Audit of WA agricultural lime quality 2013

Chris Gazey
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Supporting your success
Audit of WA agricultural lime quality 2013

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Natural limesand deposits are mined and used as agricultural lime.

Cover photo: Agricultural lime in a south coast paddock ready for spreading.
Acknowledgements

The 2013 agricultural lime quality audit was supported by the Department of Agriculture and Food, Western Australia through funding from the Australian Government’s Caring for our Country.

The audit of lime quality is in collaboration with Lime WA Incorporated, a group of accredited lime suppliers operating under the association’s Agricultural Lime Industry Code of Practice. We would like to thank the members for their continued commitment to providing accurate product information.
Naturally occurring limestone is crushed and screened to produce agricultural lime.
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Inland deposits of dolomitic lime are crushed and screened for use as agricultural lime.
Neutralising value and particle size distribution (fineness) are significant factors of lime quality.

This independent audit of lime quality allows farmers to confidently calculate the most appropriate and cost-effective lime for their individual situation.

Applying agricultural lime is the most economical way of ameliorating low soil pH in broadscale agriculture in Western Australia (WA). In WA, agricultural lime is usually limesand from coastal sand dunes, crushed limestone from coastal deposits or crushed dolomitic lime (usually marketed as dolomite) from old lake and inland drainage systems. Other sources are Cretaceous chalk and lake bed marls.

WA agriculture is well serviced by lime suppliers, although the quality of lime varies markedly around the State, and cost does not always reflect quality as measured by neutralising value and fineness. Neutralising value and particle size distribution (fineness) are significant factors of lime quality which govern the amount and rate of pH change in the soil over the short term (six months to a few years).

Both suppliers and purchasers of agricultural lime need to have a good knowledge of the product. Liming-rate recommendations to farmers usually assume high neutralising value lime. Farmers need to know the neutralising value of the lime they are using in order to accurately calculate the appropriate application rate and avoid under-liming. The cost of lime should be considered in terms of the cost per tonne (t) of neutralising value (delivered and spread).

Members of the Lime WA Incorporated group of independent lime suppliers in WA (limewa.com.au) operate under a voluntary industry code of practice and provide a standard product information sheet with a detailed product description that allows farmers to compare cost effectiveness. Although Lime WA Inc. members represent approximately 70% of the industry, non-member suppliers are not obliged to provide standard product descriptions and the level of information available to farmers is inconsistent.

At the request of Lime WA Inc. and to assist WA farmers in cost-effectively managing soil acidity, the Department of Agriculture and Food, Western Australia (DAFWA) conducts an independent audit of the quality of lime supplied by Lime WA Inc. members every two to three years. This independent audit of lime quality validates the Lime WA Inc product information sheets and allows farmers to confidently calculate the most appropriate and cost-effective lime for their individual situation.

This 2013 audit report replaces DAFWA bulletin 4830, Audit of WA agricultural lime quality 2011.
Methods

Sampling
All 19 Lime WA Inc. member lime pits were sampled in April 2013 by DAFWA soil scientists. Approximately 20 samples, of lime were collected from the working face or current stockpile of each lime source using a long handled trenching shovel (31 centimetres (cm) long, 9cm wide 1–6cm deep), giving a total of about 15 kilograms (kg) of lime (Figure 1). This collection method is quicker and easier on the operator than cores collected using a steel tube and hammer, as for previous audits.

Care was taken to ensure that samples were an accurate representation of the lime at each site (Figures 2 and 3). The bulk sample was thoroughly mixed and divided into two plastic buckets labelled with the survey number assigned to each pit. One was delivered to the ChemCentre laboratory at Curtin University for analysis and the other to Agrifood Technology in Bibra Lake. Site details, pit photographs and GPS coordinates (WGS84) were recorded during the pit visit.

Laboratory analyses
The analytical results presented in this report were determined by the ChemCentre in accordance with the procedures used to test lime samples for the Agricultural Lime Industry Code of Practice. The methods are presented in more detail in the appendix (page 32).

Figure 1 A trenching shovel was used to sample the working face or current stockpile.
Methods (continued)

Figure 2 Samples were taken along the working face of pits, ensuring a representative sample of the lime currently being sold.

Figure 3 Where the lime was crushed and/or sieved before sale, samples were taken from the current stockpile.
Excess hydrogen ions (causing acidic soil) react with carbonate to form water and carbon dioxide.

Ionised calcium binds to soil constituents.

Carbon dioxide is released into the soil air.

Hydrogen ions that were contributing to soil acidity are chemically bound in soil water.

Figure 4 Simplified representation of how lime reacts in soil to treat acidity. There are more-complicated chemical steps in this pathway, but the end result is that the soil has more calcium ions on the exchange surfaces of the soil, carbon dioxide is released into the soil air and hydrogen ions that were contributing to acidity are bound in soil water.
The key indicators of agricultural lime quality are neutralising value and particle size, regardless of the lime source.

Neutralising value (NV)
The carbonate content of limesand, limestone or dolomitic lime determines the capacity of the lime to neutralise acidity. Neutralising value is expressed as a percentage relative to pure calcium carbonate, which is given a value of 100%. With higher neutralising value, lime can be spread over a greater area, or less tonnes per hectare (t/ha) used, for the same pH change (Figure 5).

Particle size
The size of the lime particles determines how quickly the lime can neutralise acid. Lime with a higher proportion of finer particles has a larger surface area to react with the acid in soil. Research shows that finer limes (a high proportion of particles less than 0.5 millimetres (mm)) increase pH faster, which is necessary for rapid amelioration of acidic soil (Figure 6).

Figure 5 Approximately 1.7t/ha of 60% NV lime is required compared to 1.1t/ha of 90% NV lime to achieve the same pH change.

Figure 6 Finer particles of agricultural lime were more efficient in changing soil pH at an application rate of 2.5t/ha (from Cregan et al., 1989).
How to interpret audit results (continued)

Cost effectiveness of limes

When selecting an agricultural lime to treat soil acidity the total cost needs to be considered. This includes the purchase cost at pit, transport cost to paddock and spreading cost; all factors are converted to 100% NV for equal comparison and discounted to allow for differences in particle size and speed of reaction.

Online lime comparison calculator

A useful tool for calculating and comparing the cost effectiveness of agricultural limes is the Lime Comparison Calculator on the Soil Quality website, soilquality.org.au, (Figure 7).

To allow comparison of the total cost per hectare for the equivalent of 100 per cent neutralising value of lime, the Lime Comparison Calculator takes into account:

- cost of the lime
- cost of transport
- cost of spreading
- particle size distribution of the lime
- neutralising value of each particle size

Figure 7 The online lime comparison calculator at soilquality.org.au compares the effective cost of limes.

The neutralising values of larger particle sizes are discounted using the values of Cregan et al. (1989) to account for the reduced capacity to change soil pH in the short term:

- The NV of particles under 0.5mm is not discounted.
- The NV of 0.5–1mm particles is discounted by 50%.
- The NV of particles greater than 1mm is discounted by 80%.
**Long-hand lime comparisons**

The calculations performed by the lime comparison calculator (Figure 4) can be calculated by hand. Using values for lime X from Figure 4:

1. **Calculate the overall per cent efficiency of the lime (EP)**

   \[
   \text{Lime EP} = \text{Sum all individual particle size EP}
   \]

   \[
   \text{EP for the particle size} = \% \text{ of lime} \times \text{neutralising value (NV)} \times \text{particle size discount factor}
   \]

   Lime EP for lime X = 86.9 (Table 1)

   **Table 1 Calculations to determine the lime EP for lime X from Figure 4.**

<table>
<thead>
<tr>
<th>Particle size (mm)</th>
<th>Particle size discount factor</th>
<th>% of lime</th>
<th>NV</th>
<th>Per cent efficiency (EP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–0.125</td>
<td>1</td>
<td>5</td>
<td>90</td>
<td>((\frac{5}{100}) \times 90 \times 1 = 4.5)</td>
</tr>
<tr>
<td>0.125–0.25</td>
<td>1</td>
<td>48</td>
<td>90.5</td>
<td>((\frac{48}{100}) \times 90.5 \times 1 = 43.4)</td>
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<tr>
<td>0.25–0.5</td>
<td>1</td>
<td>38</td>
<td>94.8</td>
<td>((\frac{38}{100}) \times 94.8 \times 1 = 36.0)</td>
</tr>
<tr>
<td>0.5–1</td>
<td>0.5</td>
<td>8</td>
<td>72.1</td>
<td>((\frac{8}{100}) \times 72.1 \times 0.5 = 2.9)</td>
</tr>
<tr>
<td>&gt; 1</td>
<td>0.2</td>
<td>1</td>
<td>62.5</td>
<td>((\frac{1}{100}) \times 62.5 \times 0.2 = 0.1)</td>
</tr>
</tbody>
</table>

   **OVERALL EP = SUM OF PARTICLE SIZE EP = 86.9**

2. **Calculate the costs**

   Costs = lime cost + transport cost + spreading cost

   In this example, the lime costs $10/t and needs to be transported 250 kilometres (km) to the farm at a cost of 10 cents (c)/km. It can be spread for $8/t.

   Costs for lime X = $43/t (Table 2)

   **Table 2 Calculations to determine the costs for lime X from Figure 4.**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost/tonne ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lime</td>
<td>10</td>
</tr>
<tr>
<td>transport (at 10 c/km/t for 250km)</td>
<td>25</td>
</tr>
<tr>
<td>spreading</td>
<td>8</td>
</tr>
</tbody>
</table>

   **SUM OF COSTS = 43**

3. **Calculate the effective cost of lime on paddock**

   Effective cost = \((100 \div \text{EP}) \times \text{costs}\)

   **Effective cost for lime X = \((100 \div 86.9) \times 43 = 49.48\)**

   For a lime with 100% efficiency, the effective cost would be the same as the actual cost. For a lime with an overall percentage efficiency of 50, the effective cost would be twice the actual cost.
Findings of the lime quality audit

Comparison of results from two analytical laboratories
Lime analyses by both the ChemCentre and Agrifood Technologies were not significantly different from each other in any of the parameters measured. The lime industry can have confidence using either laboratory for their routine analyses. In this report, ChemCentre results are presented for the individual pits.

Overview of results
The lime quality indicators of neutralising value and particle size distribution (fineness) varied widely between the pits sampled. Bulk neutralising values ranged from 61.5 to 96.0%. Many limes were comprised almost entirely of fine particles (less than 0.5mm) (Figure 8) while others had a large proportion of coarse particles (greater than 1mm). Most results were within the previously recorded ranges for individual pits.

Figure 8 Limes with a higher proportion of fine particles increase soil pH quicker.
Implications for farmers

Accurate knowledge of lime quality is essential for farmers to calculate appropriate application rates and determine the most cost-effective lime for their situation. The most important consideration for farmers who are liming to maintain appropriate soil pH, is the overall neutralising value of the lime. Lime with a high proportion of fine particle sizes is critical for farmers liming to recover acidic soil to achieve a rapid increase in soil pH.

The most cost-effective lime will depend on transport and spreading costs, as well as lime cost and quality, and will be different for different farms. Larger amounts of lower neutralising value limes need to be used to achieve the same soil pH change so neutralising value becomes more important the further lime needs to be transported.

Recommendations for future audits

The lime pits occur over a wide geographical range and the timing of processing/stockpiling operations are different between pits. Audit-sampling of operational pits over a short period in January and February, before the start of the traditional liming season, is difficult and expensive with return trips to similar areas necessary. The timing of this audit (April) was appropriate to maximise efficiency of collection. To provide timely information to farmers, I recommended that Lime WA Inc. members conduct their routine annual sampling and testing, and present a current product information sheet, as early as practical following the commencement of seasonal operations.

Independent audits are highly valued by farmers; I recommend that independent audit sampling be continued every two years and, in the future, funded by the lime industry. Audit samples should be in addition to the standard Lime WA Inc. annual testing and reporting requirements.
Index to individual pit results

Table 3 Lime WA Inc. agricultural lime pits audited April 2013

<table>
<thead>
<tr>
<th>Supplier</th>
<th>Pit location</th>
<th>Sample ID</th>
<th>Results page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aglime of Australia</td>
<td>Lancelin</td>
<td>CG1301</td>
<td>page 12</td>
</tr>
<tr>
<td>Aglime of Australia</td>
<td>Jurien Bay</td>
<td>CG1305</td>
<td>page 13</td>
</tr>
<tr>
<td>Aglime of Australia</td>
<td>Dongara</td>
<td>CG1307</td>
<td>page 14</td>
</tr>
<tr>
<td>Beaufort River Dolomite</td>
<td>Beaufort River</td>
<td>CG1319</td>
<td>page 15</td>
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<tr>
<td>Carbone Lime</td>
<td>Myalup</td>
<td>CG1314</td>
<td>page 16</td>
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<td>Shire of Denmark</td>
<td>Denmark</td>
<td>CG1317</td>
<td>page 17</td>
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<tr>
<td>Doust Enterprises</td>
<td>Hamelin Bay</td>
<td>CG1316</td>
<td>page 18</td>
</tr>
<tr>
<td>Doyle’s Lime Service</td>
<td>Myalup</td>
<td>CG1311</td>
<td>page 19</td>
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<td>Irwin Limesands</td>
<td>Dongara</td>
<td>CG1309</td>
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<tr>
<td>Jurien Lime Sands</td>
<td>Jurien Bay</td>
<td>CG1303</td>
<td>page 21</td>
</tr>
<tr>
<td>Lake Preston Lime</td>
<td>Myalup</td>
<td>CG1312</td>
<td>page 22</td>
</tr>
<tr>
<td>Midwest Sand Supplies</td>
<td>Geraldton</td>
<td>CG1308</td>
<td>page 23</td>
</tr>
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<td>Redgate Lime</td>
<td>Redgate</td>
<td>CG1315</td>
<td>page 24</td>
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<td>Rules Lime Sand</td>
<td>Lancelin</td>
<td>CG1302</td>
<td>page 25</td>
</tr>
<tr>
<td>Versaci Lime</td>
<td>Myalup</td>
<td>CG1313</td>
<td>page 26</td>
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<tr>
<td>Western Agricultural Lime Co.</td>
<td>Manypeaks</td>
<td>CG1318</td>
<td>page 27</td>
</tr>
<tr>
<td>Watheroo Dolomitic Lime</td>
<td>Watheroo</td>
<td>CG1310</td>
<td>page 28</td>
</tr>
<tr>
<td>Yarra Sands Coolimba</td>
<td>Coolimba</td>
<td>CG1306</td>
<td>page 29</td>
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<td>Yarra Sands Green Head</td>
<td>Green Head</td>
<td>CG1304</td>
<td>page 30</td>
</tr>
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</table>
Index to individual pit results (continued)

- Towns
- Lime pits sampled
- South-west agricultural area

Figure 9 Location of Lime WA Inc. agricultural lime pits audited April 2013
**Individual pit results**

**Aglime of Australia—Lancelin**

**Sample, pit and business information**

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Lancelin</th>
</tr>
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<tbody>
<tr>
<td>GPS coordinates</td>
<td>-31.031398 115.349915</td>
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<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
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<tr>
<td>Sample date</td>
<td>8 April 2013</td>
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<tr>
<td>Sample ID</td>
<td>CG1301</td>
</tr>
<tr>
<td>Business contact</td>
<td>Steve Carr</td>
</tr>
<tr>
<td></td>
<td>1/110 Robinson Ave (PO Box 212), Belmont, WA 6984</td>
</tr>
<tr>
<td></td>
<td>Phone 9277 5529</td>
</tr>
<tr>
<td></td>
<td>Fax 9277 5379</td>
</tr>
<tr>
<td></td>
<td>Mobile 0429 917 742</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:steve@aglime.com.au">steve@aglime.com.au</a></td>
</tr>
<tr>
<td></td>
<td>Web <a href="http://www.aglime.com.au">www.aglime.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>Kim Riley</td>
</tr>
<tr>
<td></td>
<td>Office 9655 1211</td>
</tr>
<tr>
<td></td>
<td>Mobile 0408 092 022 or 0407 774 493</td>
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**Results for sieved sample**

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
<th>Audit sample</th>
<th>3-year pit range</th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
</thead>
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<tr>
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<td>3.8</td>
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<td>Audit sample</td>
<td>3-year pit range</td>
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<td>Audit sample</td>
<td>3-year pit range</td>
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<td>0.250–0.500</td>
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<td>3-year pit range</td>
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<td>3-year pit range</td>
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<td>63.2</td>
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<td>56.0</td>
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<td>3-year pit range</td>
<td>Audit sample</td>
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**Weighted average neutralising value:** 84.0

**Results for bulk sample**

<table>
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<th>Neutralising value (% of pure CaCO₃)</th>
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<th>3-year pit range</th>
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<td>Neutralising value (% of pure CaCO₃)</td>
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<td>86.0–92.2</td>
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<td>Calcium (% of sample)</td>
<td>32.9</td>
<td>32.6–34.1</td>
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<td>Magnesium (% of sample)</td>
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<td>Sodium (% of sample)</td>
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Individual pit results (continued)

Aglime of Australia—Jurien

Sample, pit and business information

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<th>Pit location</th>
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<tr>
<td>GPS coordinates</td>
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<td>Product</td>
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<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
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<td>Sample date</td>
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<td>Sample ID</td>
<td>CG1305</td>
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<tr>
<td>Business contact</td>
<td>Steve Carr</td>
</tr>
<tr>
<td></td>
<td>1/110 Robinson Ave (PO Box 212), Belmont, WA 6984</td>
</tr>
<tr>
<td></td>
<td>Phone 9277 5529  Fax 9277 5379  Mobile 0429 917 742</td>
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<td>Email <a href="mailto:steve@aglime.com.au">steve@aglime.com.au</a>  Web <a href="http://www.aglime.com.au">www.aglime.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>Dave Gartner</td>
</tr>
<tr>
<td></td>
<td>Mobile 0429 882 029</td>
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Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>2.3</td>
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<td>39.6–58.4</td>
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<td>36.1–54.9</td>
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<td>&gt;1.000</td>
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Weighted average neutralising value: 86.8 84.7–94.1

Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
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<td>Magnesium (% of sample)</td>
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Aglime of Australia—Dongara

Sample, pit and business information

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<td>Limesand</td>
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<td>Chris Gazey</td>
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<tr>
<td>Sample date</td>
<td>9 April 2013</td>
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<td>Sample ID</td>
<td>CG1307</td>
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<tr>
<td>Business contact</td>
<td>Steve Carr</td>
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<tr>
<td></td>
<td>1/110 Robinson Ave (PO Box 212), Belmont, WA 6984</td>
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<td></td>
<td>Phone 9277 5529  Fax 9277 5379  Mobile 0429 917 742</td>
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<td>Email <a href="mailto:steve@aglime.com.au">steve@aglime.com.au</a>  Web <a href="http://www.aglime.com.au">www.aglime.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>Neil Smith</td>
</tr>
<tr>
<td></td>
<td>0477 548 805 or 0418 814 561</td>
</tr>
</tbody>
</table>

Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>23.6</td>
<td>7.1–25.3</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>69.0</td>
<td>61.7–84.2</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>7.0</td>
<td>7.0–14.5</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>0.3</td>
<td>0.3–1.2</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1–0.4</td>
</tr>
</tbody>
</table>

Weighted average neutralising value: 95.5

Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
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</thead>
<tbody>
<tr>
<td>Neutralising value (% of pure CaCO$_3$)</td>
<td>95.8</td>
<td>92.6–95.8</td>
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<tr>
<td>Calcium (% of sample)</td>
<td>35.8</td>
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<td>Magnesium (% of sample)</td>
<td>1.7</td>
<td>1.7</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>0.3</td>
<td>0.1–0.3</td>
</tr>
</tbody>
</table>
### Beaufort River Dolomite

#### Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Beaufort River</th>
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<tbody>
<tr>
<td>GPS coordinates</td>
<td>-33.574743 117.052374</td>
</tr>
<tr>
<td>Product</td>
<td>Dolomitic lime</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>12 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1319</td>
</tr>
<tr>
<td>Business contact</td>
<td>Ray Kowald</td>
</tr>
<tr>
<td></td>
<td>299 Leggoe Rd, Beaufort River, WA 6394</td>
</tr>
<tr>
<td></td>
<td>Phone/fax 9862 5014 Mobile 0427 625 014</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:raydenkowald1@bigpond.com">raydenkowald1@bigpond.com</a></td>
</tr>
</tbody>
</table>

#### Pit contact

As above

#### Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>5.4</td>
<td>5.4–10.7</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>9.6</td>
<td>6.9–11.3</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>17.2</td>
<td>10.3–17.2</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>23.8</td>
<td>14.1–23.8</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>44.0</td>
<td>44.0–63.2</td>
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</tbody>
</table>

**Weighted average neutralising value:** 67.5

#### Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
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<tbody>
<tr>
<td><strong>Neutralising value</strong> (% of pure CaCO$_3$)</td>
<td>65.9</td>
<td>65.0–67.8</td>
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<tr>
<td>Calcium (% of sample)</td>
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<tr>
<td>Magnesium (% of sample)</td>
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<td>7.9–10.0</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>1.8</td>
<td>1.4–1.8</td>
</tr>
</tbody>
</table>
## Carbone Lime

### Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Myalup</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS coordinates</td>
<td>-33.094022 115.714123</td>
</tr>
<tr>
<td>Product</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1314</td>
</tr>
<tr>
<td>Business contact</td>
<td>Craig Carbone</td>
</tr>
<tr>
<td></td>
<td>PO Box 61, Brunswick, WA 6224</td>
</tr>
<tr>
<td></td>
<td>Phone 9726 1178 Fax 9726 1474 Mobile 0417 902 338</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:craig.carbone@bigpond.com">craig.carbone@bigpond.com</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
</tr>
</tbody>
</table>

### Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>6.9</td>
<td>5.4–11.5</td>
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<td>0.125–0.250</td>
<td>33.1</td>
<td>27.1–48.0</td>
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<td>0.250–0.500</td>
<td>33.5</td>
<td>21.0–36.3</td>
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<tr>
<td>0.500–1.000</td>
<td>13.6</td>
<td>9.4–16.1</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>12.9</td>
<td>9.8–19.0</td>
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</table>

**Weighted average neutralising value:** 82.8 72.9–87.3

### Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neutralising value (% of pure CaCO$_3$)</strong></td>
<td>82.7</td>
<td>72.1–88.7</td>
</tr>
<tr>
<td>Calcium (% of sample)</td>
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<td>28.2–33.9</td>
</tr>
<tr>
<td>Magnesium (% of sample)</td>
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<td>0.8–1.1</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
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<td>0.1–0.7</td>
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</table>
Shire of Denmark

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
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<tbody>
<tr>
<td>GPS coordinates:</td>
<td>-35.031624 117.326195</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1317</td>
</tr>
<tr>
<td>Business contact</td>
<td>Erica Sayer</td>
</tr>
<tr>
<td></td>
<td>PO Box 83, Denmark, WA 6333</td>
</tr>
<tr>
<td></td>
<td>Phone 9848 0322</td>
</tr>
<tr>
<td></td>
<td>Fax 9848 1985</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:engineer5@denmark.wa.gov.au">engineer5@denmark.wa.gov.au</a></td>
</tr>
<tr>
<td></td>
<td>Web <a href="http://www.denmark.wa.gov.au">www.denmark.wa.gov.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
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Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>3.3</td>
<td>2.9–3.5</td>
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<tr>
<td>0.125–0.250</td>
<td>31.4</td>
<td>28.6–31.4</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>38.7</td>
<td>38.7–43.7</td>
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<tr>
<td>0.500–1.000</td>
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<td>9.0–9.9</td>
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<tr>
<td>&gt; 1.000</td>
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<td>14.3–17.6</td>
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</table>

Weighted average neutralising value: 72.9

Results for bulk sample

<table>
<thead>
<tr>
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<th>3-year pit range</th>
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</thead>
<tbody>
<tr>
<td>Neutralising value (% of pure CaCO$_3$)</td>
<td>75.6</td>
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<td>Calcium (% of sample)</td>
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<td>30.5–31.8</td>
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<td>Magnesium (% of sample)</td>
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<td>0.6–1.0</td>
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<tr>
<td>Sodium (% of sample)</td>
<td>0.1</td>
<td>0.1</td>
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</table>
Doust Enterprises

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Hamelin Bay</th>
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<tbody>
<tr>
<td>GPS coordinates</td>
<td>-34.240278 115.066831</td>
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<tr>
<td>Product</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1316</td>
</tr>
<tr>
<td>Business contact</td>
<td>Geoff Doust</td>
</tr>
<tr>
<td></td>
<td>PO Box 386, Margaret River, WA 6285</td>
</tr>
<tr>
<td></td>
<td>Phone 9757 3291  Fax 9757 3851  Mobile 0418 907 692</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:doust_ent@westnet.com.au">doust_ent@westnet.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
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</table>

Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
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<tr>
<td>0.000–0.125</td>
<td>1.7</td>
<td>0.5–3.5</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>8.5</td>
<td>5.2–12.7</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>39.3</td>
<td>31.0–45.6</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>43.3</td>
<td>33.9–46.8</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>7.2</td>
<td>4.3–15.5</td>
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</tbody>
</table>

Weighted average neutralising value: 91.3

86.5–92.4

Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
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<tbody>
<tr>
<td>Neutralising value (%)</td>
<td>91.4</td>
<td>86.3–93.7</td>
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<td>Calcium (%)</td>
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<td>33.1–34.6</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td>1.7</td>
<td>1.5–1.8</td>
</tr>
<tr>
<td>Sodium (%)</td>
<td>0.1</td>
<td>0.0–0.7</td>
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</tbody>
</table>
**Doyle’s Lime Service**

**Sample, pit and business information**

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Myalup</th>
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<tbody>
<tr>
<td>GPS coordinates</td>
<td>-32.968029 115.699790</td>
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<tr>
<td>Product</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1311</td>
</tr>
<tr>
<td>Business contact</td>
<td>Carlo Doyle</td>
</tr>
<tr>
<td></td>
<td>PO Box 133, Capel, WA 6271</td>
</tr>
<tr>
<td></td>
<td>Mobile 0418 931 829</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:carlo.doyle@bigpond.com">carlo.doyle@bigpond.com</a></td>
</tr>
<tr>
<td></td>
<td>Web <a href="http://www.doyleslimeservice.com.au">www.doyleslimeservice.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
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**Results for sieved sample**

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
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<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>7.1</td>
<td>1.5–13.5</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>44.6</td>
<td>30.4–55.5</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>32.5</td>
<td>20.7–46.0</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>9.4</td>
<td>4.2–9.4</td>
</tr>
<tr>
<td>&gt; 1.000</td>
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<td>3.7–10.0</td>
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</table>

**Weighted average neutralising value:** 61.2

**Results for bulk sample**

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
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<tr>
<td>Neutralising value (% of pure CaCO$_3$)</td>
<td>61.5</td>
<td>61.5–75.6</td>
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<tr>
<td>Magnesium (% of sample)</td>
<td>1.0</td>
<td>0.8–1.4</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>0.1</td>
<td>0.1–0.2</td>
</tr>
</tbody>
</table>
Individual pit results (continued)

Irwin Limesands

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Dongara</th>
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</thead>
<tbody>
<tr>
<td>GPS coordinates:</td>
<td>-29.273565 114.983682</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>9 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1309</td>
</tr>
<tr>
<td>Business contact</td>
<td>Jon Firbank</td>
</tr>
<tr>
<td></td>
<td>PO Box 2768</td>
</tr>
<tr>
<td></td>
<td>Geraldton WA 6531</td>
</tr>
<tr>
<td></td>
<td>Phone and Fax 9926 1319 Mobile 0428 922 892</td>
</tr>
</tbody>
</table>

Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>1.9</td>
<td>1.0–30.8</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>63.6</td>
<td>29.3–63.6</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>29.9</td>
<td>29.9–42.9</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>3.4</td>
<td>2.7–3.4</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>1.1</td>
<td>0.3–1.6</td>
</tr>
</tbody>
</table>

Weighted average neutralising value: 88.7 87.5–90.5

Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neutralising value</strong> (% of pure CaCO₃)</td>
<td>88.1</td>
<td>88.1–90.7</td>
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<td>34.3</td>
<td>33.3–34.3</td>
</tr>
<tr>
<td>Magnesium (% of sample)</td>
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</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>0.1</td>
<td>0.1–0.2</td>
</tr>
</tbody>
</table>
Jurien Lime Sands

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Jurien Bay</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS coordinates</td>
<td>-30.187954 115.006264</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>8 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1303</td>
</tr>
<tr>
<td>Business contact</td>
<td>Russell Dolton or Brad Lewis</td>
</tr>
<tr>
<td></td>
<td>Yaramie, Dandaragan, WA 6507</td>
</tr>
<tr>
<td></td>
<td>Phone 9655 0036       Fax 9655 0056</td>
</tr>
<tr>
<td></td>
<td>Mobile 0427 550 036 (Russell) or 0428 511 200 (Brad)</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:russhills@bigpond.com">russhills@bigpond.com</a> (Russell) or <a href="mailto:lewistyres@hotmail.com">lewistyres@hotmail.com</a> (Brad)</td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
</tr>
</tbody>
</table>

Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>0.5</td>
<td>95.2</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>41.5</td>
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<td>0.250–0.500</td>
<td>45.9</td>
<td>91.3</td>
</tr>
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<td>0.500–1.000</td>
<td>11.8</td>
<td>86.0</td>
</tr>
<tr>
<td>&gt; 1.000</td>
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<td>92.8</td>
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</table>

Weighted average neutralising value: 89.5

Results for bulk sample

<table>
<thead>
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<tbody>
<tr>
<td>Neutralising value (% of pure CaCO₃)</td>
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<td>89.9–93.2</td>
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<tr>
<td>Calcium (% of sample)</td>
<td>34.4</td>
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<td>Magnesium (% of sample)</td>
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<td>1.8–1.9</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
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<td>0.1–0.3</td>
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</table>
## Lake Preston Lime

### Sample, pit and business information

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<thead>
<tr>
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<tbody>
<tr>
<td>GPS coordinates:</td>
<td>-33.022032 115.706527</td>
</tr>
<tr>
<td>Product</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1312</td>
</tr>
<tr>
<td>Business contact</td>
<td>Pam Ray</td>
</tr>
<tr>
<td>PO Box 1230, Bunbury WA 6231</td>
<td></td>
</tr>
<tr>
<td>Phone 1800 889 483 Fax 9725 7724</td>
<td></td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:pam.ray@bunburyflyingschool.com">pam.ray@bunburyflyingschool.com</a></td>
</tr>
<tr>
<td>Web</td>
<td><a href="http://www.lakeprestonlime.com">www.lakeprestonlime.com</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
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### Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
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<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
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<tr>
<td>0.000–0.125</td>
<td>12.2</td>
<td>5.1–12.2</td>
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<td>30.2</td>
<td>19.9–38.8</td>
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<td>0.250–0.500</td>
<td>22.5</td>
<td>22.5–36.9</td>
</tr>
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<td>0.500–1.000</td>
<td>16.2</td>
<td>14.6–20.5</td>
</tr>
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<td>&gt; 1.000</td>
<td>18.9</td>
<td>7.5–25.7</td>
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**Weighted average neutralising value:** 72.3 72.3–84.6

### Results for bulk sample

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<thead>
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<tbody>
<tr>
<td><strong>Neutralising value</strong> (% of pure CaCO₃)</td>
<td>73.2</td>
<td>73.1–85.2</td>
</tr>
<tr>
<td>Calcium (% of sample)</td>
<td>29.3</td>
<td>28.4–31.4</td>
</tr>
<tr>
<td>Magnesium (% of sample)</td>
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<td>0.8–1.3</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>0.1</td>
<td>0.0–0.2</td>
</tr>
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</table>
Midwest Sand Supplies—Southgates

Sample, pit and business information

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<tr>
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</thead>
<tbody>
<tr>
<td>GPS coordinates</td>
<td>-28.830780 114.631351</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>9 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1308</td>
</tr>
<tr>
<td>Business contact</td>
<td>Doug Wilson</td>
</tr>
<tr>
<td></td>
<td>PO Box 2095, Geraldton, WA 6531</td>
</tr>
<tr>
<td></td>
<td>Phone 9923 1372  Fax 9923 2227  Mobile 0427 184 308</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:willow@modnet.com.au">willow@modnet.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
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Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
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<tbody>
<tr>
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<td>Audit sample</td>
<td>3-year pit range</td>
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<tr>
<td>0.000–0.125</td>
<td>1.5</td>
<td>1.1–2.8</td>
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<tr>
<td>0.125–0.250</td>
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<td>56.4–73.8</td>
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<td>0.250–0.500</td>
<td>29.4</td>
<td>23.5–40.9</td>
</tr>
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<td>3.4</td>
<td>0.4–3.4</td>
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<td>&gt; 1.000</td>
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Weighted average neutralising value: 77.6  77.6–84.5

Results for bulk sample

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<tbody>
<tr>
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<tr>
<td>Calcium</td>
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<tr>
<td>Magnesium</td>
<td>1.5</td>
<td>1.5–1.6</td>
</tr>
<tr>
<td>Sodium</td>
<td>0.1</td>
<td>0.1–1.2</td>
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</tbody>
</table>
Redgate Lime

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
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<tbody>
<tr>
<td>GPS coordinates</td>
<td>-34.032425 115.017972</td>
</tr>
<tr>
<td>Product</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1315</td>
</tr>
<tr>
<td>Business contact</td>
<td>Karen Nash</td>
</tr>
<tr>
<td></td>
<td>556 Redgate Rd, Redgate, WA 6286</td>
</tr>
<tr>
<td></td>
<td>Phone 9757 6263 Fax 9757 6071 Mobile 0407 385 488</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:rglime@bigpond.com">rglime@bigpond.com</a></td>
</tr>
</tbody>
</table>

Pit contact: As above

Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
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<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
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<tr>
<td>0.000–0.125</td>
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<td>0.7–1.8</td>
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<td>0.125–0.250</td>
<td>22.6</td>
<td>12.0–22.6</td>
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<td>0.250–0.500</td>
<td>50.0</td>
<td>48.8–50.7</td>
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<td>0.500–1.000</td>
<td>21.2</td>
<td>21.2–32.8</td>
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<tr>
<td>&gt; 1.000</td>
<td>5.4</td>
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Weighted average neutralising value: 93.5 92.5–95.4

Results for bulk sample

<table>
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<th>Audit sample</th>
<th>3-year pit range</th>
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</thead>
<tbody>
<tr>
<td>Neutralising value</td>
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<td>92.6–95.8</td>
</tr>
<tr>
<td>Calcium (%) of sample</td>
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<td>33.8–35.5</td>
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<tr>
<td>Magnesium (%) of sample</td>
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<td>1.7–2.0</td>
</tr>
<tr>
<td>Sodium (%) of sample</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Rules Lime Sand

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Lancelin</th>
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<tbody>
<tr>
<td>GPS coordinates</td>
<td>-31.066915 115.352818</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>8 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1302</td>
</tr>
<tr>
<td>Business contact</td>
<td>Glenn Rule</td>
</tr>
<tr>
<td></td>
<td>PO Box 117, Gingin, WA 6503</td>
</tr>
<tr>
<td></td>
<td>Phone 9575 2266  Fax 9575 1256  Mobile 0418 919 553</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:gsrule@bigpond.com">gsrule@bigpond.com</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
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Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>1.6</td>
<td>1.6–3.9</td>
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<td>0.125–0.250</td>
<td>45.1</td>
<td>40.1–67.5</td>
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<tr>
<td>0.250–0.500</td>
<td>45.5</td>
<td>27.7–57.4</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>7.6</td>
<td>0.9–9.9</td>
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<tr>
<td>&gt; 1.000</td>
<td>0.1</td>
<td>0.0–0.2</td>
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</table>

Weighted average neutralising value: 94.4

Results for bulk sample

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<tbody>
<tr>
<td>Neutralising value (% of pure CaCO$_3$)</td>
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<td>93.5–96.3</td>
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<td>Magnesium (% of sample)</td>
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<td>1.7–1.8</td>
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<tr>
<td>Sodium (% of sample)</td>
<td>0.3</td>
<td>0.3–0.9</td>
</tr>
</tbody>
</table>
**Versaci Lime**

**Sample, pit and business information**

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Myalup</th>
</tr>
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<tbody>
<tr>
<td>GPS coordinates:</td>
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<tr>
<td>Product</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>11 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1313</td>
</tr>
<tr>
<td>Business contact</td>
<td>Barry Versaci</td>
</tr>
<tr>
<td></td>
<td>321 Uduc Rd, Harvey, WA 6220</td>
</tr>
<tr>
<td></td>
<td>Phone/Fax 9729 1797  Mobile 0418 931 777</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:bversaci@hotmail.com">bversaci@hotmail.com</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>Andrew Zappia</td>
</tr>
<tr>
<td></td>
<td>0428 980 106</td>
</tr>
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<td>UHF radio channel 38</td>
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</table>

**Results for sieved sample**

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>13.2</td>
<td>3.4–37.9</td>
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<td>17.3–33.5</td>
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<td>0.500–1.000</td>
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<td>9.1–22.7</td>
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**Weighted average neutralising value:** 76.8 64.2–81.4

**Results for bulk sample**

<table>
<thead>
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<td><strong>Neutralising value</strong></td>
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<td>Magnesium (% of sample)</td>
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<td>0.4–1.0</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
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<td>0.1–0.2</td>
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Western Agricultural Lime Co.

Sample, pit and business information

<table>
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<tr>
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<tbody>
<tr>
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</tr>
<tr>
<td>Product</td>
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</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
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</tr>
<tr>
<td>Sample ID</td>
<td>CG1318</td>
</tr>
<tr>
<td>Business contact</td>
<td>Keith Jackson</td>
</tr>
<tr>
<td></td>
<td>PO Box 40, Pemberton, WA 6260</td>
</tr>
<tr>
<td></td>
<td>Phone 1800 803 003 Mobile 0428 936 003</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:walco@westnet.com.au">walco@westnet.com.au</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
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<td></td>
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Results for sieved sample

<table>
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<th>Sieve Range (mm)</th>
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<th>Neutralising value (% of pure CaCO₃)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
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<tr>
<td>0.000–0.125</td>
<td>11.9</td>
<td>8.0–40.1</td>
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<td>0.125–0.250</td>
<td>15.7</td>
<td>9.3–18.1</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>18.7</td>
<td>12.3–18.7</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>16.6</td>
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Results for bulk sample

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<tr>
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<tr>
<td>Magnesium (% of sample)</td>
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<td>0.4–1.0</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
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<td>0.1</td>
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</tbody>
</table>
**Watheroo Dolomitic Lime**

**Sample, pit and business information**

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Watheroo</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS coordinates:</td>
<td>-30.351461 116.050536</td>
</tr>
<tr>
<td>Product</td>
<td>Dolomitic lime</td>
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<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
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</tr>
<tr>
<td>Sample ID</td>
<td>CG1310</td>
</tr>
<tr>
<td>Business contact</td>
<td>Peter &amp; Terri Manns</td>
</tr>
<tr>
<td></td>
<td>PO Box 71, Two Rocks, WA 6037</td>
</tr>
<tr>
<td></td>
<td>Mobile 0428 922 340 (Peter) or 0418 922 340 (Terri)</td>
</tr>
<tr>
<td>Email</td>
<td><a href="mailto:terri@dolomite.com.au">terri@dolomite.com.au</a></td>
</tr>
<tr>
<td>Web</td>
<td><a href="http://www.dolomite.com.au">www.dolomite.com.au</a></td>
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<tr>
<td>Pit contact</td>
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</table>

**Results for sieved sample**

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
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<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
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<td>28.7</td>
<td>28.7–44.7</td>
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<tr>
<td>0.250–0.500</td>
<td>11.3</td>
<td>10.7–13.8</td>
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<tr>
<td>0.500–1.000</td>
<td>15.3</td>
<td>12.5–14.9</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>35.8</td>
<td>20.6–35.8</td>
</tr>
</tbody>
</table>

Weighted average neutralising value: 95.4

**Results for bulk sample**

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutralising value (% of pure CaCO₃)</td>
<td>95.3</td>
<td>91.6–95.3</td>
</tr>
<tr>
<td>Calcium (% of sample)</td>
<td>20.0</td>
<td>18.0–21.0</td>
</tr>
<tr>
<td>Magnesium (% of sample)</td>
<td>11.0</td>
<td>10.0–11.8</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>
## Individual pit results (continued)

### Yarra Sands—Coolimba

#### Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Coolimba</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS coordinates</td>
<td>-29.826587 114.985189</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>10 January 2011</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1306</td>
</tr>
<tr>
<td>Business contact</td>
<td>Peter Rayner  PO Box 127, Carnamah, WA 6517  Phone 9951 1028  Fax 9951 1048  Mobile 0427 511 028  Email <a href="mailto:pcrayner@bigpond.com">pcrayner@bigpond.com</a></td>
</tr>
<tr>
<td>Pit contact</td>
<td>As above</td>
</tr>
</tbody>
</table>

#### Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO$_3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>0.8</td>
<td>0.5–1.2</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>31.7</td>
<td>18.9–31.7</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>54.4</td>
<td>54.4–62.6</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>12.9</td>
<td>8.1–19.2</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>0.2</td>
<td>0.1–0.6</td>
</tr>
</tbody>
</table>

**Weighted average neutralising value:** 92.4 91.2–93.3

#### Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Neutralising value</strong> (% of pure CaCO$_3$)</td>
<td>92.6</td>
<td>92.2–94.7</td>
</tr>
<tr>
<td>Calcium (% of sample)</td>
<td>34.7</td>
<td>33.6–34.8</td>
</tr>
<tr>
<td>Magnesium (% of sample)</td>
<td>1.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Sodium (% of sample)</td>
<td>0.2</td>
<td>0.2–0.3</td>
</tr>
</tbody>
</table>
Yarra Sands—Green Head

Sample, pit and business information

<table>
<thead>
<tr>
<th>Pit location</th>
<th>Green Head</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPS coordinates</td>
<td>-30.101935 115.003750</td>
</tr>
<tr>
<td>Product</td>
<td>Limesand</td>
</tr>
<tr>
<td>Sampler</td>
<td>Chris Gazey</td>
</tr>
<tr>
<td>Sample date</td>
<td>8 April 2013</td>
</tr>
<tr>
<td>Sample ID</td>
<td>CG1304</td>
</tr>
<tr>
<td>Business contact</td>
<td>Peter Rayner</td>
</tr>
<tr>
<td></td>
<td>PO Box 127, Carnamah, WA 6517</td>
</tr>
<tr>
<td></td>
<td>Phone 9951 1028 Fax 9951 1048 Mobile 0427 511 028</td>
</tr>
<tr>
<td></td>
<td>Email <a href="mailto:pcrayner@bigpond.com">pcrayner@bigpond.com</a></td>
</tr>
</tbody>
</table>

Pit contact: As above

Results for sieved sample

<table>
<thead>
<tr>
<th>Sieve Range (mm)</th>
<th>Proportion of sample (% of dry weight)</th>
<th>Neutralising value (% of pure CaCO₃)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Audit sample</td>
<td>3-year pit range</td>
</tr>
<tr>
<td>0.000–0.125</td>
<td>1.6</td>
<td>0.6–2.0</td>
</tr>
<tr>
<td>0.125–0.250</td>
<td>48.2</td>
<td>30.0–56.0</td>
</tr>
<tr>
<td>0.250–0.500</td>
<td>44.7</td>
<td>29.1–60.2</td>
</tr>
<tr>
<td>0.500–1.000</td>
<td>5.4</td>
<td>3.5–12.9</td>
</tr>
<tr>
<td>&gt; 1.000</td>
<td>0.1</td>
<td>0.1–1.0</td>
</tr>
</tbody>
</table>

Weighted average neutralising value: 90.7

Results for bulk sample

<table>
<thead>
<tr>
<th></th>
<th>Audit sample</th>
<th>3-year pit range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutralising value (%)</td>
<td>90.6</td>
<td>90.4–92.8</td>
</tr>
<tr>
<td>Calcium (%)</td>
<td>34.9</td>
<td>33.1–34.9</td>
</tr>
<tr>
<td>Magnesium (%)</td>
<td>1.8</td>
<td>1.7–1.8</td>
</tr>
<tr>
<td>Sodium (%)</td>
<td>0.2</td>
<td>0.2–0.3</td>
</tr>
</tbody>
</table>
Online references

Gazey, C & Davies, S 2009, Soil acidity: A guide for WA farmers and consultants, Bulletin 4784, Department of Agriculture and Food, Western Australia.  

agric.wa.gov.au/objtwr/imported_assets/content/lwe/rpm/landcap/soilguide_introduction.pdf

Websites

Lime WA Inc. website limewa.com.au  
Soil Quality website soilquality.org.au

Scientific books and journals


agric.wa.gov.au/objtwr/imported_assets/content/lwe/land/acid/liming/lime.pdf

References and further reading

If you would like more information please contact Chris Gazey
Northam office: 9690 2000
Mobile: 0429 107 976
Email: chris.gazey@agric.wa.gov.au
The chemical analyses of the lime samples were conducted by the ChemCentre laboratory at Curtin University. The analytical methods of the ChemCentre are protected by copyright however the following is a general description of the method used for agricultural lime analysis for the Agricultural Lime Industry Code of Practice analyses.

**Particle size distribution**

Samples for the Lime Industry’s Code of Practice are first air-dried, then the particle size distribution is measured by sieving through wire mesh screens (brass or stainless steel) with hole diameters of 1.0, 0.5, 0.25 and 0.125 mm. Hand sieving is always used because of the variability of the samples received and the soft nature of many lime materials. Extended sieving of some types of lime increases the percentage of the finer fractions by abrasion of the larger particles.

In order to obtain sufficient material of the coarse fractions for the neutralising value test, it is necessary to take a relatively large sample size, often in excess of 1 kg. However, it is not practical to sieve the entire sample through all screens, as ‘blinding’ of at least one of the finer screens inevitably occurs. This is overcome by quantitatively reducing the size of the sample as required.

Sieving through each screen is continued until the amount of additional material passing a particular screen is less than 0.1 per cent of the sample weight, being the reporting limit for each fraction. This is equivalent to 1 g for a 1 kg fraction, or 0.1 g for a 100 g fraction.

To ensure that all results are reproducible, the following steps are taken:

- All screens are of the highest analytical quality and are well maintained.
- Commercial wire meshes are unlikely to have the high tolerance of analytical mesh sieves.

- Sieving is undertaken by trained and experienced operators. The ChemCentre is registered by the National Association of Testing Authorities (NATA) for particle sizing.

- Manual sieving is used in preference to mechanical procedures to overcome the difficulties such as abrasion of soft samples and blinding of fine mesh screens described earlier.

**Neutralising value**

The neutralising value of each size fraction is measured. The neutralising value of a sample of the bulk material is also determined as another quality assurance check for the analysis of each sample.

Each sample or fraction requiring determination of the neutralising value is ground to a fine powder in a ring grinding mill.

A sample of the finely ground material is treated with 100 mL of 1 M hydrochloric acid. There is an excess amount of acid to ensure that all of the free lime dissolves. The reaction between the lime and the acid is completed by boiling gently for several minutes, then adjusting the volume of the solution to its original value.

After cooling to room temperature, a 10 mL aliquot of the solution is transferred to the titration system using a glass pipette. The excess acid of the test sample is then titrated with standardised sodium hydroxide solution using an automatic burette and the ‘end-point’ is measured with a pH meter (the reaction is complete when the pH of the test solution increases to 7 or higher). The automatic burette is very accurate, with a volume delivery tolerance of approximately ± 0.01 mL, which is significantly better than glass burettes. Indicator solutions, such as phenolphthalein, can also be used to determine the ‘end-point’ of the titration. The pH meter, however, is preferred as the method is not affected by the
Appendix—analytical methods (continued)

presence of acid-soluble iron materials which can be present in some lime samples.

The accuracy of the method is approximately ± 1 per cent or better.

**Calcium and magnesium**

If required, the calcium (Ca) and magnesium (Mg) content is measured in the acid solution of the sample. The instrument used for these measurements is an Inductively Coupled Plasma-Atomic Emission Spectrometer (ICP-AES), which can also be used to measure other elements such as sodium, sulphur, copper, iron, manganese and zinc.

Note that these results are not a true ‘total’ value, but a measure of acid-soluble forms of these elements. For lime materials, these values should be very similar to the true ‘total’ figures which can be measured independently using either X-Ray Fluorescence Spectrometry (XRF) or strong acid digestion using hydrofluoric acid.

The calcium and magnesium concentrations are checked for consistency with the measured neutralising values. The neutralising value should be closely related to the Ca and Mg concentrations by the following formula (where the molecular weight of calcium is 40 and of magnesium is 24):

\[
\text{NV} \approx \frac{100 \times \% \text{Ca}}{40} + \frac{100 \times \% \text{Mg}}{24}
\]