Analyses of Landscape Design and Maintenance Requirements in Urban Parking Lots[1]

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Abstract

Four Seattle-area transit parking lots were used as case studies in assessing the relationship between design and construction practices and future landscape management. Soil compaction and inadequate irrigation appeared to have the greatest impact on plant survival and vigor. Other problems identified included inappropriate plant selection, out-dated and vague construction specifications, and conflicts between planting bed design and pedestrian traffic patterns. The combination of such factors decreased the effectiveness of the plantings and increased maintenance efforts in urban parking lots. Long-term maintenance problems may be avoided with plant selection/specification review and maintenance requirement/cost projections during the design stage.

Index words: landscape specifications, plant selection, soils, pedestrians, irrigation

Introduction

Parking lots are often identified as a negative component of the urban landscape (13, 23, 35). Efforts to improve them have focused on using woody landscape plants, frequently in compliance with municipal ordinances and environmental impact statements (13, 26, 31, 34). Landscape plantings are used to beautify the site, create comfortable surroundings, direct traffic, buffer noise, provide screening, and improve air quality (2, 27, 28, 31, 36). Successful plant growth and development is required to meet these design goals.

Perry (31) identified improper planting site design and care among the major causes of failure in urban tree plantings. The planting conditions in most parking lots are characterized by dry, rocky, often compacted soils, reflected heat, limited water availability, and confined rooting areas (23). In addition, parking area plantings are subject to damage from pedestrian traffic, vandalism, air pollution, and neglect (2, 23).

Gans (17) observed that when landscape design fails to meet the final user's needs, the site will be altered through actual use, commonly seen as "social paths" cut across lawns and shrub beds.

Plant selection influenced both maintenance requirements and the effectiveness of the plantings. Numerous plant lists for urban planting situations have been developed (2, 6, 8, 16, 25, 38, 39). However, cost and quantity frequently outrank plant adaptations and maintenance requirements as selection criteria (5). Maintenance issues are frequently overlooked when landscape projects are developed (33). Many landscape problems are due to installation practices and errors resulting from inconsistent and inaccurate information in the specifications (18).

Little data has been available on conditions and requirements specific to parking lots. To better understand why some parking landscapes fail, this study sought to determine the specific horticultural problems of these plantings, to analyze the problems' source, and to provide recommendations for existing and future plantings. Areas of investigation were: design and implementation, plant selection, interaction of human use and lot design, and landscape maintenance requirements.

Methods and Materials

Four to 8-year old plantings in transit park-and-ride lots in communities near Seattle, King County, Washington were studied (Fig. 1). Original landscape plans, irrigation plans, and landscape construction specifications prepared between 1976 and 1980 were used in the analyses. Landscape features were categorized as perimeter beds, parking island planters, lawn areas, berms, and retention ponds. The total landscaped area ranged from 2,788 to 11,152 sq m (30,000 to 120,000 sq ft), with parking for approximately 360 vehicles (750 for the largest lot).

Design. Existing landscape features, irrigation systems, and plant inventories were compared with the original plans and specifications. Diameter (measured 1.37 m (4.5 ft) above the ground) and caliper (measured

Fig. 1. A park and ride lot in the Seattle, Washington community of Burien, one of the four study sites.

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15.2 cm (6 in) above the ground) of selected trees in the 4-year old plantings were measured. Soil cores were used to determine if soil applications were placed as specified. The content of landscape construction specifications was compared with current recommendations.

Plant selection. Evaluations of plant taxa were based on standard plant material references (6, 8, 15, 24, 32, 39, 40) and on observations of the plants at each site. A plant data sheet was completed for each species/use combination, covering site tolerance, mature size, habit, maintenance requirements, pest problems, and special cultural requirements. Inventories were compiled, detailing the species and quantities found at each site, and listed on the plans.

Human factors. Landscape areas damaged by foot traffic were recorded on copies of the landscape plans. Pedestrian routes were recorded during the 6:00 to 8:00 a.m. peak traffic hours.

To determine the human response to the landscapes, a questionnaire consisting of 16 questions conveying landscape values and demographic factors was administered while individuals waited for the bus.

Maintenance. A maintenance inventory, litter count, and annual maintenance schedule was prepared for each site. The inventories consisted of approximate area and linear measures of maintained landscape area, the types and quantities of plants, and landscape features. Litter counts were recorded on the landscape plans by category: plastic beverage containers, glass beverage containers, cans, food wrappers, newspapers, car items, large bags or boxes, and "other." A task list was developed based on a moderate level of care for high-use public areas with restricted funds for grounds maintenance (3, 9, 10). The time per task was based on published standards (3, 4, 10, 11). The schedules included labor hours for basic maintenance, omitting tasks with variable time requirements and cost figures for maintenance and materials.

Results and Discussion

The general landscape conditions observed at these sites included plant mortality, overgrown material, mechanical damage to plants, and inadequate maintenance. The investigations of this study revealed some of the causes of these landscape conditions.

Design. Discrepancies between the actual site conditions and the original plans were the result of inaccurate plan preparation, errors and changes within the plan, plant substitutions, construction changes, post-construction site changes, and plant mortality.

Landscape problems were evident at one site where tree caliper and topsoil applications differed from the specifications. Five to 6-cm (2 to 2.5 in) caliper *Acer rubrum* L. were specified. After four years, many trees were still under 6 cm (2.5 in) in caliper. It appeared that these trees were undersized when installed and had received inadequate water and nutrients since planting. During the study period, the trunks of three of these smaller trees were broken by vandals. Apparently, the combination of small size and poor growth made these trees more vulnerable to vandalism. Similar observations have been made by a local municipal arborist (7).

Fig. 2. Soil compaction along a parking lot perimeter. The boundary where grading ended is evident along the light-colored strip adjacent to the parked cars. Eighteen *Thuja plicata* were planted in this strip four years earlier.

Adherence to soil specifications was also variable. Where there should have been a uniform condition, layers of clay were interspersed in the parking island topsoil.

Soil conditions at construction sites have been identified as a major limitation to plant establishment (1, 14, 22, 29, 30, 31). The construction procedures for these parking lots were very destructive to soil structure. Specifications required the subgrade for pavement to be compacted to 95% standard density (37). This translates to a total pore space of 5% and where grading overlapped into planting areas, it had serious consequences for plant establishment. In a perimeter bed at one site, all 18 *Thuja plicata* Donn, Western red-cedar, had died (Fig. 2). Ideally, soils for planting beds should have a pore space of 45 to 50%, with a bulk density of no greater than 1.3 to 1.4 gr/cm (81 to 87 lbs/ft) (29, 31). Correction of soil compaction and interface problems, and the replacement of the missing plants after construction is far more costly than proper soil management during the original construction.

Specifications detrimental to landscape establishment included using amended backfill in planting holes, staking with a secure cross brace for deciduous trees, and leaving the root ball intact on containerized stock (12, 18, 19, 20, 21). The content of the landscape specifications varied among the contracts. In addition, several outdated practices were used, some instructions were ill-defined, and important cultural practices such as soil preparation and watering were omitted.

Plant selection. Many of the plant species used were not well-adapted for the site conditions. *Cornus florida* L., *Acer circinatum* Pursh. and *Prunus lusitanica* L. occur naturally in the understory and were not tolerant to the full sun exposure in the parking lots. They exhibited stunted leaf size, twig dieback, and high mortality.

Other species were well-adapted to the site, but were not located appropriately. For example, *Hedera helix* L. 'Baltica,' *Photinia* x *fraseri* Dress, and either *Cornus alba* 'Sibirica' Loud. or *Cornus sericea* 'Flaviramea' Rehd. were planted together in parking island planters (Fig. 3). *Hedera helix* 'Baltica' requires at least three

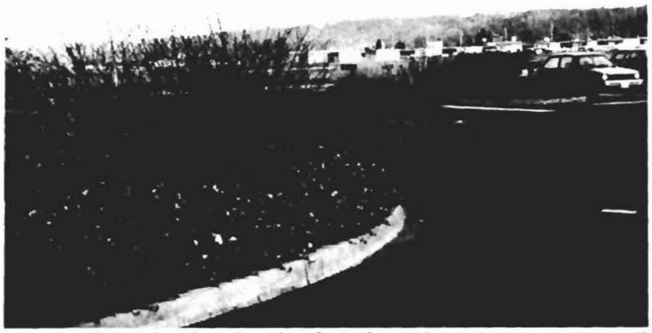

Fig. 3. Example of a densely planted parking island bed. The tall heights of *Photinia x fraseri* and *Cornus alba* 'Sibirica' contribute to visibility problems for pedestrians and vehicles. In addition, all the species used require frequent pruning to control their size.

edgings per year in the Pacific northwest, making it a high maintenance choice for island planters and narrow beds. Performance standards for these sites indicated that for safety and visibility, shrubs located within 9 m (30 ft) of an intersection were to be no taller than 0.76 m (2.5 ft) at maturity (27). *Photinia* x *fraseri* and the two *Cornus* are vigorous plants with rapid growth to over 3.2 m (10 ft) tall and required frequent pruning to maintain the low height. In addition, the *Photinia* were showing trunk dieback from frequent shearing. These shrubs would have been more appropriately used in perimeter beds where their height and spread would be more in scale with the planting space.

The plant lists among the four study sites contained 11 species and varieties of trees, 14 shrubs, and 9 groundcovers and vines, for a total of 34 taxa. Greater diversity would improve the potential for good overall plant development and reduced long-term management efforts.

Human factors. Pedestrian paths were in radial patterns focusing on the bus shelter area (Fig. 4). Parking spots were filled as a function of nearest distance to the bus stop. People who arrived early tended to follow the paved walkways. However, once a bus arrived, the pace

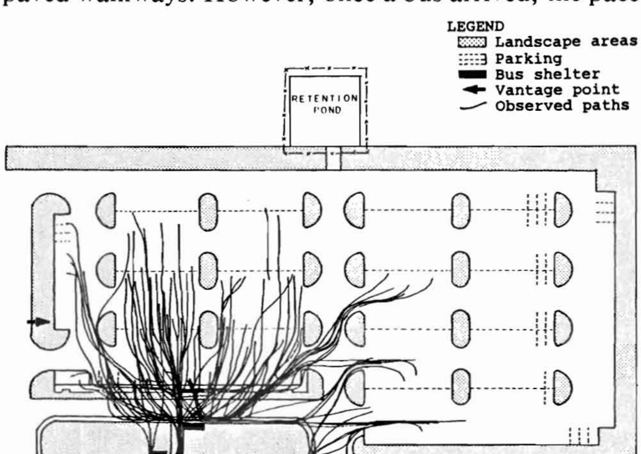

Fig. 4. Observed pedestrian paths from the parking area to the bus shelter. These paths represent the typical activity of commuters on a normal business day. The pedestrian paths observed for all the lots in this study conformed to a radial pattern as shown for this site.

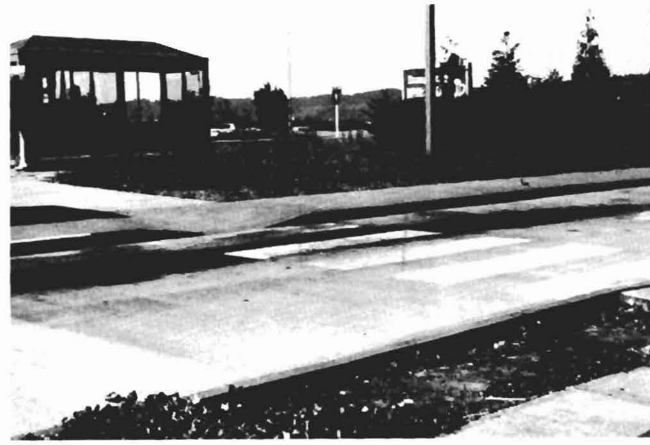

Fig. 5. Physical damage to the planting bed adjacent to the bus shelter directly corresponded to the observed traffic patterns shown in Figure 4. People using the parking lots tended to follow the provided sidewalks until a bus arrived at the stop. Then, they walked directly through any planting beds which intersected direct access to the bus.

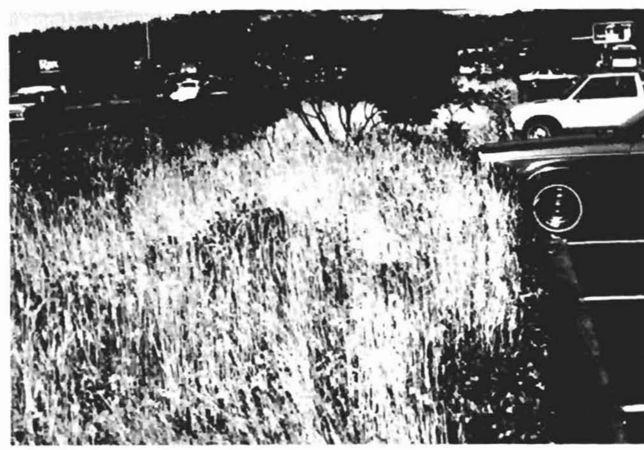

Fig. 6. Dense weed growth in a landscape bed may have contributed to the high mortality of *Rhus glabra* planted there. This problem was likely a combined result of landscape specifications which indicated that herbicides were not to be used, coupled with an inadequate maintenance program after installation.

quickened to the most direct path, often across a landscape bed. Paths and mechanical damage to planting beds near the bus shelter directly corresponded to the observed pedestrian traffic (Fig. 5). Pedestrian traffic was concentrated near the shelter areas. Designs which provided ample access and walking space around the shelters had less landscape damage and were visually more effective.

While landscaping was appreciated by most people (61% favoring maintenance, beautification, and use of landscaping), the factors of personal and property safety and access were most important (81%) (Table 1). Landscape plantings should improve the parking lot without compromising access and visibility.

Maintenance. Inadequate maintenance schedules during initial years after installation contributed to many of the plant vigor and mortality problems (Fig. 6). Litter counts indicated that litter clean up would be a required component of the maintenance schedules. Most of the litter items appeared to come from surrounding businesses and fast food chains. Other litter sources resulted from unplanned uses of the site, such as handbills placed on cars and people parking there to eat lunch.

Routine maintenance activities included maintenance inspections, lawn care, edging of groundcovers, pruning shrubs and trees, weed control, mulching, fertilization, automated irrigation, litter clean up, and vegetation management in the retention ponds. Each site had special maintenance problems requiring additional work over routine tasks.

The most serious plant health problems were due to cultural conditions, with most insect and disease damage occurring as secondary problems. Irrigation heads set on 20.3 cm (8 in) risers near curbs and sidewalks were frequently broken, disrupting water availability to the plantings and contributing to drought stress. Crowded plants which were too closely spaced needed thinning.

The landscape components that required the greatest maintenance hours were parking island planters that contained trees, several large-growing shrubs, and *Hedera helix* 'Baltica' groundcover. The most time-consuming tasks were litter clean up and weed control.

Landscape components observed in this study that required the greatest long-term maintenance included:

- the placement of shrub species with mature heights over 0.76 m (2.5 ft) in planters near intersections;
- intensively planted landscape beds surrounding bus shelters;
- large and rapid-growing plant taxa in small or narrow planting beds;
- the use of plant taxa not well-adapted to site conditions or to their design use.

No single factor was responsible for the landscape failures observed in this study. Rather, there were many small problems throughout each stage of development which had a cumulative effect (Fig. 7).

Many of the landscape problems observed could have been avoided with routine or preventive management. Other maintenance problems resulted from improper design and implementation including inadequate planting practices, the lack of soil management, and inappropriate irrigation design. Landscape beds that were less than 3.2 m (10 ft) wide were frequently damaged by foot traffic. Planting bed and walkway design for the shelter area should be integrated with actual pedestrian traffic patterns. The low-bid contract process in public projects

Fig. 7. Stages of development for a typical landscape planting. Events included or omitted at each stage influence the long-term success of the project.

LANDSCAPE GOALS
- match to site use and environmental conditions
- include projected maintenance level and budget

DESIGN AND SPECIFICATIONS
- accommodate actual use patterns
- accommodate plant growth requirements
- use current soil management and planting practices
- review for maintenance requirements

PLANT SELECTION
- species adapted to site conditions
- mature size in scale with planting bed size
- maintenance for pruning, litter control, etc.
- compatible with projected budget

INSTALLATION
- changes from original plans and specifications
- appropriate plant substitutions
- adequate soil preparation
- elimination of noxious weeds

MAINTENANCE
- aftercare and irrigation
- scheduling of routine, preventive care
- implementation of maintenance standards
- correction of landscape failures
- managed for design intent

THE MATURE PLANTING
- condition and appearance
- labor and materials required for routine maintenance

Table 1. Parking lot user survey responses.

Ranked in order of importance:

	Percent of responses		
Question	**Very important or important**	**Not sure**	**Unimportant or very unimportant**
Personal safety	92	2	6
Property safety	86	5	6
Easy access	84	3	12
Quality of landscape maintenance	69	16	14
Beautification	59	19	22
Screens to conceal unsightly views	23	18	59
Screens to conceal the lot	22	18	60

What needs the most improvement?

Item	Percent of responses
Shelter area	38
Nothing	37
Trash cans	16
Use of landscaping	6
Other	6
Sidewalks, walkways	1

Would you prefer to use a park and ride lot that is:

a. paved with landscape areas	70%
b. paved only	27%

is often seen as the cause for construction problems. Landscape specifications must be updated to include current soil management and planting practices. Standardized procedures for the industry would help insure the use of current practices and improve plant establishment, regardless of the contracting process.

Plant selection errors in terms of site conditions, mature size, annual growth rate, and special cultural requirements contributed to the intensity of plant care required.

People had a continuous impact on the landscape, especially with unanticipated site use. Vandalism is a common problem in most public areas and will likely remain part of the design and maintenance challenge.

Significance to the Nursery Industry

The information for achieving better landscapes is readily available, yet out-of-date practices continue to be employed by landscape architects and landscape contractors. Clients should demand information from planners and designers on the ultimate results and maintenance costs for the landscape plans. A review and maintenance estimate for proposed plans by a landscape maintenance professional would be instrumental in avoiding costly errors, and would allow clients to plan for adequate maintenance in their budgeting. More frequent communication between landscape designers and landscape maintenance professionals would aid in the development of more successful plantings.

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