

WATER NEW ZEALAND
Good Practice Guide for the

SUPPLY OF HYDRATED LIME FOR USE IN WATER TREATMENT



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Disclaimer:

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1 GENERAL

1.1 Scope

This Guide covers requirements for ensuring hydrated lime is of a suitable quality for use in drinking water treatment.

This Guide does not cover:

- Environmental protection or health and safety measures associated with the use of hydrated lime including labelling, site and storage, transportation, packaging or disposal requirements.
- Operational procedures for using hydrated lime.

1.2 Purpose

The main purpose of this Guide is to provide purchasers, manufacturers and suppliers with the minimum physical, chemical and testing requirements for Hydrated Lime to meet safe limits for drinking water supplies. The requirements align with requirements for drinking-water safety outlined in the *Drinking Water Standards for New Zealand* (Ministry of Health, 2008).

1.3 Application

This Guide can be referenced in specifications for purchasing and receiving hydrated lime, and can be used as a guide for testing the physical and chemical properties of hydrated lime samples. The stipulations of this Guide apply when this document has been referenced and only to hydrated lime used in water treatment.

The guide does not cover information requirements, packaging, equipment, transportation, disposal, safety or issues. Requirements for these aspects of water treatment chemical use are stipulated under New Zealand law and contained in the *Water Treatment Chemicals (Corrosive) Group Standard 2006* (Environmental Protection Authority, 2006).

1.4 Legal Requirements

This Guideline is not intended to address supplier or operators legal responsibilities and should be considered alongside other requirements of New Zealand law. Principal relevant legislation that relates to the supply and use of hydrated lime in drinking water supplies is:

- The Hazardous Substances and New Organisms (HSNO) Act 1996 (Ministry for the Environment, 2015)
- Health (Drinking Water) Amendment Act 2007 (Ministry of Health, 2008)
- Land Transport Act 1998 (Ministry of Transport, 2012)
- Health and Safety at Work Act (Ministry of Business, Innovation and Employment, 2015)
- Resource Management Act 1991 (Ministry for the Environment, 2015)

There may also be other legislation that needs to be complied with.

Legislated requirements for protecting the environment and the health and safety of people and communities from the use of hazards associated with hydrated lime are outlined in the HSNO Act. HSNO hazard classification and controls for hydrated lime can be found in the *Controls for Approved Hazardous Substances Database* under the calcium hydroxide listing, available on the Environmental Protection Authority website: <http://www.epa.govt.nz/>

They are also contained in the *Water Treatment Chemicals (Corrosive) Group Standard 2006* (Environmental Protection Authority, 2006).

1.5 Uses in Water Treatment

Hydrated lime is frequently used in water treatment in three areas:

1. prior to coagulation to increase the pH and alkalinity of the water to bring them to optimum levels for coagulation,
2. to absorb aggressive carbon dioxide from some groundwater,
3. as a final pH, alkalinity and calcium ion level adjustment before water is delivered to the consumer to reduce corrosivity (or aggressiveness or plumbosolvency).

Discussion of the corrosivity of water and associated water quality impacts and monitoring techniques is contained in the *Guidelines for Drinking-Water Quality Management for New Zealand* (Ministry of Health, 2016). The guidelines are available online at: <http://www.health.govt.nz/publication/guidelines-drinking-water-quality-management-new-zealand>

1.6 Manufacture of Hydrated Lime

When crushed limestone is calcined, or burnt, the heating process drives off carbon dioxide to leave calcium oxide, also known as quicklime or burnt lime. A specific amount of water is added to the quicklime to form calcium hydroxide or hydrated lime; this is sometimes called the slaking process.

1.7 Description of Chemicals

Hydrated lime is available as a fine white powder consisting essentially of calcium hydroxide.

1.8 Methods of Dosing

Lime is generally dosed as slurry because it has very low solubility (about 0.12% percent of weight to volume at ambient temperatures and 0.18% at 0°C) so not all of the lime is dissolved into the solution before dosing into the water to be treated. Lime is usually either delivered as a slurry and pump dosed, or delivered as a dry powder and dosed via a dry feeder:

- into a concentrated dosing slurry flowing in an open channel; or
- directly into a wetted cone which carries the lime via a pipe or directly feeds into the water to be -treated; or
- made up as a 5-10% w/v slurry and pump fed, often with the use of additional water for dilution of the slurry to increase slurry velocity to avoid settlement of lime in the dosing lines.

1.9 Definitions

The following definitions shall apply in this Guide:

- 1.9.1 *Delivery Point:* The point of physical transfer of materials from the supplier to the purchaser.
- 1.9.2 *Guideline Value:* Guideline values are the highest concentration of a determinand in the water that can be present without unduly impacting on the aesthetic properties of drinking water. Guideline values relate to determinands that do not pose a direct threat to public health, however may affect the appearance taste or smell of water. Guideline values are specified in the *Drinking Water Standards of New Zealand* (Ministry of Health, 2008).
- 1.9.3 *Hydrated Lime:* A very finely divided powder resulting from the hydration of quicklime, consisting essentially of calcium hydroxide, $\text{Ca}(\text{OH})_2$. Hydrated lime was previously known as slaked lime.
- 1.9.4 *Manufacturer:* The party that manufacturers, fabricates, or produces materials or products.
- Maximum Acceptable Value:* The highest concentration of a determinand in the water that, on the basis of present knowledge, is considered not to cause any significant risk to the health of the consumer over 70 years of consumption of that water. Maximum acceptable values are specified in the *Drinking Water Standards of New Zealand* (Ministry of Health, 2008).
- 1.9.5 *Limestone:* Calcium carbonate, CaCO_3 , sometimes called agricultural lime.
- 1.9.6 *Purchaser:* The person, company or organisation that purchases any materials or work to be performed.
- 1.9.7 *Quicklime:* Calcium oxide, CaO , the result of burning limestone.
- 1.9.8 *Specific Impurity:* Substances which have a maximum acceptable value (MAV) or guideline value assigned to them in the *Drinking Water Standards of New Zealand* (Ministry of Health, 2008).
- 1.9.9 *Specific Impurity Limit:* Specific impurity limits are the maximum limit of an inorganic impurity given as weight of impurity by weight of product (mg of impurity/ kg of product) acceptable in a product.
- 1.9.10 *Supplier:* The party who supplies material or services. A supplier may or may not be the manufacturer.
- 1.9.11 *w/v* Weight per volume.

2 MATERIALS

2.1 Physical Properties

Table 1: Some Physical Properties of Hydrated Lime

Property	Hydrated Lime
pH of a Saturated Solution	12.5 @ 25°C
Specific Gravity	2.1 – 2.4
Bulk Density	400 – 750 kg/m ³
Solubility (% w/v)	about 0.12% (at ambient temperatures)
Particle Distribution	Should be uniform
Particle size	Product shall be free from lumps or foreign material that might interfere with the operation of dry feed, pneumatic or hydraulic equipment.

2.2 Chemical Requirements

It is recommended that Hydrated Lime supplies in New Zealand be of a purity of not less than 90% water soluble calcium hydroxide (Ca(OH)₂).

Product quality grades for hydrated lime are specified in international jurisdictions which may prove instructive for lime manufacturers and suppliers in New Zealand. The range of grades used in *BS EN 12518:2014 Chemicals used for treatment of water intended for human consumption. High-calcium lime* (British Standards Institution, 2014) is shown in Table 2.

Table 2: Major Constituents and grading of lime in BS EN 12518:2014

Property	Class 1	Class 2	Class 3
Content of water-soluble Ca(OH) ₂ expressed in dry substance as Ca(OH) ₂ in mass fraction %	≥92	≥87	≥83

2.3 Impurities

2.3.1 Specific Impurity Limits

2.3.1.1 For the purposes of this Guideline the term “specific impurities” refers to the following substances, which have maximum acceptable values (MAVs) assigned to them in the *Drinking-water Standards for New Zealand 2005* (Ministry of Health, 2008) and are shown in Table 3.

2.3.1.2 The levels of specific impurities in commercially available hydrated lime shall not exceed the specific impurity limits (SILs) given in Table 3, which also specifies the parameter values used for the calculation of the SILs.

2.3.1.3 The equation in Appendix A1 has been used to calculate the SILs. Where determinands have an impact on human health the equation applies a safety factor of 10. The safety factor has not been applied for aluminium and iron. Both are

naturally occurring in New Zealand limestone deposits, both of which have aesthetic impacts on drinking water. Lower impurity limits may be warranted where iron and aluminium and iron impact on treatment plant operations, or, where determinands occur in elevated levels in source water.

2.3.1.4 SILs shall be given as weight of impurity by weight of hydrated lime.

2.3.1.5 SILs have been calculated for all inorganic impurities with MAVs in the *Drinking-water Standards for New Zealand 2005 (Revised 2008)* (Ministry of Health, 2008), but some of these are not included in Table 3 because the levels are unrealistically high. Consequently, SILs constituting more than 1% of the product have been deleted. This was the case for Zinc.

Table 3: Impurity Limits for Hydrated Lime. Specific Impurity Limits are based on a maximum dose of 32 mg/L of hydrated lime per litre of water

Determinand	MAV (mg/L)	mg of Determinand per kg of Product
Aluminium*	0.1	3100
Antimony	0.02	60
Arsenic	0.01	10
Barium	0.7	2100
Boron	1.4	4300
Cadmium	0.004	10
Chromium	0.05	150
Copper*	1	3100
Fluoride	1.5	4600
Iron*	0.2	6200
Lead	0.01	10
Manganese*	0.04	120
Mercury	0.007	20
Molybdenum	0.07	210
Nickel	0.08	250
Selenium	0.01	30
Sulphide*	0.05	150
Uranium	0.02	60
Zinc*	1.5	4600

Concentrations are rounded down to one significant figure for values less than or equal to 100 mg/kg and two significant figures for values above 100 mg/kg.

* These determinands are either aesthetic determinands having only a guideline value or are health significant determinands having both an MAV and a guideline value. In the latter case, the lower of the two is given in the table.

2.3.2 General Impurities

2.3.2.1 Additional impurity limits may be specified by the purchaser to ensure the material supplied is suitable for water treatment. If additional impurity limits are specified, the purchaser must specify the methods to be used to show that these limits have been met.

2.3.2.2 Iron and Aluminium are commonly occurring impurities in New Zealand Hydrated Lime products. Both aluminium, iron and other insoluble matter can cause turbidity when lime is applied to filtered water or to a water supply not to be filtered. Turbidity problems can be overcome by adding the lime as a saturated solution. If such a procedure is impractical, individual treatment plants may need to set up lower limits for total insoluble matter, iron, and aluminium when purchasing lime.

2.3.2.3 Additional impurity limits may be warranted in other situations where impurities impact on treatment plant operations, or, where determinands listed in Table 3 occur in elevated levels in source water.

3 TEST METHODS

3.1 Testing

3.1.1 The manufacturer or supplier shall test the materials at their own cost in order to provide a Certificate of Compliance as required in Section 4.1.

3.1.2 The purchaser may randomly take samples of the material and have these samples analysed for conformance with this Guide, at the purchaser's cost. These samples may be taken at the place of manufacture.

3.1.3 The manufacturer shall afford the inspector representing the purchaser all reasonable facilities for inspection and sampling of finished material, which shall be so conducted as not to interfere unnecessarily with the operation of the plant. When on site, the purchaser must follow the manufacturing site's safety policies and procedures when taking the sample, or allow the manufacturer to take the sample itself while under supervision of the supplier's representative.

3.1.4 Analytical methods shall be as specified in this Guide in Section 3.3.

3.1.5 Laboratories undertaking analyses to show that a product complies with the requirements of this Guide shall be suitably accredited for the tests being undertaken. Laboratory with IANZ accreditation are preferred and overseas laboratories shall have ISO 17025 accreditation.

3.1.6 If the analysis of a sample taken at the point of manufacture shows the material does not comply with the requirements of this Guide, a notice of non-conformance must be provided by the purchaser to the supplier in accordance with Section 4.3.

3.2 Sampling

3.2.1 The sampling procedure set out in Appendix B of this Guide shall be followed.

3.3 Standard Tests

- 3.3.1 For tests for water soluble $\text{Ca}(\text{OH})_2$ content, refer to test method 6.6 *Determination of sugar soluble calcium oxide or calcium hydroxide (alternative method)* contained within *BS EN 12485:2010 Chemicals used for treatment of water intended for human consumption. Calcium carbonate, high-calcium lime, half-burnt dolomite, magnesium oxide and calcium magnesium carbonate. Test methods* (British Standards Institution , 2010).
- 3.3.2 The concentrations of the specific impurities listed in Table 3 shall be determined by test methods found in *Standard Methods for the Examination of Water and Wastewater* (E.W. Rice, 2012). The purchaser must state which of the testing methods is to be used to determine compliance with the specific impurity limits.
- 3.3.3 Specific impurity concentrations shall be reported by the laboratory as mg of impurity per kg of product.

3.4 Frequency

3.4.1 Base frequency of testing for impurities

The sampling and certified analysis on which the Certificate of Compliance of a product is based (section 4.1.3) must occur at least annually for all impurities listed in Table 3. Sampling and analysis must also be carried out:

- i. whenever the process and/or raw materials changes, in which case all impurities in Table 3 must be tested, and
- ii. at the frequency listed in Table 4 if any test shows the concentration of an impurity in the product exceeds 50% of its SIL, in which case only the impurities exceeding 50% of their SIL need be tested.

Table 4: Test frequency of product impurity limits in excess of 50% of the SIL (specified in section 2.3)

Property	Test Frequency
Fluoride	Per batch, or weekly if multiple batches are received in a week
Other determinands listed in Table 3	Per batch, or monthly if multiple batches are received in a month

3.4.2 Available calcium hydroxide and insoluble matter

Tests for available calcium hydroxide (outlined in 2.2) should be undertaken per batch, unless the supplier and purchaser agree that product quality is consistent in which case testing may be undertaken per process run.

3.4.3 P2a determinands

Compliance with the chemical requirements of the Drinking Water Standards for New Zealand (Ministry of Health, 2008) for P2a determinands can be demonstrated using the alternative approach given in section 8.2.1.2 of the Standards. This requires a certified analysis stating the concentration of the P2a determinand in the product as provided for in section 4.

4 QUALITY ASSURANCE

4.1 Certificate of Compliance

- 4.1.1 The manufacturer or supplier shall provide the purchaser with a certificate of compliance with each delivery that states that the material furnished in accordance with the purchaser's order complies with all applicable requirements of this Guide. This is to include the concentrations of properties listed in section 2.3 and 2.2 using tests undertaken at frequencies outlined in section 3.4.
- 4.1.2 The purchaser shall not use a delivered product until a certificate of compliance for that delivery is received from the chemical supplier, and the supplier has demonstrated that there is a satisfactory system in place to ensure the quality of the product between the point of manufacture and point of delivery.
- 4.1.3 The chemical supplier shall provide a certified analysis of the material from a mutually agreed upon IANZ or ISO 17025 accredited laboratory showing that the requirements of Sections 2.3 and 3.3 have been met at test frequencies outlined in section 3.4.
- 4.1.4 If the method of manufacture, source and/or quality of raw material used is changed additional samples shall be tested by the supplier to demonstrate that the changes have not affected conformance with this Guideline. A copy of the certificate of compliance shall be provided to the purchaser.

4.2 Volume

The volume of bulk product shipped shall be determined by certified scales and weight certificates provided to the purchaser on per shipment basis.

4.3 Rejection

4.3.1 Notice of Non-conformance

If the hydrated lime delivered does not meet the requirements of this Guide or the additional impurity limits notified by the purchaser, a notice of non-conformance must be provided by the purchaser to the supplier within 10 working days after receipt of the shipment at the point of destination. The results of the purchaser's tests shall prevail unless the supplier notifies the purchaser within five working days after receipt of the notice of complaint that a retest or inspection is desired. On receipt of the request for a retest, the purchaser shall forward to the supplier one of the sealed samples taken in accordance with Section 3.

In the event that the results obtained by the supplier upon retesting do not agree with the results obtained by the purchaser, the other sealed sample shall be forwarded, unopened, for analysis to a referee laboratory agreed upon by both parties. The results of the referee analysis or inspection shall be accepted as final.

The cost of the referee analysis shall be paid by the supplier if the material does not meet the requirements of this Guide, and shall be paid by the purchaser if the material does meet the requirements of this Guide.

4.3.2 **Material Removal**

- 4.3.2.1 If the material does not meet the requirements of this Guideline, the supplier shall immediately advise the purchaser and review options to remedy or remove the material from the premises of the purchaser. Removal of material shall be at no cost to the purchaser.
- 4.3.2.3 The purchaser and supplier should give due consideration to isolating, minimising and or removing any stored or mixed reject material from the system. Both parties should ensure that reject material is disposed of in a safe and environmentally appropriate manner.
- 4.3.2.4 All material removed shall be concurrently replaced with material conforming to this Guide with an appropriate compliance certificate at no cost to the purchaser.

Appendix A: Specific Impurity Limits

A 1 Equation for determining Specific Impurity Limits

Health related SILs in Table 3 are calculated using the following equation:

$$SIL (mg/kg) = \frac{MAV (mg/litre) \times 10^6 (mg/kg)}{MD (mg/litre) \times SF}$$

Where	SIL	=	Specific Impurity Limit
	MAV	=	Maximum Acceptable Value of the impurity determinand set in the <i>Drinking-water Standards for New Zealand 2005 (Revised 2008)</i>
	MD	=	Maximum Dose of Hydrated Lime
	SF	=	Safety Factor

Iron and Aluminium in Table 3 are calculated using the following equation:

$$SIL (mg/kg) = \frac{MAV (mg/litre) \times 10^6 (mg/kg)}{MD (mg/litre) \times 10}$$

The SILs are calculated based on:

1. the maximum acceptable value (MAV) for each determinand taken from the *Drinking-water Standards for New Zealand 2005* (Ministry of Health, 2008).
2. a maximum dose (MD) of hydrated lime per litre of water, which is taken as 32 mg/L.
3. a safety factor (SF) of 10, which reflects the view that no more than 10 percent of a MAV should be contributed by a given impurity in a water supply chemical. Arsenic and lead have been assigned a safety factor of 20, reflecting recent concern amongst some public health practitioners of the impact on these impurities on public health.

Inclusion of a determinand in Table 3 is not an indication that the products are expected to contain the impurity, or, if present, that the impurity will occur near its calculated SIL.

A 2 Example Specific Impurity Limit Calculations

Specific Impurity Limits (SILs) are calculated based on a maximum dose (MD) of calcium hydroxide/litre of water and the maximum acceptable value (MAV) for each determinand taken from the *Drinking-water Standards for New Zealand 2005 (Revised 2008)* (Ministry of Health, 2008). The safety factor (SF) used in these calculations is 10, which reflects the view that no more than 10 percent of a MAV should be contributed by a given impurity in a water supply chemical.

The SILs, expressed as the weight of impurity in mg per kg of product, are determined using the equation below Table 3.

An example calculation is as follows:

Arsenic:	MAV	=	0.01 mg/litre
	MD	=	32 mg/litre
	SF	=	20

$$SIL (mg/kg) = \frac{0.01 (mg / litre) \times 10^6 (mg / kg)}{32 (mg / litre) \times 20}$$

The value is 15.6 mg/kg which is rounded down to one significant figure giving 10 mg/kg.

Appendix B: Sampling Procedure

B 1 Sampling Method

B1.1 General

- B1.1.1 Sampling and preparation shall be conducted as expeditiously as possible in order to avoid undue exposure of the material to the air, thus avoiding contamination and evaporation.
- B1.1.2 The sampling method must give a gross sample that is representative of the material, and which may be divided to provide representative samples for analysis. When taken on site, representative samples are best taken from the middle of a shipment, as insoluble material can settle during travel. The quantity of sample required by the testing laboratory to carry out the desired tests must be known prior to the sample being taken.
- B1.1.3 Samples for analysis shall be provided in triplicate. One sample is for the immediate use of the purchaser for testing of the shipment. The other two samples shall be retained until it is known from the results of the laboratory examination that the shipment meets the requirements of this Guide. The second sample shall be delivered to the supplier if requested within five days of notification of the examination results of the first sample. The third sample is for the use of a referee laboratory if there is a controversy over the analyses.
- B1.1.4 Samples shall be sealed in airtight, moisture-proof containers supplied by the analysing laboratory.
- B1.1.5 Each sample shall be labelled with the minimum information as follows: the material name, the name of the purchaser, the name of the sampler, package number, date sampled, and date received.

B1.2 Risk Assessment and Management

- B1.2.1 Before collecting samples, the sampler shall assess the risks to their own safety, and to others in the vicinity, of taking the sample, identify what measures can be taken to minimise these risks (e.g. different approach for taking the sample, dust masks, protective clothing), and take these steps.
- B1.2.2 Where possible, samples should be taken by an experienced laboratory technician.

B1.2 Sample size

- B1.2.1 The sample size must provide a gross sample representative of the material.
- B1.2.2 The size of the gross sample and the samples for analysis shall be agreed by the purchaser and the supplier, giving consideration to obtaining representative samples and the requirements of the laboratory to undertake analyses.
- B1.2.3 Suggested gross samples sizes are as follows:

B1.2.3.1 A minimum gross sample of 23 kg shall be taken for each 22 tonnes of material or as agreed.

B1.2.3.2 If the delivery is less than 22 tonnes, a sufficient gross sample of 16 kg shall be obtained from each.

B1.2.4 Each sample container shall be labelled with: the material name, the name of the purchaser, the name of the sampler, package number, date sampled, and date received. Each sample container shall be signed by the sampler.

B1.3 Sampling Method

B1.3.1 With packaged materials, at least 2% of packaged materials, but no fewer than five packages, shall be sampled. Individual packages shall be taken from various locations on the unit being sampled. No sample shall be taken from a broken package.

B1.3.2 For packaged powdered material, a sampling tube which takes a core not less than 13 mm in diameter shall be used. The tube shall be inserted sideways into the package so that it will take a core of the material from the entire width of the package. Three samples shall be taken from each package, evenly spaced over the length of the package.

B1.3.3 Finely divided bulk material shall be sampled by the use of a sampling tube that takes a core at least 25 mm in diameter. Cores shall be taken from at least eight separate parts of the mass to secure a representative sample.

B1.3.4 In situations where the material is delivered by bulk transport and access for uniform sampling is unavailable, the sampler must use their best judgement in collecting a representative sample. Documentation of sampling location and method is essential.

B 1.4 Handling of Samples

B1.4.1 The gross sample shall be mixed thoroughly, and at least 16 kg of the material representative of the gross sample, shall be quartered to ensure that it is homogeneous. One 4 kg sample shall be mixed well and quartered. Store three of the four 1 kg samples in sealed containers. To quarter the sample, tip it on to a clean surface so that it forms a conical or hemispherical pile. With a clean knife, cut into the pile vertically, dividing the pile into four equal parts. Make up a new pile with these four parts, and repeat the quartering process. Use three of the quarters as described in Section B1.1.3.

B2 Sample Preparation

B2.1 The preparation of subsamples for testing may affect the results obtained from identical samples so appropriate and consistent preparation procedures are most important

B2.2 Appropriate preparation techniques and test procedures must be agreed by the purchaser and the supplier.

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A consistent approach across the 3 waters sector