

# DEALING WITH BARRIERS TO TREE ESTABLISHMENT ON VICROADS ROADSIDES

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## INTRODUCTION

In a crude sense, the VicRoads Roadside Management Strategy (VicRoads, undated) has four broad objectives. This may be over-simplifying, but VicRoads roadsides should be safe, 'environmentally friendly', attractive and affordable to maintain. Trees can make an important (and often critical) contribution to these objectives.

However, we don't always find tree planting easy. Trees may threaten some of the desired functions of a declared road. There may also be concerns with specific tree management issues. At the same time, poor tree establishment suggests we have not been getting it 'right' with our practices on VicRoads roadsides.

Understanding these issues and problems is critical to the task of establishing better populations of roadsides trees. Under current arrangements, achieving this goal may require considerable investment. In deciding how much we as a community spend on tree establishment, we have to understand the benefits and costs.

## A SNAPSHOT OF TREE BENEFITS FOR VICROADS

### Trees and Road Safety

Although trees can pose a risk to the occupants of vehicles that stray from the road, there is research that supports the argument that trees (safely positioned or contained) can contribute to road safety. A growing body of literature points to the positive effects of trees on the psychology of the driver.

Trees and scenes of nature are regarded as 'restorative'. Many studies have revealed a positive correlation between views of nature and restoration (Hartig et al., 1991, Lichter and Costello, 1994, Berto, 2005, Hartig et al., 2003, Tennessen and Cimprich, 1995, Parsons et al., 1998, Cackowski and Nasar, 2003, Ulrich et al., 1991, Laumann et al., 2003, Herzog et al., 1997, Kaplan, 2001). Restoration is generally described as improved attention and recovery from stress and mental fatigue. These studies rely on objective measurements of physiology (such as changes in blood pressure, heart rate, electrodermal activity and electromyographic activity) and various objective tests of cognitive performance. Two studies have specifically been undertaken in relation to roadside 'nature' and road users. One study showed participants who viewed nature-dominated drives (versus artefact dominated drives) experienced quicker recovery from stress and greater immunisation to subsequent stress (Parsons et al., 1998). Another study showed exposure to roadside nature resulted in an increased tolerance of frustration (Cackowski and Nasar, 2003). The extent of these restorative benefits is unclear, and there is no research yet linking these benefits to a reduction in accidents.

Trees may also assist in regulating driver behaviour in relation to speed (Rosenblatt et al., 2006).

### ***Trees and Environmental Benefits***

Environmental benefits are obvious, but also complex and diverse.

Biodiversity benefits are possibly the most obvious. For example, in the south east Australian context, it has been established that around 30% woodland canopy cover at landscape scale will be required to conserve the majority of woodland bird species in the future (Radford et al., 2005). Simply looking at an aerial photograph illustrates the point that roadside trees make an important contribution to this vision.

Trees can make a contribution to sequestering carbon dioxide emissions however the scale of this reduction is very small and should not be overstated. Modelling suggests the main factor in carbon dioxide sequestration is length of growing season, though the eventual stature of the tree is also important (McHale et al., 2007). Urban trees are often small (due to hostile site conditions and species selection requirements). Furthermore, many new tree plantings often replace existing senescent trees which are mulched, meaning there is only limited sequestration over time. While the extent of sequestration by a tree may be relatively small, the contribution of the cooling effect of trees can significantly reduce CO<sub>2</sub> emissions through reducing the need for energy-intensive air conditioners (Akbari, 2002). The cooling effect by urban trees is well documented by many researchers, whose work is cited here: <http://www.treelink.org/linux/factoid.php>.

Trees also make other contributions to the protection of environmental qualities by reducing pollution.

### ***Trees, Amenity and Culture***

Anecdotally it is obvious that people prefer landscapes with trees. This intuition has been expressed in the dominant use of trees in parks, gardens and boulevards throughout the urban world. Subjective studies of preference, where various roadside settings are viewed and compared, show people have a marked preference for treed roadsides (Wolf, 2005, Wolf, 2003).

To some degree, it is arguable that our understanding of amenity is evolving to a measurable and objective area of study, with characteristics that can be understood in ways other than simply being 'pleasant'. And the benefits of the 'restorative' treed landscape extend to people other than the traveller. Roadside 'nature' that includes trees has been the subject of extensive research, with numerous links established.

For example, studies are showing that environments with views to trees and grass influence the reduction of crime and violence (Kuo and Sullivan, 2001a, Kuo and Sullivan, 2001b), self-discipline and concentration (Faber Taylor et al., 2002, Faber Taylor et al., 2001, Wells, 2000), worker productivity (Kaplan et al., 1988), coping with poverty (Kuo, 2001), perceived safety (Kuo et al., 1998) and neighbourhood interaction (Sullivan et al., 2004). Several studies identifying a relationship between environments with street trees and higher real estate prices further supports the concept that trees are seen as a valuable roadside asset by society.

### ***Trees and Affordable Roadsides***

As a land manager of over 80,000 hectares and limited funding, VicRoads manages roadsides at a paddock rather than park level of maintenance. Trees in mulched beds can play a valuable role in reducing maintenance expenditure. A recent draft study and financial projection suggested trees in mulched beds are about 45% of the whole-of-life cost of mown grass (Graesser and Chapman, 2006). In an urban environment, more trees and less mown grass can mean reduced expenditure on maintenance of a roadside landscape.

## **WHAT ARE THE BARRIERS TO TREE ESTABLISHMENT?**

While trees offer many benefits in the context of VicRoads Roadside Management Strategy, there remain substantial impediments to the establishment of trees along roadsides. A few of these impediments are discussed in detail.

### **CLEAR ZONES**

Possibly the largest impediment to roadside tree establishment is the concept of the clear zone. New plantings on declared roadsides must meet clear zone guidelines, unless a barrier system is installed to protect occupants of errant vehicles colliding with trees. These barrier systems are often costly and technically difficult to install in many urban applications.

#### ***Why are clear zones important?***

There is a disturbing relationship between road user fatalities and unprotected trees close to the road. It has been stated that in Victoria in 2003 roughly one third of all fatalities involved roadside objects (Road Safety Committee, 2005). Furthermore, between 1999 and 2003 around 50% of collisions involved trees. For this reason the design of the roadside planting is a vital factor in reducing road trauma, and the concept of a clear zone becomes a key consideration for all new plantings.

Vehicles sometimes leave the carriageway at speed for a variety of unintended reasons. The perspective of road safety experts is that a roadside should be 'forgiving', and allow an opportunity for a driver to recover control of a vehicle or significantly reduce vehicle speed. Clear zones (which are areas free of features potentially hazardous to the occupants of errant vehicles) are determined on the basis of the recovery area. To provide an adequate recovery area for all errant vehicles is impractical so clear zones are instead designed to accommodate (nominally) 85% of errant vehicles.

Accident data shows the risk of collision (and thus the recovery area) for a given situation depends on a number of factors. Collisions with roadside objects often occur at curves, particularly those of low radius. Other factors include traffic volume, speed, lateral clearance of the object, visibility and the engineering characteristics of the road (such as sealed shoulders and tactile edge markers). Some of these factors are included in clear zone calculations.

#### ***What is the guideline for clear zone distance?***

In Victoria, clear zone distances are calculated using Part 3 of the Road Design Guidelines (VicRoads Design, 2004). The required offset is determined by the design speed (normally the posted speed plus 10 km/hr), traffic volume and curvature of the road along with the batter slope. Only frangible objects ('breakable' when hit by a car) should be included in this zone. Technical Bulletin 36 (Road Construction Authority, 1987) and new draft Roadside Planting Guidelines (VicRoads Design, in prep.) state that woody limbs less than 100 mm diameter may be considered frangible.

#### ***Clear zone requirements across states and into the future***

Other states have different requirements. The basic offset distances are generally similar, though graphed in different ways. There are some interesting regional variations in relation to trees. Main Roads in Queensland, for example, has adopted 80 mm as the trunk diameter at the threshold of what is frangible.

The standards for clear zones are likely to change. A revision increasing clear zones on high speed (100 km/hr +), high volume roads may be seen in Victoria in the near future. At the same time there is a likelihood that a nationally consistent clear zone guideline may be adopted as an Austroads publication. There is no indication of what will be adopted in such a scenario.

### ***Planting on urban state arterial roads – the requirement for consent***

In Victoria under the Road Management Act (2004) municipal councils are responsible for the maintenance of nearly all urban arterial roadsides. However the Act also stipulates that for all primary and secondary state arterial roads (all the green, black and red roads in the *Melways*), VicRoads is the Coordinating Road Authority (CRA) for all activities in the road reserve. The Act requires the CRA to coordinate activities to minimise any adverse impact on the safe and efficient operation of the road and on the environment. The CRA is responsible for approving proposed activities such as the installation of infrastructure and the conduct of works within the road reserve. Examples of works that require consent include tree planting and replanting that could potentially be in breach of clear zone requirements.

In summary Councils must seek consent from VicRoads for tree planting along state arterial roads. This includes new planting and replacement planting.

### ***How do I plant in an area that is a clear zone?***

Options for siting trees outside the clear zone and as far as possible from the carriageway should always be sought to minimise the risk of incident.

Planting of trees may be possible in an area that is within the clear zone if a suitable protective barrier is installed. However it must be recognised that barriers are also considered a roadside hazard and permission for a barrier may not automatically be granted. When considering barriers, the design characteristics (and constraints) of each barrier should be understood. Flexible barriers are preferable to rigid barriers, and flexible barriers require a distance for deflection. Barriers must be included for a distance before the solid object, and minimum lengths of barrier are often required. Barriers are unlikely to be suitable for locations where there are many private access points on to the road. End terminal treatments are required with all barrier types, and these often add considerably to the per linear metre cost.

## **PAVEMENT CONSIDERATIONS**

It is well recognised that differential drying of plastic clays can lead to damage to structures (Biddle, 1998). In the case of roads, localised drying of expansive clay soils (with Plastic Indices greater than 30) due to trees has been identified as causing rapid loss of shape in the pavement (Barry, 1986). This is undesirable because it leads to an uneven ride (loss of shape) and greater maintenance costs due to longitudinal cracking (Evans et al., 1996). Longitudinal cracking and pavement roughness occurs regardless of the presence of trees due to seasonal wetting and drying (Evans et al., 1996), however vegetation may exacerbate the effects. Plastic clays are found over half the State of Victoria.

Importantly, it should be noted that the mechanism for damage is caused by drying of the subgrade leading to shrinkage. With standard road construction techniques, tree roots are generally not known for 'lifting' road pavements. Indeed, tree roots are rarely able to penetrate compacted subgrade.

To reduce the risk of pavement damage caused by uneven soil drying in clay soils with a plasticity index greater than 30, trees and large shrubs should be set back from the edge of pavement (Barry, 1986).

The following table based on Barry (1986) has been a guide to the minimum planting clearances for shrubs and trees within medians and along roadsides on heavy clay soils ( $PI > 30$ ) to minimise pavement damage (loss of shape). It is desirable that trees and shrubs should be set back by a distance equal to either 1.5 times the mature height or twice the canopy width of the tree, whichever is greater. In practice there has been a low observance of these requirements over the last decade. Assuming adherence to these requirements, tree planting within these clearances may be possible if the influence of the root system is contained by a vertical moisture barrier.

**Table 1** Tree planting clearance for pavement protection in plastic clay soils ( $PI > 30$ ).

Tree Group	Residual Median Plantation Clearances			Roadside Plantation Clearances
	median width <6 m	median width 6 to 10 m	median width > 10 m	
<b>Group A</b> Shrubs and small trees $W < 3$ m $H < 3$ m	2.5 m desirable minimum (centre planting only for lesser widths)	3 m minimum 4 m desirable	4 m minimum 1.5H or 2W desirable	4 m minimum 1.5H or 2W desirable
<b>Group B</b> Small trees $3 < W < 4$ m $3 < H < 6$ m	NO PLANTING	3 m minimum 5 m desirable	4 m minimum 1.5H or 2W desirable	6 m minimum 1.5H or 2W desirable
<b>Group C</b> Medium trees $4 < W < 8$ m $6 < H < 10$ m	NO PLANTING	NO PLANTING	6 m minimum 1.5H or 2W desirable	8 m minimum 1.5H or 2W desirable
<b>Group D</b> Large trees $W > 8$ m $H > 10$ m	NO PLANTING	NO PLANTING	8 m minimum 1.5H or 2W desirable	10 m minimum 1.5H or 2W desirable

### ***Installation of Root Barrier***

Tree planting clearances may be overridden with the installation of moisture/root barrier (or with the acceptance of increasing pavement management costs).

The aim of installing root/moisture barrier is to create a zone of little or unchanging soil moisture beneath the road (so that there is no change in volume). The soil moisture (measured as suction) should then ideally be in a state of equilibrium suction with the deeper foundation soils (Evans et al., 1996).

Various sources cite the influence of tree roots on soil moisture (and swelling and shrinkage) as occurring to 3 m in depth (Harris et al., 1999, Barry, 1986, Evans et al., 1996). While it is desirable to extend the barrier to this depth, it is impractical. A depth of 2.4 m has been adopted in Texas (Evans et al., 1996) for root barrier. A local supplier suggests laying root barrier to 1200 mm, or less where the barrier can be embedded in the road base (Root Barrier, 2007). If a barrier is to be laid at a shallow depth (which is likely given there is rock in the subgrade), then there may be benefit in pursuing some of the recommendations of Root Barrier (2007).

Research suggests root barriers made of High Density Polyethylene (HDPE) with a thickness of around 1 mm is adequate, providing some protection from tearing and damage during installation (Sukkar et al., 2001). This should require no chemical treatment. Other herbicidal treatments are available, such as time-released herbicides such trifluralin (Harris et al., 1999), however they have a finite life and appear to be useful for slightly different applications. Copper sulphate appears to be predominantly used in the management of roots in sewer applications and growing plants in containers.

Sealing around services and pipes is important. Nunn (1991) describes a treatment to deal with this, using polyurethane foam treated with Casuron herbicide (active ingredient Dichlorobenzil). Others recommend following this treatment (Evans et al., 1996, Sukkar et al., 2001), although Casuron could probably be substituted with either copper sulphate or time-released trifluralin.

## **COMPACTION AND SOIL MANAGEMENT**

Assuming there are no road safety, pavement, maintenance or other impediments to tree establishment, one great barrier often remains... Compaction.

The ideal dry bulk density for clay in a garden situation is 1.0-1.3 mg/m<sup>3</sup> (Handreck and Black, 1994). A dry bulk density of 1.4 mg/m<sup>3</sup> is considered root limiting (Daddow and Warrington, 1983). A study on the Western Ring Road found soils were mostly at least 1.6 mg/m<sup>3</sup>, with some sites as high as 2.2 mg/m<sup>3</sup> (May and Smith, 2000). For reference purposes, concrete is 2.3 mg/m<sup>3</sup>!

In consequence of these soil conditions, we see trees along many urban freeways that are still less than 2 m tall after 10 years of growth. Some are less than 500 mm tall. This is an enormous problem and remediation of compacted soils is no simple matter.

The first step to dealing with compaction is to avoid it in the first place. VicRoads would benefit from management of construction machinery to minimise traffic and disturbance in areas marked for roadside planting. This is likely to be impractical in many cases, however it is an important step for future consideration.

The second step, minimising compaction, is probably achievable through application of surface treatments that spread loads of construction machinery. Suggestions have been made in relation to existing trees, such as the temporary use of strained geotextiles beneath a layer of aggregate or mulch (Grabosky, 2003). While probably effective, they are unlikely to be practical in the context of major road construction projects.

The third step, undoing the damage, is difficult and can never be fully achieved in the short term. Ripping is the most pressing priority, together with the application of mulch.

Ripping can break subsoil and shattered clay to allow moisture penetration and increase water holding capacity. Ripping also promotes the movement of air into the soil and reduces penetrative resistance to root growth through some of the soil profile. Ideally ripping occurs as the soil is approaching its plastic limit (nearly dry) to achieve maximum shattering effect. A winged or vibrating tine further increases the degree of shattering. It has been suggested by a Contractor (with some merit) that we should consider specifying ripping machinery at VicRoads, particularly as most ripping is done with a grader, a machine that has relatively high ground pressure. Increasing the depth of rip improves tree growth rates, presumably by allowing more water and air to move into the soil profile. Cross ripping further breaks up the soil.

Further breakdown of compaction can be achieved with cultivation, though the most effective means to achieve this are unclear. Further research in this area is desirable. A key problem is that with each pass of machinery, some re-compaction will occur.

Mulch is next critical component of amendment. As well as reducing weeds and conserving soil moisture, mulch assists with the supply of organic matter and nutrients over time. Anecdotally, mulch appears critical on highly modified clay soils.

Before laying mulch, at VicRoads we have some minimum requirements for the addition of topsoil. It is sometimes a challenge to see that topsoiling is achieved, and there remains a low awareness that 'more is better'. Where topsoil is scarce, creation of topsoils from subsoils seems like a desirable proposition. In a crude sense, the addition of organic matter via composts or biosolids may assist in this process. Research being carried out by Professor Dick Haynes, University of Queensland, is exploring the potential to 'manufacture' soils in this way. Composts appear to be playing a critical role in roadside vegetation establishment in low rainfall states in the southern USA.

Other commercial products, such as water holding polymers and gels, together with generic biostimulants in various forms are unlikely to do anything in clay. Certainly the research backs this position (Abbey and T, 2005). This is because most things these products offer are already present in clay soils, and in far greater quantities. The cultivation required to incorporate these products will provide many times the moisture holding capacity that is offered by them for example. Many of the products include largely useless elements, such as miniscule amounts of scoria, which offers no recognisable benefit in any soil. I believe there is a need for many of those involved in the establishment of new trees to hone their critical faculties and technical knowledge when considering the inclusion of many of these commercial products.

A number of the problems at VicRoads stem from issues associated with the mechanism of delivery (landscape is tied to road construction) and contract management and surveillance. There are many examples of projects where site preparation does not meet the specification requirements.

## **OTHER BARRIERS TO TREE ESTABLISHMENT**

There remain other impediments to tree establishment on roadsides. Electric line clearance requirements often preclude planting where a future land manager is unwilling to commit to maintaining the clearance envelope. Offsets around gas and water pipelines are sometimes sought, though formal arrangements for offset requirements are sometimes unclear. Extended clearance from built structures and fences (eg 10 m) on clays with high plasticity is occasionally a reason to avoid tree planting for some land managers.

Many of these barriers to tree establishment ultimately come down to the willingness or otherwise to provide resources to cope with the maintenance implications that come with some roadside trees.

One final notable barrier to tree establishment is the illegal clearing and pruning of young trees, particularly in the vicinity of commercial advertising signage adjacent to the right of way on urban freeways. There are many examples of this occurring on the Western Ring Road in Melbourne.

## **CONCLUSIONS**

Treed planting arrangements are possibly the cheapest landscape treatment in several roadside situations, offering the potential to create substantial savings in maintenance, particularly on freeways. There are many other benefits to roadside tree establishment that tie with VicRoads roadside management objectives and community expectations.

However in the current climate tree planting is not always seen as the preferred roadside treatment. In some cases, tree planting is only possible with road safety barrier systems, root barriers and soil amendment. In other cases barriers to tree establishment result from an unwillingness to commit to future maintenance of trees. The impediments to much roadside tree planting may be overcome with site engineering and horticultural management practices – both of which may require significant investment.

The question that needs to be explored is 'how much are we as a society willing to spend'? It is a challenge for the financial managers, the landscape designers and landscape managers to read the collective mood of their constituents regarding resourcing of tree management. Consideration must be made of all the tree benefits, many of which have only been described in a rigorous and objective manner in the last decade. My impression is that we are not as conversant with this body of literature as perhaps we ought to be.

If trees are considered highly desirable in the community, and the community is vocal on this matter, then presumably it will follow that tree establishment will rise in the list of priorities for public investment.

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