AS 1726:2017
Geotechnical Site Investigations

Michael Gawn – Principal
(Newcastle)
New Standard

Geotechnical site investigations

AS 1728:2017

Australian Standards

Douglas Partners
Geotechnics | Environment | Groundwater
AS 1726:2017 Geotechnical Site Investigations

• Contents of Presentation
  – So What’s Different
  – Changes to DP Logging
  – Review of Universal Classification System
  – Rock Logging
  – Additional Logging Changes
  – Implications for Reporting
  – Other important changes to AS1726
  – Useful Spreadsheets for Logging
  – Take Home Message
So what’s different?

- Previous revision 1993
- Previously the delineation between a coarse material (sand, gravel) and a fine material (clay, silt) was based on the majority rule (ie. If more than 50% above 75 micron = coarse soil)
- Now new boundaries, as follows
  - >65% above 75 micron Sand or gravel
  - >35% below 75 micron Clay or silt

Why? It only takes a relatively small amount of fines to alter the behaviour of the soil
How does this differ from DP Logging?

No difference to boundaries from previously but slight difference to subdivision for sand

<table>
<thead>
<tr>
<th>Fraction</th>
<th>Components</th>
<th>Subdivision</th>
<th>Size * (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oversize</td>
<td>BOULDERS</td>
<td></td>
<td>&gt;200</td>
</tr>
<tr>
<td></td>
<td>COBBLES</td>
<td></td>
<td>63–200</td>
</tr>
<tr>
<td>Coarse grained soil</td>
<td>GRAVEL</td>
<td>Coarse</td>
<td>19–63</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>6.7–19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fine</td>
<td>2.36–6.7</td>
</tr>
<tr>
<td>Coarse grained soil</td>
<td>SAND</td>
<td>Coarse</td>
<td>0.6–2.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
<td>0.21–0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fine</td>
<td>0.075–0.21</td>
</tr>
<tr>
<td>Fine grained soil</td>
<td>SILT</td>
<td></td>
<td>0.002–0.075</td>
</tr>
<tr>
<td></td>
<td>CLAY</td>
<td></td>
<td>&lt;0.002</td>
</tr>
</tbody>
</table>

* These sizes correspond approximately to standard sieve sizes.
## Secondary Constituents and Naming

**AS 1726:2017**

Different thresholds for terminology

DP notes being changed to reflect new code

<table>
<thead>
<tr>
<th>Term</th>
<th>Proportion</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>And</td>
<td>Specify</td>
<td>Clay (60%) and Sand (40%)</td>
</tr>
<tr>
<td>Adjective Slightly</td>
<td>20 - 35%</td>
<td>Sandy Clay</td>
</tr>
<tr>
<td>With some</td>
<td>5 - 12%</td>
<td>Clay with some sand</td>
</tr>
<tr>
<td>With a trace of</td>
<td>0 - 5%</td>
<td>Clay with a trace of sand</td>
</tr>
</tbody>
</table>

**TABLE 2**

<table>
<thead>
<tr>
<th>Terms</th>
<th>% Fines</th>
<th>Terminology</th>
<th>% Accessory coarse fraction</th>
<th>Terminology</th>
<th>% Sand/Gravel</th>
<th>Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>≤5</td>
<td>Add ‘trace clay/silt’ to description, as applicable</td>
<td>≤15</td>
<td>Add ‘trace sand/gravel’ to description, as applicable</td>
<td>≤15</td>
<td>Use ‘trace’</td>
</tr>
<tr>
<td>≥5, ≤12</td>
<td>Add ‘with clay/silt’ to description, as applicable</td>
<td>&gt;15, ≤30</td>
<td>Add ‘with sand/gravel’ to description, as applicable</td>
<td>&gt;15, ≤30</td>
<td>Add ‘with sand/gravel’ to description, as applicable</td>
<td></td>
</tr>
<tr>
<td>Secondary</td>
<td>&gt;12</td>
<td>Prefix soil name with ‘silty’ or ‘clayey’, as applicable</td>
<td>&gt;30</td>
<td>Prefix soil name with ‘sandy’ or ‘gravelly’, as applicable</td>
<td>&gt;30</td>
<td>Prefix soil name with ‘sandy’ or ‘gravelly’, as applicable</td>
</tr>
</tbody>
</table>

**DP Notes**

Different thresholds for terminology

DP notes being changed to reflect new code
Secondary Constituents and Naming

• Previously a soil would become “clayey sand“ for instance with 20% to 35% clay. Now only 12% clay is required to be a “clayey sand”

• Now if a soil has greater than 35% fines it is a fine soil
  – Therefore, a soil with 64% sand and 36% clay is a sandy CLAY not a clayey SAND.
  – This is to try to convey the behaviour of the soil (i.e that amount of clay is going to make it behave like a clay).
Secondary Constituents and Naming

Note: Different thresholds for secondary constituents in coarse as opposed to fine soils.

<table>
<thead>
<tr>
<th>Designation of components</th>
<th>% Fines</th>
<th>Terminology</th>
<th>% Accessory coarse fraction</th>
<th>Terminology</th>
<th>% Sand/gravel</th>
<th>Terminology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minor</td>
<td>≤5</td>
<td>Add ‘trace clay/silt’ to description, as applicable</td>
<td>≤15</td>
<td>Add ‘trace sand/gravel’ to description, as applicable</td>
<td>≤15</td>
<td>Use ‘trace’</td>
</tr>
<tr>
<td></td>
<td>&gt;5, ≤12</td>
<td>Add ‘with clay/silt’ to description, as applicable</td>
<td>&gt;15, ≤30</td>
<td>Add ‘with sand/gravel’ to description, as applicable</td>
<td>&gt;15, ≤30</td>
<td>Add ‘with sand/gravel’ to description, as applicable</td>
</tr>
<tr>
<td>Secondary</td>
<td>&gt;12</td>
<td>Prefix soil name as ‘silty’ or ‘clayey’, as applicable</td>
<td>&gt;30</td>
<td>Prefix soil name with ‘sandy’ or ‘gravely’, as applicable</td>
<td>&gt;30</td>
<td>Prefix soil name with ‘sandy’ or ‘gravely’, as applicable</td>
</tr>
</tbody>
</table>

This reflects that it takes a lot more coarse material to change the behaviour of the soil (30% v 12%).
Minor Soil Components

• Terms used is as follows:
• Trace (<5% fines) or (<15% coarse)
• With (>5% to 12% fines) or (>15% to 30% coarse)
• Adjective modifier (eg sandy)
  (>12% fines) or (>30% coarse)

No use of “slightly” or “some”
Examples of Soils

- Sample 11: Sand with clay
- Sample 12: Sandy CLAY
- Sample 13: Sandy CLAY with silt
- Sample 14: CLAY with sand

<table>
<thead>
<tr>
<th>Bore/ Pit</th>
<th>%Silt and clay</th>
<th>%Clay</th>
<th>%silt</th>
<th>%Sand</th>
<th>%Gravel</th>
<th>Description to AS1726:2017</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 11</td>
<td>10%</td>
<td>10%</td>
<td>0%</td>
<td>90%</td>
<td>0%</td>
<td>SAND with clay</td>
<td>SP/SC</td>
</tr>
<tr>
<td>Sample 12</td>
<td>35%</td>
<td>35%</td>
<td>0%</td>
<td>65%</td>
<td>0%</td>
<td>Sandy CLAY</td>
<td>CL, CI or CH</td>
</tr>
<tr>
<td>Sample 13</td>
<td>60%</td>
<td>50%</td>
<td>10%</td>
<td>40%</td>
<td>0%</td>
<td>Sandy Clay with silt</td>
<td>CL, CI or CH -see note 2</td>
</tr>
<tr>
<td>Sample 14</td>
<td>80%</td>
<td>80%</td>
<td>0%</td>
<td>20%</td>
<td>0%</td>
<td>CLAY with sand</td>
<td>CL, CI, CH, ML or MH</td>
</tr>
</tbody>
</table>
Naming

• Primary Component in BLOCK LETTERS
• Secondary component included in name if over secondary threshold
• Minor components added after name

  – Eg Clayey SAND with trace gravel
Determining Fine Content

• If hydrometers done then use them
• If Atterberg done use the following rule
  – Above A line clay
  – Below A line silt
• If neither done then use tactile assessment for clay/silt – use water!
Plasticity

- Terms
  - Non plastic
  - Low plasticity
  - Medium plasticity
  - High plasticity

Note: Medium not Intermediate
Moisture Condition

• **Coarse Soils**
  – Only three terms used, as follows:
    • Dry
    • Moist
    • Wet
  – No use of “humid” or “saturated”

• **Fine Soils**
  – Moist, dry of plastic limit (w<PL)
  – Moist, near plastic limit (w≈PL)
  – Moist, wet of plastic limit (w>PL)
  – Wet, near liquid limit (w ≈LL)
  – Wet, wet of liquid limit (w>LL)

• Use textural test in the field (i.e roll a 7 mm long thread)
Group Symbol Classifications

• Two characters system
  • Primary Classifier (i.e. first letter)
    – (G,S,M or C for Gravel, Sand, Silt or Clay)
  • Secondary Classifier (i.e. second letter)
    – (Coarse Soils)
      • Reflect grading (W or P for well or poorly graded)
      • Or Fine content (C, M or O for clay, silt or organic)
  • Secondary Classifier (i.e. second letter)
    – (Fine Soils)
      • Reflect plasticity (L, I or H for low, intermediate or high)
      • Note silt only uses L or H (no I)
# Classifications

## Coarse Soils

**Gravel Dominated Soils**
- GW – well graded gravel
- GP – poorly graded gravel
- GM – gravel-silt mixture
- GC – gravel-clay mixture

**Sand Dominated Soils**
- SW – well graded sand
- SP – poorly graded sand
- SM – sand-silt mixture
- SC – sand-clay mixture

*Note: Fines contents between 5% and 12% to have dual classification – e.g. GP-GM*
### Classification of Fine Grained Soils

<table>
<thead>
<tr>
<th>Major divisions</th>
<th>Group symbol</th>
<th>Typical names</th>
<th>Field classification of silt and clay</th>
<th>Laboratory classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fine grained soils (more than 35% of soil excluding oversize fraction is less than 0.075 mm)</td>
<td>SILT and CLAY (low to medium plasticity, %)</td>
<td>ML</td>
<td>Inorganic silt and very fine sand, rock flour, silt or clayey fine sand or silt with low plasticity</td>
<td>None to low</td>
</tr>
<tr>
<td></td>
<td>CL, CI</td>
<td>Inorganic clay of low to medium plasticity, gravelly clay, sandy clay</td>
<td>Medium to high</td>
<td>None to slow</td>
</tr>
<tr>
<td></td>
<td>OL</td>
<td>Organic silt</td>
<td>Low to medium</td>
<td>Slow</td>
</tr>
<tr>
<td></td>
<td>SILT and CLAY (high plasticity)</td>
<td>MH</td>
<td>Inorganic silt</td>
<td>Low to medium</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CH</td>
<td>Inorganic clay of high plasticity</td>
<td>High to very high</td>
</tr>
<tr>
<td></td>
<td></td>
<td>OH</td>
<td>Organic clay of medium to high plasticity, organic silt</td>
<td>Medium to high</td>
</tr>
<tr>
<td></td>
<td>Highly organic soil</td>
<td>Pt</td>
<td>Peat, highly organic soil</td>
<td>—</td>
</tr>
</tbody>
</table>

**Silt Dominated Soils**
- ML – low plasticity silt
- MH – high plasticity silt
- OH – organic silt

**Clay Dominated Soils**
- CL – low plasticity clay
- CI – medium plasticity clay
- CH – high plasticity clay
- OH – organic clay of medium to high plasticity

**Pt – peat**
Rock Classification

• Changes in strength characterisation
  – Removal of extremely low strength
  – Material with a strength less than very low should be described as a soil but any rock structure noted.
  – UCS categories included (using a ratio of 20:1 with point load index)

• Classification Symbols – same as used by DP (without EL)
## Rock Weathering

### Classification of Material Weathering

<table>
<thead>
<tr>
<th>Term</th>
<th>Abbreviation</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual Soil (Note 1)</td>
<td>RS</td>
<td>Material is weathered to such an extent that it has lost its characteristic properties. Mass structure and fabric of original rock are still visible.</td>
</tr>
<tr>
<td>Extremely Weathered (Note 1)</td>
<td>XW</td>
<td>Material is weathered to such an extent that it has lost its characteristic properties. Mass structure and fabric of original rock are still visible.</td>
</tr>
<tr>
<td>Highly Weathered (Note 2)</td>
<td>HW</td>
<td>The whole of the rock mass is weathered, so that the colour of the original rock is not recognizable. Rock strength has been reduced by weathering.</td>
</tr>
<tr>
<td>Distinctly Weathered (Note 2)</td>
<td>DW</td>
<td>The whole of the rock mass is weathered, so that the colour of the original rock is not recognizable, but shows little or no change of strength from fresh rock.</td>
</tr>
<tr>
<td>Moderately Weathered (Note 2)</td>
<td>MW</td>
<td>Rock is partially discoloured with staining or bleaching along joints but shows little or no change of strength from fresh rock.</td>
</tr>
<tr>
<td>Slightly Weathered</td>
<td>SW</td>
<td>Rock shows no sign of decomposition of individual minerals or colour changes.</td>
</tr>
<tr>
<td>Fresh</td>
<td>FR</td>
<td></td>
</tr>
</tbody>
</table>

**REMEMBER:** RMS (NSW) has its own weathering classification system
Material with strength less than “Very Low” shall be described using soil characteristics. The presence of the original rock structure, fabric or texture should be noted, if relevant.
Additional Logging Changes

• DP carried out extensive review of AS1726 (Grahame Wilson), with changes to DP procedures agreed to by Board.

• DP review of Field Procedures Manual (to be released soon)
  - Part A – Introduction and Fundamentals (principles of soil/rock behaviour)
  - Part B – Collection (how we record data)
  - Part C – Data Entry (gINT, DigiPen)
  - Part D – Presentation (how data is to be presented)

• Log templates being amended (to suit new code and DigiPen usage)
  - No longer double up of strength graphic and description
  - Changes to descriptors (pale rather than light)
  - Main soil type in uppercase, not both (e.g., clayey SAND)

• Soil origin is required to be interpreted. If in doubt use 'possibly' or 'probably'.

• Code gives examples of soil description
  - (SP Sand, trace silt, grey, medium grained, medium dense; dry; marine; Tomago Sand Beds)

Terms not supported by AS 1726:2017
Reporting Implications

• Literature review required (ie. Previous projects, published mapping, etc)
• Don’t forget historical aerial photos and 1974 Orthophotos – excellent resource
• Code requires that a ‘geotechnical model shall be developed for every geotechnical site investigation’

**Figure 8: Slope stability analysis results**
Other Changes

• New Code has a whole section of material alteration (extremely, highly, moderately and slightly) with abbreviations. This is based on visual assessment
• It has good guidance on description of defects
  – Situation by situation. Some circumstances it is important to describe each joint/defect (ie. Unfavourable joints in excavation face)
  – Other circumstances generalisation of defects may be better to provide geotechnical model (eg foundation design)
  – Terms such as “joint spacing is typically 100 mm to 300mm and most joints traces less than 100 mm”
Other Changes

• Has a more geological approach to jointing with good descriptions around dip, dip direction and strike
• Roughness (with roughness counts, waviness, etc)
## Soil Classification Spreadsheet

Enter details and copy percentage passing from lab results

### Percentage Passing

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>75.000</th>
<th>53.000</th>
<th>37.500</th>
<th>26.500</th>
<th>19.000</th>
<th>15.000</th>
<th>12.500</th>
<th>9.000</th>
<th>6.000</th>
<th>4.000</th>
<th>2.000</th>
<th>1.000</th>
<th>0.500</th>
<th>0.200</th>
<th>0.100</th>
<th>0.050</th>
<th>0.025</th>
<th>0.010</th>
<th>0.005</th>
<th>0.003</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>98%</td>
<td>100%</td>
<td>98%</td>
<td>98%</td>
<td>96%</td>
<td>99%</td>
<td>98%</td>
<td>84%</td>
<td>80%</td>
<td>74%</td>
<td>61%</td>
<td>51%</td>
<td>40%</td>
<td>31%</td>
<td>24%</td>
<td>3%</td>
<td>23%</td>
</tr>
</tbody>
</table>

Enter Atteberg results, if any

### Atterberg Testing

<table>
<thead>
<tr>
<th>LL</th>
<th>66</th>
<th>60</th>
<th>13</th>
<th>58</th>
</tr>
</thead>
<tbody>
<tr>
<td>PL</td>
<td>30</td>
<td>10</td>
<td>13</td>
<td>36</td>
</tr>
<tr>
<td>PI</td>
<td>36</td>
<td>50</td>
<td>6</td>
<td>20</td>
</tr>
</tbody>
</table>
## Soil Classification Spreadsheet

### Grading Results and Logging to AS1726:2017

<table>
<thead>
<tr>
<th>Bore Pt</th>
<th>Depth</th>
<th>Nativity</th>
<th>Friability</th>
<th>%Silt and clay</th>
<th>%Clay</th>
<th>%silt</th>
<th>%Sand</th>
<th>%Gravel</th>
<th>Description to AS1726:2017</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>3006</td>
<td>0.3</td>
<td>Yes</td>
<td>Yes</td>
<td>42%</td>
<td>24%</td>
<td>13%</td>
<td>36%</td>
<td>21%</td>
<td>Sandy/Silty Clay with gravel</td>
<td>CH</td>
</tr>
<tr>
<td>4002</td>
<td>0.5 - 0.8</td>
<td>Yes</td>
<td>Yes</td>
<td>32%</td>
<td>18%</td>
<td>14%</td>
<td>68%</td>
<td>0%</td>
<td>Clayey SAND</td>
<td>SC</td>
</tr>
<tr>
<td>1</td>
<td>1.2 - 1.5</td>
<td>Yes</td>
<td>Yes</td>
<td>14%</td>
<td>1%</td>
<td>13%</td>
<td>57%</td>
<td>43%</td>
<td>Silty/Sandy GRAVEL with trace clay</td>
<td>GM</td>
</tr>
<tr>
<td>4008</td>
<td>0.4</td>
<td>No</td>
<td>No</td>
<td>33%</td>
<td>-</td>
<td>22%</td>
<td>44%</td>
<td>23%</td>
<td>Silty/Clayey SAND with gravel</td>
<td>SN/SC</td>
</tr>
<tr>
<td>SP1</td>
<td>1</td>
<td>Yes</td>
<td>No</td>
<td>83%</td>
<td>34%</td>
<td>-</td>
<td>-</td>
<td>17%</td>
<td>Clayey Silty with sand</td>
<td>ML or MH - see note 2</td>
</tr>
<tr>
<td>SP2</td>
<td>1</td>
<td>No</td>
<td>Yes</td>
<td>30%</td>
<td>-</td>
<td>80%</td>
<td>2%</td>
<td>80%</td>
<td>Sandy/Clayey Silty with trace gravel</td>
<td>MH</td>
</tr>
<tr>
<td>SP3</td>
<td>0.5</td>
<td>No</td>
<td>No</td>
<td>23%</td>
<td>-</td>
<td>63%</td>
<td>2%</td>
<td>7%</td>
<td>Silty/Clayey SAND with trace gravel</td>
<td>SN/SC</td>
</tr>
</tbody>
</table>

1. Clay and silt fractions unknown (could be CL, CL, or ML)

2. Where no Atterberg testing, use tactile assessment for plasticity

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### Plasticity Curve

- Provides Soil portions
- Give soil description and Unified Soil Classification
- Present data with comments on lab testing
- Grading proportions

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**Notes:**
- CL: Clayey
- LC: Loamy Clay
- ML: Muddy Loam
- CH: Clean Clay
- CR: Clayey Sand
- SL: Silt Loam
- SM: Muddy Sand
- GR: Gravelly Sand
- CH: Clean Sand
- MH: Muddy Horizons
- CL: Clayey horizons
- CL: Clayey horizons
- ML: Muddy Loam
- CH: Clean Clay
- CR: Clayey Sand
- SL: Silt Loam
- SM: Muddy Sand
- GR: Gravelly Sand
- CH: Clean Sand
- MH: Muddy Horizons
<table>
<thead>
<tr>
<th>Depth</th>
<th>Elevation</th>
<th>Unit</th>
<th>Axial Value</th>
<th>Diametral Value</th>
<th>Estimated UCS Sandstone</th>
<th>Estimated UCS Siltstone</th>
<th>Ultimate End Bearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.38</td>
<td>19.02</td>
<td>1</td>
<td>0.04</td>
<td></td>
<td>0.66</td>
<td>3.00</td>
<td>0.5</td>
</tr>
<tr>
<td>2.46</td>
<td>19.02</td>
<td>1</td>
<td>0.07</td>
<td></td>
<td>1.14</td>
<td>5.14</td>
<td>0.8</td>
</tr>
<tr>
<td>2.46</td>
<td>19.04</td>
<td>1</td>
<td>0.05</td>
<td></td>
<td>0.79</td>
<td>4.27</td>
<td>0.6</td>
</tr>
<tr>
<td>2.53</td>
<td>18.94</td>
<td>1</td>
<td>0.14</td>
<td></td>
<td>2.38</td>
<td>7.40</td>
<td>1.7</td>
</tr>
<tr>
<td>2.53</td>
<td>18.97</td>
<td>1</td>
<td>0.18</td>
<td></td>
<td>3.96</td>
<td>9.55</td>
<td>2.8</td>
</tr>
<tr>
<td>3.03</td>
<td>18.97</td>
<td>1</td>
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 Colour codes rock class (based on Pells et al) and using strength only – must consider defects/seams

Calculate estimated UCS and ultimate end bearing

Input depth, Unit, Rock Type and PL values

Enter UCS/PL ratio and adopted multiplier (guidance in box)

Provide range of estimated UCS based on common ratios
Take Home Message

• It doesn’t take a lot of fines to make a soil “fine grained”. This reflects soil behaviour
• Extremely low strength rock should be logged as soil or ‘extremely weathered (name of parent rock)’
• Pay attention to gradings and PIs (roll threads in field – take spray bottle)
• DP logging sheets and DP Field Procedure Log section of Company Manual being changed (out soon)
• New Code is a good recourse for Geo/Env Engineers
That’s all!

Thanks to the following people who are driving and assisting in the innovations to our procedures:

Grahame Wilson
Will Wright
Tim Swavley
Heidi Sirianni