Water medication provides guidelines for the provision of nutritional supplements to livestock through their water supply. This system can result in more equitable and effective consumption by all stock. Written in an easy-to-read style and well illustrated with many colour photographs, Water medication has sections on:
1. benefits of water medication
2. use of non-protein nitrogen in the rumen
3. types of nutritional supplements
4. water consumption by stock
5. problems with water quality
6. medicator technologies
7. experiences of four commercial users
Appendices provide details on water sampling and analysis, and on sources of equipment and supplements.

Water medication
A guide for beef producers
Water medication

A guide for beef producers

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Water medication – a guide for beef producers
Background

Discussions between the Western Queensland Regional Beef Research Committee and Meat & Livestock Australia led to a review of the use and application of water medication technology in the northern Australian beef industry, and the publication of a Producers Guide on water medication.

Keith Entwistle and Sandi Jephcott were commissioned to review the scientific publications on the subject, to gather information on the use of water medication on commercial beef enterprises and to provide recommendations to MLA regarding any future research on the technology and its application.

This publication is based on extensive discussions with many cattle producers, extension officers, R&D staff throughout northern Australia and with a number of manufacturers and suppliers of equipment and supplement.

Acknowledgements

It is not possible to list here the 110 people who willingly gave their time to discuss water medication issues, but their help is greatly appreciated.

Keith Entwistle and Sandi Jephcott wish to specially acknowledge those people who were of great assistance in organising visits, recommending others to talk to, supplying detailed information within their areas of expertise, outlining their experiences or providing information on equipment or sources of supplies.

They particularly thank:

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In addition, the suggestions, advice and help given by Russell Tyler, DPI&F Gayndah, Queensland were greatly appreciated.

The comprehensive report to MLA by Professor Entwistle and Dr Sandi Jephcott was edited for publication as a producers guide by Ian Partridge (DPI&F, Toowoomba), who also designed the guide.

They all acknowledge the very considerable help and guidance of Geoffrey Niethe in this project.
The improvements in productivity and profitability of our northern beef industry since the brucellosis and tuberculosis eradication campaign, with the widespread use of *Bos indicus* bloodlines and development of the live export trade, have been nothing short of spectacular. Innovative changes in the way stock are mustered and handled, and the provision of water and infrastructure, have greatly reduced labour inputs and variable costs on many of our large pastoral enterprises. However, realistically there is a limit to how much progress will continue to be achieved in some of these areas.

The new challenges for the industry will be genetic improvement, productivity gains, meeting market specifications and developing better techniques to more efficiently use pastures in a totally sustainable way. Additional protein in the diet has enabled cattle producers to get more from existing pastures but this can be costly and lead to increased grazing pressure. The provision of non-protein nitrogen (NPN) in the form of urea is widely practised. It is the cheapest means of addressing the protein shortage, but stock losses, palatability and ease of distribution are issues for many northern producers.

Supplementing urea through the water supply is an obvious delivery system that promises to offer cost efficiencies and convenience. Numerous inventions and ‘good old Aussie ingenuity’ have evolved with time and this practice has increased over the past decade. Supplements such as nitrogen, phosphorus and sulphur can all be supplied through the water; however, technical difficulties still exist in some areas and some producers have become disillusioned with this technology.

Meat & Livestock Australia (MLA) has responded to this challenge by funding a publication – this guide for beef producers – that addresses current issues and identifies the problem areas for further research. MLA aims to ensure that producers have a comprehensive understanding of water medication by providing them with the information they need to make sound decisions on the suitability of water medication for their own business.

Professor Keith Entwistle and Dr Sandi Jephcott have collected data, research findings and information from all sectors of the water medication industry in north Australia. This manual will address most questions that users have right now.

I hope you find this publication useful and, on behalf of MLA, look forward to providing answers to those outstanding issues in the near future.
"Water medication – the provision of nutrients through the water supply to address dietary imbalances."

These highlights encapsulate many of the key points that will govern whether water medication will be a managerial and commercial success on your property.

- For all grazing, feed nitrogen over the dry season. The longer the dry season, the greater the response.
- About 70% of soils in northern Australia have some degree of phosphorus deficiency.
- In low-phosphorus country, feed phosphorus during the wet season – or all year round.
- Water medication is the cheapest way to deliver a daily dose of urea.
- Water medication is good technology, but not for everyone or everywhere.
- Medication works effectively only where there is no other surface or untreated water.
- Start feeding supplements before cattle lose weight.
- Pre-mix supplements are safe, simple and quick. Home mixes may be cheaper.
- Frequent topping up of urea makes rumen bugs more efficient and the animal can eat more.
- Rumen bugs need time to adapt. Build up dosage gradually. If cattle stop eating non-protein nitrogen for 2–3 days, cut the dosage immediately and then build up again gradually.
- If cattle ingest too much urea too quickly, they will die.
- Cattle drink about 10% of their body weight per day on average, but this can vary greatly.
- It is better to overestimate water consumption than to underestimate it. This reduces the risk of urea poisoning.
- If cattle drink less water, they will eat less.
- Calculate water intake using flow meters and cattle numbers.
- The quality of your water may determine the success of medication. If quality is poor, try to improve it.
- pH is critical. Low pH causes corrosion; high pH causes scale and reacts with urea.
- High pH and urea make ammonia. Then cattle cannot get their daily doses of urea and will not drink the water because of the smell.
- Ensure quick turn-over of solution in the concentrate tank by holding only enough for 7–10 days.
- Mix the nutrient solution regularly and often.
- Calibrate and calculate dosage rates regularly. Record all the workings.
- Good records allow ‘trace back’ if things go wrong.
- Do not cut corners, do it the right way – mistakes can be costly.
- Nitrogen supplements allow your animals to eat more grass. After a few years of heavy grazing, the desirable grass species will decline. You need to monitor the condition of your pastures over time, and to adjust your stock numbers to keep your grassland productive.
1. Why water medication?

Good cattle management integrates practices such as controlled mating, early weaning, segregation of young heifers and feeding supplements to overcome the constraints of an uneven or hostile environment.

Good growth rates of animals throughout the year are increasingly important to attract premium prices and market specifications. Improving pasture with legumes or more digestible grasses is not a feasible proposition in most extensive production systems so most cattle receive insufficient nutrition for at least part of the year.

Too little protein

Most cattle in northern Australia have to eat native grasses grown on relatively poor soil under marginal conditions and with a long and severe dry season.

From the time grasses flower and mature, around March, until the first flush of green when the next wet season breaks, the herbage that cattle in many regions eat is often too low in protein and energy to maintain body weight or condition.

Supplementing the animal with nitrogen as true protein or non-protein nitrogen (NPN) over this period allows it to digest the dry fibrous grass.

For all grazing, feed nitrogen over the dry season. The longer the dry season, the greater the response.

Too little phosphorus

About 70% of soils in northern Australia have some degree of phosphorus deficiency.

Cattle need phosphorus during their period of peak growth and lactation in the wet season, but do not respond to phosphorus during the dry season if nitrogen is also limiting. Thus phosphorus should be fed during the wet season – or throughout the year on phosphorus-deficient country, along with nitrogen.

In low-phosphorus country, feed phosphorus during the wet season — or all year round.

Why supplement?

Today, cattle are being turned off breeding properties earlier for the store, export and feedlot finishing markets, and producers are receiving a better return for young heavy cattle. Fewer deaths, more calves, heavier weaners and faster growth rates make the benefits of supplementing much more profitable than in the days when bullocks were turned off at a greater age.

Supplements are not new

The basic principles behind the strategic use of nutritional supplements for beef cattle have been well established with extensive research. They are accepted by most producers as a routine management practice throughout much of the northern Australian beef industry.
Supplements have been fed to stock for decades. But feeding traditional loose lick or block supplements can pose certain problems. Is the supplement palatable? How do you ensure that each animal receives adequate, but not excessive, levels of nutrient? How do you distribute the supplement around the paddocks on extensive properties? What is the cost?

Water medication

Water medication offers the opportunity to distribute the supplements to all stock through their drinking water so that each will get the right amount. Supplement intake is directly related to water intake.

Does water medication work?

Readers should note that there is little well established scientific evidence on responses to water medication, but plenty of information from uncontrolled field studies, and from the experiences of producers.

- On the Mitchell grass plains of the Barkly Tablelands, weaners on water medication gained 0.3kg more per day in the early dry season and an extra 0.1kg per day over whole dry season than those without supplement.

- Weaner heifers on speargrass in north Queensland responded to urea and sulphate of ammonia supplied through water medication during the dry season. They did grow better when the supplements were mixed with molasses in open troughs but this was because the molasses provided extra energy and other minerals and they ate more urea.

- In the ‘desert’ country of central Queensland, breeders on medicated water had pregnancy rates some 15% higher than those on dry licks, although they were only 15 kg heavier. During both the dry season and wet season, cattle on medicated water took in considerably more urea and phosphorus than those on dry licks, and they produced slightly heavier calves.

- Under the severe dry season conditions of northern Australia, urea supplemented through water medication or dry lick blocks reduced weight losses of breeders by 6–10% and increased pregnancy rates by 8–14%. Cows became pregnant earlier in the mating season, and the number in calf in January increased by 18% and in March by 21%.

- In central Australia, lactating cows provided with nitrogen, phosphorus and sulphur supplement through a water medicator were in better body condition and 40kg heavier than those receiving no supplement; they had slightly higher pregnancy rates (53% v. 42%), and their total weaner weight was higher. Heifers on this water medication had 21% higher pregnancy rates although they were no heavier. Those critical lactating heifers had 30% higher pregnancy rates than unsupplemented heifers. Economic analysis suggested a benefit/cost ratio of about 9:1.

- Producers in the Wandoan district know that weaner steers either stagnate or lose weight on buffel grass during winter. Over four successive winters, weaners fed urea supplement through water medication gained weight.

- In south-west Queensland, supplementing steers grazing mostly mulga with nitrogen, phosphorus and sulphur through the water for three years gave a 15kg carcass weight advantage at slaughter and 2mm more rump fat than unsupplemented steers.

- On another property in central Australia, cattle drinking from a bore supplemented with medicated urea, MAP and sulphate of ammonia were heavier and had fewer dry and non-pregnant cows than those on an unmedicated bore.
1. Why water medication?

How profitable?
Recent desk studies show that supplying supplement can greatly affect the gross margin of a breeder herd.
Increasing body condition of breeders by one unit (from backward store to store) at the end of the dry season cost $30/breeder/year with commercial lick blocks, $15 for dry licks, but only $7 with efficient water medication.
If urea-based supplements reduced breeder mortality, they were highly cost effective, with gross margin increases of up to $11/adult equivalent.
If the only benefit was fertility (increased number of calves weaned) and supplementation cost $15/breeder/year, the increases in gross margin from additional cattle sales were small ($–5 to $+2/adult equivalent). But supplementation became highly cost-effective if the costs were reduced by using water medication.
Gross margins can be increased by 57% when acutely deficient herds are supplemented with phosphorus, and by 7% in herds with marginal deficiencies.

Cheapest way to feed NPN
Water medication is nominally the cheapest method of delivering the recommended daily dose of 50–60g urea, but lick or molasses-based supplements may provide extra nutrients. The costs of labour and vehicles for supervision, depreciation of equipment or possible mortalities have to be taken into account with all methods of feeding.

<table>
<thead>
<tr>
<th>Product</th>
<th>Cost/tonne ($)</th>
<th>Recommended feed rate (g/hd/day)</th>
<th>Urea (%) in product</th>
<th>g urea in recommended rate</th>
<th>Actual rate to deliver 60g urea</th>
<th>$/head/day to deliver 60g urea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proprietary water medication mixes</td>
<td>970</td>
<td>55</td>
<td>72</td>
<td>40</td>
<td>83</td>
<td>8</td>
</tr>
<tr>
<td>Loose mixes¹</td>
<td>550</td>
<td>150</td>
<td>30</td>
<td>45</td>
<td>200</td>
<td>11</td>
</tr>
<tr>
<td>Blocks¹</td>
<td>1,200</td>
<td>70</td>
<td>30</td>
<td>21</td>
<td>200</td>
<td>24</td>
</tr>
<tr>
<td>Commercial liquid NPN supplement²</td>
<td>500</td>
<td>1,000</td>
<td>4.7–11.6</td>
<td>50</td>
<td>1,200</td>
<td>20–50</td>
</tr>
<tr>
<td>M8U</td>
<td>220</td>
<td>500</td>
<td>8</td>
<td>40</td>
<td>750</td>
<td>17</td>
</tr>
</tbody>
</table>

¹Note that content and cost of these can vary considerably
²For example, Anipro⁰ and Prolix⁰: the costs of these supplements should be compared to licks and blocks.

Water medication is the cheapest way to deliver a daily dose of urea.

How much cheaper?
The costs (at July 2004) of various supplements based on their ability to supply the recommended dose of urea are shown below.
1. Why water medication?

**Advantages of water medication**

Claimed advantages include:

- all animals drink the medicated water and thus consume the supplement
- intake of water, and thus nutrient, is proportional to body size
- intakes are more uniform across a mob as factors of animal behaviour (shy feeding, bullying) and supplement (acceptability and palatability) are reduced
- costs of supplement are lower because carriers such as molasses and salt are not needed
- labour costs may be reduced, although the time spent monitoring and maintaining dispensers and concentrate tanks is probably the same as that involved in loading and transporting other supplements
- potentially less ‘wear and tear’ and maintenance costs on vehicles although waters still have to be monitored frequently
- managers have better recognition of the importance of water consumption and water quality on production
- can deliver other water-soluble substances including sugars and electrolytes

**but:**

- can be used only through troughs where no other surface or untreated water is available
- needs additional capital investment in equipment and facilities
- needs high level of management and technical skill
- needs continuous supervision and monitoring
- careful management of stock if held off water in the yards or when storm rains provide temporary surface water
- potential deaths from urea toxicity because of human error or medicator malfunctions (although these can also occur when feeding dry licks or blocks)
- increased risk if less skilled staff operate and maintain medicator
- possible losses of supplement and reduced water intake with poor quality water
- can feed only supplements that are soluble in, and remain stable in, water
- limited data on responses with medication (but should be equivalent to other methods)

**Who can or should use it?**

As with many new techniques, water medication has been most successful in the hands of producers convinced of its value. These producers have been prepared to learn and understand the principles and mode of action of medicators, the safety margins and potential risks, and to accept the need for frequent and ongoing monitoring of water points, equipment and livestock.

Water medication is good technology but cannot be used everywhere, and it cannot be used by every manager.
Successful uses

Water medication can be used on most grazing properties where water supplies are fully controlled and delivered through troughs. If stock can drink from dams, springs or creeks, they may not take in enough supplement from the medicated water supply to achieve a benefit.

Equally important is the high risk of toxicity and mortalities when animals that have been drinking non-medicated water return to the medicated source, because their rumen bugs may have lost their adaptation to high levels of urea.

Successful users

Successful users of water medication tend to have:

- desire to improve herd production levels using a range of technological and management strategies
- high level of management expertise
- good technical background and knowledge of equipment operations and maintenance
- good understanding of water intake and water quality issues

- willingness to invest in new or modified water supply facilities of a good standard
- understanding of nutritional principles and the ability to identify which, when and how limiting nutrients should be provided
- commitment to regular monitoring and recording of medicator operations and of cattle performance
- recognition of potential hazards and how these can be minimised
1. Why water medication?

<table>
<thead>
<tr>
<th><strong>You are thinking about it, but —</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>How will you check existing water quality? (Appendix 1)</td>
<td></td>
</tr>
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<td>How might the supplement react with poor quality water? (p.19)</td>
<td></td>
</tr>
<tr>
<td>How could you improve water quality? (p.23)</td>
<td></td>
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<tr>
<td>How will you monitor water quality and medicated water supplies? (Appendix 2)</td>
<td></td>
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<tr>
<td>How will you monitor water intakes and adjust medicator-dispensing rates? (p.32)</td>
<td></td>
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<tr>
<td>What are the correct grade, type and combination of supplements to minimise problems of acceptability, intake, precipitation, sedimentation and organic growth? (p.12)</td>
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<td>How will you calculate the right size of concentrate tanks to supply medication for 7–10 days? (p.31)</td>
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<tr>
<td>Do you have a system (fire pump, paddle) to mix concentrate solution thoroughly? (p.31)</td>
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<td>What is the appropriate type and size of medicator and power supply? (p.26)</td>
<td></td>
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<td>Where will you place and protect medicator units, power supplies and cabling? (p.29)</td>
<td></td>
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<td>What are the best types of pipe fittings to minimise corrosion of pipelines and dispensing equipment? (p.36)</td>
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<td>Do you thoroughly understand the operation and calibration of units? (p.33)</td>
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<td>Will you be able to regularly maintain units and filters, meters and other monitoring equipment and check dispensing rates? (p.34)</td>
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<tr>
<td>How will you formulate concentrate mixes and calculate and calibrate volumes of nutrient solution to be injected into the line? (p.33)</td>
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<td>Can you be sure the medicated water will be the only water source in a paddock? (p.4)</td>
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<tr>
<td>Do you feed dry licks or blocks containing urea? How will total daily urea consumption patterns be kept in the 40–60 g range and recorded? (p.14)</td>
<td></td>
</tr>
<tr>
<td>How will you train and supervise staff to minimise chances of human error? (p.34)</td>
<td></td>
</tr>
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<td>How will you monitor production responses and analyse costs and benefits? (p.3)</td>
<td></td>
</tr>
<tr>
<td>Will you monitor the effects of supplementing cattle on the condition of your pastures? (p.10)</td>
<td></td>
</tr>
</tbody>
</table>

Still interested? – read on
2. Feeding the rumen bugs

This section describes simply the ruminant’s digestive system as relevant to water medication. A much more complete description of ruminant nutrition can be found through the MLA EDGE network nutrition workshops.

The rumen

Ruminants can use high-fibre diets such as grass through a symbiotic relationship with cellulose-digesting microorganisms (bacteria, protozoa and fungi) living and multiplying in their large fermentation vat – the rumen.

In the simplest of terms, the microorganisms digest parts of the forage to make microbial protein for their own growth and reproduction. The bodies of the microbes flow in the rumen fluid down the animal’s digestive system; they are then digested themselves by acid and enzymes in the true stomach (abomasum), along with nutrients that were not used by the microbes. Microbial protein makes up approximately 70% of all protein absorbed from the small intestine.

The rumen has a capacity of 60–100 litres of fluid, the pH of which is maintained at a desirable level by the animal producing copious amounts (eg 140 litres per day) of saliva containing various salts (sodium, potassium, phosphates, chlorides and bicarbonate). Rumen pH for cattle on pasture is 6–7, on concentrate feeds 5.5–6.5. Rumen pH <5 indicates acidosis and >7 indicates alkalosis or ‘dead belly’.

Microbial digestion

For the rumen microbes to form their own protein, they need energy, nitrogen (N), phosphorus (P) and sulphur (S). With green grass, the plant fibres are softer and the contents of the plant cells supply these nutrients. Plant protein is broken down to ammonia by the microbes to make their microbial protein. Digestion is fast. The digested plant mass and fluid soon pass through to the rest of the digestive tract and the animal can start eating again.

In mature herbage the plant fibres are lignified and hard, and the plant cell contents have dried out—the level of protein is often too low for optimum microbial production, and little of the rumen content can move on. The rumen stays full of undigested hard material, and the grazing animal is unable to eat more.

Non-protein nitrogen

Fortunately, the rumen micro-organisms can use ammonia from a non-protein source to make their microbial protein. Thus, adding small amounts of NPN as urea can allow the rumen microbes to break down hard plant fibres more quickly, and to make more microbial protein and energy for the animal to digest in its true stomach.

Add too much urea and the extra ammonia will raise the pH of the rumen fluid and may be absorbed directly into the blood stream in toxic amounts.
The true stomach
The ruminant’s true stomach, or abomasum, digests both microbial protein and ‘by-pass’ proteins that were not attacked by the rumen microbes. This once-only ‘true’ digestion is more efficient than the two-stage digestion through microbes.

Nutrition
The whole process of capturing energy for the body is much less efficient in ruminants than in monogastric animals. Pigs and poultry may have efficiencies of nearly 80%, ruminants less than 20%. On the other hand, ruminants can turn poor-quality food such as grass into high-quality protein as meat or milk.

Grass as feed
Tropical grasses contain more structural cellulose or fibre than temperate grasses because they use sunlight in a different photosynthetic pathway. Even during the growing seasons, the dry matter digestibility (DMD) of tropical grasses is lower than that of the temperate species.

Early in the dry season, tropical pasture in northern Australia may have a crude protein content of 7.5% (1.2%N) but, from June to October when the pasture is mature, dry or frosted, this may fall to less than 6% crude protein, with a dry matter digestibility of 40–50%.

(Crude protein percentage of a feed is calculated by multiplying the nitrogen level by 6.25.)

A diet containing 4–6% crude protein is at maintenance level for a non-lactating, non-pregnant 400kg high-grade Brahman animal. It cannot support growth, reproduction or lactation in cattle without some form of supplementary feeding.

The digestibility and crude protein of herbage can be measured in plucked samples of herbage or, more reliably, assessed in the diet by analysing faeces with Near Infrared Reflectance Spectroscopy (NIRS).

The ideal ratio of dry matter digestibility to crude protein is about 8–10:1. A response to urea is highly likely when the ratio is 10 and probable when greater than 8–9.

Water
Water is an essential part of the diet. It is used for all vital processes, including digestion, removal of waste products of digestion and metabolism and in body secretions such as saliva, digestive fluids and milk, and to regulate temperature.

While a starving animal may lose almost all of its fat and half of its protein and still survive, the loss of one-tenth of its body water can be fatal.

Animals gain water by drinking, in feed and as ‘metabolic’ water formed during oxidation of nutrients from the diet and from body tissues.

Feed quality (energy and protein*) declines as the grass plant ages

<table>
<thead>
<tr>
<th>Stage of growth</th>
<th>Dry matter</th>
<th>Digestibility</th>
<th>Metab. energy (MJ/kg DM)</th>
<th>Crude protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early, rapid</td>
<td>Low (&lt;30%)</td>
<td>65</td>
<td>10</td>
<td>10–16</td>
</tr>
<tr>
<td>Stem elongation, mostly green</td>
<td>Medium (30–50%)</td>
<td>60</td>
<td>8.5</td>
<td>8–10</td>
</tr>
<tr>
<td>Flowering, seeding, growth slows, 10–30% green</td>
<td>Medium/high (50–70%)</td>
<td>55</td>
<td>7.5</td>
<td>6–8</td>
</tr>
<tr>
<td>Senescence, no growth, no green</td>
<td>High (&gt;80%)</td>
<td>50</td>
<td>6.5</td>
<td>3–6</td>
</tr>
</tbody>
</table>

* These values are more representative of an improved pasture species than of a native pasture.
Energy

Energy is not an actual substance like proteins or minerals. It is recovered from carbohydrates, fats and protein and used to drive protein production in the rumen. Energy in pasture is strongly related to the digestibility (see Digestibility and Metabolizable energy values in table on the opposite page). A ratio of dry matter digestibility to crude protein of greater than 8–9:1 indicates a deficiency of protein.

If energy is deficient, any unused ammonia will be lost in the urine; if protein is deficient, the surplus energy will be used inefficiently in other metabolic processes.

Protein

The animal’s need for protein will depend on its age, growth rate and whether it is pregnant or lactating.

Minerals

Animals grazing on fertile lands can get enough minerals from pasture, but phosphorus may be lacking when they graze phosphorus-deficient country—much of northern Australia. Deficiencies of other minerals are generally confined to isolated areas, although mature grass is often low in sulphur and sodium.

The ratios of minerals are as important as absolute levels. For example, the calcium:phosphorus ratio should be 1.2–2:1 and the nitrogen to sulphur ratio should be about 10–15:1. Sulphur is essential for microbial digestion of non protein nitrogen and other protein sources. Calcium is rarely deficient in grazing animals and is often in high concentrations in poor quality waters.

In northern Australia, the most important mineral deficiencies are phosphorus and sulphur.

Phosphorus

Phosphorus is the second most plentiful mineral in the body after calcium, and is present in all cells of the body, with most in the skeleton. The important roles of phosphorus are the conversion of feed into energy, build-up and repair of body tissues including bone, in development of the foetus and in production of milk.

Thus a deficiency of phosphorus results in poor growth and fertility. During a period of phosphorus deficiency, cattle can mobilise phosphorus from their skeleton. This can lead to soft and weak bones and, in extreme cases, ‘peg leg’.

As cattle can recognise phosphorus and sodium as being deficient in their diets, they seek alternative sources. In the case of phosphorus deficiency, this leads to bone chewing and the possibility of botulism in unvaccinated cattle.

Concentrations of both nitrogen and phosphorus vary greatly between seasons in all northern pastures. Typical seasonal variation in Mitchell grass is shown below.
2. Feeding the rumen bugs

Feed intake
The amount an animal can eat (its intake) is constrained by the speed of digestion of the herbage in the rumen.

Dry matter intake (ie the non-water component of feed) is often expressed as a percentage of body weight, and may range from 1.5% on dry winter feed to 3% on feedlot rations.
Factors that influence dry matter intake include:
• digestibility of the feed and hence rate of passage through the rumen
• amount of available pasture
• age and class of animal
• quality of water
High-producing animals (eg lactating cows, young growing animals) cannot eat the volume of poor-quality feed needed to satisfy demands—even when these pastures are supplemented with non protein nitrogen. These animals need to be supplemented with energy-rich feedstuffs that contain undegraded protein or bypass protein as well as non protein nitrogen.

Should I feed supplements?
Cattle may need supplementing when they start to lose condition. This could be caused by:
• deficiency of a component of feed (eg protein)
• too little feed
• parasites

If there is too little herbage in the paddock, it is too late; the cattle should already have been moved, sold or agisted. It is rarely economical to feed hay for extended periods.
Parasites may be internal or external. Internal parasites (worms) are rarely a problem in older cattle. External parasites such as lice are more likely to multiply when the animal is already in poor condition than to be the cause of the condition. The problems and control of ticks are well known and are outside this short publication.
However, other herd management strategies also need to be considered. For example, in north Queensland, earlier weaning can have twice the benefit on the weight and condition of cows than feeding them urea-based supplements.

Supplements and stock numbers — protecting your pastures
Nitrogen supplements allow your animals to eat more dry grass. This allows you to carry more stock during the dry season, and the subsequent low levels of ground cover increase chances of soil erosion with storm rains.

Although the grass plants are not harmed much while they are dormant over the dry season, they will be greatly weakened by continuous heavy grazing when they start to grow again after the rains come.

After a few years of heavy grazing, your desirable 3P grass species — perennial, palatable and productive — will decline, and may be replaced by unproductive grasses, woody weeds or bare ground.
You need to monitor the condition of your pastures over time and to adjust your stock numbers to keep your grassland productive.

For further information about the EDGEnetwork nutrition and grazing land management workshops, phone MLA EDGENetwork on 1800 993343, or check the internet on www.edgenetwork.com.au
3. When and what to feed

A number of compounds can be fed through water medication but the most important are the supplements of nitrogen, phosphorus and sulphur. Supplementary nitrogen is supplied in a non-protein form.

**Non-protein nitrogen**

Non-protein nitrogen (NPN) is nitrogen that does not come from a protein source.

Urea is the most common NPN supplement because it is effective, cheap, readily available, dissolves in water and is relatively palatable. However, urea is very toxic at high levels.

NPN can be delivered in sulphate of ammonia (SOA) which also supplies sulphur. SOA is unpalatable and is used to control intake. NPN is now also available in a slow-release liquid form.

**When to start feeding NPN**

Supplementing cattle with NPN does not generally improve their production, but it prevents further loss. So it is important to start supplementing before cattle lose too much weight or condition.

The time to start feeding NPN can be determined objectively or subjectively.

Objective measurements are more accurate but are more expensive and time-consuming. The most common is analysis of faeces by NIRS; nitrogen supplements should be fed when the diet of Brahman stock contains less than 4.5% crude protein.

Subjective judgement can be based on the appearance or condition of stock, the appearance of the pasture as affected by lack of rain or frost, or through the consistency of dung pats.

Start feeding when the dung pats begin to mound, dry out quickly as hard fully formed pats and become readily visible in the paddock.

Some examples of pat consistency can be seen in the adjacent photographs.

Start feeding supplement before cattle lose weight.
How much urea?

The current broad recommendations for northern Australia are to feed weaners weighing 200kg about 30g urea per day and lactating cows about 50–60g per day. If energy becomes limiting when urea is fed above these levels, there will be no further response, and the urea may become toxic.

A daily urea intake of 60g for a breeding cow equates to a dose of 0.13g/kg body weight. Intakes up to 0.33g/kg bodyweight increase blood ammonia levels; intakes of 0.44g/kg body weight produce signs of poisoning within 10 minutes, and intakes of 1–1.5g/kg body weight cause rapid death.

Rumen bugs need time to adapt

When NPN is first fed, it takes a couple of weeks for the rumen microorganism composition to change so as to handle this nitrogen source.

- Build up the dosage gradually.

Similarly when cattle stop eating NPN, the rumen bug composition changes back.

- If the animals are off NPN for more than 2–3 days, cut the dosage immediately and then build up again gradually.

Which supplement?

The right supplement will depend on seasonal conditions, pasture quality, recognised mineral deficiencies, class of cattle being supplemented, production objectives, water quality (particularly pH) and labour involved.

Producers can either mix their own supplement ingredients or buy proprietary pre-mixes.

Stockfeed grade or cheaper fertiliser?

The same basic nutrients can be found in ordinary fertilisers, stockfeed grade fertilisers and technical or food grade products.

In some products, technical grade and fertiliser grade differ slightly in formulation, with technical grades usually more soluble.

Some technical grade products use better quality raw materials and have a better production QA process giving more even sized granules. Some granular phosphorus fertilisers are specifically labelled ‘For fertiliser use only’ because of their higher fluoride content. These include fertiliser grade monoammonium phosphate (MAP) and diammonium phosphate (DAP).

Fertiliser grade products may be 30–50% cheaper than those of technical grade but, being less soluble, they may not supply enough nutrients unless the delivery rate is increased substantially.

The additional costs of increased labour for mixing, cleaning nutrient tanks and from possible damage to the dispenser may negate any savings from the cheaper grades.

What supplements and medicators are used in northern Australia?

<table>
<thead>
<tr>
<th>Region</th>
<th>Supplement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inland Central Qld, NT</td>
<td>60% use home brew mixes of urea/SOA in the dry season. In P-deficient areas, also use P (MAP) in the wet season. 30% use prepared mixes 10% use Liquid Nª 2% use trace element mixes</td>
</tr>
<tr>
<td>Western Australia</td>
<td>Equal % NORPRIM and NUTRIDOSE, small number of DOSATION units, 1 DOSIMATIC unit</td>
</tr>
<tr>
<td>SE and W Qld, Collinsville, Gulf and western Gulf</td>
<td>50% using home brew mixes of urea/SOA (and sometimes P) in the dry season 30% using prepared mixes 20% used Liquid Nª &lt;10% used the trace element supplement 30% supplemented all year round</td>
</tr>
<tr>
<td></td>
<td>50% NORPRIM, NUTRIDOSE next most popular, small number of DOSATION</td>
</tr>
</tbody>
</table>

Water medication – a guide for beef producers
Urea
There are four grades of urea. Granulated urea is hard with large particles, which make it poorly soluble and difficult to mix. Stockfeed urea or Liquifert N, which contains under-sized granules screened from granulated urea, is easier to dissolve. Prilled urea is softer and, with a slightly smaller particle size, dissolves even more quickly. The urea form should contain less than 1% biuret, which is a non-soluble condensation product of urea. High biuret urea (3%) leaves more residues in the nutrient tank and delivery system.

Urea will dissolve in its own weight of water but, as this cools the solution, it becomes increasingly difficult to dissolve. A practical limit is 25kg/100L (25% w/v) for urea (and 20kg/100L for technical grade mono ammonium phosphate.)

Phosphorus
The most suitable sources of phosphorus for medication in neutral water are technical grade mono ammonium phosphate (MAP) and food grade monosodium phosphate (MSP). Technical grade MAP is acidic in solution, has no buffering capacity but is cheap (currently being imported from China). Food grade MSP is a highly soluble, excellent quality source of phosphorus. Less recommended is technical grade di ammonium phosphate (DAP) which is neutral to alkaline in water, increases urea hydrolysis and is no cheaper than technical grade MAP.

Other phosphorus products include urea phosphate for use in alkaline water, and phosphoric acid (Class 8 Dangerous Goods code; corrosive, dry, solid) which can reduce water intake and is rarely used now. Kynofos and dicalcium phosphate (DCP) are both non-soluble forms of phosphorus and should be used only in dry licks.

Phosphorus supplements should not be mixed with calcium salts, magnesium salts, or metallic sulphates as insoluble precipitates will form. As calcium salts are insoluble, supplements containing calcium cannot be put through a water dispenser.

Sulphur
Sources of supplementary sulphur include sulphate of ammonia (SOA, Gran-Am), sodium sulphate and flowers of sulphur (elemental sulphur). Incitec’s Gran-Am is the only SOA form suitable as a stockfeed, but contains granulation and coating agents that may cause sediments to form in mixing tanks, particularly if water is alkaline or hard or if phosphorus supplements are also used in the mix. A scum may also form on the solution or be left on the internal walls of the mixing tank. If the sediment or scum cause problems, a higher-grade ammonium sulphate may have to be purchased from a supplier other than Incitec.

Elemental sulphur is not very soluble; while small particle size sulphur (eg Incitec Stockfeed Sulphur) can be used in dry licks it is less suitable for use in water medicators.

Home mix or pre-mix?
Home mix. The obvious advantage of home-made mixes is lower cost, with the cheapest costing about 4c/head/day (See Appendix 2). Producers can purchase stockfeed grade fertilisers, or technical or food grade products from the supplier with the best deal.

Home mixes can also be modified as the season changes and pasture nutrition decreases. They can be custom mixed for a particular property or livestock type, although this requires a good knowledge of nutrition, pasture quality and objective measurements of animal performance.

Pre-mix. Prepared mixes are usually formulated on the ‘one shot fits all’ principle, but special mixes can be prepared to fit specific requirements, eg changing seasonal conditions or different water qualities—at a cost.

Approximate costs of supplement component and home mixes (June 2004) and tables of various sources of prepared mixes containing a range of proportions of N, S, P and trace elements for either dry or wet season feeding can be found in Appendix 2.
Urea toxicity

Cause and prevention

If cattle ingest too much urea too quickly, they will die.

Cause

When a large amount of urea is consumed, it produces ammonia in the rumen. If there is too much ammonia for the rumen microbes to use, it is absorbed across the rumen wall into the blood stream, and becomes toxic if the liver cannot cope.

High levels of ammonia in the blood affect the brain causing ammonia intoxication and respiratory failure within 20–30 minutes of ingesting urea.

Animals unaccustomed to urea may show clinical signs of poisoning when fed even moderate levels, but become more tolerant if the intake is increased gradually. This tolerance is lost rapidly and animals that receive no urea for three days are again susceptible. Starving animals and those on a low-protein diet are more susceptible.

All ruminants including sheep, cattle, camels, goats and pseudo-ruminants such as marsupials are highly susceptible to urea toxicity. Mono-gastrics such as horses and dogs are more tolerant because they have no urease enzyme to metabolise the urea in their gut, but intakes over 1.5g/kg (about 600g in an average stockhorse) can be toxic. The clinical signs in horses and dogs are similar to those of cattle.

Prevention

Prevention is better than cure. Urea toxicity can be prevented through careful management whenever urea is fed. Many mortalities are caused by human error.

Whenever feeding urea:

- never provide urea to thirsty or hungry cattle
- make sure cattle coming out of the yards or off trucks drink at a urea-free trough until their thirst is quenched, and that they are allowed to graze for 48 hours before being exposed to urea-based supplements
- start feeding earlier in the season to avoid access by hungry cattle
- ensure urea is available to cattle consistently during the supplement season; erratic feeding may result in gorging and deaths
- try to maintain urea intakes at the recommended levels of 30–60g/head/day, irrespective of the supplement method used; do not exceed these levels when feeding urea in any form
- train staff in the risks of urea toxicity, mixing of supplements, and monitoring of intakes, equipment and the health and welfare of cattle

When feeding through water medicators:

- build urea levels gradually, increasing from 20g/day for 10 days, to 40g/day for the next 10 days, and then to desired levels
- never feed urea at more than 2g/litre of water
- always mix the product in the concentrate tank completely and frequently by stirring or pumping; check for any undissolved urea with a mesh scoop
- fill concentrate tanks to contain sufficient supplement to supply cattle for only 7–10 days; this gives good turnover in the tank, and minimises impacts of poor quality water
- position the concentrate tank and medicator between the storage tank and the troughs
- never put either concentrated or diluted urea supplements in open storage tanks as evaporation will increase urea concentration
- monitor water intakes and adjust dose rates accordingly
- make sure there are no other sources of water available to supplemented cattle
- clean concentrate tanks and equipment at the end of a feeding period and flush with clean water
- maintain equipment regularly and replace suspect parts to prevent malfunctions
- never tamper with medicators, water meters or connections without the supplier’s advice
Signs, diagnosis and treatment

Is it urea poisoning?

Diagnosis of urea toxicity is easy when several animals die quickly close to the trough or urea source. It may be difficult to distinguish from some cases of plant poisoning with single animals.

Clinical signs

Clinical signs include gaseous bloat caused by rapid build-up of ammonia gas in the rumen and neurological intoxication with ammonia.

Cattle usually exhibit a range of signs and show some or all of the following:

- excessive salivation
- frothing at the mouth
- severe abdominal (gut) pain, sometimes with teeth grinding
- muscle and skin tremors and spasms
- uncoordinated, proppy gait with staggering
- weakness
- breathing difficulties, usually slow, deep and laboured
- collapse and bloating
- violent struggling and bellowing
- regurgitation of rumen contents
- tetanic spasms immediately before death.

Death comes quickly and at a high rate. Post-mortem autopsy shows generalised clogging of blood vessels and bleeding, resulting in dark carcasses and internal organs, and fluid swelling (oedema) in the lungs.

The carcass is often bloated with a large amount of frothy ruminal fluid at the mouth and nostrils. The rumen is alkaline and both rumen and blood smell of ammonia. Urea supplement history, signs of bloat and large amounts of ruminal fluid seen at the nostrils after death are usually good indicators of urea toxicity.

Treatment

The only effective treatment is prompt and efficient emptying of the rumen through a large-bore tube (trocar) punched into the rumen high on the left flank.

In early cases, drenching with four litres of a weak acid such as vinegar or 5% acetic acid may increase rumen acidity, reduce the amount of ammonia produced and absorbed and therefore act as an antidote. But this may have to be repeated every 30 minutes before clinical signs reoccur.

Symptomatic treatment might be effective; for example, bloat can be treated by inserting a trocar into the rumen or in some cases by passing a stomach tube into the rumen through the mouth.

First aid kit

A first aid kit for urea poisoning should include vinegar or 20 litres of acetic acid, disposable trocars, a stomach tube and a mouth gag for administering acetic acid.
3. When and what to feed

The advantages of prepared mixes are safety, simplicity and reduced labour involved in mixing. Many producers not directly involved with the day-to-day operations of their water medication prefer the simpler process to reduce the risk of human error. It is easier for staff to remember ‘X’ number of bags of supplement per concentrate tank than the proportions of three different components.

With large orders, premixes may cost only marginally more than the home-mix ingredients. Some producers claim that certain prepared mixes leave residues in the concentrate tank.

**Liquid supplements.** CattleKing Liquid N® supplement is becoming increasingly popular, with 10–20% of producers interviewed using or having used Liquid N. The product has been in use for only a relatively short time and there is no objective production data.

Liquid N is sold as a slow-release source of ammonia, and consists of 32% carboxyl-amide polymer and 2% lignosulphonate – a chelating or binding agent. ‘Slow-release’ aims to provide a more constant concentration of NPN in the animal’s rumen between infrequent drinks.

But to be effective, this slow-release must extend over a period of at least 12 hours—which has not occurred in other previously developed slow-release products. Also lignosulphonates can bind nitrogen so tightly that not all is available to be converted to ammonia. Many slow-release products need an adaptation period of 12–24 days for the rumen microorganisms to develop.

Until the product has been independently assessed, producers need to be cautious in accepting some of the claimed advantages. These include the extreme safety of the product, its stability in hard and alkaline waters and its organic certification. According to Biological Farmers of Australia, CattleKing Liquid N is not currently a certified organic product.

Liquid N is considerably more expensive than the other sources of nitrogen.

**Trace element mixes** A trace element deficiency in stock may show up if a particular trace element is deficient in soil in the area or if their immune system is being compromised by stress, for example by weaning, pre-calving or transport. But animals can only respond to supplementary trace elements if the primary nutritional deficiency, usually protein or phosphorus, has first been satisfied.

Some prepared supplements, such as Norprim dry season and Growforce Flowfeed 1 and 4 products, contain trace elements. Some producers add individual trace elements separately, the most common being copper, zinc, selenium, magnesium and cobalt. However, there is always a risk of toxicity (eg copper and selenium) if individual elements are added in incorrect amounts.

The most commonly used trace element supplements are Virbac Maxi-Min and NatraKelp Liquid Seaweed. Some companies use a lignosulphonate-based chelation process to formulate their trace element mixes, but the benefit of chelating may not be economical for stock grazing native pastures.

Other compounds Other compounds that have been used in water medication include anti-bloat treatments, antibiotics, anthelmintics, amino acids including methionine and, more commonly in northern Australia, electrolyte and sugar supplements. Amino acids used in water medication are unlikely to have much benefit as most will be largely degraded in the rumen; they then become an expensive source of nitrogen and sulphur.

Some producers supplement stock before trucking with electrolytes and sugars to reduce stress and improve meat quality, but the benefit has not been proven.

Electrolytes and trace elements are sometimes given to weaners to reduce stress and improve immunity, but other issues of weaner management are probably more important.

Water-flavouring Stoc-Joy® may enhance the uptake of electrolytes and improve water consumption, but is not practical or economical in extensive paddocks.
4. How much do they drink?

Animals have to drink water to maintain essential bodily functions such as digestion and elimination of toxic substances. If the animal does not drink enough water, the herbage it has already eaten cannot be digested quickly, and it cannot eat more. Performance and production levels will suffer.

If cattle drink less, they eat less.

What influences water intake?

For effective water medication, concentrations of the supplement nutrient have to be adjusted so that animals get the required intake of the nutrient every day. Thus you need to know how much they drink and what can influence this.

Factors that have to be considered when planning water facilities and water medication strategies include animal size and reproductive status (e.g., wet or dry cows). Each class of animal drinks a different amount of water, and there can be considerable variation between individuals.

Seasonal and environmental conditions also affect water needs. Animals on high-quality wet-season pastures with high water content drink much less than those on low-quality dry-season pastures. As ambient temperatures increase, animals need more water to maintain stable body temperature. Distances between water points influence the frequency of drinking and amount of water consumed.

How much water?

Daily water intake will vary greatly but can be calculated when the number of animals on the medicated water point is known. Water flow into the trough is measured by either an electronic or mechanical water meter, and water intake data is logged. But water intake cannot be measured accurately on a water grid system with supply to a trough coming from several interconnected bores and these have to be estimated.

A general rule of thumb for calculating water needs of beef cattle has been an average daily water intake of about 10% of the live weight. Thus a 450kg steer drinks about 45 litres (10 gallons) a day. Another estimate is that cattle drink about 4L/kg of grass dry matter. As grass dry matter intake is 1–3% of live weight, this also equates to a theoretical daily water intake of 44–50L for a 450kg steer.

But these figures should be increased by at least 25% for cows with calves at foot, and when temperatures are high.
Water quality also affects daily water intake. If the water has high alkalinity, urea can break down and release ammonia gas, the pungent odour of which repels cattle from drinking. Other factors that can upset calculations of water intake include the impact of stock that have not been accounted for (not mustered) and water consumption by feral animals (goats, brumbies, donkeys, camels) and native wildlife. If this consumption is considerable, actual water intake of domestic livestock may be lower than that calculated from total water consumed at a particular water point.

### Some rough guidelines for water

<table>
<thead>
<tr>
<th>Animal type</th>
<th>Weight (kg)</th>
<th>Water intake (L/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaners</td>
<td>180</td>
<td>12</td>
</tr>
<tr>
<td>Yearlings</td>
<td>300</td>
<td>20–25</td>
</tr>
<tr>
<td>Steers</td>
<td>400</td>
<td>40 winter 60 summer</td>
</tr>
<tr>
<td>Breeders</td>
<td>400</td>
<td>100 dry (25°C) 70 dry (32°C) 70 heat wave</td>
</tr>
</tbody>
</table>

**For mature animals (450kg), allow 45–55L per day.**

**For cows with calves and during high temperatures, increase this amount by 25%**.

Without treating the water, the practice of medication can itself reduce water intake. In central Queensland, daily intakes of breeders forced to drink poor quality water during winter dropped as low as 9–12L/head, but recovered to about 25L/head when water quality was improved.

### Checking water intake levels

Since daily water intakes can vary by up to 20% depending on the factors mentioned, the dosing rate of urea needs continual adjustment to supply the right level of supplement. Although a weather forecast might help when calculating the next dosing period, it is best to over-estimate water intake, especially during hot weather and when cows have calves at foot.

Many producers record the total water passing through a water meter over a period in a notebook kept at the nutrient dispenser. But if details of cattle numbers in each paddock are kept in the office, the two sets of data are often not combined to calculate daily intakes.

Resource Consulting Services Pty Ltd (RCS), for example, recommend that managers record livestock units (LSU) on their Graze Charts. These stock numbers can easily be combined with water data using a calculator or spreadsheet to calculate litres consumed/LSU/day.

One producer takes his laptop computer with him while servicing water medicators. He enters data on water consumed and livestock numbers at a medicator to give a permanent record of daily water intakes. This gives him immediate access to previous records on which to make decisions for changes in supplement rates.

### Little and often best with urea

To the animal, frequency of drinking is less important than the total amount it drinks. But the benefits from supplementing with urea are improved if the animal drinks little and often.

More frequent exposure to urea increases the metabolism by the rumen microorganisms and so increases supplement efficiency, feed intake and productivity.

It is better to overestimate water consumption than to underestimate it. This reduces the risk of urea poisoning.

Frequent topping up of urea makes rumen bugs more efficient and the animal can eat more.
5. How good is the water?

Assessing water quality

You must check the quality of your water before you consider water medication as it may well influence the success of the whole project.

The quality of your water may determine the success of medication.
If quality is poor, try to improve it.

Water quality influences how much animals will drink and how efficiently urea can be delivered to the animals at the drinking trough.

Both water intake and the efficiency of medication operations may be affected when minerals added with the medicator react with those naturally in the water.

All types of stock water vary greatly in quality:

- surface water such as streams and dams can be influenced by the catchment soil type and climate, or nutrients running off fertilised land
- shallow ground water (from less than 80m) can be contaminated with nitrites and nitrates from fertilisers and animal effluent
- sub-artesian (100–300m) and artesian ground water may be high in ‘chlorides’ and possibly sulphur derivatives
- artesian water (>300m) may also be high in chlorides, sulphates and is often notoriously high in ‘bicarbonates’

Water analyses

From the start, water samples should be analysed by a laboratory to establish basic levels of a range of parameters. Thereafter quality should be monitored regularly but the subsequent tests need cover only elements that will have a significant effect on production. Water pH can be checked relatively easily on site. (Details of water sampling and tests are described in Appendix 1.)

Water quality

If possible, take pH and electrical conductivity (EC) measurements with your own meter at the time of the initial sampling, and calibrate your meter against the lab test report.

pH

pH can affect water intake and also cause undesirable reactions with additives such as urea and phosphorus supplements. Water with a pH <6.5 may be corrosive whereas that with pH >8.5 may cause problems with taste, scale and, most importantly, with hydrolysis of urea to ammonia.

pH is critical. Low pH causes corrosion; high pH causes scale and reacts with urea.

The pH of water that cattle drink does not affect pH in the rumen as this is maintained between pH 6 and 7 by buffers in saliva.

Total alkalinity – (buffering capacity)

Total alkalinity reflects the concentrations of carbonate, bicarbonate and hydroxide buffers; it should not be confused with alkaline pH measurement of water. The buffers contribute to the water’s total hardness and reduce the ability of acid to reduce pH. Water with a pH of 7.5 and high alkalinity will need three times more acid to neutralise than water with a pH of 8 and low alkalinity.

Hard water Hard water is caused by high levels of calcium and magnesium carbonates and sulphates that increase the chance of scaling problems in pipes.

Water mediator mounted on a controlled artesian bore and enclosed by protective panels
5. How good is the water?

Both high calcium and magnesium carbonate and sulphate levels can interact with phosphorus supplements to form calcium and magnesium ammonium phosphates. These are insoluble and may precipitate out of solution to flocculate in the water or form a hard scale in pipelines and fittings.

Scale

The potential for scaling is measured through the ‘saturation index’. This represents the difference between the actual pH of the water and the pH when it is fully saturated with calcium or magnesium. Scale formation can reduce rates of flow through pipes and sometimes interfere with float valve and water medicator functions.

High levels of anaerobic bacteria allied with iron, magnesium and sulphur can also create scale problems and may depress water intakes by animals. These bacteria can be reduced or eliminated by oxidizing the water through aeration.

pH and urea

The most serious problem occurs with high pH which causes urea to hydrolyse to ammonia and make it difficult to regulate delivery of the urea.

With high temperatures, high pH and high EC, this hydrolysis can occur quickly during storage or in delivery pipe lines over three km long. The ammonia can sometimes be smelt in concentrate tanks and, if pungent enough at the trough, it can repel cattle and reduce their water intake.

This problem is exacerbated if:
- the water pipe line from the concentrate tank to the trough is long
- the water gets hot in a pipe lying in the sun
- the pipes are laid unevenly resulting in gas pockets

Hydrolysis also affects urea levels in the concentrate. As ammonia forms the urea concentration declines and layers can form in the concentrate tank with urea more concentrated at the bottom. If the turnover of the solution has been slow, water from different levels of the concentrate tank or trough can be tested with a urea test kit. If the concentration of urea at the bottom is 1.5 times greater than at the top, the tanks should be mixed regularly or the solution stabilised with acid. Urea test kits can also be used to check that urea levels are optimal in the water at the trough where animals are drinking, although tests may be less accurate with surface water that may contain urease inhibitors.

Acid additives

High pH can be neutralised with acid:
- food grade acid – food grade acids such as citric acid are too weak and will be ineffective except in the nutrient tank – but they are palatable.
- phosphoric acid. This is generally applied as urea phosphate which becomes phosphoric acid when added to water. It also supplies both nitrogen and phosphorus, but it is expensive and additional phosphorus may exacerbate problems in some waters.
- hydrochloric acid (HCl) – this is the cheapest and most effective acid and can be dispensed through an acid injector. It has a neutral taste and will de-scale pipes at suitable concentrations. However, this acid is extremely corrosive and dangerous to handle.

This manual cannot detail all the options for adjusting water pH by acidification. Seek specialist advice from manufacturers and suppliers of water medication equipment and testing laboratories (see Appendix 1).
Salinity – total dissolved solids or electrical conductivity

Total dissolved solids (TDS) or electrical conductivity (EC) are measures of inorganic salts dissolved in water (but may also include some other dissolved organic compounds). The most important cations are calcium, magnesium, sodium and potassium with the anions bicarbonate, chloride, sulphate and sometimes nitrate.

Rainwater has TDS of <1mg/L; sea water about 35,000mg/L. Water with a TDS > 15,000mg/L is unsuitable for all stock. Recommended concentrations of total dissolved solids in drinking water for different livestock are given in the table below.

Electrical conductivity is measured in deciSiemens per metre (dS/m), but is directly proportional to TDS (mg/L) by a factor ranging from 550 to 900 depending on the types of dissolved salts. For convenience, TDS is often estimated from EC as:

\[ \text{TDS (mg/L)} = \text{EC (dS/m)} \times 670 \]

Water from artesian and sub-artesian bores is generally classified as ‘chloride type’ or ‘bicarbonate type’. The main component of TDS from bores is sodium bicarbonate in Queensland and sodium chloride in NSW, South Australia and Western Australia. Sodium is the dominant cation in most bore water samples from Northern Territory rangelands. Cattle may initially drink more water with high TDS as they try to counter the effects of the salts, but feed intakes decreases and production eventually declines.

Surface waters generally have lower TDS concentrations than ground water, but concentrations may increase in water holes, dams and water troughs through evaporation – particularly in troughs that are not flushed regularly.

Livestock generally find water of high salinity (1% sodium chloride is salty water) unpalatable.

Highly mineralised waters can cause physiological upsets such as diarrhoea and sometimes death in grazing animals under stress, while water of marginal quality can cause gastro-intestinal upsets, and reduce weight gains and milk production. Animals can adapt to water of higher salinity provided increases are adjusted over several weeks.

TDS is a convenient guide to the suitability of water for livestock. However, if the water has purgative or toxic effects, and if the TDS is above 2,400mg/L, water should be analysed to determine the concentrations of specific ions.

Calcium and magnesium

Livestock can tolerate calcium concentrations up to 1000mg/L in water if calcium is the dominant cation and dietary phosphorus levels are adequate. If concentrations of magnesium and sodium are high or if calcium is being fed in a supplement, tolerable levels of calcium in drinking water may be less.

Magnesium also contributes to the hardness of water. If phosphorus supplements and urea are

<table>
<thead>
<tr>
<th>Species</th>
<th>Total dissolved solids (mg/L)</th>
<th>Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef cattle</td>
<td>0–4000</td>
<td>No adverse effects expected Animals may initially be reluctant to drink, and may scour, but dry mature animals should adapt without loss of production. Loss of production, body condition and health expected. Dry mature animals may tolerate these levels for short periods if introduced gradually.</td>
</tr>
<tr>
<td>Sheep</td>
<td>0–4000</td>
<td>4000–5000</td>
</tr>
<tr>
<td>Horses</td>
<td>0–4000</td>
<td>4000–6000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6000–7000</td>
</tr>
</tbody>
</table>
added to alkaline waters high in magnesium, they can react to form extremely insoluble magnesium ammonium phosphate that can precipitate or form scales. If sulphate of ammonia is added to water high in magnesium, magnesium sulphate (Epsom salts) is formed and causes scouring in livestock.

**Nitrate and nitrite**

Both nitrate and nitrite can occur naturally in waters although nitrate is more common. Both can cause toxicity, but nitrite is 10–15 times more toxic. To become toxic to animals, nitrate must first be reduced to nitrite by bacteria in the rumen of cattle and to some degree in the caecum of horses.

Nitrate concentrations less than 400mg/L in livestock drinking water should not be harmful, but concentrations of nitrite exceeding 30mg/L may be hazardous.

**Sulphate**

Sulphate is found in most natural waters. No adverse effects are expected if sulphate concentrations are less than 1000mg/L, but can occur at higher levels (1000–2000mg/L) especially in young or lactating animals or when water intake is high in dry, hot weather.

Water sulphate levels greater than 2000mg/L may cause chronic or acute health problems in stock.

Under anoxic conditions, bacteria in water can reduce sulphate to sulphide. The resulting hydrogen sulphide (rotten egg gas) causes a very unpleasant taste and odour, and may corrode pipes and fittings.

**Dissolved oxygen**

Most ground water supplies, particularly artesian bores, are low in dissolved oxygen. Bacteria that can reduce sulphates and nitrates of iron and manganese can grow under low concentrations of dissolved oxygen, and cause problems with taste, odour, staining and corrosion. Oxygen levels can be improved by: using aerators on storage tanks; creating a venturi or fountain effect in turkeys nests (inlet pipe at the bottom of the turkeys nest which pushes the water through a pipe to the top); taking water from the top of the turkey’s nest with a float valve on the outlet line; and by water entering the trough above the waterline.

**Algae**

Algae can sometimes grow profusely in troughs, water storage and supplement concentrate tanks that contain nitrogen and phosphorus. Clumps of algae from the tanks can interfere with the water meter or medicator. In-line filters can help, but troughs should be cleaned frequently.

Algal growth can be reduced or prevented by applying copper sulphate or low chlor pool algicide (chelated copper compound) or by hanging ferric alum in hessian bags. Swimming pool chlorine blocks offer a short-term effect in the trough but the chlorine may affect rumen micro-organisms.
5. How good is the water?

**Blue green algae**

Blue-green algae (Cyanobacteria) exist in the natural plankton population in healthy and balanced surface waters and only become a potential hazard when they multiply to cause blooms. Blooms typically occur on warm windless days in neutral to alkaline waters that contain high levels of phosphorus and nitrogen.

Not all blue-green algae blooms are hazardous to animals, but it is prudent to consider all scums as toxic until proven safe. Animals can be affected by Cyanobacteria toxins if they ingest the cells or drink water in which dead cells have released toxins. As it may take weeks for toxins to be degraded naturally by other bacteria, water can remain potentially toxic for some time.

Typical symptoms include weakness, lethargy, loss of appetite, sometimes nervous signs, and often diarrhoea.

**Bacteria**

Microbial pathogens can be transmitted by drinking surface water contaminated by animals and their faeces, but are not usually a problem.

Ground water, particularly from deep bores and wells, is not generally contaminated by pathogens. Waters high in iron, manganese and sulphur may encourage bacterial growth, and some bacterial species use iron and manganese for energy. Iron-dependent bacteria can often be found in bores and can block filters. Polythene pipe lines may also harbour organic growth, particularly when water contains added phosphorus, and where pockets of air accumulate due to irregular laying of the pipe.

**Fluoride**

Unpolluted surface waters generally contain low concentrations of fluoride but concentrations may be higher in ground water in some areas. Ground water fluoride concentrations of more than 2mg/L have been reported in the Great Artesian Basin in Queensland, with a few bores containing more than 10mg/L. In Queensland, bores with fluoride levels too high for stock can be found: in the Carpentaria Basin in the Gulf; in the south-western Eromanga Basin in the southern channel country; in the central eastern Eromanga Basin near Longreach; in the Surat Basin around Roma; and in some areas of the Barkly Tableland and Victoria River District.

Young growing stock should not be exposed to water with high fluoride levels.

On ‘at risk’ properties, the risk of fluorosis may be avoided if enough surface water is available, but this rules out the use of water medication.

Many phosphorus fertilisers contain high levels of fluoride and are not suitable to feed as supplements. Technical grade fertilisers generally contain lower levels and are recommended.

**Improving water quality**

There are two aspects in improving water quality—that for general stock use and that for use in the water medication concentrate tank.

There is much information on techniques and technologies to improve water quality, but some claims may be dubious.
5. How good is the water?

Magnets (red) attached to outlet pipe from bore head with coiled earth wire shown attached to earth stake

This manual can only outline methods of improving water quality; professional advice should be sought.

**Chemicals**

The use of acids to regulate pH and prevent hydrolysis of urea has been described. If general water quality cannot be improved, it may be necessary to select the source of the best quality water available and to use only this in the concentrate tank. This ‘good’ medicated concentrate water is then injected into ‘poor’ stock water pipeline at each medicator.

**Magnets**

The use of magnetic and other physical treatments to suppress scale remains controversial, and they are still labelled as gadgetry by engineers and scientists who do not understand, or cannot agree on, why magnets work. Magnets do not work in all situations.

Magnets appear to promote minerals to precipitate into the bulk solution rather than to form adherent scale, especially when the mineral load is high.

The use of magnetic treatment devices (MTDs) has increased substantially in Australia over the last couple of years. Many designs of commercial magnetic treatment devices are available; some use electromagnets, some single or multiple permanent magnets clamped to the pipe and well earthed. The magnets most used for water treatment in rural Australia are the Fluid Reactor™ magnets.

Magnet size and type depends on EC level, size of pipes and their position. Magnets are installed ‘after storage and after pumping’; thus if the bore feeds to several storage points, a large magnet is installed at the bore and with smaller magnet boosters at each storage point. MTDs clamped externally to the pipe seem to have lower field strengths than the plumbed-in types.

The most successful applications seem to be in continuously recirculating systems that treat the water repeatedly.

Some devices on the market have reasonable track records with producers claiming successes in enhancing water quality and water intake. One producer found his weaners were drinking only 8L/day because of high EC levels and excessive algal growth. After applying magnets, consumption increased to 25L/day, with less fluctuation from day to day. But other magnet users did not believe the quality of their water had improved.

**WARNING!**

Anyone with a pacemaker should seek medical advice before working near powerful magnets.

**Other devices**

Other devices are claimed to improve water quality, and are listed in Appendix 2.

A water-flavouring product STOC-JOY® containing a mixture of electrolytes and flavouring agents is claimed to mask unpleasant tastes in water. It has been used to increase water intake in cattle in holding depots for export, and may also have some potential in medicators for yard weaning of cattle. However, price and practicalities may prevent its use in medicators in the paddock.

The current approaches to modifying water quality are very much ad hoc and unproven—which can make them time-consuming and costly to the producer. Many may be ineffective.
5. How good is the water?

Managing water quality

**Good quality**
- Low Total Dissolved Solids
- low pH (<7.0)
- Urea is stable
- Very low pH may cause corrosion

**Poor quality**
- High in TDS
- pH > 7.2
- urea breakdown → ammonia
- bad smell and taste
- Treat with acid
- Aeration/magnets?
- Agitate mixture regularly
- Keep mixture cool
  Enough for 7–10 days only

**Very poor quality**
- High in TDS
- pH > 8
- similar problems but high alkalinity makes it difficult to buffer with acids
- Use other water in tank
- Place close to trough
- Use other methods of supplementation

**Treat for algae if a problem**

- Concentrate tank
- Use transportable medicator close to troughs
- Avoid long pipelines (<3km)
- Bury pipelines
- Avoid gas pockets
- Regular throughput of water – trough size, stock numbers, water intakes
- Regular cleaning; maintenance for scale and algae

**Step 1.** Manage water quality and urea concentrations in the concentrate tank.

**Step 2.** Manage delivery of medicated water into trough and cattle.
6. What is a water medicator?

Water medication technology was first developed almost 25 years ago but earlier systems had problems. Most early dispensers used tipping buckets in which supplement or additive flow to a bucket was controlled by water flow into the trough. These devices were often unreliable and risky, and the practice of water medication fell into disfavour with most producers.

In the last decade, water medication has become more popular again with the development of more reliable equipment and better forms of supplements.

How medicators work

There are two main types of medicator dispenser units:

- electronic dispensers
- water pressure driven injectors.

The dispenser injects nutrients directly into the water line supplying one or more troughs. These supply lines are usually gravity-fed where the source of water is sub-artesian or ground water, but may be under pressure where the lie of the land does not allow gravity feeding or where piped artesian water supplies are under high pressures.

In installations where water is pumped through a distribution system to water points servicing a large area, dispenser units and concentrate tanks can be located at a central point and medicated water is pumped either to storage tanks (not recommended) or to troughs servicing different paddocks. However, long sections of pipeline can lead to urea loss – air pockets, hot water, stale water all increase the rate of breakdown of urea. Avoid pipelines of medicated water over three kilometres in length if water quality is poor.

The most popular medicators are the electronic proportional dispensers, Norprim (left) and Nutridose (right). This newer type Norprim unit has a solar panel mounted on its protective box. The Nutridose box shown is mounted on a post next to the water meter and within a stock-proof enclosure.
6. What is a water medicator?

The dispenser units are usually located near the source of water supply (bore, tank, turkeynest, dam) and connected to an adjacent small (500–4000L) nutrient concentrate tank.

Some producers with grazing management systems in which cattle are moved frequently have installed movable medicators and equipment. On ‘Delta Downs’ in the Queensland Gulf country, water is medicated during the dry season on areas of the property that are flooded in the wet season. Mounting the dispenser and concentrate tanks on a stand above flood height also allows supplement supplies to be unloaded onto the platform at vehicle tray height.

Portable medicator units. Above: Portable unit with concentrate tank, solar panel and medicator mounted on truck for moving between bores (‘Somerville’, Richmond). Upper right: This concentrate tank and dispenser can be moved by tractor and tapped into the drinking water pipeline close to the trough (Tressa Vale, Gympie). Lower right: Dispenser with concentrate tank and medicator (enclosed by mesh panels) next to turkey nest tank. This unit, at ‘Narweitooma’, Alice Springs, can be moved between bores.
6. What is a water medicator?

Electronic dispensers

The most commonly used makes of fully electronic proportional dispensers are the NORPRIM® and NUTRIDOSE® medicators. In both, a small electric pump is used to inject an adjustable amount of nutrient concentrate into the pipeline or water trough. A paddle-wheel flow sensor in the line or a turbine flow meter in a mechanical water meter measures water in-flow in the supply line, and sends an electronic pulse to trigger the nutrient pump. The pump timer can be adjusted to vary the amount of nutrient concentrate injected into the watering system.

Medicator units are available in different sizes depending on flow rates, water pressure and numbers of animals being supplied. Medicator manufacturers can provide advice on appropriate water meters.

Water meters

In some models, water consumption data is electronically measured and logged; in others, it is measured with a mechanical water meter that requires manual logging of data. In some units, producers can read the amount of water used off the electronic unit and confirm it by manually checking the water meter.

Safety features

These electronic medicator units have a number of safety features including electronic cut-out valves and anti-siphon devices to prevent concentrate loss or over-supply through malfunction. Power is supplied by 12-volt battery; often charged by solar panel. Solar panels should not be used for dual purposes such as also powering an electric fence energiser lest the medicator unit malfunctions and pumps an excessive amount of nutrient concentrate into the water supply. The 12-volt power can come from a mains battery charger, but 240-volt models are also available.
6. What is a water medicator?

Remote control
In recent models, telemetry equipment can be linked
to the electronic circuitry to activate alarm systems
in the event of malfunction. It also enables remote
sensing of water levels in the tank, trough and
concentrate tank, as well as dispenser operations
and nutrient concentrations in the water trough.

Protection
Concentrate tanks, dispensers and solar panels
must be fenced off from livestock and wildlife. Extra
screening may be needed to prevent birds and
dingoes chewing the exposed cables between the
power source and dispenser and between the water
flow meter and dispenser. The medicator unit should
also be protected from the weather.

Modifications
Some producers have made minor modifications to
their units. These have included:
- installing an in-line filter on the pump inlet line
to minimise pump diaphragm wear and damage
from crystals of nutrients
- installing isolator switches to allow line purging
with clean water
- minor modifications on the outflow side
between dispenser and trough to allow
calibration of pump dispensing rate and checks
on pump function.

Note: any modifications should be made in
consultation with the equipment manufacturers
to ensure that the unit’s integrity is not compro-
mised.
6. What is a water medicator?

Dispensers powered by water pressure

Several types of proportional dispensers are powered by water pressure; the most common is the DOSATRON® although some DOSMATIC® units are still in use. A water-powered unit manufactured by Gundrill Trading Pty Ltd, and designed specifically for use with liquid supplements (not suitable for urea) has recently been released, but there is little information on its performance characteristics at this stage. The DOSATRON and DOSMATIC units were developed in France to supply fertilisers through irrigation water and to deliver supplements and animal health products in the intensive pig and poultry industries. These units have been widely used for grazing livestock in Australia, and are still the preferred choice of users concerned about electronic breakdowns in other types of units.

These units use a water-driven reciprocating piston to inject the nutrient concentrate solution into the water line; proportional injection of the concentrate is governed by the rate water flows into the pipeline or trough. Water intake is usually monitored by a mechanical water meter, and intake data has to be logged manually. Safety devices include an in-line filter on the inlet side and an anti-siphon device. Some producers bury the concentrate tank, and have the DOSATRON unit and nutrient tank below the storage tank to provide sufficient pressure and to prevent siphoning.

Wear from sediment and crystals

The plastic cylinder and piston can wear excessively from sediments in the water; but wear can be minimised with stainless steel pistons and cylinders, improved seals and extensive filter systems that are cleaned regularly. The plastic casing of the DOSATRON medicator should be shaded to reduce deterioration from exposure to the sun.

Both high-pressure and low-pressure units require a head of pressure to operate, and this type of dispenser is not appropriate for all stock watering systems or where water consumption is low and the units only operate intermittently. However, they are preferred by some operators with adequate water pressure because they feel the mechanical types are more reliable than the electronic ones.
6. What is a water medicator?

Concentrate tanks

Light-coloured, sealable squat polythene concentrate tanks are preferable because they:

- are not corroded by concentrate solutions
- reduce evaporation losses
- inhibit algal growth by reducing UV light penetration
- reduce water temperature of the concentrate solution
- are more accessible for mixing, cleaning and checking.

Dark polythene tanks will reduce UV light penetration more than light coloured tanks, but concentrate temperatures can get higher. This is especially important when poor quality water has to be used since high temperatures accelerate hydrolysis of urea (and loss of NPN as ammonia).

Tank size should allow quick turnover of the nutrient concentrate by holding enough for 7–10 days.

Calculating tank size

The common concentrations supplying 50–60g urea/head/day equate to about 15L of concentrate/100 head/day. Water for 500 head at the medicator will require 75L of concentrate a day or about 750L for a 10-day period. For this, a 900-litre tank would be the best option.

Ensure quick turn-over of solution in the concentrate tank by holding only enough for 7–10 days.

Concentrate mixing

Concentrate tanks must be mixed regularly and frequently, especially when using poor quality water in which some nutrients settle out. While some managers mix the tank manually with a paddle or other device, others use a portable fire-fighting pump for quicker and more thorough mixing.

Producers have their own modifications to overcome sedimentation. These include placing the hose from the pump into tubing in the nutrient tank to create a venturi effect for more efficient mixing, placing the inlet pipe to enter the bottom of a nutrient tank so that mixing occurs as the tank is filled and connecting...
6. What is a water medicator?

A hot air roof ventilator to a propeller through a shaft. The solution can also be agitated regularly with a small 12-volt submersible marine pump, powered by the dispenser power source and activated by a household electricity mechanical timer, or by connecting an electrical pump operated by a timer to the concentrate tank.

**Mix the nutrient solution regularly and often.**

After mixing, a gauze scoop can be used to remove undissolved crystals in the nutrient tank and to remove contaminants that float to the surface.

Calibrating and calculating

Always follow the manufacturer’s recommendations on equipment calibration and calculations of dose rates of supplements.

Some types of units calculate dose rates based on pump cycles. The newer NUTRIDOSE units express the dosing ratio in percentages. When the dosing ratio is set at 1%, the unit will deliver 100mL per 10L water. The cut off is also expressed as a percentage and when set at 1.10%, the unit will cut off at 110mL per 10L of water flow.

**Calibrate and calculate regularly.**

Users must clearly understand the calibrations and calculations involved and make sure these, and other basic equipment routines, are understood by all operators. This will minimise the chances of human error – the cause of many mortalities.

Never feed urea at concentrations of more than 2g/L of water. Higher concentrations will depress water intakes, and increase urea intakes to critical levels.

**Record all the workings.**

Many stock deaths from urea poisoning result from human error.
6. What is a water medicator?

Extract from NORPRIM® Nutrient Dispenser Operating Manual

Guide to Nutrient Usage

Mix 40kg urea and 10kg sulphate of ammonia to 150L water to make up 200L nutrient mix. (Assume 1kg = 1L)

Thus 40kg urea in 200L nutrient mix is equivalent to 40,000g urea in 200,000mL nutrient mix or 1g urea in 5mL nutrient mix.

Pump operation is 100mL nutrient mix per second (although this needs to be monitored and some pumps can deliver up to 120mL).

If 5mL nutrient mix contains 1g urea, 100mL nutrient mix (or 1 sec of pump cycle) contains 20g urea.

Formula for setting water flow on the unit:

\[
\text{Number of grams urea in 1 second of pump cycle} \times \text{Number of grams urea to be fed/head/day} \times \text{Average daily water intake}
\]

Assumptions:

From above, known concentration of urea is 20g/1-sec pump cycle
Average daily water intake (taken from water meter) = 30L
Number grams urea to be delivered = 20g

Then

\[
\frac{20}{20} \times 30 = 30
\]

Thus set unit for water flow of 30L against pump cycle 1 sec.

The answer from this formula always gives the required water flow setting against 1 sec of pump cycle.

As daily water intake decreases with cold weather, eg 18L/head/day, and feeding level is increased due to reduced quality of pasture, for example 40g urea/head/day.

Then

\[
\frac{20}{40} \times 18 = 9
\]

Thus required water flow is 9L per 1 second pump cycle.

In this instance, because of increased pump initiation, it is advisable to set alternatives such as 18L/2 sec; 27L/3 sec or 36L/4 sec. This will achieve the same concentration of urea in the trough but put less demand on the pump and system due to fewer ‘stops’ and ‘starts’.
Examples of routine instructions to staff responsible for servicing water medicators on two Queensland properties are given in this and the next page:

**Ardie Lord, ‘Sutherland’ Richmond**  
**Servicing NORPRIM® units**

**Record book**
- Date
- Volume of concentrate in tank (using notch stick, calibrated in litres from bottom, 1 notch = 400L)
- Note any changes eg excessive ammonia smell. (If very bad, drain and clean tank)

**Filling**
- Turn off switch on NORPRIM
- Turn off blue tap on tank
- Add urea 2 x 25kg bags per notch to fill tank
- Add ammonium sulphate, 25kg per 7 bags of urea added
- Add copper sulphate, 1 teaspoon per 2 notches to fill tank
- Add water making sure the hose is agitating the urea off the bottom of the tank.

**Checking and cleaning**
- Check outlet for solids
- Use plunger to agitate for 5 minutes. Be sure solution is properly dissolved
- Prime pump (test button on NORPRIM)
- Wash any spillage as it is very corrosive and destructive
- Check solar panel is clean
- Check battery water level OK
- Go over all equipment, piping, taps and joiners.

**Record in notebook**
- Date
- Starting and finishing notches
- Supplements added (kg)
- Settings on NORPRIM (eg 3 secs/40 L)
- Any comments
- Sign name

These records allow the manager to monitor NORPRIM performance by comparing the number of notches by which the mix has actually gone down since last filled against the amount that theoretically should have been used. The theoretical use is calculated using water flow, flow rate settings, number of seconds/pump and theoretical volume/notch.

Ardie Lord has also developed a matrix outlining grams urea/L delivered at 1-second intervals for every 5L change in water flow settings. These are easily developed in software spreadsheets, and can include costs. For each season and similar numbers of cattle, the concentration and mixing formula in the nutrient tank remains the same and the water flow per pump cycle (L/sec) is varied to change the amount of urea delivered per head.
6. What is a water medicator?

Tony Mott, ‘Somerville’, Richmond (with manager, Spud Thomas) has NORPRIM units at either bore heads (high-pressure type) or at turkey nests (both high-pressure and low-pressure types) with different size concentrate tanks at different installations. Instructions are written out for each size concentrate tank or NORPRIM type.

**NORPRIM® unit**

**Example**

**Tank filling procedures**
- Turn off tank outlet
- Measure and write down amount in tank (using notch stick, calibrated in cm from bottom)
- Decide how many cm of water you are putting in tank and how many bags of supplements are needed
- Put shade-cloth strainers over filler hole, and empty one bag into shade cloth
- Turn on water and wash supplement into tank until desired number of bags is added
- Fill tank to required level.

**Checking and cleaning**
- Unscrew and clean in-line filters and replace
- Check lid is back on tank to prevent light getting in
- Check count the number of empty bags put into tank, and record all details in book in red
- Check NORPRIM is reset and record settings.

Other users may have slightly different procedures for calculating and checking operations, but they have established a standard method each time medicators are serviced. They maintain good records of what has been done, water consumption patterns and numbers of cattle on a particular medicator. Should some cattle die, analysing these records should help ascertain what has gone wrong and minimise the chances of it recurring.
Potential problems with equipment

Corrosion

Concentrated nutrient solutions containing urea, sulphur and some phosphorous compounds can be extremely corrosive, particularly when prepared with poor quality water. For this reason, polythene delivery systems are preferable to metal pipes and fittings.

Poly fittings reduce corrosion

The electronic NORPRIM and NUTRIDOSE units are sealed units designed to prevent nutrient solutions leaking onto or around the electronics. The most recent models also have the controls set vertically so any contaminant liquid will drain away. Other preventative devices include an automatic closing lid.

Despite the safeguards, the controls should always be handled or adjusted with care to avoid contamination. Routine care and maintenance of all units is a MUST to minimise malfunction problems.

Scale

Although pipe size and grade will depend on factors such as numbers of stock watering on a trough or tank, trough capacity and water pressure, larger diameter pipes have less of a problem with scale formation.

Crystals and sediment

An in-line filter on the inlet line from the concentrate tank is usually installed to remove sediment and crystals from the concentrate before it enters the pump.

Concentrate solutions left in the lines and pump at the end of the season may crystallise.

As the crystals can damage the solenoid valve and pump when it starts up the next year, lines and pumps should be flushed with fresh water before shutdown. Some users on poor quality water have incorporated an isolation switch that enables the pump and lines to be purged with fresh water regularly to remove sediments (Note: discuss all modifications with the equipment manufacturer.)

Algal and bacterial growth

A combination of nitrogen and phosphorus nutrients and sunlight can stimulate algal growth in medicated water in concentrate tanks, troughs and sometimes in storage tanks. This algal growth will reduce nutrient concentrations in the medicated water, and may produce toxins harmful to livestock. Excessive algal growth in turkey nest and other storage tanks has caused water meters and dispenser units to malfunction; in-line filters should strain the algae but may themselves become blocked.
## Problem solving

### Common causes and their solutions

- **Damage to rubber pump diaphragms from crystals when concentrates are allowed to stand in pump line when dispenser is not in use.**
  
  **Solutions:** Purge regularly with fresh water during season; maintain unit regularly; flush pumps with fresh water after season; renew diaphragms as required.

- **Blockage or malfunction of water-flow sensors and pumps with organic matter, concentrate precipitates and sludges or scale, resulting in pump malfunction.**
  
  **Solutions:** Improve water quality; acidify water to remove scale; fit in-line filters: mix concentrate tanks regularly; fit magnets.

- **Failure of safety devices such as solenoid switches, allowing continued injection of supplement concentrate into trough line.**
  
  **Solutions:** Maintain unit regularly; monitor operations regularly and frequently; update unit.

- **Excessive wear on moving pistons and cylinders of water-powered proportional medicators as a result of water impurities, resulting in incorrect dosages.**
  
  **Solutions:** Replace plastic pistons and cylinders with stainless steel units; fit in-line filters to remove impurities.

- **Failure of anti-siphon devices, allowing concentrate to siphon from tank to trough.**
  
  **Solutions:** Install correctly; check functioning; monitor operations regularly and frequently.

- **Electronic failures due to power failures or lightning strike.**
  
  **Solutions:** Check battery and solar panel regularly; fit lightning arrestors.

- **Electronic failures due to wiring or cable damage from chewing by birds and dingoes.**
  
  **Solutions:** Fit protective shielding on cables and units eg wire mesh cage.

- **Electronic failures due to exposure to ammonia fumes or contamination with concentrate solution.**
  
  **Solutions:** Correct water quality problems to minimise ammonia fumes; avoid removing any protective/waterproof covers on units; mount units in vertical position; clean hands before adjusting settings.

- **Incorrect setting on units to either under or over-deliver supplement concentrate, often because of lack of information on water intakes.**
  
  **Solutions:** Record and log water intake data routinely and adjust medicator as needed.

- **Adjustments and modifications to medicators by staff unfamiliar with operations, sometimes leading to medicator malfunctions or delivery of incorrect doses.**
  
  **Solutions:** Train staff and write out instructions; principal operator should monitor regularly.

- **Long pipe lines, unburied pipe, air pockets in pipeline.**
  
  **Solutions:** Apply basic principles or use transportable medicator and concentrate tank closer to trough.
7. Their experiences

Users of water medication describe their experiences and provide information and tips on their successes and failures in adopting this technology.

1. Bill Ferguson
‘Politic’, Aramac, central-western Queensland

Bill Ferguson runs a Droughtmaster herd and a Merino flock on a mix of open Mitchell grass downs, cleared gidgee country carrying buffel grass, and less productive ‘desert’ country with spinifex and buffel grass pastures.

He uses a number of labour-saving devices for cattle handling, including trap-yards around water points and a system of laneways to several yards. Most of the property is watered from bores, and surface water is usually available only for a short time during the wet season. He has been using water medication for several years, currently with NORPRIM® medicators on the artesian and sub-artesian bores.

Through water points used by both sheep and cattle, he feeds phosphorus supplements throughout the year in the desert country, and urea and sulphur during the dry season in all areas. All medicators are powered by solar panels, as are a number of his pumps on the bores, and the medicators are well protected from livestock.

Bill has made some small modifications to his NORPRIM unit including an isolator switch that allows him to flush the pump and dispenser line when required.

Bill believes that his supplementation has improved herd fertility and growth rates, and breeder survival particularly on lighter desert country, but has identified some critical issues for the safe and effective use of medicators.

He recommends that new users of water medication consider the following points before and while using this technology:

- Do the installations properly from the start, or don’t do it at all.
- Start with one installation and when you have this right, extend the system.
- Use professional assistance in the design of the watering system and medicator facility.
- Test water quality first, as pH needs to be as close to neutral (pH 7.0) as possible. If needed, get professional advice on how to modify water quality. Magnets on the pipeline have been helpful.
- Check water pH regularly with a portable pH meter.
- Continually monitor the system, especially when first using medicators, and always be vigilant when checking bores and medicators.
- Check for ammonia odours in the trough and concentrate tank. Strong smell suggests urea is interacting with poor quality water components due to high pH.
- Always remember that urea is potentially toxic at high doses.
- Be careful when introducing fresh cattle to water medicators.
- Try starting at 12g urea per day, and then build up on a weekly basis to a maximum of 60g per day. Feeding above this level is wasteful.
- If it rains or water is lying around in the paddock, turn off the medicator or go back to a minimum dose of urea (eg 12 g/day).
- Where there is surface water in the paddock, use a maximum dose of 25g urea per day. Once cattle get a taste for the medicated water, they seem to prefer it to surface water.
- If cattle have been yarded without water for more than about 2 days, there is a risk of urea toxicity due to high water intakes. Either don’t yard for more than one night or reduce urea concentrations in the medicator.
- Don’t use dry licks in the same paddock when cattle are receiving urea from a water medicator.
7. Their experiences

- Measure and record water intakes, and adjust urea concentrations if necessary.
- Make one person responsible for the medicator to minimise human errors in adjusting or refilling the concentrate tank.
- Ensure everyone knows how to turn the medicator off in the event of a problem.
- Always be vigilant and prepared for trouble when using water medicators.

Bill carries his laptop computer with him on his bore-runs and medicator checks. Using a simple software program, he records water intakes and, knowing numbers of animals at a particular water point, calculates supplement intakes. He then adjusts his NORPRIM unit: this removes human errors in calculations and provides a permanent record of water and supplement intakes.

He also uses a water medicator to provide cattle with electrolytes before trucking them any distance. This is the cheapest and most efficient form of supplementation as all animals receive the right amount.

Bill believes there are endless possibilities for the technology, and is interested in the development of better remote sensing equipment that can be linked with telemetry systems.

"Don't cut corners, do it the right way – mistakes can be costly."

2. Paul Erbacher
‘Kalang’, Guluguba, southern Queensland

The Erbachers started water medication four years ago on ‘Kalang’, a predominantly buffel grass property, south of Wandoan in southern Queensland. His herd is mainly Hereford, with breeding and backgrounding to 350–400kg turn-off weights. The Erbachers have had up to 800 weaners and yearlings averaging 265kg on water medication during the winter/dry season.

Paul believes that "water supplementation is the most cost effective feeding method as it eliminates shy feeders." Generally the water is medicated from early June to late November, with start time being determined by the consistency of dung pats. If necessary, medication may start earlier in dry conditions or finish earlier with good spring/summer rains.

"Last year we started supplementing 110 steers in early February and they had gained 2kg/day over 7 weeks."

"Before water medication, young cattle stagnated or lost weight during the winter. Since we started medicating, we have been getting winter weight gains of 0.7 to 0.9kg/week. We originally aimed to use urea supplements to get weaners to hold weight; it has done a lot better than that, and we paid for the water medicator in the first 12 months."

Initially he used dam water, but now uses good quality sub-artesian water. Average daily water consumption through the summer on dam water was 35–36L per head, and this has increased slightly to 40L on sub-artesian water. Similarly, winter consumption increased from 13L per day to 16–18L on sub-artesian water. During one drought, when the dam level was very low and the water putrid, consumption dropped to 27–28L per day.

Paul uses two Nutridose dispensers — one in constant use, the other a portable unit as a back-up. The unit is powered by a 15-amp solar panel and deep cell battery (which has lasted 4 years). The units cost $2,800 plus $1,200 for upgrades, making a total cost of $4,000.

The nutrient tank is a custom-designed plastic silo cone Clark tank with the inlet pipe reaching the bottom so it mixes as it fills. He also uses a fire-fighting pump for additional mixing of the supplement concentrate.

During installation and initial operations, there was a lot of trial and error during setting up with the following advice from another Wandoan producer, Dennis Conway. "The more you ask the more confused you will get; start using and you will work it out!"

Paul uses a home-mix of urea and sulphate of ammonia, but does not use phosphorus supplements as the property is not phosphorus-
Their experiences

deficient. He buys supplements from the cheapest source, currently a supplier in Wandoan. He usually uses technical-grade sulphate of ammonia, but has used fertiliser grade and believes it is acceptable. “You just have to clean out the sediment and at a large price differential this can be worth it”. The supplement costs 3.5–4 cents/head/day.

The aim is to supply 50–70g urea/head/day. He starts cattle at 30–35g/day as he is now confident that cattle will handle this level as long they are not thirsty. If there is no bulk in the pasture, he reduces urea levels to 35g just to keep the rumen bugs alive.

Safety precautions include making sure thirsty cattle do not have access to medicated water, and that there are water troughs in the yards.

Problems have included wear of the NUTRIDOSE delivery pump due to the high concentration of urea in a relatively small (1000L) concentrate tank feeding about 800 head.

Paul has had cattle die on two occasions: one when a faulty solenoid switch allowed excessive concentrate to be pumped into the system; the other was a management issue when cattle in two paddocks delayed coming up for water, drank too much and received a toxic dose of urea.

“The productivity gains on urea have more than paid for the small number of losses. Positives significantly outweigh the negatives.”

3. ‘Weetalaba’
Collinsville, north Queensland

“Weetalaba” is located 60km west of Collinsville in north Queensland and, up to May 2004, was owned and operated by Stanbroke Pastoral Company as a Brahman stud. Pastures are mainly buffel grass with some invading Indian couch. Rainfall for the last 10 years has averaged 580mm, with most falling between December and March.

“Weetalaba” property and cattle were managed by Ray and Jo Thieme, with Brad Roberts managing the cell grazing areas, the water supply and water medication units. Water medication was used throughout the year except when roads were inaccessible for short periods during the wet season.

A NORPRIM® medicator was used between 1997 and January 2003. Water medication with NPN was adopted because of the protein deficiency during the dry season. NIRS faecal tests showed that, in the first quarter of the year, crude protein levels in the pasture were above 10% and digestibility was nearly 70%, but crude protein dropped below 5% and digestibility below 55% during the third and fourth quarters.

Complete control of the water supply under cell grazing also suited the use of water medication, and dispensing urea through the water was considered to be more cost effective than providing it in dry licks. The aim was to supply urea at the rate of 30g/head/day.

As much as 20% of the herd received urea supplements through the water. These were 1,000–1,400 replacement breeders, from weaners to yearling heifers. Calves weaned in June at 180–200kg were placed in the cell grazing area six weeks after weaning, and stayed there until joining 18 months later.

Water came from bores and springs. The bores were about 30m deep as water was difficult to find. It was poor quality with high pH, and high calcium and sodium levels. This poor water quality affected medication strategies — algae growth and ammonia odour were a problem when
nitrogen and phosphorus were provided together, but not when fed separately. Water pH was not monitored regularly.

Water was pumped from a bore to a 135,000L concrete header/storage tank, and gravity fed via the NORPRIM unit to ‘cup and saucer’ troughs with 30,000L tank capacity at three cell centres respectively 2, 3 and 3.5km from the water medicator. Only one cell centre was in use at any one time.

The polypropylene concentrate tank at the medicator with 4500L capacity was too large. Because of slow turn-over and poor water quality, this tank gave off a strong ammonia smell, and ‘layering’ of urea concentrations occurred regularly. This was managed by carting concentrate to the site in a separate 1000L mixing tank (with graduated volume marks), medicated water being pumped into the large concentrate tank. A firefighter pump was used for transfer and mixing, and the mixture was passed through a strainer on the top of the concentrate tank.

Water consumption rates were measured and recorded every bore run (2–3 days) and cattle numbers were accurately known from the cell grazing charts. Water intakes at ‘Weetalaba’ were poorer than expected. In winter, weaner heifers were drinking only 10–12L/day, and in the hotter months, 1 LSU (400kg heifer) was drinking 20–22L/day.

The installation of the NORPRIM unit identified some problems including the need for higher flow rates, and elimination of the ‘sipping’ effect when only small numbers of cattle drank at any one time. This latter problem also resulted in ineffective injection of concentrate into the line. Modifications to address these included the installation of two floats on a trough to reduce ‘sipping effects’; bypassing the storage component of the ‘cup and saucer’ tank/trough because of settling problems and ammonia build-up in the tank, and replacing the paddle wheel flow sensor (which came with the NORPRIM unit) with a Multijet flow meter (recommended by manufacturer). The paddle wheel sensor could not accurately read the low flow rates arising from the low water intakes.

The most successful changes implemented were:
- use of the Multijet flow meter.
- changing from a urea/sulphate of ammonia mixture to a premixed Norprim product which was easily soluble, was safer and easier to use, and increased water consumption.
- changing to lower dispensing rates and using dry licks to provide additional urea requirements. Over the last four years, the 30g urea/day was supplied as a combination of 12g from water medication and 18g from dry lick. Costs per head of the supplement using water medication were 3–4¢/day and for dry lick 10–12¢/day.

Management strategies to reduce the risk of urea toxicity included significantly reducing levels of urea when new cattle were introduced, after falls of rain, and when cattle were taken to yards for processing.

Ray’s comments were: “It becomes a very irregular and ineffective form of supplementation because of the continual starting and stopping.”

“A major disadvantage of water medication at ‘Weetalaba’ was trying to implement an effective supplementation program with the low water intake rates. Attempts were made to increase the amount of urea dispersed through the medicators. The result was high risk and low animal performance due to increased urea hydrolysis, decreased water consumption and inadequate protein levels in the grass.”

Other problems included ammonia build-up in the pipeline (managed by flushing) and the need for a high level of understanding to manage the water medication system. As only two key personnel, Ray and Brad, operated the NORPRIM, this diverted them from other managerial roles.

Between 1997 and December 2002, mortalities due to urea toxicity averaged six per year. This was probably caused when heifers suffering from 3-day sickness did not drink for a couple of days, and then drank large amounts of (treated) water when they recovered.
In early January 2003, when 1,300 heifers were being medicated, 111 mortalities occurred over a couple of days. All signs were typical of urea poisoning from the water source:

- deaths radiated around the water (many in the first 500m and up to 1km)
- carcasses were bloated, full of fluid and decayed rapidly
- froth from mouth and excessive fluid excretion from the anus
- carcasses found in social groups that may have watered together.

From late December until these major losses, there were problems with inconsistent supply of the NORPRIM pre-mix, and Ray had reverted to a urea/sulphate of ammonia mix. As mentioned, poor water quality caused settling and crystallising of this home-made mix.

According to Ray, there were several causes of the mortalities. The 'big crash' was a combination of:

1. Poor supply of NORPRIM mix resulting in reversion to home-made urea mix. Cattle had been on NORPRIM mix for 4 to 5 months previously.

2. Urea crystallised in the solenoid valve, allowing continual injection of urea solution.

3. Recent rain caused reduced water consumption, decreased flow rates, and increased crystals forming.

4. Safety override didn’t switch on due to corrosion in the circuit. The shut-down was meant to operate after 12 seconds continuous pumping, and failed.*

The NORPRIM unit was sent to Mitchell for inspection by the manufacturer. Mr Mike Peart believed the problem was actually due to a malfunction of the water meter caused by earlier tampering, and/or corrosion from urea contamination. Also poor maintenance had resulted in urea solutions dripping into the unit, disrupting the seal and corroding the electronics. (The configuration of the NORPRIM units has since been changed to minimise contamination from urea).

NORPRIM recommendations included:

- greater focus on improving and monitoring water quality
- more regular liaison with equipment supplier before modifying equipment or installation
- regular maintenance of equipment particularly through the wet season, and flushing the system with water to eliminate damage to the solenoid.
- regularly testing the safety override
- meticulous cleanliness when handling the NORPRIM units.
- better communication between Peart Rural Services, Landmark and the producer regarding consistency of supply of the product
- replacement of NORPRIM unit at least every 5 years. (The current price of the units at approximately $2,500 is much less than the cost of 111 stud heifers at about $1,000 each.)
4. ‘Alcoota’

Alice Springs, Central Australia

‘Alcoota’ is an extensive cattle breeding property north-east of Alice Springs, and is managed by Christopher and Margot Nott. The property is in an extremely arid area with an average rainfall of 250–280mm.

Land types include sandy desert spinifex areas, mulga, some flood-out country and Mitchell grass plains plus small areas where buffel grass has been established. It normally runs about 2,200 Santa Gertrudis breeders with grow-out cattle that are sent to Queensland for finishing.

Water is supplied from bores and dams with only very limited surface water available in most paddocks after rain. Some of the early experimental work in central Australia on water medication was done on the property in the late 1980s using the old tipping-bucket type medicators, but their use was discontinued because of some problems.

‘Alcoota’ now uses 12 NUTRIDOSE medicators across the property to supply cattle with both urea and phosphorus. Chris also uses the medicators to supply electrolytes to weaners, and to cattle to reduce stress and quieten stock before transport to Queensland properties for finishing.

Waters on ‘Alcoota’ are generally spaced at intervals up to 9km, but the plan is to have most waters about 3km apart. Supplement delivery though the medicators is adjusted to supply about 10g phosphorus and 40–50g urea per day, with water intakes of 40–50L a day. Water intakes are measured using large mechanical water meters that are logged at each bore-run, and supplement intakes are adjusted as needed.

Chris has developed a few innovations in using water medication. Water quality varies considerably between bores affecting the stability of the urea solutions in concentrate tanks, and ammonia odour at the trough.

To overcome this problem, Chris now uses good-quality water from a bore near the homestead to prepare supplement concentrate in a bulk tanker of about 3,000L, and refills his concentrate tanks at each bore from the bulk tanker. This has the added advantage of reducing human error in preparing the bulk concentrate solutions. To reduce labour, he now uses a prepared mix containing urea, sulphate of ammonia and phosphorus, which is only slightly more expensive than the home-mixes he was using previously.

When first using the NUTRIDOSE units at Alcoota, occasional malfunctions were caused by dingoes and birds chewing the exposed wiring between the solar panel, water meter and the dispenser unit. A cheap and simple removable wire mesh cage has solved this problem.

Another innovation is a small bypass tap on the dispenser line to the trough (illustrated in Section 6) through which he can regularly check and calibrate supplement delivery rates from the pump. This gives him more confidence in the safety of the dispensers.

Chris emphasised the need for constant monitoring of facilities, and for regular and thorough mixing of concentrate tanks. He regularly flushes units with clean water to prevent crystals forming and damaging the dispenser pump, and has an end-of-season maintenance program on all his units.

On a large property such as ‘Alcoota’ with long distances to travel on bore-runs, Chris is very interested in the development of telemetry systems for remote sensing of bores, tank and trough levels and medicator functions for added security.

However, he is a keen believer in the KISS principle in relation to new technologies—‘Keep it simple stupid’.
Appendix 1. Water sampling and analysis

Water sampling

The accuracy of a water analysis depends on the sampling methods and the time between sampling and analysis. It is not as simple as filling a bottle and giving it to an analyst, and recommendations from the laboratory should be followed.

Ideally, polythene or glass bottles of about one litre capacity should be obtained from the laboratory or a pharmacist. Plastic soft drink bottles may be used if they are thoroughly washed out with the water to be sampled. Bottles should be cleaned before sampling by rinsing the bottle three times in the water to be sampled. The bottle is then filled to the top to exclude air and sealed tightly. Samples should be properly labelled with details of the source, date of sampling, name and address and the intended use of the water.

Water should be sampled at the outlet pipe for bores, still waters such as dams, turkey nests and billabongs or flowing creeks. The condition of flow in a stream (volume and/or velocity of flow) should be noted as this often influences the water quality at times of the year.

For still waters, samples should be taken away from the water’s edge and at the normal pumping depth. Layering of the body of water due to seasonal temperature differences and chemical content can result in greatly varying results.

When sampling water from bores and wells, the ‘stale’ water inside the casing must be pumped out. Note the pumping rate, the water level and the time of sampling after pumping started. Some bores may have more than one water-bearing zone.

It can be useful to sample trough water as water quality can change significantly between the bore and the trough, particularly with very long pipe lines that become hot during the summer.

Samples for bacteriological analysis should be collected in a sterile container supplied by the analyst. A minimum sample volume of 200mL should be immediately refrigerated, but not frozen; ideally, it should be analysed within 6 hours, but certainly within 24 hours of collection.

A sample taken for algae identification and cell count should be in an opaque bottle of one litre capacity. The bottle should be sealed with about 25mm air space at the top. The sample should not contain thick ‘scum’ algae as this makes the count inaccurate. If the sample can be delivered to a laboratory within 24 hours, it need only be kept in the dark and in cool storage (eg in an esky). Otherwise it must be kept under refrigeration, or on ice, but not frozen.

Water analyses

Initial water samples should be analysed at an appropriate laboratory to establish basic levels of a range of parameters.

Laboratories and companies that provide routine water analytical services include:

CASCO Agritech Laboratories
Diana Abbott (manager) and Robert Lascelles (chief chemist and assistant manager)
214 McDougall St, Toowoomba Qld 4350
Ph 07 4633 0599 Fax 07 4633 0711
Website: www.casco.com.au

Agritech provide a stock water profile and are NATA-accredited for water analysis. They provide opinions on suitability for stock and can also provide bacterial counts. (February 2005 costs $115.70)

Gundrill Trading Pty Ltd
Ian Gundrill
PO Box 534, Arundel Qld 4212
Ph 1300 888 008 or 07 55633335
Email: gundrill@bigpond.net.au

Water samples are sent to laboratories for analysis and interpretation, and advice is provided to producers on solutions to problems. (June 2004 costs $140)

Public services for water analyses are no longer available from the Queensland Department of Natural Resources and Mines.

Local authorities

Sampling for chemical or bacteriological analysis can be arranged through many local authority health departments, although this service is generally limited to water for domestic purposes.

Inclusion of laboratories in the above list does not imply any approval or warranties by MLA of the services offered.

Measuring your own water

If possible, take electrical conductivity (EC) and pH measurements at the time of sampling. The Hanna H198129 combination meter measures pH, EC and TDS, and costs about $200. Meters that measure EC only cost $90–115, portable pH meters $80–100.

Hanna meters are imported by Hanna Instruments Pty Ltd, Melbourne, tel: (03) 9769 0666. Meter specifications can be found on www.hannainst.com/
Understanding the analysis

Typical stock water analyses undertaken by laboratories are shown in Table 1.

Note: the acceptable range can vary depending on feed intake of the ion in question or concentrations and interactions with other ions in the water. These ranges refer to cattle health and do not refer to optimal water intake levels or interactions of ions with substances added to water, for example through water medication.

Hard water

Hard water is caused by high levels of calcium and magnesium carbonates and sulphates which increase the chance of scaling problems in pipes. Hard water is difficult to lather. The hardness can be categorised into permanent and temporary hardness. In temporary hardness, boiling or heating breaks down the carbonate causing the calcium and magnesium to precipitate; in permanent hardness, the typical sulphate salts are stable under these conditions.

Both hardness and alkalinity are expressed as mg/L \( \text{CaCO}_3 \).

<table>
<thead>
<tr>
<th>mg/L ( \text{CaCO}_3 )</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td>soft but possibly corrosive</td>
</tr>
<tr>
<td>60–200</td>
<td>good quality water</td>
</tr>
<tr>
<td>200–500</td>
<td>increasing scaling problems</td>
</tr>
<tr>
<td>&gt;500</td>
<td>severe scaling expected</td>
</tr>
</tbody>
</table>

Table 1. Typical information included in water analyses reports and range of acceptable values for cattle health

<table>
<thead>
<tr>
<th>Test</th>
<th>Units of measurement</th>
<th>Acceptable range for cattle health</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>pH units</td>
<td>6–8</td>
</tr>
<tr>
<td>Electrical conductivity (EC)</td>
<td>dS/m</td>
<td>&lt;15</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>mg/L</td>
<td>&lt;10,000</td>
</tr>
<tr>
<td>Total alkalinity</td>
<td>mg/L</td>
<td>n/a</td>
</tr>
<tr>
<td>Bicarbonate alkalinity</td>
<td>mg/L ( \text{CaCO}_3 )</td>
<td>60–200 ideal. Above or below this will affect water quality but not stock health.</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>mg/L</td>
<td>8 – equilibrium value for fresh, properly aerated water depending on temperature.</td>
</tr>
<tr>
<td>Nitrate</td>
<td>mg/L</td>
<td>&lt;400</td>
</tr>
<tr>
<td>Nitrite</td>
<td>mg/L</td>
<td>&lt;30</td>
</tr>
<tr>
<td>Sulphate</td>
<td>mg/L</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>&lt;400</td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/L</td>
<td>&lt;2</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>&lt;250 (human consumption) based on taste, not health.</td>
</tr>
<tr>
<td>Aluminium</td>
<td>mg/L</td>
<td>&lt;5 may be higher depending on P levels in diet</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/L</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/L</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Boron</td>
<td>mg/L</td>
<td>&lt;5</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>mg/L</td>
<td>&lt;0.15</td>
</tr>
<tr>
<td>Algal concentration</td>
<td>cells/ml and/or µg/L</td>
<td>Microcystis &lt;11500 cells/ml (cells)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Microcystins &lt;2.3µg/L (toxins)</td>
</tr>
<tr>
<td>Bacterial levels</td>
<td>Thermotolerant coliforms/100ml</td>
<td>&lt;100</td>
</tr>
</tbody>
</table>
Appendix 2. Medicators and supplements

Suppliers of medicators and other equipment

<table>
<thead>
<tr>
<th>Medicator</th>
<th>Supplier</th>
<th>Contact Details</th>
<th>Price (June 2004)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORPRIM®</td>
<td>Norprim</td>
<td>PO Box 87, Mitchell, Qld 4465 Ph 07 46231141 Fax 07 46231941</td>
<td>Base unit $2,600</td>
</tr>
<tr>
<td></td>
<td>(Mr A. McEvoy; Mr J. Dobbins; Mr M. Peart)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NUTRIDOSE®</td>
<td>Pastoral and Feedlot Systems</td>
<td>17 Railway Rd, Fairfield, Qld 4103 Ph 07 38485290 Fax 07 38485231</td>
<td>Base unit $2,900</td>
</tr>
<tr>
<td></td>
<td>(Dr T. Wood; Mr N. Basford)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOSATRON®</td>
<td>Hortec Dosing Systems</td>
<td>Factory 4, 152 New St, Ringwood, Vic 3134 Ph 03 98769355 Fax 03 98769354</td>
<td>Base unit $2,300</td>
</tr>
<tr>
<td></td>
<td>(Mr K. Nicol; Mr R. Young)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DOSMATIC®</td>
<td>IMEXCO Aust Pty Ltd</td>
<td>Lot 2, Winta Rd, Tea Gardens NSW 2324 Ph 02 49972045 Fax 02 49972085</td>
<td>Base unit $550</td>
</tr>
<tr>
<td></td>
<td>(Mrs S. Johnston)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Liquid Nitrogen</td>
<td>Gundrill Trading Pty Ltd</td>
<td>PO Box 534, Arundel, Qld 4212 Ph 07 5563 3335 1300 888 008 Fax 07 5563 3443</td>
<td>Base unit $2,000–2,200</td>
</tr>
<tr>
<td>dispenser</td>
<td>(Mr I. Gundrill)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fluid Reactor™</td>
<td>Gundrill Trading Pty Ltd</td>
<td></td>
<td>$150 for boosters $1600 for 100 mm pipes</td>
</tr>
<tr>
<td>magnets</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aerators</td>
<td>eg Gundrill Trading Pty Ltd</td>
<td></td>
<td>$165–850</td>
</tr>
<tr>
<td>pH and EC meters</td>
<td>Hannah Instruments Pty Ltd</td>
<td>18 Fiveways Boulevard, Keysborough, VIC 3173 Ph: 03 9769 0666 Fax: 03 9769 0699</td>
<td>$80–200</td>
</tr>
<tr>
<td></td>
<td>Melbourne (head office)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Devices to improve water quality

Other devices are claimed to improve water quality. Some, such as the ‘Water wizard’ (Nutri-Tech Solutions P/L; 0754729900; $870) and WaterPure, are claimed to induce a vortex effect on flow patterns of water in a pipeline; this reduces ion precipitation and build-up of scale thus improving flow efficiency.

Others, such as the CALCLEAR® water conditioner, use ionisation by electromagnetic induction; this is claimed to change the ability of calcium ions to crystallise, thereby minimising scale formation. A number of aerators on the market are claimed to improve dissolved oxygen levels in artesian waters.

Note. The current approach to modifying water quality is very much ad hoc. Inclusion of suppliers and equipment in this publication does not imply any approval or warranties of the product by Meat & Livestock Australia.
### Proprietary supplements (costs at June 2004)

#### Wet season proprietary mixes and other supplements used through water medicators (June 2004)

<table>
<thead>
<tr>
<th>Product</th>
<th>Urea %</th>
<th>N%</th>
<th>CPE %</th>
<th>S %</th>
<th>P %</th>
<th>TE</th>
<th>Cost $/tonne (Roma)</th>
<th>Cost c/head/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>NORM PR Green feed</td>
<td>37.5</td>
<td>41.9</td>
<td>262</td>
<td>2.5</td>
<td>13</td>
<td>Yes</td>
<td>1677</td>
<td>8</td>
</tr>
<tr>
<td>Growforce Flowfeed GF Formula 4 alkaline waters; wet season (30g urea and 18g P)</td>
<td>35</td>
<td>16.1</td>
<td>101</td>
<td>2.4</td>
<td>21.2</td>
<td>Yes</td>
<td>1328</td>
<td>11</td>
</tr>
<tr>
<td>Maxiphos – chelated minerals</td>
<td>16.2</td>
<td>1012/200L</td>
<td>31</td>
<td></td>
<td></td>
<td></td>
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#### Trace element supplements

<table>
<thead>
<tr>
<th>Co</th>
<th>Cu</th>
<th>Zn</th>
<th>S</th>
<th>P</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1 %</td>
<td>0.6 %</td>
<td>0.8 %</td>
<td>4.2</td>
<td>0.3</td>
<td>0.2</td>
</tr>
<tr>
<td>Virbac Maxi-Min</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$312/20L ex Brisbane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Others: Bo, Fe, Mg, Mn, Na, Se. Recommended rate: 2ml daily for maintenance or 1ml/10kg for deficiency or stress

<table>
<thead>
<tr>
<th>Co</th>
<th>Cu</th>
<th>Zn</th>
<th>S</th>
<th>P</th>
<th>Ca</th>
</tr>
</thead>
<tbody>
<tr>
<td>12ppm</td>
<td>6ppm</td>
<td>30ppm</td>
<td>0.82</td>
<td>0.15</td>
<td>1.4</td>
</tr>
<tr>
<td>Natrakelp Liquid Seaweed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$72/20L ex Brisbane</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Others: Bo, Fe, Mg, Mn, Na, Se, I, K. Recommended rate 1 ml daily

#### Dry season proprietary mixes available for adding directly into nutrient tanks (June 2004)

<table>
<thead>
<tr>
<th>Product</th>
<th>Urea %</th>
<th>N%</th>
<th>CPE %</th>
<th>S %</th>
<th>P %</th>
<th>TE</th>
<th>Cost $/tonne (Roma)</th>
<th>Cost c/head/day</th>
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<td>12/40ml</td>
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### Supplement component and home mix costs (June 2004)

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<th>Product</th>
<th>Urea %</th>
<th>N %</th>
<th>CPE %</th>
<th>S %</th>
<th>P %</th>
<th>Trace elements</th>
<th>Cost $/tonne (Roma)</th>
<th>Cost 60g urea</th>
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<td><strong>Fertilisers – ingredients for home mixes</strong></td>
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<td>SOA (Incitec Gran-Am; tech grade)</td>
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<td>380 Gran-Am</td>
<td>580 Tech grd SOA</td>
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<td>70% urea, 10% tech grade SOA, 20% MAP</td>
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<td>No</td>
<td>512</td>
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Further reading

General


Feeding Standards for Australian Livestock:


Scientific and technical


