Review of Soil and Land Components of Hills of Gold Wind Farm Environmental Impact Statement and its Soil and Water Amendments

29th March 2022

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

 This document is a review of soil and land components of amendments of the proposed Hills of Gold Wind Farm Environmental Impact Statement

The client is Hills of Gold Preservation Inc (HOGPI), a voluntary group of citizens.

In preparing this review, I made all the inquiries I believed were necessary and appropriate and to my knowledge there have not been any relevant matters omitted from this review. I believe that the facts within my knowledge that have been stated in this review are true.

The opinions I have expressed in this review are independent and impartial, based on my training and abilities as a soil scientist. I have read and understand Schedule 7 to the Uniform Civil Procedure Rules and have used my best endeavours to comply with it.

In the case where I might appear in court regarding this review, I understand my duty to the Court and state that I have complied with it and will continue to do so. I believe I have the relevant expertise to be able to provide such information as requested for this review.

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Summary:

My main concern is that the **prevailing severity of soil and land limitations are not properly assessed against the true scope of proposed works.** I find it remarkable that the EIS has not identified the severity and extent of engineering challenges, and consequent soil and drainage disturbance, concerned with haulage of various long and heavy components up steep gradients and across unstable terrain. Further, the consequent disturbance of earth materials and slope instability implications of loading heavy towers on the edge of potentially unstable slopes has not been properly assessed. Both these issues necessitate far greater scrutiny of land which has been clearly identified as being in places extremely steep, unstable and highly erosive. In other words, the true extent of the scope of works has not been presented in the EIS. Consequentially the extent, likely long-term effectiveness, and expense of drainage, erosion and sedimentation control works have not been properly included in the EIS. This means the true environmental impact cannot be assessed. However, the expected degree of likely soil disturbance, compared against extreme erosion hazards, spatial footprint constraints and extreme slope instability hazards indicates large and multiple and on-going mass movement, erosion and sedimentation and water quality risks. It is expected that the proposed development will be very expensive to establish and may well have on-going residual mass movement, soil erosion, sedimentation and water quality risks. This means it will be expensive to maintain and expensive to decommission over the long term.

Information sources:

I have relied on development plans and information provided by in the preparation of this document. Any errors in these documents may impact on the conclusions provided.

The EIS and appendix G concerning roading:
https://pp.planningportal.nsw.gov.au/major-projects/projects/hills-gold-wind-farm

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
and in - 2022
https://drive.google.com/file/d/1rsCYvffaRKkbRqH3N0PAp9nTn-jAX-cr/view

The Soil and Water Addendum from the Response to Submissions in January 2022
https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=S

SD-9679%2120221109T223105.979%20GMT

Soils and Water Mitigation Measures
https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-9679%2120221108T020517.754%20GMT

Hills of Gold Preservation Inc's latest submission which includes soil related concerns on pgs 13, and 31-37.
https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=EXH-50789958%2120221213T221059.398%20GMT

Other items are referenced as footnotes where they appear in the text.

Background:

An Environmental Impact Statement was prepared by Amanda Antcliff and Murray Curtis of ERM on behalf of the proponents of a proposed wind farm east of Crawney Pass in the Liverpool Ranges, south east of Tamworth and North of Muswellbrook in NSW.

Dr Robert Banks (a Soil Science Australia certified practicing soil scientist) was commissioned by Hills of Gold Preservation Inc to review soil and land related components of the EIS. In response to Dr Bank's critique an addendum was prepared by and was further reviewed by Dr Banks in response to an update of the EIS. Dr Banks is not available to further respond. I was approached by Hills of Gold Preservation Inc to comment on the EIS and its consequent amendments.

Qualifications

I am a suitably qualified soil scientist and have worked since 1984 variously as a soil conservationist, a soil surveyor and as a soil scientist. I am recognised by my peers as being experienced and competent, for example, by having reached stage three (highest level) of the Soil Science Australia CPSS scheme in 1999. I am the senior author of the Sydney Soil Landscape mapping report, the first published 1:100,000 project of its type for NSW. I subsequently ran the NSW soil state mapping and information programs for sixteen years and later established the NSW soil condition and land management within capability monitoring, reporting and evaluation programs. The later involved development of rule sets and the application to mapping land and soil capability for NSW. I have written over 100 papers and major reports concerning various aspects of soil and land assessment, including several papers on the application of the revised universal soiloss equation. I was a Department of Land and Water Conservation reviewer of the first edition of the Managing Urban Stormwater Soils and Construction Manual.

My curriculum vitae is in **Appendix One**. List of major reports and publications is available on relevant request.

Methods

Review of relevant sections and amendments of the documents listed above.

Assessment of prevailing soil and land conditions.

Assessment of any impacts the proposed development may have on soil condition and receiving waters.

Examination of the geometrical limitations of proposed roading to, and on the site, with respect to prevailing soil and land limitations (slope gradients, soil types, erosion and mass movement hazards) within the study area, especially considering the likely degree of soil disturbance and consequent expected requirements to control erosion, sedimentation and maintain water quality.

Review of EIS adequacy for soil and land issues

I agree with the scientific basis and endorse all the comments raised by Dr Banks in 2020 and 2021.

The site of the proposed wind farm appears to have selected particularly according to windiness, ignoring the extreme challenges of the terrain. See figure 1.

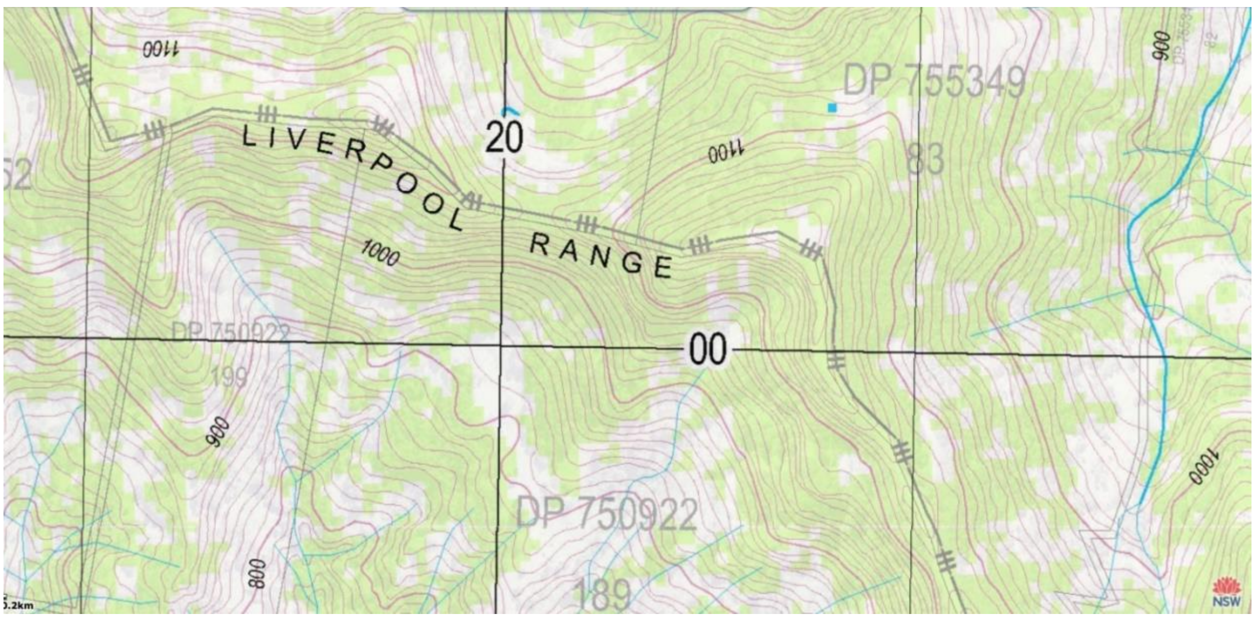


Figure 1 Topographic map detail of part of the proposed wind farm on the Liverpool range. It requires road access to deliver wind turbine parts up from the valley floor then along the spine of the range. Note the predominantly steep terrain.

No other known wind farm in NSW appears to be sited on a predominantly narrow ridge crest of a very steep to precipitous and unstable basalt mountain range. Interestingly, readily available standard contour mapping shown in figure 1 better depicts the steepness of the land than the maps presented in the EIS.

Other proposed wind farm developments are on flat, undulating or rolling land. In these instances erosion, mass movement and spatial site restrictions are not nearly as pronounced. It is an understatement to say that the impact of this proposed wind farm, particularly because the degree of soil, saprolite, rock and drainage disturbance involved, has not been studied adequately with respect to the prevailing soil and land hazards and consequent environmental impacts. From a soil conservation perspective, the scale and nature of the proposed development in an extreme location presents a technically demanding challenge.

Previous comments by Dr Banks made in 2020 and 2021 concerning lack of onsite soil survey effort and poor description and understanding of prevailing soil capability remain and are endorsed by me- despite minor efforts in the amended soil and water section of the EIS.

There is failure to present any soil mapping, location of inspection sites, laboratory test results, despite repeated requests by Dr Banks. This begs the question why this information has not been provided at least as an appendix? I note also that the geotechnical report is also missing – despite referral to it in the text.

Throughout the EIS only plan views and drawings have been provided. End elevation and other diagrams clearly showing slopes and the extent of soil disturbance have also been omitted.

Additionally, there has been no attempt to assess the degree of mass movement hazard, via for example Land and Soil Capability assessment. See appendix two.

Water Erosion Hazard

Firstly, Modelled Revised Universal Soil Loss Equation (RUSLE) for prediction of sheet and rill erosion. The EIS output of 471 tonnes/hectare/year is not placed into any context in the EIS. Given it is a worst-case scenario, and even if the average figure is less than what is often considered to be extreme at 60t/ha/yr, it actually still indicates an **extreme erosion hazard**. 471 tonnes per hectare is equivalent to 636 cubic metres of soil per hectare, or 451 cubic metres (assuming bulk density of 1.35) per soccer field - approximately 47mm deep in one average rainfall year for each hectare disturbed. For example, 10 tonnes per acre/year is considered an upper limit to tolerable erosion rates by the USDA. Teng *et al* (2016)[1] modelling Australian soil erosion ranked >25 tonnes/hectare/year in the highest of ten classes. It is understood that even two tonnes/hectare/year of erosion of clayey soil can impact water quality.

The extreme nature of the erosion hazard means that detailed assessment is required. Boiler plate statements concerning implementation of any standard erosion and sediment control plans are not sufficient compared to the very large risk. Given the magnitude of erosion to be prevented and the limitations imposed by a narrow ridge directly above, what is in many places very steep to precipitous terrain, the ability to contain erosion may well be impractical.

1

Teng H, Viscarra Rossel R, Shi Z Behrens T, Chappell A, Bui E, 2016. Assimilating satellite imagery and visible–near infrared spectroscopy to model and map soil loss by water erosion in Australia. Environmental Modelling & Software 77:156-157

No attention is given to the propensity of fine basalt derived clays to remain in suspension. This is important for these Type F soils (HIA 6-11[2]). With type F soils traditional erosion control measures such as sediment fences, and turf cannot be expected to necessarily be effective. If sediment control basins are to be relied on, then where will they be placed and how will they be designed, how will they be maintained? This is pertinent when concentration of seepage and runoff issuing out of sediment detention basins can exacerbate mass movement. It also means use and maintenance of expensive measures such as rock-lined, or reinforced grass water ways, paved flumes and piping to save disposal areas (away from areas of slip hazard). Furthermore, analysis of 80 and 90th percentile five day rainfall, which is required to determine volumes and depth configurations of sediment basins may result in structures which cannot be placed on-site due to slope and mass movement hazard restrictions.

Given the highly localized orographic rainfall, rainfall erosivity assessments cannot be based on figures from nearby towns. For example, the 36-year rainfall average rainfall at "Chittick" (-31.569498° 151.223432°) near the junction of the Barnard River and Brayshaws Creek is just over 1100mm and it is estimated from three years of records at "Nycooma" to average around 1500mm at 1400m elevation (B Tomalin, pers com). Whilst average figures indicate greater rainfall erosivity at higher altitudes, the impact of mountain top storms on rainfall erosivity is likely to be very large but has not been studied. Flooding caused by such events clearly indicates the need to 'over-engineer a large safety factor' into soul conservation works. See Figure 2. It is plausible that the intense rainfall event measured 500m and 5km below the crest was greatly exceeded by rainfall on the Liverpool Range.

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

Figure 2 Barnard River flooding approximately 5km downstream and 500m below the crest of the Liverpool Range on 2/1/2010 after 74mm of rain was measured over 40 minutes. Photo Brian Tomlin HOGPI. Note sediment in the river water.

It is expected that very large sediment detention structures will be required – on steep land where practical flat areas are often small and isolated.

Similar attention should be given to this matter in the EIS as to say road access of equipment. I note that Appendix B (Updated Mitigation and Management Measures) pages B26-B30 contains standard erosion control provisions which, whilst possibly beneficial, are not matched with the severity of site characteristics or the degree of disturbance. This section of the EIS is inadequate.

Mass Movement Hazard

Readily available published literature, eg soil landscape mapping, shows mass movement and engineering hazards where it exists, over the entire mountain range, see for example McInnes-Clarke (2002)[3]. Any competent soil scientist would be able to confidently extrapolate the same mapping along the same geology and landscape configuration to conclude that the proposed works are in an extreme mass movement and erosion environment. In addition, steep to precipitous basalt ranges in NSW are all well known to be prone to mass movement. Building in environments with unstable slopes is costly for

[3] McInnes-Clarke SK (2002) Soil Landscapes of the Murrurundi 1:100,000 sheet. NSW Department of Land and Water Conservation. Sydney

adequate road construction. For example, the New England Highway crosses the Liverpool Ranges, the same mountain range – and its upgrade was a difficult engineering challenge and an expensive public investment.

Mass movement LSC for much of the study site is class 8, that is it is extreme. Data provided by Dr Banks in his January 2021 review of the EIS shows much of the area has extreme land and soil capability with the majority (33) of proposed wind turbines being on sited on class 6 or 8 land. See figure 2. In response a geotechnical survey of the site, which has been referred to in the EIS amendment, but does not seem to have been made available, makes no mention of assessment of each of the proposed towers, nor the route of the proposed roading network.

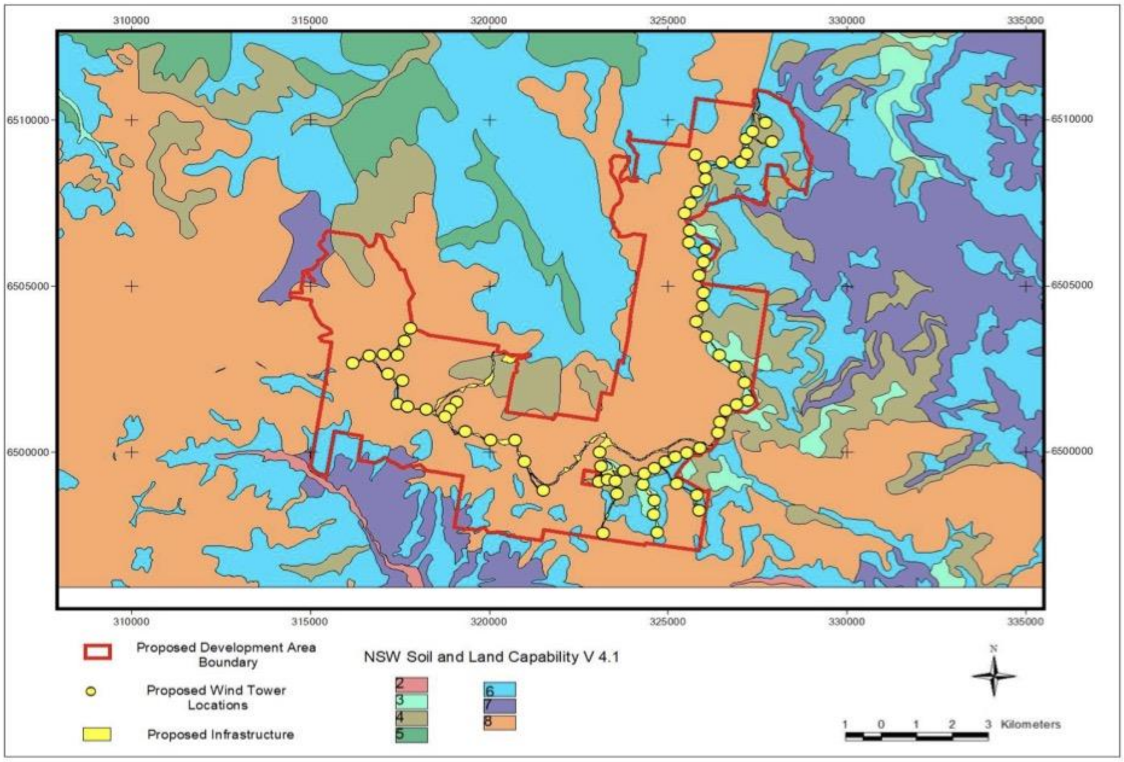


Figure 2: Corrected LSC mapping with broad development footprint provided by SOMEVA

A summary of the significance of the information presented in Figure 2 is summarised in Tables 2 – 4 below.

Table 2: Area of LSC Classes within greater proposed development area.

LSC	Development Area (ha)	% of Development Area
3	188.6	2.3
4	842.9	10.2
6	1224.8	14.9
7	134.5	1.6
8	5843.9	71.0

Figure 3: Land and Soil Capability map of the proposed wind farm and area analysis. Acknowledgement: Dr Banks of Soil Futures 2021

The EIS amendment, however, identifies in various places: very steep to precipitous slopes; numerous current land slips (see figure 4) ; presence of deeply weathered weak basalt saprolite; local ephemeral springs; and patches of deep expansive, low wet strength clays-- each of which is a feature commonly associated with mass movement hazard.

Figure 4 Section of the Liverpool Ranges, with numerous instances of land instability, on pastures in the vicinity of the proposed development. Photo provided by HOGPI

Despite this there is scant connection of the hazard, nor the implication of the soil and landscape features, with regard to the scope of works. For example, drainage works around roads and towers may increase profile wetness, thereby exacerbating the risk of nearby, or downslope, mass movement. Mass movement exposes unconsolidated soil to erosion and subsequent creek and river water quality issues. An example is clearly seen in figure 3 where localised concentration of run-on from a local quarry on the Liverpool Range has triggered a landslip.

Clearly detailed geotechnical analysis is needed for the proposed development but has not been presented in the EIS. A geotechnical analysis was referred to in the January 2022 Amended Report but has not been presented in the EIS. Why?

It is noted that the Tamworth Regional Council rejected the proponent's proposal for a delivery route in the vicinity of the Devils Elbow noting, amongst other issues, that the *'engineering associated with stabilising and draining such an extreme formation would be challenging the say the least'*. Council also raised issues with practicalities of erosion and sedimentation works. [4]

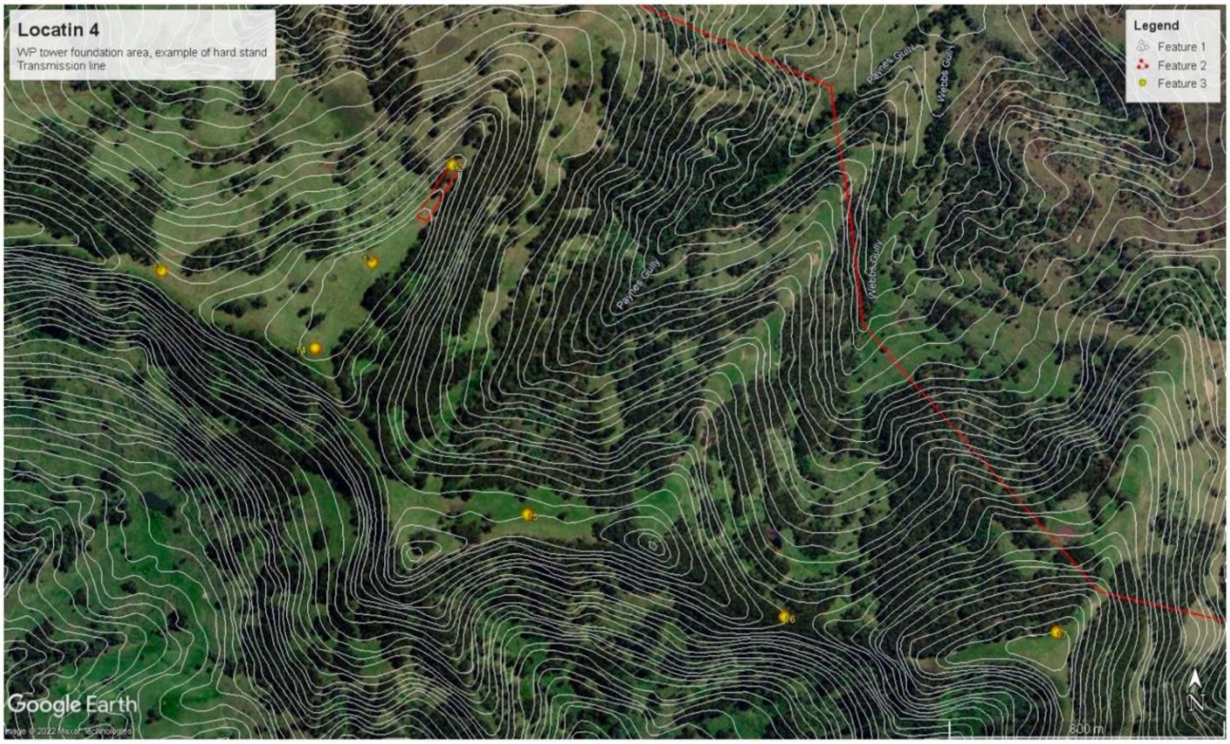
The position of the Liverpool Ranges quarry on the edge of a very steep break of slope mimics some of the WTG locations. Geotechnical survey of each wind tower should have been included in the EIS. This is because cost of loaded slope failure (triggered by the weight of the WTG) can be expected to have

[4] https://majorprojects.planningportal.nsw.gov.au/prweb/PRRestService/mp/01/getContent?AttachRef=SSD-9679%2120221109T223106.731%20GMT

large impacts on biodiversity and water quality as well as high remediation costs and probably catastrophic impacts on the viability of the rest of the proposed project.

Figure 5 Small quarry on the Liverpool Ranges where concentration of run-on is associated with slope collapse. Photo provided by HOGPI.

In another example, provided by Brian Tomlin of HOGPI, it can be seen that turbine number 12 is proposed for installation on a knife-edge spur. See figure 5. Brian has superimposed the location of the necessarily level ie horizontal hard stand (for fitting parts and crane operations), which is understood to be 150m by 60 metres on a 10m interval contour map. Three ten metre contours can be seen crossing the proposed hardstand foot print, indicating that a 30m batter will be required. Mass movement hazard given the steep slopes and geology is extreme. Simple geometry, assuming: 1) that crane and component weights will require a cut surface; and 2) a stable vertical batter is even possible; indicates that some 135,000 metres of earth and rock (15/2x150x60 cubic metres) could need to be removed from this single component of the proposed development. Whilst other WTGs for the development may not be in as extreme locations, the point is that the environmental impact, due to the extent of earthworks and its associated soil conservation challenges has not been assessed.



Map 4: WP tower locations showing 25-30m foundation area with WP12 hardstand on top of 1169m ridge requiring a 20-30m cut

Figure 6 Hardstand for WTG 12 compared to local terrain. Image source Brian Tomlin of HOGPI

Disruption of soil pore spaces through compaction and cut and fill has a substantial impact on runoff – and can be expected as a result of construction activity. Extra runoff water generated can be expected to exacerbate erosion as well as lead to further land slips, especially where drainage becomes more concentrated.

Sedimentation and Water Quality hazards

It is noted that both the northern and southern flanks of the Liverpool Ranges have steep slopes and highly erosive conditions for basalt soils. The Northern flanks are part of the rim of the Murray Darling Basin. They are drained by the upper reaches of the Peel River, which eventually joins the Namoi. On the southern side of the Liverpool Range, water from the proposed development flows into the upper reaches of the Pages River and the Isis River. Both of which flow into the Hunter River. To the east portions of the proposed development flow into the Barnard River which is a major tributary of the Manning.

The proposed development has potential to impact the water quality of catchments because eroded basalt derived ferrosols have far more impact on water quality than other eroded soils.

Once eroded fine soils are difficult to contain – leading to water quality issues. This is because, unless caught in specially designed and maintained sediment detention basins, clays tend to stay suspended in water and so make their way into receiving waters.

Soils derived from Basalt are naturally high in phosphorus. Phosphorus is usually held tightly onto basalt soil particles, but P is released into the water column when oxygen is low – leading to blue green algae blooms and then fish kills. Caitcheson *et al* (1994)[5] found that, although the situation is complex, high phosphorus levels in eroded basalt soils are the main source of phosphorus which is the driving factor for blue green algae outbreaks in Chaffey Dam. Their isotope study found that whilst half the basalt material was from eroding stream banks, the other half was found to be from upland erosion of basalt top soils. The proposed development could, if erosion is not properly contained on-site, greatly increase input of phosphorus both to the dam and onto floodplains, in both the Hunter and Murray Darling Basin River systems.

Blue Green Algae outbreaks are a recurring problem in the Upper Hunter. See for example, https://www.facebook.com/ABCNewcastle/photos/a.189166632590/10157809440447591/?type=3. Blue Green Algae is also a recurring problem at Chaffey Dam (as of 17th of February 2023) https://www.waternsw.com.au/water-services/water-quality/algae-alerts/algae-alerts/2023/blue-green-algae-red-alert-warning-for-chaffey-dam-and-the-peel-river-downstream-of-the-storage-has-been-cleared and is associated with fish kills in the Darling River. It is expected that adding extra eroded basalt clays to the Murray Darling, Hunter and Manning Rivers will further exacerbate current water quality issues.

No practical linkage is made between erosion, drainage changes, mass movement risk and the placement and soil and land disturbance created by roads.

The proposed wind farm requires heavy and long parts to be driven on special trucks into position. The following is a quick analysis of proposed roading taking into account vehicle restrictions on gradients, turning circles and change of gradient.

1 Road Gradients

Slope maps in the amendment of the EIS show numerous steep instances along proposed roads (It is understood that there are about 40km of road within the site were turbine blades of around 80 metres, and other oversize heavy loads are to be delivered). In figure 7 it can be seen that there are numerous places which roads are planned for slopes which exceed 20% ie 1 in 5 (in brown) and to a lesser extent between 33% and 50% (1 in 3 to 1 in 2 slope) (in red). (Slope classes beyond the construction buffer are inexplicably not shown). NB The NSW Soil Conservation Service generally identifies slopes greater than 18 degrees (33%) as being Protected Land- requiring a permit to remove trees.

[5] Caitcheson GG, Donnelly TH, Wallbrink PJ and Murray AS (1994) *Sources of Phosphorus and Sediment in the Catchment of Chaffey Reservoir*. Technical Memorandum 94/16 NSW CSIRO Division of Water Resources,Canberra.

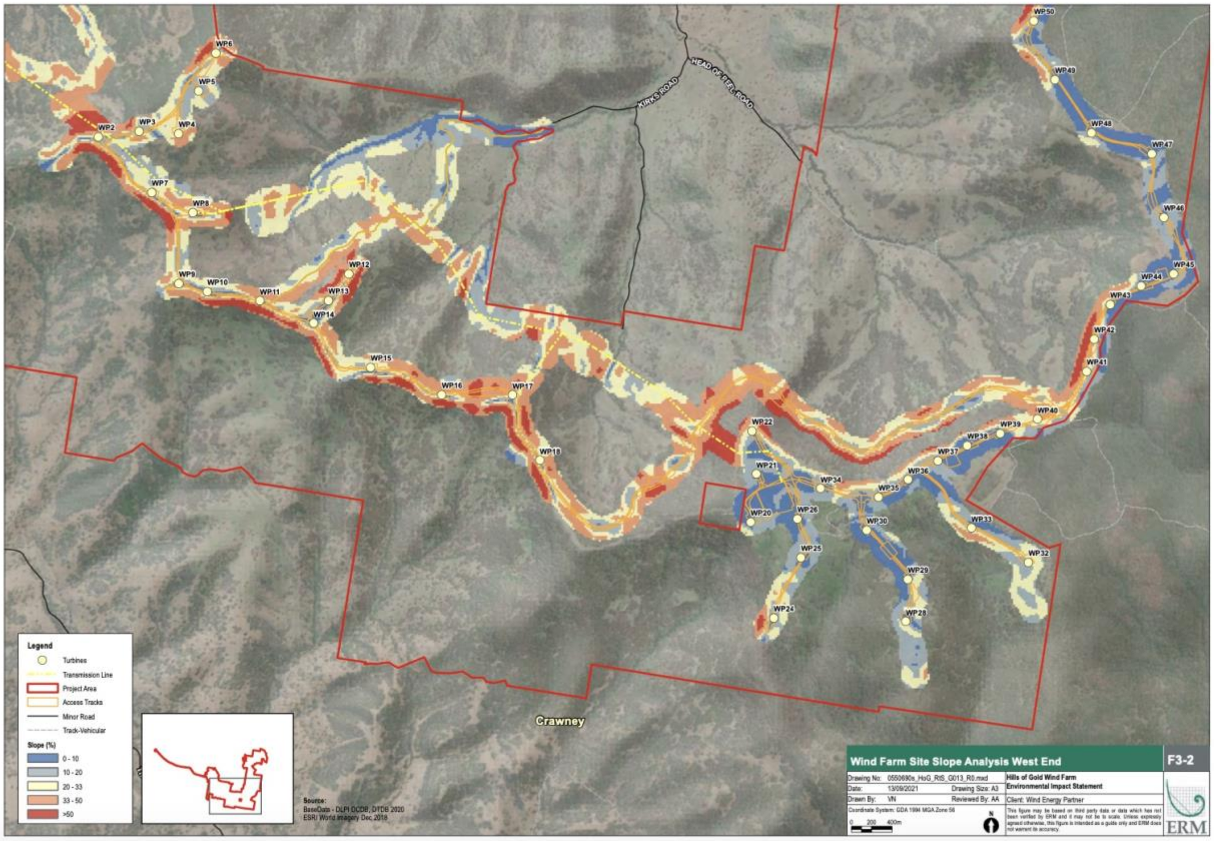


Figure 7: One of the slope maps for the proposed development

To place this in context, many local governments do not allow driveways where the slope exceeds 15%. Mine haul roads generally have upper gradient limits of 10% https://sites.google.com/site/mininginfosite/miner-s-toolbox/materials-handling/truck-haulage/haul-road-design-guidelines?tmpl=%2Fsystem%2Fapp%2Ftemplates%2Fprint%2F&showPrintDialog=1 .

Although information is scant for road specifications for wind farms, at least one informed road builder considers wind farm internal roads to be extreme if they are on slopes of more than 15%. See figure 8.

What we normally do in extreme cases (above 15%) is to build a ramp using concrete slabs or an asphalted road: this solution is not only more expensive, but can also introduce additional problems, such as the need for environmental authorizations or from other authorities.

Here you have a 17% asphalted curve:

Concrete slabs are normally cast on site on a layer of aggregate stone, and they have dowel bars for load transfer and sealed contraction joints. An initial texturing is made with a burlap drag or a broom device, while final texturing is made with a spring steel tine.

Figure 8 Web screen shot of extreme windfarm roading from BOP wind farms. https://www.windfarmbop.com/maximum-road-grade

Note comments on the website (figure 8) concerning: 1) environmental authorisations, and 2) expense. The relatively benign nature of the terrain in the background of the 'extreme example' in figure 8 can be seen to be comparatively gentle compared to what is proposed. Road gradient considerations do not appear in the EIS.

The salient point for soils is that having to align roads on steep land will require substantial earthworks. This means disturbance of soil, rock and saprolite and local drainage. The EIS makes no mention of this. Neither does it mention restrictions to road geometry which would also be expected to require large scale earth works with exposed soils on unstable slopes. The elevation range of the proposed wind farm is between 776m and 1418m. Within the proposed development it is expected that equipment will be trucked more than upwards 600m and that is just within the site. (600m is more than double the height of Sydney Tower). Other steep climbs on public roads are required to approach the site at almost 800m above sea level.

Where is the disturbed rock and disturbed and therefore highly erodible soil material to be placed? There will be issues with finding space on tight steep narrow ridges. There will also be issues with loading and containing plastic and somewhat expansive (ie potentially heavy wet) clay materials onto steep and unstable slopes. This is well beyond the scope of HIA guidelines. Assessment of environmental impact requires at least conceptual earthworks, disturbed materials handling and storage and drainage plans to be included in the EIS.

The area of land disturbed by road and other cuttings is in turn exacerbated by mass movement hazard. HIA (4-9) guidelines specify, where there is mass movement hazard maximum grades of cut soil batters as 4 horizontal to 1 vertical (25%). For fill batters the maximum recommended grade is 4.5 horizontal to 1 vertical (22.2%). This means unconsolidated spoil cannot be stored on slopes of more than 22% - precluding storage on steeper slopes. HIA batter guidelines contrast to far steeper (and likely unstable) specification of 50% batters seemingly arbitrarily specified (perhaps for another location?) in 2.7.4 of the EIS. Without informed and site-specific geotechnical investigation of all major cut and fill batters, it can be concluded that the area of land disturbed in the will be far larger than what has been stated in the EIS. Greater areas of disturbance may also have ecological impacts because more habitat is disturbed.

Similar slope and road gradient issues apply for the newly proposed Western Connector Road and the Transverse track as well as public roads. It does not matter if erosion occurs on public or private land, it still impacts water quality.

2 Turning Radius

No specific information concerning required turning radii for delivery of turbine blades is provided in the EIS, nor in appendix G which deals with roading issues. The closest is the diagram, provided by Rex J Andrews in Appendix G. See figure 9. It appears, from interpretation of the unexplained diagram, that the minimum road width is to be around 6.45m, with an inner turning radius of around 45.5m, and an outer radius, to accommodate the rotor tail, of some 63.5m.

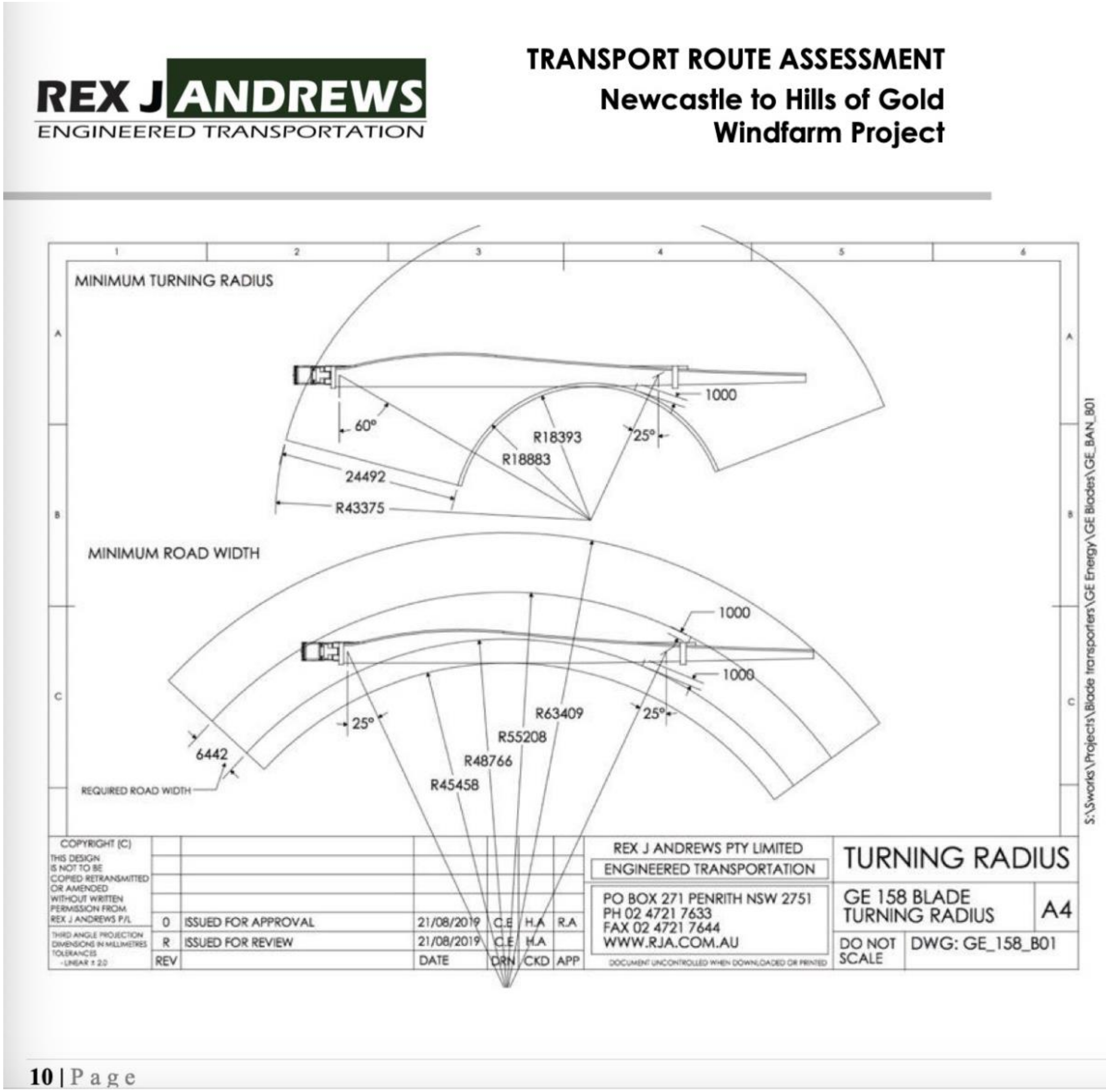


Figure 9 Turning radius diagram for transported blades

Given: 1) the length of the truck and 2) overhang of the blades which are between 83 and 75 metres, an enormous turning circle of at least 45.4m and up to 63.4m radius is required. This means broad sweeping turns with cuttings on **inside** ie concave, curves around 18m wide (*equivalent to a six lane highway*) if the back of the blade is below ground level. Road width on **outside** ie convex curves, according to the diagram would seem to need to be 7m or more wide (a bit wider than a standard two lane road). This is because the tail of the blade can hang out into space on some outer bends. To allow sufficient turning space to accommodate steep rises the route must be circuitous. This is salient as restricted turning involves further soil disturbance. Furthermore, inside bends are typically valley crossings. An extreme erosion hazard is expected where large volumes of disturbed construction material for a six lane wide road is placed in a drainage line! Perhaps other methods such as bridging may be used. Regardless major works such as this which have the potential and risk of movement of thousands of tonnes of soil material is not dealt with in the EIS.

There is no provision in the EIS in dealing with emergency road access (such as in the event of slope failure), nor does there appear to be any information concerning space for long or otherwise over size vehicles to turn around so that they can leave the site.

3 Approach, departure and breakover angles

A further problem is consideration of clearance when there are changes of haul road gradient for long vehicles. Figure 10 shows the concept of critical clearance angles.

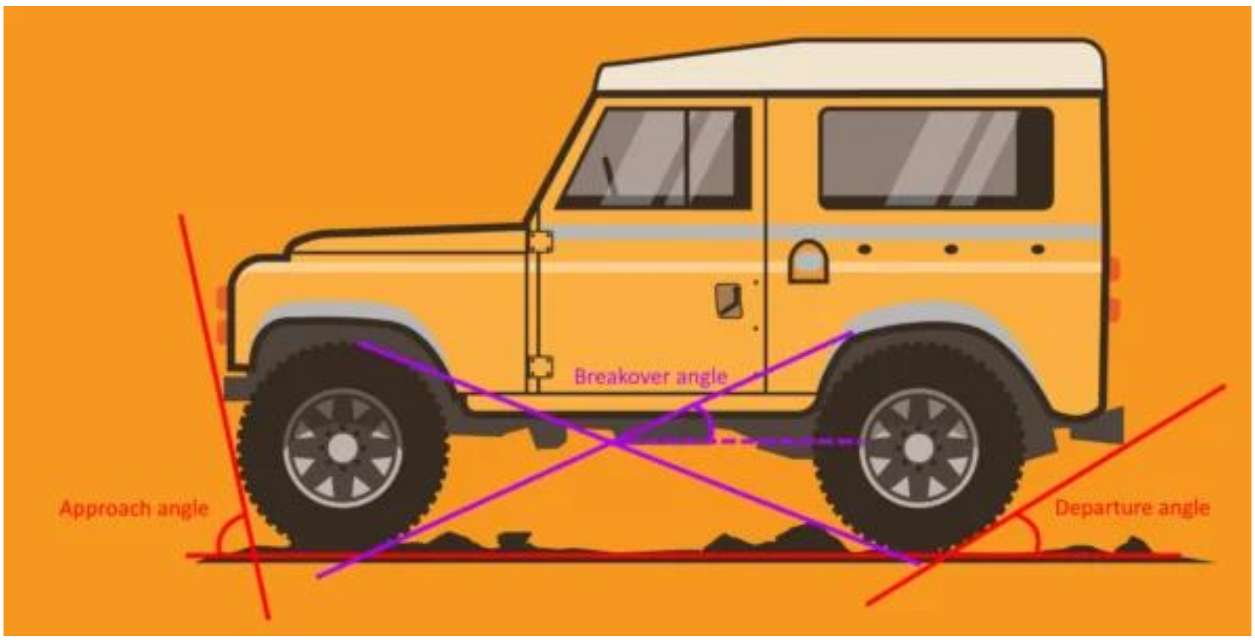


Figure 10 Diagram showing types of clearance angles in relation to road geometry (Acknowledgement https://4x4outside.com/wp-content/uploads/2021/11/breakover-angle-departure-angle-approach-angle.png)

Where the slope suddenly steepens the end of the rotor is likely to be damaged as the back drags on the ground.

Similarly, as a long wheel base low vehicle approaches a crest, the centre, if the vehicle does not have sufficient breakover angle, may scrape or jam onto the road.

Breakover and departure angles will have little tolerance if a 70m plus blade is being carried. See figure 11. Other truck configurations carrying even heavier loads for nacelles and other parts may be even more restricted by their wheel configurations.

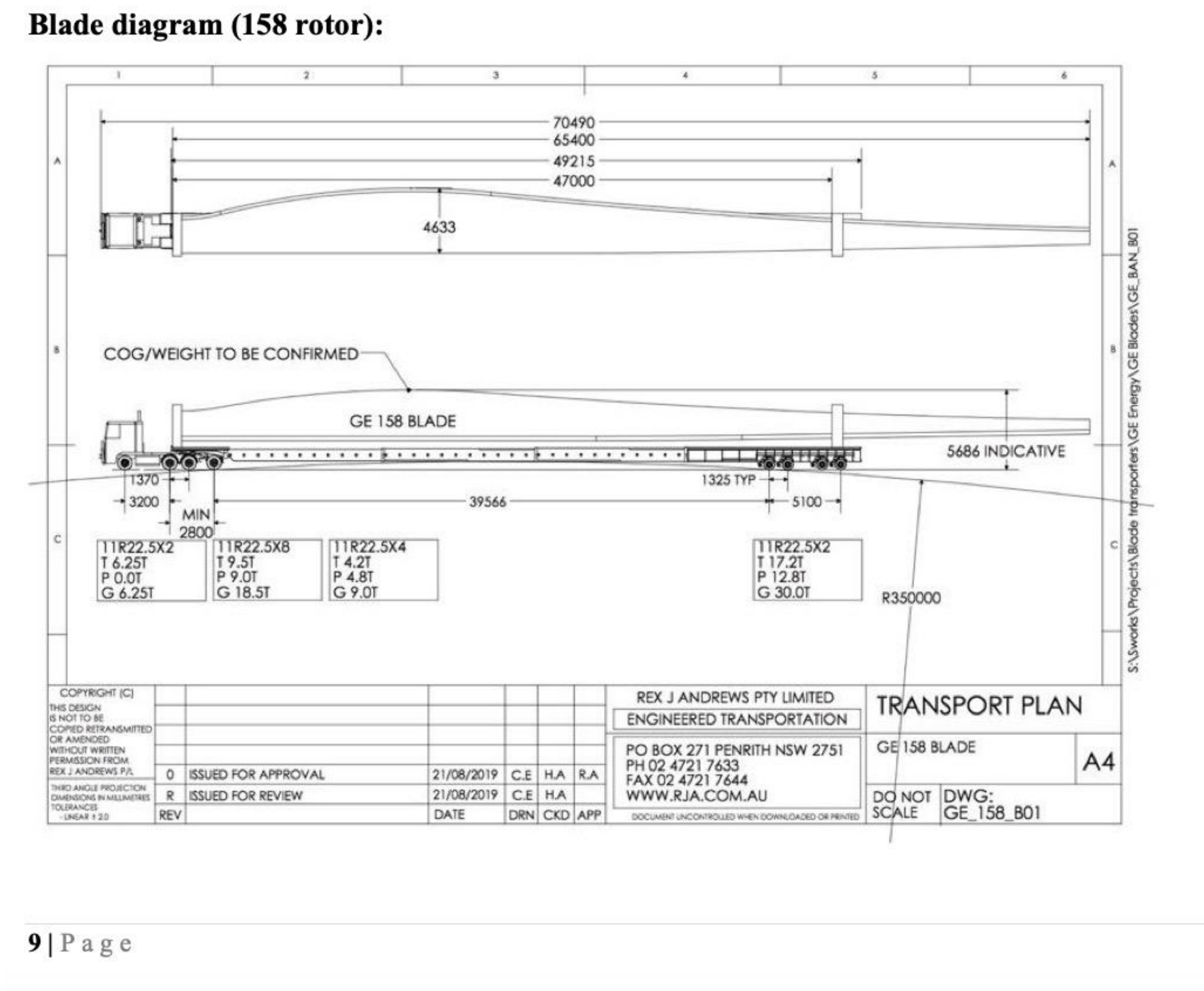


Figure 11 Wind turbine blade on proposed semi-trailer shown in appendix G of the EIS. What are the clearance angles?

Clearance angles have not been specified in the EIS for any of the proposed delivery vehicles – and the example of the blade vehicle may not be the most critical. Clearance criteria is another factor which governs road geometry. It is consequentially another factor which increases the amount of cut and fill and impacts drainage – hence erosion, sedimentation, drainage, mass movement risk and water quality. The EIS has made no attempt to address these considerations.

Roading and soil disturbance on traverse slopes

On the slope map, it can be seen (Figure 7) that several kilometres of the proposed road traverses a steep northern facing slope, ie below the ridge top. Much of this land has slopes between 33 and 50% (1 in 3, and 1 in 2 gradients- Protected Land). This section, and other smaller sections where the road runs along a hill slope, rather than along a ridge top, will require cut and fill batters. This is problematic on unstable steep hill sides, as greater amounts of cut and fill are required on side slopes when: 1) the transverse slope is steeper, and/or 2) the road needs to be wide eg 7 to 18m (see turning circles above) depending on the nature of the curve and 3) the vehicle is heavy – requiring a greater degree of insitu support rather than support from less consolidated fill and 4) turning circles, clearance angles and achievable vehicle gradients are restricted. See Figure 12.

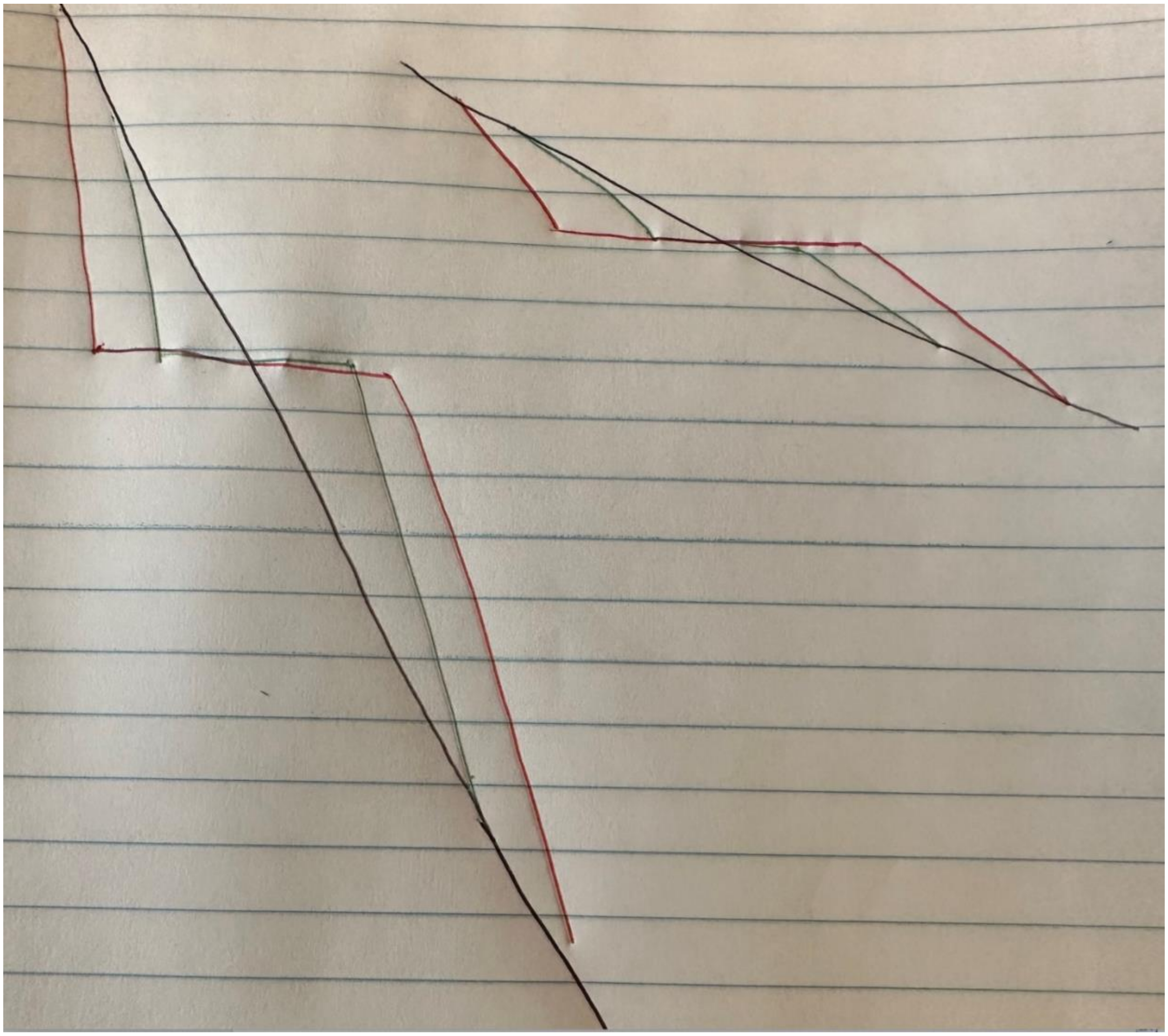


Figure 12 Rough sketch showing how steeper transverse slopes and need for wider roads impacts on the amount of earth disturbance

It is noted, from section 2.3.2 in the amendments, that the angle of repose of basalt scree on site is about 35 degrees or 75 percent. This means, unless unspecified measures are taken fill batters on steep traversing roads where the prevailing slope exceeds 75 percent, will have very long downslope fill batters – from which erosion cannot be properly controlled without large expense. See figure 12.

In section 2.4.4 batters are specified as being less than 50%. HIA, however, specifies far less steep batters on mass movement prone soils. The implications for exposure of disturbed soils are large and require geotechnical advice. The implication is that on steeper slopes traversing roads will have far more exposed material which is ready to erode.

This matter is not addressed in the EIS or its amendments.

Figure 13 illustrates a section of 1.3-11.6km of Barry Road from Nundle to Hanging Rock where a cutting is used to traverse a steep section of hill side. Exposed soil and rock materials can be seen both above and below the road.

Image 2:

Figure 13 Barry Gap road cutting showing evidence of previous landslip. Photo from appendix G of the EIS

In figure 13 topsoil, trees and understory vegetation can be seen hanging over the top of the cut batter. This may be due to rock falling from the batter, or more likely, illustrates slope creep – a slow and relatively benign form of mass movement. On the right-hand side of the cutting a slightly brighter redder zone shows a chaotic jumble of unsorted soil, cobbles and boulders. This is likely a typical old mass movement deposit. Cutting the toe of mass movement material means removal of support from below. Increased risk of landslip associated with cuttings on unstable slopes requires careful geotechnical assessment and may be costly to stabilise. As previously indicated, landslip is often followed by erosion, and this can lead to significant deterioration of water quality – sometimes completely choking waterways – and greatly increasing propensity for blue green algae blooms and consequent fish kills. In steep country landslip debris has sufficient momentum to reach waterways. See figures 14 and 15.

Figure 14 Google earth image of landslip on electrical station access road between Carrai and Jeogla. At least part of the landslip is associated with an inside bend.

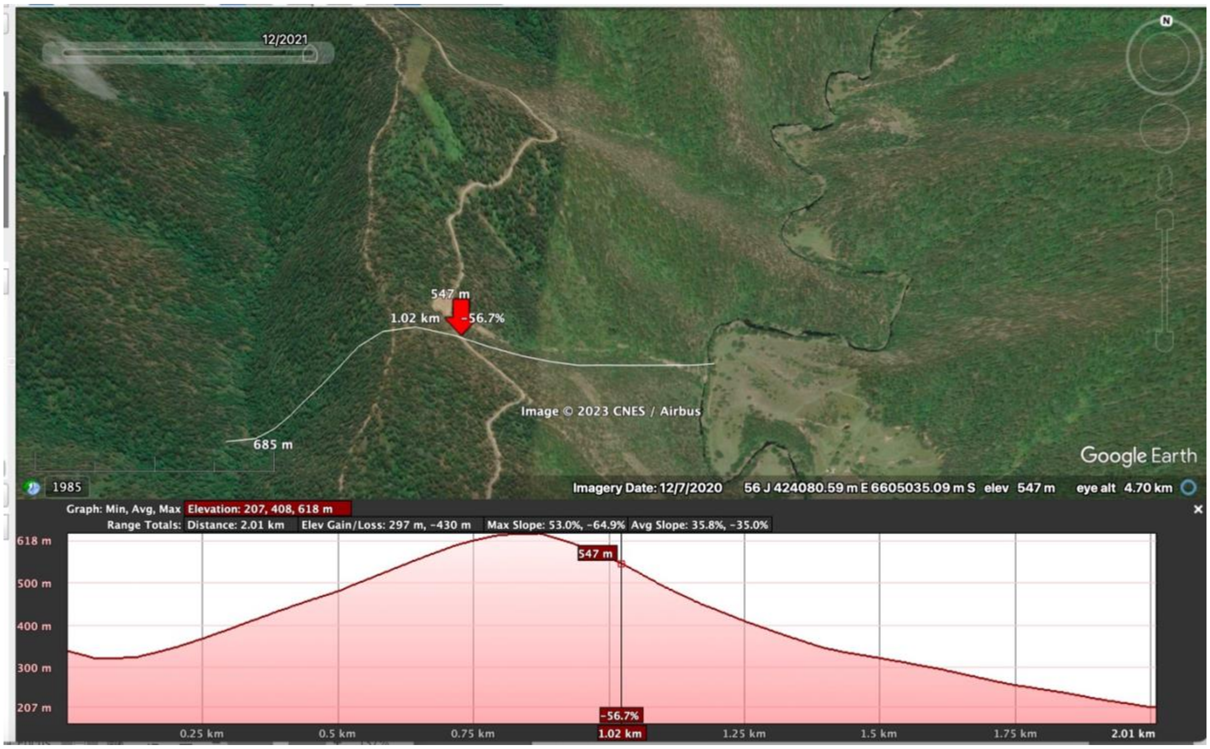


Figure 15 Google earth Hill side profile showing the same landslip. The road shown is far smaller than would be expected for the proposed development. Note the slope where the landslip has occurred is around 57% on a slope which shows less previous mass movement than the Liverpool Ranges.

The comments above, of course, apply to widening and modifications for public roads. In landslip prone country expanding road cuttings may not lead to any immediate mass movement, slope collapse may occur years or decades after the viable or commercial life of the proposed development. Costs for maintenance and repair by public bodies may be a long-term liability, especially if there is inadequate cost sharing arrangement with the developer.

Soils, landscape and trafficability issues

Basalt soils (ferrosols) when wet are notoriously slippery. Figure 16 shows several instances of road maintenance equipment which has slipped off wet ferrosol public roads.

Figure 16 Grader and a vibrating roller have slipped off local basalt roads eg Morrison Gap Road. Even with this relatively small construction equipment, compared to what will be required for the proposed development, large recovery vehicles are needed. Photos supplied by Brian Tomlin HOGPI.

Where ferrosols are not rocky they are plastic and soft when wet. Traffic on these soils when damp enough to be plastic means road deformation, exposure of rocks and accelerated erosion. See figures 17 and 18.

Figure 17 Plastic deformation and low wet strength of ferrosols requires careful road construction

Figure 18 Exposed basalt rocks at Barrington Tops. Acknowledgements https://onthedirt.com.au/barrington-tops/ and https://www.offroadaussie.com/the-barrington-tops-4wd-guide-review/

Figure 19 Snow fall near Hanging rock. Photo supplied by HOGPI

Figure 20 Snow on the Liverpool Range. Morrison Gap Road near Dirt Hole Gully 6/7/1984 Photo by Brian Tomlin HOGPI

In addition, the proposed wind farm is at high elevation. Snow is possible, see figures 19 and 20, and can effect trafficability as well as slope loadings. Runoff and muddy conditions from snow melt on construction sites will require erosion and sediment control considerations. In addition, ice needle growth in frosted soil tends to separate small soil entities from the main body of the soil – increasing soil erodibility.

Slippery when wet, sometimes icy, and widespread rocky and soft wet soil conditions will likely require a stable road base, especially for heavy vehicles. The risk of a laden heavy over-size vehicle slipping and falling off a greasy road surface could be catastrophic. Trafficability is not addressed in the EIS but can be expected to add to the scope of works [traffic, stockpiling, timing etc] where some 40km of roads and tracks will require designed surfacing. Where are stockpiled road base materials to be obtained and stored? A road construction engineer's report should have been included in the EIS.

Costs and risks to build a sustainable road on a very high mass movement side with engineering and soil erosion challenges, to sufficient standards are not addressed in the EIS. They may render the development impractical and/or unsustainable.

Seasonal timing

High elevations have short growing seasons making revegetation and establishing and maintaining ground cover difficult.

Additionally, intensely erosive rainfall can be expected at high elevations with orographically accentuated summer thunderstorms. Timing of construction works to avoid seasonal issues, especially exposure of bare soil during late summer, and to aid revegetation, both of which effect the degree of erosion have not been considered in the EIS.

Limited operational ridge top space.

Obviously large-scale earth moving, roading soil conservation and tower construction activities require space. It is noted that in many places flat ground is limited or isolated.

The EIS needs to address the following matters:

How do the large-scale earthworks and roading alter the alignment of the currently planned onsite roads? How is excavated and imported material going to be stored/stockpiled/removed and if so to where? Where will stockpiles and ancillary works be placed along a narrow ridge? How is sediment to be retained, what provisions are there to be for drainage away from mass movement prone land?

The large-scale earthworks which will be necessary for the project are an important part of environmental impact assessment and no doubt they will require sufficient detail for proper assessment. At present this matter is barely mentioned.

Maps and estimated volume tables are reasonable to expect in the EIS to assess the impacts of placement and extent of cut and fill batters, material storage locations, drainage and erosion and sediment control works.

It is suspected that space may already be an issue for operations. For example, the BDAR (Table 54, pg 454) describes the turbine layout design workshop where some 14 turbines are unable to be moved due to topographic, vegetation or boundary issues. How is there going to be sufficient space along narrow steep parts of the ridgeline for appropriate erosion mitigation works, stockpiles and road construction materials and other requirements?

It important that catchment water quality is not compromised for electricity generation during the life of the proposed development. That means the EIS must demonstrate that there is sufficient space for all erosion control measures during the entire life of the proposed development -especially if repairs or replacement work is required.

Hydrological Impacts

A characteristic of basalt geology is the presence of springs at the base of columnar jointing. Such local water supplies may be crucial for the survival of critically endangered ecosystems such as the Sphagnum Moss Cool Temperate Rainforest in Ben Halls Gap Nature Reserve. No study has considered how changes in hydrology from engineering and soil erosion and sediment mitigation works may impact on this or other Endangered Ecological Communities.

Decommissioning and on-going maintenance.

There is no provision in the EIS for inevitable on-going and regular inspections, maintenance and repair of drainage and erosion control structures, as well as any roads which may be agreed to be left open.

Given the scale of soil disturbance and the likelihood of:

- mass movement, including soil creep and
- shrink swell of soils moving from moist to dry and back again; and
- extreme weather events; and
- hail and snow falls blocking drains and culverts; and
- impacts of erosion of phosphorus laden basalt clays on water quality;

it is expected that failures from ground movement and weather will mean that maintenance will be ongoing and expensive for many decades.

A securely financed erosion, sediment and drainage maintenance plan is required beyond the life of the development.

A glib statement in the EIS concerns removal of tracks and rehabilitation of disturbed areas. How is this to be achieved and to what degree? Given issues of drainage, mass movement and erosion and water quality, further earthworks to reform and then revegetate previous surfaces are likely precluded – especially if the operators are out of business. Further issues of ensuring successful revegetation, settlement and disturbances and further erosion of soil moved for rehabilitation require careful. planning and complicate inspection and maintenance. They are not included in the EIS.

Conclusion

Truck gradient, bend and radius and gradient change intolerances mean require large scale land and soil disturbance on very steep to precipitous, unstable and highly erodible land which contributes high phosphorus soil to water ways.

Heavy towers built on the edge of unstable slopes and limited space and scope for erosion and sediment controls present large environmental challenges which have either not been properly assessed or ignored.

I find it remarkable that the EIS has not identified the severity and extent of engineering challenges concerned with haulage of components to the WTG sites. In other words, the true extent of the scope of works has not been presented in the EIS. When the true extent of soil disturbance is compared against acknowledged extreme erosion hazards, spatial footprint constraints and extreme slope instability and water quality hazards, the proposal has palpable environmental soil and water quality risks which could be impractical to reduce over the long term to acceptable levels, or will be very expensive to install, expensive to maintain and expensive to decommission

Greg Chapman

Director, Land and Soil Capability

29th March 2023

Appendix One. Curriculum Vitae Greg Chapman

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Career:
July 2013 to present: *Owner Land and Soil Capability Consultancy.* Part time soil, land management and ecological consulting and volunteering:
1) Soil and land science advice for contentious issues. In all eight completed cases my advice has been accepted by the NSW Land and Environment Court, or been used as the basis for decisions, including out of court settlement. And,

2) Provision of spatial ecosystem service and resilience science products to assist regional institutions with geographic prioritisation and strategic planning. Clients include Local Land Services, Natural Resources Commission and 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 plan 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.

3) Founding member and inaugural and current secretary of the NSW Soils Knowledge Network- small, elite group of retired and semi-retired soil specialists who disseminate soil extension and knowledge to institutions such as Local Land Services. Organising and running soil refresher training field days, preparing educational videos and position statements.

4) Honorary Science Fellow for the science division of the NSW Department of Planning and Industry. Soil advice; staff technical support; improving Revised Universal Soil Loss equation soil erodibility spatial layers; and assessing impacts on soil condition of National Park and Keyline management regimes. Byado research team member. MemberNSW NPWS Blue Mountains Regional Advisory Committee.

2006- July 2013: *Theme Leader Soil Condition and Land Management MER.* 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 fire and 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 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 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 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 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 specific land capability 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 covered by 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.
- 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 great 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 student. 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.

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

>110 publications, conference presentations and major reports. Focus mostly on soil information application and landscape processes.

President NSW Branch Australian Soil Science Society 2002-2004 and Office bearer 1998-2006

Peer recognition: Certified Practicing Soil Scientist (Since scheme inception. Gaining stage 3 accreditation (highest level obtainable) in January 1999.

President Springwood Bushwalking Club (2004-2007, 2011-2015 and 2021 to March 2023) plus other committee positions.

Recreation: Travel, Gardening, Bushwalking- especially leading multi-day wilderness navigation walks.

Appendix Two. Calculation of Land and Soil Capability for Mass Movement Hazard

10 Assessment of mass movement LSC classes

Table 10.1 shows the assessment table for determining mass movement LSC classes and Table 10.2 presents the results.

Table 10.1 Mass movement LSC class assessment table (OEH 2012)

Mean annual rainfall (mm)	Mass movement present	Slope class (%)	LSC class
<500	No	n/a	1
	Yes	n/a	8
>500	No	n/a	1
	Yes	<20	6
		>20–50	7
		50 or any scree or talus slope	8

Notes: Note that scree or talus slopes go automatically into Class 8

Figure 21 Land and Soil Capability for Mass Movement hazard https://www.iluka.com/iluka/media/balranald-documents/nsw%20eis%20docs/volume-6_balranald-mineral-sands-project-eis_appendix-l-soil-resource-assessment.pdf