Pervious Concrete

Cost Effective Infiltration BMP

2,000+ gallons of water flow onto the Vacaville Police Department parking area

SIDEWALKS AND PATHWAYS

Seattle, WA

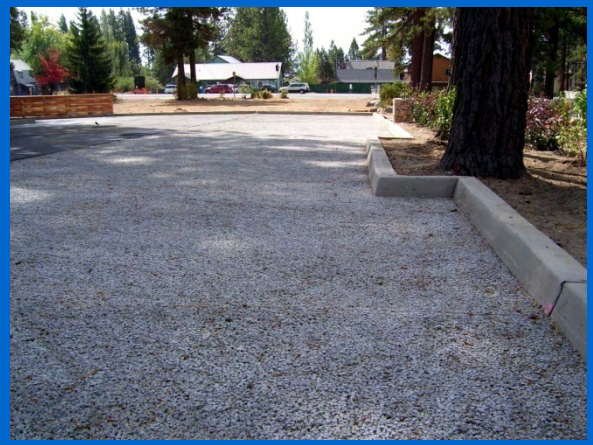
Sacramento, CA

Olympia, WA

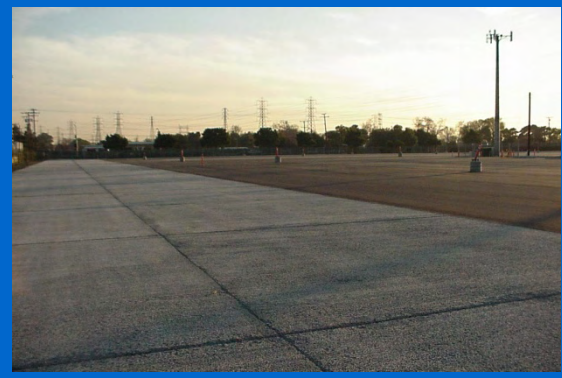
San Francisco, CA

Fair Oaks, CA

PARKING LOTS



Kings Beach Placer County, CA



Cerritos, CA

Menlo Park, CA

Petaluma, CA

STREETS

Portland, OR

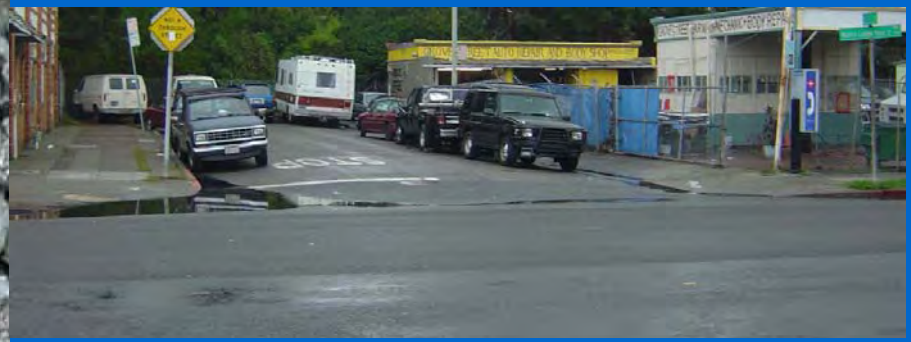
Sacramento, CA

Oakland, CA

Sultan, WA

PREVENTING PONDING

Problem



Solution

Elk Grove Bus Yard

Solution

Santa Rosa

LOAD & SHEAR

Quality Block

West Sacramento Fire Station #41

Gate 9 Infineon Raceway

Federally Funded ADA Access Project – Phoenix Park Vernal Pools Access

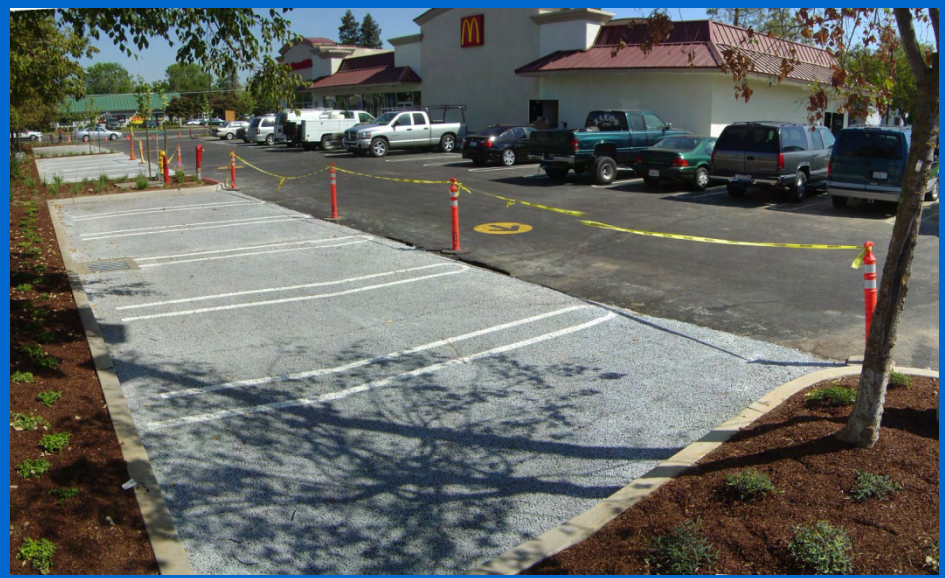
ADA COMPLIANCE

UC Davis Extension Project

McPervious Concrete!

McDonalds

Elk Grove, CA



Starbucks Retail Center

Sacramento

Grande Half-Caff Non-Fat Pervious

Approximately 500,000 square feet of pervious concrete was placed in California in 2007. In 2008 it will be in the millions!

NRMCA Certification Class CSU Chico August, 2006

Pervious Concrete is Not New!

In use as pavement in the US for over 30 years!

- **Initial US applications were in Florida**
- **FL/GA/WA/OR initial applications were for flood control**
- **1987 Clean Water Act and NPDES brought pervious concrete into use for control of urban runoff**
- **Several large applications in California that are 6 - 7 years old and performing well**
- **Large number of parking areas in Florida which are 25 - 30 years old**

Pervious Concrete is Strong!

Essentially the same strength as conventional concrete -

- **Linden High 7 day compressive strengths of 3003 psi; 56 day strengths over 4000 psi. Newer mixes have increased infiltration rates and retain 2,500-3,000 psi**
- **Usually utilize 500 psi flex as design strength**
- **Design for the reduced strength of the saturated subgrade**
- **Base depends on soil type, but is usually drain rock for stormwater storage, not structural capacity**

	Pathways & Sidewalks	0-20 ADTT	20-100 ADTT	100+ ADTT
Sandy	4” on native	6” on native	8” on native	10” on native
Silty w/ low clay	4” on 3-6” drain rock with filter fabric	6” on 3-6” drain rock with filter fabric	8” on 3-6” drain rock with filter fabric	10” on 3-6” drain rock with filter fabric
Moderate clay	4” on 6-12” drain rock with filter fabric	6” on 6-12” drain rock with filter fabric	8” on 6-12” drain rock with filter fabric	10” on 6-12” drain rock with filter fabric
Heavy clay	4” on 12” drain rock with filter fabric	6” on 12” drain rock with filter fabric and (optional) Darcy Columns	8” on 12” drain rock with filter fabric and (optional) Darcy Columns	10” on 12” drain rock with filter fabric and (optional) Darcy Columns

Reinforcement?

- **Rebar, even epoxy coated, rusts away over time**
- **Low slump material forms poorly around fiberglass rebar**
- **Don’t need reinforcement even with conventional concrete for most pavement applications anyway – prepare the subgrade properly and joint it properly to take care of crack and curl control**
- **Remember that an extra inch of concrete can do much more for you than rebar anyway**

What is it?

- **Cement**
- **Coarse aggregate**
- **Water**

A Discontinuous Mix

- **12-25% Voids**
- **3 to 15 gallons per minute per sq. ft.**

  = 6,000 to 30,000 inches per day!!!

Clogging is NOT an issue…..

- At 99.9% clogging infiltration rate is still 7 to 30 inches of rain per day
- 30 years experience in Florida shows clogging not to be an issue unless the pervious area is too small or it is impinged on by landscape dirt, etc.
- Maintenance, while rarely necessary, consists of vacuum sweeping and pressure washing.
- A simple test with a sprinkler can, a gallon of water, a stopwatch and a tape measure determines if maintenance is needed.

A Simple Test To Determine If Cleaning Is Needed:

A sprinkler can, a gallon of water, a tape measure and a stopwatch are used to ascertain whether the infiltration rate of the pervious concrete falls into an acceptable range

Cleaning

Vacuum dry sweeping is usually sufficient to restore 50% or more of initial flow rate. Pressure washing can restore 90% or more of initial flow rate and has been documented at a rate of 175 square feet per man-hour.

First Flush Pollution Mitigation

Much like a grassy swale or retention pond, pervious concrete paving mitigates first flush pollution and manages stormwater via infiltration.

The large surface area captures and degrades much of the hydrocarbon residue – the remainder is degraded by soil bacteria.

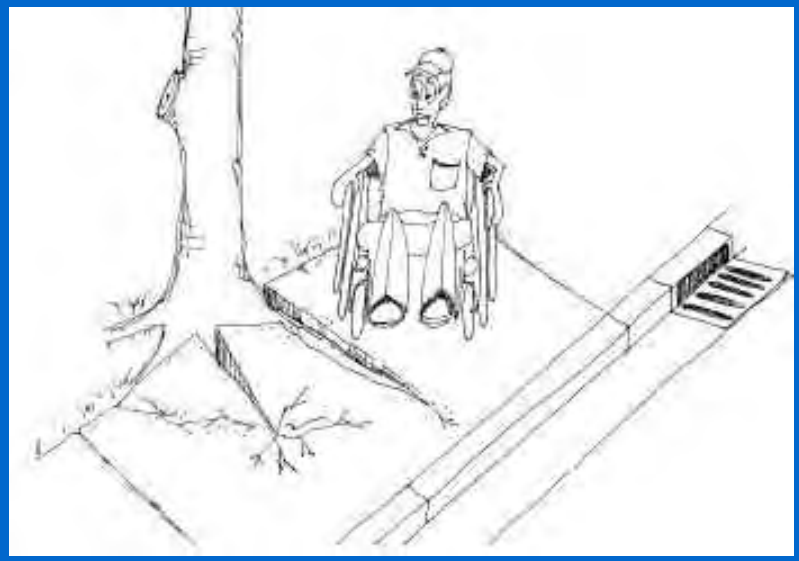
Large catastrophic spills are contained in a small area – relatively easy and inexpensive to mitigate.

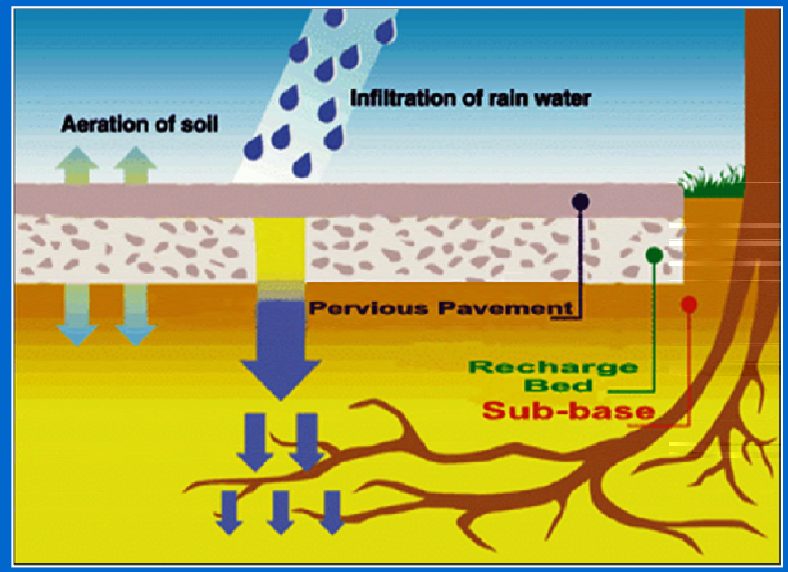
Pervious Concrete

- Saves Money for Owners:
  - Reduce or eliminate storm sewer tie-ins
  - Reduced impact fees
  - No extra SWPP devices
  - Reduced grading reduces engineering time and construction time and expense
  - The owner can use ALL of the land – no retention ponds
  - Lighting savings of $1.00 per sq ft up front and $0.05 - $0.10 annually
  - Zero to no maintenance and longevity of concrete provides lowest possible life-cycle costs

Pervious Concrete

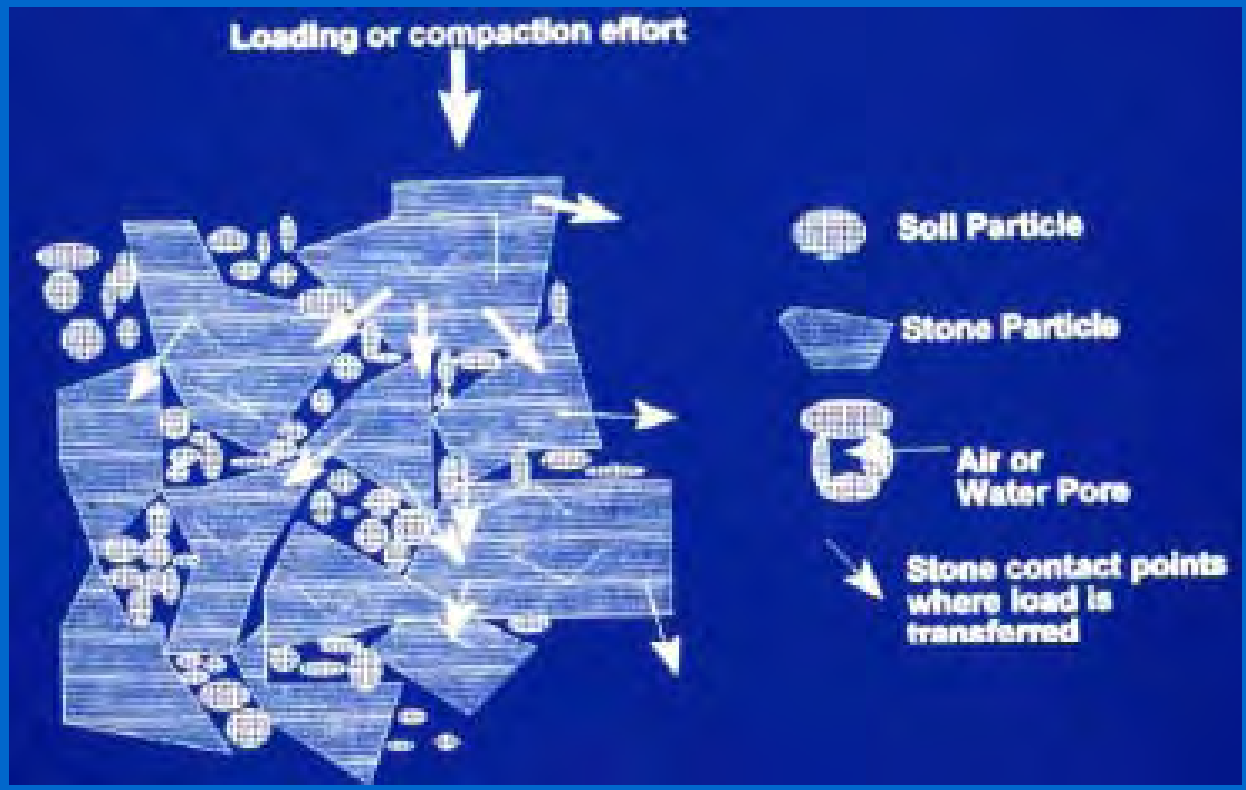
- **Saves Money for Agencies:**
  - **Eliminate upgrading of overburdened storm sewer systems**
  - **Reduce stormwater runoff monitoring requirements**
  - **Recharge groundwater to extend the lifetime of aquifer water sources**





Pervious concrete saves trees by providing both AIR and WATER to the tree roots. This allows the trees to thrive and reduces tree-root lifting of the pavement.

Structural Soils



The structural soil material is designed as follows. The three components of the structural soil are mixed in the following proportions by weight, crushed stone: 100; clay loam: 20; hydrogel: 0.03. Total moisture at mixing should be 10% (AASHTO T-99 optimum moisture).

Crushed stone (granite or limestone) should be narrowly graded from 3/4 -1 1/2 inch, highly angular with no fines. The clay loam should conform to the USDA soil classification system (gravel <5%, sand 25-30%, silt 20-40%, clay 25-40%). Organic matter should range between 2% and 5%

Miller Park Pervious Concrete Parking Lot 2002

Miller Park is at 8480 Sunset Avenue in Fair Oaks, CA

Pervious concrete in Miller Park saved 23 mature olive trees. This parking area is designed to retain aesthetics while providing function and ADA compliance.

Freeze Thaw Environments!

Pervious concrete has been used in freeze thaw environments in the US for over 15 years

- Air entrain the cement paste
- Ideally use larger aggregate (1/2” x3/8” minimum)
- Place on 6-12 inches of drain rock (3/4” or larger clean crushed rock)
- Vibratory plate compactor placement critical to obtain snow-plow durability
- Nearly 100 installations in the Lake Tahoe basin
- Safeway parking area in Denver
- Approved by TRPA (Tahoe Regional Planning Agency) as an infiltration BMP

What A Difference!

The Next Morning After a Twelve Inch Snowstorm

Pervious concrete in Denver at the Safeway Shopping Center

The conventional asphalt parking lot across the street

Which store would <u>you</u> like to shop at that day?

Greenbook

Standard Specifications for Public Works Construction

Approved for Publication in the 2008 Supplement

SECTION 303 – CONCRETE AND MASONRY CONSTRUCTION

303-8 Pervious Concrete.

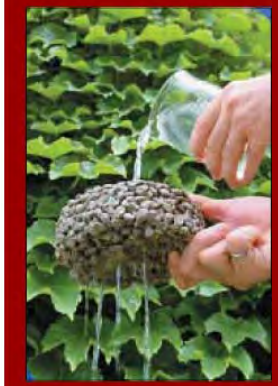
Approved Changes

Changes Approved for 2008 Supplement

- Change 176ZNS - Update Specifications for Concrete, Mortar, and Related Materials
- Change 118NU - Update Specifications for Corrugated High Density Polyethylene Pipe
- Change 124NU - Update Specifications for Manhole and Structure Rehabilitation
- Change 144NU - Differentiation between Epoxy Resin and Epoxy Vinyl-Ester-Resin
- Change 149NU - Update Installation Requirements for HDP Pipe
- Change 150NU - Update HDP Pipe Bedding and Backfill
- Change 152S - Extra Work Payment
- Change 167NU - Reinstatement of lost wording for the "Pickle Jar" Test
- Change 186NS - Reinstatement of Cement content for Alternate Class Table Shotcrete Mix

http://www.greenbookspecs.org/approved.asp

Construction



"Your Concrete Resource"
www.cpcnc.org

NRMCA's Pervious Concrete Contractor & Technician Certification Course

Tuesday, June 13th, 2006 9am-3pm

Concrete Promotion Council of Northern California

This **5 hour technical course**, provided by the National Ready Mixed Concrete Association, will include three segments: **the instructional and written exam portions will be conducted at the Sonoma County Sheriff's Department: 2796 Ventura Ave, Santa Rosa, CA 95403, with the installation segment to follow at a nearby location.** This course will provide each attendee a comprehensive and working knowledge of Pervious Concrete Pavements for installation, design and/or supervision of placements. The program is tailored to suit the needs of civil engineers, city supervisors, contractors and ready mix producers. Cost: $200 each (includes written materials, lunch and installation).

Instructor & Examiner:
Andy Youngs, CNCPC

For more information contact Rob Wallace:
Phone: 888-633-0393
Fax: 831-302-7330
Email: rob@cpcnc.org

4021 Woodcreek Oaks Blvd #156-205
Roseville, CA 95747

This certification was requested by Sonoma County and the regional water quality control agency in that area, and will train agency engineers and inspectors as well as contractors

Pervious concrete is supplied in conventional ready-mix trucks …

or volumetric mobile mixers

Improved Mix Designs

- **Cement:** Still 6.5 – 7 sack
- **Coarse Aggregate:** 900 lbs. 3/8" pea gravel + 1400-1500 lbs. ½" X 3/8" crushed ; or straight ½" X 3/8" crushed
- **Water/Cement Ratio:** 0.27
- **Admixtures:**
  - minimum 10 oz/cwt hydration stabilizer (delvo, recover, eucon ds)
  - latex adhesion modifiers such as daraweld or Euclid SBR latex
  - VMA's used by some to improve discharge rates and widen processing window

Pervious concrete is a very low slump mix

It can’t be pumped, but a belt conveyor can improve productivity

Pervious Concrete Placement:

Use of a weighted Bunyan screed strikes off the surface and compacts it at the same time – the surface is covered with plastic and cross-rolled. Joints are rolled into the mix and then it is covered again with plastic.

Optional Techniques:

Use of a vibratory plate compactor after hand screeding has become common in California. It requires some extra care, but can produce a very durable, non-raveling surface, especially with larger aggregate. Contractors often first place plywood sprayed with release before platewhacking to obtain a less wavy surface.

Raveling

- If the top layer of cement paste dries out instead of cures, the top layer of gravel will come loose under traffic. This is referred to as raveling.

- Relative humidity of the air and wind are the two biggest environmental factor when it comes to preventing raveling

- The most important thing the contractor can do to provide ravel-free installations is to provide sufficient crew size and be sure that the pervious concrete is screeded, compacted and covered in a minimum amount of time.

This backpack blower with sprayer attachment can be used to fog the pervious concrete during placement and reduce potential for surface raveling.

(if you don’t mind being mistaken for a Ghostbuster!)

Embracing the Environment….

Mace Ranch Park in Davis, CA

Economics

- Look at the site holistically. Calculate savings from:
  - Reduction or elimination of underground piping and drain inlets
  - Reduced number of light poles (often about $1.00 per square foot of pavement)
  - Quicker construction schedules
  - Reduced grading costs
  - Savings in storm sewer utility fees
  - Value of total land use
  - Value of quicker plan approval
  - Value of paving under tree driplines
  - Elimination of other SWPP devices
  - Life cycle cost advantages of long life and reduced maintenance

THANK YOU!
Questions?

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CNCA
California Nevada Cement Association

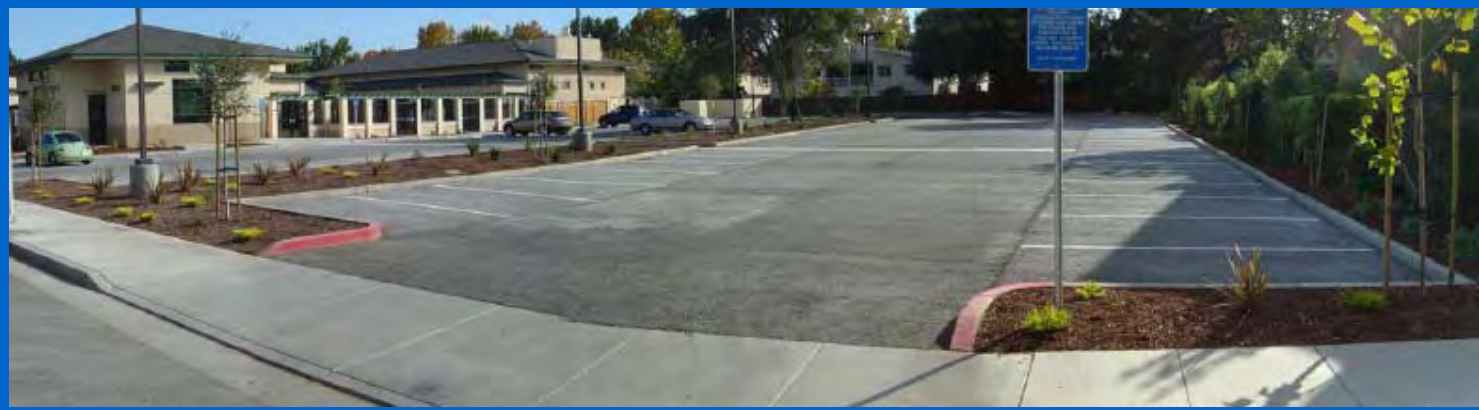
Pacific Southwest
Concrete
Alliance

Marine Mammal Center

Marin Headlands

Aqua Pool & Spa

Manteca



Eitz Chalm Academy

San Jose

City Parking Plaza

Menlo Park

Heritage Bomanite in Fresno – stamped pervious concrete mixed with stamped decorative conventional concrete.

Mace Ranch Park

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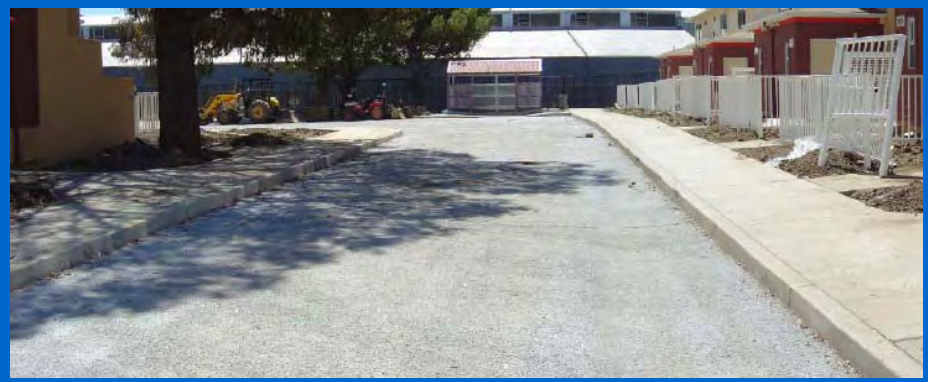

Lockwood Gardens

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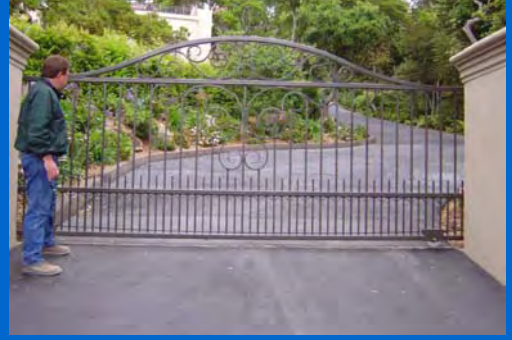
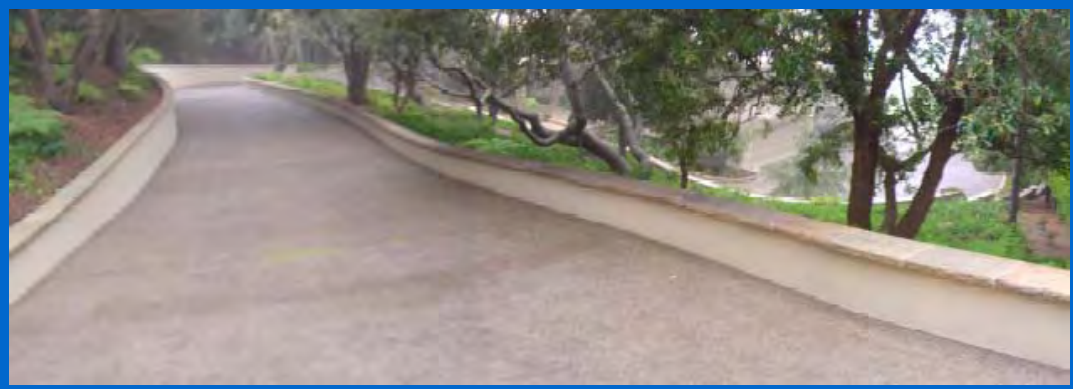




Monterey Peninsula

Estate Drives & Parking

Berkeley

Franklin Adult School

Sacramento

Sun Tree Commons

Sultan, WA

CMI Homes

Extra lots and savings in stormwater management provided an extra $250,000 profit to CMI

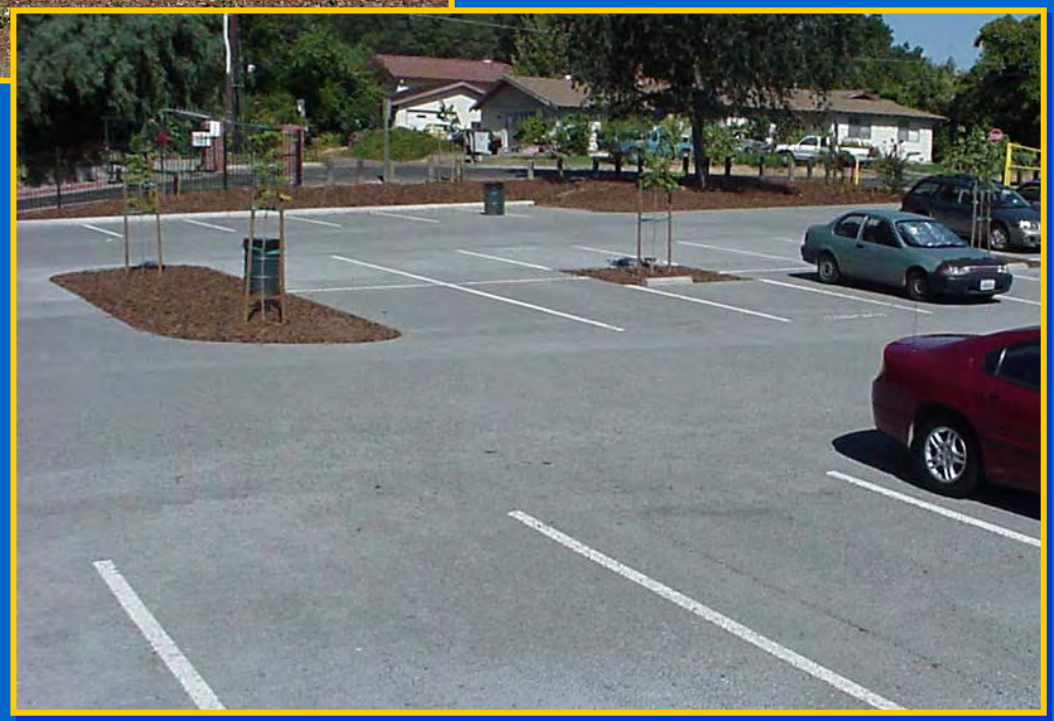
Oakland

Boathouse Lofts

Linden

Linden High

2 Acres Pervious Concrete Parking



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Fair Oaks, CA

January, 2001

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Sacramento

Hackberry Lane
Development

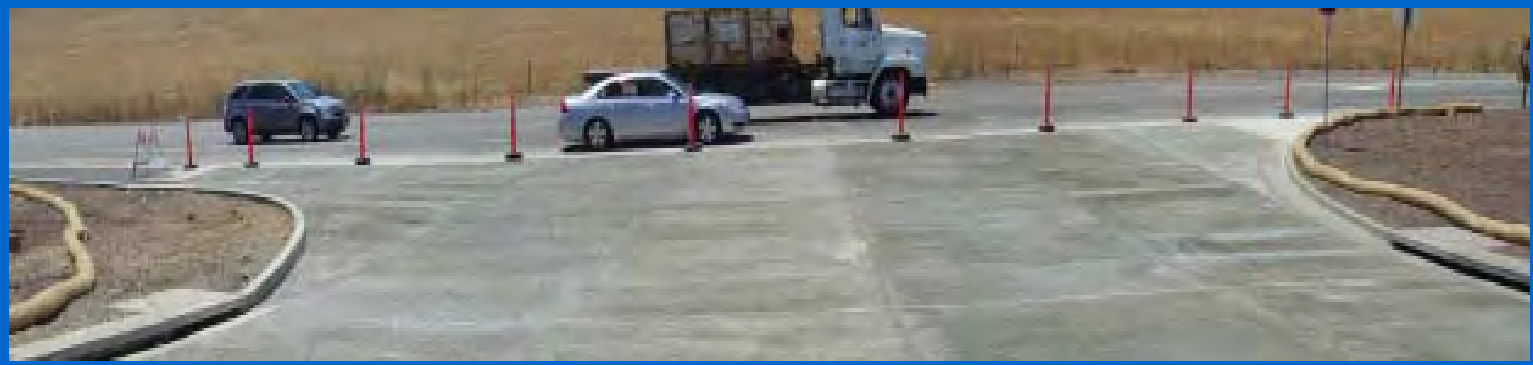
Vallejo

Medical Facility Parking

Elk Grove

A1 U-Store

3.5 Acres Pavement



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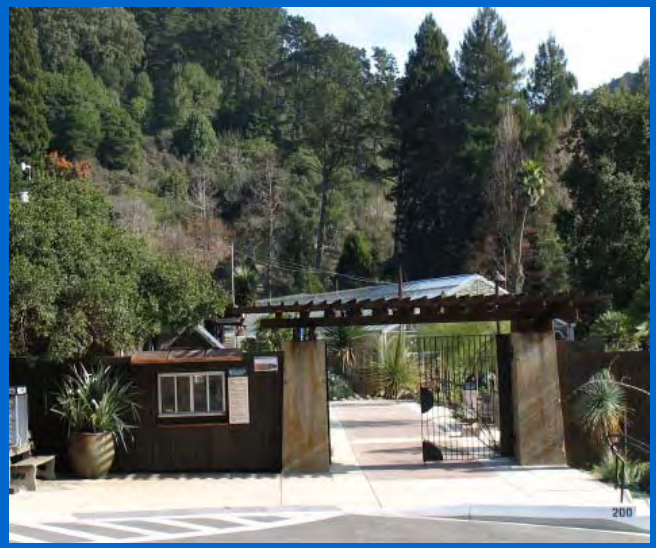

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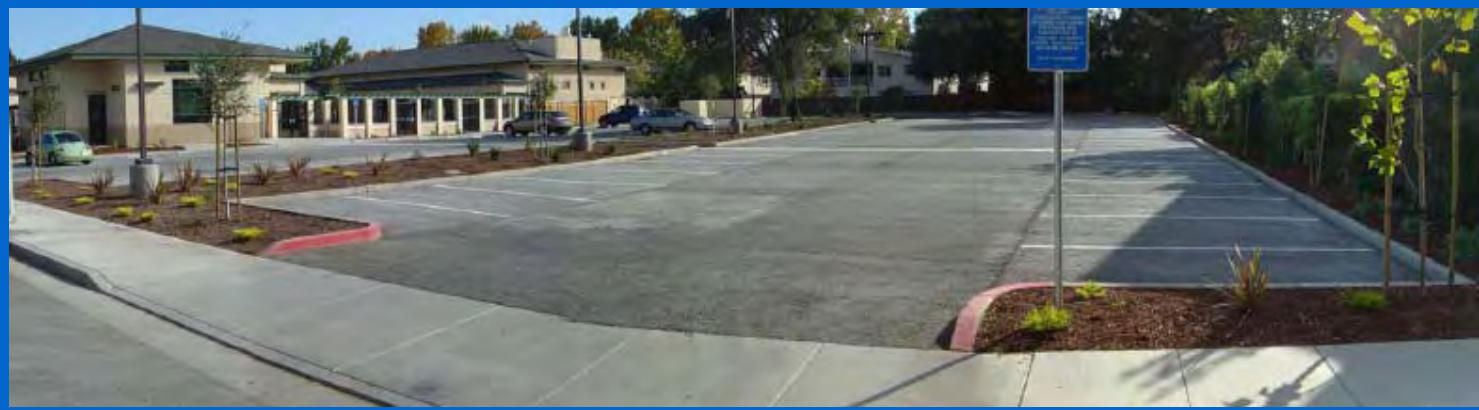

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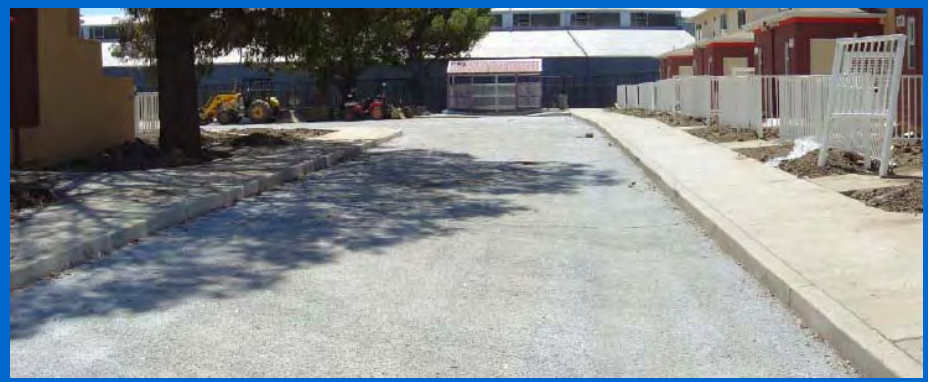

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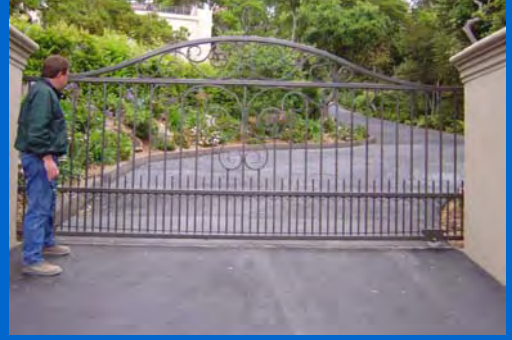

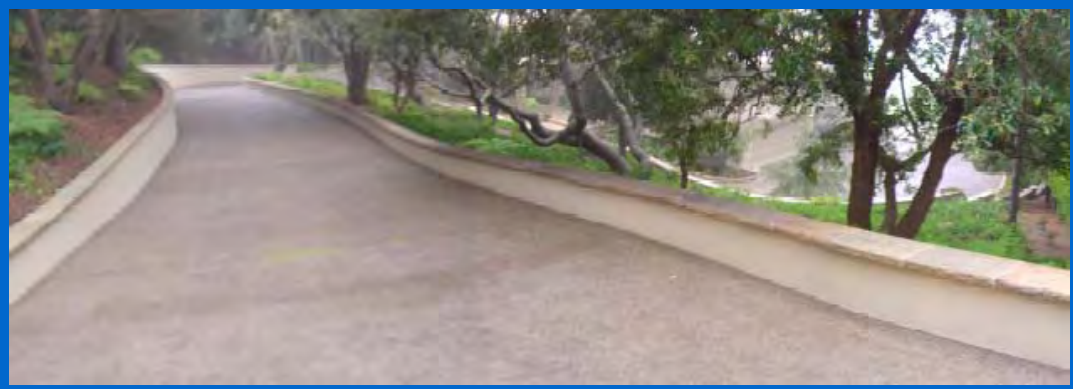

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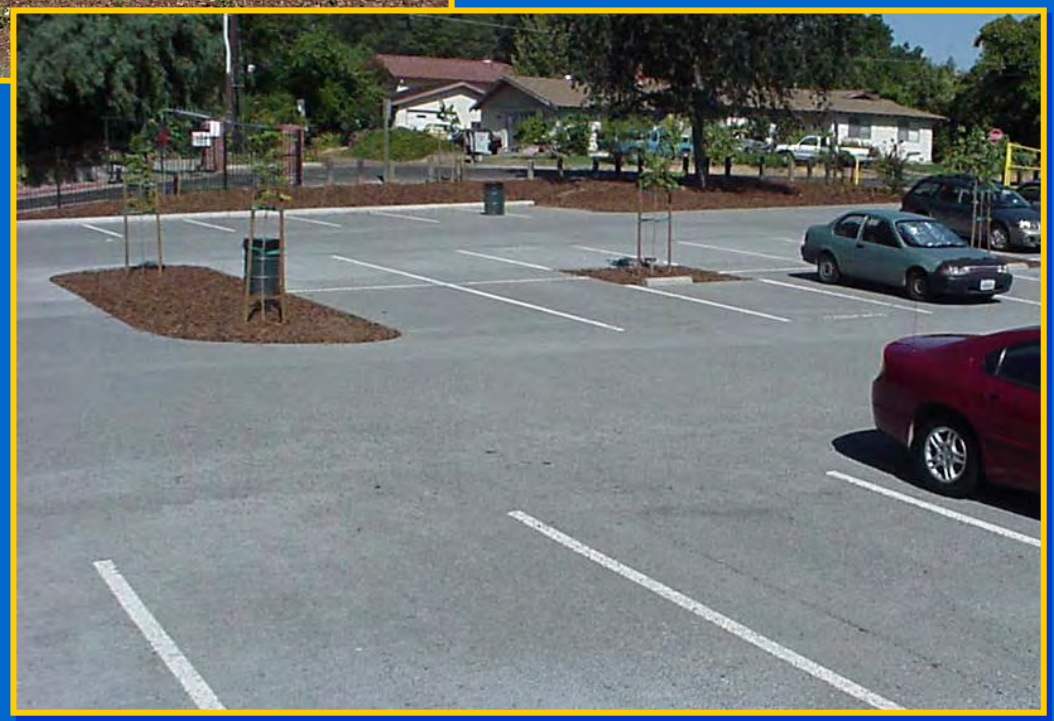

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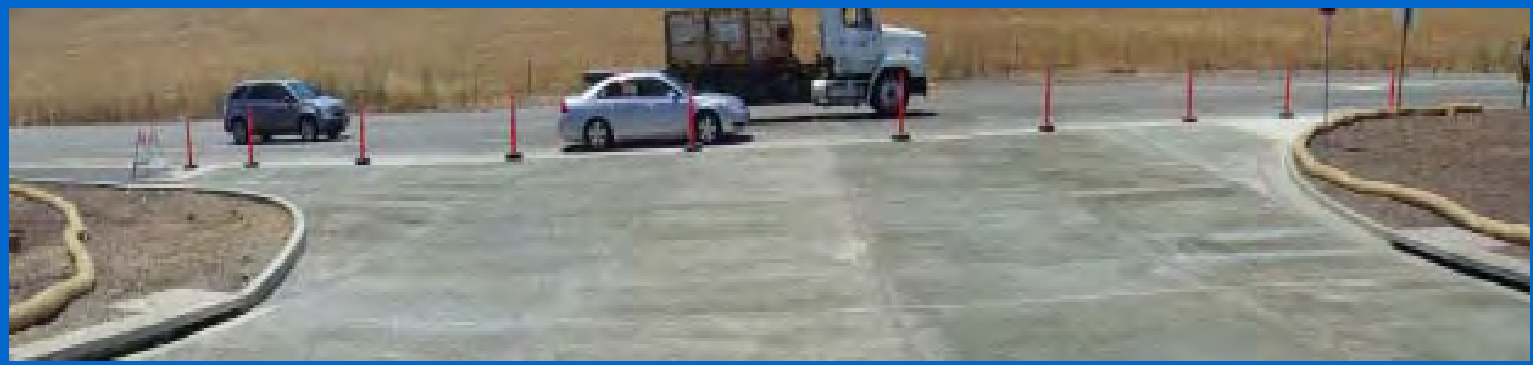

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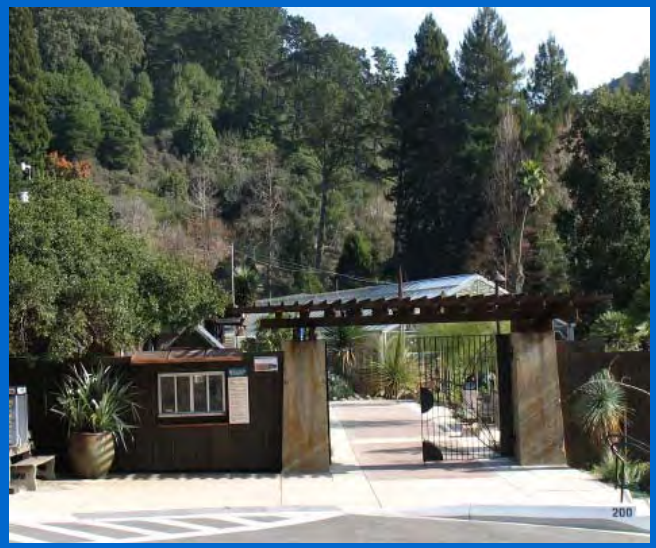

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