Appendix D. Report on Geological Logging of Diamond Drill Core

REPORT ON GEOLOGICAL LOGGING OF DIAMOND DRILL CORE FROM THE PROPOSED ARMIDALE LANDFILL SITE

For

E.A. Systems Pty Ltd

Purchase Order 2945

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OBJECTIVES

A 26 metre vertical borehole had been drilled at the site of the proposed new landfill for the Armidale Dumaresq Council for E.A. Sytems Pty Ltd (EAS). The borehole is at grid reference 383471.27 mE, 6619105.1 mN and had been cored from 5 m to 26 m, with the top 5 m not being cored due to it being weathered and soft, leading to poor to nil recovery. EAS sought professional geological logging of the drill core, with reference to identification of rock type, structures that might have geotechnical implications (e.g. groundwater migration, site stability) and weathering effects.

GEOLOGICAL SETTING

The general site of the proposed landfill site is approximately 12 km ESE of Armidale. According to the 1:250 000 geological map of the region (Gilligan et al., 1992), the proposed landfill site is underlain by Late Palaeozoic deep marine sedimentary rocks of the Girrakool Beds, but close to the contact with the nearby Sandon Beds. The latter sequence is also largely deep marine sedimentary in character and of Late Palaeozoic age. Both of these rock units are composed largely of low grade metamorphosed greywacke, mudstone and chert and have been folded (Gilligan et al., 1992). As a consequence of folding, it is common for the rock sequence to be steeply dipping. The proposed landfill site is in an undulating landscape on the New England plateau and weathering has affected all rocks types. It is common to have weathering effects manifest to depths of metres to tens of metres on the plateau.

METHODS

The drill core was provided on December 5, 2005 and was subsequently logged in detail on December 5-6. The 21 m of core was logged for rock types, weathering phenomena and structures. Photographs were taken of whole trays of core as well as specific rock types and structures.

RESULTS

A detailed drill core log for the interval from 5 m to the end-of-hole at 26 m is displayed in Appendix 1. Photographs of each of the core trays containing 5 m intervals are shown in Appendix 2.

Rock types

The core contains two primary rock types. The somewhat more dominant one is a medium grained, rather massive **greywacke** (quartz-feldspar-lithic sandstone). Original detrital grains are up to 0.5-1 mm across, are tightly packed and the rock is not porous. Where fresh, the rock is grey in colour, with a slightly greenish tinge. Apart from the detrital components (quartz, feldspar, lithic grains), the rock probably has a small amount of low grade metamorphic derived chlorite and sericite. The other rock type is similar, but is characterised by containing scattered to abundant larger lithic grains, typically up to 5 mm – 20 mm across (Fig. 1). Lithic grains are commonly angular and are composed of dark grey, fine grained sedimentary rock, e.g. mudstone. Because of the conspicuous presence of these larger mudstone lithic grains, this rock type is termed **“mud chip greywacke”** and is shown as such on the drill log.

The mud chip greywacke is much the same colour as the fine grained greywacke when fresh. Contacts between the two rock types are commonly difficult to discern, as they are probably rather diffuse. Intervals of mud chip greywacke range from about 15 cm to nearly 3 m in thickness. At approximately 8.5 m depth, there is a “bleached zone” about 15 cm long in the greywacke. This could represent a small zone of hydrothermal alteration.

Figure 1: Fresh mud chip greywacke at 23.4 m. Dark fine grained angular to elongate mudstone lithic grains are enclosed in a medium grained greywacke matrix, in places containing a few slightly larger pale coloured quartz-rich grains. Blue scale on left hand side has centimetre markings.

Structures

Definite evidence of sedimentary bedding is lacking in the drill core. For example, there are no distinct different sedimentary rock units, or graded bedding. However, there are a few possible thin bedding laminations, marked by thin (<1 cm) finer grained units. These layering effects are steeply dipping, i.e. are shallowly oblique to the core axis. An implication of this observation is that the vertical drill hole would be unable to obtain a significant representative sample of the possible rock types at the site (i.e. a vertical drill hole would intersect a very limited portion of a steeply dipping sequence of rock types).

Much of the greywacke and mud chip greywacke is rather massive and homogeneous. However, in places, a weak foliation is evident. This is due to tectonic effects imposed on the rock when it was deeply buried in the crust of the earth. Foliation is defined by development of a weak cleavage in places and by preferred orientation and elongation of mud chips (Figs 2 and 3). Foliation is always at a low to moderate angle to the core axis (Figs 2 and 3), implying that it is steeply dipping.

Figure 2: Weathered mud chip greywacke at 14.2 m showing zone of foliation to the right of the coin.

Figure 3: Slightly weathered mud chip greywacke at 13.4 m showing weak foliation defined by preferred orientation of elongate dark mudstone fragments.

Rare thin veins of quartz have been observed in the core. They are sub-planar, less than 1 cm thick and are at low to moderate angles to the core axis, implying that they are steeply dipping.

Planar to arcuate and irregular fractures are common in the core. They are slightly more abundant where weathering effects are stronger. Fracturing has occurred after the formation of foliation. There are two main orientations of fractures. One, interpreted to be earlier, is typified by steeply dipping fractures (i.e. at low angles to the core axis – generally <20°). These fractures may be co-planar with the foliation. A second fracture set is typified by fractures at a moderate to high angle to the core axis (e.g. 50°-90°). This fracture set is interpreted to be later and could be due to unloading of the rocks due to weathering and erosion as it is sub-planar with the landscape surface. In a few places, there are zones of strong dislocation, resulting in rubbly intervals up to a few tens of centimetres in length. These could be due to multiple intersecting fractures and accentuated by weathering effects. The core exhibits several zones of strong clay alteration as a result of weathering imposed on strongly fractured rock. The clay-rich zones can be up to 10 cm wide (Fig. 4).

Figure 4: Weathered mud chip greywacke and greywacke with several sub-planar to irregular zones of fracturing and strong clay alteration (e.g. to the right of the coin and in the lower left of the image). Coin is located at 12.6 m.

Weathering

The effects of weathering are common in the drill core. It is manifest by brown staining of the rock, due to the presence of iron oxide minerals and the breakdown of rock components to clay. Most of the core displays pervasive weathering to a depth of about 19.5 m, although there is a zone of mud chip greywacke between 16.3-17 m that is little weathered. Below 19.5 m, weathering effects tend to be more limited to zones of stronger fracturing, illustrating the importance of fracturing to allow the migration of shallow oxidising groundwater. Fracture sets commonly display development of clay zones (especially where fracturing is stronger, e.g. Fig. 4) and many fractures throughout the core show thin coatings of black to brown oxides, considered to be of iron and manganese. At about 8.7 m, fractures locally contain yellow-green nontronite clay as well as iron and manganese oxides (Fig. 5).

Figure 5: Weathered massive to weakly foliated greywacke, with prominent sub-planar fractures that are coated with brown iron oxide, black manganese oxide and a little yellow-green nontronite clay (centre). Coin is at approximately 8.7 m.

IMPLICATIONS

As the borehole was vertical, it is unlikely that it has been able to obtain a representative sampling of the steeply dipping sedimentary rocks of the proposed landfill site. Maybe this is of little consequence as it is likely that other rock types to be expected in the district (e.g. mudstone, chert, etc.) would not be greatly different in composition, structure or weathering effects than the greywacke type rocks that were sampled.

No wide zones of major faulting were recognised in the core, but again, the chances of intersecting such structures would be minimised because of the vertical borehole. Most geological faults in the region are near-vertical.

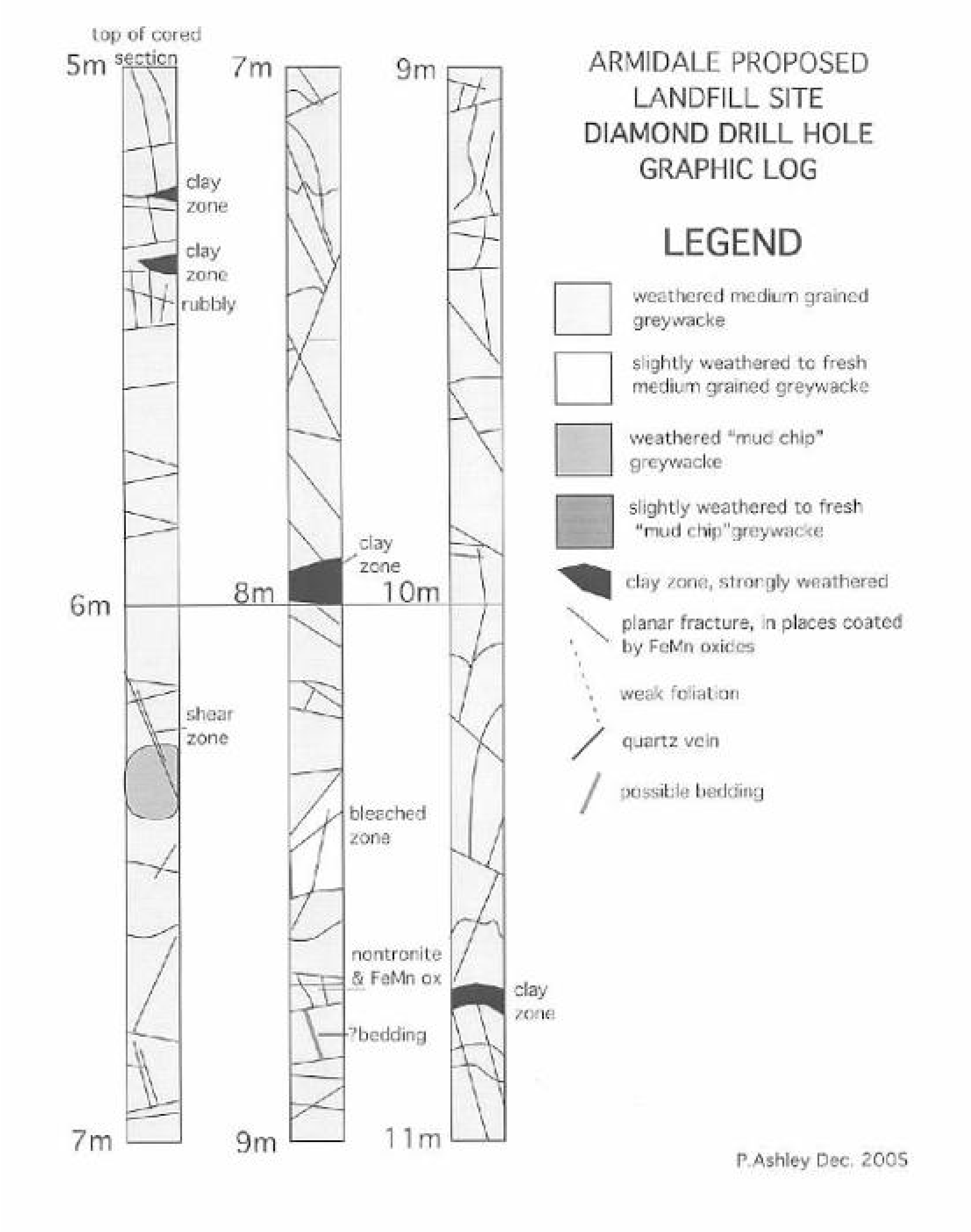
Fracturing and weathering effects observed in the drill core would have implications on the transmission of groundwater and potential leachate from a landfill. The fact that weathering effects in the deeper part of the drill core are concentrated along fractures indicates that oxidising groundwater penetrates at least to the depth of the bottom of the hole (26 m). Zones of strong fracturing and clay development in the weathered zone might have the potential for considerable groundwater transmission.

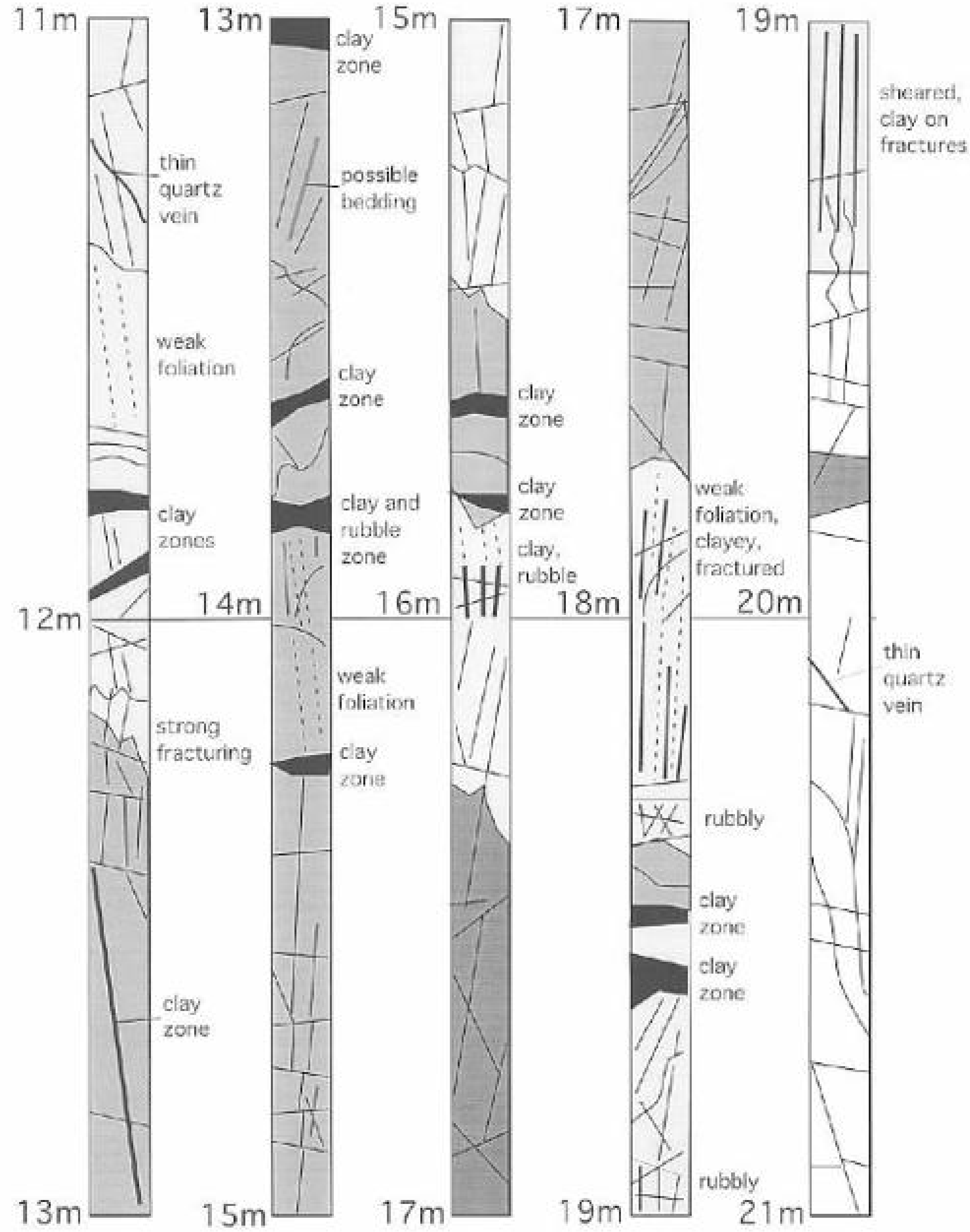
Reference

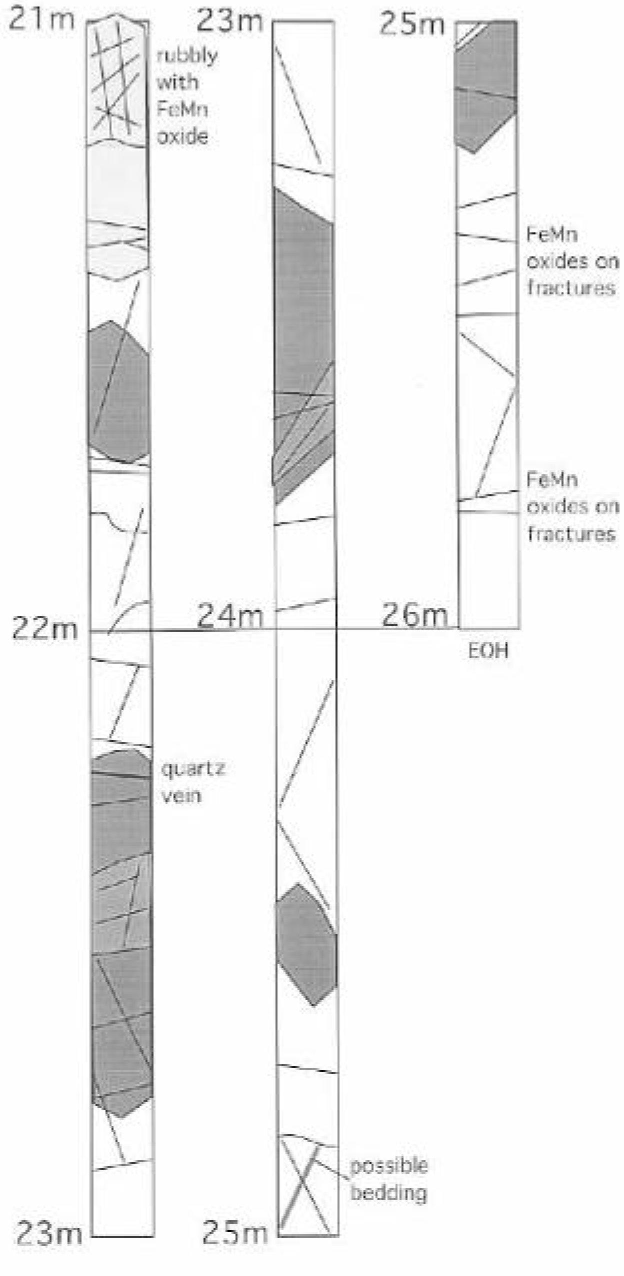
Gilligan, L.B., Brownlow, J.W., Cameron, R.G., Henley, H.F., 1992. Dorrigo-Coffs Harbour 1:250 000 Metallogenic Map. Metallogenic study and mineral deposit data sheets. NSW Geol. Survey, Sydney, 509 pp.

APPENDIX 1

DETAILED DRILL CORE LOG OF VERTICAL DRILL HOLE AT PROPOSED ARMIDALE LANDFILL SITE




11m
12m
13m
thin quartz vein
weak foliation
clay zones
strong fracturing
clay zone
13m
14m
15m
clay zone
possible bedding
clay zone
clay and rubble zone
weak foliation
clay zone
15m
16m
17m
clay zone
clay zone
clay, rubble
17m
18m
19m
weak foliation, clayey, fractured
rubbly
clay zone
clay zone
rubbly
19m
20m
21m
sheared, clay on fractures
thin quartz vein



21m
rubbly
with
FeMn
oxide
22m
quartz
vein
23m
23m
24m
possible
bedding
25m
25m
FeMn
oxides on
fractures
FeMn
oxides on
fractures
26m
EOH

APPENDIX 2

PHOTOGRAPHS OF DRILL CORE
NOTE: INTERVAL FROM 0-5 m WAS NOT RECOVERED

Interval 5-10 m

Interval 10-15 m

Interval 15-20 m

Interval 20-26 m