Australian Building Codes Board

3/33 ALLARA ST
CANBERRA CITY ACT 2601
GPO BOX 9839
CANBERRA ACT 2601 AUSTRALIA
PHONE: 02 6213 7240
FACSIMILE: 02 6213 7287
IVAN.DONALDSON@ABCB.GOV.AU

The Secretary
Senate Environment, Communications, Information Technology and the Arts
References Committee
Parliament House
Canberra ACT 2600

Dear Dr Dewar

I refer to your invitation to the Chairman of the Australian Building Codes Board to put forward a submission to your inquiry into the economic impact of salinity in the Australian environment.

The ABCB recognises the problem of salinity, and has identified salt attack as an issue of specific relevance to the built environment.

Please find attached our submission.

Yours sincerely

Ivan Donaldson
Executive Director

/ February 2006

SENATE ENQUIRY INTO THE EXTENT AND ECONOMIC IMPACT OF SALINITY

THE ABCB AND THE BUILDING CODE OF AUSTRALIA

The Australian Building Codes Board (ABCB) is a joint initiative of all levels of Australian Government and includes representatives from the building industry. Our mission is to provide for efficiency and cost effectiveness in meeting community expectations for health, safety and amenity in the design, construction and use of buildings through the creation of nationally consistent, building codes, standards, regulatory requirements and regulatory systems.

The Building Code of Australia (BCA) is a performance-based building code, which states the technical provisions that buildings and other structures throughout Australia must meet. These provisions cover, among other things, the structure of the building, fire resistance of building elements and materials, access and egress, services and equipment, and health and amenity.

BACKGROUND

Discussions at the ABCB's 2001 National Technical Summit[1] highlighted that salt attack (salinity) was a growing problem affecting Australia's building stock. Since the summit the ABCB has carried out preliminary research in an attempt to determine the extent of the problem.

In September 2004, the ABCB issued the discussion paper titled 'Buildings Subject to Attack from Salt and Acids Sulphate Soils' (Appendix A, attached). The paper addressed the damage caused to buildings by salt attack. It identified reasons why damage caused by salt attack is a problem, reviewed recent developments, summarised the current measures available and presented a proposal.

Comments were sought on the discussion paper to determine the appropriateness of developing technical solutions to protect buildings against damage from salt attack. Twenty six respondents from industry and government commented on the discussion paper. The comments provided positive feedback with substantial support for the proposal as outlined in the discussion paper.

CURRENT SALINITY PROVISIONS IN THE BCA

Currently, the degree to which the BCA addresses salt attack is minimal. The provisions that have been identified as assisting the reduction of salt attack are largely based on reducing moisture uptake by buildings, as this is a major factor in the cause of building deterioration. However, South Australia and New South Wales have individually identified salt attack as a major problem and have specifically included requirements for housing that address the issue. These are further explained in the attached discussion paper, Appendix A.

FUTURE DEVELOPMENT OF SALINITY PROVISIONS IN THE BCA

The Building Codes Committee (BCC), which acts as the peak technical advisory body to the ABCB, addressed the discussion paper outcomes at their meeting of March 2005. The Committee agreed that the proposal outlined in the discussion paper would be developed into a Regulation Document (RD)[2] and Regulation Impact Statement (RIS)[3] for possible inclusion in a

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[1] Annually, the ABCB hosts the NTS in order to assist in progressing key initiatives of the ABCB's regulatory reform agenda. It is attended by approximately 50 representatives of peak building industry, research and regulatory bodies from around Australia and New Zealand.

[2] A RD is a document outlining the details of a proposal for regulatory change.

future amendment. The proposal as agreed by the BCC is attached as Appendix B. It is anticipated that the RD/RIS will be finalised this year, released for public comment, and amended if necessary.

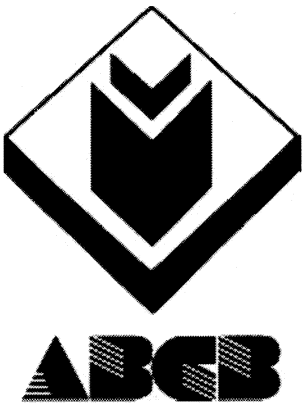
In developing proposals that involve regulatory change, the ABCB is bound by the COAG Principles and Guidelines for standard setting bodies. The Office of Regulation Review (ORR) provides guidance on the preparation of RIS and advises whether the guidelines have been met. The ORR ensure that:

- the Regulatory Impact Statement Guidelines have been followed;
- the type and level of analysis are adequate and commensurate with the potential economic and social impact of the proposal; and
- alternatives to regulation have been adequately considered.

The proposal to amend the BCA to include further provisions for salt attack will be assessed in accordance with the above, so as to determine the suitability of the proposal.

[3] A RIS is a document that contains assessment of the costs and benefits of each identified option, followed by a recommendation supporting the most effective and efficient option. It must be incorporated into the assessment process used for reviewing and reforming regulations.

APPENDIX A



BUILDINGS SUBJECT TO ATTACK FROM SALT AND ACID SULPHATE SOILS

DISCUSSION PAPER

August 2004

CONTENTS

1. Purpose of this Document

The Australian Building Codes Board (ABCB) has produced this Discussion Paper on the construction of buildings that may be subject to salt attack or damage caused by acid sulphate soils. The ABCB is seeking to determine the appropriateness of developing technical solutions to protect buildings against these forms of damage.

This paper considers the damage to buildings caused by salt attack and acid sulphate soils. It outlines some of the reasons why damage caused by salt attack and acid sulphate soils is a problem, looks at recent developments and summarises the current measures available. It also puts forward a proposal to amend the Building Code of Australia (BCA).

Further information about this project can be obtained by contacting Shawn Kidner on telephone (02) 6276 1180 or e-mail: Shawn.Kidner@abcb.gov.au.

2. Background

2.1. What is the Building Code of Australia

The BCA is a performance-based building code, which states the technical provisions that buildings and other structures throughout Australia must meet. These provisions cover, among other things, the structure of the building, fire resistance of building elements and materials, access and egress, services and equipment, and health and amenity.

The BCA consists of two volumes: Volume One deals with Class 2 to 9 buildings, and Volume Two deals with Class 1 and 10 buildings.

A Class 1 building is either a single dwelling or small boarding house, which is not located above or below another dwelling or another Class of building other than a private garage. A Class 10 building is a non-habitable building or structure such as a private garage, carport, shed or the like.

Class 2 – 9 buildings include all other types of buildings such as apartment buildings, hotels, office and retail buildings, factories, warehouses, hospitals etc.

2.2. BCA and State/Territory Legislation

The BCA is produced and maintained by the ABCB in conjunction with the Australian Government and each State and Territory Government.

Each State and Territory has its own building control legislation that references the BCA as the technical document that contains the requirements for the design and construction of buildings. The State and Territory legislation is generally administrative and does not contain technical building requirements.

The building control authority within each State and Territory determines the application of the BCA within the State or Territory. Due to recognition of local influences, the manner of the application and administrative arrangements differs between the States and Territories.

The States and Territories may also vary the technical provisions of the BCA. These variations are included in the BCA as State and Territory Appendices and are given legal effect by the relevant State or Territory building control legislation.

Because of these differences between the States and Territories, there are different criteria or 'triggers' for how the BCA applies to existing buildings. Essentially the BCA applies to:

- All new buildings.
- New building work in existing buildings, such as additions and alterations.
- Existing buildings that are to be used for a purpose different from that for which it was originally designed (often referred to as a "change of use").
- Existing buildings that are substantially affected by new alteration or addition.

2.3. Salt Attack

Damage to buildings caused by salt attack has been steadily increasing. This may be due to:

- an increase in the number of buildings being built in areas that are susceptible to this type of damage because of the soil composition;
- widespread increase in the levels of salinity in ground and water sources;
- the local climate, which may accelerate the actions of rising damp and salt attack;
- porosity or salt content of materials used in construction;
- increased use of slab-on-ground construction; and
- changes in construction detailing that may allow moisture (from the ground or other sources) to penetrate the building fabric.

Salts in the soil are an inherent part of Australia's landscape. This is mainly due to three sources. The first is as a result of an inland sea, which approximately 100 million years ago covered a much of Australia. When the sea retreated, sediments containing large amounts of salt were left behind. The second source is salt from the sea which is carried inland by strong winds and which falls in rain. The final source is salt found in rocks. As the rocks weather over time, salt is released into the soil. Minor sources of salinity include groundwater, effluent and building products.

Australia's salinity problems have resulted largely from human activities. Prior to European settlement, the situation was in equilibrium. Native deep-rooted vegetation had evolved which had adapted to the rainfall and saline soils. Clearing of land for agriculture and planting of shallow rooted crops and pastures, along with increased watering has caused the water table to rise significantly. As the water table rises, dissolved salts are being brought with it.

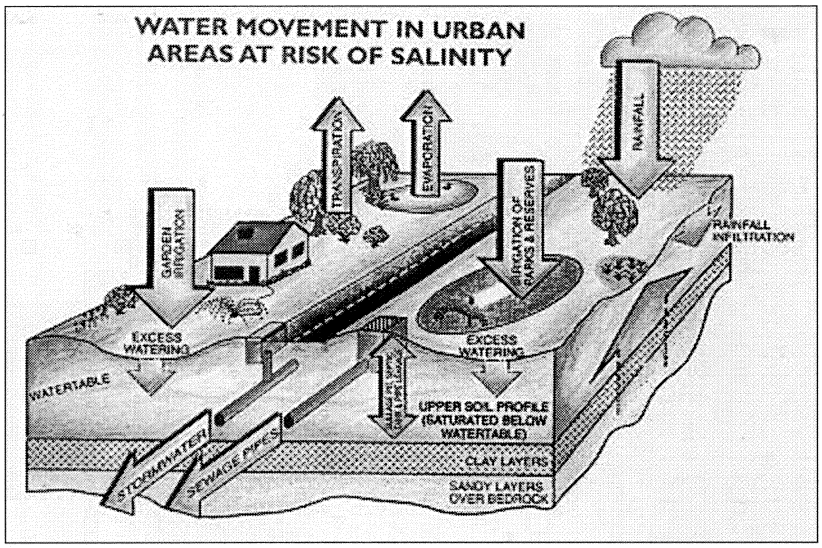
Salinity can generally be classified as one of five different forms. They are: dry land salinity; groundwater salinity; irrigation salinity; river salinity and urban salinity. The first four forms affect rural areas, however urban salinity is a problem that is affecting infrastructure such as roads, pipes and buildings in both rural and metropolitan areas.

A rising water table is not always the main cause of urban salinity. A site with naturally poor draining soil can experience urban salinity if the soil becomes waterlogged due to problems such as over watering, leaking pipes etc. Another example would be where compaction of the soil during construction stops the lateral flow of water, causing the area upslope to become waterlogged and at risk of urban salinity.

The Australian Government report, Australian Dryland Salinity Assessment 2000 has estimated 68 towns are currently affected by urban salinity. This figure has caused some conjecture as the survey was based on visual indicators of urban salinity, not site investigations. However, the report estimates the number of towns currently affected is

likely to triple by 2050. Towns affected are in areas such as Western Sydney, Wagga Wagga, Liverpool Plains of New South Wales, Yass River Valley around Canberra, upper south east of South Australia, the Victorian Mallee and Western Australia's wheat belt.

Low-lying towns are often susceptible to rising water tables and in turn urban salinity. Rural towns are often low-lying as they were established close to rivers and also railways, which were normally constructed in low-lying areas.[1]



Source: NSW Department of Land and Water Conservation's web-site 25/07/02

Damage caused to buildings by the presence of salts and moisture is referred to as either salt attack or salt damp. It results from various salts and water moving via capillary action through the pores of materials such as concrete, bricks, mortar and stone. Evaporation of the water causes crystallisation of the salts on the surface and in the pores of the building material, causing fretting or efflorescence. The deposited salts then act like a wick in drawing any available moisture from the atmosphere or ground, thus exacerbating the problem as more salt is deposited in building elements and the rate of deterioration increases. Typical symptoms of buildings affected by salt attack include salt crusting on bricks, concrete and pavers, deterioration or reduced life of footings and slabs and corrosion of underground services.

Apart from buildings, infrastructure such as road materials, concrete pipes and engineering works can be affected.

2.4. Acid Sulphate Soils

Acid sulphate soils underlie significant parts of Australia's coastal areas. There are extensive occurrences of acid sulphate soils along the eastern and northern coastline of Australia with smaller areas in southern Western Australia, South Australia, Victoria and Tasmania.

Acid sulphate soils contain iron sulphides. When the soil is waterlogged, the water prevents the oxygen in the air reacting with the iron sulphides. When the iron sulphides are exposed to air through drainage or excavation, sulphuric acid is formed.

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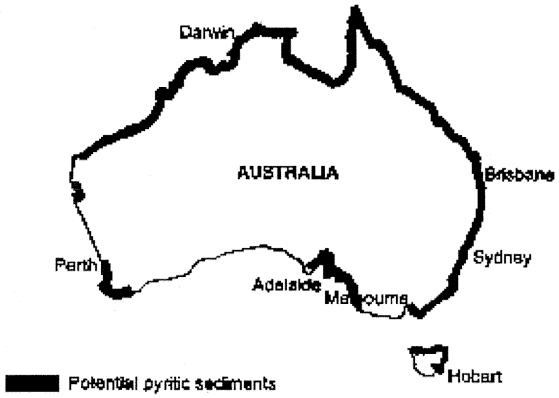
[1] NSW Department of Land and Water Conservation's web-site

As coastal areas are being developed, if appropriate precautions are not taken, iron sulphides can become exposed forming sulphuric acid and putting buildings in these areas at risk. Steel and concrete construction in areas affected by acid sulphate soils is at risk of corrosion due to the acidity of the soil.

It is estimated in Queensland that up to 25% of the cost of subdivisions is due to testing, treating and monitoring acid sulphate soils (source: NSW DIPNR web-site).

Indicative distribution of coastal acid sulphate soils in Australia.[2]



Source: Australian Government Department of Agriculture, Fisheries and Forestry's web-site 17/03/04

[2] Australian Government Department of Agriculture, Fisheries and Forestry's web-site

3. Development of this Discussion Paper

The ABCB 2001 National Technical Summit[3] (NTS) highlighted salt attack as a growing problem affecting Australia's building stock. Possible BCA options for dealing with the issues were explored at the NTS. These included:

1. Develop a map of Australia indicating areas affected by urban salinity. This map and salt attack provisions would be included in the BCA. The salt attack provisions would only apply to building work in areas affected by salt attack.

2. Survey local governments to establish the municipalities that have recorded cases of urban salinity. Once the extent of the problem is known, a proposal for the BCA would be developed.

3. Develop salt attack provisions for inclusion in the BCA. Provisions would apply to all building regardless of whether they are built in an area affected by urban salinity.

4. Make no change to the BCA. Allow State and Territory or Local Government to develop provisions or guidelines, if necessary.

5. As an outcome from the NTS it was decided that the ABCB Office would examine the cost of these various options and consult with industry about ways to proceed.

At Building Codes Committee[4] 29 (BCC 29), the findings of the research since the NTS were presented. It was noted that adopting option 4 above i.e. allowing State/Territory and Local Governments to development requirements, would not provide a nationally consistent outcome. Therefore, it was determined to pursue and refine options 1 – 3. The refined options were:

1. Develop a map of Australia indicating areas affected by salt attack. This map would to be included in the BCA along with salt attack provisions. Provisions would only apply to building in areas shown to be affected by salt attack on the map.
2. Develop salt attack provisions for inclusion in the BCA. The provisions would be applicable when a building is considered susceptible to salt attack. The provisions would be similar to the BCA termite provisions.
3. Develop salt attack provisions for inclusion in the BCA. The provisions would apply to all buildings.

During the development of this Discussion Paper, the issue of damage caused to buildings by acid sulphate soils was raised. It was determined that this matter would also be considered as part of the project.

Since BCC 29 the ABCB has put in place a Technical Working Group (TWG) with terms of reference to review and comment on documents/proposals related to the project. Membership of the TWG includes regulators, researchers and members of industry.

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[3] The National Technical Summit is an annual event held by ABCB that brings together members of the Building Codes Committee, State and Territory building technical committees and industry experts to discuss matters related to the BCA.

[4] The Building Codes Committee is the ABCB's peak technical advisory body. It has responsibility for providing technical advice on reforming, maintaining and upgrading the technical content of Australia's building codes and standards. The Building Codes Committee's membership includes the Australian, States and Territory, and local government along with members of Industry.

4. Recent Developments

There have been a number of developments dealing with salt attack and acid sulphate soils at a State/Territory and Local Government level. These developments can be summarised as follows:

4.1. Salt Attack

New South Wales

In 2000, a Parliamentary Select Committee was established to investigate salinity. The terms of reference included the examination of options for salinity management via building codes. The findings were presented in May 2002. A recommendation of the committee was "the inclusion of requirements for building in salinity hazard areas in the Building Code of Australia."

The NSW Department of Infrastructure, Planning and National Resources (DIPNR) have produced a draft salinity hazard map for Western Sydney along with an accompanying Guideline. The map depicts the potential hazard. The Department has produced a number of publications on the topic of urban salinity. Publications include "Indicators of Urban Salinity", "Broad Scale Resources for Urban Salinity Assessment", "Site Investigations for Urban Salinity" and "Building in a Saline Environment".

DIPNR has also developed interim requirements dealing with the salt attack pending a comprehensive national review which appeared in the BCA from 1 May 2004 as a NSW Variation.

The provisions apply to Class 1 buildings and require a damp-proofing membrane to be placed beneath slab-on-ground construction. The damp-proofing membrane must be 0.2 mm nominal thickness polyethylene film, have high impact resistance and be branded accordingly. The damp-proofing membrane must lap not less than 200 mm at joints and be taped or sealed with a close fitting sleeve around service penetrations and fully sealed with additional film and tape where punctured.

A damp-proof membrane has a higher resistance to moisture penetration, damage during construction and degradation by dissolved salts when compared to a vapour barrier.

The Western Sydney Regional Organisation of Councils (WSROC) represents local Councils in Sydney's western suburbs. The issue of salinity in this area was raised with the release of the "Salinity in the South Creek Catchment" report (Dias and Thomas) in August 1997. Their salinity problems are unique in that they are caused by a number of different mechanisms. WSROC, NSW DIPNR and local Councils have developed a 'Western Sydney Salinity Code of Practice'. The project was funded by a grant from the Commonwealth Governments National Heritage Trust. The code is intended to provide a guide to the options available for the local governments of greater western Sydney to address salinity problems. The code outlines some measures that could be used for buildings in saline areas.

Victoria

The Victorian Planning Provisions (VPP) is a standard set of planning provisions that are used by local governments. The VPP contain a number of standard overlays. A Salinity Management Overlay has been developed. One of the objectives of the overlay is to prevent damage to buildings in saline areas. The overlay has been adopted in the planning scheme of 9 local councils.

Western Australia

There are a number of initiatives in Western Australia dealing with salinity. One of the goals of the Western Australian Salinity Action Plan strategy is to protect infrastructure affected by salinity. The State Salinity Council is leading and supporting the community in addressing salinity. The Rural Towns Program is promoting awareness of urban salinity and its management.

4.2. Acid Sulphate Soils

The majority of the recent developments regarding acid sulphate soils relate to assessing and managing acid sulphate soils rather than the development of technical building solutions to protect buildings. Some of these developments can be summarised as follows:

- The Natural Heritage Trust (NHT) is an Australian Government initiative. Its role is to help restore and conserve Australia's environment and natural resources. The NHT has provided catalytic funding for a number of on-ground works projects that demonstrate options for the better management of acid sulphate soils.
- In 1999, the National Working Party on Acid Sulphate Soils prepared a National Strategy for the Management of Coastal Acid Sulphate Soils. The aims of the strategy were to improve the management and use of coastal acid sulphate soils to protect and improve water quality and assist governments, industry and the community in identifying and managing coastal acid sulphate soils. The strategy lists four principal objectives for achieving these aims. These being to identify and define coastal acid sulphate soils, avoid disturbance of coastal acid sulphate soils, mitigate impacts when acid sulphate soil disturbance is unavoidable and rehabilitate disturbed acid sulphate soils.
- The Queensland Government has developed a state planning policy for development involving acid sulphate soils in low-lying coastal areas (State Planning Policy 2/02). The purpose of the policy is to ensure that development involving acid sulphate soils in low-lying coastal areas is planned and managed to avoid the potential harmful effects on the natural and built environment and human health.
- NSW DIPNR has assisted local councils in NSW with the preparation of local environment and development control plans dealing with acid sulphate soils. The plans outline when council consent is required for development of areas affected by acid sulphate soils. The purpose of these measures is to plan and manage the harmful effects that can be caused by development in areas affected by acid sulphate soils. NSW DIPNR has also produced acid sulphate soil risk maps for NSW.

5. Current Measures Dealing with Salt Attack and Acid Sulphate Soils

There are a number of documents available that contain technical building solutions dealing with salt attack. However, documents containing technical building solutions dealing with acid sulphate soils are limited.

Some of these documents are referenced by legislation and therefore the measures in these documents are mandatory. Measures in documents not referenced by legislation are generally voluntary.

Documents containing technical building solutions dealing with salt attack and acid sulphate soils can be summarised as follows:

5.1. Mandatory Requirements

Building Code of Australia

The BCA has provisions aimed at preventing moisture from the ground or from external walls causing unhealthy or dangerous conditions for occupants and causing dampness or deterioration of building elements. These provisions are aimed at moisture in general, however, they are also likely to make buildings less susceptible to salt attack or damage from acid sulphate soils. The BCA provisions are as follows:

Volume One

Performance Requirements

1. BP1.1 requires buildings to remain stable by resisting the actions to which it may be subjected. Actions include liquid pressure action and ground water action.
2. FP1.5 requires that moisture from the ground must be prevented from causing undue dampness or deterioration of building elements and unhealthy or dangerous conditions, or loss of amenity for occupants.

Deemed-to-Satisfy Provisions

1. F1.9 generally requires buildings to be constructed to prevent moisture from reaching:
   - the lowest floor timbers and the walls above the lowest floor joists; and
   - the walls above the damp-proof course; and
   - the underside of a suspended floor constructed of a material other than timber, and the supporting beams and girders.

   Where a damp-proof course is used, it must comply with either AS 2904 or be impervious termite shields in accordance with AS 3660.1.

2. F1.10 generally requires a vapour barrier, in accordance with AS 2870, to be laid beneath a floor of a room that is laid on the ground or on fill.

Volume Two

Performance Requirement

1. P2.2.3 requires that moisture from the ground must be prevented from causing unhealthy or dangerous conditions, or loss of amenity for occupants; and undue dampness or deterioration of building elements.

There is also a limitation where P2.2.3 does not apply to a Class 10 building where in the particular case there is no necessity for compliance.

NSW and SA have inserted a State Variation to P2.2.3 to address the issue of dissolved salts.

Deemed-to-Satisfy Provisions

1 3.1.2.3 requires surface water to be diverted away from Class 1 buildings. For slab-on-ground, 3.1.2.3 specifies the minimum height of the slab above the finished external surfaces and requires the external finished surface to be graded away from the building. For suspended floors, the ground beneath the floor must be above the adjacent external finished ground level to prevent water ponding under the building.

2 3.2.2.6 requires a vapour barrier to be provided beneath slab-on-ground construction.

3 3.3.4.4 and 3.3.4.5 nominate where a damp-proof course is required along with installation and material requirements.

Provisions dealing specifically with salt attack and acid sulphate soils appear in both Volumes of the BCA. In Volume One, the provisions are contained in referenced documents. In Volume Two the provisions are generally contained in referenced documents except for some specific requirements in Part 3.3 Masonry, which are summarised below.

Clause 3.3.1.5 specifies that masonry units must be classified. For masonry used below the damp-proof course, where walls are expected to be attacked by salts in the groundwater or brickwork itself, the masonry units must be Exposure Class classification.

Clause 3.3.1.6 has requirements for mortar mixes. It requires mortar to comply with AS 3700, be mixed by volume in the proportions stated in Table 3.3.1.2, contain fine aggregate sand with low clay content and free from efflorescing salts and contain water which is potable. Table 3.3.1.2 requires the mortar mix for Exposure Class masonry to be 1 part cement, 0.5 parts lime and 4.5 parts sand.

Documents referenced by the BCA which consider both salt attack and acid sulphate soils are:

- AS 2159 - 1995 Piling - Design and Installation
- AS 3600 - 2001 Concrete structures

Documents referenced by the BCA which consider salt attack but not acid sulphate soils are:

- AS 2870 - 1996 Residential slabs and footings - Construction
- AS 3700 - 2001 Masonry structures

There are no documents referenced by the BCA which consider acid sulphate soils but not salt attack.

The above documents are referenced by both volumes of the BCA. The salt attack and acid sulphate provisions of these documents can be summarised as follows:

1. AS 2159 sets out requirements for the design and construction of piled footings.

   Section 6 of AS 2159 contains durability requirements for piled footings. For durability purposes, it requires concrete piles to have a minimum concrete strength and minimum cover to reinforcement based on the exposure classification of the

concrete pile. The exposure classification must be determined in accordance with Table 6.1. Table 6.1 nominates the exposure classification based on the location of the pile (i.e. soil, water, refuse fill etc.), presence and amount of sulphates and chlorides, and the pH of the soil. The exposure classifications range from non-aggressive to very severe. The concrete strength and cover are increased as the aggressiveness of the soil increases.

For durability purposes, section 6 of AS 2159 specifies the uniform corrosion allowance (mm/year) that steel piles are to be designed for. The design uniform corrosion allowance is dependant on the exposure classification of the steel pile. The exposure classification must be determined in accordance with Table 6.3. Table 6.3 nominates the required exposure classification based on the pH of the soil, presence of chlorides and the resistivity of the soil.

2. AS 2870 sets out requirements for the design and construction of slab and footing systems for small buildings.

   AS 2870 contains requirements for vapour barriers in section 5.3.3. This section also covers damp proof membranes. The clause requires a raft or slab to be provided with a vapour barrier, or where required a damp proof membrane. A note for this section advises that damp proofing membranes are normally required in South Australia and that they are recommended in areas prone to rising damp or salt attack.

   Section 5.3.4 of AS 2870 contains edge rebate requirements for slab on ground and stiffened and waffle raft with masonry cavity or veneer construction. It advises that in areas of high salt damp, careful detailing of damp-proof courses is required.

   Section 6 of AS 2870 contains general construction requirements for footing systems. Section 6.4.8 contains additional requirements for salt-damp areas. It advises 'where required for durability in known salt damp areas, the concrete shall be vibrated and cured for at least 3 days'.

   Section 1.2 states that "residential footing system design and construction shall comply with AS 3600, except that, where in conflict, this Standard (AS 2870) shall take precedence."

3. AS 3600 sets out requirements for the design and construction of concrete structures.

   Section 4 of AS 3600 contains durability requirements. Table 4.3 nominates the exposure classification of concrete members. For concrete construction in aggressive soils, the exposure classification is U. A note to this table specifies permeable soils with a pH < 4, or ground water containing more than 1 g per litre of sulphate ions, would be considered aggressive. The note also advises that salt-rich soils in arid areas would be considered exposure classification C.

   AS 3600 is currently being revised. It has been proposed that concrete in contact with salt rich soils or soils in salinity affected areas would be included in exposure classification U.

   Section 4.5 specifies that concrete for exposure classification C, shall be initially cured continuously for at least 7 days under ambient conditions, or cured by accelerated methods so that average compressive strength at the end of curing is not less than 32 MPa. The concrete in the member is to have a characteristic strength (f'_c) at 28 days of not less than 50 MPa. Where the f'_c of 50 MPa can not be

satisfied, concrete with f'_c not less than 40 MPa, may be used, provided the cement content of the mix is not less than 470 kg/m³ and the cover required by Clause 4.10.3 of AS 3600, is increased by 10 mm.

Section 4.6 specifies that concrete for exposure classification U, shall be specified to ensure durability under the particular exposure environment. Therefore, it is up to the designer to specify what is required to ensure that durability of the member is satisfactory.

Table 4.10.3.2 contains the concrete cover requirements for reinforcement. For exposure classification C, the cover required varies between 50 - 70 mm, depending on the characteristic strength of the concrete. There is no reference in Table 4.10.3.2 to Exposure Classification U as the requirements of Section 4.6 apply (see above).

In the revised version of AS 3600 it is also proposed that there will be more specific requirements for concrete in acid sulphate soils.

4. AS 3700 contains requirements for the design and construction of masonry.

   Section 5 of AS 3700 contains general durability requirements for the design of masonry. Section 5.3 specifies masonry units shall be of at least the minimum salt attack resistance grade given in Table 5.1.

   Section 5.4 contains requirements for mortar. Mortar is to comply with the minimum classification requirements given in Table 5.1. This section specifies that where sulphate attack from groundwater is possible, sulphate resistant cement is to be used.

   Table 5.1 outlines the minimum salt attack resistance grade of masonry units, minimum classification of mortar, minimum durability classification of built-in components and minimum cover to reinforcement and tendons in grouted cavities or cores for masonry. The requirements are based on the exposure environment of the masonry. The requirements are more rigorous for elements in areas such as aggressive soils, elements subjected to saline wetting and drying and elements in marine environments. For masonry units below the damp-proof course in areas subject to salt attack, the masonry units need to be Exposure Class while the mortar needs to be of the M4 classification.

   The salt attack resistance grade of a masonry unit is determined by testing in accordance with AS/NZS 4456.10. During this test, samples of masonry are subjected to soaking in salt solution, oven-drying and cooling. The particle loss is then measured to determine the salt attack resistance grade of the masonry unit. The mortar classification relates to the composition of the mortar.

Building Code of Australia – Variations and Additions

South Australia

Salt attack has been a problem in South Australia for a number of years. South Australia typically has clay-based soils that have a high salt content, cool wet winters and dry hot summers which all aid salt attack. During the 1970's a salt attack research committee was formed to investigate the matter. As part of the investigations they produced a number of publications. Some of these publications provide advice for building in areas affected by urban salinity.

As result of this work, a South Australian variation dealing with salt attack has been inserted into the BCA. The content of the variation can be summarised as follows:

1. For slab on ground, the provisions require the membrane/barrier beneath the slab to be a damp-proof membrane rather than a vapour barrier.
2. For damp-proof courses, the provisions permit only embossed black polyethylene film, polyethylene coated aluminium and bitumen impregnated materials, providing they all comply with specific clauses from AS/NZS 2904. The BCA permits materials that comply with AS/NZS 2904 and certain termite shields.
3. For Class 1 buildings, the provisions list additional requirements that must be followed whilst the slab is curing. They are:
    a. concrete slabs must be adequately compacted, and slab surfaces, including edges, moist cured for 7 days.
    b. after vertical surfaces are stripped of formwork, slab edges must be finished prior to curing.
    c. loading of concrete slabs with stacked materials or building plant must not occur for a minimum of 7 days after pouring, although construction of wall frames and setting out brickwork may be undertaken during this period.

New South Wales

See Section 4 – Recent Developments, New South Wales.

5.2. Non-Mandatory Requirements

NSW DIPNR

The NSW DIPNR has produced a number of documents on the topic of urban salinity. One such publication is "Building in a Saline Environment". This publication provides information on how to build structures less susceptible to salt attack. It recommends the use of concrete and masonry resistant to salt and water. For bricks, it advises "bricks that are less susceptible to damage from salt and water:

- are less permeable so the salt and water cannot penetrate
- do not contain excessive amounts of salts, thus are not adding more salts to the process
- have good internal strength so that they can withstand the physical stress created by the formation of salt crystals".

For concrete, it advises that the concrete should have low permeability to prevent water passing through via capillary action.

The publication also discusses the concept of preventing salt and water moving into the building, to make the building less susceptible to salt attack. This can be achieved by providing a damp proof course for masonry which will restrict moisture rising above the damp-proof course. For concrete slabs, this can be achieved by providing a sand layer and damp-proof membrane beneath the slab. The layer of sand decreases the rise of moisture through the sand via capillary action due to the large pore spaces in the sand. The sand also helps prevent the damp-proof membrane from being punctured. As with the damp-proof course, the damp-proof membrane helps prevent moisture moving into the slab.

The publication also advocates good drainage to reduce the amount of water on the site.

WSROC/NSW DIPNR

As mentioned in the previous section, WSROC and NSW DIPNR have produced a Western Sydney Salinity Code of Practice. The document outlines some of the principles for building in saline areas. It advises that where severe dampness is a problem, consideration should be given to using alternative construction methods such as suspended slab or pier and beam, rather than slab-on-ground. Some of the other measures suggested include:

- use of damp-proof membranes for slab on ground construction rather than a vapour barrier.
- taking care when installing damp-proof courses to ensure that the damp-proof course is properly installed and not left short of corners or the outer wall. Care also needs to be taken to ensure that the damp-proof course is not bridged by landscaping, paving or rendering.
- use of salt resistant bricks and concrete.
- seek advice from product manufacturers regarding the durability and correct use of their products.
- use of salinity resistant materials for underground services and other infrastructure.

Wagga Wagga City Council

Wagga Wagga was one of the first cities in Australia to identify salt attack caused by urban salinity as a major problem. Wagga Wagga is located in a catchment area. The expansion of the city changed the catchment's water balance causing the water table to rise. Wagga Wagga City Council has produced a guideline for new buildings in saline areas. The ABCB have been advised by an author of the document that it is inappropriate for these measures to be considered the standard for dealing with salt attack, as the document was prepared by people with limited building experience and there was limited time and resources spent developing the booklet. The booklet was published for guidance of a general nature, where builders and owners should obtain detailed information and evaluate level of salinity risk. The recommendations for buildings in saline areas are as follows:[5]

1. Provide a minimum 50-mm layer of sand under concrete slabs. Use a damp proof membrane rather than a vapour proof membrane.
2. Use brick or concrete masonry resistant to water and salt. Mortar below the damp-proof course must be suitable for saline environments and may need waterproofing. Ensure mortar not stronger than masonry to prevent bricks from cracking.
3. Increase concrete strength to reduce permeability by using not less than 32 MPa concrete or use concrete that will reduce reinforcement corrosion, such as sulphate resisting concrete with a water cement ratio of 0.5 (water weight/cement weight).
4. For concrete slabs, cover reinforcement a minimum 40-mm to unprotected ground, 40 mm to external exposure, 30 mm to a membrane in contact with the ground and 20 mm to an internal surface.

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[5] http://www.wagga.nsw.gov.au/home-garden/pdf/Building%20in%20a%20Saline%20Environment.pdf

5. For concrete beams and strip footings provide minimum 50 mm concrete cover on reinforcing.
6. (Optional) Use waterproofing admixtures to reduce concrete permeability and keep salts out. Use corrosion inhibitors to improve the resistance of the reinforcing steel to corrosion.
7. Compact concrete through vibration to reduce spaces that water and salt can move.
8. Cure concrete for at least 7 days, this includes slab surfaces and edges, to ensure hard dense surface.
9. Use copper piping for water supply pipes. Non-metal pipes such as polybutylene or polyethylene may be used in some instances, subject to some restrictions. Use unplasticised polyvinyl chloride (upvc) for waste water pipes.

6. Issues for Consideration

It is apparent that damage caused to buildings by salt attack and acid sulphate soils is a problem. If BCA requirements are to be developed to deal with salt attack and acid sulphate soils, there are a number of points that need to be considered and these are outlined below.

6.1. Application of Measures

As mentioned in section 3, the ABCB has discussed at 3 options to deal with the problem of salt attack and damage from acid sulphate soils. These are:

Option 1 Develop a map of Australia indicating areas affected or likely to be affected by salt attack and acid sulphate soils. The map would be included in the BCA along with technical provisions to reduce the likelihood of salt attack and damage from acid sulphate soils. The provisions would only apply to building work in affected areas.

Option 2 Develop technical provisions to reduce the likelihood of salt attack and damage from acid sulphate soils for inclusion in the BCA. The provisions would apply to building work in areas considered susceptible to salt attack or having acid sulphate soils. The developer would seek advice from the appropriate authority (or expert where there is no appropriate authority) to determine whether the location of proposed building work is susceptible to salt attack or acid sulphate soils.

Option 3 Develop technical provisions to reduce the likelihood of salt attack and damage from acid sulphate soils for inclusion in the BCA. Provisions would apply to all building work.

All of the above options have both positive and negative aspects. The intent of option 1 and option 2 is that the requirements would only apply to building work in known affected areas. Therefore, building work in areas not affected would not have to comply. However, these 2 options would require information on areas susceptible to salt attack and acid sulphate soils. If this information is not already available, this may require State/Territory and/or Local Authorities to undertake this work. Alternatively, it may require an assessment of the site by an appropriately qualified and experienced expert to determine if buildings on the site would be at risk from salt attack or acid sulphate soils, and this may be more costly than adopting standard provisions.

As discussed in previous sections, salt attack caused by increased levels of urban salinity is a dynamic problem. Areas that are unaffected can become affected in a relatively short period of time and vice versa. Therefore a building could be built in an area that was deemed unaffected at the time of its construction, but then become affected in the future.

Having differing requirements for affected areas and unaffected areas, could create some confusion for building practitioners when determining the BCA requirements for a particular project.

Option 3 has a number of positive aspects. Salt attack can only occur in the presence of moisture, therefore the technical provisions will largely focus on reducing the potential for moisture to be able to penetrate and move through building elements. As the requirements would apply everywhere, there would not be a need for areas affected by salt attack and acid sulphate soils to be identified. Neither is there an issue for buildings

constructed in unaffected areas, without protection, that might become affected in the future. There would also be reduced confusion for building practitioners about the BCA requirements that prevent moisture penetration in buildings, as they would be nationally consistent. This approach is similar to the approach used for the salt attack requirements in New South Wales and South Australia.

A negative aspect of this option is that there would be a considerable percentage of new building work that is not likely to be affected by salt attack or acid sulphate soils that would have to comply with the new requirements.

Another consideration regarding the application of any new provision are the classes of buildings that the requirements would apply to. In South Australia, the variations to the BCA, (see section 5 – Current Measures Dealing with Salt Attack and Acid Sulphate Soils), which requires more stringent damp-proof membranes and damp-proof courses, apply to Class 1 – 9 buildings. Additional requirements for curing of concrete slabs on ground only applies to Class 1 buildings, as curing of concrete for other buildings is covered by AS 3600 (according to the relevant exposure classification). The New South Wales variation which requires a damp-proof membrane to be placed beneath slab-on-ground construction, only applies to Class 1 buildings.

6.2. What are Appropriate Provisions?

The intent of the provision needs to be considered initially so that appropriate provision are developed.

Salt Attack

Salt attack primarily affects concrete and masonry construction. The two main methods of reducing the chance of a building being affected by salt attack are:

- providing barriers to prevent contact between salt and building materials susceptible to salt attack; and
- using building materials/methods that are less susceptible to salt attack etc.

Barriers include the use of damp-proof courses and membranes and the placement of a sand layer beneath concrete slabs. Providing the sand barrier helps prevent the membrane being punctured. Due to the size of the sand grains, it also decreases the capillary rise of moisture through the sand due to its high porosity.

Building materials and methods less susceptible to salt attack include the use of salt resistant bricks and mortar, increasing concrete strength and cover to reinforcement and paying additional attention to vibration and curing of concrete to reduce permeability and ensure concrete achieves its maximum strength.

As outlined in Section 5, the BCA currently has some requirements that are intended to deal with salt attack. Apart from the requirements which apply to masonry in Volume Two, the measures appear in documents referenced by the BCA. In summary these provisions require:

- Masonry below the damp-proof course in areas subject to salt attack to be Exposure Class, whilst the mortar is required to be M4 classification.
- Concrete complying with AS 3600 that is exposed to salt attack, is to be specified to ensure the durability of the concrete under the particular environment.
- For concrete slabs and footings designed in accordance with AS 2870, which are located in areas subject to salt attack, of is recommended that a damp-proof membrane is used, that the damp-proof course is carefully detailed and that the concrete is vibrated and cured for a minimum 3 days (note that requirements of AS

3600 apply to AS 2870, where not in conflict with AS 2870, see Section 5 – Current Measures dealing with Salt Attack and Acid Sulphate Soils).

- Concrete and steel piles in areas subject to salt attack are required to meet durability requirements for the appropriate exposure classification.

Acid Sulphate Soils

Acid sulphate soils primarily affect concrete and steel construction that is in contact with the ground. There are no Deemed-to-Satisfy provisions in the BCA that are intended to deal with acid sulphate soils however the BCA references three acceptable construction manuals which contain some measures. AS 3700 contains requirements for masonry, AS 2159 has requirements for concrete and steel piles that are in contact with acid sulphate soils while AS 3600 has requirements for concrete construction (i.e. slabs, footings etc.) in contact with acid sulphate soils. In summary these provisions require:

- For masonry, sulphate resistant cement to be used where sulphate attack from ground water is possible.
- Concrete and steel piles in areas subject to acid sulphate soils, to meet durability requirements for the appropriate exposure classification.
- Concrete complying with AS 3600 that is exposed to acid sulphate soils, to be specified to ensure the durability of the concrete under the particular environment.

AS 2870 does not have any measures that deal with acid sulphate soils. However, it could be reasoned that the measures of AS 3600 apply due to Section 1.2 of AS 2870 stating that residential footing systems shall comply with AS 3600, where AS 3600 is not in conflict with AS 2870.

It is not known whether buildings that have been affected by acid sulphate attack complied with AS 2159 and AS 3600 nor is not known if the measures in these standards are effective forms of construction in acid sulphate soils. As noted previously, AS 3600 is undergoing revision, and it is proposed that the requirements for concrete construction in acid sulphate soils will be amended.

As outlined in section 4 – Recent Developments, there have been a number of recent developments concerning the construction of buildings on land affected by acid sulphate soils. The developments are mainly in the area of planning and managing sites which contain acid sulphate soils, to prevent sulphuric acid forming. These measures are generally contained in State, Territory and Local Government planning requirements. Therefore, if sites which contain acid sulphate soils are properly planned and managed so that the acid sulphate soils are not exposed to air, there may not be a need for buildings on such sites to be constructed with additional measures, to prevent attack from acid sulphate soils.

For acid sulphate soils, apart from the requirements contained in AS 2159 and AS 3600, appropriate building solutions have not been identified for adoption in the BCA. The requirements in AS 3600 can not really be considered building solutions as they require concrete members in contact with acid sulphate soils to be "specified to ensure durability under the particular environment."

6.3. Economic Impact

It is difficult to estimate the economic impact of the technical building provisions dealing with salt attack and acid sulphate soils without knowing what the proposed requirements would be and how they would apply. There may be initial costs for buildings which need to be constructed in accordance with the new provisions, however, there would also be cost savings for buildings constructed in accordance with the new provisions which

could have been subjected to damage as these buildings are not likely to require rectification works in the future. It is expected that the initial costs would be a small fraction of the rectification costs for affected buildings.

Information provided from Wagga City Council estimates the cost of provisions dealing with salt attack could range between 1.7% and 2.3% of the total cost of the building.

These figures are based on adopting the salt attack measures outlined in the Wagga City Council publication "Building in a Saline Environment". For a 140 m² brick veneer house with concrete slab on ground, the following additional measures would add 1.7 % to the cost of the house. The additional measures are:

- 25 MPa concrete for slab and footings.
- Black plastic membrane under slab and paths around house.
- Mechanically vibrate concrete and cure.
- Additional damp proof course, to ensure damp-proof course is for full width of walls.
- Exposure grade brickwork below damp-proof course.
- Use of non-corrosive in-ground service pipes.
- Expansion joint membrane against perimeter walls.

If the concrete strength was increased to 32 MPa and a heavy duty damp-proof membrane used to increase the level of salt attack protection, these additional measures increase the cost by 2.2% rather than 1.7 %. For 200 m² brick veneer house on a concrete slab, the cost of the lesser requirement is 1.8%. For the higher requirement, the cost is 2.3%.

The above figures have included mechanically vibrating and curing the slab as an additional cost. AS 2870, which is referenced by the BCA, recommends dwellings in areas affected by salt damp to be vibrated and cured for 3 days. It also recommends the use of a damp proof membrane in areas prone to salt attack or rising damp.

The above figures have also included the use of exposure grade bricks below the damp-proof course and for the damp-proof course to extend through the entire width of the masonry. The use of exposure grade bricks is a requirement of both the BCA and AS 3700 for areas where walls are expected to be attacked by salts in the groundwater or bricks itself. The BCA also requires damp-proof course to be of sufficient width to extend through the entire width of the masonry leaves.

Therefore for the above examples, the increases in cost is likely to be less as some of the additional salt protection requirements are already mandatory requirements under the BCA and BCA referenced Australian Standards.

Information provided by the NSW DIPNR suggest that the additional cost of substituting a vapour barrier with a damp-proof membrane is approximately $ 120 for a 200 m² house.

Information provided by a major brick manufacturer suggests that the additional cost of exposure grade bricks compared to general purpose bricks is negligible for most face bricks whilst for common bricks the difference is approximately $ 100 per thousand bricks.

6.4. Amendment Process

Any BCA amendment covering salt attack and acid sulphate soils will be developed after directions outlined in this paper have been agreed. If the proposed changes are significant a Regulation Document and Regulatory Impact Statement will be developed and released for public comment.

7. Comments

Comments are invited on this Discussion Paper. It would assist analysis if the enclosed pro-forma was used and the specific questions answered. General comments or comments on other issues could then be made in the space provided or as an attachment.

To assist in providing comments to the questions, proposals have been included in Appendix A.

The ABCB's Building Codes Committee will review comments received prior to the development of a final proposal for consideration.

The closing date for comments is **29 October 2004**.

8. References

Australian Standard, *AS 2159, Piling – Design and installation,* Amdt 1, April 1996, Standards Australia, Homebush NSW

Australian Standard, *AS 2870, Residential slabs and footings – Construction,* Amdt 4 May 2003. Standards Australia, Homebush NSW

Australian Standard, *AS 2904, Damp-proof courses and flashings,* Amdt 1, March 1998 Standards Australia, Homebush NSW

Australian Standard, *AS 3660, Conctrete structures,* Amdt 1, May 2002, Standards Australia, Homebush NSW

Australian Standard, *AS 3700, Masonry structures*, Amdt 2 Dec 2003, Standards Australia, Homebush NSW

Australian Government Department of Agriculture, Fisheries and Forestry's web-site: www.affa.gov.au

Commonwealth of Australia and States and Territories of Australia, 1996. *Building Code of Australia: Class 2 to 9 Buildings* (Volume One), CanPrint Communications: Canberra

Commonwealth of Australia and States and Territories of Australia, 1996. *Housing Provisions* (Volume Two), CanPrint Communications: Canberra

Commonwealth of Australia and States and Territories of Australia, 1996. *Guide to the Building Code of Australia: Class 2 to 9 Buildings*, CanPrint Communications: Canberra

NSW Department of Land and Water Conservation's web-site: www.dlwc.nsw.gov.au

Wagga Wagga City Council Website Building in a Saline Environment: www.wagga.nsw.gov.au

9. Response sheet — Salt Attack

Name: ..... Date: .....

Organisation: .....

Address: .....

Telephone No: .....Fax No:.....

Email Address: .....

Your response to the following questions will assist the ABCB in determining whether there is a need for regulatory changes and provide guidance on nature of those changes.

Q	Description	Answer
1	Do you think there is a need to amend the current provisions relating to salt attack in the BCA and BCA reference documents?	Yes/No
2	Do you think there is a need to amend the current provisions relating to acid sulphate soils in the BCA and BCA reference documents?	Yes/No
3	Do you agree with a damp-proof membrane being required under slab-on-ground construction rather than a vapour to increase the slabs resistance to salt attack?	Yes/No
4	Do you agree with the vibrating, finishing and curing measures for slab-on-ground construction to increase the slabs resistance to salt attack?	Yes/No
5	Do you agree that any salt attack measures should apply to all buildings, rather than just buildings that are expected to be attacked?	Yes/No
6	Do you agree that any salt attack measures should apply to Class 1 - 9 buildings and attached Class 10 buildings?	Yes/No
7	Do you support a review of the relevant Performance Requirements to consider salt attack?	Yes/No
8	Do you support a review of the relevant Performance Requirements to consider acid sulphate soils?	Yes/No
9	Do you think slab-edge dampness is an issue in buildings?	Yes/No

10	Do you have any other comments on the content of this discussion paper?	Yes/No
	Comment	

11	Do you have any information on technical solutions for dealing with salt attack and acid sulphate soils?	Yes/No
	If yes, please describe and attach the necessary information.	

Remember closing date for comment is **29 October 2004**.

Comments should be forwarded to:

Shawn Kidner
Project Officer
Australian Building Codes Board
GPO Box 9839
CANBERRA ACT 2601

or

Fax to (02) 6213 7287

or

E-mail to Shawn.Kidner@abcb.gov.au

APPENDIX A – PROPOSALS

Salt Attack

It proposed that the BCA salt attack provisions be amended. It is noted that there are salt attack provisions in Volume Two of the BCA, which cover masonry construction and that there are various salt attack provisions in the documents referenced by the BCA. However it is unclear in some instance when these requirements apply. This is especially the case in Volume Two which references AS 2870 and AS 3600, yet there are extensive details for concrete construction in the prescriptive requirements which do not make reference to salt attack. For clarity it is proposed that the inconsistencies between the BCA and relevant Standards are corrected.

It is recommended the proposed changes not affect the technical requirements for piled footings or masonry construction as:

- the BCA does not contain prescriptive requirements for piled footings. It references AS 2159 which contains requirements dealing with salt attack. Anecdotal evidence suggests that these provisions have not been shown to be defective; and

- the BCA prescriptive provisions for masonry and AS 3700 have identical requirements dealing with salt attack. These measures have not been shown to be defective and consistent with what is recommended in most recent publications for measures dealing with salt attack.

It is recommended that changes are made to the BCA requirements for concrete construction. The recommended changes are as follows:

- A damp-proof membrane be required under concrete slab-on-ground construction rather than a vapour barrier. The damp-proof membrane would provide a higher resistance to moisture penetration, damage during construction and degradation by dissolved salts when compared to a vapour barrier. This requirement is consistent with the South Australian requirements and NSW requirements.

- Concrete slab-on-ground construction to be adequately vibrated and cured for a minimum 3 days. After vertical surfaces are stripped from formwork, slab edges must be finished prior to curing. Vibrating and curing concrete slab-on-ground construction for a minimum 3 days is consistent with AS 2870. Finishing slab edges is consistent with the South Australian requirements. Both requirements will decrease the permeability of the concrete and help prevent moisture passing through the slab.

As salt attack is a dynamic problem, it is proposed that the requirements, including the masonry measures would apply to all buildings, not just buildings that are expected to be subject to salt attack. This is consistent with the approach used in South Australia and what will be used in New South Wales. The requirements would improve the general performance of a building against moisture from the ground. Having the requirements apply to all buildings will also avoid confusion for building practitioners.

It is also proposed that the requirements would apply to Class 1 – 9 buildings and attached Class 10 buildings. This approach is consistent with the South Australian requirements and the BCA damp-proofing requirements.

It is recommended that any proposed change to the BCA also include a review of the relevant Performance Requirements.

Acid Sulphate Soils

It is proposed that the BCA not be amended to incorporate acid sulphate provisions, due to the following:

- Acid sulphate soils affect concrete and steel members that are in contact with the ground. The BCA references standards which cover concrete and steel in contact with the ground, these being AS 2159 the piling standard and AS 3600 for concrete structures. Both standards have requirements that deal with acid sulphate soils;

- Section 4 – Recent Developments highlighted that there are initiatives at federal, state/territory and local level to ensure that new developments avoid the disturbance of acid sulphate soils. Therefore, if acid sulphate soils are not disturbed in these new developments, there may not be a need for buildings to be constructed with measures that deal with acid sulphate soils.

- There are no recognised technical building solutions for concrete in aggressive acid sulphate soils. AS 3600 requires the designer to specify the member to ensure its durability under the particular exposure environment. The proposed revision of AS 3600 is not proposing to change this.

As there are no requirements in AS 2870 for slabs and footings exposed to acid sulphate soils, it is proposed that the Standards Australia committee responsible for AS 2870 be requested to consider incorporating measures or some reference to acid sulphate soils in AS 2870.

APPENDIX B

Amended discussion paper proposal
(as agreed to by BCC)

Salt Attack

- It is proposed that the BCA Performance Requirements include salt attack.

- It is proposed that the BCA provisions be amended to include salt attack. There are inconsistencies between the BCA provisions and BCA referenced standards that require resolution. Some BCA provisions cover salt attack and some do not. Also, some referenced standards cover salt attack and some do not. For example, AS 3700, AS 2159 and AS 3600 cover salt attack while AS 2870 does not. The BCA provisions for masonry construction cover salt attack while BCA provisions for concrete construction do not.

- It is proposed that the BCA concrete slab-on-ground construction provisions be amended to require a damp-proof membrane rather than a vapour barrier. The damp-proof membrane would provide a higher resistance to moisture penetration, damage during construction and degradation by dissolved salts when compared to a vapour barrier. This requirement is consistent with the South Australian and NSW provisions.

- It is proposed that concrete slab-on-ground construction be required to be adequately vibrated and cured for a minimum of 3 days. After vertical surfaces are stripped from formwork, slab edges must be finished prior to curing. Vibrating and curing concrete slab-on-ground construction for a minimum 3 days is consistent with AS 2870. Finishing slab edges is consistent with the South Australian provisions. Both requirements will decrease the permeability of the concrete and help prevent moisture passing through the slab.

- As salt attack is a dynamic problem, it is proposed that the requirements would apply to all buildings, not just buildings that are expected to be subject to salt attack. This is consistent with the approach used by South Australia and New South Wales. The requirements would improve the general performance of a building against moisture from the ground. Having the requirements apply to all buildings will also avoid confusion for building practitioners. These proposed requirements would apply to Class 1 – 9 buildings and attached Class 10 buildings. This approach is consistent with the BCA damp-proofing requirements.

Acid Sulphate Soils Attack

- It is proposed that the BCA Performance Requirements include resistance to acid sulphate soil attack. This has been proposed due to strong support in the responses to Question 8 in the discussion paper.

- It is proposed that the BCA DTS provisions not be amended to incorporate acid sulphate soil attack. Section 4 – Recent Developments in the discussion paper highlighted that there are initiatives at federal, state/territory and local level to influence new developments to avoid the disturbance of acid sulphate soils. If acid sulphate soils

are not disturbed in new developments, there is less need for BCA provisions to include building measures that resist acid sulphate soil attack. As acid sulphate soil attack is limited to particular areas, it is preferable that the referenced standards which contain more comprehensive building solutions include solutions for materials to resist acid sulphate soils attack, for example AS 2870. A number of referenced standards already contain solutions that deal with acid sulphate soils, for example AS 3600 and AS 2159.