

**Juniper Networks
CO-8**

Site Location:

1194 N. Mathilda Avenue
Sunnyvale, CA

Features:

- Multi-story buildings reduce building footprint
- Rocky swales and trees in parking lot
- Rooftop runoff drains to landscaping
- Promotes alternative transportation
- Permeable pavement
- Located buildings to protect existing heritage tree

Stormwater Benefits:

- Reduced impervious surface area
- Reduced transportation-related pollutants
- Natural treatment of runoff
- Reduced volume and velocity of runoff
- Reduced directly-connected impervious area (DCIA)



Runoff from rooftop drains into landscaping reducing the directly-connected impervious area (DCIA).



This pathway made of pervious pavers allows infiltration through the sand filled crevices. Also, these benches are provided on pervious surfaces.



Parking lot runoff drains through curb cuts and then filters through the rocky swale. Trees provide visual amenities as well as reduce the volume and velocity of runoff.

**Juniper Networks
CO-8 (cont.)**



The convenience of the Light Rail Station across the street encourages employees to take public transportation to work.



Charging stations allow employees with electric vehicles, like the Sparrow pictured here, to charge-up while at work.



Plenty of carpool parking encourages employees to share rides to work.



Covered bike racks are provided for employees who prefer to ride their bicycles to work.

Juniper Networks CO-8 (cont.)



An existing oak tree was preserved in the development of this project.

Lessons Learned:

- During storms, ponding does occur in parking lots. This can be prevented through better design and construction of the rocky swales to ensure that the infiltration rate of the swale is fast enough to prevent ponding, or by adding a perforated drainage pipe for runoff overflow. It is also important that the site is graded properly to direct water toward the swale.

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**Pruneyard Towers
CO-12**

Site Location:

1999 W. Campbell Avenue
Campbell, CA

Feature:

- Trees in structural soils

Stormwater Benefits:

- Reduced volume of runoff
- Reduced velocity of runoff



Photograph courtesy of Dave Dockter (City of Palo Alto)

Trees in structural soils frame the entrance to the Pruneridge Tower. These trees not only reduce the volume and velocity of rainwater, but the structural soil helps prevent pavement damage.



Photograph courtesy of Dave Dockter (City of Palo Alto)

A variety of top-dressing and landscape designs may be used. Colorful planting, irrigation and injection capability were built into this structural soil installation.

Pruneyard Towers CO-12 (cont.)



Photograph courtesy of Dave Dockter (City of Palo Alto)

As an experiment, London plane trees from the same nursery and grow lot were planted in structural soil in 1999 (shown above) as well as in traditional tree pits (shown to the right). After 3.5 years, the trees above are over 30 feet tall providing more canopy to absorb the impact of and to collect rainwater.



Photograph courtesy of Dave Dockter (City of Palo Alto)

These trees are not yet 20 feet tall and are developing at a much slower rate.

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**Santana Row
MU-2**

Site Location:

360 South Winchester Blvd.
San Jose, CA

Features:

- Mixed-use high-density housing and regional commercial
- Encourages pedestrian activity and public use of outdoor space
- Preserved mature trees in redevelopment areas
- Use of multi-story buildings reduces building footprints
- Street trees

Stormwater Benefits:

- Transportation-related pollutant reduction
- Reduce impervious surface area
- Reduce volume and velocity of runoff



Photograph courtesy of Jenny Nusbaum (City of San Jose)



Photograph courtesy of Jenny Nusbaum (City of San Jose)

Mixed-use, high-density multi-story housing combined with commercial areas, provide access to conveniences without the need to drive. Street trees have many benefits, including stormwater management.

Shops conveniently located below housing units promote pedestrian activity.

**Santana Row
MU-2 (cont.)**



Photograph courtesy of Jenny Nusbaum (City of San Jose)

Trees in place before redevelopment were maintained for the new residents to enjoy. Trees reduce the volume and velocity of rainwater.

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Palo Alto Trees and Structural Soils PA-3

Site Location:

Various Locations
Palo Alto, CA

Features:

- Structural soils
- Street trees

Stormwater Benefits:

- Reduced volume and velocity of runoff

Costs:

- Majority of cost is to remove existing soil
- Approximately \$30/cubic yard
- Cost savings for reduction in pavement maintenance
- Estimated savings of \$7/tree yearly for stormwater runoff reduction

Structural Soil Components:

- 70-75% crushed granite stone
- 25-29% clay loam soil
- 0.03% hydrogel
- Other soil amendments



Photograph courtesy of Dave Dockter (City of Palo Alto)

Bryant Street: Roots growing in a planter strip eventually cause repetitive damage to hard surfaces such as the sidewalk near this tree related. Sidewalk repairs can cost a city hundreds of thousands of dollars per year.



Photograph courtesy of Dave Dockter (City of Palo Alto)

University Avenue: The use of structural soil allows the planting of large shade trees in narrow medians where the tree planting area would otherwise conflict with infrastructure. The large tree canopies reduce the amount of rainwater reaching the street. The trees absorb much of the force of the rainfall, allowing for reduced velocity of runoff entering the storm drain system. Reduced velocities can result in less stream erosion or scouring at the outfalls.



Photograph courtesy of Dave Dockter (City of Palo Alto)

999 Alma Street: A green-building technique using engineered structural soil under pavers encourages rapid growth of trees and roots with a minimum of damage to the parking lot.



Photograph courtesy of Dave Dockter (City of Palo Alto)

Hillview Avenue: A vegetated swale at the Tibco campus is surrounded by parking spaces with a new lattice base material, providing the young London plane and Chinese pistache trees a larger root growing volume.



Photograph courtesy of Dave Dockter (City of Palo Alto)

390 Lytton Avenue: On the surface, this appears as a typical planting pit. Below surface, over 1,200 cubic feet of Structural Urban Tree Soil Mix (per tree) will help large shade trees grow for at least 40 years. The structural soil allows the roots to grow down, protecting nearby pavement, and also infiltrates stormwater. The engineered soil provides enough strength for load-bearing surfaces such as the roadway and sidewalk pictures above.



Photograph courtesy of Dave Dockter (City of Palo Alto)

Stanford University: This 20-foot-wide pedestrian connector is lined with trees that should produce a long-term shade-covered canopy. The entire area is installed with structural soil to a 24" depth.

Palo Alto Trees and Structural Soils PA-3 (cont.)

Lessons Learned:

- Trees with extensive root systems have damaged streets and sidewalks, costing cities a lot of money to repair. By installing structural soils, this can be prevented, because root systems can be directed to grow down and away from the pavement.
- Tree growth is limited by the amount of space the roots have to grow. Structured soils can be installed under the paved areas, creating a larger area for the roots to grow. This allows trees to grow to medium or large shade trees, improving aesthetics, as well as decreasing the amount and velocity of rainwater runoff.
- In the Alma Street example, although the parking lot trees are growing without problems related to the lot's infrastructure, there have been many replacements of tree guards due to automobile accidents. In the future, trees may be designed outside of the main parking areas, where the tree will may be better protected.
- Large trees, and evergreen trees provide better stormwater benefit than deciduous trees because most precipitation in the Santa Clara Valley occurs in the winter.
- Based on studies in Modesto, CA and coastal Southern California, the City of Palo Alto estimates it is receiving a stormwater benefit from reduced runoff of \$7/tree annually for each of its 30,000 street trees, or \$210,000 per year.

References:

- Dockter, Dave, "Structured Soils for Improved Landscaping: Examples from the City of Palo Alto," SCVURPPP: Overcoming Hurdles to Using Better Site Designs Workshop. January 29, 2004.
- Lii, Jane, "Palo Alto trades old ground for tony topsoil," San Jose Mercury News, July 24, 1999.

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