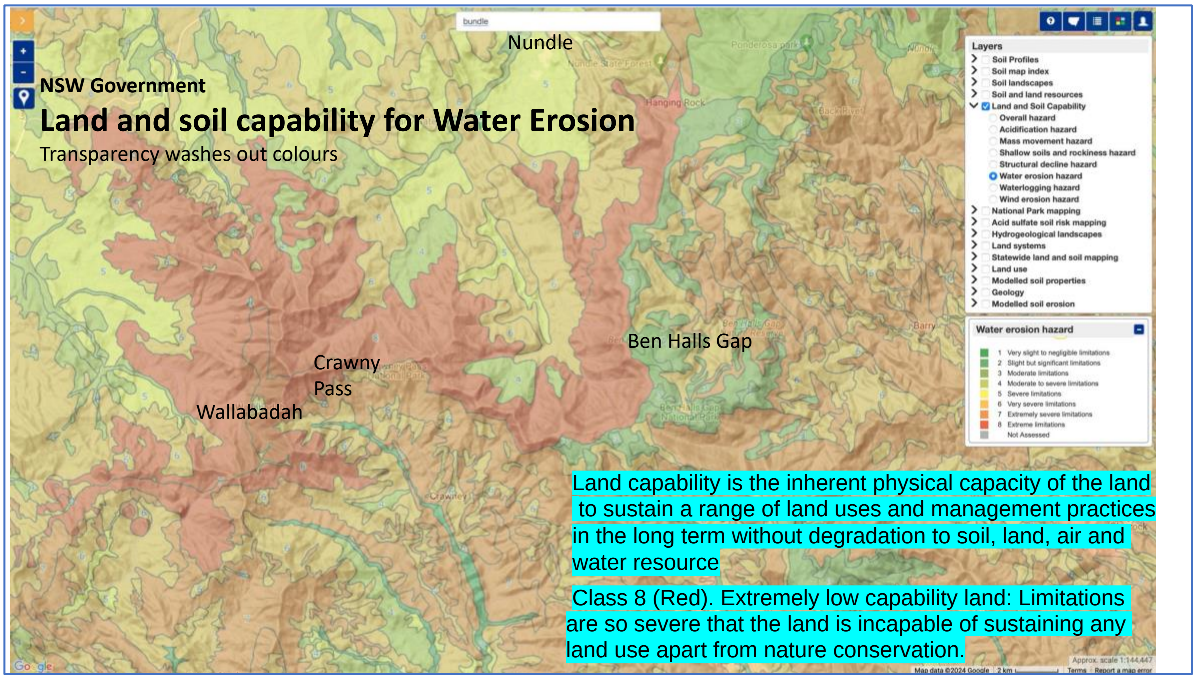


Figure 10 Land and Soil Capability for Water Erosion showing much of the proposed development area being extreme. This layer has transparency applied over a digital terrain model to help viewers identify pertinent locations.

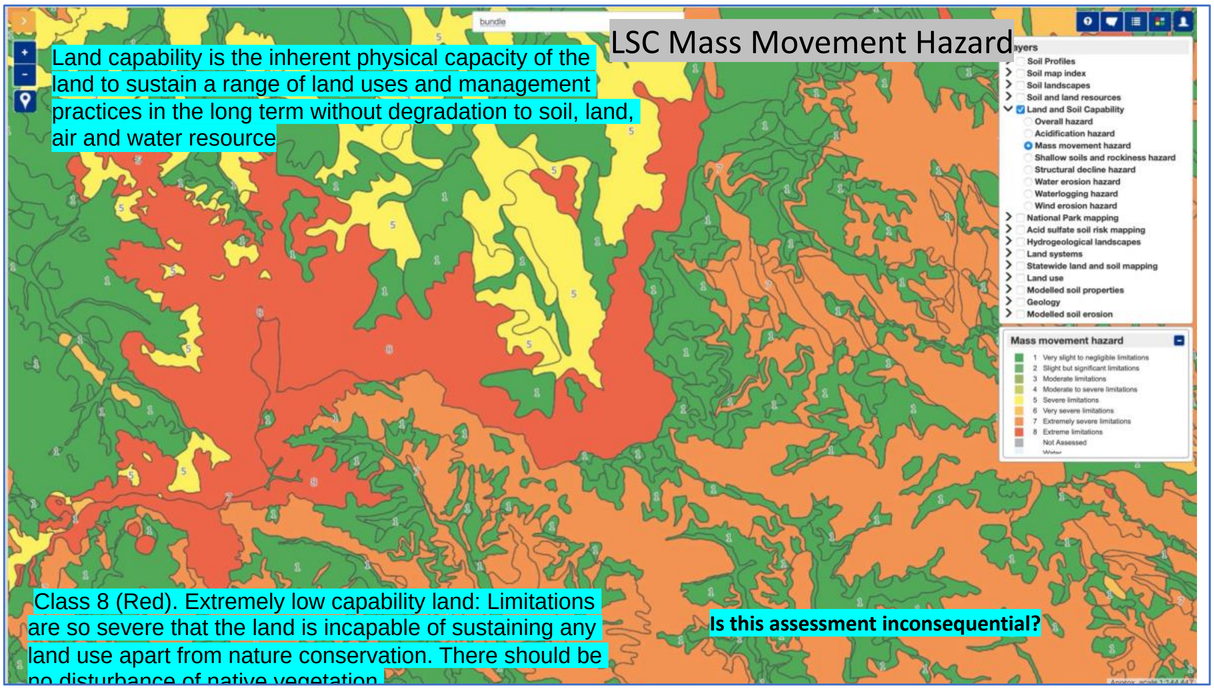


Figure 11 Land and Soil Capability for Mass Movement shown as extreme for much of the development area

Figures 10 and 11 are from publicly available data on ESpade
https://www.environment.nsw.gov.au/eSpade2WebApp
The figures are based on soil landscape and related mapping. Information about how soil landscape mapping is done can be seen by referring to the methodology section of soil landscape mapping reports (see for example, Banks 2001 and McInnes-Clarke 2002)
Why has this Government data not been used? Or taken into account either by the EIS proponents or by PSM? - especially when it has been emphasised by Banks and Chapman in their reports. It is hard to see how this information can be considered inconsequential.

Issues understanding the degree and consequences of soil erosion

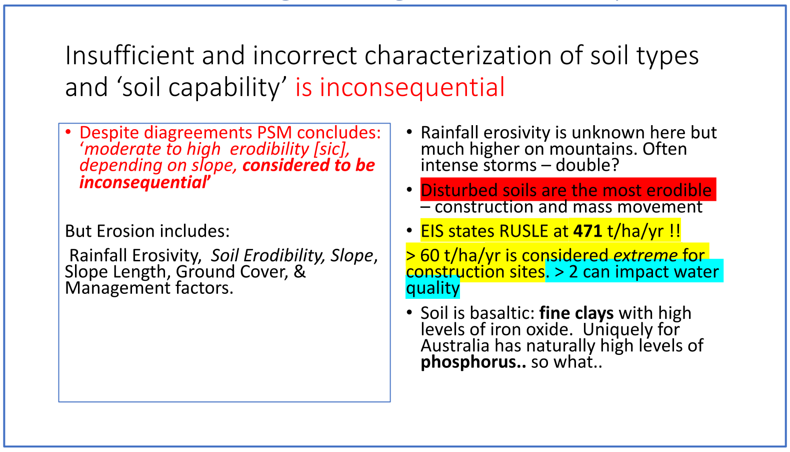


Figure 12 Summary of soil erosion problems not appreciated in the EIS or by PSM

PSM and the Department seem to have difficulty understanding the difference between soil erodibility and soil erosion[3]. See figure 12. Erodibility is a characteristic of the soil concerning how easily it erodes. The most erodible soil is disturbed soil. Disturbance in this case is from construction but it can also be from mass movement – which has not been included.

The extent of water erosion is also dependent on various factors including:

- Rainfall Erosivity (ie rainfall intensity- nominally maximum rainfall in a 30 minute period), Numerous speakers at the public meeting, notably Brian Tomalin, have mentioned intense storms on the top of the Liverpool Ranges and how rainfall is much higher than for settlements in the valleys below. This may be double what has been used in RUSLE calculations. After more than five years the development proponents do not appear to have installed any weather stations on the proposed development site.
- slope,
- slope length (water running longer distances erodes more than over shorter distances)
- Ground cover (how protected the ground surface is from raindrop impact by items such as grass, leaves, twigs, stones, mulch etc
- Management factors – such as measures which reduce slope length or divert water.

PSM takes into account two factors out of six.

In the EIS Application of the Revised Universal Soilloss Equation (RUSLE) Renard (1997) quotes several numbers and I have used their highest as an example. "The RUSLE is the most used and abused erosion modelling tool in the world." Xihua Yang RUSLE expert, pers com. Given questions concerning soil technical expertise of the EIS authors, the values may well be wrong. The value of 471 tonnes/hectare/year cited is the highest presented in the EIS. However, if it is expected that mountain top rainfall erosivity is actually double that

[3] In my experience the sloppy use of terminology usually indicates lack of appreciation of key land resource assessment concepts.

calculated from the nearest meteorological station, then it can be expected that a closer approximation is over 900 tonnes.
Espade depicts RUSLE erosion modelling for bare undisturbed soil. See figure 13. Values for the proposed development area range from around 200t/ha/year to between 1000 and 2000 t/ha/year.

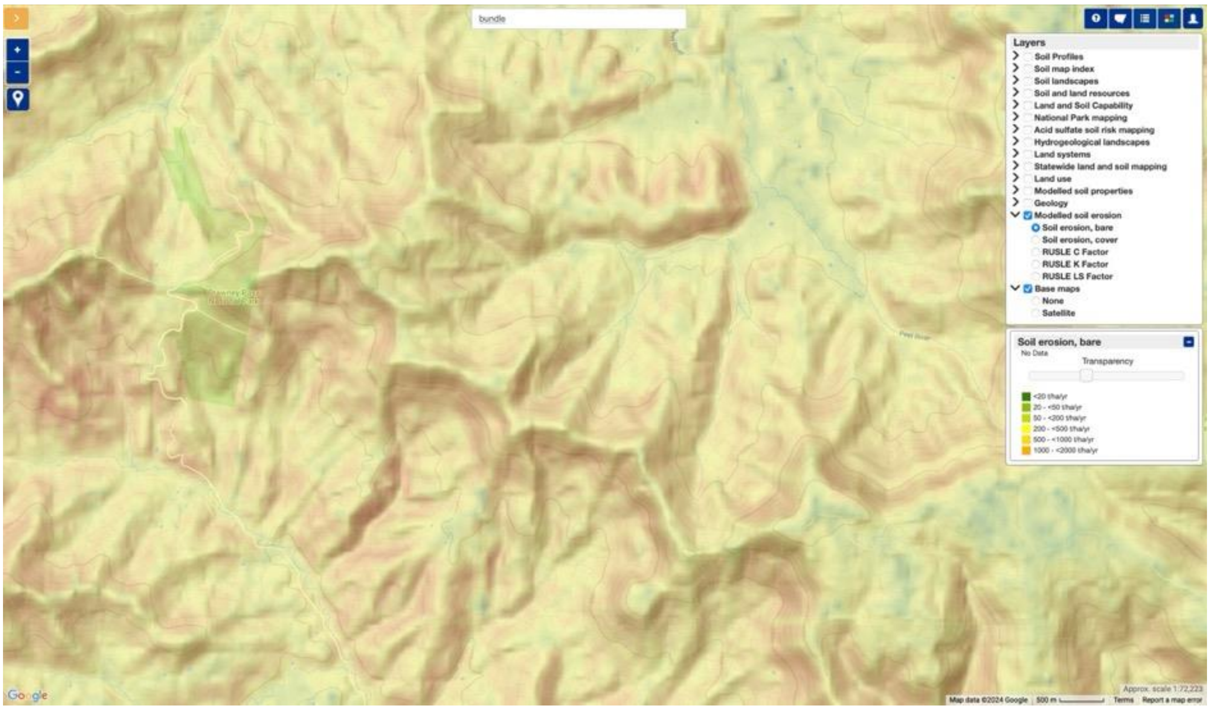


Figure 13 NSW Government Website Espade showing modelled RUSLE soil erosion for undisturbed bare soil

Interestingly, the soiloss tonnages are presented in the EIS as standalone (ie uninterpreted numbers, without any attempt at interpretation). Is this because the model outputs are very large and do not assist with the desired general impression? Were the authors confident that the EIS would not be examined in detail?

There is a typo in the slide, figure 12, it is actually >100 (not 60) tonnes hectare per year erosion which many consider extreme for a construction site (Chapman and Murphy, 1989)[4]. Other sources, such as Morse and Rosewell (1993) expect that around 37.5 tonnes of soil loss per hectare per fortnight can be managed using standard erosion and sediment control measures. This equates to 975 tonnes/hectare/year if erosion is evenly distributed – but as most water erosion occurs during and just after episodic storms, any fortnightly figure is nonsensical – and in this case likely to be far exceeded. It is useful to note that Morse and

---

[4] To provide further context, Bui et al 2010 evaluate tolerable Australian soil erosion rates at up to 0.2 tonnes/hectare/year – a rate at which soil erosion keeps pace with soil formation. They cite Caicheon et al 1995 (not accessed) who measured erosion of the 420 square kilometre catchment of Chaffey Dam at 0.05 tonnes/hectare/year using Caesium isotope measurements. Such tolerable and background erosion figures are orders of magnitude less than what is presented in the EIS.

Rosewell (1996) consider over 1500 tonnes/hectare per year as extreme. This would probably apply to most the red areas shown in figure 13. Finally, it can be expected that soil loss figures are higher for disturbed and bare soil, compared to undisturbed and bare soil. Values for disturbed soil may well be double again.

This implies erosion will occur to such an extent that soil erosion control may be impractical or uneconomic. Given previous comments about cramped ridge top conditions and difficulty preventing erosion on steep cut batters of high liquid limit clays, proper erosion control may well be impossible. This is of consequence.

Impact of erosion of basalt derived soils on water quality

Figure 14 shows on MinView https://minview.geoscience.nsw.gov.au/#/(report:strat-unit/Grom)?lon=151.0270&lat=-31.57931&z=11.7&bm=bm1&l=ge611:n:100,ge610:n:100,ge69:n:100,ge68:n:100,ge67:n:100,ge66:n:100,ge65:n:100,ge64:n:100,ge63:n:100,ge62:n:100,ge61:n:100,ge612:y:100,hi1:n:25,wa1:y:100,ut1:y:100,ad0:y:100 that the Liverpool Ranges encompassing the proposed development are composed of Mount Royal Volcanics. They are predominantly basalts.

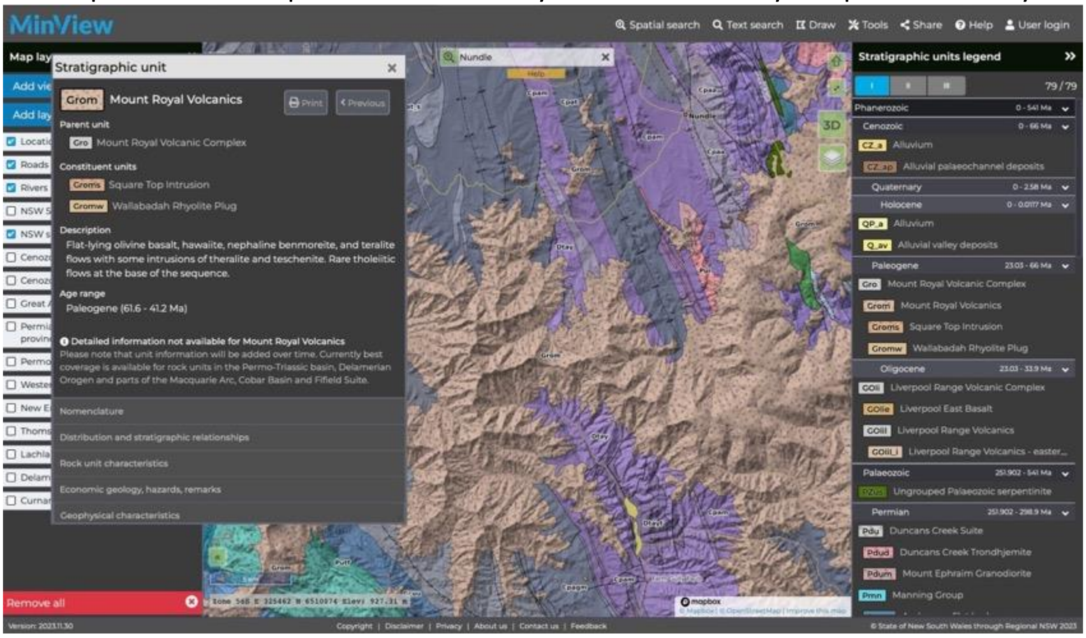


Figure 14 Minview (NSW Government geological Survey Web Viewer) showing coincidence of the Liverpool Range with Mount Royal Volcanics.

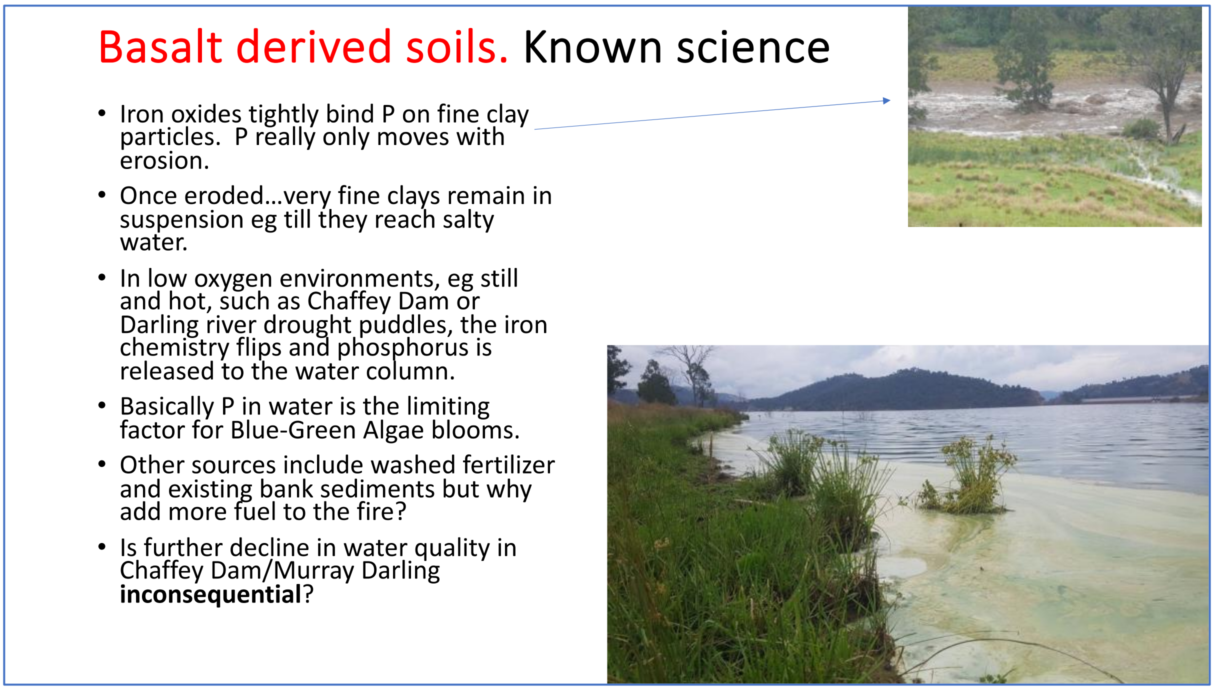


Figure 15 Processes driving blue green algae blooms from basalt soil erosion

Basalt and related mafic rocks are the only group of rocks in Australia which contain appreciable quantities of iron oxide bound phosphorus (P) (Norrish and Rosser, 1983). They show that basalt derived soils contain between 0.4 and 0.9 percent P by weight. I used those figures to look at tonnes phosphorus which could theoretically be added to water bodies down-stream from the EIS quoted 471 tonnes per hectare of erosion. (0.004 x 471 = 1.9 kg/hectare and 0.009x471=4.2 kg/hectare of disturbed soil during the construction phase). Using the mid-point value of 1550 tonnes/hectare/year for bare soil on steep slopes of the Liverpool Range shown in Espade, eroded P values would be around triple. Of course, not all the soil eroded could be expected to *immediately* reach still water bodies as some will be caught in hollows, deposited on floodplains, coat vegetation etc.

Iron oxide bonds tightly with phosphorus. Changes and oxidation reduction chemistry are well establish in soil science, and it is well known that low oxygen environments cause iron chemistry to change. (See for example, Probert, 1983).

There are numerous examples by various institutions, including Water Quality Australia https://www.waterquality.gov.au/issues/blue-green-algae, Indiana Department of Environmental Impact https://www.in.gov/idem/algae/about-blue-green-algae/#:~:text=Blue%2Dgreen%20algae%2C%20also%20known,%22bloom%22%20in%20large%20numbers and CSIRO https://www.csiro.au/en/research/natural-environment/ecosystems/blue-green-algae/what-are-blue-green-algae
which explain how once a low nitrogen threshold is reached phosphorus, becomes the limiting factor for blue green algae blooms. It is claimed that blue green algae can gain sufficient nitrogen from the air eg https://leafcollective.com.au/blog/the-path-to-preventing-toxic-blue-green-algal-blooms/

Blue-green algae need P concentrations greater than 0.03 mg litre to bloom.
https://leafcollective.com.au/blog/the-path-to-preventing-toxic-blue-green-algal-blooms/
This means one kilo of P can theoretically induce blue green algal blooms in some 333,000 litres of water. To add further context, 1500 tonnes/hectare/year of soil loss provides sufficient P (~12kg) to drive a blue green algae bloom in for around 4 megalitres of water for each hectare of bare soil. Far more could be expected for erosion from large landslips.

The extent of P increasing blue green algae blooms is not known across the Murray Darling Basin- however, it is fair to say that it would make the problem worse. Given the importance of the Murray Darling Basin the precautionary principle calls for means to prevent phosphorus laden soils reaching significant water bodies. One of these is to build effective sediment detention basins. Another, lower risk option, would be to prevent soil disturbance.

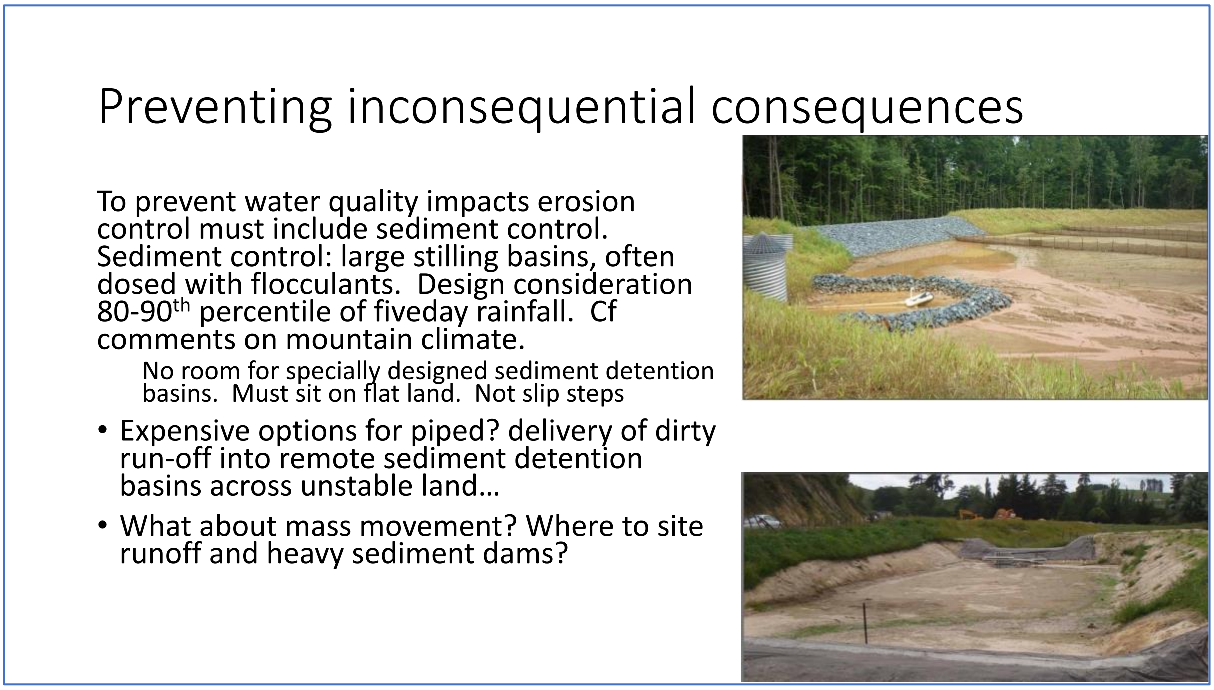


Figure 16 Some sediment basin requirements

Figure 16 Quotes Landcom (2004) requirements for effective sedimentation basins. Basically, the idea is to capture as much dirty water runoff as possible and retain it in flat-floored temporary storage basins, or dams, to encourage clay particles to settle out of the water column. To do this requires very large storages. Landcom (2004) recommends the 80^{th} to 90^{th} percentile of all rainfall over any five-day period. This amount is unknown, as the mountain top climate is unknown – but is expected to be large enough to be problematic.

It is important that sediment detention basins are located in areas that are not only flat, but also which are not prone to landslip. Extra weighting of water several metres deep, and likely infiltration[5] of that water into the head of ancient landslips increases the chance of

[5] Basalt soils are well structured and have high permeability. Unless treated much of the water would quickly penetrate through the bottom of sediment basins – possibly increasing the effectiveness of the basin – but also wetting basalt soils and accelerating the risk of mass movement.

further slope failure – with captured high P silt from sediment dams then being washed into water bodies.

Some secondary considerations include:

- Extra footprint required and consultation and permission from landholders
- Extra traffic, budget and noise from sediment basin construction
- Facilities, traffic, labour and roading required to remove and store the collected sediment as a maintenance issue
- Specialist erosion control works and pipes or waterways to divert dirty water down extremely steep and unstable slopes. These pipes would need to be able to cope with torrential storm run-off volumes. Leaking pipes caused by slope creep is expected to be difficult to manage.

Structural instability of basalt landscapes

As lava cools it cracks. This gives basalt, and related rocks such as dolerite, characteristic columns. See figure 17. Volcanoes typically do not just disgorge a single lava flow, but numerous flows might happen between ash falls, thin flows may occur or, during intervals of thousands of years, fresh flows may bury soils forming on lava (bole) etc. This gives rise to the stratigraphic scenario below in figure 18

(diagram of basalt sequences from https://www.semanticscholar.org/paper/The-3D-facies-architecture-of-flood-basalt-and-from-Single-Jerram/d235d3fca05851692629740eb574ae007775a94c and schematic of wind turbine from https://en.wikipedia.org/wiki/File:Wind_turbine_diagram.svg)

Alteration of basalt and ash layers can give basalt terrain characteristically stepped spur slope profiles.

There are many examples of scree slopes on steep basalt country. A dramatic example is from Iceland is shown in figure 17. (Acknowledgement https://www.daveshowalter.com/photo/993/)

Figure 17 Collapsed basalt columns and associated scree. Image by Dave Showalter

A characteristic of basalt soils is that iron oxide provides good soil structure and high permeability. This means water can easily enter basalt soils. Some water flows deeper, beyond the soil profile and then preferentially into wet and weathered layers at the base of the columns, where it then moves laterally, often emerging as typical basalt springs. The wet, weathered material eventually loses strength and can collapse along with the materials above. This is a reason why basalt scree slopes are relatively commonplace in steep basalt terrain.

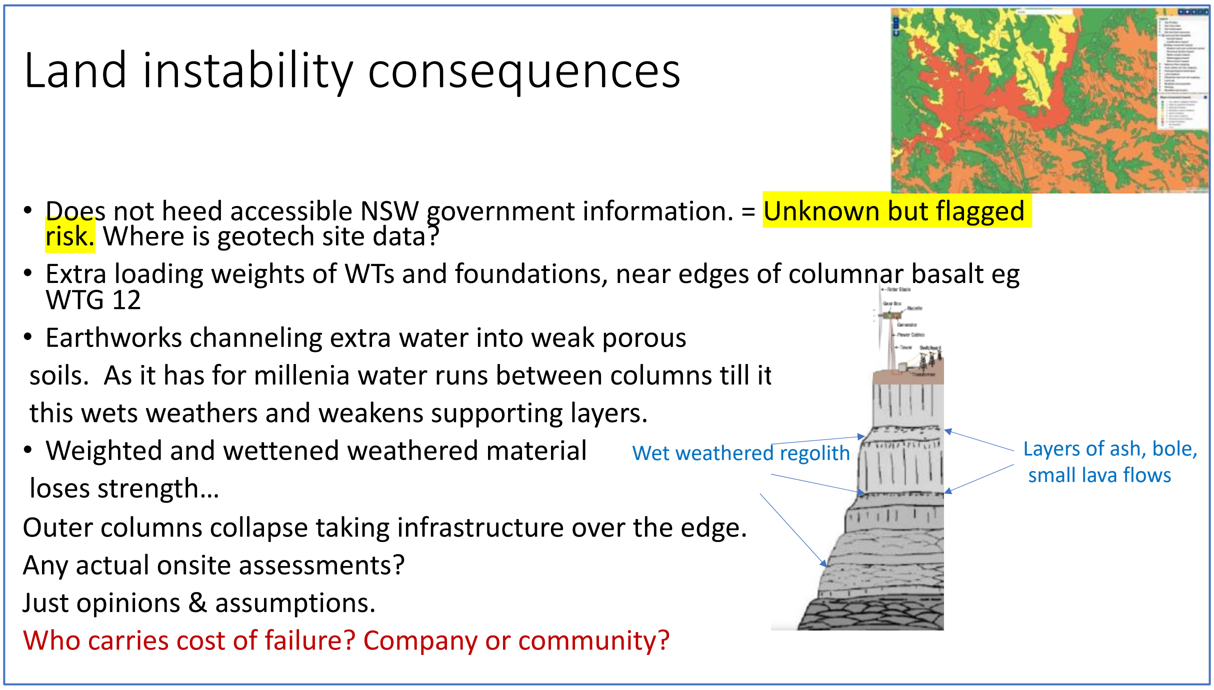


Figure 18 Columnar basalt collapse mechanisms

With the disturbance of construction, it is expected that extra water could be inadvertently directed between basalt columns. It may be decades before the extra water sufficiently weakens base layers below columns for collapse to occur. Hence the need for effective rehabilitation and maintenance well beyond the decommissioning phase.
One scenario could be collapse of a WTG- exacerbated by strong winds during wet weather. Another scenario could be loss of a turbine blade which then causes ‘harmionic wobble’ - progressively weakening columnar basalt foundations- and leading to collapse.

There is also the likelihood of mass movement removing or falling onto important construction roads- rendering them unusual. This could be catastrophic for the project – especially if it stops WTG installation after only a few have been installed. If this occurs during construction, the entire project could become economically unviable as roads damaged by landslip typically take years and millions of dollars to fix. If the developer decides to pull out, restructures and becomes insolvent, then it will be up to the community to tackle fixing the damage. A classic example of Government paying for clean-up is the Urunga Wetland, see https://www.crownland.nsw.gov.au/sites/default/files/2022-07/Urunga-Wetlands-fact-sheet.pdf   In this case the antinomy processing plant once on the site was owned by a very large Australian mining corporation. The corporation restructured ownership to a smaller independent subsidiary, which then became financially insolvent and leaving the parent company with no environmental responsibility. Much later NSW Crown Lands spent $10m on remediation in 2015-2016.   At this stage the project faces known broadscale risks, but otherwise detailed information vacuum with consequentially unquantified risks is lacking.   In that case it is reasonable to ask what insurance/assurance where is the corporation to pay for repairs and corporate responsibility and capacity to stem consequent erosion and water quality issues, during and well beyond the life of the development?

Slope failure of soil and weathered basalt

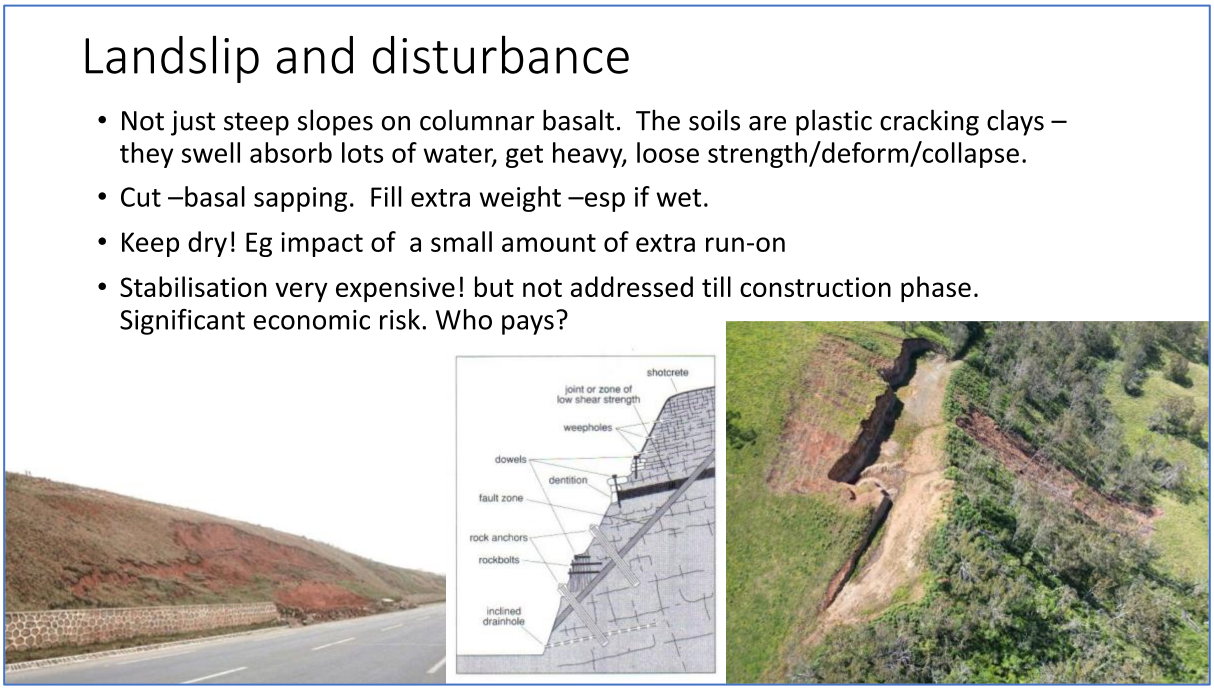


Figure 19: Landslip cannot always be closely predicted. Prevention is costly and small changes can make a difference

Figure 19 indicates that most basalt subsoils are plastic cracking clays which readily absorb and hold large amounts of water. As the water content increases they become soft and plastic – resulting in deformation. With further water increase, often with disturbance, they can liquify into soft and slippery mud. Keeping excess water away from areas to be disturbed is important, but there is then a conundrum of how to dispose of that water.

Residual risk after investigation

Humans can generally only sample a small portion of what cannot be seen below the ground surface. This means that with any soil survey or geotechnical engineering investigation there is a residual risk (even with a reasonable amount of sampling and testing). The slip shown on the left of figure 19 is a good example. A retaining wall has been installed – but it has not been adequate – presumably despite investigations indicating that it would be sufficient to provide stability.

In the circumstance of mass movement from above, the amount of material to be removed is usually far larger than what has blocked passage. This is because there is more unsupported material behind and above and it keeps slumping as toe retaining material is progressively removed. For repair excavations are often required to reach a relatively stable surface which can be then treated.
Implications include:

- Extra traffic to truck out and store collapsed material, and

- economic delays and unforeseen budget imposts.
- As mentioned earlier cracking clays are not ideal construction materials so the slipped material is unlikely to be suitable as foundational materials so has to be discarded – where?

Clear examples of the residual risk and cost of repair of landslip on public roads which cross the same geology and mountain range can be seen at Nowlands Gap where the New England Highway crosses the Liverpool Range. A similar scale road to what is envisioned for the proposed development is on the Willow Tree to Merriwa public road, also on the same geology and mountain range but further west so presumably having lower rainfall. Figure 20.

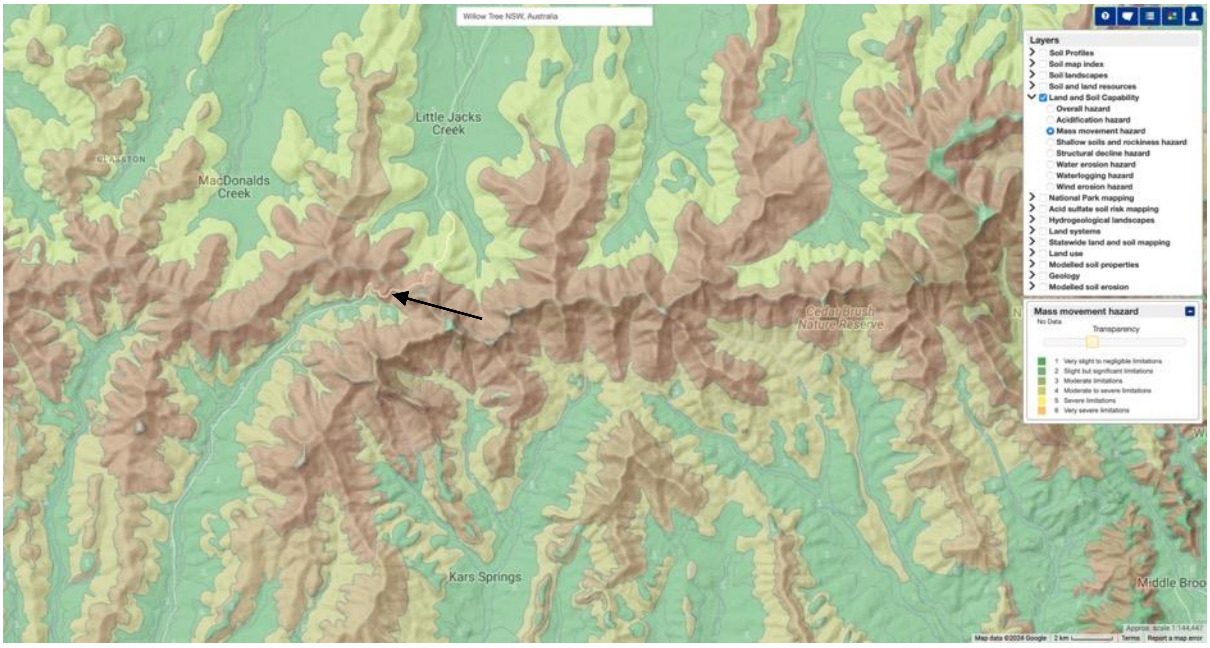


Figure 20 Willow Tree Merriwa road crossing the Liverpool Range. Arrow is in the vicinity of closure due to mass movement. Mass movement LSC mapping is class 8 = Extreme.

The road, where it crosses the Liverpool Range, has also been mapped as LSC Mass Movement class 8 (extreme limitations) See figure 20. It has been closed since shortly after it was upgraded. Upgrading was followed by heavy rain since March 2020 when the failure occurred. There is a $38.6m repair budget and it is expected to take many months to repair and re-open. See for example https://www.abc.net.au/news/2022-10-26/merriwa-to-willow-tree-road-funding-returned-budget/101577600 It can be assumed that the original upgrade to this road was closely supervised by authorities and has been built to a recipe rather than a price. Who will ensure similar quality control for the commercial development?

Stablising cut batters on unstable slopes is very expensive. Specialist geotechnical techniques are required including walls, special drainage, shotcrete, and rock bolts to name a few – see middle figure 19. It is argued that if this expense is not taken into account prior to construction, then financial viability of the project could be jeopardised. Stabilising failed fill batters can be more problematic as foundations need to be rebuilt onto a stable base. As fill batters are more likely to be associated with road crossings of drainage lines, it can be expected that soil and regolith materials will be more deeply weathered due to the presence of extra water and spring outlets.

Surface instability is increased through disturbance, especially if supporting material is cut away from the supporting toe of a slope.   In short cut and fill operations are likely to exacerbate mass movement, which in turn may jeopardise the economics of the development. This cost does not include repair of environmental impacts of triggered erosion events.

Consequences of mass movement

Mass movement disturbs soil, leaving it uncovered, loose and predisposed to erosion- figure 21. The fine fraction of clays and silts is readily entrained and washes as suspended particles into water bodies.   Many subsoils on basalt reported in Banks (2001) are dispersible. This means any exposed dispersible subsoil is more prone to erode and be suspended in water until it reaches still waterbodies.
Apart from turbidity, release of phosphorous is the prime driver of blue green algae blooms.

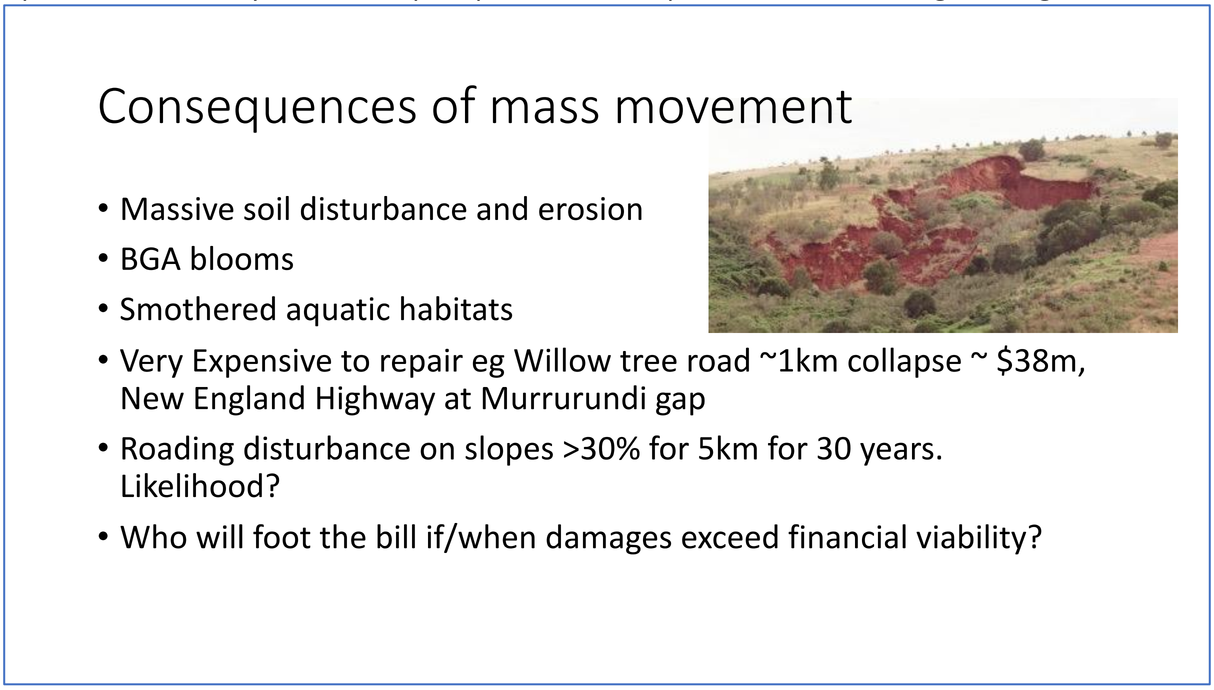


Figure 21 Consequences of mass movement events

The finer fraction of silt and sand size particles, which for basalt derived soil is often naturally aggregated into as entitites (peds), is variously deposited further down slope, on floodplains or fills pools.
Gravels and boulders have greater momentum during mass movement and may reach, roll and bounce along streams for surprising distances, especially with storms where high velocity first order streams on extreme gradients have the competence to move surprisingly large rocks. See submission by Brian Tomalin for examples of the steepness first order streams in the area. Finer associated sediments are often washed further down leaving a gravel and boulder mixture which fills and chokes aquatic habitats. Figure 22 illustrates that this process is already currently active on the same mountain range prior to further

disturbance, which can be expected to worsen with cut and fill operations accelerating further mass movement.

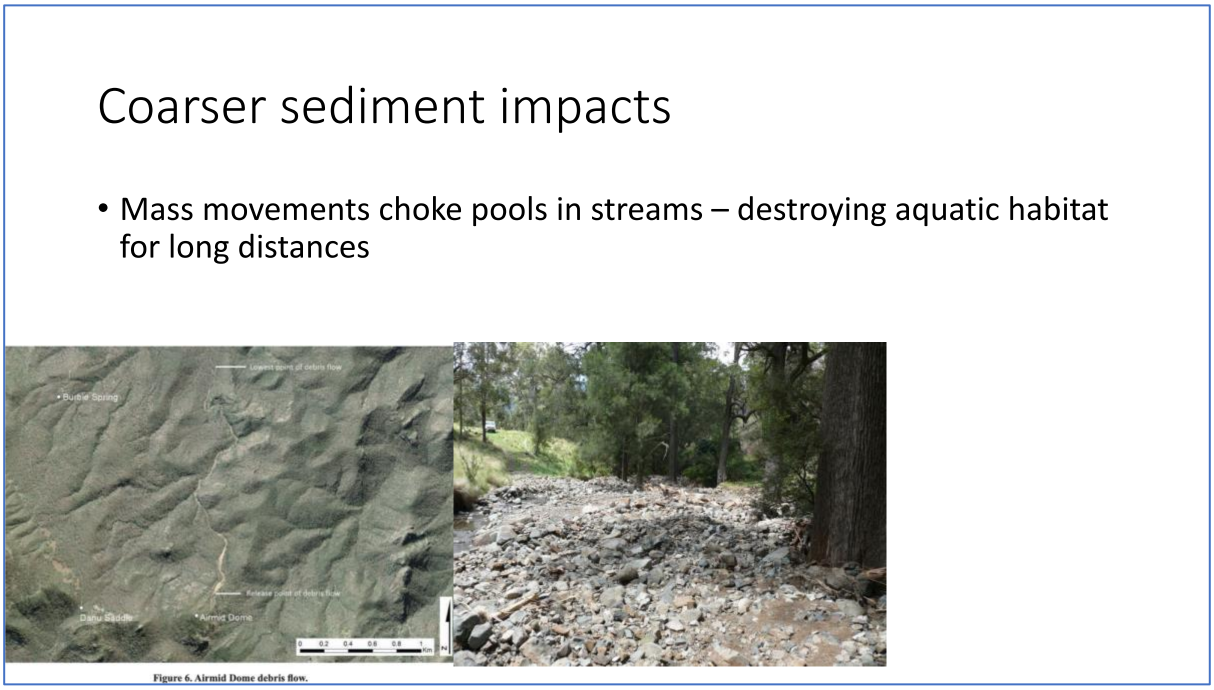


Figure 22 Example of a debris flow Warrumbungles national park Tulau et al (2019) and photo of a gravel and boulder choked riverbed below the Liverpool Range (photo supplied by B Tomalin HOGPI)

Visual impacts of mass movement.

Mass movements leave long term scars of bare soil on the otherwise vegetated landscape, often in prominent areas if disturbance initiates debris flows from upper slopes all the way to flatter land below. This does not appear to have been considered in the EIS.

3 Third conclusion of PSM: Impacts and the Life of the development

Figures 2 and 23 indicate PSM downplays that the proposed development may have environmental impacts for (and beyond) the life of the development. PSM has not mentioned the instability of the land except for erosion. There is a risk that environmental impacts due to the development may manifest well beyond the life of the development (see accelerated weathering from disturbance of hydrology). Consider, for example, excess ground water impacting on weathering of layers between basalt columns. I argue that these slowly manifesting impacts need to be considered in the EIS – rather than be dismissed as 'second order'. This means decommissioning has to be assessed correctly. The Thredbo landslide, for example, occurred *decades after a temporary road installed for the Snowy Mountains Scheme failed* – although other factors were also at play. https://knowledge.aidr.org.au/resources/ajem-jan-2013-impact-of-landslides-in-australia-to-december-2011/

The same Geoscience Australia summary notes numerous significant landslides happening after torrential rain. At the development site, cutting and filling operations on basalt soil landscapes are known to exacerbate land instability (see for example, Hicks and Hird, 2007).

As described earlier, the propensity for basalt soils (ferrosols) to admit and store water is very large. In the process these soils become progressively swollen, heavier, increasingly plastic then can liquefy into slippery mud with essentially no strength. This is especially the case on steep terrain where mountain thunderstorms produce torrential rain.

Climate change as a second order effect

Over the life of the development climate change is expected to increase severity of storms with intense erosive rainfall increasing by around seven percent from 2020 to 2059 and 19 percent from 2060 to 2079 Yang, (2015). The effect may be even larger on mountain tops. Such future events can be expected to further increase mass movement on land which is already prone to mass movement. See for example, the video presented by Chris Eagle at the public meeting on 2nd of February. In addition, prolonged rainfall events, more severe storms, flooding, increased bushfires and intense droughts are expected for The Hunter and NW NSW https://www.climatechange.environment.nsw.gov.au/my-region/new-england-and-north-west. Various speakers at the public meeting have touched on the impact of control of wildfire for the development. Tulau *et al* 2019 examine the role of fire and then torrential rain triggering mass movement in the steep volcanic terrain of the Warrumbungles, some 200km to the NW. This hazard can also be expected to apply to the proposed development site.

The EIS does not appear to have considered incorporation of such hazards into design criteria for erosion control works over the whole expected life of the development.

Decommissioning

The EIS decommissioning impact on soil and land is not at all detailed. It is not clear if there will be any attempt to reshape the land surface, or how this may be done- except in the broadest of terms. Reshaping to place soil and regolith against exposed cut toe slopes, is expected to be a complex and specialized process to ensure sufficient toe strengthening, adequate drainage, proper drainage disposal and presumbably some type of reinforcement. The soil and regolith material would also need to be sourced, transported, protected against slipping, eroding, and avoiding concentrating water flows into hazardous areas and revegetated – yet these 'second order' operations are not mentioned. Such works will need time to become effective and will require maintenance in the meantime – this process is expected to take several years, possibly longer. Installation of peaked banks at various intervals to divert water from running along unmaintained roads, organizing permanent drainage and installation of level exit sills is not cheap, and must be carefully designed but is not mentioned. The above does not include considerations for the decommissioning of specialist erosion and sediment control works- which by their nature are in more difficult terrain.

The process of phased decommissioning could be expected to take years, and it could amount to a second round of site disturbance. Maintenance of banks, cross banks, drains and culverts is also an ongoing expense. Changes in runoff and concentration of water into small areas like bank and culvert exits, which is usually expected from standard practices, can be expected to result in mass movement, so should be somehow avoided. This is problematic as space is often very cramped. This means another round of detailed designs. It is unlikely that these have been properly costed – nor does there appear to be contingency or a bond, for long term (multi-decadal) funding arrangements for decommissioning and second, and subsequent rounds of rehabilitation – nor insurance.

The EIS states that the amount of wind the top of the ranges receives is important reason for siting the proposed works at the top of the range. Can it be assumed that the area will still be important for wind power generation at the end of the life of current WTGs? If so will another set of infrastructure be expected to replace the obsolete equipment? Given the likelihood of this scenario: roading, hardstands and other infrastructure should be considered permanent, and therefore be constructed with permanence in mind – at least to be able to haul components out and replacements in. The budget for roads and associated infrastructure would presumably require a degree of public ownership and investment to ensure current roads are made permanent and kept maintained. This however, does not appear to have been considered. Permanence of infrastructure and associated additional disturbance can be expected to change costs as well as the environmental impact.

Toward the conclusion of the public meeting, the Commissioners asked the chief representative from ENGIE- Australia and New Zealand, how ENGIE would ensure successful decommissioning and rehabilitation. The response was that ENGIE would maintain its successful reputation for such matters. Some material concerning ENGIE's rehabilitation budgeting process and planning prowess was found here https://envirojustice.org.au/press-release/concerns-escalate-over-rehabilitation-of-agls-loy-yang/ I cannot vouch for the veracity, or otherwise, of this information but draw the Commissioner's attention to corporate difficulties which may impact public expenditure for rehabilitation.

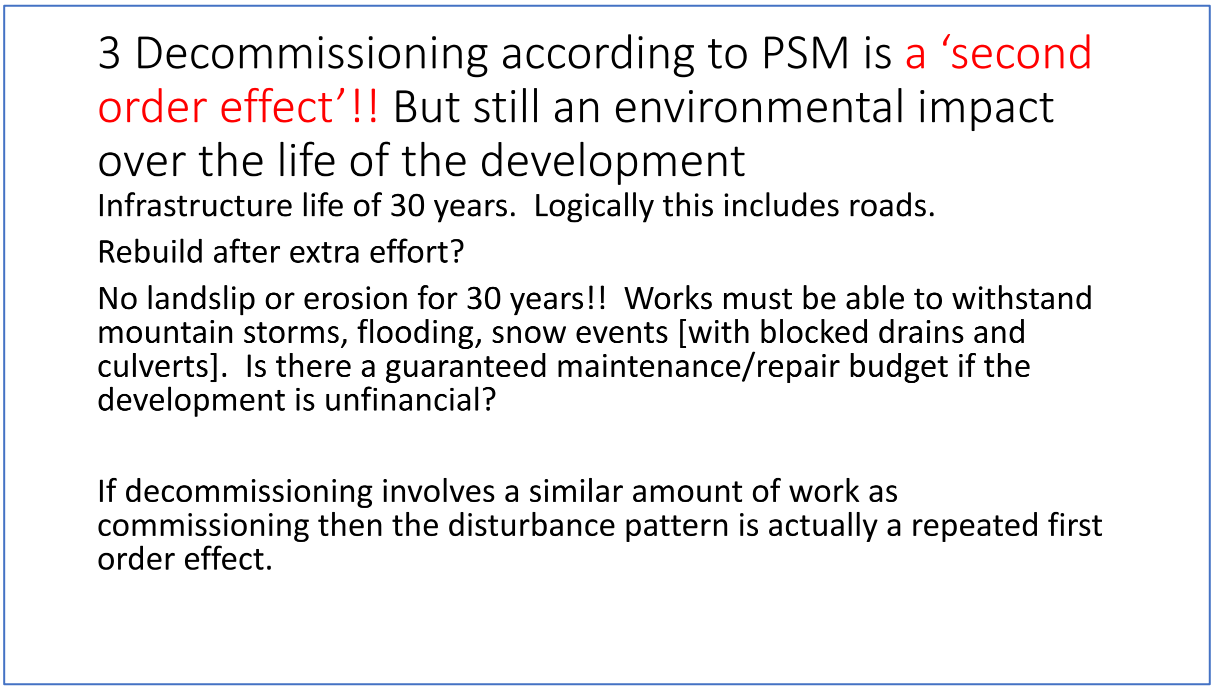


Figure 23 Decommissioning and climate change are second order effects according to PSM

My Conclusions

My conclusions are self-explanatory and can be seen in figure 24. The backdrop map of NSW illustrates that there are many places which do not have red flags for erosion or mass movement – where the development could be placed with far less risk of significant environmental impact.

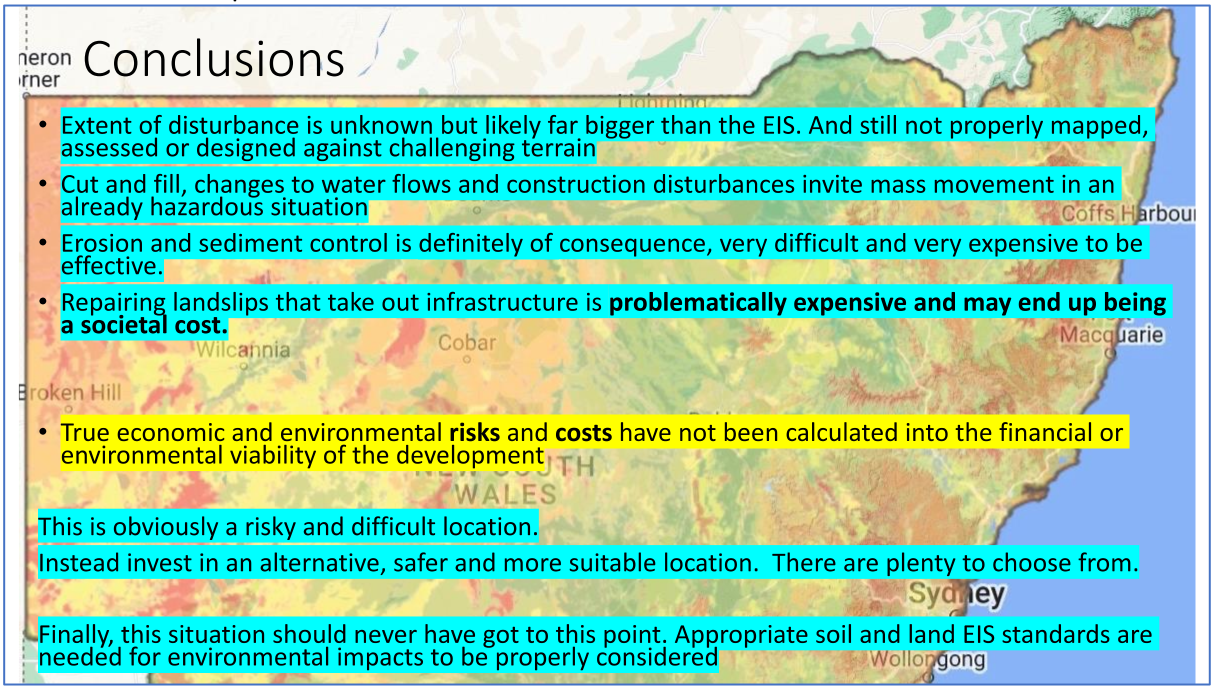


Figure 24 Concluding remarks

Comments on the NSW planning process

In this case, a lot of time, community division, emotional distress and needless effort has been unnecessarily expended on a proposal that is simply in the wrong place.

I believe the NSW planning process can be improved at two points:

1) Prior to selection of any sites for developments of state significance, a broadscale feasibility study should be undertaken in conjunction with Planning and relevant government representatives to consider the merits of various place-based options. This process should be apolitical. Multi-criteria spatial analysis for orderly development has considerable merit and was used successfully for the NSW Coastal Planning process in the early 2000s. Since that time spatial datasets and software have become far more reliable and efficient.

See for example DECCW 2010, and Gray *et al* 2011. If the NSW Government had persisted with this scientific rules based approach, then it is likely that the development could have been already approved and placed somewhere less hazardous, and possibly be already running.

2) Once a site/location has been selected, a set of standards is required to ensure environmental impacts are properly assessed. Whilst standards exist for soil and land assessment for Environment Impact Studies (eg Gray *et al* 1997), they are basically out of print, undigitised and are largely unknown to both planners, developers and the EIS consulting industry. Furthermore, the guidelines pre-date web-publication for pan NSW Land and Soil Capability (LSC) spatial layers. The degree of land and soil capability,

compared in a matrix against the expected intensity of the development, could be used to determine the degree of environmental risk, and therefore guide the minimum amount of on-site soil and land assessment required for an effective EIS. If appropriate standards were available, the developer and society would be able to assess and address environmental impacts. A first step could be to arrange a forum of planners, developers, and soil and land consultants to determine how better standards might be developed and managed. A similar process could be used as was developed for the Wind Energy: Visual Assessment Bulletin https://www.planning.nsw.gov.au/sites/default/files/2023-03/wind-energy-visual-assessment-bulletin.pdf

References

Banks RG (2001) Soil Landscapes of the Tamworth 1:100,000 Sheet. Map and Report NSW Department of Land and Water Conservation. Sydney.

Banks RG (2021) Responses to the EIS by Dr Rob Banks - 2021 https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SUB-13742159%2120210129T030126.282%20GMT

Banks RG (2022). Review of Hills of Gold EIS Appendix N Soils and Water Addendum Report https://drive.google.com/file/d/1rsCYvffaRKkbRqH3N0PAp9nTn-jAX-cr/view

Bui EN, Hancock GJ, Chappell A, and Gregory LJ (2010) *Evaluation of Tolerable Erosion Rates and Time to Critical Topsoil Loss in Australia.* Caring for Our Country Report. CSIRO Division of Land and Water. Canberra.

Caitcheon GG, Donnelly T, Wallbrink P and Murray A (1995) Nutrient and sediment sources in Chaffey reservoir catchment. *Australian Journal of Soil and Water Conservation*, 8(2): 41-49.

Chapman (2023) Review of soil and land on the Hills of Gold Project.

Chapman GA and Murphy CL *Soil landscapes of the Sydney 1:100,000 sheet: Report*. Soil Conservation Service of NSW. Sydney.

Crouch RJ, Reynolds KC, Hicks RW and Greentree DA (2007) soils and their Use for Earthworks Chapter 20 in *Soils Their Properties and Management*. Third Edition Charman PEV and Murphy BW (eds) Oxford University Press

DECCW 2010 *Soil and land constraint assessment for urban and regional planning*. Department of Environment, Climate Change and Water NSW. Sydney.

Department of Planning and Environment (2023) Hills of Gold Wind Farm State Significant Development Assessment Report SS9679 https://www.ipcn.nsw.gov.au/resources/pac/media/files/pac/projects/2023/12/hills-of-gold-wind-farm/case-referral-documents-from-dpe/assessment-report.pdf

Gray Jonathan, with Murphy Casey, Noble Rick and Chapman Greg (1997) *Soil and Landscape Issues in Environmental Impact Assessment.* Technical Report No 34 NSW Department of Land and Water Conservation. Sydney.

Gray JM, Chapman GA, Yang X, and Young M (2011) "Soil and Land Constraint Assessment for Urban and Regional Planning." *Australian Planner* 48, no. 1 12–23. https://doi.org/10.1080/07293682.2011.530585.

Hicks RW and Hird C (2007) Soils and Urban Land Use. Chapter 21 in *Soils Their Properties and Management*. Third Edition Charman PEV and Murphy BW (eds) Oxford University Press

Jaboyedoff M, Oppkofer T, Abella ́n A, DerronM, Loye A, Metzger R and Pedrazzini A (2012) Use of LIDAR in landslide investigations: a review. *Natural Hazards* **61**,5-28.

Morse, R.J. and Rosewell, C. (1993). "Application of the USLE to Classifying Urban Lands", in *Proceedings of the 24th Annual Conference of the International Erosion Control Association*, Indianapolis, Indiana, 23-26 February 1993: 169-184.

Landcom 2004 *Managing Urban Stormwater*: Volume 1 *Soils and Construction*. Also known as the Blue Book. NSW Department of Housing. NSW Government Printer. Sydney

McInnes-Clarke SK (2002) *Soil Landscapes of the Murrurundi 1:100,000 Sheet.* Map and Report. NSW Department of Land and Water Conservation. Sydney.

Norrish K and Rosser H (1983) Mineral Phosphate Chapter 24 in *Soils: An Australian Viewpoint* CSIRO Division of Soils. CSIRO Melbourne. Academic Press London

Probert ME The sorption of phosphate by soils Chapter 29 in in *Soils: An Australian Viewpoint* CSIRO Division of Soils. CSIRO Melbourne. Academic Press London

Renard KG, Foster GR, Weesies GA, McCool DK, Yoder DC (1997) 'Predicting soil erosion by water: a guide to conservation planning with the Revised Universal Soil Loss Equation (RUSLE).' Agricultural Handbook, Vol. 703. (USDA: Washington, DC)

Tulau MJ, Nyman P, Young M, Morand DT, McInnes-Clarke SK and Noske, P (2019) Mass movements of Warrumbungle National Park. *Proceedings of the Linnean Society of New South Wales* **141**: 115-S130.

Yang X, Gray JM, Chapman GA, Qinggaozi Z, Tulau MJ, and McInnes Clarke SK. "Digital Mapping of Soil Erodibility for Water Erosion in New South Wales, Australia." *Soil Research* 56, no. 2 (2018): 158. https://doi.org/10.1071/SR17058.

Yang X, *Climate Change impacts on rainfall erosivity and hillslope erosion in NSW*. NSW Office of Environment and Heritage. Sydney. https://www.climatechange.environment.nsw.gov.au/sites/default/files/2021-06/Climate%20Change%20Impacts%20on%20Rainfall%20Erosivity%20and%20Hillslope%20Erosion%20in%20New%20South%20Wales.pdf

Appendix A: Curriculum Vitae: Greg Chapman

Career:
July 2013 to present: Part time soil and related land management and ecological consulting.

Expert witness for NSW Land and Environment court and Federal Supreme Court. Soil based assessments of the presence, extent and delineation various critically endangered ecosystems. Expert reports on the impacts, and expected impacts, of land management on soil and ecosystem services. So far in nine out of ten matters my evidence has either been accepted by judges, or it has been used for out of court settlement. One matter remains pending.

Specialist in the provision of spatial ecosystem service and resilience science products to assist regional institutions with geographic prioritisation, monitoring, land management and strategic planning. Clients include: Local Land Services, NSW Natural Resources Commission, NSW National Parks and Wildlife Service and the then Federal Department of Agriculture, Forestry and Fisheries.

MCAS-S based products include mapping ecosystem services, mapping temporal distance to resilience tipping points for soil condition by soil type and land use according to sustainability of land management. Also mapping geographic vulnerability to extreme climate events such as intense rain after drought, windstorms and extreme hot and cold.

Developed business case and implementation program for the Australian Soil Assessment Program as part of the Australian Soil Research, Development and Extension Strategy on behalf of the National Committee for Soil and Terrain. This report was instrumental in building a case for the information component of the National Soil Strategy.

Founding member, inaugural and current secretary of the NSW Soils Knowledge Network- small, group of retired and semi-retired soil specialists who disseminate soil extension and knowledge to institutions such as Local Land Services. Production of various videos, running and presenting at field days and various soil and land management training sessions. All workshops rated by all attendees as either excellent or very good. Soil training for ecologists scored on average 8.87 out of 10 with no scores below 8.

Honorary Science Fellow for the Science Division of the NSW Department of Planning and Environment, providing soils advice to staff, running experiments and investigations. Examples include: improvement of soil erodibility spatial layers for the Revised Universal Soil Loss equation; investigation of the impact of Yeomans Keyline farming on soil carbon; and using paired site soil testing to assess impacts of feral grazing in the lower Snowy Catchment.

June 2022 appointment to the Blue Mountains National Parks and Wildlife Service Regional Advisory Committee (BMRAC). Set up and implemented comparative study quantifying erosion and other soil damage in National Parks caused by trail bikes and mountain bikes. Evidence base used by NPWS to guide policy.

Part-time senior soil consultant with SLR. Numerous soil projects and costings ranging from mine dust suppression strategies, soil management plans, revegetation assessments and assessment of land capability.

2006- July 2013: *Theme Leader Soil Condition and Land Management Monitoring, Evaluation and Reporting (MER). NSW Office of Environment and Heritage.* Responsible for NSW soil condition and land management capability monitoring, evaluation and reporting. Development of methods, standards, encouraging data collection and delivery to inform natural resource management decisions.
Lead multidisciplinary 30 member project team to successfully design and implement $4m soil condition and land management benchmarking program. Some achievements:

- Conceptualised and delivered initial maps of land management within its capability to assist prioritisation of intervention and extension efforts by NSW regional land management authorities
- Acclaimed for leading the development and first deployment of the erosion and flooding Bushfire Area Assessment Team (BAAT). For the Wambelong/Warrumbungles 2013 fire developed rapid response priority mapping methods using MCAS-S.

- Acknowledged by CSIRO as developing the *best existing soil monitoring data set and highest utility soil carbon dataset in Australia*.
- Recognised by CMA contacts as Soil & Land MER *'extremely useful' for catchment action planning*.
- NSW MER methods I developed recommended by CSIRO as the basis for national carbon and pH monitoring and for the national Soil Carbon Research Program.
- Encouraged, collaborated and contributed to advances in sheet erosion modelling to best in the world standards. Developed applications and influenced outputs to be arranged as NSW standards for bushfire management, monitoring and catchment planning.
- Praised by HNCMA, SCA and NSW Office of Water for innovative impact allowing targets setting and setting land-based priorities to improve water quality.
- Developed spatial threat analysis system using soil condition and land management within capability to prioritise targets for catchment action planning.
- Praised for taking NRM targeting "to a higher level" by HNCMA for coordinating, developing and delivering soil and land spatial priority products for catchment management authorities using innovative spatial viewer (MCAS-S) technology – including mapping four separate soil ecosystem service values.
- Use of ecosystem service concept linking soil values to people values as a framework for investment.
- Designed and instigated the SoilWatch performance monitoring program. Adopted by most CMAs and contributing 250+ additional soil monitoring sites to the 853 formal soil condition monitoring sites at low cost.
- Influenced/supported NRC designing NRM targets and positioning soil condition monitoring, soil mapping and land use mapping as high priority activities.
- 2010 Soil Science World Congress presentation on Land Management within Capability assessment.

Also:

- Represented NSW on National Committee for Soil and Terrain. Used influence to break a delivery deadlock in providing NSW soils information to the Australian Soil Resource Information System. Steering committee member for TERN soils facility which delivered over state of the art digitally modelled soil parameters for multiple control sections. Participated in MCAS-S based priority planning workshops for soil acidity and soil carbon. Instigated and chaired specialist sub-committee for nationalised laboratory test methods and database result storage.
- Provided initial instrumental technical input to DPI Strategic Regional Land-Use Planning strategy (BSAL).
- Collaboratively arranged establishment of the NSW Soil and Land Network for CMAs and NSW soil agencies to develop standards and undertake "critical mass" soils projects –eg training.

1996-2006 *Manager Soil Information Systems, renamed Manager, Soil Natural Resources Decision Support* Managed the Soil Landscape Mapping Program and the NSW Soil and Land Information System. Technical development, soil advice and advocacy, product development, project and program management of the NSW Soil Survey Team, Soil survey laboratory and Soil and Land Information System.

- Nominated for the Premier's Award for development of feasibility land assessment mapping system for orderly planning in coastal NSW.
- Strategic development and management of the NSW Soil Data System and its redevelopment into the NSW Soil and Land Information System, including development of SPADE (Soil profile access data engine), spatial linkage to GIS and development of queries to build numerous derivative maps for a wide range of natural resource management applications
- SALIS database increased from 1000 profiles to over 60000 and recognised as the best of its kind in Australia by the Australian Association of Commercial Soil Surveyors.
- $9m external funding obtained to accelerate strategic soil map coverage, develop new soils products and strengthen and populate soil data bases.
- 96% of NSW completed with modern soil mapping under my leadership.

1990 -1996 *State Manager Soil Survey and Soil Survey Coordinator*.
Directed and resourced all aspects of the NSW Soil Landscape mapping program.

- Trained and developed the NSW soil survey team and ran and further developed the NSW Soil Landscape mapping program.
- Three month soil survey in Kuwait followed by three months visiting soil survey institutions in Europe.
- Coastal Acid Sulfate Soil Risk Mapping instigated, designed, lead and successfully completed within "an impossible time frame". Coordinated release of this controversial work, including: 10 regional workshops, front page newspaper; television news and numerous radio interviews.

- Influenced risk map conversion to SEPP maps- preventing environmental damage to numerous coastal water bodies along the entire NSW coast.
- Development of Soil Landscape mapping and derivative products. >44:1 benefit:cost ratio. (ACIL 1996)

1986-1990 *Soil Conservationist – soils specialist.* Laboratory Manager at Scone Research Service Centre.

- Commercial lab establishment & achieving National Testing Authority Registration.
- Instigated and managed Soil Conservation Service soil testing laboratory quality control systems. Large improvements in test result consistency across five laboratories.
- Expert soil forensics witness.
- Successful completion of numerous soil survey and consulting jobs.
- Senior author of Sydney Soil Landscapes- first 1:100,000 soil landscape map. Published and launched by the Minister to much fanfare.

1986-1984 *Urban Areas Investigations Team Soil Conservationist.* Urban Capability studies and report editing. Soil Landscape mapping in Sydney area.

Education:
BSc Macquarie University. Soils, Ecology and Land Management. 80-83 GPA 3.43. Independent employed mature age full time student [mostly as a builder's labourer]. Science dux Balgowlah Boys High for four years.

Other:
Staff development: Soil survey team developed with exceptional camaraderie, eg via round robin peer field review. Massive development in soil surveyor extension and influencing skills. Four of eight initial soil surveyors from the 1990s have PHDs.

>$9m in external funding received and all 30+ projects completed and successfully delivered.

>110 publications and reports. Focus mostly on soil information application and landscape processes. Publication list available on request.

Peer recognition: Stage 3 Certified Practicing Soil Scientist since 1999 (highest level then obtainable).
President NSW Branch Australian Soil Science Society 2002-2004 and Office bearer 1998-2006

President Springwood Bushwalking Club (2020-2022, 2011-2015 and 2004-2007) Various committee roles since 2001.

Recreation: Travel, Gardening, Bushwalking- especially leading multi-day and off-track walks. From March 2000 to April 2023 lead 323 bushwalking activities totalling 493 days.