Urban trees and associated root problems: Part 2

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PLANTING AN INAPPROPRIATE TREE SPECIES in a site with restricted space generally produces two negative outcomes: escalating costs for hardscape repairs and a shortened useful life span. Hardscape damage is likely to occur when large-stature trees are planted near pavement or due to root and root buttress development. Hardscape displacement may also occur when roots are prevented from developing downward due to unfavorable soil conditions. It may be practical to replace such trees when the conflict becomes evident, particularly if they are an undesirable species or their condition warrants removal. Trees should also be removed when root pruning necessary to replace damaged pavement is likely to affect stability or cause decline. Species suitable for the site constraints should be considered for replacement. Potential root problems can often be identified in young trees and mitigated relatively easily. Early root pruning can help to direct roots away from potential conflicts with hardscape. The most difficult situations occur when attempting to mitigate root problems in mature trees.

Minimizing root problems in young trees

Potential root problems identified within a few years of planting are the easiest to mitigate. The most common problem is the development of shallow or surface roots. Factors such as clayey and compacted soils, restricted drainage, and excessive irrigation are the most likely causes.

Monitoring irrigation — Excess irrigation is one of the most common causes of shallow rooting. Tree roots are typically restricted to the surface layer when the soil below is saturated most of the time. Irrigation scheduling and rate of application should be based on the tree species, soil conditions, topography, and climate. Irrigation frequency and volume should be monitored and adjusted to prevent the accumulation of excess water in the root zones of trees, and to avoid surface runoff. Proper irrigation demands soil moisture monitoring and a sufficient 'dry-down' period. Conditions limiting water infiltration and percolation should be also mitigated whenever practical.

Prune surface roots before they cause damage — Individual surface roots of young trees threatening adjacent hardscape can be easily pruned. Root pruning can also produce a more diffuse root system with smaller diameter roots. Bear in mind that roots will only regenerate downward if soil conditions below are favorable.

Mechanical loosening of compacted soil within the root zones of young trees — Root development of trees is greatly restricted when the surrounding soil is compacted. Physical impedance of root growth, lack of oxygen, restricted drainage, poor water penetration and infiltration (movement through the soil profile), as well as limited water-holding capacity are the factors most commonly involved. Mitigation of compacted soil around most sidewalk plantings is problematic due to the lack of exposed surface area and potential for root damage. One treatment that can

Early root pruning can help to direct roots away from potential conflicts with hardscape.

This 'Nevada' cottonwood (*Populus fremontii* 'Nevada') was planted in a confined space three years earlier. The soil was not loosened deep enough, and the tree was heavily irrigated. Consequently, roots have proliferated near sprinkler heads and along the expansion crack in the pavement where oxygen is readily available. Minor pavement uplift is already evident. At this point, considering the species attributes and ultimate size, little can be done to improve the situation. The tree was therefore recommended for replacement with a more suitable species.

The sidewalk adjacent to this camphor (*Cinnamomum camphora*) was replaced with a narrower section to accommodate the large trunk flare. Camphor trees propagated from seed often develop significantly larger DGL (diameters at ground level) than those propagated from cuttings (personnol communication Stew Winchester).

be used for young trees is to prune the roots 2-3 feet from the trunk and excavate the compacted soil to a depth of 3-4 feet. For larger trees, pneumatic soil excavation tools can be used to loosen compacted soil without causing serious root injury. Compacted soils are more easily loosened if they are slightly below field capacity. Compost may be incorporated as needed, and in some cases, gypsum may also be of some benefit.

Managing root problems in mature trees

Mitigating problems associated with the roots of larger, well-established trees is problematic due to proximity of hardscape and potential for root damage. Pruning more than ⅓ of a tree's roots within a distance equal to three tree diameters is likely to affect stability or cause decline.

Successful remediation of root/pavement problem is based on identifying the underlying cause(s) and exploring solutions that minimize root damage and are reasonably long term. Decisions regarding remedial action should factor in species, age, condition, and intrinsic value. Some problems, such as excess irrigation, are relatively easy to correct, others such as compacted soil is more difficult and expensive.

Other options include:

Core-venting (vertical mulching) — This involves excavating vertical or obliquely-oriented holes in the soil using a mechanical augur, water jet or pneumatic soil excavation tool. Core-venting provides some improvement in drainage and gaseous diffusion.

Tree removal — Low value trees and those in decline or with a high risk potential are poor candidates for remedial

Originally, many of the large trees along this street were posted for removal because they had caused serious hardscape damage and drainage problems. Ultimately, the city decided to narrow the street slightly to facilitate tree retention. The old curbs were allowed to remain in place to avoid causing injury or instability. This is an expensive option but considering the value of the trees, justifiable.

action other than replacement. When city codes specify surface grades that will require significant root loss, tree removal should be considered.

Narrowing, meandering or relocating conflicting hardscape — Consideration should be given to relocating, realigning or meandering sidewalks to avoid root conflict. Careful removal of damaged hardscape near the trees is an important consideration to avoid unnecessary root damage. In some cases, streets can be narrowed or the curbing 'popped out' to minimize or avoid root damage.

Root pruning — Moderate root pruning to allow for hardscape repairs can usually be done without adversely affecting tree health and stability. Decisions on how much root cutting is possible are best made by an arborist familiar with the species, soil conditions, and environmental factors. Consideration should also be given to the distance from the tree that roots can be cut and the timing of root pruning. The impact of root pruning is less when done from about late fall to early spring. Root pruned trees should be monitored for drought stress and irrigated as necessary to prevent decline.

Prior to root pruning, roots should be exposed to allow for a full assessment. Soil removal should be done using minimally injurious methods, e.g., manually or using pneumatic or hydraulic soil excavation tools. When root pruning is unavoidable, roots should be pruned as far from the trunk as practical. When pruning roots close to the trunk is necessary, consideration should be given to wind exposure, crown size, shape, and density, as well as the soil conditions (depth, texture, and drainage). Roots should be cut relatively perpendicular to their long axis using sharp tools to minimize splintering of the wood and tearing the bark. Properly made cuts allow for better root regeneration and are less likely to decay.

Severing larger roots, particularly those within a distance equal to or less than three times trunk diameter (DBH) should be avoided. Cutting more than one-third of the buttress roots within that distance is likely to destabilize the tree.

When possible, prune to retain any sinker (vertically directed) roots. This usually involves probing to locate sinker roots prior to making pruning cuts.

Root shaving

The top sides of roots, or occasionally one side, can be 'shaved' to reduce root thickness. This provides some clearance between the shaved root and new hardscape. The objective here is to avoid having to completely sever the root. The retention of the treated roots allows for some

(Left) The saw blade indicates the location where the pruning cut will be made to eliminate the offending root and direct root growth downward.

(Right) An adze, commonly used to smooth, shave or shape wood, can be used to shave tree roots.

Root shaving may be appropriate during sidewalk repairs when other alternatives are impractical. The procedure is done to increase clearance between the root and hardscape. Unfortunately, the clearance provided by shaving gradually decreases as the resulting vigorous callus growth along the top edge of the shaved roots develops. Loosening or removing soil under treated roots to minimize upward pressure can extend the time before repairs become necessary again.

structural strength and uptake of essential resources. Root shaving is only occasionally used because of the increased potential for root decay and because the resulting callus tissue often causes additional damage.

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Rubber sidewalks — Rubber-based sidewalk materials are most useful when small diameter roots are likely to develop back into the interface below the pavement. Rubber sidewalks allow for some upward pressure and help minimize trip and fall hazards. When roots regenerate and begin to cause uplifting, the rubber sidewalk section can be pulled up and the offending roots pruned. The rubber section can then be replaced.

Mitigation for root loss — The loss of roots during hardscape repair can adversely affect tree health and stability. When tree stability is compromised by root pruning, there is little that can be done to reduce risk potential short of 'crown reduction'. Crown thinning is unlikely to appreciably reduce wind-resistance. Bear in mind that heavy crown pruning may lead to decline and additional maintenance costs.

Loss of roots reduces a tree's water and mineral uptake, limiting the tree's capacity to manufacture carbohydrates. It also increases the expenditure of stored energy reserves needed to resist decay and replace lost root surface area. Furthermore, large roots severed near the trunk may result in basal decay. Follow-up treatment to mitigate stress resulting from moderate to severe root loss should be considered. Remedial action should involve one or more of the following measures:

Vigorous root development under the rubber sidewalk due to ample water from the adjacent sloping turf area has begun to displace the rubber sections.

- **Supplemental irrigation**—Monitor soil moisture to ensure an adequate supply. Providing supplemental irrigation helps to compensate for reduced water-uptake capacity, thereby avoiding severe water-deficit injury, or attracting stress-related pests. When trees have suffered significant root loss, particularly during the late spring or early summer, close attention to soil moisture conditions for a few years is recommended. Do not wait until the tree shows signs of stress to apply supplemental irrigation.
- **Mulching —** Mulch applied to the soil surface retards the loss of water due to evaporation and creates more favorable conditions for root regeneration.
- **Fertilization —** Unless there is a confirmed soil nutrient deficiency, fertilization is unlikely to benefit root injured trees.
- **Pruning —** Pruning of foliage and branches to compensate for root loss should generally not be considered as part of a management plan for root-pruned trees. Moderate crown reduction and thinning may be useful in cases where root stability is a concern.
- **Sugar solution —** Application of a sugar solution directly after root pruning has been shown in field studies to improve root regeneration (Percival 2004). Such treatments are thought to provide a readily available source of carbohydrate that can be used for root development.

Remediation of soil compaction — Root growth in compacted soil can be increased using methods or tools that loosen compacted soil or increase soil aeration within it. Compacted soil within the root zone of affected trees can by effectively loosened with pneumatic soil excavation tools without causing appreciable root injury. Other methods such as soil-augering and water-jetting (drilling holes) can increase soil aeration and drainage somewhat by penetrating compacted soil and hardpan, but are generally less effective. In addition, they may cause root injury particularly when applied near the trunk.

Proper irrigation — Surface root development is less of a problem when irrigation water is properly applied. Excess irrigation and drainage problems should be identified and mitigated as needed to minimize surface rooting and the potential for root disease. When drainage problems cannot be sufficiently mitigated, irrigation and soil moisture must be closely monitored.

Correcting supplemental irrigation is accomplished through a water audit and soil moisture monitoring using a soil moisture sensor or soil augur.

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