Old Great North Road

Dharug National Park

Maintenance Plan

David Young · Neil Urwin · Dr Tracy Ireland

March 2007

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For the Parks and Wildlife Division of the
Department of Environment and Conservation

Contents

1. Introduction

1.1 Background

The Great North Road was built using convict labour between 1826 and 1836, spanning the 250km distance between Sydney and the Hunter Valley. The 43km between Wiseman's Ferry and Mt Manning is the most substantial section of the Great North Road which has not been re-used, overbuilt and up-graded, due to its early abandonment for more convenient routes. This section is known by the Parks and Wildlife Division of the Department of Environment and Conservation as the 'Old Great North Road' (OGNR).

This plan is about the 16km stretch of the Old Great North Road between the spectacular ascent of Devine's Hill from the Hawkesbury River at Wiseman's Ferry, through to 10 Mile Hollow. The plan also covers the original 5km ascent from the Hawkesbury known as Finch's Line which was abandoned in 1829. Also covered in this document are Simpson's Track which joins the OGNR at 10 Mile Hollow and the Shepherd's Gully and Sternbeck's Gully Roads which join the OGNR at the top of Devine's Hill and once provided routes through to the Macdonald Valley. The latter two roads are within Yengo National Park while the remainder fall within Dharug National Park.

A revised Conservation Management Plan (CMP) for these roads was prepared in 2003-2004 by Griffin NRM Pty Ltd. The CMP (Ireland et al, 2005) has a strategic management approach and views the Old Great North Road as a cultural landscape rather than a series of sites. The brief for the preparation of the CMP envisaged that a detailed Maintenance Plan would provide comprehensive guidelines for the future maintenance of the OGNR.

This document was commissioned in late 2003 by the National Parks and Wildlife Service, now the Parks and Wildlife Division (PWD) of the Department of Environment and Conservation (DEC). Circumstances prevented its completion in 2004 and the project was re-activated in 2006.

The aim of the project has been to provide:

- comprehensive maintenance guidelines for the Old Great North Road;
- detailed maintenance schedules on a precinct by precinct basis;
- training for NPWS (PWD) staff; and
- to ensure best practice management of a cultural heritage place.

1.2 Location

The Old Great North Road forms the northwest border of Dharug National Park which is located north of the Hawkesbury River, 55 km north of the centre of Sydney, and 25km west of Gosford (National Parks and Wildlife Service, 1997). It is bounded by Yengo NP, Wiseman's Ferry, McPherson State Forest, private land along Mangrove Creek, and the townships of Gunderman and Spencer. Except for the Shepherd's Gully Roads, the management of the OGNR is the responsibility of Dharug NP.

1.3 Methodology

This document was prepared 'in the field' as distinct from a solely desk-top exercise. Five field trips to the OGNR were made in the period February – May 2004 and a sixth in September 2006. Most trips had a specific purpose related to components of the plan: drain and culvert clearing, including a demonstration of techniques; road pavement materials, including inspection of quarries; graffiti removal, including trial cleaning of examples; and timber fence post conservation, in which all known timber fence elements were inspected and treated. The first trip included a workshop with seven NPWS (PWD) staff including field officers, field supervisors and rangers, and covered all aspects of maintaining the OGNR. Another workshop and field training session focussed on the removal of modern graffiti. Other staff, and former staff and consultants, who had worked on the OGNR were consulted about their experiences of working on the road.

1.4 Authorship

The principal author is David Young, who also contributed to aspects of the CMP. Young undertook all field trips and led the field workshops. Neil Urwin (Griffin NRM) contributed the vegetation management sections (4.2 and 4.3) of the plan. Dr Tracy Ireland (Griffin NRM), who was principal consultant for the CMP, reviewed drafts and participated in a field trip. All photographs are by Young and were taken in the period February 2004 to September 2006.

1.5 Acknowledgements

The consultants acknowledge the contributions made to this study by the field staff of PWD, including Sarah Breheny, Garry Bull, Bob McCullough, Alan McDonough, Sheen Mohekey, Dave Towell and Kerry Wellham. Robin Aitken, Bill Jordan, Jonathan Sanders and Ian Webb gave of their considerable experiences of working on the road. David Lambert showed us how to remove modern graffiti. Elisha Long and Cath Snelgrove commented on drafts and provided useful ideas. Sarah Breheny managed this study for PWD and made a valuable contribution in terms of time, support and understanding of the place and its challenges.

2. Conservation Management Plan

A Conservation Management Plan (CMP) for the Old Great North Road Cultural Landscape in Dharug National Park was prepared during 2003 and 2004 (Ireland et al., 2005). The CMP reviews the history and landscape of the OGNR, assesses its significance and then analyses the factors affecting its future leading to policies and strategies for its ongoing management. The next stage in caring for the OGNR, the development and implementation of this Maintenance Plan is one of the key strategies identified in the CMP.

2.1 Precincts

For effective management the CMP divides the OGNR into seven precincts as follows:

Precinct 1	Devine's Hill ascent to Finch's Line
Precinct 2	Shepherd's Gully Road and Sternbeck's Gully Road
Precinct 3	Finch's Line
Precinct 4	Finch's Line Intersection to (and including) Mitchell's Loop
Precinct 5	Mitchell's Loop to the Western Commission Track Intersection
Precinct 6	Western Commission Track Intersection to Ten Mile Hollow
Precinct 7	Simpson's Track

An overall map showing the location of the precincts and detailed maps of each precinct are incorporated as Appendix 5. As with other management objectives, maintenance activities will vary from precinct to precinct.

2.2 Strategic Management Approach

The CMP sets out a strategic management approach which aims to minimise loss and deterioration of cultural fabric and landscape quality and has three levels of implementation:

1. baseline management of the entire road corridor;
2. management cycles of maintenance and inspection/monitoring on a precinct by precinct basis; and
3. identification of strategic and long term objectives which can be activated as funding becomes available.

These levels of implementation include the following activities:

2.2.1 Baseline management

Baseline management will comprise

- ongoing activities controlling access and usage of the road corridor;
- management of vegetation impinging on the road corridor and its associated sites; and
- establishment of monitoring targets and inspection and monitoring activities.

These activities should be considered to be routine and an integral part of the PWD's custodial role over the OGNR cultural landscape.

Figure 1

Baseline management will include controlling access and vegetation impinging on the road corridor. Precinct 5.

2.2.2 Management Cycle in Precincts

The management cycle for each precinct will follow the iterative loop characteristic of all environmental management systems. The cycle will comprise:

- Planned targets;
- Maintenance/corrective activity;
- Monitoring effectiveness;
- Revised targets on the basis of monitoring data.

The areas covered in this way will be the ongoing maintenance of re-surfaced areas, including culvert and drain clearance, surface consolidation as well as areas of potential structural weakness (embankment bulges and areas of potential collapse), monitoring of archaeological sites and visitor impacts.

2.2.3 Strategic and Long Term Management Objectives

The key Strategic and Long Term Management objectives identified by the CMP, which can be activated as funding becomes available, are:

- An Interpretation and Visitor Facilities Strategy;
- A Masonry Conservation Strategy;
- A Long Term Reconstruction and Major Repair Strategy covering:

Precinct 2: Shepherds Gully Road upgrading to provide access for vehicles for maintenance works, thus avoiding Devine's Hill; and

Precinct 4: Mitchell's Loop stabilisation and road surfacing works.

- Minor Repair Works, with the following priorities:
  1. Localised repairs to road surface (principally to maintain access);
  2. Culvert repairs, including replacement of multiple cover slabs;
  3. Repositioning multiple coping and/or kerb stones; and
  4. Stabilising base of retaining walls.

Figure 2

Hangman's Rock, Devine's Hill ascent. The CMP envisages a masonry conservation strategy to investigate longer term stone conservation issues, such as decay of the light-coloured bench at centre left, that are not dealt with in this maintenance plan.

3. This Maintenance Plan

This plan principally provides guidance on activities in the first two levels of implementation of the strategic management approach of the CMP — i.e. baseline management and management cycles in precincts. These two levels are not dealt with separately in this plan, rather the maintenance schedule (Appendix 2) provides for each of them as appropriate on a precinct by precinct basis. This plan also provides some introduction to some of the strategic and long term management objectives of the CMP. Like the CMP, the conservation philosophy that underlies this plan is drawn from the Australia ICOMOS *Burra Charter*, 1999.

3.1 What is our aim?

The CMP envisages that the integrated heritage values of the Old Great North Road cultural landscape will be retained by:

- ongoing maintenance and repair to best-practice conservation standards;
- managed access for sustainable uses;
- strong community management partnerships;
- creative interpretation; and
- promotion as a key destination.

This Maintenance Plan is about putting into practice an important part of the first point. By establishing a maintenance program with guidance on how the maintenance activities should be undertaken, this plan provides a basis for the long term care of the OGNR.

3.2 Maintenance or Repair?

Caring for the fabric of the OGNR will involve a range of maintenance activities and also repair works such as reconstruction of retaining walls. All physical works are divided into three groups: Maintenance, Minor Works and Major Works. These are shown in relation to the various elements of the OGNR in Appendix 1 which is a matrix identifying the different activities to be undertaken, and also shows the relevant planning approvals needed for works in each group.

Maintenance works are usually of a cyclic or routine nature and include clearing drains and culverts and controlling vegetation.

Minor Works are generally repetitive activities, such as repositioning multiple kerb or coping stones. While each individual task is not substantial, when collected together they add up to a project that is well beyond the scope of routine maintenance.

Major Works will usually involve reconstruction of substantial elements such as retaining walls, culverts and road surfaces.

The aim is to undertake maintenance in a timely way so that the need for minor works is minimised, and to carry out minor works in order to reduce the need for major works.

3.2.1 Principles of repair

Policy 6 of the CMP (Conservation of the fabric, page 8-5) sets out the following important principles governing repair works:

- Repair and reconstruction should aim to maintain, rather than replace, existing fabric as far as possible.
- The introduction of modern materials, which perform better than original materials, should be considered when this will assist in the long term conservation of significant fabric.
- Repair and reconstruction may be undertaken pro-actively to prevent the loss of significant fabric.
- Significant fabric which is beyond repair should be stabilised and conserved *in situ* as far as possible, to prevent the cumulative loss of historic fabric.

3.2.2 Approvals

The OGNR is an item listed on the DEC's S170 register and an item listed on the State Heritage Register and consequently some works require special approvals. One of the aims of classifying all works as either *Maintenance*, *Minor Works* or *Major Works* (Appendix 1) is for clarity about the nature of approvals required for any particular task.

Following the endorsement of the CMP, and provided all work done is consistent with the CMP and the advice of this Maintenance Plan, all activities described as *Maintenance* should not require approval as they will be covered by exemptions under the NSW Heritage Act. There are two types of exemptions, Standard Exemptions and Site Specific Exemptions. Standard Exemptions are set out in a NSW Heritage Office document (NSW Heritage Office, 2006), current versions of which can be downloaded from the Heritage Office website. Standard Exemptions cover such things as maintenance, cleaning, repairs, excavation and restoration. The procedure for some of these (including excavation and restoration) still requires an exchange of letters to satisfy authorities that the work is indeed in accordance with the Standard Exemptions. The Executive Director, Cultural Heritage in the Department of Environment and Conservation has delegated authority to issue a notice to that effect.

Works which are defined as *Maintenance* by this plan but which are not covered by the Standard Exemptions are the removal of trees (as part of controlling vegetation) and the removal of deep engravings (recent graffiti). Site Specific Exemptions should be sought for these activities: recommendations to this effect are provided in Appendix 4.

Works defined in Appendix 1 as *Minor Works* will require approval under S60 of the Heritage Act. The documentation and follow up recording required by such approvals may require expert professional advice from an archaeologist, conservator, engineer or other practitioner.

Major Works will require adherence to the REF procedures of the Environmental Planning and Assessment Act as well as approvals under S60 of the Heritage Act. These works will require expert professional advice from an archaeologist, conservator, engineer or other practitioners.

3.3 Terms used in this Plan

All maintenance work is described in terms of *Activities* and for each activity there is a planned *Target*. *Activities* can be divided into various *Tasks* that are to be undertaken to fulfil these targets and are generally divided into three *Levels*: *Inspection*, *Routine* and *After Major Events (AME)*.

- *Inspection* is an important part of each maintenance activity: it incorporates *monitoring* and *recording* of observations, and is undertaken cyclically and as-needed.
- *Routine* maintenance, as its name suggests, is that work undertaken on a routine cyclical basis. In addition, some 'routine' maintenance is undertaken on an as-required basis following inspections that identify the need.
- *After Major Events (AME)* recognises the additional need for maintenance after major events such as rainstorms, bushfires or earthquake, or a combination of these.

Catch-up maintenance, the work undertaken to 'catch-up' after a prolonged period of falling behind, is not separately identified in this plan. The nature of the work is the same as that identified for normal activities, but is likely to take longer and be more intensive during the catch-up phase. Some catch-up work will have much in common with maintenance undertaken after major events, such as unblocking culverts, or removing fallen trees.

3.4 Scheduling Maintenance

Section 4 of this plan contains detailed explanations of each of the maintenance activities. Appendix 2 is the Maintenance Schedule which identifies the location and required frequency of each of the activities and their component tasks. The activities are summarised in dot point form in this appendix in order to give some understanding of the nature of work. However, reference should always be made back to Section 4 of this plan for the detail of each activity.

3.4.1 Frequency of maintenance activities

Two sets of frequencies are indicated in the Maintenance Schedule, an ideal frequency and a minimum frequency. The ideal frequency is just that, an ideal. Management of the OGNR should seek to ensure there are sufficient resources to enable maintenance activities to be undertaken at the ideal frequency. Recognising that resources may not be sufficient to achieve the ideal, the minimum frequency establishes a lower limit of maintenance activity below which there is a substantially increased risk of damage to the significant fabric.

3.4.2 Climate dependence of maintenance needs

One of the difficulties in scheduling (and resourcing) maintenance needs for the OGNR is the unpredictability of severe and extreme weather conditions. Major events such as bushfires or rainstorms (and potentially, earthquake) will lead to blocked culverts and eroded road surfaces, demanding a rapid maintenance response so that further heavy rains do not make the damage much worse. While such weather events might be anticipated, they cannot be predicted, and so there is no option but to schedule *Routine* maintenance on a cyclical basis and to recognise and resource the need for additional maintenance work to take place on an as-required basis. This latter level of maintenance activity is described as *After Major Events (AME)*. The *Inspection* level of each activity also incorporates a response to major events — the need to first check for blockages, surface erosion, fallen trees and the like, so that maintenance needs can be identified and implemented.

3.4.3 Interrelated maintenance activities

Though described as discrete activities in Section 4 and listed separately in the Maintenance Schedule (Appendix 2), there are some tasks (particularly inspections) which should be undertaken at the same time: e.g. walking below the walls of Devine’s Hill to inspect the base of the walls (4.7.1.1) would also be the opportunity to check culvert outlets (4.1.1.2).

Conversely, there are some inspections that are deliberately specified as separate tasks. This is because of the impracticality of safely and accurately observing all of the things that need to be inspected and recorded in one pass. Inspections for road pavement conditions

(4.8.2.1) also include checking on kerbs (4.9.2.1) and copings (4.10.2.1), but are kept separate from those for drains and culverts (4.1.2.1).

3.5 Implementation

A brief look at the Maintenance Schedule (Appendix 2) will show that there is substantial variation in the extent and nature of maintenance activities between precincts. All precincts are to be maintained to a baseline level which includes management of vegetation impinging on the road corridor. In accordance with the CMP some precincts are to be much more intensively maintained. These include the more conserved sections of the road (precinct 1 — Devine's Hill) and those that have broader park management functions such as access for firefighting (precinct 6 — Western Commission Track intersection to Ten Mile Hollow, and precinct 7 — Simpson's Track).

The CMP envisages a long term reconstruction and major repair strategy (Major Works) that can be activated as funding becomes available. This will see the upgrading of Shepherds Gully Road (precinct 2) to provide vehicular access for maintenance works, avoiding the more sensitive Devine's Hill; and stabilising and road surfacing of precinct 4 out to Mitchell's Loop. As these works are undertaken the maintenance activities in these precincts will need to be upgraded to match, and so this plan will need updating to accommodate the changes.

The CMP also envisages programs of Minor Works, and identifies the following priorities:

1. Localised repairs to road surface (principally to maintain access);
2. Culvert repairs, including replacement of multiple cover slabs;
3. Repositioning multiple coping and/or kerb stones; and
4. Stabilising base of retaining walls.

While these works are often repetitive activities in which each individual task is not substantial (such as repositioning kerb and coping stones), there is much to be gained by doing them as a group, in a single campaign, for the whole or part of a precinct. A campaign approach brings economies of scale and with them the opportunity to properly train those involved and to provide appropriate supervision, equipment and materials.

3.6 Recording

Recording information is a key component of effectively managing the OGNR. Recording will be of two types:

- recording observations made during inspections; and
- recording maintenance and repair works as they are undertaken.

Recording observations made during inspections is about recording the condition of the various elements of the road. The records will lead to:

- confirmation of adequacy of existing maintenance regime; or
- further maintenance work if deficiencies are noted; and/or
- repairs, which may be required after some major events; and
- monitoring outcomes against established targets for each activity.

Recording maintenance and repair works as they are undertaken has two purposes:

- it will become the historical record of work undertaken, important in itself as evidence of maintenance activity, but also invaluable to future custodians of the road; and
- it will lead to a better understanding of problem areas which may in turn indicate the need for corrective action such as changes to the nature and frequency of activities.

Recording of inspections and maintenance works should initially be undertaken on the existing sheets (Old Great North Road Maintenance Works) to which a column should be added to indicate the precinct. The sheets should be modified as experience determines. The recording sheets should be considered as guides only and should not constrain or limit the making of records.

3.7 Monitoring

Monitoring is about judging how effective the maintenance activities have been in achieving their planned targets. Monitoring should be undertaken annually as a desk-based review and audit of the maintenance records. There should be an annual report of monitoring which should contain:

- an analysis of results — have the maintenance targets been achieved?
- comparison against climate and bushfire data for the year so that major events can be acknowledged and understood for their impact on the road;
- a summary of survey monitoring of retaining walls;
- recommendations for any changes considered necessary to frequency and nature of maintenance activities; and
- a forecasting of the need for any minor or major repair works.

The annual report of monitoring would fulfil part of the substantiation requirements under Section 170 of the NSW Heritage Act.

3.8 Review of this plan

This Maintenance Plan should be reviewed every five to ten years. Unlike the annual monitoring, the review should be undertaken by someone independent of the PWD, thus providing an external audit function. The five to ten yearly review should include an inspection of the OGNR and a review of the annual reports of monitoring and the maintenance records. The review should consider whether maintenance targets have been met and the possible need to revise targets in the light of the experience of the previous period. The review should also take account of any changed maintenance requirements resulting from changing climate patterns, implementation of the CMP's long term reconstruction and major repair strategy, and from the outcome of the masonry conservation strategy (CMP Policy 6, Conservation of the fabric, pages 8-5 to 8-7).

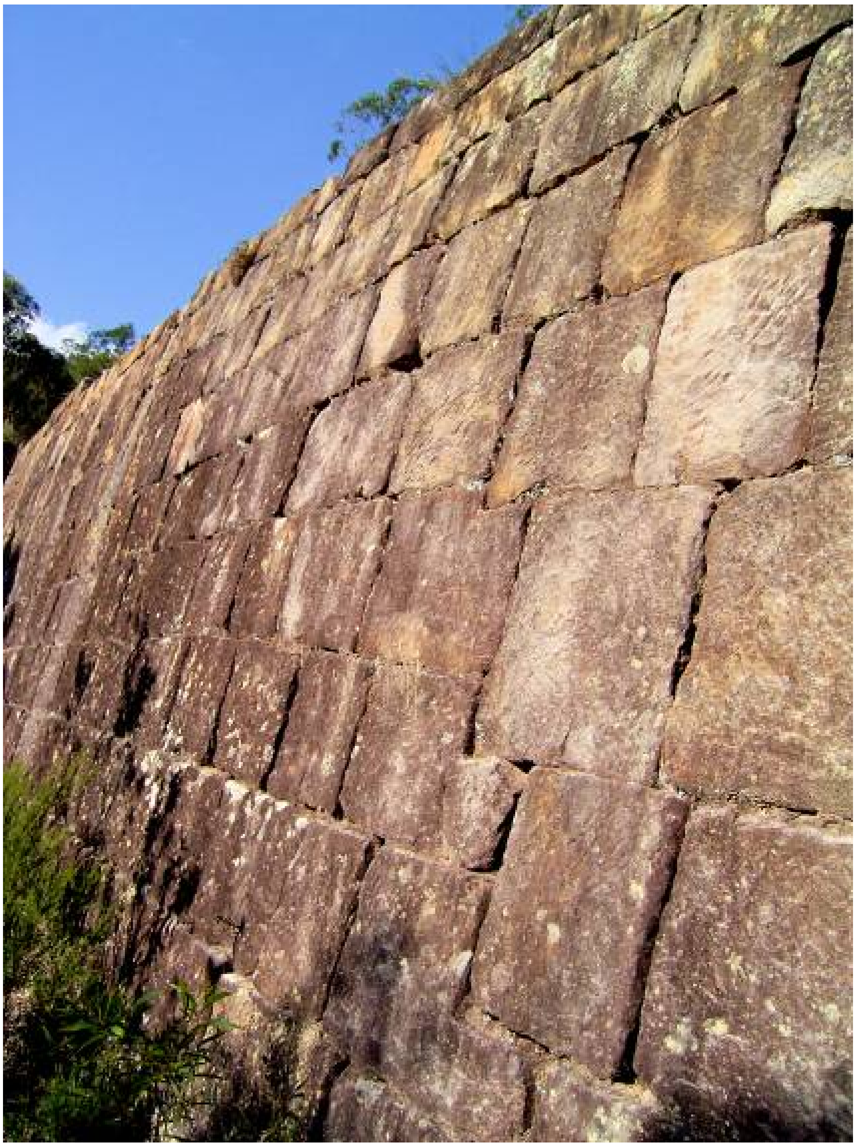


Figure 3

Remarkable quality drystone retaining walls are a feature of the Devine's Hill ascent (Precinct 1).

4. Maintenance activities

This section is a detailed explanation of the various maintenance activities. It should be read in conjunction with the Maintenance Schedule (Appendix 2) which identifies the location and required frequency of each of the activities. While the Maintenance Schedule has a dot-pointed summary of each activity, this section should always be referred to for the detail of how each activity is to be undertaken.

Most maintenance activities are undertaken at three Levels: Inspection, Routine and After Major Events (AME). The latter recognises the increased need for maintenance resulting from major events such as rainstorms, bushfires or earthquake, or a combination of any of these. Recording of observations and of works undertaken (see Section 3.6) should occur at each of the three levels.

Maintenance Activities are listed below and explained in detail in the pages following. Most begin with an explanation of what the relevant risks are to the significant fabric and hence why the activity is needed. The tasks to be undertaken at the different levels are indicated, with each task separately numbered. The first numbered point is the planned maintenance target for that activity. Any frequencies indicated in the explanations that follow are the ideal maintenance frequencies. The Maintenance Schedule also indicates minimum frequencies for maintenance, below which there is a substantially increased risk of damage to the significant fabric.

Maintenance Activities list

- 4.1 Drain and culvert clearing
- 4.2 Vegetation management
- 4.3 Threatened species management
- 4.4 Historic graffiti conservation
- 4.5 Modern graffiti cleaning
- 4.6 Survey monitoring of retaining walls
- 4.7 Maintaining base of retaining walls
- 4.8 Maintaining road pavements
- 4.9 Repositioning kerb stones
- 4.10 Repositioning coping stones
- 4.11 Repair of culvert cover slabs
- 4.12 Maintenance of timber fences

4.1 Drain and culvert clearing

Good drainage is fundamental to the long term conservation of the Old Great North Road. The greatest risk to the survival of the road fabric is blocked drains and culverts leading to a build up of water within the road structure. Such a build up could lead to softening of any clay-rich foundations causing slope failure and collapse of the retaining wall and road structure, as happened in the major 1857 event on the Devine's Hill ascent. In addition, there could be bulging of the retaining walls due to increases in hydrostatic and earth pressure as a result of excess water accumulating in the backfill behind the walls.

Although made without a lot of knowledge of local climate, the original convict construction was generally well equipped to handle water runoff and drainage along and through the structure. Today, our role is to ensure that the drainage system functions as well as possible and this means regular and as-required clearing of tree litter, rocks, sand and other debris.

4.1.1 Maintenance target for drain and culvert clearing

The maintenance target for this activity is a drainage system that is cleared at sufficient frequency and following major events (fires, storms) so that blockages are minimised and so that stormwater is rapidly carried away from the road pavement and the retaining walls and other structures that support it.

Figures 4 & 5

Accumulation of leaves bark and other tree litter in drains leads to the risk of blocked culverts, with potentially serious damage to the road structure. Note that the culvert on the right is missing its original entrance cover: recesses cut into the sandstone bedrock indicate where it was positioned.

4.1.2 Inspection of drains and culverts

4.1.2.1 This inspection can be vehicle-based as the high seating position of a 4WD enables good sighting of the side drains and reasonable sighting into the intakes of culverts. Record the build up of debris, precinct by precinct, as light or heavy. Heavy accumulations of debris should be cleared as soon as practicable as an additional task to the routine clearing of 4.1.3 below. This inspection will also identify any vegetation growing in culvert entrances and drains (see 4.2.4.2) and similarly record it as light or heavy, with heavy growth requiring clearing (4.2.4.3).

4.1.2.2 Once a year, the regular inspection of intakes and outlets of culverts should be undertaken on foot. This will involve walking above and below the wall, so that any blockages within culverts can be observed with the aid of powerful torches. As before, any blockages should be recorded and responded to as soon as practicable, in addition to the routine clearing. This inspection will also check the condition of the culvert cover slabs and entrance covers (see 4.11.2.1) looking for any failures or breakages.

4.1.2.3 When the opportunity arises (and it safe to do so) the drainage system should be inspected during severe rainstorms. This will develop a working knowledge of the functioning of the drains and particularly the culverts, so that informed decisions can be made about any improvements that may be needed or changes that may be required to the frequency of clearing tasks. Record observations such as culverts that do not appear to flow (for whatever reason) and those that may be overcharged (overloaded) with water.

4.1.2.4 Once a year, the intercept drain above the Devine’s Hill quarry should be inspected along its full length and the build up of debris recorded. There is a need to better understand the impact of this drain on runoff flows into the side drains and culverts of the road below. Inspection (in dry weather) suggests that at present most water from this drain would enter Culvert 32 (Buttress B3) which may be overcharged during high intensity rainfall (Jordan, 1997), while some may reach Culvert 31 (Buttress B2) which is much less stressed. The toe of this drain has been effectively extended in the past with two short walls of sand bags. These are now in poor condition and need replacement. A third wall (below the first two) may be needed to ensure that stormwater reaches the intake for Culvert 31.

The intercept drain, and run off from it, should be inspected during periods of high rainfall and the observations recorded so that a picture of its contribution to the overall drainage system can be built up.

4.1.3 Routine clearing of drains and culverts

4.1.3.1 The first stage of clearing drains and culverts is the removal of debris from the intakes of culverts. This should be done with a drag or mason's hoe (larry) which is conveniently shaped to enable hooking out of twigs and leaves. Care should be taken to minimise dragging the metal blade against the sandstone, for this will produce undesirable scratching of the convict picked stonework. Other than a small (round-headed) gauging trowel, the larry is the only metal bladed tool that should be used in any clearing of drains. It would be worthwhile experimenting with a thin rubber edging to the larry blade. Also worth testing are plastic grain shovels (see Appendix 3) for use in removing silt, sand and small rocks from drains. The shovels may be too wide for most drains, but might be narrowed by bending while heating. While plastic shovels would wear rapidly against the sandstone, this is a better outcome than abrasion damage to the sandstone.

4.1.3.2 The drains are then swept of accumulated leaves, twigs, bark and other debris using the blower (see Figure 6) to progressively build piles at intervals along the drains. To minimise any 'sandblasting' effect, do not concentrate the blower jet on any one spot for any length of time. When the heap of debris becomes too large to move with the blower, plastic rakes (see Appendix 3) and shovels should be used to gather the material, either onto tarpaulins (see Figure 7) or into plastic rubbish bins. The debris is then placed in utility vehicles for disposal. Experiments with a vacuum type blower showed that it had insufficient 'suck' to be effective on sand, small stones and twigs. However, it may be useful for collection of lighter material such as sawdust generated during removal of fallen trees.

Figures 6 & 7

Use of a powerful blower to move tree litter to stockpiles along the drain. The stockpiled waste is then collected using plastic rakes and a tarpaulin for transfer to a vehicle for disposal.

4.1.3.3 Rocks and larger branches are collected by hand and transferred to the vehicle.

4.1.3.4 On the upstream side of some culverts there are sumps which collect sand and silt before it reaches the culvert. Cleaning of these should be by bucket and (plastic) shovel, except that a backhoe may be used in more open areas such as precincts 6 and 7 to ease lifting of material. A general principle applying to the choice of tools should be ‘The closer to old (historic) stonework, the smaller the implement.’

Consideration should be given to using truck-mounted industrial drain suckers such as those used by local government authorities. Provided they were fitted with rubber nozzles and were within OGNR weight limits (when loaded) they may offer advantages in rapid clearing of debris. Try out such equipment before buying, hiring or contracting.

4.1.3.5 Water flushing may be useful for removal of excess material from culverts. This technique will require tanker loads of water and should be utilised infrequently, preferably only when natural flows over an extended period have been insufficient to flush culverts in the normal way.

4.1.3.6 Debris collected during drain and culvert clearing may have some application as compost material for use elsewhere in the Park. Depending on its nature, the remaining material should be disposed using vehicles and stockpiles in appropriate locations. Alternatively, it may be disposed over the downhill edge of the road except below Hangman’s Rock on Devine’s Hill (precinct 1).

4.1.3.7 Outflows from culverts in low lying areas (particularly precinct 6) can become clogged due to low gradients. They should be cleared using a backhoe and shovels to ensure water does not pond against the road structure and weaken it by softening clay minerals in the substrate.

4.1.3.8 Weeds, mostly in the form of grasses, grow in the drains and trap silt and sand leading to blockages. Weeds should be sprayed on an annual basis and in accordance with PWD Job Safety Analysis (JSA) procedures. Minimum concentrations of glyphosate poison should be used. Spraying should be limited to the floor of the drain and 100 mm up the wall on either side, except where the kerb wall is root bound soil (see Figure 8). In this case spraying should be controlled so that no spray lands within 100 mm of the kerb edge.

Figures 8 & 9

Spraying grasses and weeds growing in the drains is part of ensuring good drainage. However the drain on the left depends on the grasses to support the drain edge (kerb) and contain the road pavement. In a case like this no spray should land within 100 mm of the kerb. On the right *Ancistrachne maidenii* a threatened species, has been found growing in the drains and on the rock faces above. Prior to any spraying activity, the Ranger should inspect for threatened species and use tags to indicate spray and no-spray zones

Special considerations should apply where threatened flora species occur. For example, *Ancistrachne maidenii* (Figure 9) has been found colonising areas disturbed by road construction in precinct 1. Operations involving spraying of drains and trimming along drains and the base of walls need to be amended in areas where these species have been identified (see Threatened species management, Section 4.3). The Ranger should inspect for threatened species and use tags to indicate spray and no-spray zones prior to any spraying activity.

4.1.3.9 The intercept drain above the quarry on Devine's Hill (Figure 10) should be cleared using the blower and rakes as in 4.1.3.2 above. Two thirds of the way along the drain there is a hollow which readily blocks with leaves. The hollow should be cleaned out and consideration given to building a short wall of sandbags to improve the 'connection' to the next section of sandstone drain. A section of the sandstone drain has a very shallow outer edge which may be spilling too much water in high flows (Figure 11). This section may also need sandbagging.


Figures 10 & 11

The intercept drain above the quarry on Devine's Hill provided protection from flooding during quarrying. Now it may be serving an important drainage function, reducing stress on an overcharged culvert (C32). The section on the right may need sandbagging to improve stormwater retention in the drain. The effectiveness of the drain should be checked during prolonged moderate to heavy rain.

The deteriorated sandbagging at the toe of the intercept drain should be renewed and a third section of sandbag wall constructed below the first two (Figures 12 and 13), with the aim of maximising the amount of stormwater that reaches Culvert 31 (Buttress B2) rather than falling short into Culvert 32 which may be overcharged during high intensity rainfall (Jordan, 1997). This does not mean building major walls, but developing some understanding of the functioning of the intercept drain (by inspecting it during periods of rain) and making small non-invasive improvements to the outfall as necessary.


Figures 12 & 13

On the left are remains of the second of two short walls of sandbagging below the outfall of the intercept drain. These walls need to be rebuilt to redirect run off towards culvert 31. A third wall needs to be constructed from the large rock in the bottom right of the right hand photograph, running at an angle towards the edge at the upper centre and then curving towards the small leaning tree.

4.1.4 After Major Events (AME) clearing of drains and culverts

Major events such as storms and fires are likely to leave substantial tree debris on the road surface and in the drains. Hot fires are likely to result in large quantities of rocks, sand and silt being washed into the drains by subsequent heavy rain. The drains should be cleared as before (Section 4.1.3) but with the possible additional need for the following:

4.1.4.1 Large trees and branches that have fallen across the road will need to be chainsawn into pieces that can be lifted into vehicles. Smaller section of branches should be chipped for use as mulch elsewhere in the Park. See also 4.2.1.

4.1.4.2 As for Section 4.1.3.6, disposal of waste material will depend on its nature and will involve using vehicles and stockpiles in appropriate locations.

4.1.4.3 Consider the use of silt traps in adjoining areas to prevent debris entering inlets and drains after hot fires. While aesthetic considerations do need to be borne in mind, the judicious and limited use of silt fencing for a period of say 12 months after a fire may be effective in reducing the amount of clearing of drains and culverts that is subsequently needed. Straw bales will block drains if they come lose and should not be used for silt control: instead use shade cloth firmly secured to star pickets which should be well driven into areas away from the historic drains.

4.2 Vegetation management

Vegetation management within the context of this Maintenance Plan is to be implemented in line with the Vegetation Management Procedure set out in Appendix 3 of the OGNR Conservation Management Plan (Ireland, et al., 2005). Various forms of vegetation management are required on different parts of the road and in different environmental settings. The Procedure in the CMP has identified the main categories of vegetation management activity and these are incorporated into this Maintenance Plan under the following general headings, and summarised in the Maintenance Schedule (Appendix 2).

4.2.1 Vegetation clearing after major events (AME)

This is essentially the same as activity 4.1.4 — there is a need to clear fallen trees and branches blocking the road alignment after storms. Whereas 4.1.4 applies particularly to the drains and culverts this activity applies to the whole of road structure and to the archaeological sites and features such as the Stockade and quarry sites on Devine’s Hill.

4.2.1.1 Target

To maintain a cleared road structure and to prevent blockage of drains and culverts.

4.2.1.2 Maintenance after major events (AME)

Fallen trees and branches should be removed using chainsaws. Smaller section of branches should be chipped for use as mulch elsewhere in the Park. See also 4.1.4.

4.2.2 Weeds and native plants growing on the road formation

4.2.2.1 Target

To maintain the structural stability of the road surface and formation and to protect the visual amenity of views along the road (see CMP section 4.2.2).

4.2.2.2 Inspection

Inspections should be undertaken every twelve months, or, in the case of clean-up of vegetation debris, after major events. These inspections can be vehicle-based and should record the growth of weeds and native plants on the road formation as acceptable or excessive, the latter triggering the need for a maintenance response. See also 4.8, Maintaining road pavements.

4.2.2.3 Routine maintenance

With an ideal return frequency of 6 months, grasses and small ground cover plants should be mown or slashed where appropriate machinery can access the area. This will apply particularly to precincts 1 and 3. Shrubs and tree saplings should be poisoned and manually removed on an as-required basis. All cut or uprooted vegetation should be removed from the site to avoid the build-up of litter and humus on the road surface.

4.2.3 Woody plants invading rock faces, embankments and retaining walls

4.2.3.1 Target

To maintain the stability of cuttings, rock walls and embankments both for their structural integrity and the protection of any features (e.g. historic graffiti) on them.

4.2.3.2 Inspection

Inspections, assessing woody plant growth as acceptable or excessive, should also cover all aspects of risk to fabric, safety and access for maintenance vehicles and should be undertaken every twelve months. Excessive growth should trigger an as-required maintenance response.

4.2.3.3 Routine maintenance

Where possible and no damage to fabric will ensue, woody shrub growth on cuttings, rock walls and embankments should be manually removed. Where roots of woody shrubs are tightly bound to the fabric or have exploited cracks or joints, the plants should be cut off at a convenient point and the stump poisoned. The poisoned parts of the plant should left in place to disintegrate slowly. All other vegetation should be removed from the site to avoid the build-up of litter and humus which would encourage regrowth.

4.2.4 Vegetation growing in culvert entrances and in drainage structures

4.2.4.1 Target

To avoid damage to road structures by excessive water build up due to vegetation blocking drains and culverts.

4.2.4.2 Inspection

A range of inspections need to be undertaken to ensure the maintenance of good drainage (see 4.1.2 above). Particular inspections for vegetation management are not required. Instead vegetation removal needs should be noted during the general drainage inspections.

4.2.4.3 Routine maintenance

Routine vegetation management will comprise spraying and manual removal of grasses and other small plants growing in and around culverts and in drains (see 4.1.3.8). All vegetation should be removed from the site to avoid the build-up of litter and humus which would itself block drainage and would also encourage regrowth. As in 4.1.3.8, special considerations apply to vulnerable flora species (see Threatened species management, Section 4.3).

4.2.5 Vegetation encroaching on archaeological sites and features

4.2.5.1 Target

To protect relic structures and ruins from increased weathering and deterioration due to vegetation encroachment and to avoid or reduce disturbance to underground archaeological deposits by plant roots. An additional target in some sites (see below) is to enhance site interpretation by controlling encroaching vegetation.

4.2.5.2 Inspection

Inspections, covering all aspects of risk to fabric, safety and interpretation issues should be undertaken every twelve months.

4.2.5.3 Routine maintenance

Vegetation management at archaeological sites will cover a variety of vegetation removal activities. In general, yearly trimming/mowing (with motor mowers or boom flail mowers) and spraying of weeds can be undertaken at most sites to keep structures clear. As in the case of woody plants growing on or within the fabric of structures or relics, or growing on sub-surface archaeological deposits, the plants should be cut off at a convenient point and the stump poisoned. The poisoned parts of the plant should remain in place to disintegrate slowly. All other vegetation should be removed from the site to avoid the build-up of litter and humus which would encourage regrowth and impair interpretation and visitor amenity. Other tree clearing to facilitate site interpretation can be achieved using chainsaw and chipper. Requirements for particular sites are described on the next pages.

4.2.5.4 The Quarry on Devine's Hill (Precinct 1)

The quarry on Devine's Hill is a special case of vegetation clearing (Figure 14). Here the *objective* of vegetation management is to maintain the quarry site in something like its present open configuration, with the quarry benches and faces readily apparent, yet with some tree cover so that the site does not appear too open.

The *vegetation management plan* for the site (as required by the Vegetation Management Procedure, Appendix 3, OGNR CMP, 2005) should be to maintain about 15–20 mature trees across the quarry area including those immediately on top of the rear faces. At present there are about 22 trees in this area. Selection of trees to be removed should be based on:

- any safety hazards;
- priority for removal of trees given to those close to edges of faces or growing in fissures with nearby edges that therefore are at risk of spalling.

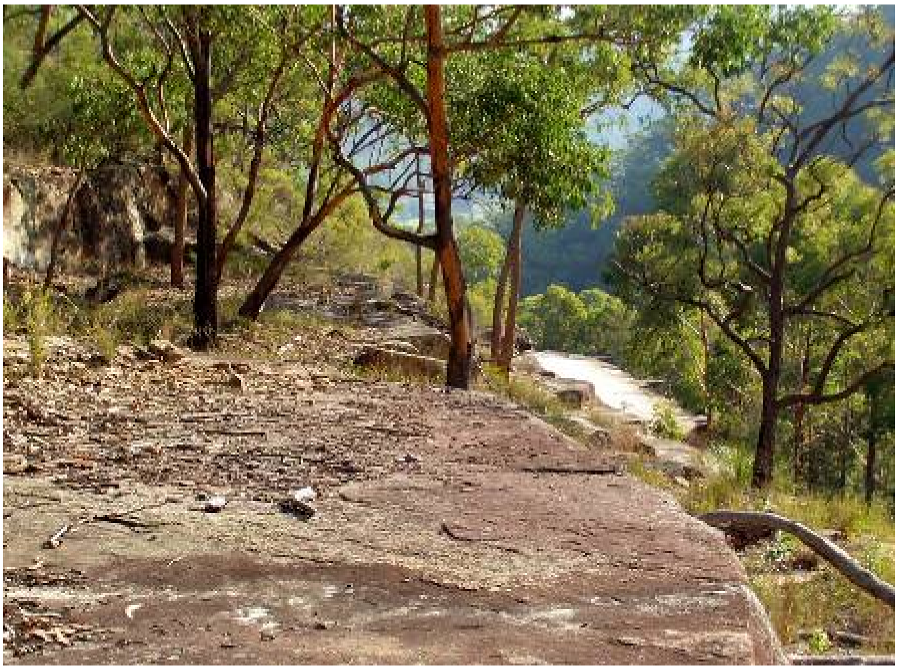


Figure 14

The quarry on Devine's Hill (precinct 1). Here the objective is to maintain the relatively open configuration so that quarry benches and faces are apparent.

4.2.5.5 The Stockade on Devine's Hill (Precinct 1)

Here the *objective* of vegetation management is to maintain the experience of the site as a clearing in the bush and to conserve archaeological remains. The *vegetation management plan* for the site is to maintain the cleared area through slashing of encroaching shrubs and protecting archaeological remains from disturbance by weeds and woody plants.

4.2.5.6 The Store (powder magazine) on Finch's Line (Precinct 3)

Here the *objective* of vegetation management is to maintain the character of the landform (depression) and to conserve the masonry remains adjoining it. The *vegetation management plan* for the site is to prevent the growth of trees and shrubs in the depression or on its sides. Vegetation litter should also be prevented from building up in the depression. Woody vegetation should also be kept clear of the masonry walls.

4.2.5.7 The 10 Mile Hollow occupation site (Precinct 6)

Here the *objective* of vegetation management is to conserve the archaeological remains. The *vegetation management plan* for the site is to prevent further growth of trees and shrubs in a 6 metre radius from the currently exposed stone footings. This area is currently covered by only a light cover of saplings, with only one mature tree, which should be cut and poisoned, stumps to be left *in-situ*. Woody vegetation should also be kept clear of the masonry walls. The current vegetation cover is shown in Figure 15.

Figure 15
10 Mile Hollow Inn Site.
Here the objective is to limit damage to the archaeological remains by preventing further growth of trees and shrubs in a 6 metre radius from the exposed stone footings.

4.3 Threatened species management

The locations of vulnerable plant species adjoining the road and other archaeological features, which would be subject to the maintenance procedures described in this plan, should be identified and mapped. Using a combination of data layers from the Central Coast Hunter Region GIS (“threatened flora” and “ROTAP licensed”) the OGNR Conservation Management Plan (Ireland et al., 2005) has identified four species along the road (*Ancistrachne maidenii* (precinct 1), *Tetratheca glandulosa* (precinct 5), *Acacia matthewii* (precinct 6), and *Boronia rubiginosa* (precinct 1.)

4.3.1 Maintenance target for threatened species management

To not damage any threatened or vulnerable plant species during maintenance activities.

4.3.2 Inspection and routine maintenance

In the specific locations mentioned above, and in any other locations identified by the recommended mapping, operations involving mechanical activities such as trimming, slashing and mowing, as well as activities such as spraying where selectivity of impact may not be sufficiently controlled, will need to be amended. Manual methods should be used near threatened species to minimise accidental damage. As noted in 4.1.3.8, *Ancistrachne maidenii* grows in the drains and on exposed rockfaces on the Devine’s Hill in precinct 1 which otherwise would be sprayed to control vegetation growth. The Ranger should inspect for threatened species and use tags to indicate spray and no-spray zones prior to any spraying activity.

4.4 Historic graffiti conservation

The valuable historic graffiti of the OGNR needs the specialised skills of a conservator experienced in the care of natural stone surfaces. David Lambert, PWD rock art conservator has contributed to the modern graffiti cleaning section of this plan and is an appropriate person to undertake periodic monitoring inspections and conservation work as required.

4.4.1 Maintenance target for historic graffiti conservation

The maintenance target is a minimal rate of deterioration of historic graffiti and of the stone surfaces into which they are engraved.

4.4.2 Inspection and conservation

4.4.2.1 The historic graffiti should be inspected at five yearly intervals by a specialist rock art conservator and a record made of its condition. The data accumulated should be used as a basis for determining the need for conservation work.

4.4.2.2 A rock art conservator should undertake conservation treatments as-required.

4.4.3 Routine maintenance of conserved graffiti

4.4.3.1 Annually following conservation treatment of graffiti there should be an inspection to check that run off is controlled and that sediment is not being deposited on the graffiti. Clear tree litter and other debris from above the graffiti and make any necessary adjustments to cut-off walls and the like.

4.5 Modern graffiti cleaning

Unlike the historic graffiti which has cultural value and should be conserved, modern graffiti is a form of vandalism to be discouraged and removed or disguised. Of course this is a value judgement in itself: we might well ask why isn't modern graffiti part of an ongoing practice which should be tolerated? Part of the answer lies in the observation that doing nothing would result in the historic graffiti (about which we can be confident of its value) being obscured or damaged by more recent markings. And so our aim is remove or disguise recent graffiti so as to reduce its visual impact, and through doing that, to discourage further graffiti attack.

This section is drawn from the workshop contribution of David Lambert, PWD rock art conservator, whose published manual, Conserving Australian Rock Art (Lambert, 1989) should be referred to for further information. Based on Lambert's advice, three graffiti tool kits have been put together and can be carried in field vehicles working on the OGNR. Lambert's recommended contents of the toolkit are listed in Appendix 3.

Most of the modern graffiti on the OGNR is in the form of relatively shallow surface scratchings (Figures 16 and 17), but there are also deeper engravings. While waterproof (wax) crayons and paint have not been used in this area, advice on their treatment is provided in case it should be needed.


Figures 16 & 17

Before and after graffiti cleaning by brushing and washing as described in 4.5.3. At left immediately before treatment in March 2004, and at right the same area in September 2006. While not totally removed, the scratchings are no longer legible. Natural regrowth of microflora will soon hide the remainder. Hangman's Rock, Devine's Hill.

The naturally weathered and exposed sandstone surfaces of Dharug National Park (and the Sydney basin more generally) have a dark colour which is principally due to the presence of microflora such as algae, bacteria, fungi and lichens which grow on and in the rock surface. Beneath this dark organic layer there is often a thin patinated (or weathered) layer of stone which may be orange-red in colour and beneath that is the natural pale brown coloured sandstone. Light scratching will remove the dark organic layer which is soft (particularly when wet), moderate scratching will remove some of the patinated layer and leave white powdered stone particles and heavy scratching or engraving will cut through to the fresh light coloured stone and leave abundant white stone dust in the groove.

4.5.1 Maintenance target for modern graffiti

The maintenance target is a minimal visual impact of modern graffiti.

4.5.2 Inspection for modern graffiti

4.5.2.1 This (vehicle-based) inspection should look out for the location, nature and degree of graffiti attack. On account of visitor numbers there is an increased frequency of inspection scheduled for Devine's Hill (precinct 1) with particular attention needed at Hangman's Rock and the rockface downhill from there, which seem to attract much of the graffiti in that precinct. Close inspection of the upper surfaces at Hangman's Rock reveals a lot of old 'modern' graffiti, including deep engravings which are now best left alone as they are covered with a dark organic layer making them less obvious.

4.5.3 Cleaning of surface scratchings

4.5.3.1 Closely examine the area to check for historic graffiti that may be present. If discovered, consider the likely impact of cleaning and the possible need for specialist advice before proceeding. Also, consider only cleaning up to, but not through the historic graffiti and leaving the latter untreated. Always photographically record any graffiti before attempting removal. Even though the modern graffiti is not wanted, it is important to document the site before and after treatment to assess results and to refine cleaning techniques.

4.5.3.2 Mosses or moss bound lumps of dirt should be gently scraped off the surface with wooden kitchen scrapers. Do not use metal implements.

4.5.3.3 Then dry brush the surface with a paint brush to remove as much loose dust and organic matter as possible (Figure 18). Avoid following the pattern of lettering when brushing as that will simply widen the graffiti letters. Assess results — this may be enough!

4.5.3.4 Because the dark organic layer is very soft when wet and is easily removed, the decision to proceed with this stage should not be taken lightly. Wet the surface thoroughly with clean water and gently scrub with a slightly stiffer brush. Flush thoroughly with clean water. Again assess results before proceeding — this may be enough!

4.5.3.5 Next use a very small amount of appropriate detergent (non-ionic or colourless and pH-balanced — see Appendix 3) in clean water (one part in 10,000, i.e. one millilitre in 10 litres) and brush again with a soft brush. Fade out the edge of the cleaned area so as not to leave a ghosted image of the graffiti. Flush down with lots of water. This step might be omitted, in which case proceed directly to 4.5.3.6 and the use of a stiffer brush.

4.5.3.6 Allow to dry (about 45 minutes) before reviewing results of treatment. Repeat if necessary and consider the use of stiffer bristled brush such as a household scrubbing brush. Always remember the Burra Charter maxim — do as much as necessary but as little as possible.

Figures 18 & 19

Removing modern graffiti. At left soft brushes are used dry to remove dust from light surface scratchings. At right hard stones (or sandpaper) are used to remove deep engravings. This work requires great care and should begin with a close examination to decide whether it's best to leave alone or to treat.

4.5.4 Cleaning of deep engravings

4.5.4.1 Deep engravings should initially be approached as for surface scratchings: closely examine the area, assessing the likely impact of cleaning and decide whether it's best to leave alone or to treat (Figure 19). Again, record before (and after) any treatment.

4.5.4.2 Removing deep engravings involves cutting back the surrounding surface until the engraving is no longer identifiable. This is done with a comb hammer (scutch) or with a hammer and chisel, or just a hand-held chisel if the stone is soft enough.

4.5.4.3 The excavated surface is smoothed with coarse sandpaper, a brass-bristled brush, or with a harder piece of sandstone to reduce the raw appearance.

4.5.4.4 Flush dust with lots of clean water and finish by washing with a scrubbing brush and clean water.

4.5.5 Cleaning of paint

4.5.5.1 With newly painted graffiti it is important act quickly before solvent evaporates and the paint film cures. But first, assess the impact of cleaning, for it will substantially lighten the stone around the graffiti, removing most of the dark organic layer. Perhaps it is better to do nothing if the paint is not very obvious? Record before cleaning.

4.5.5.2 Brush on a paint stripper over painted areas. Use methylene chloride paint stripper in a gel without other additives. Note that methylene chloride (also known as dichloromethane) is toxic, considered to be carcinogenic, and is banned in some parts of the world. Because it is to be used externally (and in relatively small quantities) its use will be much less hazardous. Nevertheless, take appropriate safety precautions and do not breathe its vapour. On review check for any Australian safety requirements. The rock surface must be dry for the paint stripper to work.

4.5.5.3 After 10–15 minutes flush off with lots of water using a pump spray (such as a 10 litre garden spray) or a fire fighting unit.

4.5.5.4 Then scrub with brushes to release paint, starting with a household scrubbing brush and working up to a harder brass brush if necessary. The swollen paint film will froth up as methylene chloride is a detergent. Scrubbing is necessary to release the paint from the rock surface.

4.5.5.5 Flush off with lots of water and repeat scrubbing until no more paint comes off.

4.5.5.6 Allow to dry, then consider repeating the treatment, beginning again at 4.5.4.2. It’s often best to accept a 95% removal as the last 5% may not be too obvious, particularly as the dark organic layer reforms and helps to disguise the paint remnants which will eventually weather off. If this treatment fails completely then seek specialist advice from a rock art conservator.

4.5.5.7 After removal of the paint, a broader area will need to be cleaned to avoid a shadow or ghosting of the former graffiti. Do this broader cleaning by washing as for 4.5.3.

4.5.6 Cleaning of wax crayons

Waterproof crayons are paraffin wax with a colouring additive. Their removal is essentially a mechanical process as follows:

4.5.6.1 Trickle water continuously over the graffiti to produce a flushing action.

4.5.6.2 Brush with a brass bristle brush to break up wax which floats off on the water.

4.5.6.3 Flush off with lots of water.

4.5.6.4 After removal of the wax, a broader area will need to be cleaned to avoid a shadow or ghosting of the former graffiti. Do this broader cleaning by washing as for 4.5.3.

4.6 Survey monitoring of retaining walls

Survey monitoring of bulges and other areas of movement in the face of retaining walls commenced in 1998 (Bannister & Hunter, various dates). Until recently the sites have been measured every six months, and with the exception of a short section of wall on Devine's Hill (Chainage 1617 which required dismantling and reconstruction (Jordan & Associates, 2001b, Hughes Trueman, 2002)), most sites have been shown to be relatively stable. Consequently, in 2006 the frequency of measurement was reduced to 24 monthly intervals.

Many of the bulges are on sections where the walls are convex in plan and so are less resistant to outward thrust. Concern about their stability is understandable. Ian Webb advises (2004, pers comm) that in his view most of the bulging was caused by roots of large trees growing in and through the walls and that these were removed during his time on the OGNR (1975–1989). Irrespective of original cause, the bulged sections of wall are now weaker than before and will be less resistant to other stresses.

4.6.1 Maintenance target for survey monitoring

Retaining walls monitored at appropriate intervals so as to identify structural movements before failure (where practicable), and also to provide confidence in the stability of the walls.

4.6.2 Inspection (monitoring)

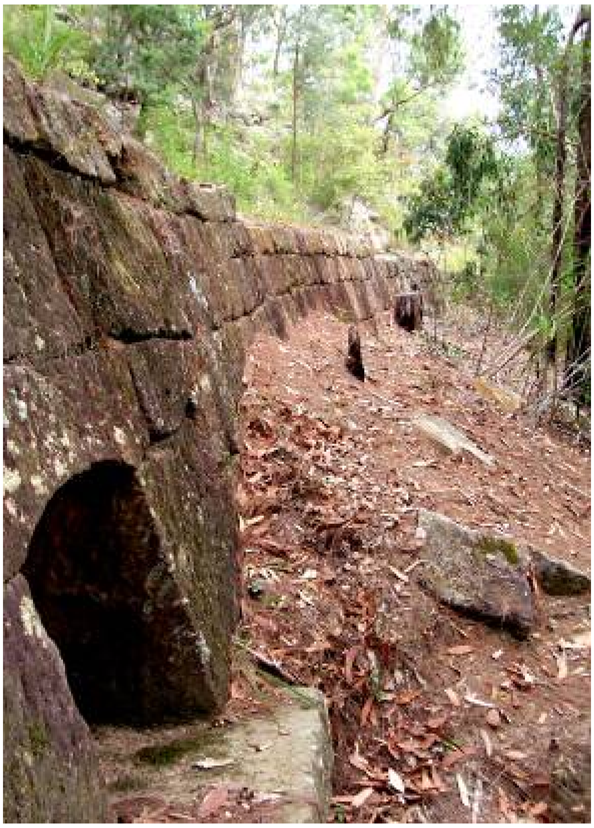
4.6.2.1 The current inspection and monitoring by licensed surveyors every 24 months should continue. More frequent surveying should be undertaken wherever significant displacements are observed. Record details of measurements and any movement and provide a biennial report setting out results in an easily understood format.

Figure 20

Bulge in retaining wall where failure has led to early reconstruction of the section between the displaced stonework in the foreground and a point just this side of Ranger Sarah Breheny. Bulges are monitored for any significant movement as an early warning sign of potential failure.

4.7 Maintaining base of retaining walls

In places along the retaining walls there are areas of sediment and debris build up at the base of the wall (see Figures 21 and 22). This is most apparent at Devine's Hill where the steep road gradient and previous lack of maintenance led to material from the road surface being washed over the edge of the retaining walls. Though much better maintained, the process continues today: white dusty runs down the wall faces showing where material is washing over the top during high rainfall. The accumulating sediment at the base of the walls is potentially a threat as it may be trapping water within the wall and the fill behind, leading to the risk of excessive hydrostatic pressures within the base of the road structure. There is also a risk of softening of any clay-rich material in the foundations.



Figures 21 & 22

Mounds of sediment accumulating at the base of retaining walls. There is a risk that the sediment may trap excess moisture in the road structure and in any clay rich material in the foundations, leading to possible failure and collapse of a section of wall..

To minimise these risks, the road structure, including walls and fill behind, should remain as free-draining as possible. This is why, as a general principal, the joints between stones in the retaining walls should remain open and not be filled with mortar.

There are places where a 'natural mortar' of sand, silt and clay bound with lichens and mosses is accumulating in joints low in the walls (Figures 23 and 24). This material is low in strength and shallow depths would not resist significant hydrostatic pressure from behind. However, progressive build up of the mortar over time may eventually pose a risk of damming too much water. Meanwhile the mortar will reduce the free-draining capacity of the road structure and will be retaining moisture in the walls leading to increased decay.

Figures 23 & 24

Stonework on Devine's Hill showing accumulation of 'natural mortar', a mixture of washed in sand, slit, clay and microflora such as lichens and also mosses. Progressive build up poses a long term risk of trapping water within the road structure leading to potential failure of the base of the walls.

There should be a program of clearing the base of the walls down to the footings (the bottom stones) so that at least the top 100–150 mm of the footing course is visible. Part of this program should include removal of 'natural mortar' from the joints. Such a program should be carried out as single phase on a precinct by precinct basis, beginning with Devine's Hill (precinct 1). This work is identified in the Maintenance and Repairs Matrix (Appendix 1) as Minor Works requiring Heritage Act approvals and archaeological input, as many of the mounds of sediment will have been accumulating from the very beginning of the OGNR. There is also the need to take account of the vulnerable species: *Ancistrachne maidenii* (see Section 4.3: Threatened Species Management).

Once the sediment mounds have been cleared there will need to be ongoing maintenance to ensure that the base of the walls remains reasonably clear of sediment and other debris. This section explains that work.

While not as common as mounds of excess sediment, there are areas at the base of the walls where there is too little material. Figure 25 shows a section of wall where the sandy gravel beneath the footings is being eroded. If this were allowed to continue the retaining wall would eventually collapse. In such cases material will need to be added to bury the toe of the footing and protect it from erosion. Consideration should be given to using small shrubs and/or grasses to bind the slope and so minimise erosion.

Figure 25

A section of retaining wall on Devine's Hill showing the distinctively dressed lower course which indicates that it was intended to be largely buried with only the upper portion visible. Erosion has removed earth from in front of the base, and if this were to continue it would pose a long term risk for the road structure. New material should be added to bury the lower half of the bottom course. Grasses and shrubs would help stabilise the slope below.

4.7.1 Maintenance target for base of retaining walls

To maintain stable, well-supported, free-draining bases to retaining walls.

4.7.2 Inspection of base of retaining walls

4.7.2.1 This inspection, which must be on foot along the full length of the base of retaining walls, can be combined with the inspection of culvert outlets. Record any areas of excessive build up of sediment and check to see if these relate to problems with surface flow along or across the road surface. Also be on the lookout for areas where the base of the walls is being undercut, requiring new material to be added to prevent further erosion.

4.7.3 Routine maintenance of base of retaining walls

4.7.3.1 Use a plastic rake to remove sediment from the base of the wall. Firmly bound lumps may require a (round-headed) gauging trowel to separate them from the wall, but this is the only metal bladed instrument that should be used. The aim is to produce a flat or gently graded profile away from the wall (Figure 26), but not a steep one which would promote erosion. Be aware of threatened species (see 4.3), and avoid damaging any specimens. Where erosion is exposing the foundation below the base course of the retaining walls, add new material (and plants, or seeds, as appropriate) to bind the slope.

Figure 26

Accumulated sediment is removed from the base of retaining walls using a strong plastic rake and a round-headed (gauging) trowel. The trowel is used to free root-bound earth from the stonework. The basal course of stone is left half buried to protect it from erosion.

4.7.4 After Major Events (AME)

4.7.4.1 Major events are likely to lead to build up of sediment in places and to erosion in others. Though not as important as clearing drains and culverts, the base of the walls should be kept reasonably free of unnecessary sediment and other debris, and also be kept topped-up where erosion threatens to undercut the walls. Refer to 4.7.3.1 for details.

4.8 Maintaining road pavements

Road pavements (surfaces) have been repaired in precincts 1 and 6 (Devine's Hill and WCT to 10 Mile Hollow) during the last decade with additional resurfacing of parts of Devine's Hill in 2006. Precinct 7 (Simpson's Track) has been graded during firefighting in recent years. Maintaining these pavements is explained in this section. Pavement materials and their selection are discussed at the end.

4.8.1 Maintenance target for road pavements

The maintenance target is safe and stable road pavements with good drainage and minimal erosion and scouring.

4.8.2 Inspection of road pavements

4.8.2.1 There should be an annual inspection focussing only on the pavement and associated stonework. The inspection should check for:

- correct cambers — so that water flows off the road and not along it;
- silting up of diversion mounds (rollover drains);
- signs of scouring along or across the road surface; and
- movement of copings stones on retaining walls or inside kerb stones (see 4.9 & 4.10).

Record any concerns and things requiring attention. Ensure that any scouring is dealt with as soon as practicable. Likewise silting up of diversion mounds (rollover drains) which would allow water to flow over the top and cause more scouring should be dealt with promptly. Inspections should also be conducted after major (storm) events so that any damage can be attended to before the next storm makes road surface conditions many times worse.

4.8.3 Routine maintenance of road pavements

4.8.3.1 Diversion mounds (rollover drains) should be cleared of sediment by hand shovels and tractor-mounted scoop with the aim of re-establishing their former profiles. Substantial silting of mounds will produce significant quantities of waste which should be trucked to suitable storage areas for use as fill on other parts of the OGNR. Alternatively, it could be delivered directly to washed out sections of road in other precincts (including 2, 4 or 5) that need filling before subsequent resurfacing with new material.

4.8.3.2 After clearing the diversion mounds of silt they will need reshaping with shovels, tractor scoop and rakes and then wetting with a water spray from a tanker, rolling to compact down, wetting again and a second rolling.

4.8.3.3 As vehicular traffic wears the surface and produces ruts and wheel channels which promote longitudinal scouring, the road should be graded in the normal way, and then wetted with a water spray from a tanker, rolled to compact it down, wetted again and a rolled a second time.

4.8.3.4 With continuing use there comes a time when there is not enough pavement material to grade and a new topping must be added to sections of the road. This will vary from precinct to precinct depending on vehicle use, and within precincts depending on gradients and susceptibility of the existing road surface to erosion. The new topping, which should be sandstone crushed and screened to minus 30 mm and containing sufficient clay to bind the surface, should be added to the road and graded to correct profiles and cambers with more, rather than less, passes with the grader. Then it should be wetted down and compacted with a roller with sufficient wetting and rolling cycles to produce a well-compacted road surface (National Association of State Road Authorities, 1975).

Figure 27

Sandbagging of drain to catch silt run off from recent (2006) resurfacing of portions of the Devine's Hill ascent. This silt is collected and disposed of. Sandbags should be removed once the amount of run off has stabilised. Like the culvert in Figure 4 this one is missing its original entrance cover: recesses in the sandstone bedrock on either side show where it was fitted.

4.8.4 After Major Events (AME) repairs to pavements

4.8.4.1 Rainstorms will lead to washouts and scouring of the road surface. Where practicable these should be repaired before subsequent storms make the condition of the road much worse. Emergency supplies of filling material should be obtained from stockpiles of waste removed as part of other maintenance activities on the OGNR. Some material remains in stockpile beneath the powerlines at 10 Mile Hollow. Though not of good quality, it may be useful as an emergency filling material.

Washouts and deep scouring should be filled with available materials including whatever can be recovered from the road surface (at silted up diversion mounds) or from side drain clearing activity. Compact with vehicle or tractor wheels as an interim measure. Ensure road surface drains as intended.

A severe rainstorm may do so much damage that the only effective way of repair is reconstruction with new materials, rather than temporary patching with emergency supplies.

4.8.5 Access repairs

4.8.5.1 Repairs to road surfaces may be needed to provide access for other activities such as vegetation clearing in the precincts that are not intensively maintained (precincts 2, 4 and 5). As with the previous section these repairs should be made as required, utilising stockpiled material or material from old quarry sites along the road.

4.8.6 Road pavement materials and sources

To understand potential sources of road making materials, various old quarry sites, both within and beyond Dharug National Park, were briefly inspected as part of preparing this plan. The principle of making use of existing resources within the Park: e.g. the shale quarry on Shepherds Gully Road and gravel pits at 10 Mile Hollow and at the 2 mile and 4 mile should be adopted. It will make use of materials from sites of degraded natural value and make substantial savings on transport costs. However, the resources available at these sites appears to be limited. This warrants further investigation which should be undertaken as part of planning for the upgrading of Shepherd's Gully Road. The old quarry sites may also serve as locations for stockpiles of new or recovered materials.

Old shale quarries along Wiseman's Ferry Road between the ferry and Spencer were also inspected. These have little readily available material but may be useful as stockpile sites particularly in circumstances where contractors deliver material to a stockpile for later recovery and use by PWD staff and vehicles.

The original road surfacing or topping material is likely to have been shale, obtained locally, including from some of the quarries mentioned above. Today, the only practical sources of road making and surfacing material in the near vicinity of the OGNR are the sandstone quarries at Maroota. Transport costs make any further distant source prohibitively expensive. The product from Maroota is variable, both between quarries, and within a single quarry as different beds are worked over time, and so it is difficult to say that any is preferred.

It is possible to comment on the material used in recent times for resurfacing Devine's Hill (1997–2001 and 2006) and a section of precinct 6 (descent into 10 Mile Hollow). The material used on Devine's Hill (in the period up to 2001) is too rounded in grain shape with many smooth quartz pebbles which give an unfortunate ball bearing-like quality to the material with insufficient clay binder to hold it together. The material used on precinct 6 in 2002 has a higher clay content and is better bound as a result. In 2006 sections of Devine's Hill were resurfaced with a blended material. This was based on the material used in 2001 but with additional clay blended into it to improve binding. While the result is a significant improvement, its performance should be closely monitored to see whether it is better than the material used in precinct 6.

Some concerns remain, as the road edges, particularly the steeper outer edges, are soft with potential hazards to vehicles and pedestrians. The edges are soft because of the difficulty of safely compacting them with a roller. Two possible solutions are worth considering. One is the use of a vibrating plate compacter carried on a truck-mounted hydraulic arm, which would allow safe compaction of the steeper outer edges (while the vehicle is centrally located on the road). The other would be to promote the growth of grasses on the edges and achieve stabilisation through the binding effect of the grass roots. In the lower parts of the Devine's Hill ascent (where shading by trees has encouraged growth) there is already considerable grass growth on the edges of the road surface (Figure 28). Provided that appropriate grasses can be obtained, they offer a convenient way of binding the road surface, not only on the outside, but also on the inside where kerb stones are missing (Figure 8). Grasses may not survive on the more exposed (hotter, drier) parts of the ascent and for these areas mechanical compaction should be undertaken.

Figure 28

Grasses growing on the lower and well-shaded part of the Devine's Hill ascent. The grass roots effectively bind the road surface material and offer a solution to the challenge of stabilising sloping edges of pavement that cannot be readily compacted with rollers.

The colour of the crushed sandstone topping on Devine's Hill has been criticised as being too light and glary (OGNR CMP Stakeholder Workshop, Gosford, 26.2.2003) in contrast to the original shale topping which would have been less-reflective and pale brown in colour. While careful selection from the Maroota quarries will enable use of material that is more coloured, the sandstone topping will always be lighter and brighter than the original shale. As already mentioned, because of transport costs, the Maroota quarries are the only practical source of commercially available material.

Figure 29
Original pavement in precinct 5 showing cobblestone-like effect of the coarse aggregate base course of the Macadamised road. The finer topping, or surface layer, has eroded away.

When road pavements are being repaired for the first time, they should be of at least two layers with the main layers being of coarser aggregate followed by a finer-grained topping or surface layer. Geofabric is laid beneath the new work to define its extent. The main layers (known as base course) should be sandstone, crushed and screened to minus 100mm (Figure 29). Surfacing (and re-topping the surface) should be sandstone crushed and screened to minus 30mm. Clay content is important, particularly in the surface topping, as it binds the particles together and seals the surface. Higher clay contents should be used on low-trafficked sections (Devine's Hill), but too much clay would be a problem for the more frequently travelled sections (precinct 6) as it makes roads slippery when wet (Jordan & Associates, 2001c) (see also National Association of State Road Authorities, 1976–1982).

4.9 Repositioning kerb stones

For convenience, the inside wall of the road (against the gutter) is described as the kerb. The kerb, which is generally formed of one course of stones but occasionally two or three, has two functions. It adds to the height and therefore capacity of the side drains and it retains the road surface material, preventing its erosion and washing into the drains. Some kerb stones are missing, either due to theft, to damage by vehicles, or to being graded off the road at a time when conservation was not the management objective. Many kerb stones are now out of alignment, often as one or two, spread here and there along the road (Figure 30). These are best dealt with by a campaign to reposition the kerb stones along a complete precinct or section of a precinct at a time, which should be undertaken prior to any substantial resurfacing of the road. Such work is identified in the Maintenance and Repairs Matrix (Appendix 1) as Minor Works requiring Heritage Act approvals and specialist recording.

Figure 30

Displaced kerb stones that have fallen into the side drain, reducing its capacity and risking erosion of the road pavement.

There are extensive areas with no surviving kerb stones. As we cannot be sure about their form, or even existence, these areas are best left alone with no kerb. Some areas show good growth of grasses whose roots help to bind and retain the road surface (Figure 8). In these areas it will be important to avoid any weed spray coming in contact with the grasses.

Even after a complete section or precinct of kerbing has been realigned, there will arise circumstances where one or two kerb stones need repositioning and this work should be undertaken as a maintenance activity as follows.

4.9.1 Maintenance target for kerb stones

Existing kerb stones maintained soundly bedded and in their correct alignment so that road surface material is retained and that drains function well to their capacity.

4.9.2 Inspection of kerbs

4.9.2.1 This inspection should be undertaken as part of the inspection of the road surface (4.8.2.1). Any movement or misalignment of kerb stones should be recorded, together with any observations that might explain why the stones have moved (vehicle damage, surface flow, undercutting by high flows in adjacent drains, etc).

4.9.3 Routine maintenance

4.9.3.1 Using (round-headed) gauging trowels remove road surface material from around the displaced kerb stones. Observe the way the stones face, so that they can be returned to the kerb in their correct orientation.

4.9.3.2 Using synthetic webbing slings and a small crane (or tractor) lift the stones aside and lay them in their correct orientation with respect to each other and to the road.

4.9.3.3 Prepare a new bed for the stones, lift them back into their correct positions and ensure that the stones are evenly bedded and do not rock. Confirm their correct alignment before replacing the road surface material around the stones and compacting it down with the end of a wooden tamping rod such as a mattock handle.

4.9.4 After Major Events (AME)

4.9.4.1 There may be a need for repositioning one or two kerb stones after major events, in which case the work should be undertaken as per the clauses above. Should a large number of kerb stones need repositioning, the work belong belongs in the Minor Works category and should be undertaken as part of a larger campaign as explained in the introductory comments above.

4.10 Repositioning coping stones

As with the kerb stones of the inner walls, there are stones missing from the top of the outer (retaining) walls. The topmost stones of walls are generally referred to as copings.

Some consider that there is an entire course of stone missing from the top of the retaining walls of Devine's Hill (Ian Webb, 2004, pers comm.), presumably stolen for use elsewhere. This would be understandable if the course were of uniform height and so useful for building, rather than tapered as the topmost stones are today. This view is supported by an image held in the State Library of New South Wales (reproduced in Commonwealth of Australia, 1999) which shows a distinct coping or kerb to the outer edge of the road.

As well as occasional stones missing from the coping, there are many that are now out of alignment due to tree growth or to pressure from the road surface material (Figure 31). Like the kerbing, re-aligning copings stones is best undertaken not piece by piece, but in a single campaign aiming to repair a complete precinct or section of a precinct. The advantages of a whole-of-precinct or sectional approach is the opportunity to train those involved in the work practices and to provide archaeological and supervisory input in an efficient and timely way. Such work is identified in the Maintenance and Repairs Matrix (Appendix 1) as Minor Works requiring Heritage Act approvals and appropriate specialist input.

Figure 31

Coping stones displaced sideways. This is likely to have been due to trees growing in the road at a time when it was not maintained, though pressure from heavy vehicles on the pavement may have contributed. Repositioning of multiple stones like these should be a low priority Minor Works program.

There will however, be the occasional opportunity to return to the wall a missing coping stone that still exists lying on the slopes below. In this case, or where single stones are still in the wall but displaced from their correct positions, their repositioning should be undertaken as a maintenance activity as follows.

4.10.1 Maintenance target for coping stones

Existing coping stones maintained soundly bedded and in their correct alignment so that road surface material is properly retained.

4.10.2 Inspection of copings

4.10.2.1 As part of the inspection of the road surface (4.8.2.1) any loss, movement or misalignment of coping stones should be recorded, together with any observations that might explain why the stones have moved (vehicle damage, surface flow, old movements due to tree growth etc). Displaced stones may be discovered during inspections below the wall (4.7.2.1) and these should be recorded so that they can be retrieved later.

4.10.3 Routine maintenance

4.10.3.1 Possible coping stones found on the slopes below retaining walls should be carefully measured to check that they belong in the wall at the identified location. Test the 'fit' of the blocks to the location, lifting them temporarily into place using synthetic webbing slings and a small crane (or tractor).

4.10.3.2 For those coping stones still on the wall but displaced from their original location, use gauging trowels to remove road surface material from around the stones. Then use synthetic webbing slings and a crane (or tractor) to lift the stones aside.

4.10.3.3 Prepare a new bed for the stones, lift them back into their correct positions and ensure that the stones are evenly bedded and do not rock. Use pieces of hard ironstone as shims to level the coping as necessary, keeping any shims well back from the edges to avoid overstressing the face of the stones. Confirm correct alignment before replacing the road surface material around the stones and compacting it down with the end of a wooden tamping rod such as a mattock handle.

4.10.4 After Major Events (AME)

4.10.4.1 There may be a need for repositioning single coping stones after major events, in which case the work should be undertaken as per the clauses above. Should a large number of stones need repositioning, the work belong belongs in the Minor Works category and should be undertaken as part of a larger campaign as explained in the introductory comments above.

4.11 Repair of culvert cover slabs

Stone culverts were 'roofed' with large slabs of sandstone set in rebates on the side walls, the whole being covered over with the coarse and then finer aggregates of the road pavement. Natural erosion, made much worse by 4WD and heavy vehicles, reduced the thickness of pavement on the cover slabs, exposing many, particularly on the Devine's Hill ascent where the steeper gradients contributed to erosion. Many cover slabs were broken. Major conservation works to the Devine's Hill ascent in the last 25 years have involved reconstruction of culverts including replacement of cover slabs. Some sound slabs, as well as some culvert entrance covers, were moved from their original locations (Alan McDonough, 2004, pers comm). New sandstone cover slabs have also been introduced.

Figure 32

Broken culvert entrance cover now largely blocking the culvert. The risk of damage to the road structure during a storm is high, which is why individual examples like this should be repaired as a maintenance activity.

The Maintenance and Repairs Matrix (Appendix 1) anticipates work to culverts falling into three categories as follows:

Maintenance	Repair of one or two exposed cover slabs per culvert;
Minor works	Excavation and repair of multiple cover slabs;
Major works	Reconstruction of culvert and associated backfill and surfacing.

This section is principally about those works considered as maintenance: the repair of one or two exposed cover slabs per culvert. Being exposed they will generally be on either side of the road where the loss of road pavement material means the slabs are no longer covered, placing them at greater risk. Before dealing with their repair it is useful to consider the broader issue of protecting all culvert cover slabs.

Protecting culverts from excessive vehicle loads is one of the challenges for the ongoing care of the OGNR. This is the reason for imposing 13 tonne weight limits on all vehicles using Devine's Hill. Other responses include:

a) use of large diversion mounds (rollover drains) sited directly above the culvert, as has been done on the section of road between the top of Devine's Hill and Finch's line. The mound over the culvert spreads the wheel load thereby reducing the stress on the centre of the culvert cover (Jordan & Associates, 2001c);
b) use of additional support within the culvert, such as the steel angles beneath some cover slabs on Devine's Hill (though these can trap branches, causing blockages);
c) use of reinforced concrete slabs, longer than the existing cover slabs, and laid over the top of the existing, so as to take most of the load.

Following repairs to culvert covers, the road pavement should always be built up again to protect the culvert beneath (though it may not always be appropriate to install an oversize diversion mound as in a) above). Where the pavement is thick enough there is the opportunity to insert new material such as reinforced concrete slabs as in c) above. These will be hidden from view and not apparent to visitors. Precast in sections to enable ease of installation (and also removal, should subsequent repairs be required) and laid over the top of the cover slabs, such a system would enable "the *in-situ* conservation of the existing fabric" (Policy 6, Conservation of the fabric, CMP, 2005, pages 8–5 to 8–7).

In these circumstances, *in-situ* conservation of weak or broken slabs might simply be achieved by inserting galvanised steel angles to support the edges of the slabs, leaving any breaks unrepaired. Alternatively, the broken slabs might be repaired with stainless steel dowels and suitable epoxy adhesives. As vehicle loads will be carried by the overlying reinforced concrete the strength of the repaired slabs need not be great. While another alternative is to replace a damaged cover slab with a new one of sandstone, this option involves reconstruction (in *Burra Charter* terms) which is less acceptable than repair and retention of the existing fabric (Strategy: Repair and reconstruction, CMP, 2005, page 8–6).

Turning now to the maintenance activity of repairing one or two cover slabs per culvert, the options include:

x) supporting weak or broken slabs with galvanised steel angles;
y) gluing and dowelling broken slabs (with or without additional support as in x);
z) replacing the damaged slabs with new sandstone, matching the existing as closely as possible, including the dimensions.

Of these, z) is the least acceptable as it does not achieve “the *in-situ* conservation of the existing fabric.” Where practicable, options x) and y) are to be preferred. However, there will be circumstances where neither of these are appropriate. These include situations where the outer cover will always remain visible despite reconstruction of the pavement. This is most likely to apply to some culvert entrance covers which are often set much higher and were not intended to be covered by the road pavement. Where these stones are generally sound, a simple break should be repaired by gluing and dowelling, but where the stone has decayed to the point that it is too weak to span the opening safely, then reconstruction in new sandstone may be the appropriate option. The decision to reconstruct should not be made lightly: opportunities for strengthening a weak existing stone might include chemical consolidation, though such work should only be undertaken with specialist advice.

Any reconstruction should be identified by inscribing the year of the work, on the face of an entrance cover, or on the top of a cover slab. The inscriptions should be reasonably deep so that they do not weather off. The initial obvious appearance of exposed dates will soon be disguised by growth of dark microflora on the stone.

With the exception of culvert entrance covers, it is likely that few cover slabs will be replaced as a Maintenance activity. More likely, is the excavation and repair of all cover slabs to a culvert as part of a larger program of either Minor or Major Works. As with conservation of some of the other elements of the OGNR, these may be best undertaken in a campaign of works in which there are advantages of repetition of similar tasks, and opportunities to train staff in correct procedures.

4.11.1 Maintenance target for exposed culvert covers

Culvert covers and culvert entrance covers repaired as required to a high standard, in such way that stormwater passage is not limited, and, where appropriate, road pavement is reconstructed over them.

4.11.2 Inspection of culvert covers

4.11.2.1 This inspection should be undertaken in conjunction with that for the drainage of the culverts (4.1.2.2) as it will require looking into each with the aid of a powerful torch to check for any failures of the cover slabs. Culvert entrance covers should also be inspected. There should be a prompt response to any failed covers that are blocking the passage of stormwater. Even where there is only a slight reduction in the cross sectional area of the culvert, there is a risk of trapping branches during storm events, leading in all likelihood to complete blocking of the culvert.

4.11.3 Routine repair of exposed culvert covers

4.11.3.1 Should inspections reveal failed covers blocking the culvert, consideration should be given to appropriate short term action to minimise the risk of blockages. The action might include supporting a displaced cover with timber props within the culvert, or introducing sections of steel angle to carry the edges of a cover slab where those edges are readily exposed.

4.11.3.2 The next stage is to determine the scale of the repairs needed. Is it just one or two exposed covers in which case the work should proceed as a Maintenance activity in accord with 4.11.3.3–4.11.3.7 below. Or, are there several buried covers requiring attention, in which case it becomes Minor Works requiring appropriate approvals as per Appendix 1. More serious failure of the culvert, which might include structural settlement resulting in stormwater discharging through the surrounding fill, will require a Major Works program of excavation and reconstruction of the culvert base (invert), walls and covers.

4.11.3.3 Partly exposed cover slabs that have failed should be cleared of overlying pavement material so that the whole slab is exposed and there is working room around it. Safety fencing, such as high visibility webbing, should be used to alert road users to any reduction in the available pavement.

4.11.3.4 Remove the cover slab and assess its condition. If it can be supported in the long term by steel angles set onto the same rebate in the culvert walls as the slabs, then steel should be cut to length and hot dip galvanised. The cross-sectional dimensions of the steel angle should be the subject of engineering advice with a range of common culvert widths considered. Install the steel angles and then the cover slab, using ironstone pebbles as packing shims as needed to steady the slab and prevent rocking.

4.11.3.5 Circumstances where the cover slab may need to be glued and dowelled include:

- the pattern of fracturing is such that steel angles alone will not support the slab;
- one face of the slab will always be very visible and so the best solution is a combination of gluing and dowelling together with a steel angle on the hidden side; or
- the slab is a highly visible entrance cover and use of steel supports is not possible.

In these cases a stonemason experienced in this type of work should be engaged to undertake the repair, using stainless steel dowels and a suitable epoxy adhesive. Engineering advice should be sought to confirm dowel dimensions: the recommendations should be appropriate to the range of sizes of OGNR cover slab dimensions.

4.11.3.6 Where the condition of the cover slab is so poor that none of these approaches will work (the slab has fractured into smallish pieces, or the stone is so weak and friable that it will not survive) it should be replaced with a new piece of sandstone that closely matches the type of stone found in the sound cover slabs. A stonemason experienced in this type of work should be engaged to dress the stone to match the dimensions of the failed slab, inscribing the year of work into the top or face of the stone as explained above. As previously, ironstone pebbles should be used as packing shims to provide steady beds for the new slab or entrance cover.

4.11.3.7 Once the repaired or new stones have been laid in position they should be covered in geofabric prior to relaying the road pavement over them. The purpose is to prevent sand and other fines washing through the joints and being lost from the pavement. Relay pavement as in section 4.8.

4.11.4 Repairs After Major Events (AME)

4.11.4.1 These repairs will follow the same procedure as outlined in 4.11.3.3–7 above. Before beginning any works, make a thorough inspection of the culvert to ensure that no other remedial works are needed which would require a Minor or Major Works approach.

4.12 Maintenance of timber fences

This section is principally about conserving the remnants of timber fences that remain in three locations in precinct 5 (Mitchell's Loop to the Western Commission Track Intersection). These were probably intended as guard-rail fencing as each is located above steep drops and two at sharp corners in the road. The timber elements include fence posts and rails, and partially buried bed logs that supported posts.

The CMP Feature numbers and grid references of the locations are:

5/T1.	319 185E, 6308 850N	where four partially buried bed logs remain;
5/T2.	317 680E, 6308 750N	where there are posts and rails, mostly collapsed; and
5/T3.	316 680E, 6307 800N	where two posts remain *in situ*, and some rails lie below.

A preliminary investigation of the bed logs at site 5/T1 was undertaken by Ireland and Young in May 2004 and as a result, the opportunity of inspecting and undertaking initial treatment of all three sites was taken in September 2006 by Young in company with Sarah Breheny, Ranger. Figures 33–36 show two of these sites and give an impression of the extent and amount of remaining timbers. More photographs (Figures 37–56) follow the treatment recommendations. The survival of these elements is remarkable and a testament to the durability of the wood (ironbark?).

Figures 33 & 34

Partially buried bed logs at site 5/T1 showing above how these logs supported an upright post. Shallow bedrock at this site made bed logs necessary to support the posts. Soil and heavy stones help stabilise the bed logs. All four known bed logs at this site are (just) visible at right, with their outer ends in a line: the first (above) is near the top of the picture in the centre, the second shows as a dark shadow not far below it.

Figures 35 & 36

Post and collapsed rails at site 5/T2. At left can be seen how the post was built in as part of the wall and is not an afterthought. 'Mud' around the post base is termite gallery. No rails remain *in situ*, but displaced rails such as those at right occur at both 5/T2 and 5/T3. Inspection downslope at 5/T3 revealed more rails and posts than previously documented. Further investigation of all three sites is warranted.

The greatest risk to these timbers is fire, with obvious charring apparent at all three sites. Another risk is that of damage due to falling trees or branches. Termites are a threat, with active termites found in a post at site 5/T2. As this fragile post had already been repositioned, and was precariously supported, it was lifted and laid down adjacent to its location on large stones so as to minimise the risk of further termite attack (Figures 47 and 48). Most, but not all, timbers have central cores hollowed out long ago by termites. Standing posts and buried logs are likely to have fungal rot in their damper sections.

The life of all the timbers can be prolonged by clearing and maintaining firebreaks around them and by use of fungicidal rod treatments which will limit rot and discourage termites. Inspection and routine maintenance treatment should be undertaken together. *Tetratheca glandulosa* occurs close to several of the buried bed logs at site 5/T1 and so additional care is required when clearing firebreaks at this site.

4.12.1 Maintenance target for timber fences

The maintenance target is prolonged survival of the timber fence elements.

4.12.2 Inspection and routine treatment

4.12.2.1 WARNING: many of the posts and fence timbers are fragile — avoid contact and do not lean tools or other equipment on them. Rake leaves and tree litter away from the timber elements (whether posts, rails, or bed logs) to form a 'firebreak' at least two metres in diameter or away from any timber element. Ideally, this should be done twice a year, once at the beginning of the fire season and again in the middle of the fire season.

4.12.2.2 Insert boron and fluoride based preservative rods ('Polesaver Rods', see Appendix 3) into existing gaps and holes in the timber elements. There is no need to make new holes in the timbers as there central voids, and also holes and depressions in the outer surfaces that are large enough to take the preservative rods. The locations of many of the fungicidal rods are shown in the pages of photographs that follow (Figures 37–56). Loading rates should be 2–3 rods per post or other element. The rods work by slowly dissolving when wet whereupon the boron/fluoride fungicides diffuse through the wood thus protecting it from further decay. Keeping the posts topped up with new rods is all that is required.

4.12.3 After Major Events

4.12.3.1 Check posts, record condition and maintain firebreaks and fungicidal rods.

4.12.4 Bridge Timbers at 10 Mile Hollow

Two long timber poles lie beside Simpson's Track at the 10 Mile Hollow Inn site (6/HA7). These are understood to be remnants of the former nearby bridge and were removed for safekeeping to their present location (Ian Webb, 2004, pers comm). One is badly burnt and the other has evidence of termite attack. They should be lifted from the ground and supported on large stones, thus reducing the termite and fungal rot risks. Where possible, fungicidal rods should be inserted into existing holes and voids in the timbers. Create and maintain 2-metre firebreaks as before.

4.12.5 Timber elements not covered in this section

This section does cover conservation of timber culverts. Separate investigations are required to assess potential conservation treatments of remaining timber culverts. These may need to be site specific, depending on the condition of the culverts. The challenge with timber culverts is to find a way of conserving without dismantling: the latter will almost certainly result in total replacement as happened at Ten Mile Hollow. This is Major work and will need to be the subject of an REF process and a S60 application under the Heritage Act.

Figures 37 & 38

Bed log 1 at left and bed log 2 at right showing two loading points for fungicidal rods in each log. Large screwdriver indicates one point in each. Two rods are placed in the deeper (damper) point of all bedlogs.

Figures 39 & 40

Bedlog 3 during archaeological investigation in May 2004 at left, and in September 2006 at right showing loading points for fungicidal rods. The screwdriver indicates one point. It is conceivable that the hole in the top of the log at left is from an iron spike inserted as a brace for the post.

Figure 41 & 42

Bedlog 4 showing at left, burial of fungicidal rod in sand covering bottom portion of log. Large screwdriver has 300mm shaft and 115mm handle. At right showing how a groove in the handle is used to deliver rods deep into the hollowed out centre of the log, which has a total measured internal depth of 1550 mm.


Figures 43 & 44

Remaining *in situ* post at 5/T2 (see also Fig 35). At right, top of post showing fungicidal rod loading point.


Figures 45 & 46

At left, base of post seen in 43 and 44 above. Fungicidal rod loading points. End of displaced rail at right.

5/T2


Figures 47 & 48

At left, looking down on post removed from relocated site, note fork to carry rail. Side view at right.


Figures 49 & 50

Collapsed rail and posts after clearing firebreak at site 5/T2. More posts lie nearby.

5/T3


Figures 51 & 52

Before and after clearing firebreak at one of two standing posts at site 5/T3. The post has already been damaged by fire and is now very fragile. Take care when working around it and do not lean tools against it!


Figures 53 & 54

Same post as in Figures 51 and 52, termite galleries at left. At right the base of the post showing extreme thinning from termites, fungal rot and fire. Post is now very fragile: take great care when working around it.

Figure 55

Timbers lying downslope at 5/T3. There are several more close by and the area warrants further investigation. This ?rail timber was lifted slightly onto stones to improve drainage and reduce risks of fungal rot and termite attack. Another timber lies partly buried to the right.

Figure 56

Ranger Sarah Breheny contemplates the longevity of the second standing post at site 5/T3.

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5. References

A long list of OGNR references is incorporated in the CMP (Ireland et al., 2005). The list below includes references relevant to this plan, and also those undertaken since the CMP was completed (Banksia Heritage & Archaeology, 2004, and Stedinger Associates, 2006).

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