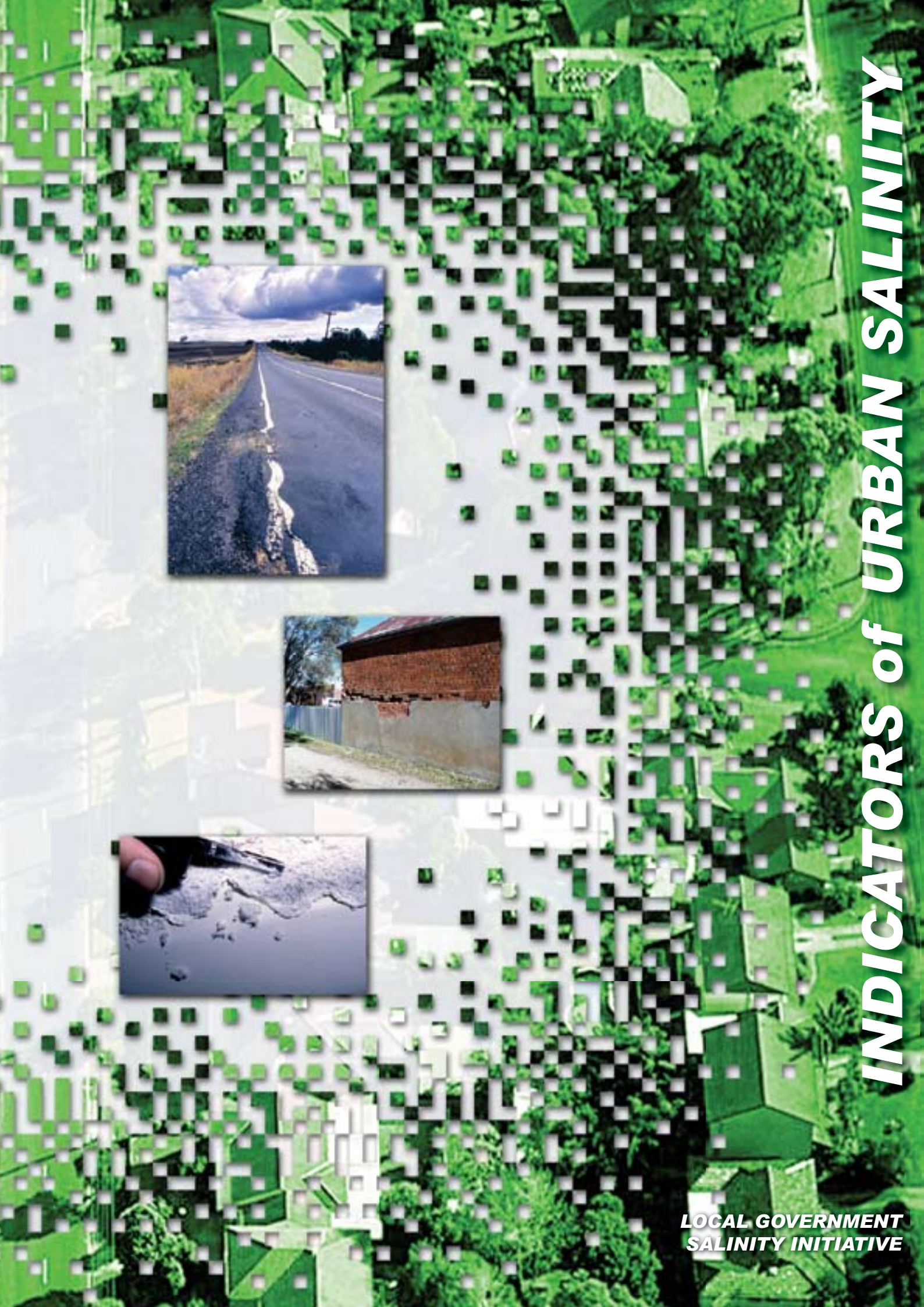

INDICATORS of URBAN SALINITY

LOCAL GOVERNMENT
SALINITY INITIATIVE

First published 2002
Department of Land and Water Conservation
22-33 Bridge Street
Sydney NSW 2000

Indicators of Urban Salinity
ISBN 0 7347 5267 9

Designed and printed by ClickMedia, Penrith
Photography by Adam Collings, NSW Agriculture

LAND & WATER CONSERVATION

NSW Agriculture

Indicators of Urban Salinity

Urban salinity is causing damage in towns and cities throughout New South Wales. Damage to buildings, roads, infrastructure, gardens and the environment can show up as a range of different symptoms depending on:

- Construction material used
- Construction method used
- Usage and maintenance of the structure
- Soil type and amount of rainfall or irrigation
- Type and quantity of salt present
- The amount of water mobilising and concentrating salts in particular areas

Care must be taken when attempting to diagnose urban salinity from any one symptom as there may be other explanations other than urban salinity. This pamphlet has attempted to cover a broad range of common symptoms of urban salinity. The following photos should be used both as a guide to the types of symptoms that may be viewed in affected areas and as a trigger for further investigation and management.

Fig. 1 *Salt scald caused by saline ground water reaching the soil surface.* Photo: A. Collings

Fig. 2 Early signs of mortar break down caused by growing salt crystals and rising damp. Photo: A. Collings

Fig. 3 White staining indicating the growth of salt crystals on the surface of brickwork. Photo: A. Collings

Fig. 4 "Tide mark" caused by rising damp. Photo: A. Collings

White markings or stains on the surface of bricks and mortar may be crystallised salts, which have been formed by water evaporating from the surface of these materials. These salts may come from two sources. Firstly, they may be naturally present in the material from the time of manufacture. Secondly, the salts may be present in groundwater or irrigation water being absorbed by the brickwork. **Figure 2** shows small salt crystals forming in a mortar joint leading to the break down of the mortar. **Figure 3** illustrates the growth of salt crystals, observed as white staining over the lower part of a wall.

The effects of high watertables and salinity may be most evident as rising damp. **Figure 4** shows the typical "Tide Mark" of rising damp which should only occur below a damp proof course unless the damp course is absent, broken, or bridged by other structures such as cement renders, footpaths or garden beds. The height of the tide mark depends on the size of the pores in the building material, the amount of evaporation and amount of water.

Materials which undergo numerous wetting and drying cycles such as the brickwork pictured in **Figure 5**, will accumulate more salt with each cycle. This leads to the break up of the brickwork due to the pressure of growing salt crystals.

Mortar can also be broken up mechanically by the growth of salt crystals. Lime mortars are particularly susceptible to rising damp, which can cause the lime component to dissolve, further weakening the structure. This process is seen in **Figure 6** where the sand component has accumulated around the base of the structure, where wind and rain has eroded out the weakened mortar.

Cement renders may aggravate the problem of rising damp by trapping moisture in brick walls and other structures. This water will be forced to rise to the first point where it may escape by evaporation, usually the first few layers of exposed bricks above the render. **Figure 7** illustrates salt damage to brickwork caused by saline groundwater rising above a cement render. Render has also been forced off the brickwork by the same processes.

Fig. 5 Mechanical breakdown of brickwork caused by rising damp and the growth of salt crystals. Photo: A. Collings

Fig. 6 Severe breakdown and loss of mortar with accumulation of powdered mortar around the base of the wall. Photo: A Collings

Fig. 7 Cement render has aggravated rising damp leading to damaged brickwork further up a wall. Photo: DLWC Library Cowra

Fig. 8 Growth of salt crystals through blistered paintwork. Photo: A. Collings

Fig. 9 A consistently high watertable around house foundations has led to rotting of timber floorboards and joists.
Photo: DLWC Library Cowra

Fig. 10 Bleaching of sandstone caused by salt and rising damp Photo: A. Collings

Rising damp occurring under painted surfaces inside buildings may produce a web like growth of fine crystals which appear through blisters or breaks in the painted surface. **Figure 8** illustrates this type of growth, which may extend up to 3cm from the wall.

High watertables may lead to excess accumulation of water around foundations and under buildings. **Figure 9** illustrates a house with excessive damp from a high watertable occurring beneath a suspended floor which has led to the rotting of support beams and floor boards underneath the house.

Stone structures may also be affected particularly the more porous sandstones and limestone which will readily absorb water. The tide mark of rising damp and salinity may sometimes appear a lighter or bleached colour in some stones **(Figure 10)**, unlike brickwork, which is often darker when affected.

Salts may appear as white marks on the surface of the stone as in **Figure 11**, which also shows exaggerated wear of the step surface.

Mechanical break down of the stone may occur due to the growth of salt crystals in its pores. This can be seen as excessive grain by grain erosion of the surface layers shown in **Figure 13**. This can lead to a hollowing out of the stone. Alternatively, the outer layers of the stone may flake away due to the pressure of expanding salt crystals along lines of weakness in the stone, as evident in **Figure 12**.

Fig. 11 White staining and erosion of the tread of a sandstone step caused by salt. Photo: A. Collings

Fig. 12 White staining and flaking of the sandstone surface caused by the growth of salt crystals and rising damp. Photo: A. Collings

Fig. 13 White staining and loss of the surface of sandstone caused by rising damp and salt. Photo: A. Collings

Fig. 14 Breakdown of concrete piers caused by salt induced corrosion of the steel reinforcing in the concrete. Photo: A. Collings

Fig. 15 Sulphate attack of the cement component in concrete kerb and guttering has exposed the aggregates. Photo: A. Collings

Fig. 16 Sulphate attack of the cement component in a concrete footpath has exposed the aggregates. Photo: A. Collings

Breaking up of surfaces may also occur in reinforced concrete where the depth of concrete over the reinforcing steel is inadequate or where the strength of the concrete is not high enough, subsequently allowing water penetration. Water borne salts, which penetrate through to the steel reinforcing, can cause corrosion of the steel. As the steel rusts it expands putting pressure on the concrete causing it to crack apart, as seen in **Figure 14**.

Concrete may also lose structure due to attack from sulphates. Sulphate salts are most common in coastal areas or near wetlands. Sulphates react chemically and physically with the cement in concrete leading to loosened aggregates and the break down of the structure. **Figures 15 and 16** illustrate this.

Pipes **(Figure 17)** and other metal fixtures may also corrode quickly where they come into contact with the saline ground water or saline soil. Corroded pipes may then leak which will further add to the problem.

Damaged pavements or roads due to salinity and rising watertables is primarily the result of saturation of the different layers within the structure.

If the natural soil on which the pavement is built becomes saturated it may weaken or in the case of reactive clays move due to the shrinking and swelling processes. This can cause the surface layer and roadbase (middle layer) to distort leading to rutting **(Figure 18)** and potholing **(Figure 19)**.

Fig. 17 Premature corrosion and breakdown of a galvanised pipe due to high soil salinity. Photo: A. Collings

Fig. 18 Rutting and breaking up of road surface due to saturation of the underlying soil and the roadbase. Photo: A. Collings

Fig. 19 Disruption of natural drainage lines has caused a build-up of ground water next to the road. This has led to rutting and potholing of the road surface. Photo: A. Collings

Fig. 20 Saturation and salinisation of the road base is leading to premature breakdown of the road surface. Photo: DLWC Library Cowra

Fig. 21 Water and salt build-up between the asphalt surface and the road base has led to potholing and delamination of the road surface. Photo: A. Collings

Fig. 22 Raised saline groundwater has led to the partial death of this lawn. Salts have also built up on the surface of brickwork below the damp course. Photo: DLWC Library Cowra

Saturation may also cause the bond between the roadbase and the surface layers of tar or bitumen to fail, leading to the breaking up and loss (delamination) of the road surface. **Figure 20** illustrates the loss of bond strength in a bitumen road surface leading to the breaking up of the surface. **Figure 21** illustrates early blistering and loss of patches of bitumen.

In some locations salinity and watertable rise may affect the health of plants before being obvious at the surface or as a cause of damage to structures. Lawns **(Figure 22)** and sporting greens **(Figure 24)** may develop bare patches that do not respond to increased fertiliser or irrigation.

Trees and large shrubs that die back from the outer canopy to leave a halo of dead branches above the remaining new growth may indicate stress due to either high watertables or salt toxicity. **Figure 23** illustrates an affected tree and turf at the edge of a cricket pitch. These symptoms are similar to those of drought so further investigation is required. Affected garden plants may show symptoms of drought when water is not lacking. These may include burning or die back of the leaf margins, death of whole leaves, or abnormal reddening of the foliage.

Bare patches of soil that appear in the presence of salinity may display patches that are darker in colour or have a greasy appearance. This colour change is the result of the organic matter in the soil accumulating at the soil surface due to high salt levels, as see in **Figure 25**. Other symptoms include bare patches with obvious white salt crystals and a 'puffy' soil structure.

Fig. 23 Disruption to natural drainage has led to a raised saline watertable causing tree decline and the die back of turf on this cricket pitch. Photo: A. Collings

Fig. 25 High salt levels may cause the organic matter in the soil to rise to the surface causing dark or greasy looking patches. Photo: A. Collings

Fig. 24 Salinity is indicated in this cricket pitch by turf grass that has patchy growth, is dieing back and is showing no response to water or fertiliser. Photo: A. Collings

Author

Adam Collings - Salinity Advisory Officer, NSW Agriculture, Griffith

Acknowledgments

Sian McGhie - Urban Salinity Team Leader, Department of Land and Water Conservation, Penrith

Katrine O'Flaherty - Salinity Advisory Officer, NSW Agriculture, Forbes

David Looney – Scientific Officer, Road and Traffic Authority, Forbes

Dirk Spennerman, Cultural Heritage Studies, Charles Sturt University, Albury

Elizabeth Madden, Urban Salinity Facilitator, Wagga Wagga City Council