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# Soil tests for houses: Thoughts from a practicing classifier

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## A true story

A newly-married couple was attracted to a vacant block of land in a seaside location, and signed a contract to purchase it subject to a satisfactory soil test report. A site classifier engaged by the seller provided the report (which was favourable), the couple bought the land, and subsequently applied for permission from the local regulatory authority to build a new house. The authority, aware that the land was in an area with a history of landsliding, requested that the couple provide an independent geotechnical report stating that the land was capable of supporting residential development. The geotechnical report concluded that the land was at a high risk of slope instability, that development was possible, but that it would be costly. The couple could not afford to proceed with building. They instigated legal proceedings against the classifier. He in turn sought a second geotechnical opinion which, to his dismay, supported the first. The case never got to court: the classifier recognized his culpability and settled the matter by buying the vacant land from the couple. It is still vacant. It emerged in this case that the classifier had not visited the land in question. Instead, he sent a junior assistant to the site who drilled only one test hole and did not recognize the landslide potential of the property.

Soil testing and classification for house sites is specified in Australian Standard 2870, and has been a requirement for all new dwellings and additions to existing dwellings in Australia since about the mid-1990s. Classifications are Class A (rock or sand), Class S, M, H1, H2 and E for clay soils with slight, moderate, high or extreme reactivity, and Class P (Problem sites; for a range of reasons).

The system is working for Tasmania if we can confidently state that since the mid-1990s there is now a lower proportion of new houses and additions with structural defects caused by foundation conditions and footing design. The best people to judge that are engineers, builders, local council personnel, landowners and lawyers.

As a practitioner in this field, and an engineering geologist, I've seen a fair amount of substandard work from fellow classifiers over the years and I have some fairly strong ideas about how site classification should be done and improved. Here are some suggestions for my peers, and the public, which I think are important. They are in no particular order.

## Classification is a difficult job

I think site classification is difficult and challenging to do properly. Each site comes with its own pitfalls, traps and idiosyncrasies. There is no room for complacency or short cuts. Our guard should be up at all times, and our approach to it should be constantly evolving and improving. It goes without saying that people rely on our classifications to make significant financial decisions. The legal implications of mis-classification are equally serious.

## Our site classifications must be professionally defensible.

We should always strive to work in accordance not only with AS2870, but also with our Tasmanian guidelines: *Recommended Practice for Site Classification to AS 2870 in Tasmania* (Institute of Engineers Australia Tasmania Division, May 1996).

Both documents are or should be under revision at all times. Our Tasmanian guidelines state they should be reviewed every 18 months, so we are overdue for a revision. (I was on a committee which produced a draft revision in 2005, but it faltered and was shelved.)

## Site classification should be done by "appropriately qualified professionals"

These people are defined in Section 1.3 of the Tasmanian guidelines as members of the Australian Geomechanics Society who are either Chartered Professional Engineers with specific expertise or engineering geologists with similar expertise. The key here is "specific expertise". Do we all have it? We must stick to what we are reasonably qualified or experienced to do.

For example, I note the guidelines recommend (Clause 2.5) that footing design be done by an "appropriately qualified" engineer. I agree – this is an engineering issue, and I don't venture there. But the site classification process which precedes the design requires the classifier to look at the relationships between soils, rocks, slopes, water and human activities, and surely demands that the professional's "specific expertise" contains more than a smattering of geology. More of this later.

## AS2870 classification should be part of a geotechnical assessment of the site.

This is an important issue. It is implicit in the Australian Standard and our Tasmanian guidelines:

- "*Site classification may require consideration of factors beyond the boundaries of the subject site*." (AS2870 Clause 2.1.1), and

- "*The proposed building site should be visually inspected in the context of its general surrounding to develop an awareness….*" Tasmanian guidelines Clause 2.2.3.

If classifiers can't recognize geotechnical issues such as existing or potential slope instability, tunnel and surface erosion, soil creep, drainage, flooding or waterlogging, effects of vegetation change, low strength soils, on-site wastewater implications, site contamination from former activities, storm surge, sea level rise, riverbank erosion – as well as reactive soils – we are not properly doing our job. What possible benefit is a Class M classification if the property is on high-risk unstable ground but the classifier failed to recognise the issue?

I think classifiers have a duty of care to provide clients with a statement not only of site classification, but with one of general geotechnical risk. I developed and routinely embody geotechnical risk in a single, standard table accompanying each site classification. The table:

- lists a range of typical geotechnical issues,
- assesses the likelihood of the issue occurring,
- categorises the consequences to property (and life if necessary),
- categorises the level of risk, and
- suggests risk management actions (if any)

This approach is in accordance with AS/NZS4360 2004 (Risk Management) and is set out clearly in the Australian Geomechanics Society publication: Landslide Risk Management *Australian Geomechanics 42*(1) March 2007.

Of course, we are relieved of the need to address geotechnical risks if they have previously been investigated. But the reverse may be the case: often, I am called in by a local Council to provide a geotechnical report after someone else has done a site classification.

## Tasmanian geological conditions are complex and variable

We acknowledge that in some parts of the world foundation conditions can remain essentially unchanged over tens, if not hundreds, of square kilometers. In Tasmania, expect the opposite: foundation conditions often change dramatically over tens of metres, over the footprint of a house. These situations are much more common that we might think.

I would suggest that probably 5 – 10% of Tasmanian house footprints straddle geological boundaries, but more importantly probably 10 – 20% of house footprints straddle more than one AS2870 site classification.

Despite the suggestion in Clause 2.4.4(a) of AS2870, in Tasmanian conditions a single test hole per house is highly risky, since it cannot possibly show lateral variability. The more holes that are dug, the more variability is found.

Between about 30 – 50% of the sites I investigate are Class P – mainly because of subsurface variability arising from natural processes, or cut and fill. For these sites, Class P should be viewed as a good classification which flags sensitive conditions.

## Classification requires inspection by an "appropriately qualified professional"

Because of Tasmania's inherently variable site conditions, it is very risky to rely on site information provided by people who are not "appropriately qualified professionals", or who are not supervised in the field by them.

It is acceptable, of course, to engage others to drill holes, dig test pits, sample soils or do related work, but if you are signing the classification report you or another "appropriately qualified professional" must be present and must supervise. Unqualified people can miss important site features.

## Use the latest geological maps and other information

Classifiers should be able to properly interpret geological maps and engineering geology and geotechnical reports. And we should stay up to date, because geological interpretations change, and maps are revised. For example, large parts of metropolitan Hobart previously mapped as dolerite bedrock are now recognized as Tertiary unconsolidated sediments, with different implications for site classification. We also now have newer, 1:25,000 digital geological maps for most of Hobart, Launceston, Devonport, Burnie, Ulverstone and Wynyard. Check with Mineral Resources Tasmania.

Other information may be available. For example, geotechnical reports are routinely prepared for residential subdivisions. Many Councils (in particular Hobart, Glenorchy, Clarence, Huon Valley, Sorell, Derwent Valley) routinely request geotechnical and/or wastewater reports for all new subdivisions. These Councils have their own guidelines for reporting. People like me do the reports, which usually contain general information on AS2870 site classification. If you are classifying sites, check first to see if there is a geotechnical or domestic wastewater report already available to assist you.

## Issues of job costing

**Resist the temptation to quote for a site classification**

Quoting implies a classifier is certain or complacent about an individual site before visiting it.

Being restricted to a firm price might also mean the classifier will be reluctant to spend extra time and effort when it is needed. This is not only a disservice to the client, it may in turn increase the risk of a wrong classification.

**Resist the temptation to set a fixed price for all site classifications**

To me, this implies a classifier is certain or complacent about all sites.

The only thing certain about site classification is that every site is different. Being restricted to a common price might also mean the classifier will be reluctant to spend extra time and effort when it is needed. This is not only a disservice to the client, it may significantly increase the risk of wrong classifications.

**Set a realistic cost estimate for each classification**

The cost estimate ought to be flexible enough to enable you to professionally carry out the requirements of AS2870 and our Tasmania guidelines.

Site classification investigations might typically include all or some of the following expenses. Most are variable costs, so how is it possible to work on a fixed price and still do the things the Standard and guidelines recommend?

- Travel time from office to job and return ($/hr)
- Mileage from office to job and return ($/km)
- On-site consultancy time ($/hr)
  (discussions with client; site and near site inspection of topography, soils, drainage, geology; site mapping and photography; siting, location, logging,

photography, undisturbed drive tube and disturbed bulk sampling of test holes; hand augering, penetrometer testing, etc…)

- Excavator, backhoe, bobcat or rig hire, including establishment and/or min. fee ($)
- Underground cable location services ($/job, but sometimes also $/km)
- Laboratory soil testing ($/sample)
- Reporting time ($/hr)

  (including the preparation of location and geological maps, site plan, logs of test holes and/or summary table of test hole logs, notes on geological interpretation of site, compilation and interpretation of shrink/swell test results and calculation of ground surface movement; compilation of dispersion testing, compilation of geotechnical risk table; site photos and captions, classification certificate, wind classification….)

## Select appropriate investigation techniques

The Tasmanian guidelines recommend excavator test pitting as the preferred method of subsurface investigation. How many of us are doing this?

As an engineering geologist I've logged thousands of machine-excavated test pits and auger/drill holes around Tasmania. Where access permits, test pits are best. They can cause site disturbance and may sometimes be depth-limited, but these disadvantages can be overcome and are far outweighed by the advantages – superior visual exposure of materials; ease of examination, testing and sampling; ability to obtain a photographic record of the subsurface; much less risk of misinterpreting material origins, types and relationships. But forget test pitting if you are into low-cost classifications.

The Tasmanian guidelines suggest the routine collection of undisturbed drive tube or bulk samples. How many of us are doing this? My company routinely does.

The same guidelines recommend that cohesive soil samples should be laboratory tested using AS1289 to derive Shrink/Swell and Instability Indices for the soil. How many of us are doing this? My company routinely does.

## Resist the temptation to be overly conservative in classification or footing design

Being overly conservative in classifying a site ("Just classify it up a notch, from Class M to Class H1") might mean we can't be bothered, or haven't budgeted for, enough investigations to refine the classification. It may also add extra to the costs of footings. Being overly conservative in footing design might mean we're trying to conceal a suspect classification.

## Ensure reports are thorough

The Tasmanian guidelines set out the scope for site classification reports, but are classifiers thorough enough?

As well as classifying a building site, I think it's important for reports to also explain why the particular classification was made, and to contain clear comments about what subsurface conditions a builder, architect or owner might expect to find when a site is prepared for footings. Statements should be made about how a classification may need to change depending on how the site is excavated or filled.

The locations of test pits or auger holes must be accurate in relation to the house site and recognisable property features (eg boundaries). GPS coordinates may not be an accurate enough way of recording test hole locations.

To assist stakeholders, reports may contain, as attachments, explanatory sections of AS2870 (with permission of Standards Australia) and any other relevant guidelines or information bulletins such as the series of Geoguides made available free of charge by the Australian Geomechanics Society.

## A site classification should only apply to a defined location

Subsurface conditions can change dramatically over very short distances. Indicate on a site plan the area within which the site classification refers. Building outside the envelope ought not to be covered by the classification.

## Where to from here in Tasmania?

- Review and if necessary revise the Tasmanian guidelines?
- Is accreditation needed for classifiers?
- Is education on site classification and management needed for architects, builders, conveyancing lawyers?
- Is education/information on site management getting to new home owners? If so, what happens to the information when a house is sold?
- General flow chart of site investigations needs to be drawn up by local Councils so homeowners know what geotechnical-related reports are needed, and when they are required, in the development process.
- Regulatory authorities including local, state and federal government departments should make geotechnical information available to site classifiers and other stakeholders (ie to everyone).