Speakers

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Presentation Outline
Green infrastructure goals for permeable pavements
Permeable pavements overview
Exemplar green street projects
Critical design, construction & maintenance factors
Industry resources
ASCE Manual of Practice on Permeable Pavements
Q & A
Next speaker


EPA definition of green infrastructure
…maintains healthy waters, provides multiple environmental benefits and supports sustainable communities.
Unlike single-purpose gray stormwater infrastructure which uses pipes to dispose of rainwater, green infrastructure uses vegetation and soil to manage rainwater where it falls.
By weaving natural processes into the built environment, green infrastructure provides not only stormwater management, but also flood mitigation, air quality management, and much more.

Green Infrastructure Goals for Permeable Pavements

Stormwater Management Comply w/ NPDES MS4 permits, reduce runoff & pollutants, save money with reduced damage to lakes, rivers and beaches; reduce drainage upsizing costs. reduce combined sewer overflows (CSO) in 770+ older urban areas

Efficient water use Recharge aquifers for water supplies, reduce in/out of state imports, store/use urban irrigation water; support shade tree watering & longevity

Transportation/safety Traffic calming, support way finding, mark on/off-street parking areas, increase neighborhood identity, support urban design contexts and complete streets

Energy Efficiency Use with horizontal ground source heat pumps for building cooling/heating; reduce lighting use to with reflective surfaces on sidewalks/parking lots/roadways to enhance high-efficiency lighting

Green Infrastructure Goals for Permeable Pavements

Recycling/reuse Reinstate same pavers; specify paving materials with a minimum 10% recycled content e.g., flyash, silica fume, glass, etc. LEED v4: Attain material from sources within 100 mile radius of project site; compare product LCAs

Urban Heat Island Reduce ambient summer temperatures on streets and sidewalks through reflective pavers on roadways, light colored units on sidewalks and use of trees for shading

Education Municipal PICP projects & infiltration demos, project signs to highlight sustainable design; maintenance education for owners/clients


Pervious concrete (PC)
Concrete with reduced fines


Porous Asphalt (PA)
Reduced fines over an open-graded aggregate base
Sister to asphalt-treated permeable base & open-graded friction course

Typical Applications: walkways, parking lots, green alleys, low-speed/low-volume roads, road shoulders

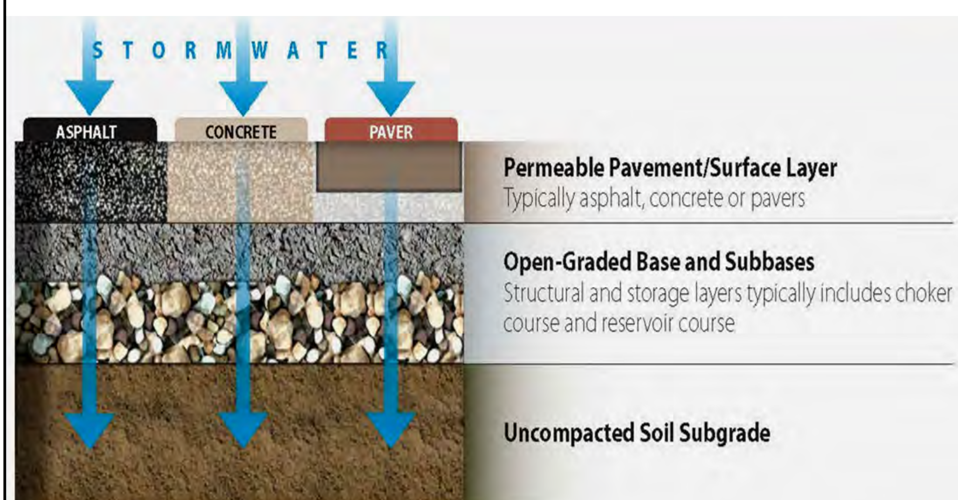
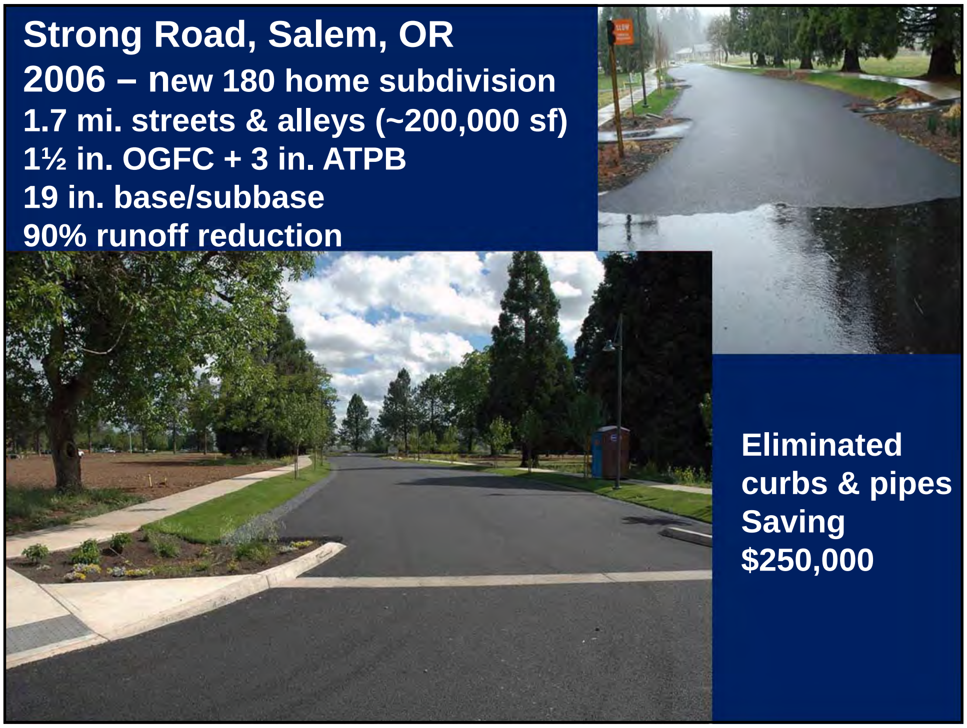


Figure 1-1
Generic permeable pavement cross-section
Source: VHB/Vanasse Hangen Brustlin, Inc 2013

Video: Permeable Pavement & the Louisville, KY Fire Department

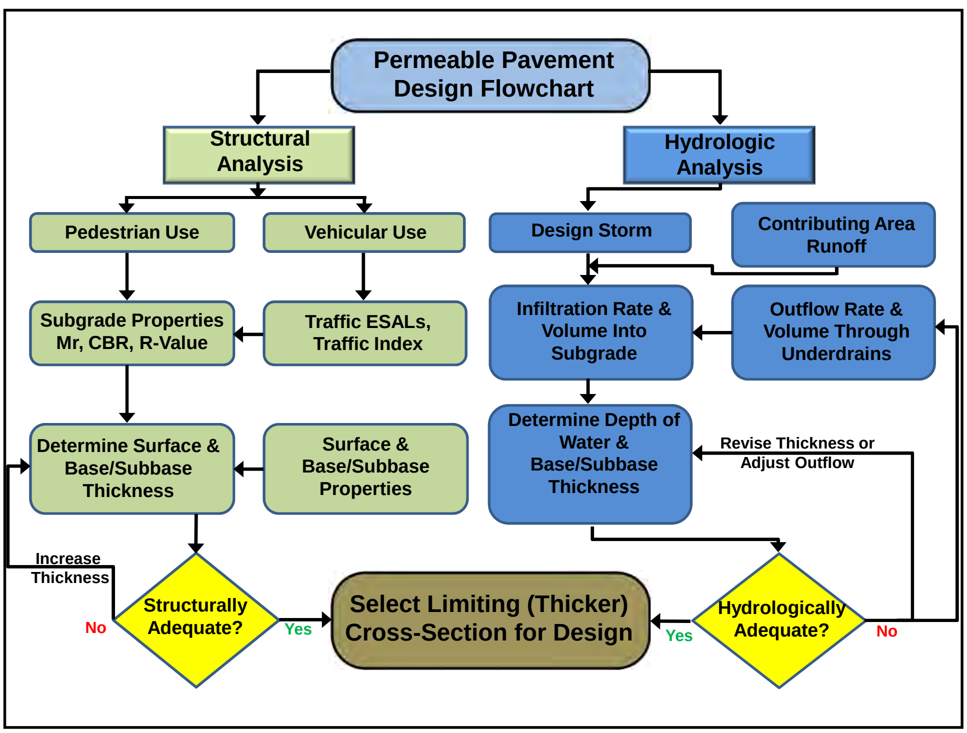
City of Shoreview, MN - 2009

7 in. pervious concrete
¾ mile (79,000 sf) residential road
Reduce pollutants to nearby Lake Owassa
$1.4 million


Strong Road, Salem, OR
2006 – new 180 home subdivision
1.7 mi. streets & alleys (~200,000 sf)
1½ in. OGFC + 3 in. ATPB
19 in. base/subbase
90% runoff reduction
Eliminated curbs & pipes
Saving $250,000


Before
Main Street
Warrenville, IL
2007- 09
0.9 miles – 125,000 sf
3 in. concrete pavers
24 in. base/subbase
Manages 10-yr storm
Eliminated flooding
$4.7 million


Machine
installed
paving
units
Perforated storm pipe
for infiltration & drainage
in road center


Permeable Pavement
Design Flowchart
Structural
Analysis
Hydrologic
Analysis
Pedestrian Use
Vehicular Use
Design Storm
Contributing Area
Runoff
Subgrade Properties
Mr, CBR, R-Value
Traffic ESALs,
Traffic Index
Infiltration Rate &
Volume Into
Subgrade
Outflow Rate &
Volume Through
Underdrains
Determine Surface &
Base/Subbase
Thickness
Surface &
Base/Subbase
Properties
Determine Depth of
Water &
Base/Subbase
Thickness
Revise Thickness or
Adjust Outflow
Increase
Thickness
No
Structurally
Adequate?
Yes
Select Limiting (Thicker)
Cross-Section for Design
Yes
Hydrologically
Adequate?
No

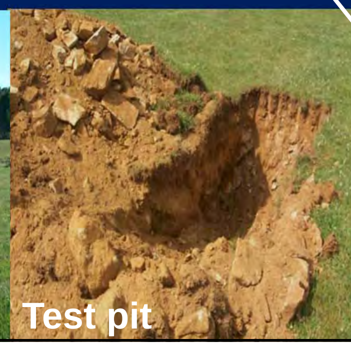
Critical Hydrologic Design Factor: Subgrade Infiltration

Double ring infiltrometer test
Use avg. infiltration rate
Apply safety factor for clogging & construction compaction

Portable soil infiltration device

Multiple test holes

Test pit



Critical Structural Design Factors:

Uncompacted or compacted…

Strength characterization of *saturated* soils via…

- California Bearing Ratio (96 hr soaked)
- Resilient Modulus M_r
- R-value
- Modulus of subgrade reaction, k

Pavement surface layer strengths
Base/subbase aggregate strengths

CBR test apparatus

Critical Construction Factors

Minimizing compaction

Maintaining clean aggregates & pavement surface

Critical Maintenance Factors

- Regenerative air vacuum sweeper
  - Routine cleaning
  - Removes loose sediment, leaves, etc.
  - More common
  - ~$1000/acre
- True vacuum sweeper
  - 2X more powerful
  - Restores highly clogged surfaces
  - Narrower suction

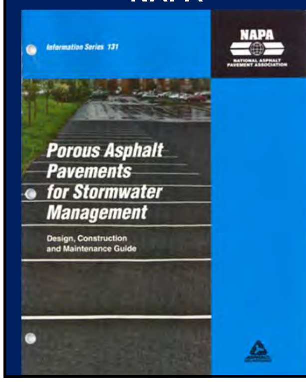
Industry Resources

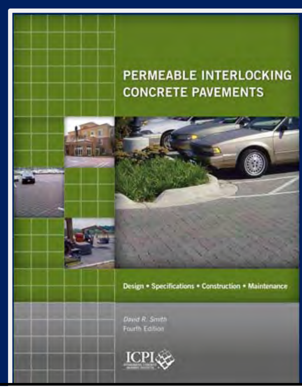
Design software
Manuals
Plus ACI, ASTM
AASHTO stds

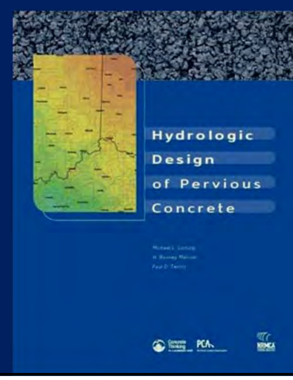
ICPI

ACPA/NRMCA

NAPA





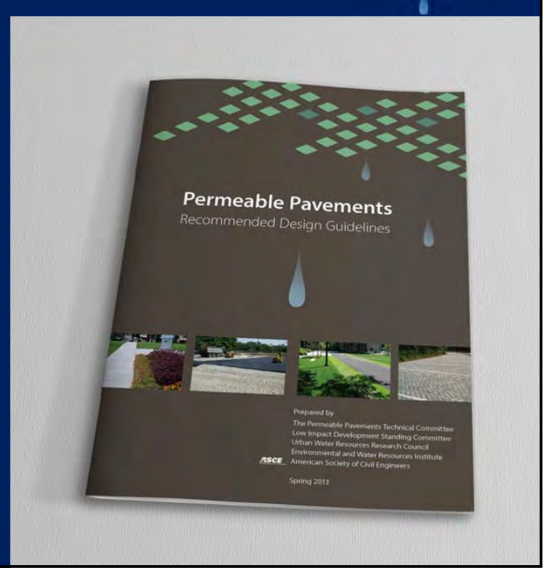


Coming Soon: Permeable Pavements Recommended Design Guidelines

ASCE Manual of Practice

- Fact sheets
- Checklists
- Design information on
  - PA
  - PC
  - PICP
  - Grids
- Maintenance
- Standards, guide specs & modeling methods
- Research needs

- Available Winter 2014



ASCE Technical Committee on Permeable Pavement

Co-chairs: Bethany Eisenberg
VHB Consultants, Boston
Kelly Lindow, P.E.
RK&K Consultants, Baltimore

Goals of Manual

- Document best practices
- Address technical concerns
- Resources & references
- Identify research needs
- Digital version: hyperlink among chapters & their Tables of Contents

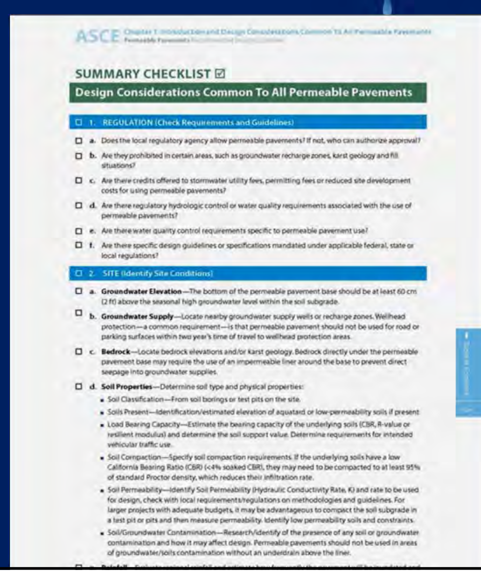
ASCE Committee

- Academia/ researchers
- Industry associations
- Public agencies
- Consultants
- Users
- Vendors

Chapter 1

Introduction and Design Considerations Common to All Permeable Pavements

- Regulatory requirements
- Site conditions
- Hydrologic & Structural Design
- Sustainable design credits
- Installation & maintenance overview
- Summary checklist


SUMMARY CHECKLIST ☑

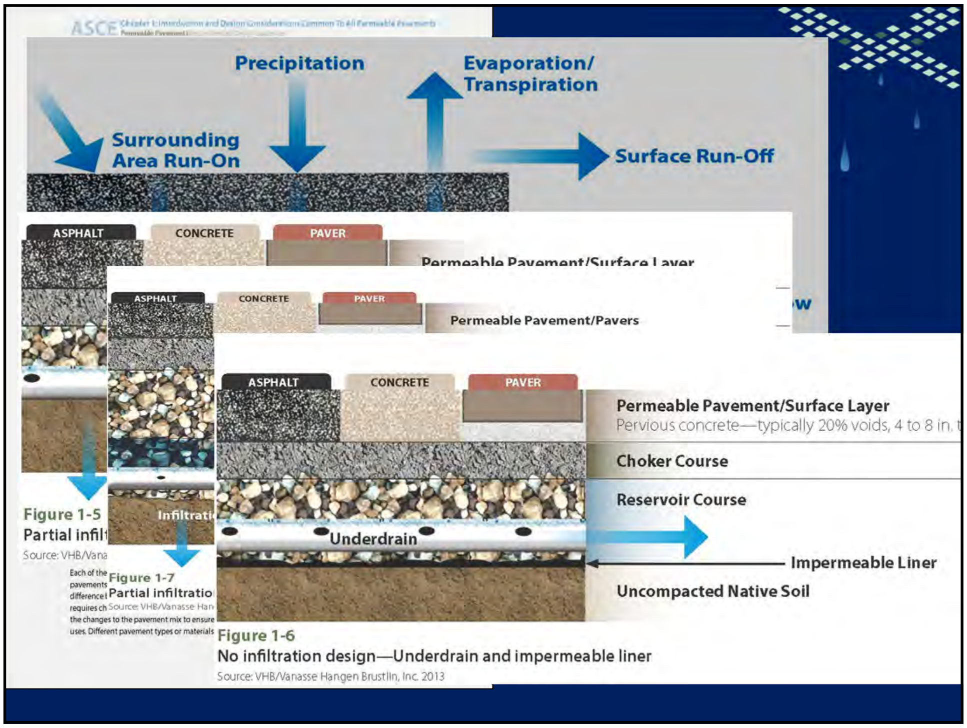
Design Considerations Common To All Permeable Pavements

☐ 1. REGULATION (Check Requirements and Guidelines)

☐ a. Does the local regulatory agency allow permeable pavements? If not, who can authorize approval?
☐ b. Are they prohibited in certain areas, such as groundwater recharge zones, karst geology and fill situations?
☐ c. Are there credits offered to stormwater utility fees, permitting fees or reduced site development costs for using permeable pavements?
☐ d. Are there regulatory hydrologic control or water quality requirements associated with the use of permeable pavements?
☐ e. Are there water quality control requirements specific to permeable pavement use?
☐ f. Are there specific design guidelines or specifications mandated under applicable federal, state or local regulations?

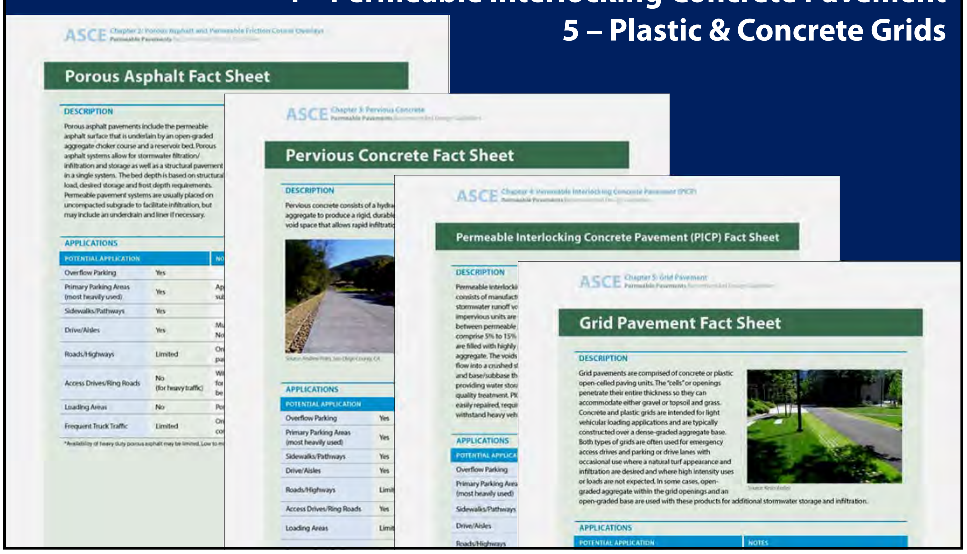
☐ 2. SITE (Identify Site Conditions)

☐ a. **Groundwater Elevation**—The bottom of the permeable pavement base should be at least 60 cm (2 ft) above the seasonal high groundwater level within the soil subgrade.
☐ b. **Groundwater Supply**—Locate nearby groundwater supply wells or recharge zones. Wellhead protection—a common requirement—is that permeable pavement should not be used for road or parking surfaces within two year's time of travel to wellhead protection areas.
☐ c. **Bedrock**—Locate bedrock elevations and/or karst geology. Bedrock directly under the permeable pavement base may require the use of an impermeable liner around the base to prevent direct seepage into groundwater supplies.
☐ d. **Soil Properties**—Determine soil type and physical properties:
- Soil Classification—From soil borings or test pits on the site.
- Soils Present—Identification/estimated elevation of aquatard or low-permeability soils if present
- Load Bearing Capacity—Estimate the bearing capacity of the underlying soils (CBR, R-value or resilient modulus) and determine the soil support value. Determine requirements for intended vehicular traffic use.
- Soil Compaction—Specify soil compaction requirements. If the underlying soils have a low California Bearing Ratio (CBR) (<4% soaked CBR), they may need to be compacted to at least 95% of standard Proctor density, which reduces their infiltration rate.
- Soil Permeability—Identify Soil Permeability (Hydraulic Conductivity Rate, K) and rate to be used for design, check with local requirements/regulations on methodologies and guidelines. For larger projects with adequate budgets, it may be advantageous to compact the soil subgrade in a test pit or pits and then measure permeability. Identify low permeability soils and constraints.
- Soil/Groundwater Contamination—Research/identify of the presence of any soil or groundwater contamination and how it may affect design. Permeable pavements should not be used in areas of groundwater/soils contamination without an underdrain above the liner.



Chapters Fact Sheets

2 – Porous Asphalt
3 – Pervious Concrete
4 – Permeable Interlocking Concrete Pavement
5 – Plastic & Concrete Grids



Chapter 2
Porous Asphalt and Permeable Friction Course Overlays

- Fact shee
- System de
- Applicati Site constrain
- General d
- Recomme installatic
- Post cons operation maintena
- Cost information
- Stormwater benefits

Chapter 3
Pervious Concrete

- Fact sh
- Subgra reserv
- Perviou layer
- Polluta heat isl

Chapter 4
Permeable Interlocking Concrete Pavement (PICP)

- Fact she
- Structu conside
- Recomm

Chapter 5
Grid Pavement

- Fact sheet
- Climate considerations
- Specific design considerations
- Detailed installation
- Recommended guide specs

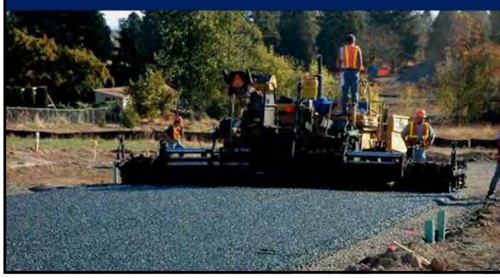
Chapter 6
Alternative Technologies

- Pervious pavers
- Rubber overlay pavement
- Rubber composite pavers
- Engineered aggregates for pollutant reduction
- Performance, concerns & limitations
- Installation
- Operations & maintenance
- Costs
- Guide specifications

Chapter 7

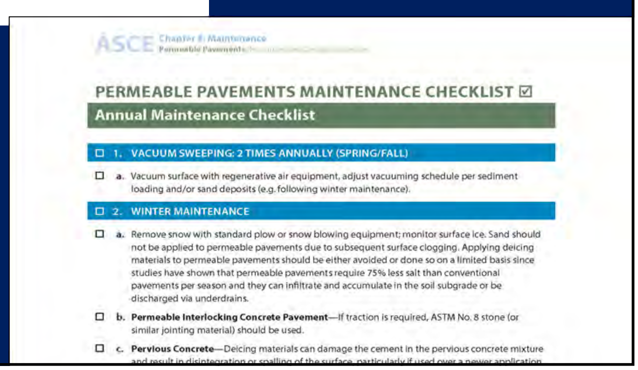
Achieving Success and Avoiding Failures with Permeable Pavements

- DRTFT
- Practical hints
- Planning & site selection
- Design
- Construction
- Operation & maintenance



Chapter 8 – Maintenance

- Primary inspection and maintenance tools
- Checklist: Regular inspection & maintenance guidance
- Annual inspection checklist



ASCE Chapter 8: Maintenance
Permeable Pavements

PERMEABLE PAVEMENTS MAINTENANCE CHECKLIST ☑

Annual Maintenance Checklist

☐ 1. VACUUM SWEEPING: 2 TIMES ANNUALLY (SPRING/FALL)

☐ a. Vacuum surface with regenerative air equipment, adjust vacuuming schedule per sediment loading and/or sand deposits (e.g. following winter maintenance).

☐ 2. WINTER MAINTENANCE

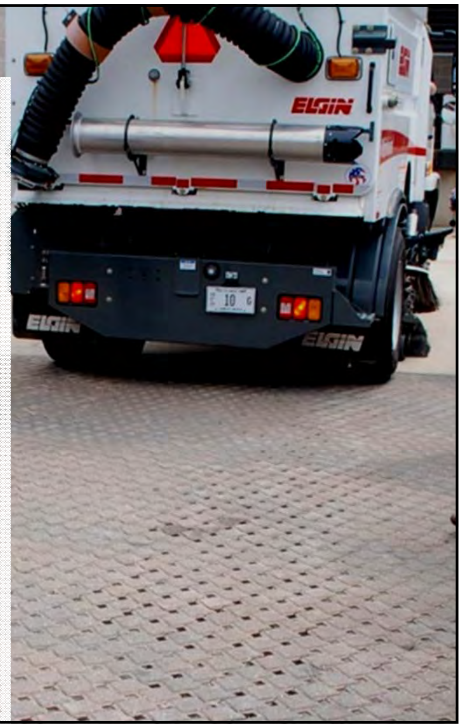
☐ a. Remove snow with standard plow or snow blowing equipment; monitor surface ice. Sand should not be applied to permeable pavements due to subsequent surface clogging. Applying deicing materials to permeable pavements should be either avoided or done so on a limited basis since studies have shown that permeable pavements require 75% less salt than conventional pavements per season and they can infiltrate and accumulate in the soil subgrade or be discharged via underdrains.

☐ b. **Permeable Interlocking Concrete Pavement**—If traction is required, ASTM No. 8 stone (or similar jointing material) should be used.

☐ c. **Pervious Concrete**—Deicing materials can damage the cement in the pervious concrete mixture

Maintenance

- Surface infiltration rates improved through maintenance
- Vacuum sweeper – regen air
  - Initially: 1 to 2 times/year
    - Site dependent
  - Remove surface sediments
  - Limit deep clogging
  - Surface clogging ≠ sealed
  - Assess surface infiltration rate w/ ASTM test or similar
  - Use true vacuum machine when clogged



Chapter 9
Hydrologic & Hydraulic Design Models

- Overview of common models
- Hydrology & hydraulics/water balance
- Water quality modeling
- Agency modeling requirements

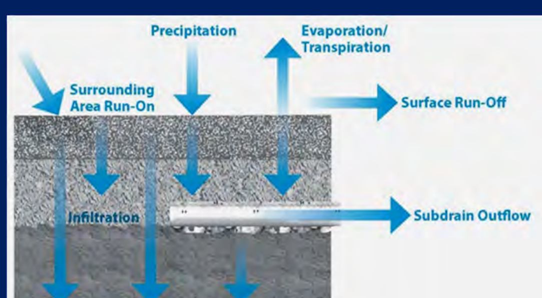
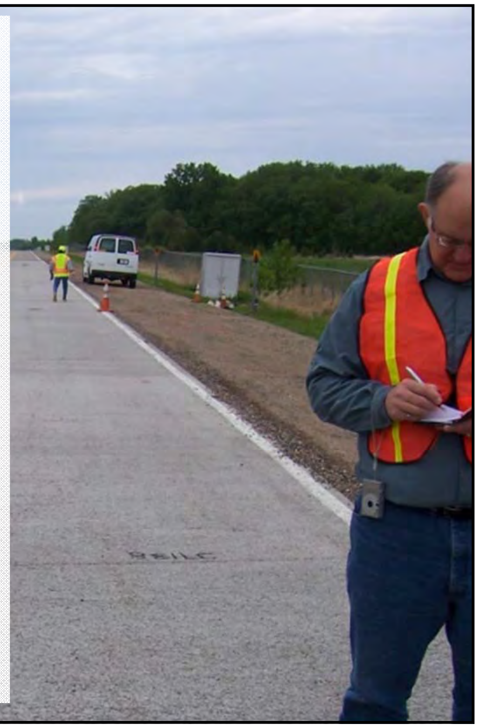


Figure 9-1
Water balance variables for permeable pavement
Source: VHB/Vanasse Hangen Brustlin, Inc. 2013



Chapter 10
Research Needs

- Improved specifications
- Validated hydrologic/hydraulic performance data & modeling techniques
- Validated, reliable structural design procedures
- Refined pollutant removal performance data & modeling techniques
- Installation & maintenance requirements
- Initial cost, life cycle costs & life cycle assessment data
- Long-term evaluation studies
- Proven cold climate specs for pervious concrete
- Clogging/hydraulic failure & rehabilitation information

Appendix A
Fact Sheet: Common Concerns Regarding Permeable Pavements

- Clogging
- Costs
- Maintenance
- Cold climate
- Durability
- Soil constraints
- Groundwater constraints
- Spills
- Slopes

Common Concerns Regard Permeable Pavements Fact Sheet

Clogging

Concern: Permeable pavements clog and fail.

Response: Properly installed and maintained permeable pavements should not experience surface clogging that results in complete failure. Typically, even with some clogging, permeable pavements continue to infiltrate at acceptable rates due to the typically high initial rates at installation and permeable subbases.Some clogging will occur over time from natural deposition and material tracked on to the pavement from vehicles, but pavement cleaning with a vacuum sweeper a minimum of two times per year should help prevent this type of clogging. More severe clogging is typically caused by a lack of cleaning and from one or more of the following: fine soils or organic materials being tracked onto the pavement; fines introduced with runoff from adjacent areas; or sand accumulation associated with winter sanding for road safety practices. Recent studies show that even when pavements experience clogging due to accumulation of fines in the pores of pervious concrete and porous asphalt, significant rehabilitation can be achieved with washing and vacuum sweeping (see Chapter 8).

- Recommendations to prevent clogging include:
- Perform vacuum sweeping two times per year.
- Prohibit runoff from adjacent areas on to the pavement, especially with nearby unstable soils.
- Avoid placing pavement in areas of exposed or fine soils where run-on may occur.
- Prohibit winter sanding and include signs to clearly depict the prohibition.
- Avoid areas where blown-in sand may occur (i.e. beach parking or arid areas)
- Avoid designs where organic matter accumulation may occur (i.e. under or directly adjacent to trees or at the toe of vegetated slopes).
- Prohibit traffic/equipment on pavements during construction and prohibit until all soils are permanently stabilized.
- Avoid landscape maintenance practices that may be deposit soil or organic matter on the pavement.

Costs

Concern: Permeable pavements are cost-prohibitive.

Response: Permeable pavements vary in price depending on the product and the base thickness. As with impermeable standard pavements, pavers and pervious concrete are also typically more expensive than hot mix asphalt. Prices for plant-prepared materials vary based on the distance from the supplier to the

Appendix B
Design and Performance Summary Tables

Summary tables
- Pavement applications
- General pavement properties
- Installation and material specifications
- Permeable pavements surface cost comparison
- Water quality performance summary
- Hydrologic performance summary

Table B-1 Pavement Applications

TYPES OF APPLICATIONS	POROUS ASPHALT	PERVIOUS CONCRETE	PICP	GRID PAVERS
Overflow Parking	Yes	Yes	Yes	Yes
Primary Parking	Yes	Yes	Yes	Limited
Sidewalks and Pathways	Yes	Yes	Yes	Yes
Road/Highways	Limited	Limited	Limited	Limited
Access Drives/Ring Roads	No (for heavy traffic)	Yes	Yes	Yes
Loading Areas	No	Limited	Yes	No
Frequent Truck Traffic	Limited	No	Yes	Limited
Cold Climates	Yes, should avoid the use of abrasives on pavement surface	Yes, should avoid the use of deicers, especially during first year following installation	Yes, require only standard snow removal procedures	Yes, special snow removal procedures required for grass filled applications

Appendix C
Standards, Specifications, Testing Methods, Resources and References

- Standards, specifications & testing methods
  - Pervious concrete
  - Porous asphalt
  - Permeable pavers

Appendix D
Glossary

- Key words, terms & phrases
- Acronyms

Green Alleys & Historic Streets

Incorporating Green Infrastructure in Richmond, VA

Michelle Virts, PE

August 25, 2013

City of Richmond
Department of Public Utilities

Richmond – Background and History

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- 60 sq. miles
- Pop: 210,309
- Falls of James River
- Stormwater Utility
- Combined Sewer System

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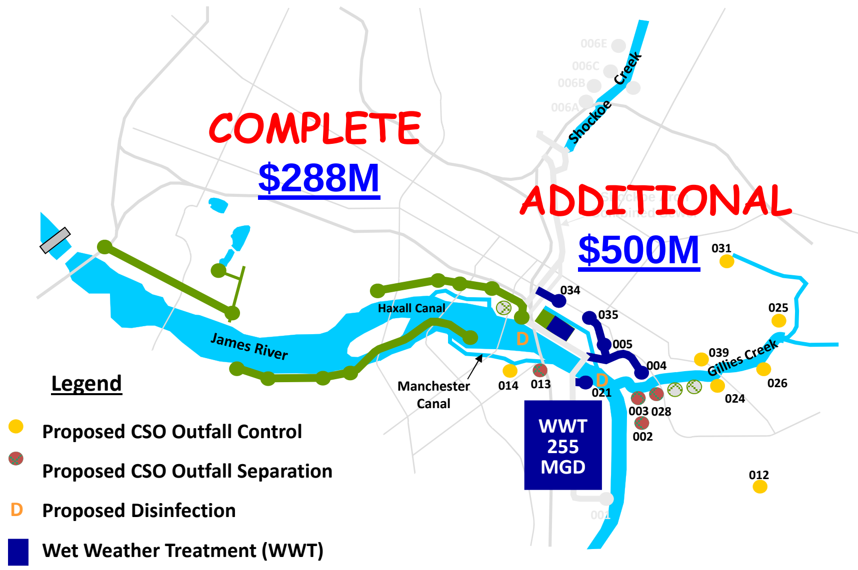
Richmond Water Quality Needs



Green Infrastructure

- Multiple benefits:
  - Improve health of James River & streams
  - Improve water quality
  - Support sustainable community
- Address stormwater & combined sewer
- Already in: Chicago, LA, Philly & New York

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Current Pilot Projects

Case Studies:
- Green Alleys
- Street Retrofits
- Green Roofs
- School Retrofits

Goals:
- Reduce Volume
- Remove N, P
- Remove Bacteria

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Green Alleys

- Detain up to 10-year storm
- Pavers looks like historic cobblestone

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Design Considerations

- Steep slope
- Several entrances
- Several utilities
- Lined
- Check dams

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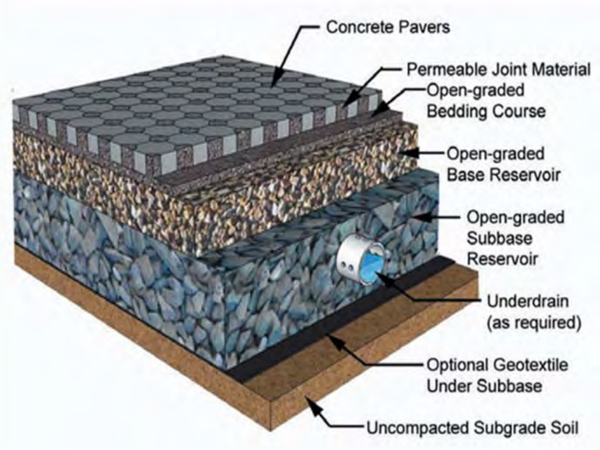
Pervious Technology

- Porous Asphalt
  - Conventional installation equip. used
  - Reliability uncertain in VA climate
- Pervious Concrete
  - No fine aggregates
  - Larger aggregate - snow plows
- Permeable Interlocking Concrete Pavers
  - Freeze-thaw durability
  - Withstand heavy vehicles

CITY OF RICHMOND
DEPARTMENT OF PUBLIC UTILITIES

Typical Paver Cross Section

- 16” depth
- 10 year storm storage
- No infiltration
- 6” under drain



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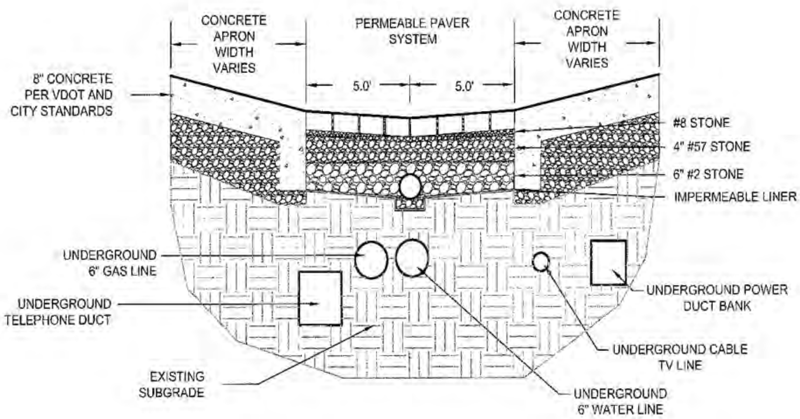
Typical Alley Cross Section



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Paver Selection

Richmond Cobblestone

Green Alley Pavers

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Pilot Green Alleys

Before

After

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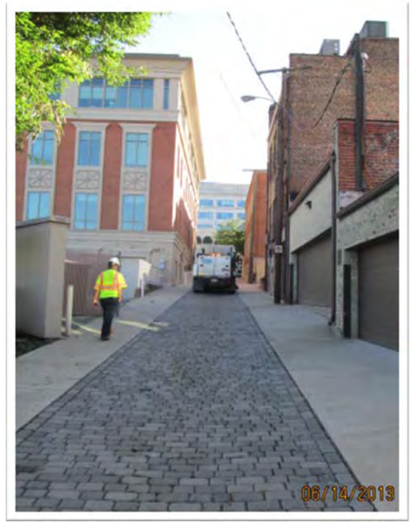
Maintenance Needs

- Inspection
- Sweeping
- Weed Control
- Litter Control

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Are Green Alleys Working?

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Street Retrofits


Before   After

- Streetscape
- Traffic Calming
- Address Nuisance Flooding

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Incentivizing Green Infrastructure - Credits

Single Fam. Residential
- Max credit of 50%
- Calc % area treated

Non-Residential
- Max credit of 50%
- Each BMP earns 20%

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Department of Public Utilities

Questions?

Michelle Virts, PE
Deputy Director
(804) 646-5203
Michelle.virts@richmondgov.com

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Department of Public Utilities

City of Los Angeles

City of Green Angels

Green Alleys & Streets: How are they Working?

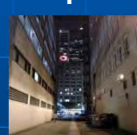
The East Cahuenga Corridor Alley Story

an Example of Climate Adaptive Infrastructure

By Carl De la Fuente : BOE – Street & Stormwater Division 8/25/2013

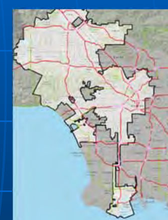
Los Angeles Existing conditions and Challenges

With a wide spectrum of existing conditions, the City of Los Angeles envision possibilities for Green Alleys.



The main inquires are what these Green Alleys could do to benefit L.A.? and what are the specific advantages for SWM.

Los Angeles Infrastructure : Facts



- Area : 503 SQ. miles
- Alleys : 914 miles
- Coastline of L.A : 75 miles
- Annual Avg. rainfall : 11” to 13”

Opportunities

Let’s assume if only 20% of the ex. 914 miles of alleys is converted to green Alleys, what would be the benefits ?

- 20% of 914 Miles = 183 miles of GREEN ALLEYS
- If 70 gr of oil can be degraded with 1 square meter, then
- 1 Lb of this material of other contaminants can be degraded with approx. 70 sf, therefore
- In 183 miles of green alleys we could remove approx. 138 Tons of oils, fats, contaminants and other hazards.

Opportunities - Cont’

Studies have been performed for Green Infrastructure in Los Angeles based on the average annual rainfall. The study states that in ¼ acre of hardscape (permeable pavers area) we have the **potential to collect 100,000 gallons of rainwater !!**

Major Benefit

- The increase use of LID (Low Impact Developments) would result in savings of 74,600 – 152,500 acres-feet of imported water
- In addition Los Angeles could be pumping less water from distant locations, which means 131,700 – 428,000 MWH of energy saved per year by 2030. This is the equivalent to 20,000 to 65,000 households

Existing Threats

- In March 2008 approx. 40% of L.A County Beaches needed cleaner polluted runoff to be disposed to the Pacific Ocean.
- We have a net Average of 15,000 acres of existing public land within the City and the County suitable for LID (Green Alleys).
- 48% of L.A city water supply originates from the Mono and Owens Valley aqueducts. And at least 30% of all the water used in L.A is used outdoors.
- Los Angeles beaches in average presently have closures between 17 to 21 days per year, specially in the summer.

Economical Losses

- According to a report in 2009 of the National Oceanic Economics Program, the nation's shoreline-adjacent counties contributed an estimated of $6.0 Trillion dollars to the GDP and 47 million jobs
- In March 2008 approx. 40% of L.A County Beaches needed Los Angeles / Orange County an study concluded that the public health cost of the gastrointestinal illnesses caused by poor water quality was between $21 million and $51 million dollars per year cleaner polluted runoff to be disposed to the Pacific Ocean.

Economical Losses -2

- We have a net Average of 15,000 acres of existing public land within the City and the County suitable for LID (Green Alleys).
- 48% of L.A city water supply originates from the Mono and Owens Valley aqueducts. And at least 30% of all the water used in L.A is used outdoors.
- Studies and assessment in Public Health threw statistics that every year between 627,000 to 1.5 million in L.A were exposed to the danger of gastrointestinal diseases due to polluted beaches

Looking Ahead with Green Infrastructure and LID's

- Health pollution concerns for better air quality and much more comfort to pedestrian oriented communities.
- Trade offs of classical approaches of planting trees vs. the implementation of permeable pavers. A balance of these two benefits would greatly make Los Angeles one of the most Livable cities in America.
- Increase of water retention per groundwater recharge.
- Creation of more sustainable environments and cycles.

Major Limitations for Green Alleys and LID's

- The City of Los Angeles. Located in Southern California faces considerable issues of **PERMEABILITY**, creating challenges to build green alleys or either LID's.
- Los Angeles being the 2nd largest city in the US has a very complex network of **UTILITIES**, which in many cases (more in the urban locations and downtown) makes it ineligible for these projects.
- Since the present conditions limit these green alleys only as pedestrian mall, then the conversion of a conventional designated alley to a green alley has its process, which could be very lengthy due huge **BUREAUCRACIES**.

The East Cahuenga Corridor Alley

an Example of Climate Adaptive Infrastructure

By Carl De la Fuente : BOE – Street & Stormwater Division 5/15/2013

The East Cahuenga Corridor Alley

an Example of Climate Adaptive Infrastructure

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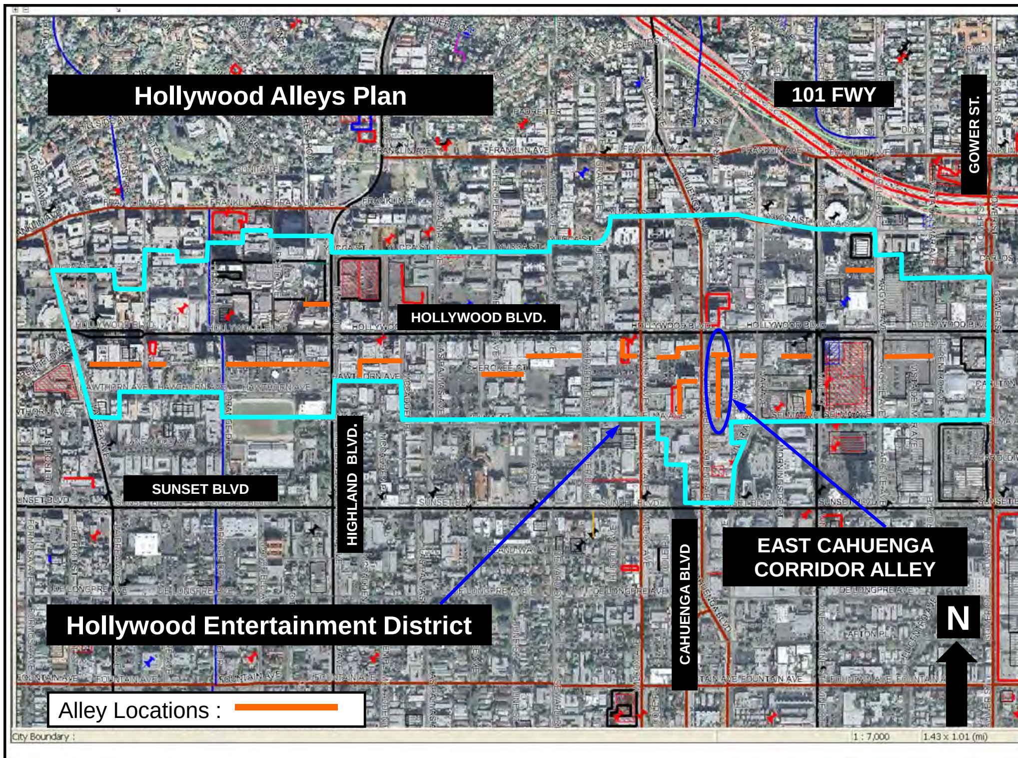
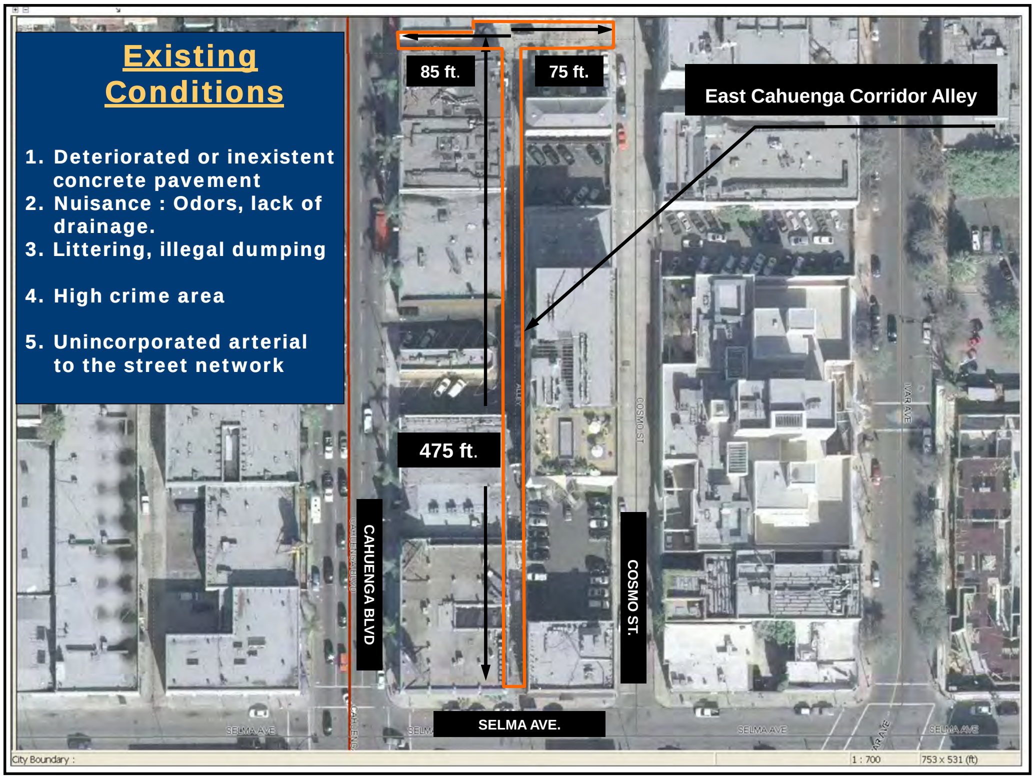
Table of Contents



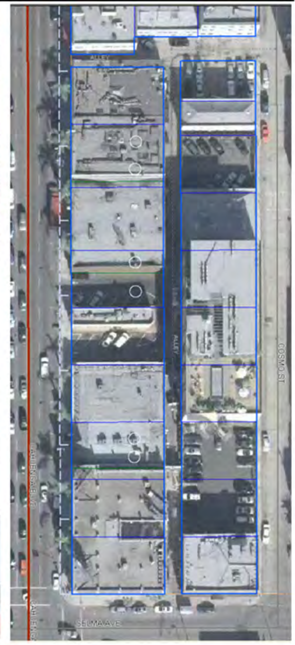
Existing Conditions

The East Cahuenga Corridor Alley is approximately 485 ft. long with a width of 15 ft. The alley geometry has a "T" shape, the north end has two extensions to the adjoining streets of Cahuenga Blvd. and Cosmo St.

Observations during several field visits documented illegal improvements performed by adjacent property owners along the alley strip. The illegal improvements included raised concrete entrances to back doors, altered flow lines with localized ponding. In some areas the pavement was completely cracked and another good segment the broken concrete surface was covered with deteriorated hardwood with intensive odors.



EAST CAHUENGA CORRIDOR ALLEY



Alternatives of Drainage

&

Pavement Selection

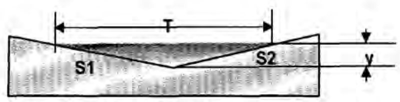
HYDRAULIC ANALYSIS

Project Title — **Cahuenga-Selma Alley Improvement**

V-shape Swale Capacity

Known — **Req'd Q10=2.17 cfs**

	n=	0.013	
	T=	6.000	ft
Slope #1	S_1=	0.020	
Slope #2	S_2=	0.020	
Combined Cross Slope Sx	Sx=	0.010	
	K=	0.560	
longitudinal	S_L=	0.020	
depth	y=	0.060	ft= 0.72 in <1.5"?
Find	Q=	0.3330	cfs
	A=	0.1800	sq.ft.
	V=	1.8499	ft/s



Sx=S1x S2/(S1+S2)

y=T(S1)(S2)/(S1+S2)

$$Q = \left(\frac{K}{n}\right) S_x^{1.67} S^{0.5} T^{2.67}$$

where Q = rate of discharge, ft³/s
K = 0.56
n = Manning's coefficient of roughness
S_x = cross slope
S = longitudinal slope
T = spread or top width of flow in gutter = d/S_x, ft
d = depth of flow at face of curb, ft

T (ft)	Q (cfs)	OK? >2.17 cfs (req'd capacity)
4.000	0.113	NG
6.000	0.333	NG

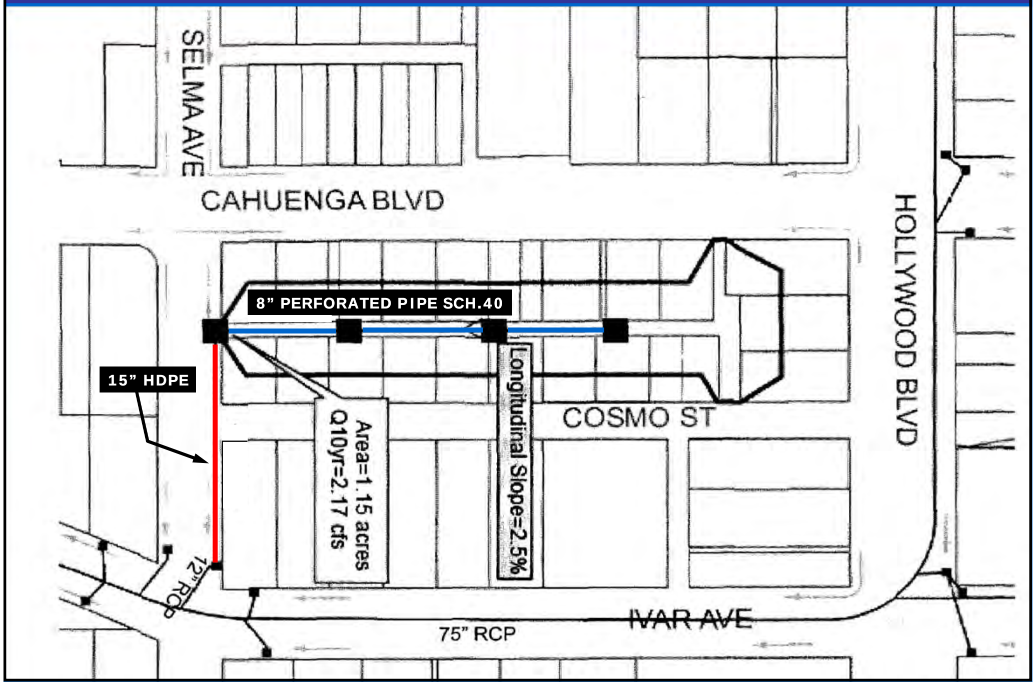
Capacity of CLA bike-safe Grating Inlet

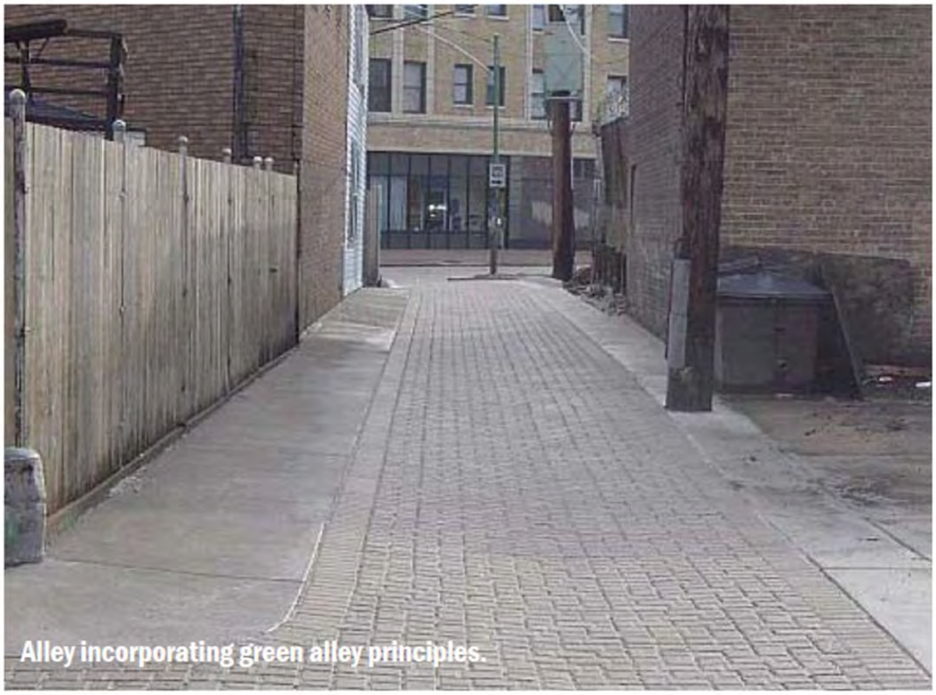
Use Weir Equation **Q=CwLd^1.5**

Given Q10= **2.17** cfs

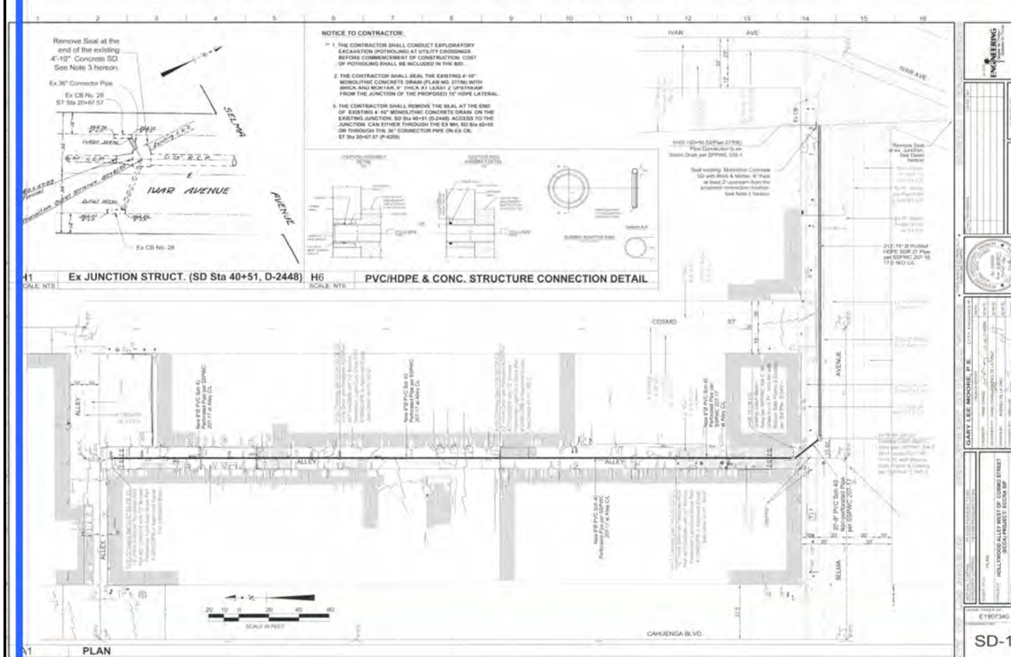
Weir condition: d<2.5" $Q_i = C_w L d^{1.5}$

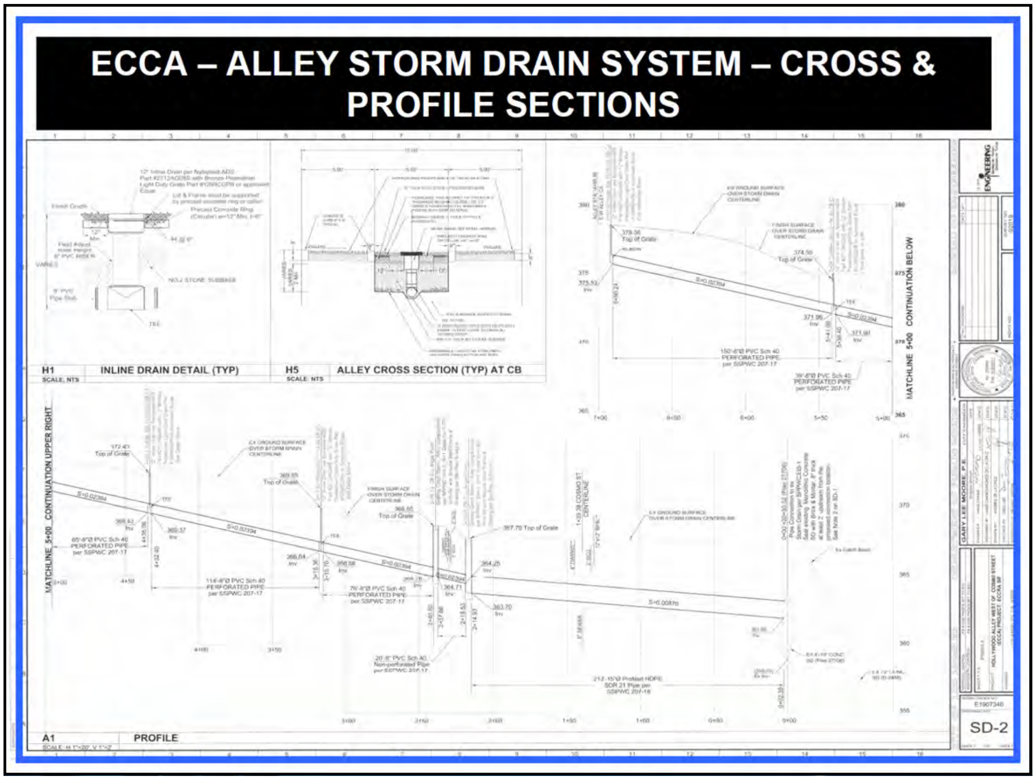
LAYOUT OF PROPOSED DRAINAGE SYSTEM



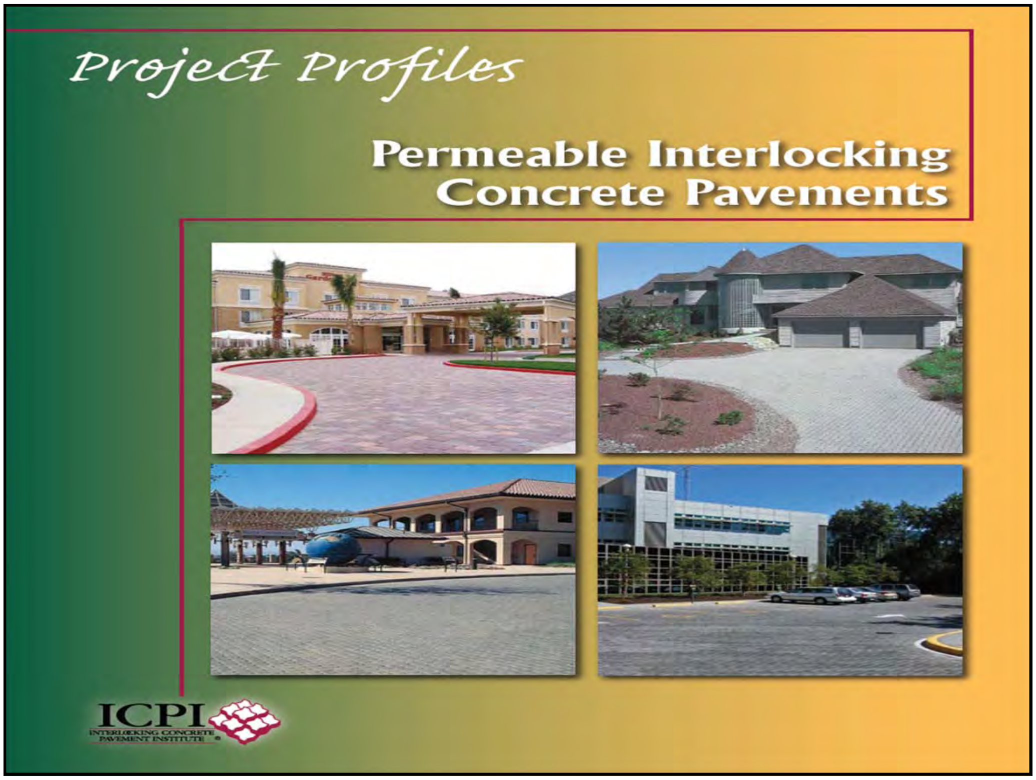


ECCA – ALLEY STORM DRAIN SYSTEM




ECCA – ALLEY STORM DRAIN SYSTEM – CROSS & PROFILE SECTIONS
H1 INLINE DRAIN DETAIL (TYP)
SCALE: NTS
H5 ALLEY CROSS SECTION (TYP) AT CB
SCALE: NTS
MATCHLINE 5+00 CONTINUATION BELOW
MATCHLINE 5+00 CONTINUATION UPPER RIGHT
A1 PROFILE
GARY LEE MOORE, P.E.
SD-2


DEPARTMENT OF PUBLIC WORKS
BUREAU OF ENGINEERING
STREET AND STORMWATER PROGRAM
LA DPW ENGINEERING
TRANSFORMING LOS ANGELES
GARY LEE MOORE, PE
ALLEY WEST OF COSMO ST. – HOLLYWOOD
PROPOSED IMPROVEMENTS
COUNCIL DISTRICT 13
CITY OF LOS ANGELES
ANTONIO VILLARAIGOSA
MAYOR
STAMPED CONCRETE WITH
LONGITUDINAL GUTTER ALTERNATIVE
STAMPED CONCRETE WITH
GRATE DRAIN ALTERNATIVE
STAMPED/BRICK CONCRETE
ALTERNATIVES
ALLEY IMPROVEMENTS EXAMPLES


Project Profiles
Permeable Interlocking
Concrete Pavements
ICPI
INTERLOCKING CONCRETE
PAVEMENT INSTITUTE

LA DPW ENGINEERING TRANSFORMING LOS ANGELES

Green Alley Design

&

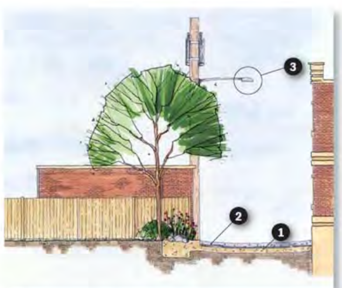
Benefits

Green Alley Pilot Approach #1:
Green Pavement Materials with Conventional Drainage

1 Properly graded and pitched alley surface directing stormwater towards the center of the alley, into adjacent streets, and finally into the existing sewer system
2 High albedo concrete paving with recycled aggregate and slag
3 Energy efficient dark sky compliant light fixture

Plan

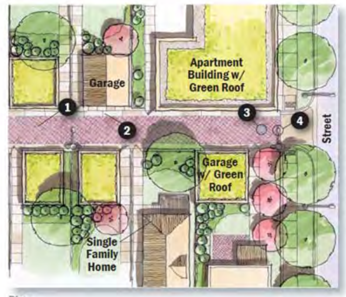
1 Recycled concrete base material
2 High albedo concrete paving with recycled aggregate and slag
3 Energy efficient dark sky compliant light fixture



Section

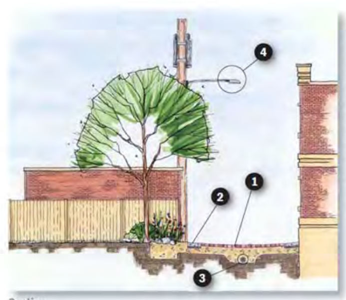
Green Alley Pilot Approach #2:
Full Alley Infiltration Using Permeable Pavement

1 Permeable pavement material (permeable asphalt, permeable concrete, or permeable pavers)
2 High albedo concrete paving with recycled aggregate and slag
3 Optional inlet structure with pipe under drain
4 Energy efficient dark sky compliant light fixture



Plan

1 Permeable pavement material (permeable asphalt, permeable concrete, or permeable pavers)
2 High albedo concrete paving with recycled aggregate and slag
3 Optional pipe under drain
4 Energy efficient dark sky compliant light fixture



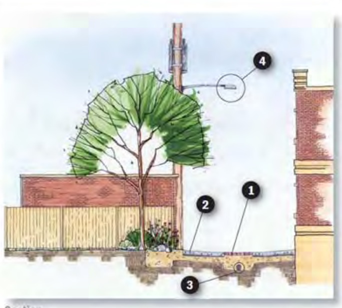
Section

Green Alley Pilot Approach #3:
Center Alley Infiltration Using Permeable Pavement

1 Permeable pavement material (permeable asphalt, permeable concrete, or permeable pavers)
2 High albedo concrete paving with recycled aggregate and slag
3 Optional inlet structure with pipe under drain
4 Energy efficient dark sky compliant light fixture

Plan

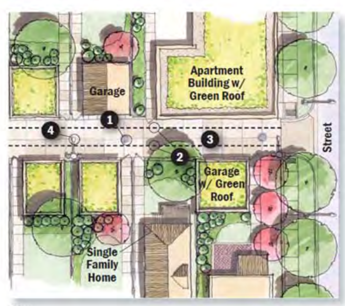
1 Permeable pavement material (permeable asphalt, permeable concrete, or permeable pavers)
2 High albedo concrete paving with recycled aggregate and slag
3 Optional pipe under drain
4 Energy efficient dark sky compliant light fixture



Section

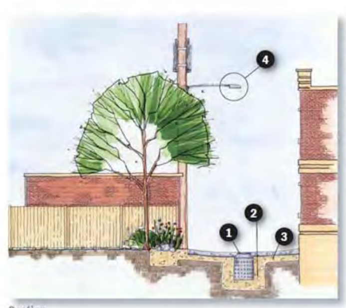
Green Alley Pilot Approach #4:
Green Pavement Materials with Subsoil Filtration System

1 Inlet structure with perforated sides
2 Limits of infiltration trench below for additional storage capacity
3 High albedo concrete paving with recycled aggregate and slag
4 Energy efficient dark sky compliant light fixture



Plan

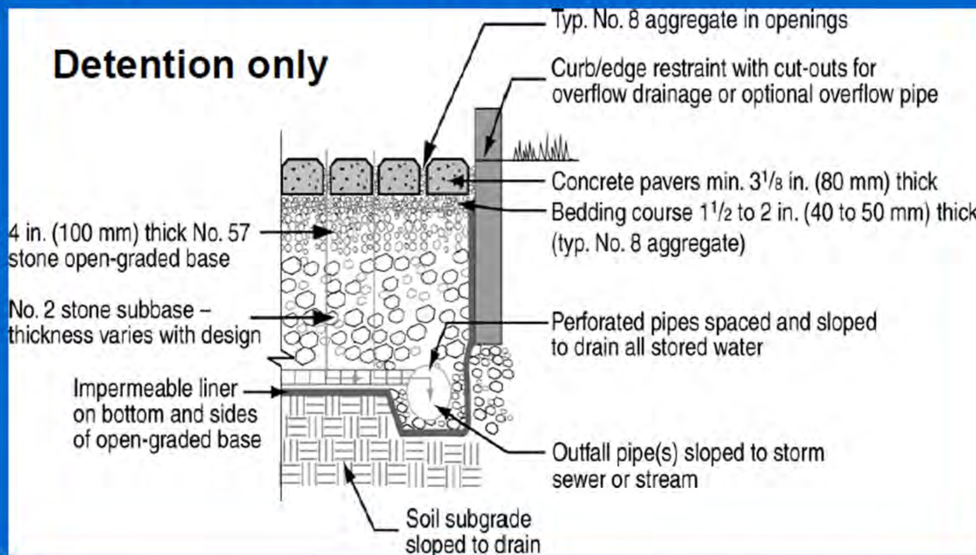
1 Inlet structure with perforated sides
2 Stormwater infiltration trench
3 Recycled concrete base material
4 Energy efficient dark sky compliant light fixture



Section

No Exfiltration

Detention only



Typical max. lifetime loading: 600,000 18,000 lb ESALs or TI = 8.5

Climate	No Frost	No Frost	No Frost	No Frost	Frost	Frost	Frost	Frost
ESALs* (Traffic Index)	Soaked CBR Base Subbase (R-value)	>15 (>24)	10-14 (18-23)	5 to 9 (11-17)	Gravelly Soils	Clayey Gravels, Plastic Sandy Clays	Silty Gravel, Sand, Sandy Clays	Silts, Silty Gravel, Silty Clays
Pedestrian	No. 57 No. 2	4 (100) 6 (150)	4 (100) 6 (150)	4 (100) 6 (150)	4 (100) 6 (150)	4 (100) 6 (150)	4 (100) 6 (150)	4 (100) 6 (150)
50,000 (6)	No 57 No. 2	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	**
150,000 (7.2)	No. 57 No. 2	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 10 (250)	**
600,000 (8.5)	No. 57 No. 2	4 (100) 8 (200)	4 (100) 8 (200)	4 (100) 10 (250)	4 (100) 8 (200)	4 (100) 14 (350)	4 (100) 18 (450)	**


Bedding, base &
subbase stone sizes
No. 8
No. 57
No. 2


SWINGER
220
JLG

PICP Design: Exfiltration Options

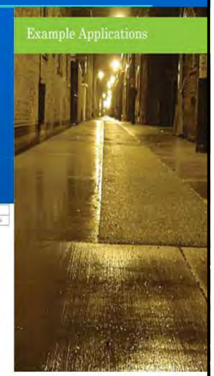
Full - exfiltration
- Sandy soils
- No perforated drain pipes

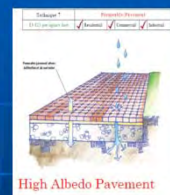
Partial – detention & exfiltration
- Silt/some clays
- Perforated pipes at bottom of base

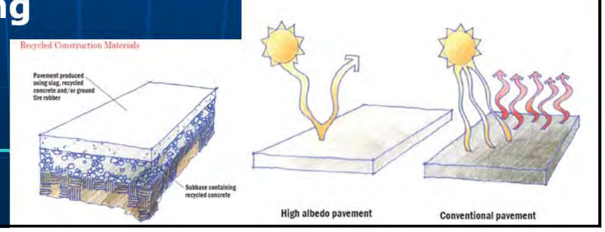
None – detention only
- High rock, water table, poor soils

BENEFITS OF GREEN ALLEYS

- Stormwater Management
- Heat Reduction
- Material Recycling



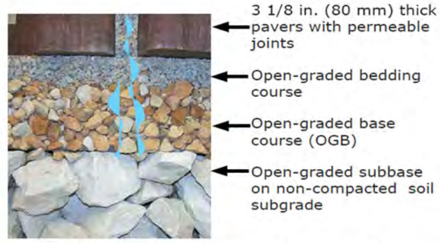




PERMEABLE INTERLOCKING CONCRETE PAVEMENT (PICP)
MUNICIPAL OFFICIALS FACT SHEET

Stormwater Benefits

- Reduces pollutants from rainwater runoff
- Complements buildings and visually unifies streetscape, many colors available
- LEED® points eligible for Sustainable Sites, Water Efficiency, Materials & Resources and/ or Innovative Design; Earns Green Globe points
- Meets U.S. Environmental Protection Agency stormwater performance criteria as a structural best management practice (BMP) while providing parking, road and pedestrian surfaces
- Helps meet local, state and provincial stormwater drainage design criteria and provides compliance with the U.S. National Pollutant Discharge Elimination System (NPDES) regulations
- Reduces runoff from common rainstorms by as much as 100%; eliminates surface puddles and local flooding
- Promotes street tree survival
- Snow melts faster on permeable pavement and drains, reducing ice hazards
- Snow plow with typical snow removal equipment; reduce winter ice hazards, de-icing salt use and snow removal costs.
- 50 year life-cycle for surface
- Compatible with underground stormwater storage systems, many slower-draining clay soils and cold climates
- Governments may offer tax incentives, utility fee reductions, expedited permitting or a demonstration project to encourage use.



Permeable interlocking concrete pavement (PICP) with base and subbase for infiltration and storage

PICP supports sustainable development and livable green communities

Performance

Volume Reduction

- PICP significantly reduces runoff from most storms.
- Runoff volume reductions relieve flooding in storm sewers operating at capacity and relieve sewage treatment plants receiving combined storm and sanitary waste flows.
- Reduced runoff can reduce sewer overflows and stream bank erosion.

Peak Flow Reduction

- Promotes stream and lake health with decreased erosion
- Reduces water pollution by reducing combined sewer overflow frequency
- Reduces the need for continuous expansion of drainage infrastructure

Additional Benefits

- Cooler than conventional pavements
- ADA compliant
- May be used on sloped site with proper design

Water Quality Improvement

- 80% or greater TSS removal
- Preserve and increase drinking and recreational water supplies; preserve aquatic and wildlife habitats.
- Gain recognition for innovative design through sustainable BMPs

FAQs

Can PICP be used on clay soils? *Yes. Even in clay soils, PICP reduces runoff and helps to capture "first flush" runoff and reduce pollution.*

Can PICP be used to replace every kind of pavement? *PICP is best suited for use in areas of low speed traffic such as parking lots, residential streets, driveways, patios, plazas, sidewalks and parking lanes on busier travelways. Nevertheless, PICP has been successfully used even under heavy commercial loads.*

Will PICP enhance property values? *The data from installed PICP projects indicates that PICP meets multiple criteria for project success including enhancing property values.*

Is Maintaining PICP difficult? *No. PICP can be maintained through street sweeping and vacuuming based on periodic inspection.*

References

Ferguson, B. K. *Porous Pavements*. Boca Raton, FL:CRC Press, 2005.

Smith, David R. *Permeable Interlocking Concrete Pavements*: *Selection • Design • Construction • Maintenance*, Washington,DC:ICPI 3rd ed., 2006. www.icpi.org.

Construction and Project Examples

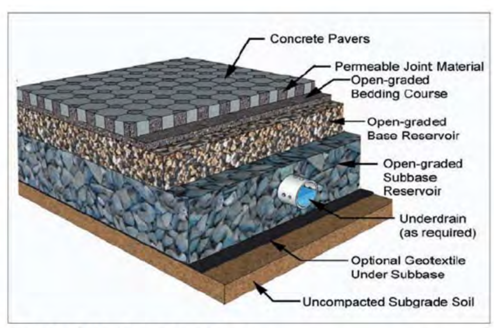

Prepared subgrade for 20,000 sf (2000 m²) Portland, OR street retrofit with PICP

Portland, OR street project with PICP parking lanes

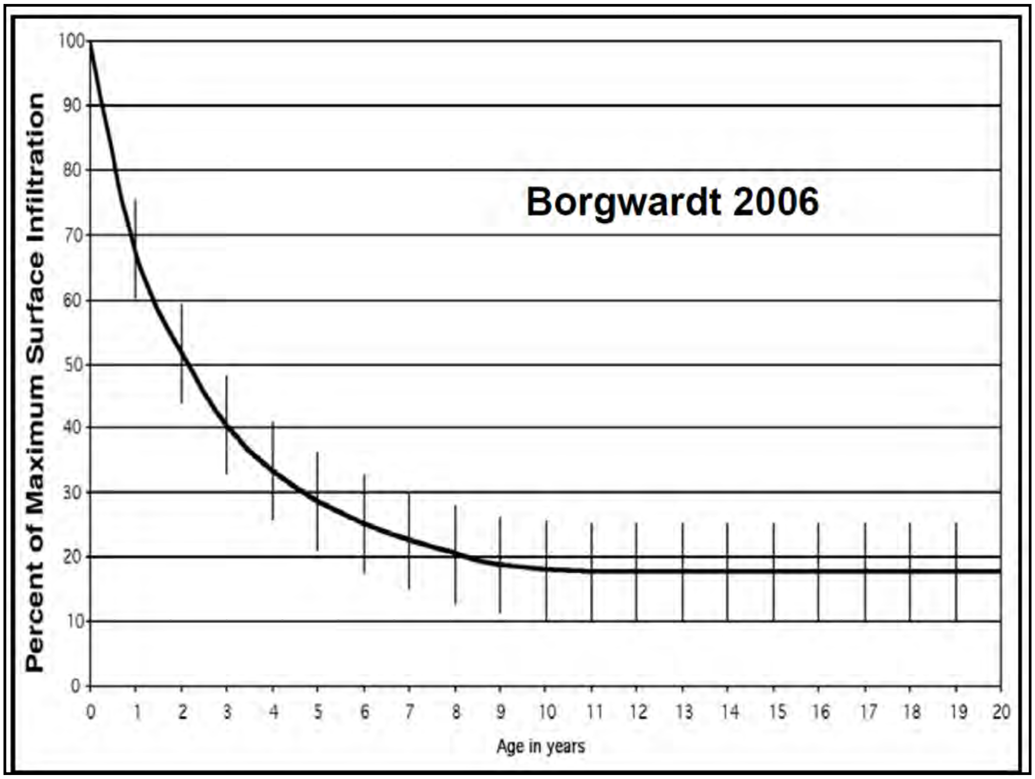
Base construction uses locally available materials.

Mechanical installation speeds construction.


Aggregate base is spread and compacted; pavers are delivered ready to install. After placement of bedding course, joints and/or openings are filled with small aggregate and the pavers are compacted. Joints may be filled mechanically as shown.



Typical PICP cross section



What About Oils?

Studies by C. Pratt & S. Coupe
Coventry University, UK

"…the system is capable of degrading at least 70g of oil per square meter per year."

PICP can process occasional drips

Chicago Green Alleys Program

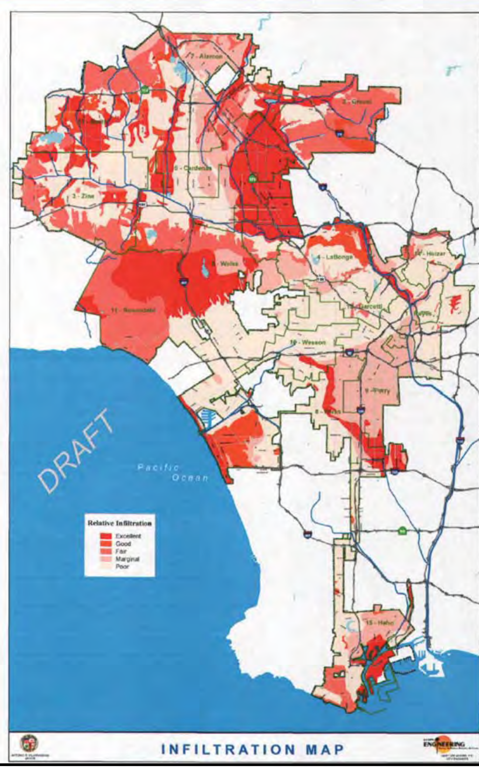
Green Alley Program

1,900 miles of public alleys - largest of any US city

- 3,500 acres of impermeable surface, the equivalent area of over 5 Chicago Midway Airports

Total: 13,000 alleys

- 20% unimproved
- 20% in need of repairs



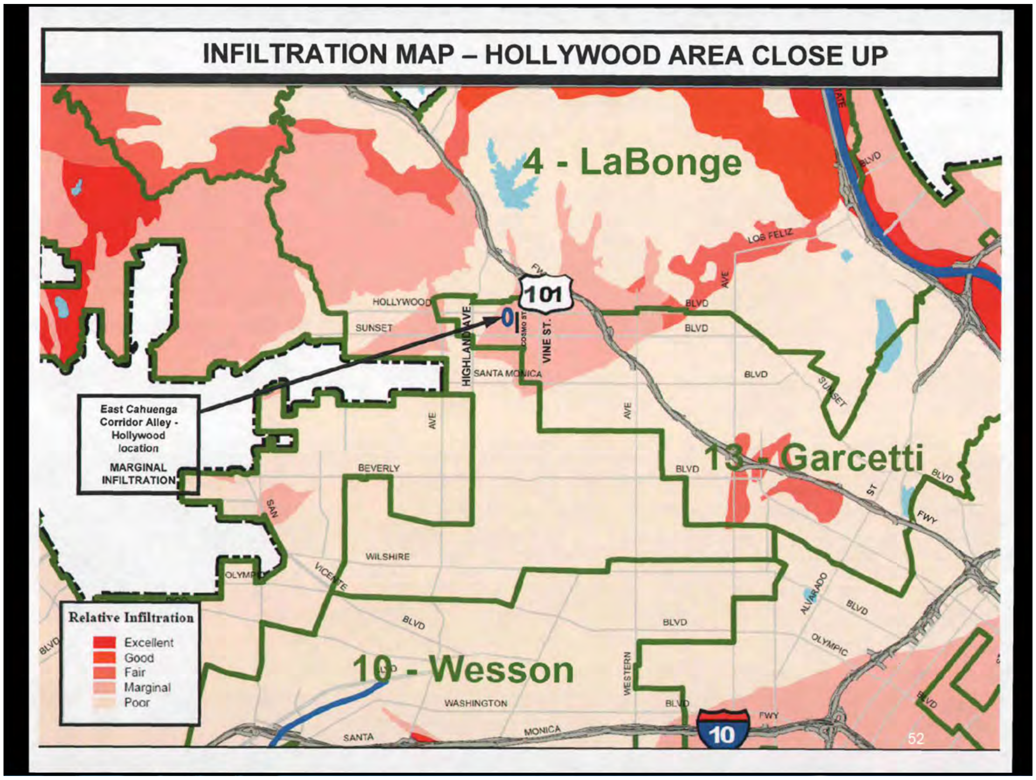
Los Angeles a 503 SQ MILE City

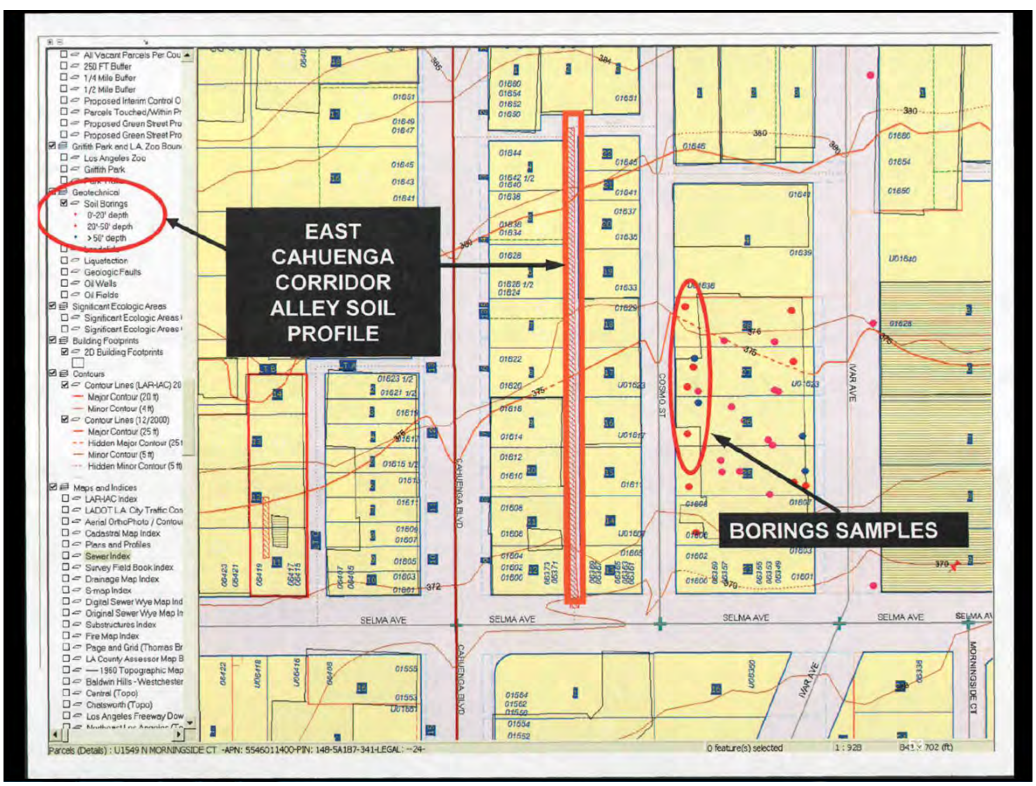
With

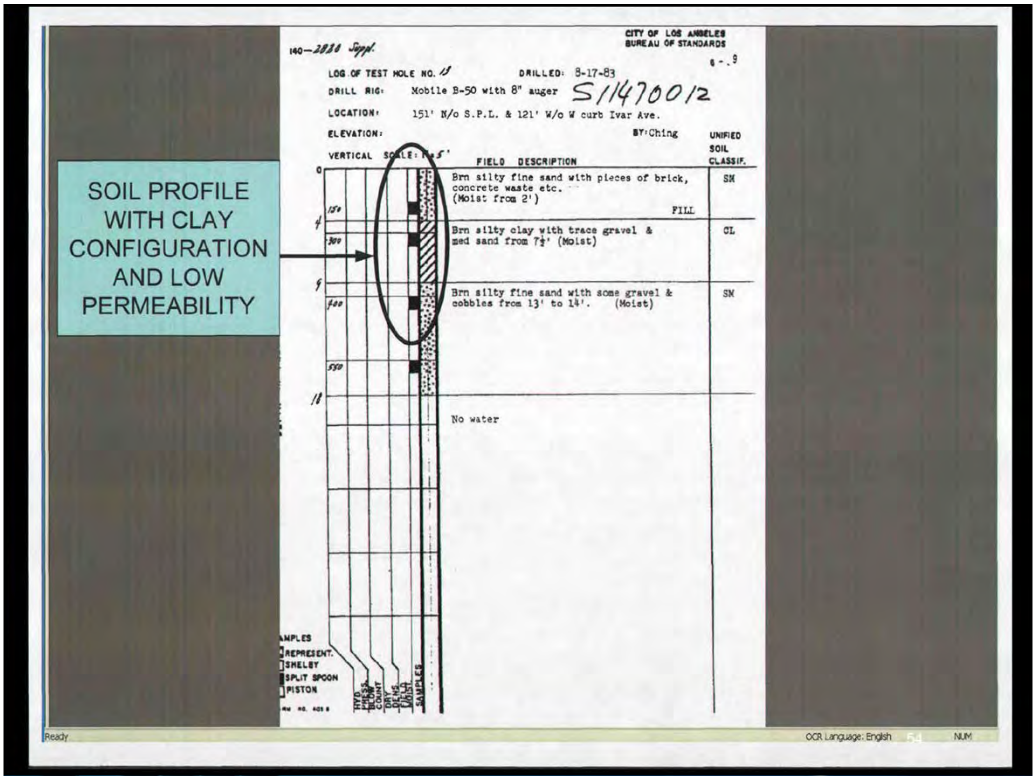
914 Miles of Alleys

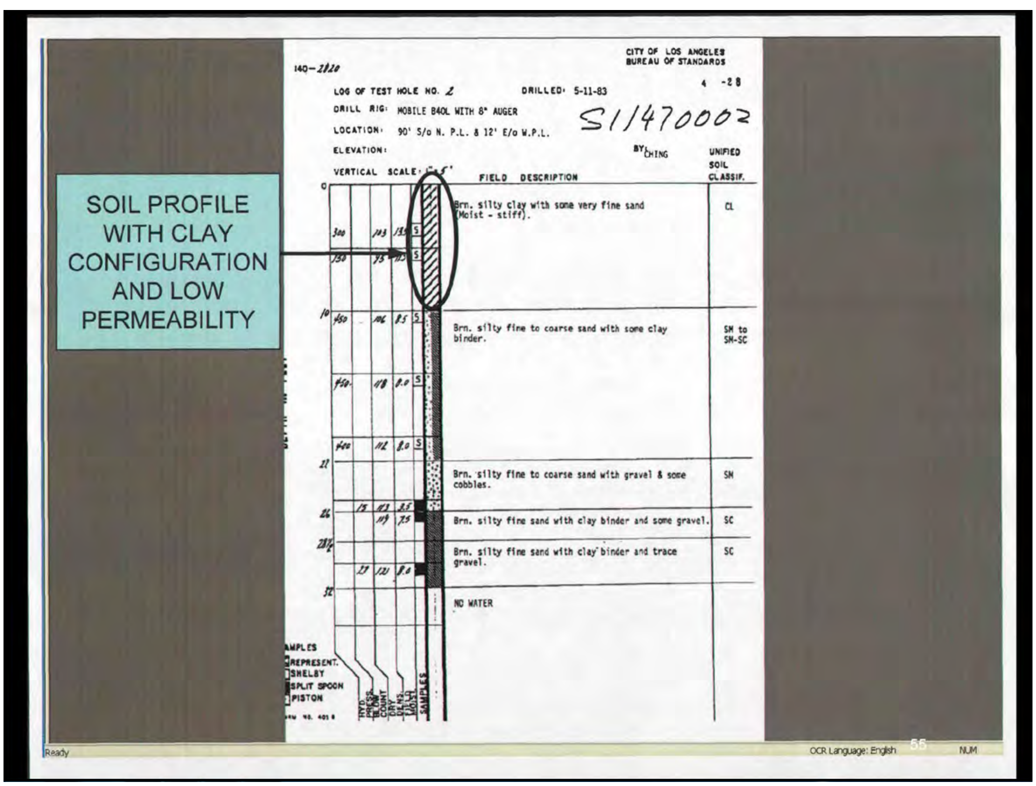
And

75 Miles of Coastal Beaches

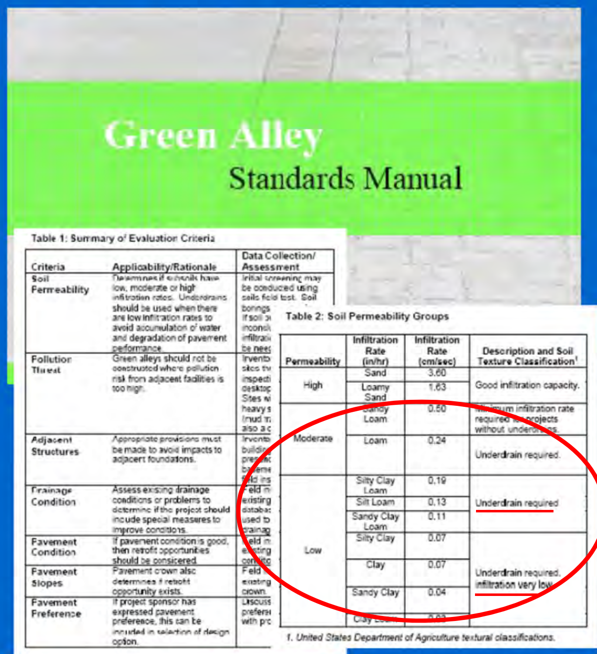

INFILTRATION MAP – HOLLYWOOD AREA CLOSE UP
4 - LaBonge
13 - Garcetti
10 - Wesson
East Cahuenga Corridor Alley - Hollywood location
MARGINAL INFILTRATION
Relative Infiltration
Excellent
Good
Fair
Marginal
Poor
HOLLYWOOD
SUNSET
SANTA MONICA
BEVERLY
WILSHIRE
WASHINGTON
HIGHLAND AVE
VINE ST.
LOS FELIZ
101
10
52


EAST CAHUENGA CORRIDOR ALLEY SOIL PROFILE
BORINGS SAMPLES
SELMA AVE
CAHUENGA BLVD
COSMO ST
IVAR AVE
MORNINGSIDE CT


SOIL PROFILE WITH CLAY CONFIGURATION AND LOW PERMEABILITY
CITY OF LOS ANGELES
BUREAU OF STANDARDS
140—2830 Suppl.
LOG OF TEST HOLE NO. 13
DRILLED: 8-17-83
DRILL RIG: Mobile B-50 with 8" auger
S1147001 2
LOCATION: 151' N/o S.P.L. & 121' W/o W curb Ivar Ave.
ELEVATION:
BY: Ching
VERTICAL SCALE:
FIELD DESCRIPTION
UNIFIED SOIL CLASSIF.
Brn silty fine sand with pieces of brick, concrete waste etc. (Moist from 2')
FILL
SM
Brn silty clay with trace gravel & med sand from 7½' (Moist)
CL
Brn silty fine sand with some gravel & cobbles from 13' to 14'. (Moist)
SM
No water
SAMPLES
REPRESENT.
SHELBY
SPLIT SPOON
PISTON
Ready
OCR Language: English
NUM


SOIL PROFILE WITH CLAY CONFIGURATION AND LOW PERMEABILITY
CITY OF LOS ANGELES
BUREAU OF STANDARDS
140—2820
LOG OF TEST HOLE NO. 2
DRILLED: 5-11-83
DRILL RIG: MOBILE B40L WITH 8" AUGER
S11470002
LOCATION: 90' S/o N. P.L. & 12' E/o W.P.L.
ELEVATION:
BY: CHING
VERTICAL SCALE:
FIELD DESCRIPTION
UNIFIED SOIL CLASSIF.
Brn. silty clay with some very fine sand (Moist - stiff).
CL
Brn. silty fine to coarse sand with some clay binder.
SM to SM-SC
Brn. silty fine to coarse sand with gravel & some cobbles.
SM
Brn. silty fine sand with clay binder and some gravel.
SC
Brn. silty fine sand with clay binder and trace gravel.
SC
NO WATER
SAMPLES
REPRESENT.
SHELBY
SPLIT SPOON
PISTON
Ready
OCR Language: English
NUM

Criteria for Chicago's Public Right of Way



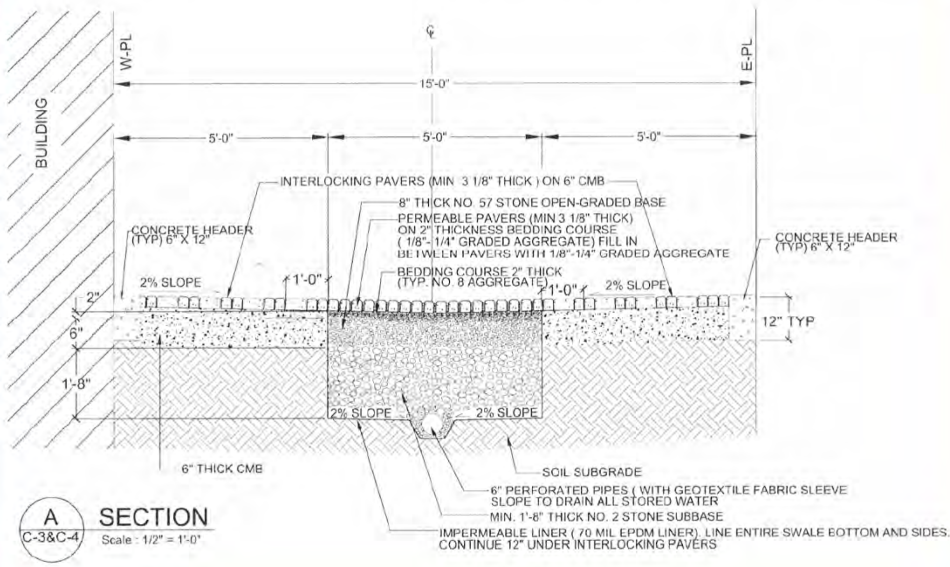
Using research data to establish a Chicago Standard for sustainable infrastructure in the public right of way.

Infiltration Realities of Los Angeles

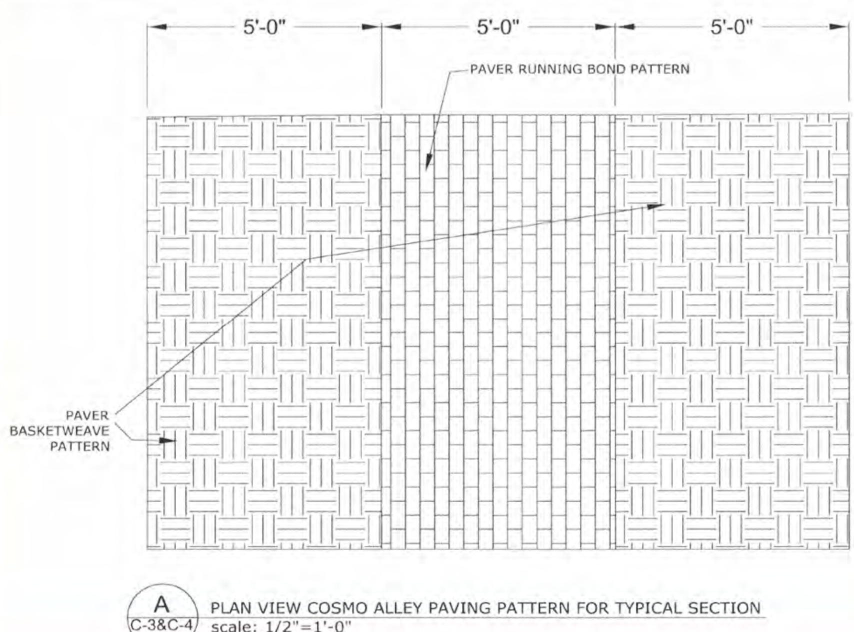
LA DPW ENGINEERING TRANSFORMING LOS ANGELES

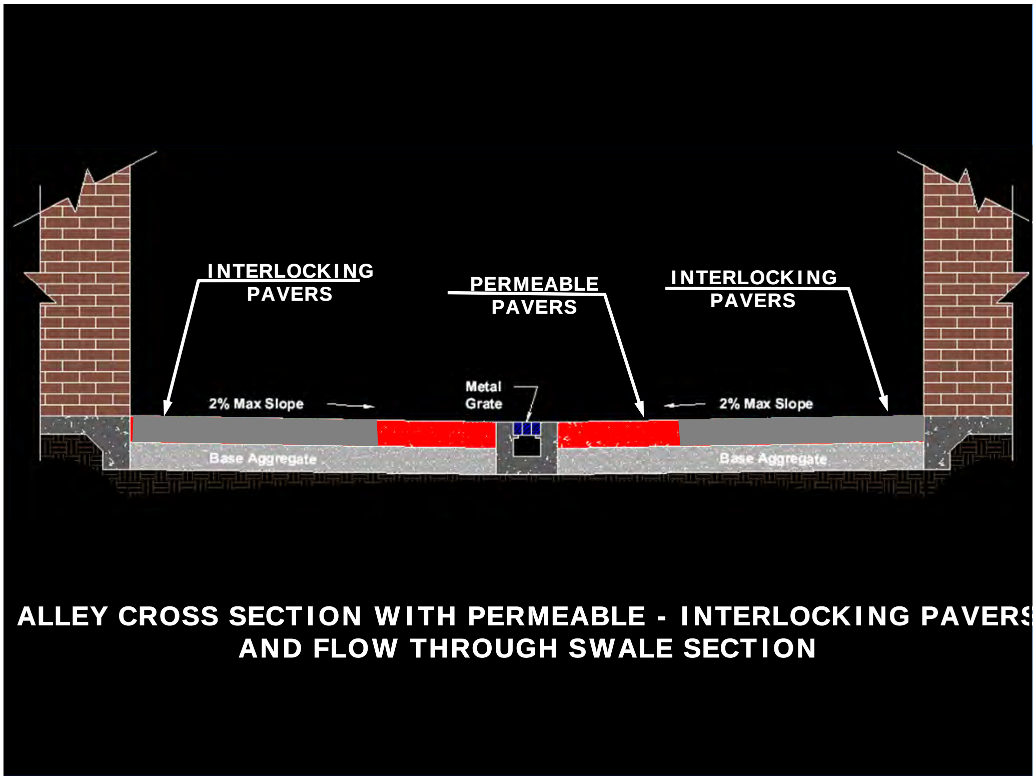
Architectural Hardscape & Modeling

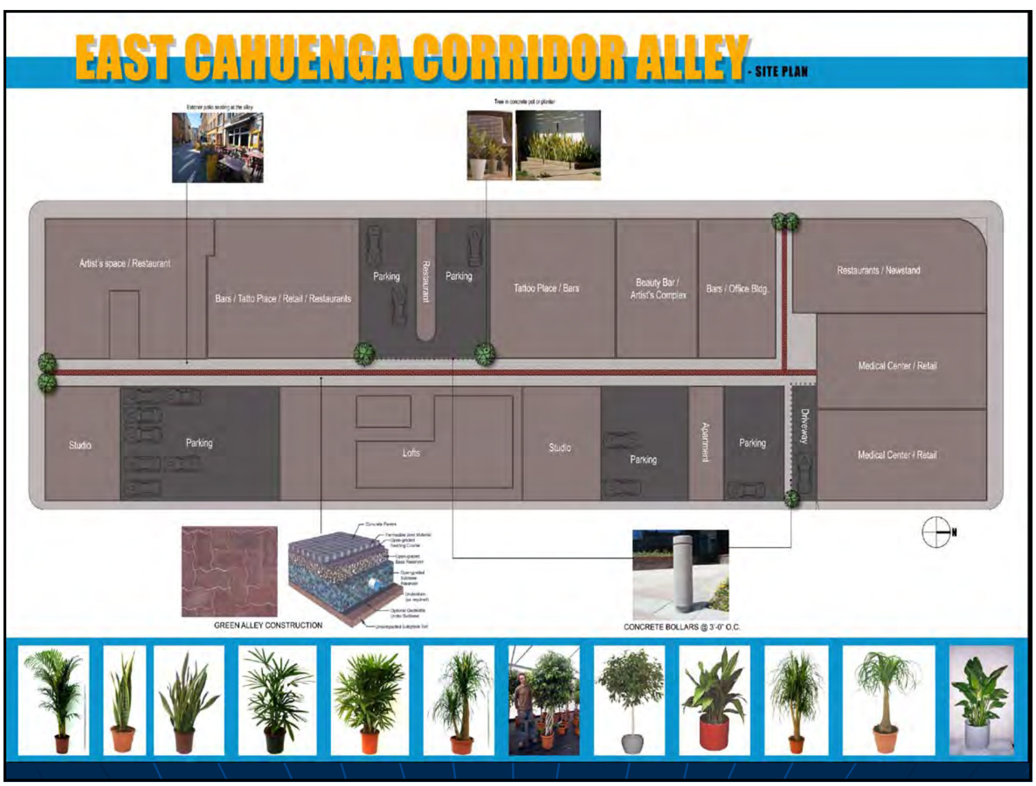
ECCA – TYPICAL SECTION FOR THE ALLEY STRIP



ECCA – ALLEY PAVING PATTERN FOR TYP.SECTION




INTERLOCKING
PAVERS
PERMEABLE
PAVERS
INTERLOCKING
PAVERS
Metal
Grate
2% Max Slope
2% Max Slope
Base Aggregate
Base Aggregate
ALLEY CROSS SECTION WITH PERMEABLE - INTERLOCKING PAVERS
AND FLOW THROUGH SWALE SECTION


EAST CAHUENGA CORRIDOR ALLEY - SITE PLAN
Artist's space / Restaurant
Bars / Tatto Place / Retail / Restaurants
Parking
Restaurant
Parking
Tattoo Place / Bars
Beauty Bar / Artist's Complex
Bars / Office Bldg.
Restaurants / Newstand
Medical Center / Retail
Studio
Parking
Lofts
Studio
Parking
Apartment
Parking
Driveway
Medical Center / Retail
GREEN ALLEY CONSTRUCTION
CONCRETE BOLLARS @ 3'-0" O.C.

PANORAMIC VIEW OF THE ECCA

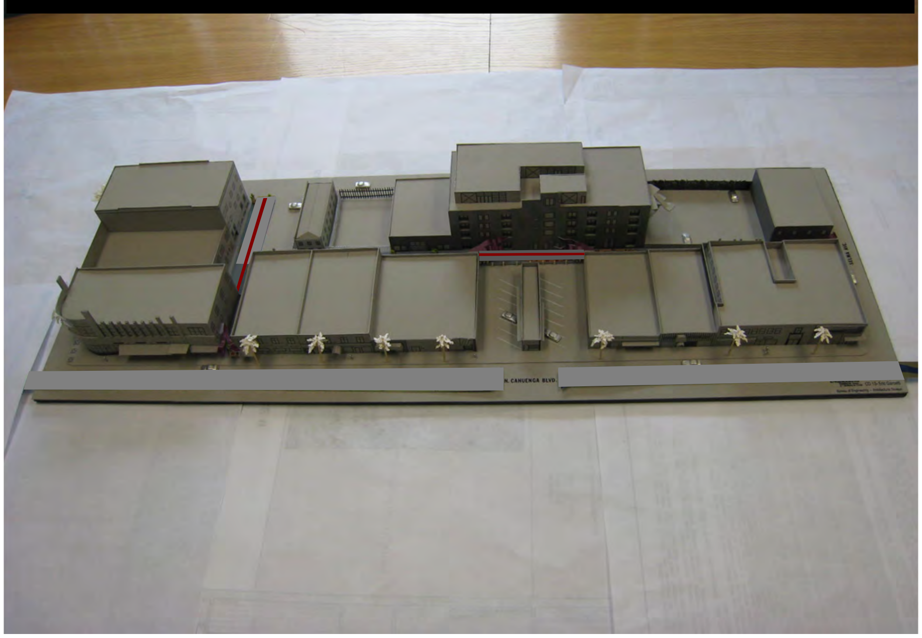
PERSPECTIVE FROM SOUTH EAST CORNER

PANORAMIC VIEW OF ECC ALLEY

SOUTH ENTRANCE THROUGH SELMA AVE.

MID-ENTRANCE THROUGH CAHUENGA BLVD. WEST SIDE

AERIAL VIEW – WEST ELEVATION



NORTH EAST ENTRANCE CLOSE UP

NORTH EAST CORNER PERSPECTIVE

Jobname:
Hollywood Alley_Lumec Domus 82 LED.AGI
Report for: STEVE LEE
Report by: Frank Lesaca // Applications Engineering Manage
Mounting Ht.: see drawing
Date:3/5/2009

——Disclaimer——
Luminaire data is obtained according to IES procedures under controlled laboratory conditions. Field results may differ from computer predictions due to many uncontrollable factors such as:
Line Voltage Variations, Lamp Performance, and Jobsite Conditions.

Prudential *Lighting* Products

Numeric Summary

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Ground_Level	Illuminance	Fc	2.35	3.3	1.1	2.14	3.00

Luminaire Schedule

Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
	8	DMS50-82LED	SINGLE	-1	1.000	LUMEC // LifeLED-DMS50-82LED63

Jobname:
Hollywood Alley_Gardco 121.AGI
Report for: STEVE LEE
Report by: Frank Lesaca // Applications Engineering Manag
Mounting Ht.: see drawing
Date:3/5/2009

——Disclaimer——
Luminaire data is obtained according to IES procedures under controlled laboratory conditions. Field results may differ from computer predictions due to many uncontrollable factors such as:
Line Voltage Variations, Lamp Performance, and Jobsite Conditions.

Prudential *Lighting* Products

Numeric Summary

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
Ground_Level	Illuminance	Fc	2.18	2.9	1.1	1.98	2.64

Luminaire Schedule

Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
	8	121	SINGLE	3663	1.000	GARDCO // 121-WT-50LA

LA DPW ENGINEERING TRANSFORMING LOS ANGELES

Construction Costs

LA DPW ENGINEERING TRANSFORMING LOS ANGELES

ECCA CONSTRUCTION COSTS

Demolition & Excavation	$ 88,620
Flow – Through Swale	$ 56,680
Hardscape – Permeable & Interlocking Pavers	$ 158,985
Selma Ave. Drainage Repairs	$ 6,000
Storm drain System	$ 69,000
Roof Drainage (vertical gutters adjustment)	$ 5,000
Traffic Control	$ 10,000
Miscellaneous (Mobilization, gate removals, other)	$ 15,000
Peripheral Improvements	$ 180,367
SUBTOTAL-1	$ 589,652
Contingency 20%	$ 117,930
SUBTOTAL-2	$ 707,582
Unforeseen Item – Grease Interceptor R&R	$ 53,000
Construction Management for the Project	$ 25,000

TOTAL CONSTRUCTION ESTIMATE...... $ 785,582

Disclaimer: This estimate does not include any lighting, security system or fencing in or around the alley. CDLF 8-7-09

ECCA PROJECT COST

PRE -DESIGN ....$ 70,000
Feasibility study

DESIGN ....$ 83,980
Survey, Geotech, Environmental Clearance, Project Mgmt, Plans, Specs and Estimates

CONSTRUCTION..$ 760,285
Demolition & Excavation, Flow Through System (Drainage), Hardscape, Drainage Repairs (Selma Ave.) Roof Drainage, Traffic Control, Miscellaneous, Construction Contingency 10%.

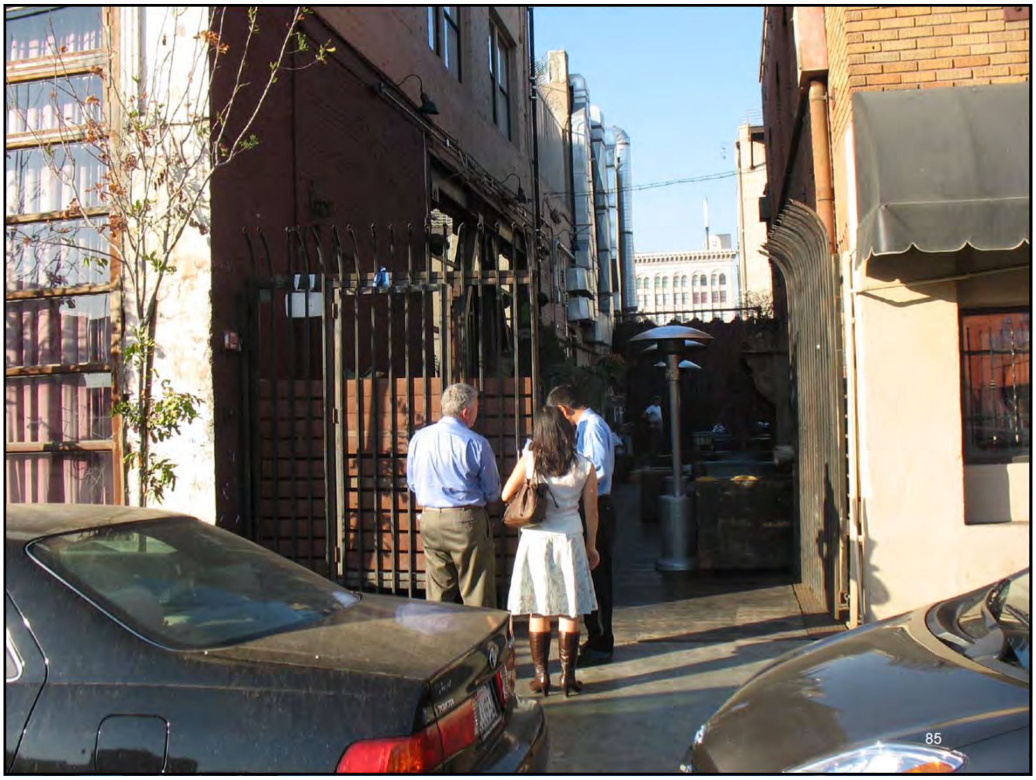
CONSTRUCTION MANAGEMENT..$ 25,000
Construction Cost for Contract Management and/or support for Inspection.

TOTAL PROJECT ESTIMATE........$ 939,265

Disclaimer: This estimate does not include any lighting, security system or fencing in or around the alley. CDLF 8-7-09

Initial Conditions

How it used to be this "Alley"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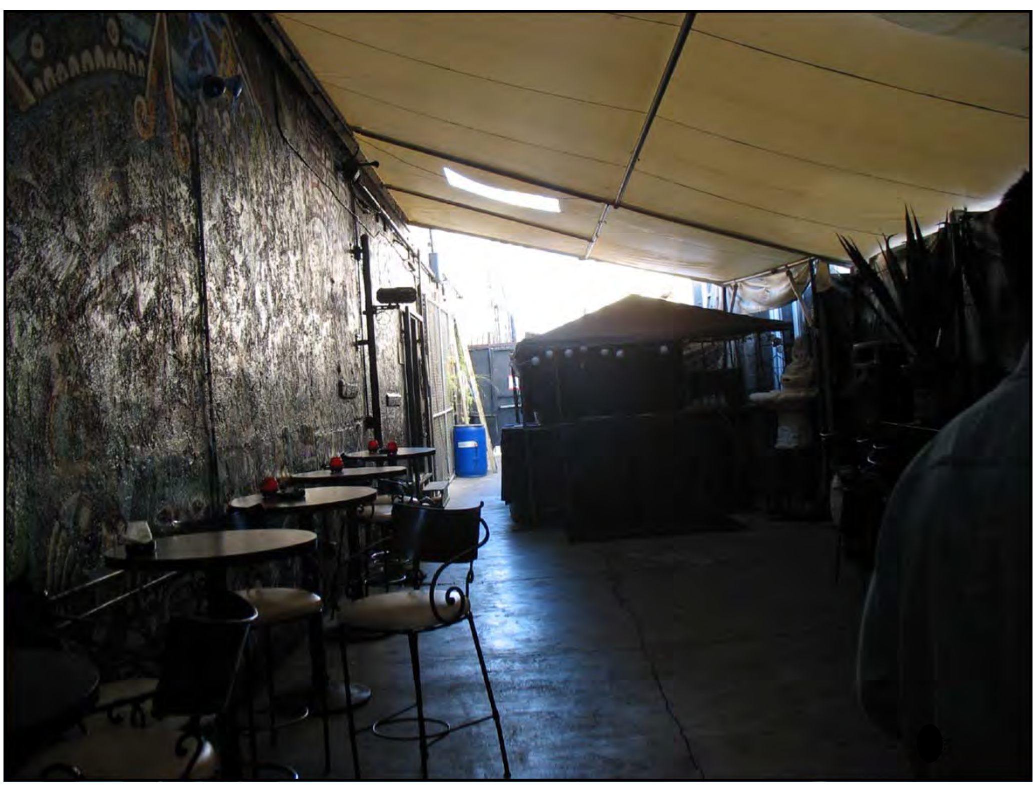

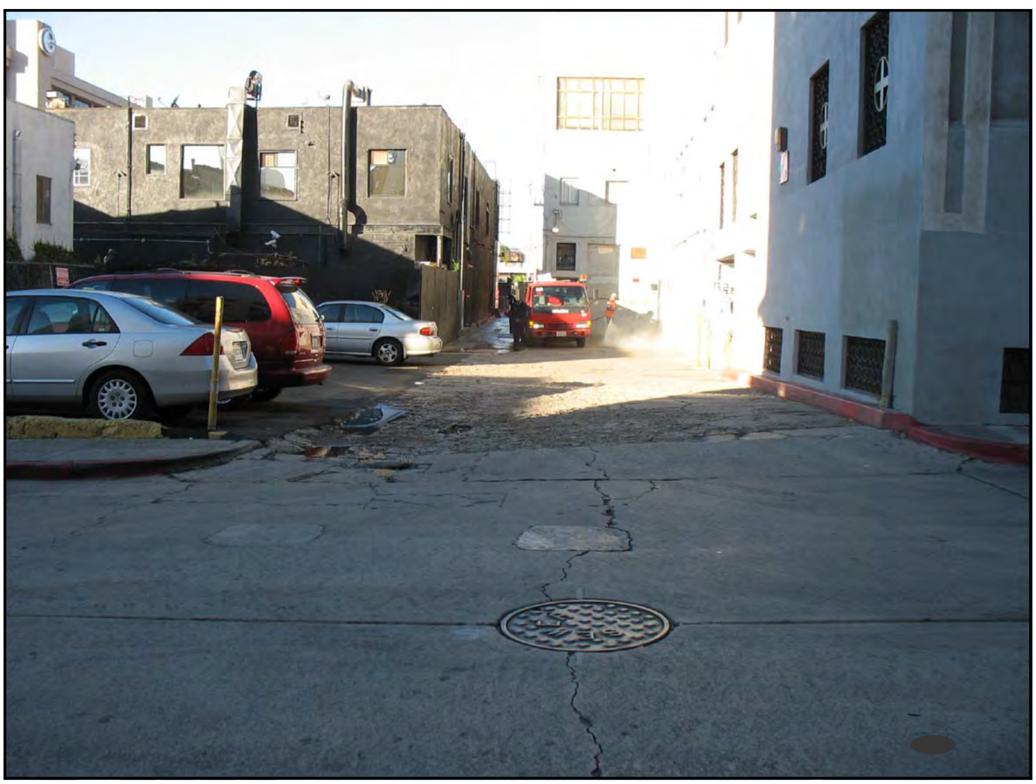

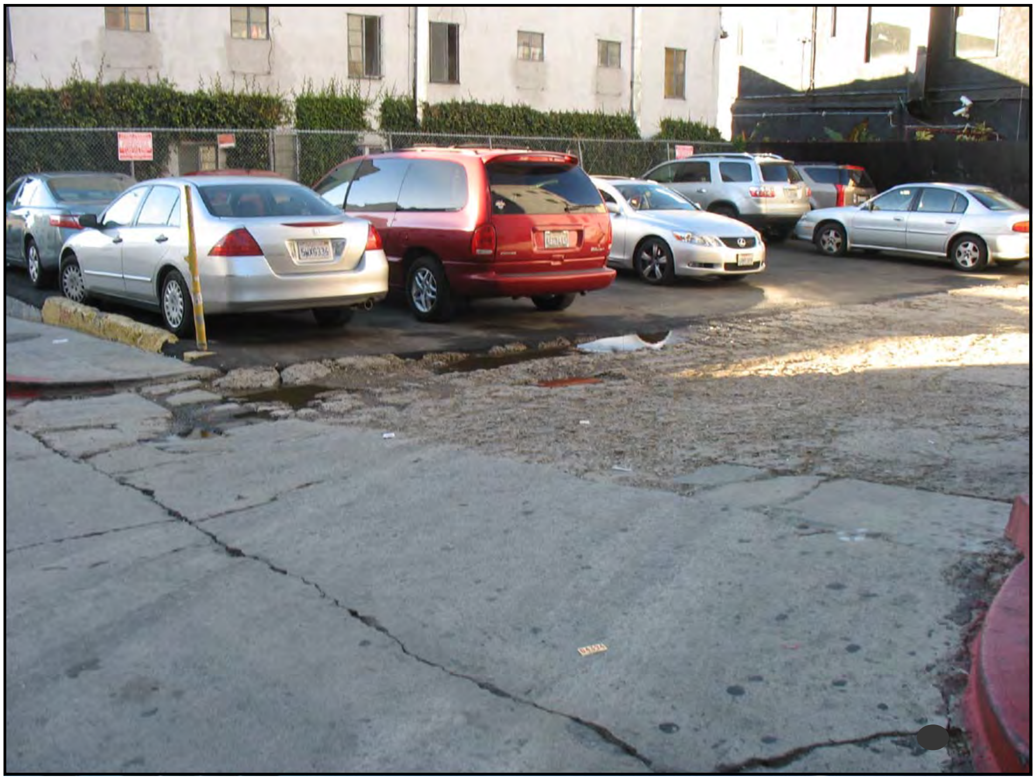

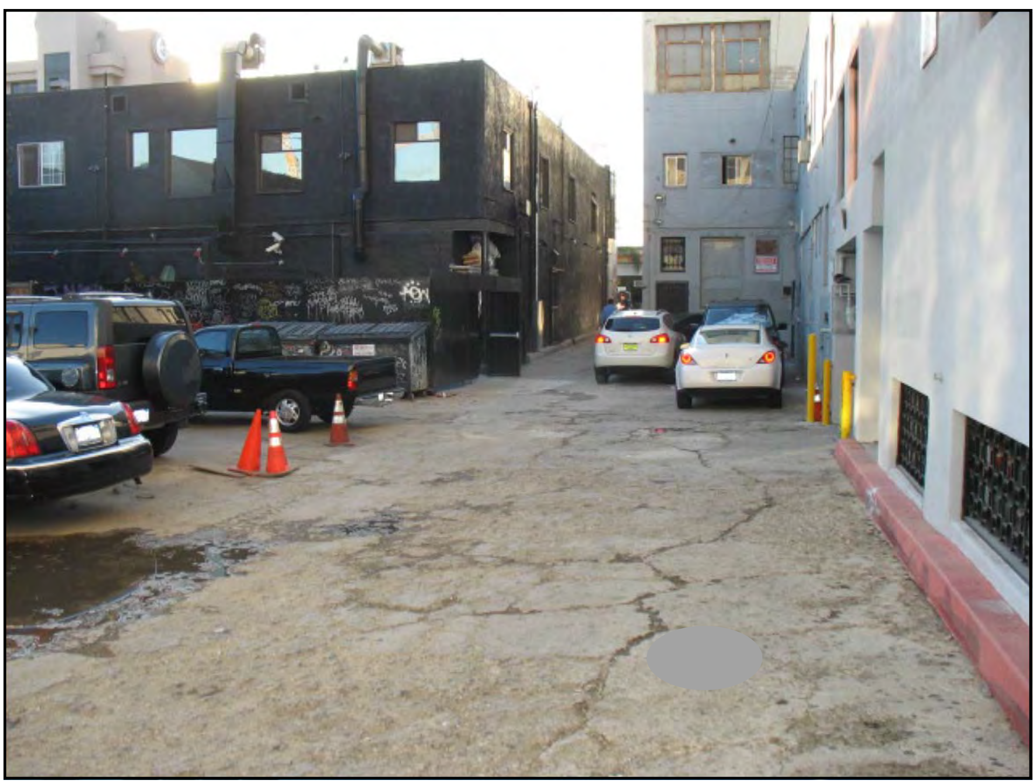

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CITY OF LOS ANGELES FOUNDED 1781

During Construction


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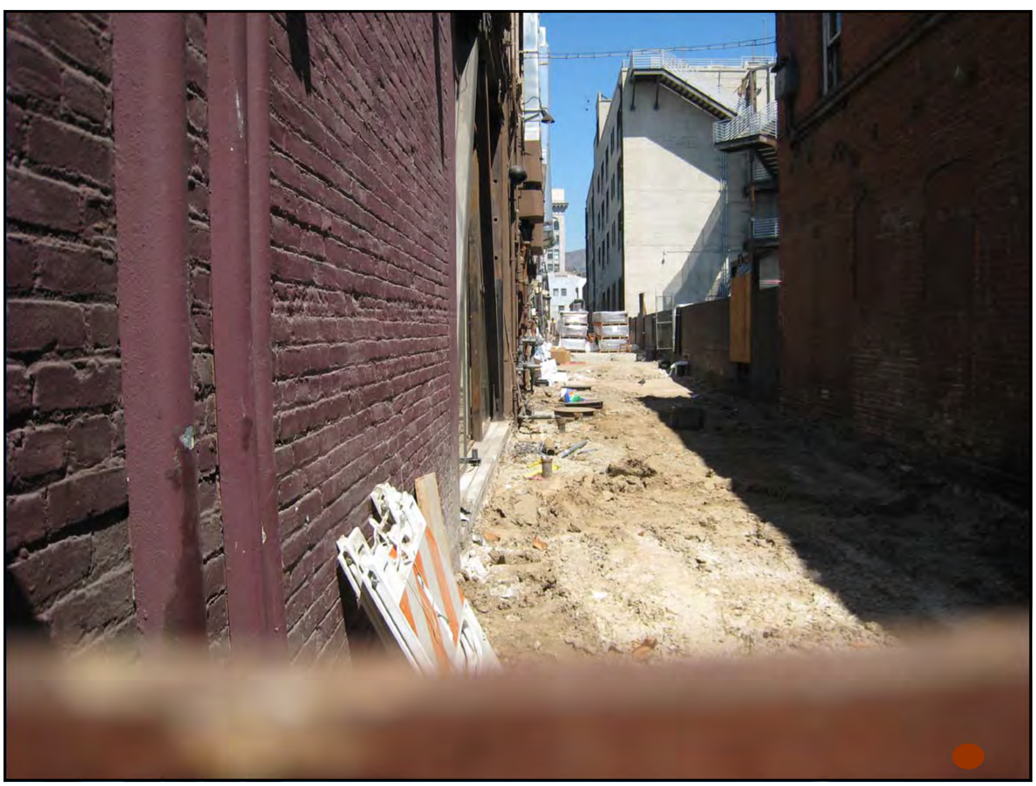
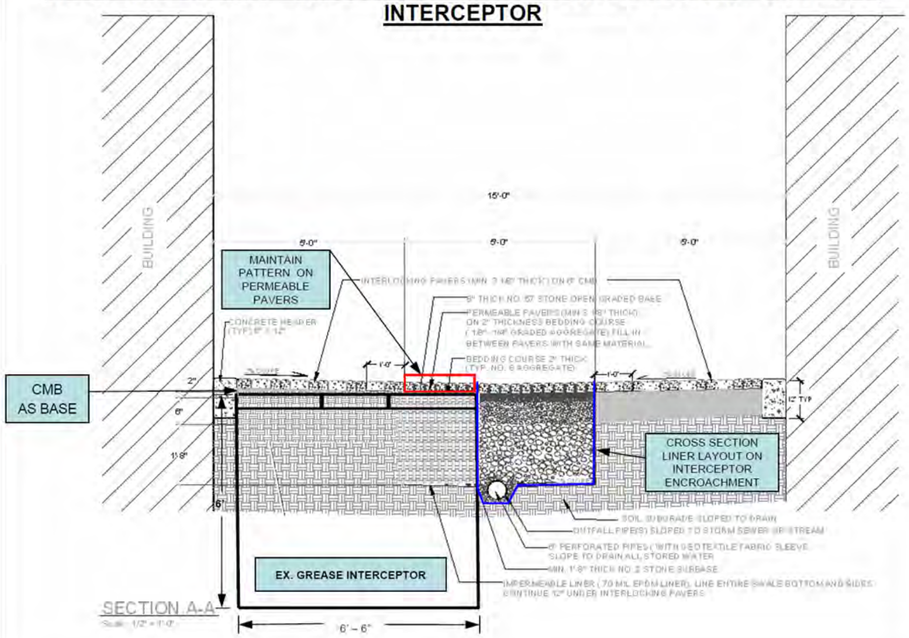
LA DPW ENGINEERING
TRANSFORMING LOS ANGELES

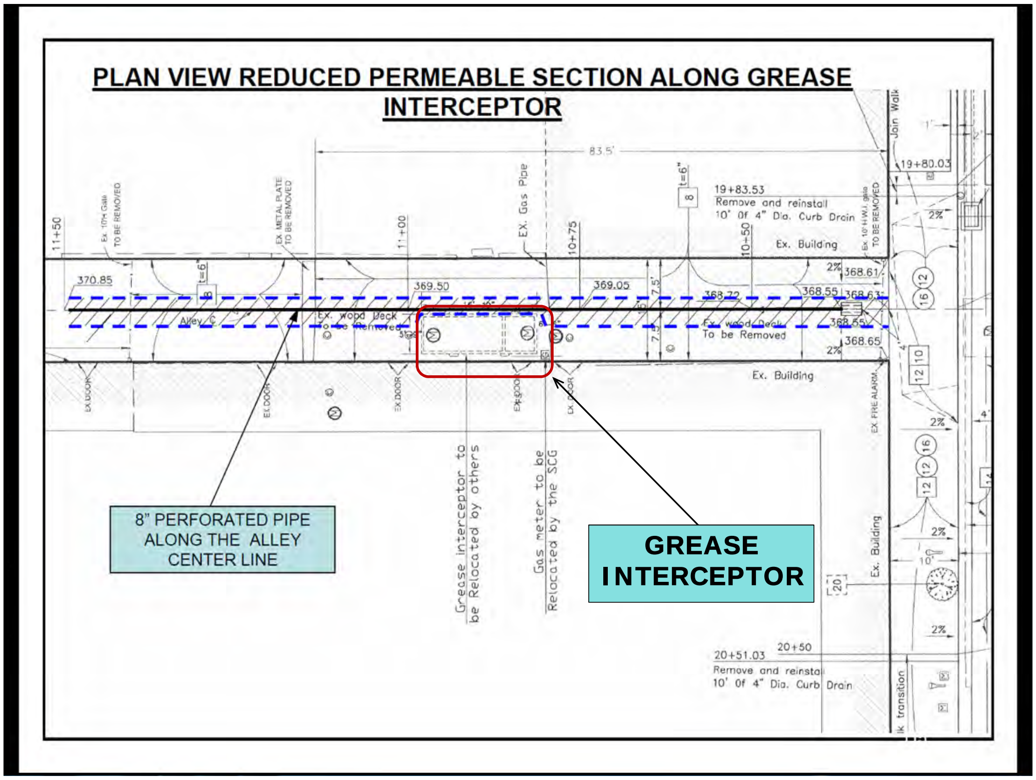
Dealing with the Alley Grease Interceptor

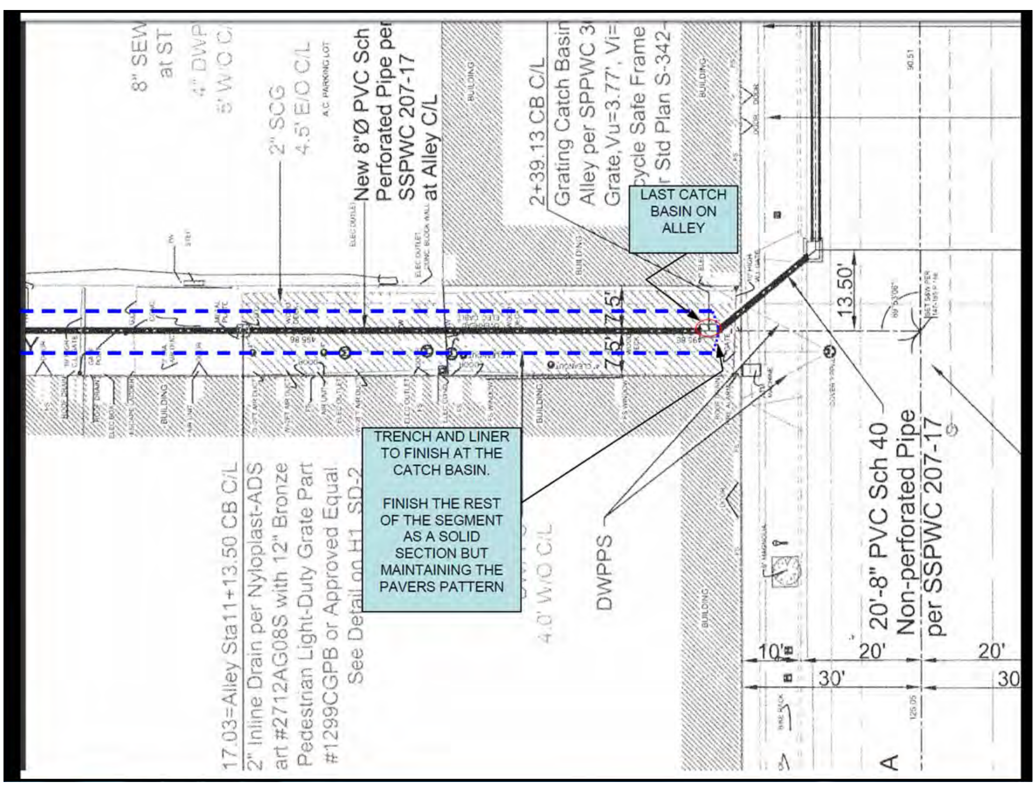

JUN 15 2011
JUN 15 2011
JUN 15 2011
JUN 15 2011

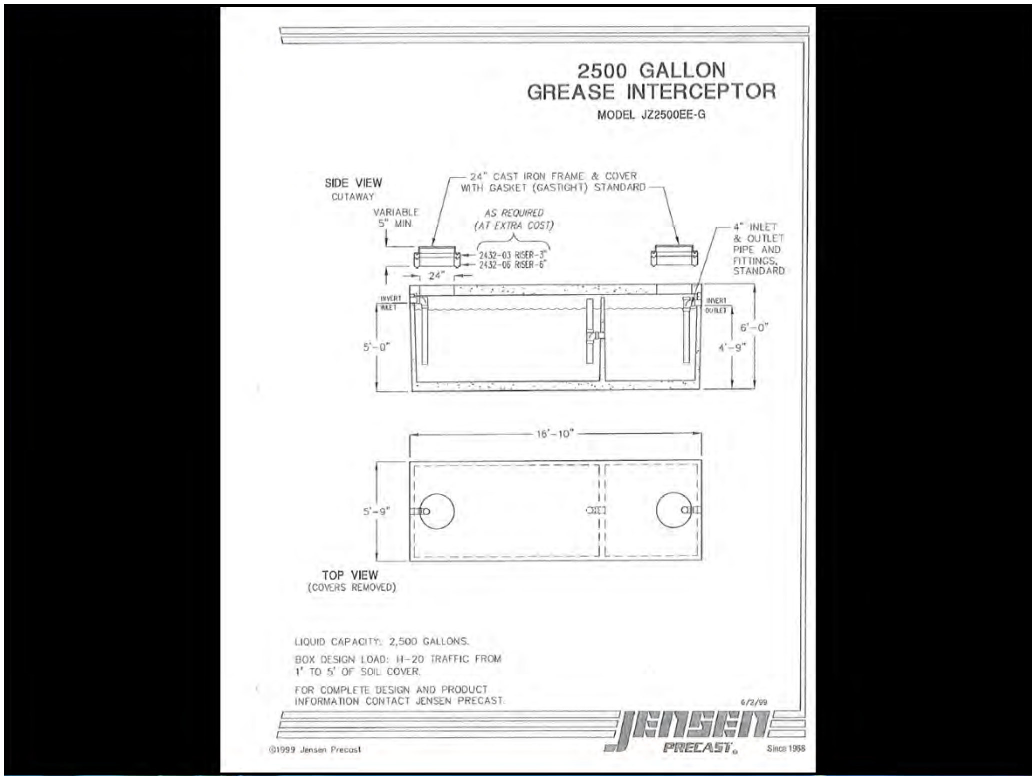


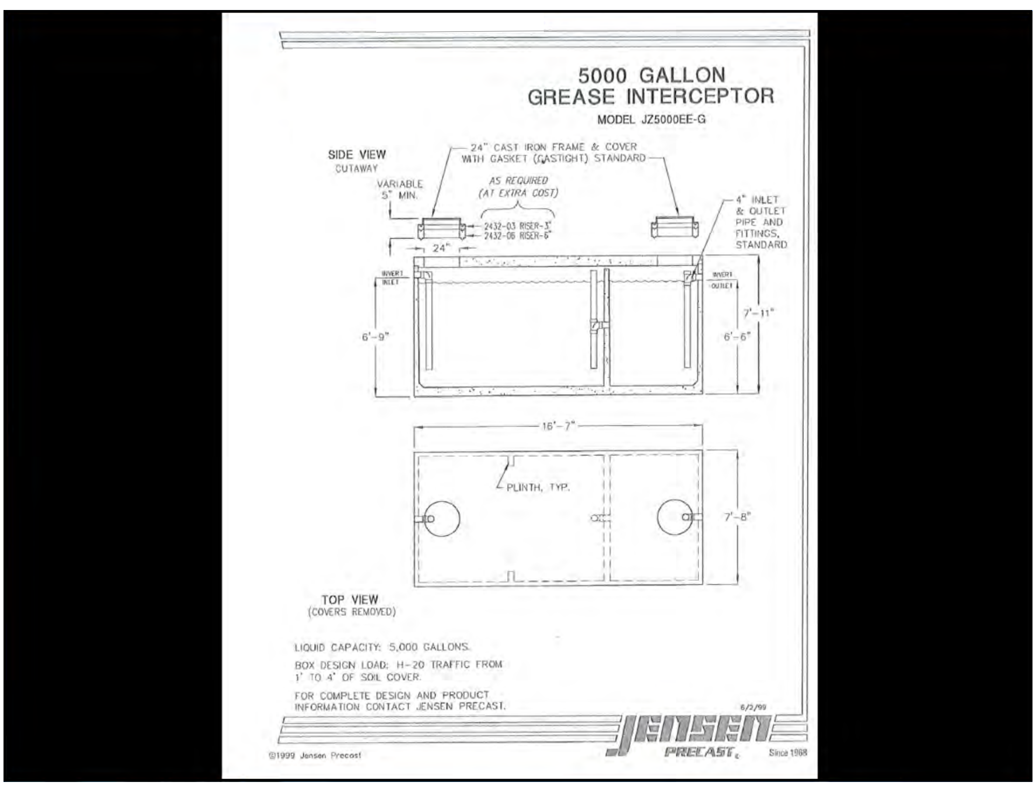
HOLLYWOOD ALLEY – REDUCED PERMEABLE CROSS SECTION ON GREASE INTERCEPTOR




PLAN VIEW REDUCED PERMEABLE SECTION ALONG GREASE INTERCEPTOR
8" PERFORATED PIPE ALONG THE ALLEY CENTER LINE
GREASE INTERCEPTOR
Grease Interceptor to be Relocated by others
Gas meter to be Relocated by the SCG
19+83.53 Remove and reinstall 10' Of 4" Dia. Curb Drain
20+51.03 Remove and reinstall 10' Of 4" Dia. Curb Drain
Ex. Building


LAST CATCH BASIN ON ALLEY
TRENCH AND LINER TO FINISH AT THE CATCH BASIN.
FINISH THE REST OF THE SEGMENT AS A SOLID SECTION BUT MAINTAINING THE PAVERS PATTERN
New 8"Ø PVC Sch Perforated Pipe per SSPWC 207-17 at Alley C/L
20'-8" PVC Sch 40 Non-perforated Pipe per SSPWC 207-17


2500 GALLON
GREASE INTERCEPTOR
MODEL JZ2500EE-G
SIDE VIEW
CUTAWAY
24" CAST IRON FRAME & COVER WITH GASKET (GASTIGHT) STANDARD
VARIABLE 5" MIN.
AS REQUIRED (AT EXTRA COST)
2432-03 RISER-3"
2432-06 RISER-6"
24"
4" INLET & OUTLET PIPE AND FITTINGS, STANDARD
INVERT INLET
INVERT OUTLET
5'-0"
6'-0"
4'-9"
16'-10"
5'-9"
TOP VIEW
(COVERS REMOVED)
LIQUID CAPACITY: 2,500 GALLONS.
BOX DESIGN LOAD: H-20 TRAFFIC FROM 1' TO 5' OF SOIL COVER.
FOR COMPLETE DESIGN AND PRODUCT INFORMATION CONTACT JENSEN PRECAST.
6/2/99
©1999 Jensen Precast
JENSEN PRECAST
Since 1968


5000 GALLON
GREASE INTERCEPTOR
MODEL JZ5000EE-G
SIDE VIEW
CUTAWAY
24" CAST IRON FRAME & COVER WITH GASKET (GASTIGHT) STANDARD
VARIABLE 5" MIN.
AS REQUIRED (AT EXTRA COST)
2432-03 RISER-3"
2432-06 RISER-6"
24"
4" INLET & OUTLET PIPE AND FITTINGS, STANDARD
INVERT INLET
INVERT OUTLET
6'-9"
7'-11"
6'-6"
16'-7"
PLINTH, TYP.
7'-8"
TOP VIEW
(COVERS REMOVED)
LIQUID CAPACITY: 5,000 GALLONS.
BOX DESIGN LOAD: H-20 TRAFFIC FROM 1' TO 4' OF SOIL COVER.
FOR COMPLETE DESIGN AND PRODUCT INFORMATION CONTACT JENSEN PRECAST.
6/2/99
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Since 1968


BUD LIGHT
LOADING ONLY
119


121


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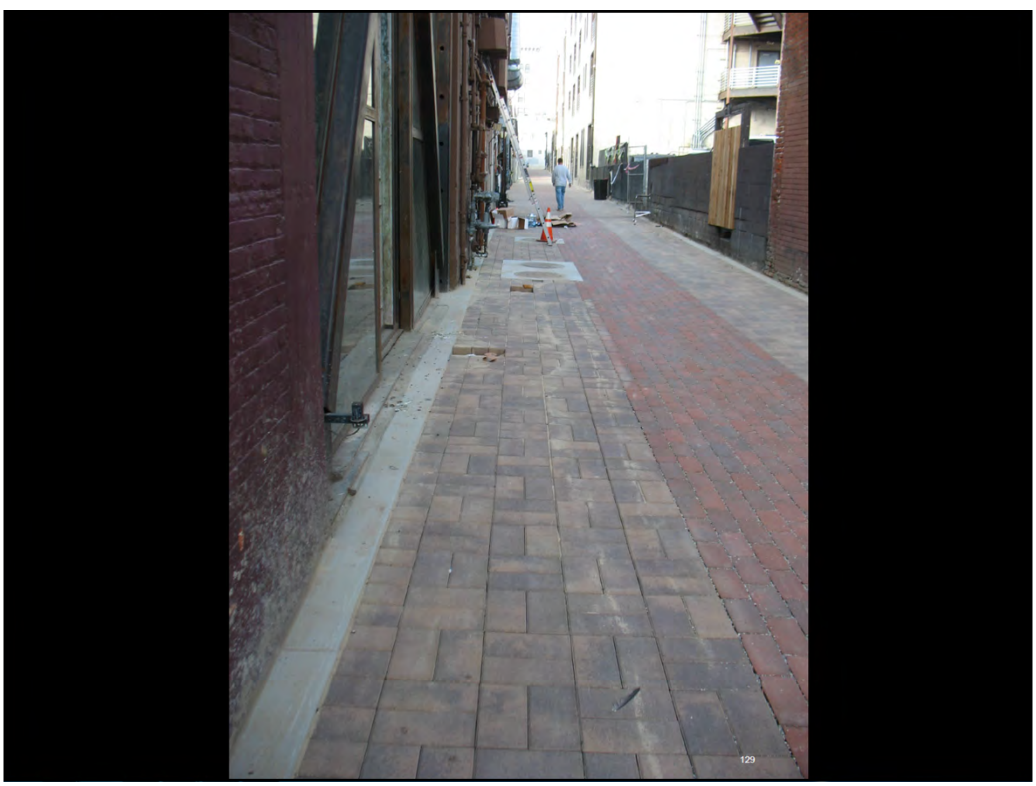
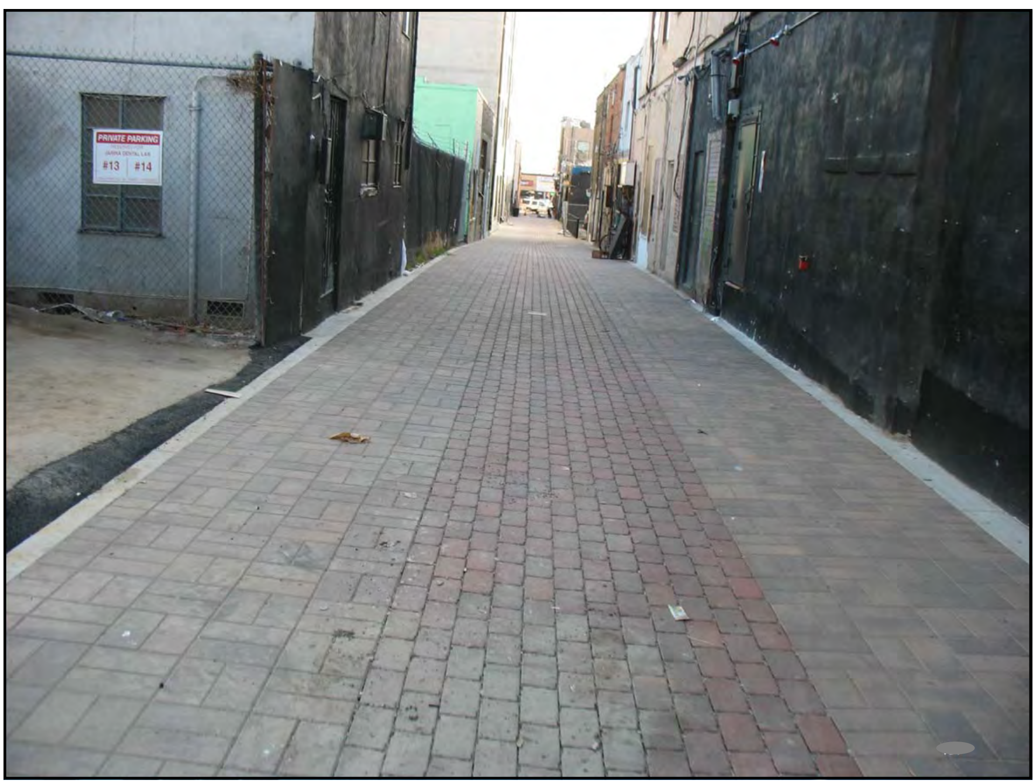
FOUNDED 1781

The Final Product

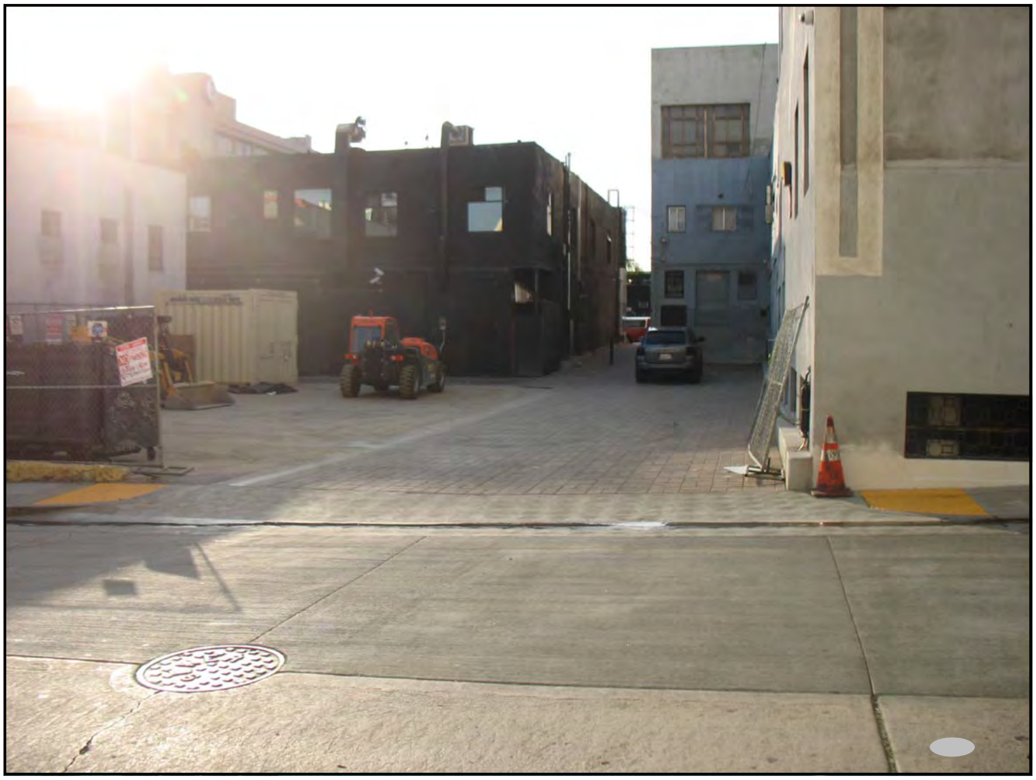
A Green Alley


129


130


PRIVATE PARKING
#13
#14


Hertz
G5-18A




NOV 15 2011


A BRAND NEW CONSTRUCTED GREEN ALLEY


EaCa alley

LA DPW ENGINEERING TRANSFORMING LOS ANGELES

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First Green Alley

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From Crime and Grime to Wine and Dine

By Aaron Blevins, 3/01/2012

East Cahuenga Pedestrian Alley Opens

The latest installment of "urban acupuncture" in Los Angeles has finally found its chi, as city officials last Thursday opened the East Cahuenga Alley, a pedestrian alley west of Cosmo Street between Hollywood Boulevard and Selma Avenue.

Councilmember Eric Garcetti (with scissors) joined business leaders and city officials at a ribbon cutting for the new pedestrian alley. (photo by Aaron Blevins)

Since 2005, the city and area property owners have been working to eliminate the alley's many nuisances — standing water, graffiti, trash and crime. After installing storm drains, lights, permeable paving and more, the site will now serve as an outdoor dining area for St Felix and Kitchen 24.

"[We] never imagined it'd be as beautiful as it is," said Council-member Eric Garcetti, 13th District. "This is a wonderful example of the public and private sectors working together for our neighborhoods. … It's innovative. It's fresh and exciting."

Garcetti said the pedestrian environment, which is the first of its kind in Los Angeles, was developed in conjunction with property and business owners in the area. Whereas the alley was previously crime-ridden and unappealing, it will now serve as a place for locals and tourists alike to stroll and relax, he said.

"They say the car is king here, but the car only gets us to where we really want to be," Garcetti said, adding that officials want tourists to feel at home immediately after arriving in L.A. "We want people to have that experience — whether you're a tourist from abroad or somewhere else in the United States, or whether you're a local resident here in Hollywood, we know that you will love this alleyway. … This is the place where the new Hollywood — the second Golden Age — is being born."

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