City of Busselton

Geographe Bay

Engineering and Works Services Standards and Specifications

Section 7

Requirements and Guidelines for Road, Drain, Path Maintenance and Reinstatements

These Standards and Specifications have been adopted by the Council, and are required to be practiced in the City of Busselton for all road, drain and path maintenance and reinstatement works carried out by Consultants, Contractors, Developers and City Staff. These Standards and Specifications will be maintained by the Director, Engineering and Works Services.

Revision No	Date	Section Amended	Prepared	Reviewed
A	**December 2009**	**All**	**Engineering and Works Services**	**Engineering and Works Services**

I n d e x

1 GENERAL

These standards and specifications have been developed for all works on existing or potential reserves, public roads, right-of-ways and public access ways to be ceded in the subdivision process.

It is acknowledged that accepted industry standards will change over time. In order to accommodate such changes, the contents of this document will be reviewed on a regular basis. These standards and specifications will be posted on the City's website at www.busselton.wa.gov.au/services/engineering/tech_stds and are available for downloading.

Any reference to the City's Officer, Engineer, Supervisor or the Director, Engineering and Works Services shall mean the Director, Engineering and Works Services of the City of Busselton or his / her authorised representative.

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1.1 Maintenance and Reinstatement

Surfaces used by pedestrian, cyclist and vehicles are designed to varying standards and are built from natural or processed materials to meet the needs they serve. If the facility is to give the standard of service for which it was designed, maintenance is essential.

Maintenance programs within the City of Busselton are adjusted to control the rate of deterioration and to ensure that serviceability does not fall below a minimum standard.

Maintenance may be classified as either "preventative" or "remedial". Preventative maintenance involves action to prevent roads from deteriorating, whereas remedial maintenance is necessary to repair defects. Reinstatements are repairs after works have been carried out, and must be done to a standard to prevent deterioration at a rate greater than surrounding surfaces.

1.2 Public Relations

Many public works activities have potential for danger and/or inconvenience to the public. Efforts should be made to reduce these aspects to a reasonable minimum.

The term "public relations" refers to the relationship that exists between the City of Busselton and the public that it serves.

Good public relations may be achieved by maintaining the public access and road network controlled by the City, in a condition that gives an adequate service and minimises risks to the public. This is achieved by keeping the ways free of defects which can adversely affect the user's safety and comfort and also cause damage or injury.

There will be occasions when maintenance personnel will need to seek permission for access to private property to execute works, to park plant on the property, investigate drainage problems or to repair damaged items. Under certain circumstances there may be statutory power to enter private property, however, it is most important that due notice of the proposed entry and formal identification of the person, is given to the property owner and appropriate consents obtained in advance.

1.3 Provision For Public Access

Regard must be given to the safety of employees, plant and equipment as well as to the safety and convenience of the public.

The Australian Standard AS1742.3 sets out the traffic control devices to be used to warn, instruct and guide road users safely through, around or past work sites on roads, including footpaths.

1.4 Terms

All terms used in this Specification are in accordance with Australian Standard AS1348 “Road and Traffic Engineering - Glossary of Terms”.

1.5 Authority to Repair Works

The Director, Engineering and Works Services is the Officer of the City of Busselton authorised by it under the delegation from the Chief Executive Officer (CEO) to ensure that methods used and standards are in accord with this specification.

2 ROAD PAVEMENTS

2.1 General

Pavement deficiencies which immediately affect normal vehicle use should be given first priority. Typical defects in this category are slippery and loose pavements, dust, loss of surface aggregate, excessive bridge approach settlement, potholes, broken edges adjoining abrupt vertical variations and debris. The safety of property and other users of the road reserve must be taken into account.

Second priority should be given to the correction of defects having a long range effect on normal vehicle operations, riding quality, and/or structural condition. Typical defects in this category are pavement cracks, pavement and shoulder distress and drainage blockages.

There are two (2) main types of pavements, rigid and flexible. The most prominent type within the City of Busselton is flexible.

2.2 Rigid Pavements

The definition of a “rigid” pavement is one which has a rigid base or sub-base material such as concrete. The pavement is characterised by an even disbursement of vehicle load over it.

Rigid pavements should be monitored and maintained for the following deficiencies:

(a) Skid resistance — Skid resistance should be determined as for flexible pavements. Deficient areas should be corrected promptly.

(b) Cracking — All cracks not provided for in the design and likely to affect structural stability, and joints that have opened to approximately 5mm wide or more should be sealed.

(c) Spalling

- When a transverse spalling in the pavement exceeds 100mm in length or 150mm in width, or adversely affects normal vehicle use, it should be repaired promptly and loose material removed;
- When longitudinal spalling adversely affects normal vehicle use, it should be repaired promptly;
- All spalls over 50mm depth should be repaired promptly; and
- Edge spalling should be considered for repair if normal vehicle use could be affected.

(d) Blow-ups — Blow-ups in excess of 25mm (15mm in the case of paths) should be repaired promptly.

(e) Settlements — When surface level differences exceed 15mm between adjacent slabs, correction should be made promptly and surface irregularity should not exceed the limits set out for flexible pavements (see Section 0).

(f) Joints — Joints should be maintained so as to exclude foreign materials, preserve the original joint filler and minimise the infiltration of surface water. Unless so designed, joints should not become wider than 15 mm, regardless of panel length.

(g) Pumping/blowing — All panels observed to pump or blow should be repaired promptly.

(h) Drop-off (vertical) — Standards for drop-off from edges of rigid pavements are as set out for flexible pavements.

(I) Edge Separation — Any separation of pavement and shoulder or kerb greater than 25mm should be repaired.

2.3 Flexible Pavements - Bituminous Surfaced

Bituminous surfacing may be broadly classified as sprayed sealing, hot mix asphalt or bituminous slurry surfacing. The choice of surfacing is influenced by environmental conditions, accepted local practice, availability of materials and cost.

The definition of a “flexible” pavement is one which has a gravel surface, bitumen seal or an asphalt surface as the wearing course with a granular base or sub-base material. Vehicle loads applied to the surface result in flexing of the pavement. Vertical stresses will eventually form ruts, whilst horizontal stresses will eventually create cracking and other deformations.

If the bituminous surface of a pavement shows distress or deformation it is essential to determine whether the defect is in the surface, the pavement or in the subgrade before repairs or resurfacing works are carried out. Defects such as those arising from a faulty subgrade, a soft area in the pavement, faulty pavement material or poor drainage will continue unless the cause is removed.

Surface Irregularity and Skid Resistance

Remedial work on travelled surfaces should be aimed towards providing an acceptable riding surface for the normal movement of traffic.

Correction should be considered when surface irregularity or distortion exceeds one or more of the following limits:

(a) NAASRA Roughness Meter Counts:
Freeway .....120 counts / km
Other.....150 counts / km

(b) Riding quality is considered to be unacceptable for normal vehicle use;

(c) When measured along any three (3) metre section of roadway the depression at any point below a four (4) metre straight edge exceeds 30mm; and

(d) Corrugations exceed 50mm when measured from crest to trough (gravel pavement).

Remedial action should be initiated when skid resistance in any wheel track is lower than the minimum level over a 20 metre length or 15% of any gross wheel track area.

Patching

If excavation of a pavement is required the sides of the area to be patched must be trimmed vertical, the depth of the hole being just sufficient to remove the poor material. Dewatering shall be used where required to maintain stability of excavation walls.

Gravel or crushed rock used for backfill must be moistened to facilitate compaction. All materials should be compacted in layers not exceeding 100mm in thickness. Moisture control is critical during compaction as excessive or inadequate moisture can lead to premature failure of the patch if sealed when too damp.

The amount of material used must be chosen to ensure that the patch, when compacted is flush with the surrounding pavement surface and will not subside.

Before applying the final bituminous surface the patched area must be swept clean of dust and loose stones.

The surfacing is then applied using materials, as far as practicable, similar to those in the original surface and in such a manner that it will have a similar texture and colour as the surrounding area. The exception is in urban areas, where asphalt shall be used at not less than 25mm thickness.

After application, loose aggregate should be removed to prevent a hazard for traffic and the possibility of windscreen damage.

The two types of bituminous patching are as follows (when using hot bitumen, the ground temperature for spraying shall be as required by the specifications for the works):

(a) Seal Patching

If a patch involving excavation is made, the existing seal should be stripped for at least 75mm beyond the perimeter of the excavated area.

Where gravel or crushed rock has been used to restore a pavement, priming of the compacted and swept surface is generally required before sealing. The primer that may be used is cutback bitumen or bitumen emulsion spread at a rate to ensure uniform coverage and adequate penetration without an excess of primer remaining on the surface. Cutback bitumen primers may be light or heavy grade depending on the season.

For primer sealing, the primer binder can range from a light to heavy grade according to the size of aggregate used and predicted weather conditions at the time of application. Primer seals are used when it is not considered practicable to keep traffic off a primer until it has cured or patching is to precede a general reseal which may follow within approximately 12 months.

After the primer has cured a seal coat of binder and aggregate is applied. The binder may be bitumen (fluxed and/or cutback) or bitumen emulsion. With bitumen emulsion it is not practicable to spray heavy applications and thus large cover aggregate may only be used in multiple application work. For single application work, aggregate should be spread uniformly to one stone thickness leaving virtually no binder visible. The aggregate so placed is incorporated by light ramming or rolling and brooming off all excess aggregate.

(b) Asphalt Patching

Asphalt must be used in urban areas and is preferable in all cases.

It is preferable to use hot mix asphalt rather than cold mix asphalt as it can be satisfactorily transported, placed and compacted within the available temperature range.

When patching with cold mix asphalt it is necessary to grit the surface to prevent pickup by traffic.

The grade of binder used in cold mix asphalt will depend upon the weather expected during storage and use but will usually be Class 170 bitumen, flexed and/or cutback bitumen or bitumen emulsion.

To avoid the problem of flushing or bleeding, cold mix asphalt should not be used for patching on heavily trafficked roads if resealing is planned to take place within the following two (2) months (Except where cold mix asphalt patches have been trafficked for long periods, i.e. greater than six (6) months, are firm and stable and all volitates evaporated).

Cracked Pavement Surface Defects

Cracking is a symptom of pavement distress and in the early stages the crack pattern can indicate the cause. However, more developed cracks may allow the entry of surface water or disturbance of the surfacing by traffic and it is more difficult to determine the original cause of the trouble.

It is important that crack repair (if considered necessary) should not mask the need for investigation of the underlying cause(s) of crack manifestation.

As a general indication, the following conditions should be regarded as the minimum state justifying rectification:

(a) Individual cracks 5mm or wider; and

(b) Extensive cracking over broad areas of the pavement, or where the pavement shows signs of plucking out or moisture is penetrating to a plastic base or sub-base.

Thin surface layers of asphalt are less flexible than sprayed seals and therefore more likely to crack. Flexibility is reduced by the hardening of the bitumen binder as the surfacing becomes older.

Cracks wide enough to be treated should be cleaned out with compressed air and/or heavy brooming, and then may be filled with an unmodified binder such as cutback bitumen or bitumen emulsion having a viscosity low enough to enable it to be poured or worked into the cracks. Unmodified binders are hard and brittle at low pavement temperatures and tend to crack easily in cold weather, whereas they are soft and semi-fluid at higher pavement temperatures and tend to track under traffic in hot weather. A binder of aggregate or sand should be used.

Alternatively, seal the cracks using specialised mechanical equipment with a rubber or polymer modified binder. Modified binders give improved service life in the normal ambient temperature ranges.

In asphalt surfaces, cracks can also be widened by the use of a power router to provide improved bonding faces and more effective application of binders.

Large areas with fine cracks should be spray sealed.

Where cracking is accompanied by rutting or depression of the surface, reconstruction of the pavement may be required.

In planning maintenance of cracking pavements, consideration should be taken of the likely effect of delaying work.

Fatty Surface Defects

A fatty surface is due to surplus binder on the surface. Fatty surfaces become soft in hot weather (bleeding) and slippery in wet or frosty weather. This surface defect is also known as “flushing”.

Where fatty surfaces remain even after sanding or fritting has been employed to avoid binder pick-up, further remedial action should be considered when:

(a) A continuous fatty strip exceeds a length of 10 metres on curves or on the approaches to or within an intersection, or 15 metres on straights; and/or

(b) Sanding or gritting operations have been required over an aggregated area of more than 10% of any lane kilometre of road surface.

The successful treatment of this condition is difficult and requires careful consideration and field trials before any extensive work is carried out. Possible methods of treatment include:

(a) Resurfacing with open-graded plant mix asphalt which will absorb surplus bitumen.

(b) Water jet scrubbing to remove surplus binder (suitable only for dense graded asphalt surfaces).

(c) Resealing with special attention to the application rate of the binder and the size of the aggregate. Where the amount of free binder is excessive, resealing may not be appropriate.

(d) Incorporation of additional aggregate into the existing binder by spreading and rolling in hot weather.

Depressions

Depressions occur in the pavement surface when a fill or backfill has been inadequately compacted.

Depressions caused by inadequate compaction of the fill may continue to increase in size and depth through consolidation which may require deep correction.

If deemed necessary to make a surface patch, hot mix asphalt should be used.

Pavement Failures

Pavement failures are areas where the seal is cracked and deformed. They may be caused by poor compaction, defective or inadequate depth of pavement material, unbound subgrades, and/or the ingress of moisture into the pavement.

The repair of pavement failures will involve the removal of the defective pavement and/or subgrade materials until a sound base is reached.

The hole should be squared by vertically trimming the edges and all loose material removed.

Where gravel or fine crushed rock is used to reinstate the hole it will be necessary following compaction to seal the surface of the patch.

Where asphalt is used to reinstate the hole it will be necessary to square or cut edges and to lightly prime or tack coat the squared sides and base of the hole followed by compaction.

Cold mix asphalt shall not be used for the repair of pavement failures.

Potholes

Potholes not accompanied by distortion of the adjacent surface are usually due to a cracked bituminous surface allowing moisture to enter the pavement.

Potholes and localised failures should be repaired promptly.

The repair of potholes will involve the squaring of the hole, vertical trimming of edges and removal of loose material prior to reinstatement. Where gravel or fine crushed rock is used to reinstate the hole, it will be necessary after compaction to seal the surface of the patch.

Where asphalt is used to reinstate the hole, it will be necessary to lightly prime or tack coat the squared surfaces of the hole followed by compaction. If cold mix asphalt is used it may be necessary to grit the patch to prevent pickup by traffic, and later seal the surface of the patch.

Ravelled Surface Defects

Ravelling is a condition in which the sealed pavement surface becomes rough in texture due to a loss of aggregate and binder.

Ravelled surfaces will require binder to be added. If the condition has not developed too far, it can be corrected by a sprayed seal, slurry seal or enrichment seal. Otherwise resurfacing will be required. An enrichment seal should only be undertaken if the binder is capable of being softened for incorporation with the new binder.

Treatment for ravelled surfaces in sprayed seals is usually more urgent than for asphalt seals sue to the potential for more rapid deterioration of the underlying pavement.

Shoving Surface Defects

A fairly regular waviness (somewhat resembling corrugations in a gravel road) may develop in bituminous surfaces due to movement under traffic. Bulging of the road surface may also develop parallel to the direction of traffic and often at the edge of the pavement. The deformations are usually shallow and are not likely to be confused with larger depressions or pavement failures resulting from weaknesses in the pavement or the subgrade.

If the bituminous material has been compacted by traffic to a stable condition it will be practicable to fill the depressions with hotmix asphalt. If it remains unstable it will be necessary to remove the unsound material and replace it with a hotmix asphalt.

Slick Surface Defects

Slick surfaces are hard, smooth and slippery. Exposed stones may become polished or smooth under the action of traffic, causing slippery conditions when wet.

Slurry sealing may be suitable for slick surfaces provided a suitable texture depth is able to be achieved, however, the best treatment of this surface defect is to reseal using a selected aggregate of better quality and size than the existing.

Stripped Surface Defects

Stripping is a condition in which aggregate is lost from a spray seal for a number of reasons.

Remedial action should be considered when:

(a) Isolated stripped patches exceed one (1) m^2 in area;

(b) There is a marked loss of surface aggregate;

(c) Normal vehicle use is impaired; and/or

(d) Extensive pavement loss is likely.

If stripping occurs due to aged and hardened binder it should be treated without delay to avoid further loss of aggregate.

If there has been loss of scattered individual stones only, the condition may be corrected by an enrichment seal with or without fine cover aggregate.

If stripping has occurred over large isolated areas a reseal will be necessary.

Wheel Rutting Surface Defects

Rutting usually takes the form of depressions in the wheel tracks.

Corrections in hotmix asphalt should be considered when water is ponding on the pavement. The treatment in this case will be as described for shoving (see Section 0) provided there is no weak pavement or subgrade movement. Any faulty pavement or subgrade material must be replaced by suitable material.

Edge Breaks and Drop-Offs

Fretting or breaking of the edge of a bituminous surface may be caused by worn shoulders, inadequate strength at the edge of the pavement or entry of water through the shoulder. Edge patching is similar in requirement to pothole patching.

HORIZONTAL

(a) Unsealed shoulders - remedial action should be initiated when edge breaks approach 150mm measured from the nominal seal edge.

(b) Sealed shoulders - remedial actions should be initiated when edge breaks approach 250mm measured from the nominal edge of the shoulder.

(c) Shoulders of edge-lined pavements - edge of shoulder repairs should be initiated when breaks encroach into the edge line.

VERTICAL

(a) Remedial actions should be taken when edge breaks and drop-offs could affect normal vehicle use, interfere with drainage or threaten the structural integrity of the pavement.

(b) Unsealed shoulders - remedial action shall be carried out when vertical drops from the traffic lane to the shoulder are approach 50mm or more, and initiated when the drop approaches 50mm.

(c) Sealed shoulders - remedial action should be initiated when vertical drops from the traffic lane to shoulder approach 25m.

(d) Where sealed shoulders are constructed, remedial action should be initiated when vertical drops from the outer edge of the sealed shoulder approach 75mm.

Loose material must be removed from the shoulder in the area of the edge break to be repaired prior to application of a tack coat to the broken edge of the seal or shoulder.

Hot or cold mix asphalt is to be used to repair edge breaks and is placed and compacted to conform with the level of the adjacent seal. Gritting or sanding is usually required where cold mix asphalt is used to avoid pickup by traffic.

2.4 Flexible Pavements - Unsealed

Unsealed pavements should be maintained to provide an efficient and safe running surface for normal vehicle use, having regard to the weather and traffic conditions to which the pavement will be subjected.

Unsealed roads generally fall into three categories:

(a) Formed and Sheeted Roads - Are typically sheeted with materials such as limestone, shale, ironstone, laterite, sand and/or clay.

(b) Formed Roads - These roads are formed by the grader utilising the naturally occurring materials which the road traverses, or imported fills.

(c) Unformed Roads - Vary from gravel roads to two-wheel tracks. As the frequency of grading increases, these roads become further below the natural surface. Drainage then becomes a problem as the water cannot escape and the road may even become the water-course.

Grading Operations

Graders are designed primarily for the work of trimming, shaping and finishing in road construction, however, they are not designed for heavy excavating. In paving work, they are used for blending materials, including incorporation of water.

Grading is the most important operation in the maintenance of unsealed roads and is best undertaken after moderate rains. The basic purpose of grading is to keep the road well shaped and drained to maintain a satisfactory running surface.

The frequency of grading depends upon the importance of the road and the nature of traffic using the road. Grading may vary from 3-4 times per year on the more important, heavily trafficked roads (i.e. main tourist or major link roads), to 1-2 times per year on less important, less trafficked roads (i.e. access roads to farms, homesteads and cattle yards). More grading will be required on some busier roads but consideration should be given to upgrading to reduce maintenance costs.

If the pavement is dry, fine material may be dispersed by wind and traffic before it can bond with the underlying surface. In dry conditions it is often better to avoid grading because of the risk of the surface beading up and becoming worse. In some instances it may be necessary to grade surplus dry material to the side of the road. Loss of fines will cause coarse materials on the surface giving a loose and usually corrugated running surface.

If the surface is damp (not wet), the loose material graded into low spots may be compacted by traffic to give a more uniform surface with little loss of material.

The effectiveness of grading can be increased if a roller is utilised, especially after wet weather or by the addition of water from a tanker. A multi-wheel rubber tyred or smooth drum roller can be drawn behind the grader at relatively low cost.

After heavy rain, the most important task is often to grade out scours in the running surface and fill in wheel ruts. A truck and loader may be required to move material necessary to fill deep scours. Culverts and inlets must be kept clear of grader windrows and checked for blockage or obstructions.

When grading, it is important to maintain or restore the crossfall of the running surface. The desirable crossfall for a gravel road is between 3-5%. If the crossfall is steeper than 5%, scouring is likely during heavy rainfalls. If the crossfall is less than 3% water will not be effectively shed.

Windrows formed during grading operations can be hazardous to traffic and affect cross drainage, and should not remain in place for extended periods, especially overnight. If windrows have to be left for some time because of plant breakdown, etc, ensure that the correct warning signs are erected.

Forming, Sheeting and Resheeting

The forming and sheeting of a road is similar to the formation and sub-base construction operation for a sealed road. Resheeting is carried out where there is a loss of fines and so to restore a bound surface, clayey gravel may be tyned mixed and compacted with the base material. Resheeting may also be used where the subgrade breaks through the base course.

Scarifying and Reshaping

When a sheeted road has become worn to a state where the surface has depressions, potholes and/or corrugations, it can sometimes be restored by loosening (or tyning) and reshaping. Mixing the sheeting with subgrade material would lead to an inferior surface, so loosening and reshaping should not be attempted in this case.

Fresh material must be brought in to increase the thickness of the pavement if it is less than 75mm and/or not able to carry the traffic load. In such cases it should be increased to a 100mm compacted thickness.

In the scarifying process, a number of passes may be required to avoid leaving hard areas between the grooves which will produce an unsatisfactory riding surface.

Unless there is adequate moisture in the pavement for compaction, water should be added.

Final shaping by a grader and compaction by multi-wheel rubber tyred roller should follow the scarifying and reshaping.

Patching

Where a depression is too large to be eliminated by grading (and is not a result of inherent weakness in the subgrade), it should be lightly scarified and filled with material similar to that in the adjoining pavement, finished to a smooth surface by grading and compacted by rollers and/or traffic.

An unsealed road with a running surface of silt or dry clay may form potholes of varying sizes and depths, which fill with fine dust. These holes may only be satisfactorily repaired during the dry season by replacing the fine material with better quality moist material.

In wet conditions, manual patching of potholes with an “all in” crushed granular aggregate or shale may be required to address safety. Metal dust is another useful material in adverse, wet conditions.

2.5 Shoulders

The road shoulder is that portion of the road which is continuous and flush with the seal. Shoulders may be constructed of earth, gravel, asphalt or concrete depending on the needs of the traffic. The surface may be unsealed, grassed, stabilised, sealed or concrete.

The crossfall of shoulders should be at least 1% more than the sealed or unsealed pavement.

A shoulder should have a smooth running surface, a minimum of loose material, an adequate slope for drainage, sufficient strength to support wheel loads and a surface flush with the pavement edge.

Sealed shoulders

Sealed shoulders are subject to conditions similar to roadway surfaces and should therefore be maintained as for flexible surfaces (see Section 2.3).

Unsealed Shoulders

Remedial action should be initiated to maintain unsealed shoulders in a condition that will ensure correct transverse and longitudinal shape is retained. Corrective action should also be initiated to minimise edge rutting, persistently soft or wet areas, and rock or debris build-up.

Shoulder width should not be allowed to reduce to more than 300mm less than the original width on each side of the road.

Maintenance of unsealed shoulders will normally involve one or more of the following operations:

- Recovering displaced material, smoothing and reshaping with a grader;
- Adding new material (resheeting) to replace material lost from the actions of traffic, water erosion or grading operations; and/or
- Watering and rolling to compact new or existing shoulder material; and
- Sweeping of loose stone off the seal.

GRADING

(a) Regular shoulder grading using a grader should be employed as part of the maintenance programme.

(b) Watering and rolling in conjunction with grading will produce a stronger more stable and less permeable surface on the shoulders.

(c) Following grading of shoulders, remove any windrows as soon as possible. Where it is not possible to remove the windrow immediately, it should be placed as far from the seal edge as possible and openings provided to allow runoff to disperse and retain access to properties.

(d) The shoulder should not be allowed to become higher than, or extend over, the edge of seal. This leads to saturation of the pavement at the seal edge on flat grades, and erosion and rutting on steeper grades.

(e) Maintenance operations likely to disturb a well compacted and impervious should not be carried out during prolonged dry periods.

(f) It is usually uneconomical and minimally effective in extended dry periods and during or immediately after heavy rain.

EDGE RUTTING

(a) Regular inspection should be carried out to ensure the drop-off from the seal surface to the unsealed shoulder does not become dangerous.

(b) Edge rutting not attended to promptly can lead to fretting along the edge of the seal thus reducing the sealed width and impairing drainage.

(c) Replacement material may be obtained from the rill at the edge of the shoulder or from the table drain. If this material is not suitable fresh material should be imported.

RESHEETING

Where the natural moisture content is insufficient for suitable compaction to be achieved, consideration should be given to adding water and mixing it uniformly through the material before taking it to the shoulder.

Grassed Shoulders

Grass shoulders must be mown or sprayed with herbicide on a regular basis. Grass does stabilise, however, it can also obstruct drainage and cause a build up of silt and sands.

Where edge rutting occurs solely as a result of the action of traffic, importation of selected material will be required to build up the shoulder so that it is flush with the pavement edge (see Section 0).

Where erosion results from high shoulders impeding transverse drainage and contributing to edge rutting, the shoulder should be graded to the correct profile in addition to repairing the rutting.

Stabilised Shoulders

Where shoulders have been previously stabilised with bitumen, cement, lime or other materials, it is generally difficult to patch minor defects with a similar material because of the problem of achieving a bond between the old and the new material.

It is preferable to reinstate with hotmix asphalt finished to a width giving a uniform appearance.

Where defects are of a size to warrant reworking or removal and replacement of the shoulder material, stabilisation similar to the surrounding material may be considered.

Weed growth on a stabilised shoulder can disrupt the stabilised material due to penetration by the root system. Weeds need to be controlled by herbicide methods at a frequency which will prevent development of a damaging root system, usually autumn and spring applications. When herbicide is used, the spray should extend to table drains and culvert inlets and outlets.

2.6 Traffic Facilities

Traffic facilities should be maintained and preserved in accordance with the applicable standards used for construction, and the general quality levels set out below.

Traffic aids such as signs, pavement markings and other road furniture are provided on roads to aid in the safe and convenient movement of vehicular and pedestrian traffic.

Traffic Signage

The following considerations in the design and placement of signs and markings, should be given for night operation:

- The size of the signs in relation to vehicle approach speed;
- Adjustment to existing signs and traffic control devices;
- Delineation;
- Structural barriers;
- Clearance and load limitations; and
- Pedestrian and cycle movements.

Individual signs and devices should always be examined for condition and effectiveness immediately before installation. Only effective signs and devices should be used.

Signs should be positioned in accordance with arrangement diagrams shown in AS 1742.3 and maintained accordingly, with the following considerations in mind:

- Visibility - within the driver's line of sight, cannot be obscured from view either by vegetation or parked cars and do not obscure other devices;
- Stability - secure mountings, footings and supports;
- Hazardous - do not become hazardous to employees, vehicles, cyclists or pedestrians;
- Do not deflect traffic into an undesirable path; and
- Placement in a position so as not to cause a traffic hazard.

It is important that the relevant signs and devices used for road works, be removed or concealed from view as soon as the work is completed or when the hazard ceases to exist, and if no longer required for the purpose they were placed.

Traffic Signage Maintenance

In general, traffic signs should be replaced when their condition deteriorates markedly.

Maintenance of warning and regulatory traffic signs should take precedence. Main Roads are to be notified of regulatory warning signage requiring maintenance.

Regulatory signs are the responsibility of Main Roads WA (MRWA) and works on these signs must be with its approval.

Colour, legibility, visibility and reflectivity should be maintained in accordance with the following accepted practices:

(a) To maintain legibility, replace existing signs when either rust is evident, the reflective sheet has faded, or the sign has been badly damaged by vandals or by accident;

(b) Carry out regular inspections, including night-time inspections to gauge any loss of sign reflectivity;

(c) Posts should be maintained in a vertical position with boards level and bolts tightened;

(d) All vegetation, scrub or overhanging limbs should be cleared to ensure that signs are visible to approaching drivers from as great a distance as possible;

(e) Timber signs should be repainted in the field, preferably without removing them from the posts;

(f) Non-reflective signs and posts, where approved, should be repainted with one coat 12 months after erection and approximately every two (2) years thereafter;

(g) In some cases replacement rather than repainting may need to be considered;

(h) To obtain maximum legibility and reflectivity, all signs should be kept clean and free from dirt, diesel smut, tar, bitumen or other contamination. The sign should be flushed thoroughly with water to remove loose dirt and abrasive particles and washed clean with a soft brush or mop using a mild detergent.

Traffic Signals

Red aspect lamps, stop-line lanterns, other lanterns (including “Don’t Walk”) and traffic control signals at rail or road crossings are the responsibility of MRWA.

Pavement Markings

Pavement markings in accordance with Australian Standards 1742, are essential for safe and efficient traffic operation and are categorised as follows:

(a) Paint - with or without embedded glass beads or premixed;

(b) Epoxies (2 part cold plastics) - with or without embedded glass beads;

(c) Raised pavement markers (RPM) - either retro-reflective or non-retro-reflective, attached to the road pavement with epoxy resin or thermoplastic adhesives.

In general, pavement markings should be remarked when their condition deteriorates markedly.

Maintenance of regulatory markings should take precedence. MRWA undertake this work after initial set out by the City or a contractor.

Pavement marking obliterated by other activities should be remarked promptly. Spotting for remarking should be carried out as soon as possible.

Colour, legibility, visibility and reflectivity should be maintained in accordance with MRWA accepted practices.

Raised pavement markers (reflective or non-reflective) should be replaced in a reasonable time. Groups of markers should not be allowed to reduce to less than 50% of original installation. When used individually, loss of consecutive markers should be cause for replacement.

Guideposts

Guideposts may be of timber, metal, plastic or rubber fibre-glass. Guideposts should be maintained to preserve the intent of the posts and their delineators and placed on the edge of an unsealed pavement at not less than one (1) metre from the sealed edge of a two (2) lane seal, or two (2) metre in the case of a single lane seal or not less than 600mm from a kerb-face.

Guideposts should be repainted or cleaned as required, straightened or replaced after being struck by vehicles or vandalised.

Grass should be cleared from around posts, either by clipping or by the use of appropriate herbicide. Guideposts are generally removed and rest in the maintenance grading process.

Delineators

Delineators are small retro-reflectors or panels of retro-reflective material which are attached to guideposts, safety barriers, bridge end posts, etc. to provide delineation of the edges of the carriageway as an effective aid to night driving. Red reflectors are placed on the left and white on the right side of the guideposts or other edge posts, for approaching traffic.

To maintain optimum reflectivity, delineators must be kept free from dirt and other contamination. Delineators should be inspected regularly at night.

The following colours shall be used:

(a) *White* - 100mm by 25mm sheeting delineator or 80mm diameter corner cube delineator;

(b) *Red* - 100mm by 50mm sheeting delineator or 80mm diameter corner cube delineator; and

(c) *Yellow* (temporary delineator) - not less than 200cm^2 of retro-reflective sheeting material mounted on both sides of a rectangular plate.

Delineators are placed on the centre of the guideposts, the top of the delineators being not less than 50mm nor more than 100mm below the top of the post.

On safety barriers, the delineators are attached to plates mounted on the barrier posts so that they protrude above the top line of the barrier.

Guardrail

The purpose of safety barriers is to reduce the severity of accidents where vehicles may run off the road.

The shoulders under and around guardrails should be kept free and clean of vegetation and debris. Guardrails should not be partially obscured by vegetation.

Where replacement parts and rail are required, new units should be of galvanised steel and should not be painted. Delineation should be achieved by the use of reflective markers.

Damaged terminal sections should be replaced promptly. Temporary repairs may be required to make the terminal safe until permanent repair is effected.

A cable guard fence is an alternative to a guard rail. Its effectiveness is sensitive to the cable height. The cable should be maintained to the correct design height.

Concrete or steel median barriers are also used to protect vehicles from adjoining carriageway vehicles and should be maintained to preserve their alignment and structural integrity.

Fences

Fences are generally used for vegetation protection or pedestrian/cyclist access control. Fences for which the City is responsible should be maintained to preserve the intent of the fence.

2.7 Roadside

Herbicides

Use of herbicides is the most economical and effective way to maintain roadsides and drains against intrusion and obstruction caused by grasses. Herbicides should be applied in accordance with safety specifications by licensed operators using calibrated, specialist equipment only during favourable (not windy) conditions. They should only be used where there is a heavy grassing of shoulders, open drains, table drains or

culvert inlets and outlets. When spraying in wet areas, herbicide without wetting agent should be used. Dyes to indicate sprayed areas are recommended. All other verge areas not required to be kept free of vegetation must be allowed to return to a natural state.

Shoulders should be sprayed to 1.5 metres from road seal edge and/or into the table drain. Culvert inlets and outlets are also to be sprayed.

Spraying is best carried out during September/October/November when growth is vigorous but plants are mature. A late autumn application may also be required.

Mowing & Slashing

Mowing and slashing is a means by which grass and other vegetation can be controlled at the road edge or verge. It is not effective when the grass has reached the end of its growing season and is more aesthetic than spraying.

Grasses 300 mm or more in height should be mown to a height appropriate to the circumstances in the following locations:

(a) A narrow strip of not less than one (1) metre adjacent to the edge of the shoulder, and where possible into the table drains;

(b) A one (1) metre wide swathe cut behind guard rails, barriers and fences;

(c) Where sight distance requirements dictate; and

(d) Within 500mm of signs, guide posts, markers and other safety and information devices.

Constructed flush medians should be fully mown. Kerb edges should be sprayed.

The area outside the established mowing limits should be allowed to return to its native state by encouraging desirable natural growth or by the protection or planting of trees, shrubs, flowers and ground-covers appropriate to the local environment.

Mowing should be restricted on areas too high or too low to be visible from the road unless necessary for the slope drainage, elimination of local fire hazards, the proper blending of the growth on the verge abutting properties in the more developed areas and where use of herbicide is undesirable.

Landscaped Areas

Landscaped areas include areas sown to grass, clover, ground-cover material and other vegetation to control erosion, protect batters and road user facilities and for the treatment of medians.

Maintenance of planted areas is different from other facets of road maintenance and should preferably be treated by persons specially trained in horticultural practices.

Vegetation Control

Vegetation within the carriageway should be controlled to lessen unreasonable obstructions to vehicles, visibility limitations to drivers, erosion and fire hazards.

Brush or scrub should be kept under control to preserve sight distances where needed.

Special areas may require attention, such as parking areas, lookouts and in the vicinity of timber bridges.

Conservation of Roadside Vegetation

The City's policy with respect to the conservation of roadside vegetation is as follows:

"Roadside and remnant vegetation are essential for the conservation of wildlife, acting as corridors for the movement of native animals across the landscape. Well conserved areas are important seed sources, assist in erosion, salinity and fire control, and contribute significantly to rural aesthetics. Even dead timber is home for some animals and an important part of the natural cycle.

No fallen or felled timber is to be collected from roadside verges or areas for domestic or commercial purposes. Only City staff carrying out City business are permitted to collect fallen or felled timber for City purposes.

The Director, Engineering and Works Services, in special circumstances, may grant an applicant permission to remove a limited amount of timber derived from road clearing operations. In such circumstances, the applicant must apply in writing and produce a written conditional approval from the Director, Engineering and Works Services upon demand by a City Officer."

Noxious Weeds and Insect Control

Weeds growing on roadsides may be noxious or undesirable, detrimental to adjoining land, create or add to bush fire fuel and can invade and sometimes destroy native vegetation.

Noxious weeds and insect control on roadsides is not currently, actively pursued by the City but trained, qualified contractors with appropriate equipment may carry out these works under the supervision of the Parks and Gardens Co-ordinator.

Tree Pruning

Pruning of roadside vegetation is often necessary to maintain adequate road safety clearances, to maintain sight distance, allow access, facilitate mowing operations, maintain drains and keep clearances to road furniture. Lopping may be required when overhanging limbs become dangerous to the road user, following storm damage, insect attack or to prolong the life of older trees.

Tree pruning and lopping will be carried out by local contractor under the supervision of the Parks and Gardens Co-ordinator.

Special Areas

Areas such as parking areas, lookouts, roadside rests, etc, may require special attention to maintain the facility in a way that enhances the road environment.

3 DRAINAGE

Drainage facilities should be maintained and preserved as nearly as practicable to the condition and capacity of the facilities as designed and constructed.

3.1 Drainage of Bituminous, Brick & Concrete Pavements

The seal should be maintained in a waterproof condition by the prompt sealing of cracks in the surface and by filling minor depressions that would hold surface water.

Water flowing along or over the road adversely affects the serviceability of the road as follows:

(a) On smooth surfaces the tyres of high speed vehicles may aquaplane resulting in loss of traction and control by the driver; and

(b) Water flow or ponding along the edge of the pavement with a softer shoulder will result in scouring, loss of edge support for the pavement and dangerous driving conditions.

3.2 Drainage of Unsealed, Paved Roads

Steep crossfalls and high longitudinal gradients on unsealed paved roads, whilst aiding the shedding of water, also produce higher velocities with consequent removal of fines and the creation of transverse scouring of the pavement and shoulder.

Ponding of water in depressions in the pavement can have serious results due to the weakening of the pavement material and its displacement under wheel loading. Not only do deepened depressions become potholes, but they also assist the entry of water into the subgrade, undermining the pavement.

To prevent serious damage from water and to maintain unsealed surfaces in reasonable condition for traffic, scours and depressions must be promptly filled and the surface kept in a smooth and self-draining condition by frequent grading.

3.3 Drainage of Unsealed, Unpaved Roads

Most unpaved roads are composed of the natural material found in the top layers of the ground over which the road passes.

Many unpaved surfaces are subject to severe damage when traversed by vehicles in wet weather. A common form of damage is the development of wheel ruts, ponding of water in wheel ruts and the formation of potholes.

Grading to restore the crossfall, raise the formation, create side drains and to fill potholes and ruts, is the major activity to maintain the pavement surface and surface drainage.

3.4 Types of Drainage

Batter Drains

Batter drains are generally lined with concrete, stone, metal or some other durable material. It is important that batter drains are inspected frequently and immediate steps taken to make good any undermining and repair any breaks in the lining.

Bridges

It is an undertaking of MRWA to check the structure of local road bridges and recommend upgrading. The City is to maintain the majority of bridges within the City by repairing minor failures in the deck or running surface, repairing barrier fences and rails, and applying insecticides against termites. MRWA contributes $^1/_3$ to the structural work on bridges.

Other routine maintenance operations include:

(a) The regular removal of silt or debris in the gutters and scuppers of bridges to ensure adequate drainage of the structure;

(b) The regular inspection and removal as required of silt and grit from expansion joints to ensure the expansion and contraction of bridge components can occur as designed; and

(c) The removal of debris collected against piers or in the channels, and the removal of vegetation that may impede the even flow of water.

Catch Drains and Banks

The purpose of catch drains and banks is to intercept surface water flowing towards the road cutting or formation embankment.

Maintenance involves regular inspection, clearing of obstructions, repairing of breached banks and the filling of scours. Spraying for vegetation control of the wetted perimeter may also be required.

Scours may be stabilised by re-grading the drain or by backfilling the scour and covering the damaged area with paving of concrete, stone pitching or bituminous material, or by revegetation using techniques such as mulching, hydromulching, hydro-seeding, sodding and direct planting. Revegetating grassed waterways with synthetic woven fabric or mesh with straw may also be used to stabilise the channel until vegetation is established.

Culverts

Failure of culverts may cause damage to the road formation if it is overtopped by flood water or damage to the culvert or formation by scour due to high velocity. Detection involves close inspection of the inside of the culvert as well as both the inlet and the outlet.

Maintenance tasks include the clearing of debris and spraying or removal of growth from the channel and inlet and outlet pits, particularly after heavy rainfall, forest or bush fires or in seasons when trees shed their leaves. In problem areas debris screens may be required. The accumulation of silt or drift sand in the culvert barrel must also be removed periodically by mechanical or hydraulic means. A silt pit at the culvert entry is a useful means of preventing silting.

Scour in the vicinity of culverts must be recognised in the early stages and repaired promptly before the damage becomes extensive.

Floodways and Fords

Maintenance of floodways and fords may be divided into three types as follows:

(a) *During dry weather* - The pavement, batters and supplementary culverts require routine maintenance. Warning signs and depth indicators need special attention;

(b) *During flooding* - Regular inspection is necessary to ensure that the floodway is safe for traffic. Debris may collect on the floodway should be removed and holes under the water filled with rock pending permanent repair when the water has receded; and

(c) *After flooding* - High priority must be given to the restoration of physical damage so that the floodway is safe for traffic and is not further damaged by subsequent flooding. Debris should be cleared from the upstream channels leading to the floodway and culvert. Markers and signs should receive special attention.

Open Drains

The aim of drain line maintenance should be at least to enable flow so that build up of water does not occur to the point that water levels affect pavements or result in erosion, flooding of scour.

Side and Diversion Drains

The purpose of side and diversions drains is to convey water from a table drain or catch drain to enable disposal by way of soakage or by spreading over the natural surface.

Periodic grading and/or herbicide application for the wetter perimeter of diversion drains and reinstatement of table drain blocks (where installed) preferably in conjunction with the table and catch drains, is the main maintenance attention required.

Sub-Soil Drains

The two main purposes of subsoil drains are to lower the level of the water table and to intercept or drain underground water trapped or held by impervious material.

To be effective subsoil drains need to sit below the structure they are to protect. The depth will vary according to terrain, soil type and structure being protected. Adequate grades need to be allowed for the flow of ground water.

Maintenance action for sub-soil drains consists primarily of inspection of outlets to ensure that water is seeping from them.

Any growth or siltation at the outlet should be cleared and if vermin-proof screens or flaps are provided these should be repaired or replaced as required.

Damp areas or water seepage at any location above a subsoil drain should be investigated for blockages.

Pipes should be probed to find suspected blockages and cleaned by flushing where this provision is included in the design of the subsoil drainage system. This should be carried out at least once annually.

Table Drains

Table drains are frequently constructed on very flat grades to suit the road grade and subsequently must have either a large cross-sectional area or be provided with frequent discharge points where the water can escape. They have a combined role of storing and soaking water and transferring water to culverts, nature flow lines or water courses.

Depending upon the nature of the material in which they are constructed and their longitudinal grade, table drains may need to be lined with stone, concrete or a bitumen seal to resist scouring. A layer of geofabric material may be required underneath the material to prevent under scouring.

Table drains require frequent maintenance, such as grading (unlined drains) to remove silt and other debris that may easily block the flow and to restore original shape.

Short term measures for the repairing of scours in table drains, such as the placing of loose rock, etc., should be avoided because it can lead to even more serious damage before final remedial measures can be effected.

4 PATH MAINTENANCE

Paths should be maintained to at least the following standards:

(a) Paths should connect to the road system at controlled intersections, quiet roads or cul-de-sacs where possible;

(b) Sharp down-grades to road junctions should be avoided where possible;

(c) Cyclists and pedestrians should be able to negotiate path entrances with ease. Pavement ramps should not have over-restrictive barriers. Paths should be clear of overhanging vegetation for a minimum of 2.7 metres vertically and 300mm horizontally;

(d) Barriers forcing cyclists to dismount should generally be used;

(e) General barriers that preclude entry by motorcycles should be used only where severe problems occur. Unnecessary bollards, barriers, kerbs, etc. will encourage cyclists to bypass the control;

(f) To slow traffic at the point where the path crosses the roadway, it may be appropriate to install the intersecting cycle path as a plateau on the roadway that provides continuity of the path; and

(g) The entry point of a path to a road should not be in a straight line with the path. The path entry to a road should deviate to approximately one (1) car length back from the stopping position, if at an intersection. A grab-rail 900mm high, placed on the left hand side of the path approach to the road, will enable the cyclist to balance while stationary at the kerb.

(h) Disabled access should always be reinstated and/or provided to Australian Standards where works are carried out.

5 REINSTATEMENTS

5.1 Road Openings

During the currency of the contract, services may be installed which procedures could involve excavation through pavement at some stage of completion. The contractor shall ensure that the pavement is re-instated to conform in all respects to this specification.

Where trenches cross the pavement or public roadway or footway the contractor shall obtain a Road Opening permit from the City or the relevant road authority covering the necessary opening and shall comply with all the conditions covering the issue of such permit. The contractor shall pay all fees in connection with the issue thereof in advance, NO permit will be issued if a conduit is available.

Where completed pavements are opened for public utility authorities during the course of a contract for the installation of services, the contractor may be entitled to reimbursement of restoration costs, paid in advance, as determined by the Director, Engineering and Works Services.

Provisional quantities have been included in the Schedule of Prices and the contractor is to nominate unit rates and extend prices for this work.

Backfilling of Trenches

After laying and jointing of pipes has been carried out and passed by the Director, Engineering and Works Services, backfilling of trenches shall proceed. Trenches shall be filled with sand or approved sandy loam at least to the level of crown of pipes, filling being evenly placed on both sides of pipes, well watered and thoroughly rammed under haunches at sides and on top and compacted uniformly. Where the pipe line crosses any carriageway or is laid in the line of kerb and gutter to be constructed under a contract the whole of the trench shall be backfilled with sand or other approved material. The remainder of the trench shall be carefully filled with approved filling free from large stones or sods, well rammed and watered. Filling shall be carried up in layers not exceeding 225mm in thickness and shall be thoroughly consolidated, the filling on both sides of pipe being carried up at same time. Filling shall be well packed around the barrel of the pipe and between pipe lines when two or more lines of pipe are laid side by side.

The filling is to be compacted to a density which will offer a resistance of not less than 7 blows per 300mm to a Standard Penetrometer or not less than adjoining subgrades.

Standard Penetrometer

The Standard Penetrometer is a flat ended 15.875mm (5/8") diameter round steel rod driven by a 9.0kg (20lb) mass falling through a height of 610mm (24") on to a circular anvil. Readings are taken for the number of blows per 300mm depth after 150mm original penetration. It is effective in sand only, i.e. subgrades. Seven blows per 300mm is the normal requirement.

5.2 Reinstatements - Works in Road Reserve

Where works by private contractors occur in a road reserve, the City requires approval to be issued for the work and that all cost be met by the contractor, for reinstatement of drainage to roads, paths and drains. The City will require payment in advance, where the reinstatement is done by the City, based on standard rates.

The contractor shall undertake to leave the site in a safe, tidy and clean condition and where excavation and trenching takes place, carry out the backfill and compaction, using the appropriate materials, to the City's specifications.

The City will normally carry out surface repairs such as to paths, drains and kerbing.

A performance/maintenance bond is also to be paid in advance of the works, where a road cut is involved. This covers the cost of possible failure and subsidence within 12 months of the reinstatement. The performance/maintenance bond is reviewed annually by the Engineering and Works Services Division.

6 REFERENCES

- Australian Standard AS1348 "Road and Traffic Engineering - Glossary of Terms" sets out the terms used in this Specification.
- Australian Standards 1742 "Manuals of Uniform Traffic Control Devices" sets out safe and efficient traffic operation practices.
- "Sealed Local Roads Manual" ARRB Transport Research, August 1995.
- "Unsealed Roads Manual" ARRB Transport Research, May 1993.
- "General Field Guide MRWA Traffic Management for Road Works" Main Roads Western Australia, July 1995.