

# Live And Let Live: Finding Common Ground between Emergency Safety Needs and Effective Storm Water Management

Drs.

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# Ventura County California



# Aligning Land Use and Water Quality Protection in Ventura County (A watershed plan)

<http://water.lgc.org/ventura>

“Within Ventura County, street and driveway design is highly influenced by the [Ventura County Fire Protection District’s Codes Standards and Ordinances](#)...These standards do not support and very often preclude narrow streets, traffic calming, alternative paving and other elements of a “green/complete” streets program.”

“Ventura County Fire Protection District’s Codes and Ordinances limit paving materials to asphalt and concrete in travel lanes... Alternate surface pavers are allowed on a limited case by case basis only. It must be approved by the Fire Prevention Bureau and comply with all the requirements of this standard. No vegetation is allowed between pavers in driveways and turnarounds, though gravel and non-vegetative filler can be used.

“Materials shall be tested in accordance with the test methods required by the ‘Standard Land Development Specifications,’ as well as those supplementary test methods required by the DPW. ...The significance is that as new technologies come on line, communities in Ventura County may find that the “Standard Land Development Specifications” limit alternative/permeable pavement options if test methods are not updated.”

# Davis, California Village Homes



# Data Collection Process

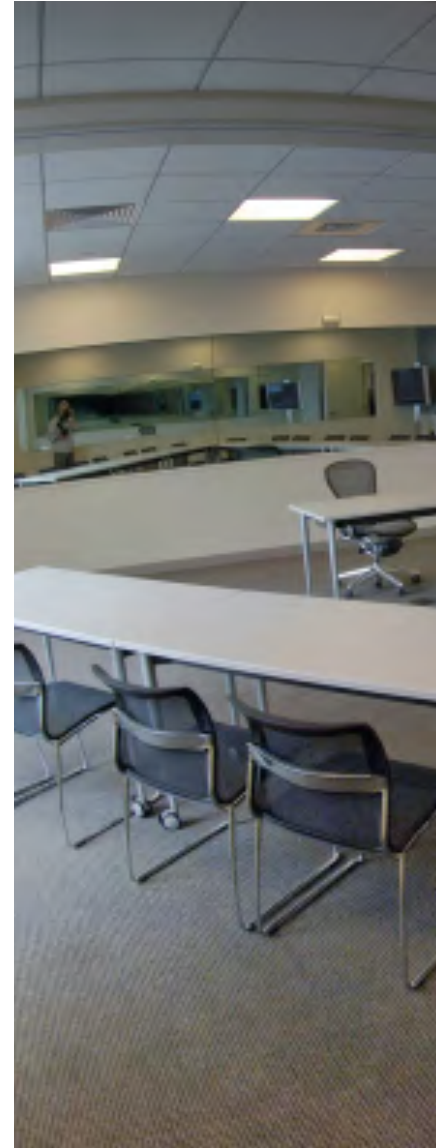
- ▶ Focus Group Interviews
- ▶ Telephone Interviews
- ▶ Face-to-Face Interviews
  - ▶ Formal
  - ▶ Ride along
  - ▶ Informal
  - ▶ Email Contact with European Fire Experts



# Focus Group Interviews

Fire Marshals

City Engineers/Planners





# Fire Marshal's Concerns

General Lack of Confidence in Alternative Storm Water Management Systems -

- Maneuverability
- Structural Support
- Maintenance of Infiltration Areas





# Fire Marshal's Concerns

General Lack of Confidence in Alternative Storm Water Management Systems -

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Limitation to Access Areas



# Planners and City Engineers

Fire Fighters Often Block “Smart Growth” and So Call “Low Impact Development” Designs

Street Widths Are Often Decided on a Myriad of Issues and Concerns Concerning Access, Maneuverability, and Use



# Face-To-Face Interviews

- ▶ Formal interview with former Fire Marshal and current member of the Governor's Green Building Task Force -
  - Invitation to Attend Regional Fire Fighter Conference
  - Provided Access to Other Fire Fighters
  - Ride Alongs to View Situations From Fire Fighters Perspective





# Telephone Interviews

- ▶ GoodYear Tire Company
- ▶ American Concrete Pavement Association
- ▶ 7 Fire Apparatus Company's
- ▶ City Engineers & Planners



# GoodYear Tire Company

- ▶ Most Common Tire Used on Fire Trucks/Engines
  - ▶ G286 12R22.5
  - ▶ Inflated to 90 psi
  - ▶ Average Surface Area of Tire Contact  $95 \text{ in}^2$  ( $613 \text{ cm}^2$ )
  - ▶ Maximum weight displacement for each is 357 psi

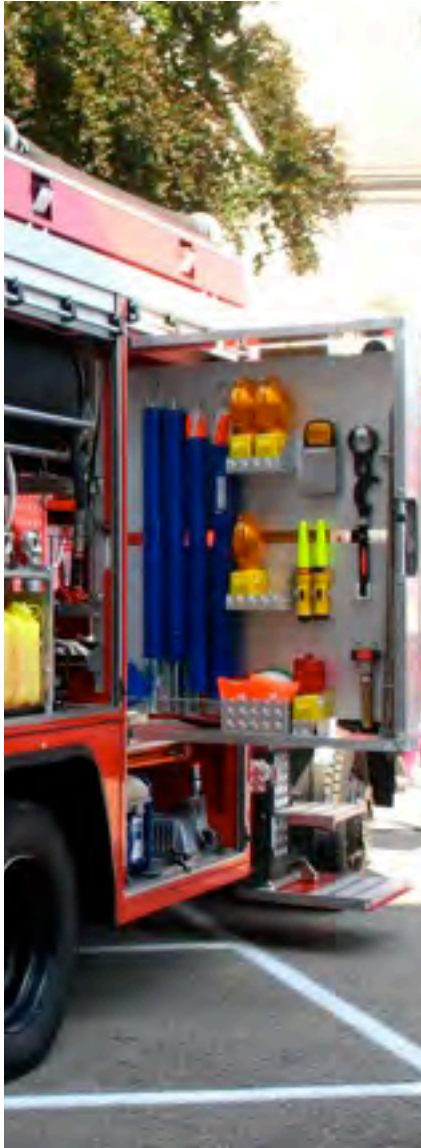


# Pervious Concrete

- ▶ Can Develop Compressive Strength of 500-4,000 psi - Typical Values - 2,500 psi (7-Fold Safety Factor)
- ▶ General Rule - “6 in Pervious Pavement with 15-20% Void Space Can Handle Occasional Truck Traffic”







## Fire Truck Size

Truck Size Dictated by Size of  
the Radiator - Clean Air  
Requirements

European Trucks Smaller to  
Accommodate Older Narrower  
Streets





## Fire Truck Size

Location of the Pump is important  
- 30% reduction in energy from  
directly behind the engine to the  
rear of the truck - reduced  
pumping capacity.

European Fire Trucks typically  
pump 1600 liters/min (413 gal/min)

Minimum US Standard 1000 gal/  
min (3785 liters/min)



# Conclusions

To address storm water runoff requirements and Emergency Services needs:

- Open and early dialog with ES providers
- Understand the issues and constraints other departments face
- Flexibly and an appreciation there is no one-size-fits-all solution





# Deliverable - Six Page Factsheet

described as

"...the most equitable treatment of the topic I have seen to date."

- Davis CA Fire Chief

# Emergency Services and Storm Water Management

Timothy Lawrick, Ph.D. and Melissa Myers, D.Div., California Sea Grant College of Engineering

**Many communities are interested in reducing environmental impacts of storm water by changing local infrastructure. They recognize the importance of accomplishing this without compromising essential community services such as fire safety. To identify the needs of emergency services (ES) personnel (primarily fire marshall) and the contracts city-county planners, elected and other municipal officials have when making land use decisions related to storm water management, we convened two focus groups and organized personal interviews with representatives of these groups in both Northern and Southern California. The purpose of this fact sheet is to help communities address storm water runoff problems while maintaining excellent public health and safety services. The main findings from our work are summarized, highlighting the benefits and drawbacks of alternative site designs for storm water management from the perspectives of ES personnel, planners and municipal officials.**



## Emergency Safety Needs

- Easy/quick access to buildings
- Maneuverability
- Structural integrity of access ways
- Quick access to hoses and equipment

## Environmental Impact of Storm Water and LID

Urban storm water runoff is the predominant cause of water quality decline and nonpoint-source pollution in streams, lakes and estuaries (Arnold & Gibbons, 1996; USEPA, 1996). Toxic materials found in storm water such as heavy metals, nutrients, pesticides and pathogens can degrade the environment and impact human health (Fleish & Jackson, 1997; Pitt, Clark & Field, 1998). A key factor contributing to the contamination and flow of storm water runoff is hardscape or impervious surface areas, such as roads, parking lots and rooftops (Arnold & Gibbons, 1996; Schwab, 1996).

The United States Environmental Protection Agency (U.S. EPA) and state regulatory agencies are requiring a reduction in both the volume and rate of urban runoff. Communities interested in reducing storm water runoff by limiting impervious development are using "Smart Growth" strategies, which are often used to protect sensitive areas, reduce hardscape by encouraging redevelopment and higher population densities, and encourage walkability and bike riding through narrower street widths (USEPA, 2004). Another way to achieve a reduction in urban runoff is by directing it to permeable surfaces (such as porous asphalt and cement), infiltration landscape areas (such as bio-retention basins, rain gardens and meadows, which treat storm water by allowing it to percolate into the ground), wetland ponds, and green roofs (Gosler, Hunt & Callaway, 2006).

Collectively, these strategies are often called Better Site Design or Low Impact Development (LID). Some of these new storm water management strategies potentially conflict with essential public health and safety services that communities provide including: waste management, public transportation, flood fighting, fire fighting and other emergency services (Jiang, Shroyer & Brown, 2007). Changing community design and development practices to accommodate new storm water management systems presents challenges and opportunities for ES personnel and government officials.

## Concerns of Emergency Service Professionals

ES professionals are understandably wary of alternative approaches to storm water treatment that may affect their professional responsibilities. Site design features that cause the greatest amount of concern include narrow streets, permeable surfaces and bio-retention basins. The overriding concerns about these features expressed by ES professionals are limitations to access, maneuverability, structural support for vehicles, and maintenance of infiltration areas. Any of these factors may hinder access in an emergency situation or affect response time.



[http://www.csgc.ucsd.edu/BOOKSTORE/Resources/LID\\_FACTSHEET.pdf](http://www.csgc.ucsd.edu/BOOKSTORE/Resources/LID_FACTSHEET.pdf)

# Emergency Services and Storm Water Management

Timothy Luerbeck, Ph.D. and Marissa Myers, D.Grn., California Sea Grant College Program



## Emergency Safety Needs

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## Environmental Impact of Storm Water and LID

Urban storm water runoff is the predominant cause of water quality decline and erosion/sedimentation in streams, lakes and estuaries (Arnold & Giblin, 1996; USFWS, 1996). Toxic materials found in storm water such as heavy metals, solvents, pesticides and pathogens can degrade the environment and impact human health (Smith & Jackson, 1997; FNL Clark & Todd, 1998). A key factor contributing to the contamination and flow of storm water runoff is hardening of impervious surface areas, such as roads, parking lots and rooftops (Arnold & Giblin, 1996; Schwab, 1994).

The United States Environmental Protection Agency (EPA) and state regulatory agencies are requiring a reduction in both the volume and rate of urban runoff. Communities interested in reducing storm water runoff by limiting impervious development are using "Smart Growth" strategies, which are often used in urban sensitive areas, reduce hardpads by encouraging redevelopment and higher population densities, and encourage walkability and bike-ownership through narrower street widths (SUDPA, 2004). Another way to achieve a reduction in urban runoff is by directing it to pervious surfaces (such as porous asphalt and gravel), infiltration landscape areas (such as permeable basins, rain gardens and swales, which treat storm water by allowing it to percolate into the ground), wetland ponds and green roofs (Stover, Blum & Callaway, 2000).

Collectively, these strategies are often called Better Site Design or Low Impact Development (LID). Some of these new storm water management strategies potentially conflict with essential public health and safety services that communities provide including: water management, public transportation, flood lighting, fire fighting and other emergency services (Swing, Stover & Brown, 2007). Changing community design and development practices to accommodate new storm water management systems presents challenges and opportunities for ES providers and government officials.

## Concerns of Emergency Service Professionals

ES professionals are understandably wary of alternative approaches to storm water treatment that may affect their professional responsibilities. Site design features that cause the greatest amount of concern include narrow streets, permeable surfaces and permeable basins. The overriding concerns about these features expressed by ES professionals are limitations to access, maneuverability, structural support for vehicles, and maintenance of infiltration areas. Any of these factors may hinder access in an emergency situation or affect response time.



## Narrow Streets

**Benefits:** Reduced amount of impervious surface area, reduced storm water runoff, more intimate community character, better walkability, slower traffic, safer for children to play.

**Drawbacks:** Reduced maneuverability potential for delay in response time to emergencies.



Photo: Mike Smith, City of San Diego Fire Department

Residential street design professionals believe residential streets have a greater function than providing access, street parking and convergence of traffic. They suggest that traffic in residential areas should be minimized to reduce noise and accommodate bicycle and pedestrian traffic. Residential streets can provide a sense of space and community, and often function as meeting places for neighbors and play areas for children. Street widths should be based on the neighborhood function while providing for suitable access in emergency situations. They contend that 24-26 foot wide streets, as suitable for most local streets and can include parking on both sides (Ruhoff, 2005).

\* FIC 402.2.1 (Fire Apparatus Access) - Streets  
 \* FIC 402.2.2 (Fire Apparatus Access) - Streets  
 \* FIC 402.2.3 (Fire Apparatus Access) - Streets

## Reducing Fire Engine Size

**Benefits:** Greater maneuverability ability to access narrower streets, and light turning radius.

**Drawbacks:** Reduced pumping capacity (less volume is available to fight a large blaze), may not be able to carry all the equipment needed in an emergency.

There are two main factors that determine fire engine size: storage and pumping capacity. Since the safety personnel are first responders to many situations where there are risks to public health and safety, the engines are "rolling tool boxes" storing a large amount of equipment. The primary factor that determines the width of the fire engine is the engine size and the water pump it drives. Fire engines in the United States have large pumps capable of discharging 1,250-2,000 gallons per minute. To maximize the energy transfer from the engine through the transmission and into the pump, the pump is placed directly behind the transmission. The location of the pump dictates that the jumping station and the operator needs to be positioned on the side of the truck directly behind the cab (Pfeifer, 2004). The fire engine length is a function of the size of the cab, the pump, and the equipment storage area for hoses and other tools and supplies.

Recently, the width of most fire engines increased from 36 inches (9 feet) to a maximum of 102 inches (8.5 feet). This resulted from new ocean air regulations on diesel emissions that required engines to burn better to reduce particulate matter. To deal with the excess heat needed for complete combustion, trucks have larger engines (500-600 hp) and cooling systems, since the size of the engine and radiator affect truck weight, clearance turning trucks, with larger, taller engines and bigger cooling systems, are wider. Some trucks are built to the maximum allowable width, and with permits adding 10 inches to built above the total permissible truck width to 112 inches (10 feet, 2 inches).



Photo: Mike Smith, City of San Diego Fire Department

[http://www.csge.ucsd.edu/BOOKSTORE/Resources/LID\\_FACTSHEET.pdf](http://www.csge.ucsd.edu/BOOKSTORE/Resources/LID_FACTSHEET.pdf)



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Photo: Mike Hootman, www.firetruck.com

The International Fire Code (IFC) guidelines (California Building Standards Commission, 2007) adopted by the state of California recommend a minimum of 26-foot wide streets with no parking. This allows enough room for two trucks to pass each other or one truck to get around another of the emergency scene. The IFC also allows exceptions to their guidelines if the alternate follows the "intent of the provision of the codes and are at least equivalent of that prescribed in quality, strength, effectiveness, fire resistance, durability and safety." Generally, jurisdictions require wider lanes from the minimum IFC guidelines to allow traffic maneuverability and access for services.

Typically a two-lane highway will have a minimum of 12-foot (24 feet total) travel lanes (Chen, 2006). There is not a clear requirement for parking lane widths in California's codes, however, most jurisdictions use 8 feet for parking and 15 feet if the lane is to be used for both parking and driving (7 feet for parking spaces and 8 feet for the drive lane). Parking areas are designed to accommodate the size of the vehicle and enough room for door opening and maneuvering, although the size may vary according to the traffic function and flow in an area. On a busy street, for example, widths for maneuverability and safe access are greater than on a quiet residential street.



Photo: Mike Hootman, www.firetruck.com

## Reducing Fire Engine Size

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Recently, the width of most fire engines increased from 36 inches (9 feet) to a maximum of 102 inches (8.5 feet). This resulted from new ocean air regulations on diesel emissions that required engines to burn better to reduce particulate matter. To deal with the extra heat needed for complete combustion, trucks have larger engines (600-600 hp) and cooling systems. Since the size of the engine and radiator affect truck width, cleaner burning trucks, with larger, better engines and bigger cooling systems, are wider. Some trucks are built to the maximum allowable width, and with options adding 10" trailers to built onto the total permissible truck width is 132 inches (10 feet, 2 inches).



A better fit approach with compact station in the rear and compact design for maneuverability and access of smaller streets.

## Innovative Neighborhood Design

In Davis, California, the Village Homes community, built in 1970, is an example of innovative neighborhood design. To build community character and maintain inspiration now, the streets are curvy, only 16-24 feet wide without on-street parking (off-street parking is allowed), and end in cul-de-sacs. These first laws occurred in job development and the city has benefited from the visible success they provided. The curvy streets can be problematic when fire trucks are charged since lanes tend to straighten and not follow the curvature of the street. This and the lack of on-street connectivity due to cul-de-sacs can impeded access to other

emergency personnel after water is delivered to the fire. If a development similar to Village Homes were proposed today the design would look substantially different. Community local officials try to work with developers to meet the goals of the community. Any new development is reviewed on a case-by-case basis. Twenty four foot wide streets with parking on one side and 16-foot streets without parking may be acceptable with drive-connecting streets (without cul-de-sacs). This flexible approach in Davis is a good model for finding a balance in meeting environmental concerns and emergency service requirements.



24 Feet

## Smaller Trucks

Some proponents of narrower streets suggest that smaller trucks would reduce the concern generated by emergency service professionals (Wong, et al., 2007). They argue that in European cities, where narrow streets are common, smaller fire engines are used. Newer U.S. trucks have already adopted some of the common features from the European design, such as roll-up doors for quick and easy access to confined areas. The main difference between European and U.S. fire apparatus is the location of the pump. European fire engines use a power take-off system with the pump located at the rear of the truck, allowing the riggers to work the pump from the back-end, a necessity on narrower streets. Cargo transfer between the engine and the pump at the rear of the truck results in a 30% energy loss, substantially reducing the pumping capacity. European fire engines typically have a pumping capacity of around 1,000 liters per minute (633 gallons/minute), well below the U.S. standard. It would take three to four European fire engines to match the pumping capacity of one U.S. fire engine (Pattis, 2008).

The length of a fire engine is also a concern since it affects maneuverability, the turning radius, which varies between vehicles, is based on wheelbase, steering gear geometry, axle placement and other factors. Many communities use single axle trucks that have 30 feet in length, which generally have a smaller turning radius. There is a trend toward using commercial trucks, including greater use of cargo trucks, on which to mount the apparatus body work (Landy). This trend will result in smaller whitebox trucks and U.S. apparatus will resemble European designs to a greater degree (California, 2002).

## Village Homes Community

To instill community character and minimize impervious cover, the streets are curvy, only 16-24 feet wide without on-street parking (off-street parking is allowed), and end in cul-de-sacs.



6 Below: The apparatus with compact station in the rear and compact design for maneuverability and access of curbside streets.

### Smaller Trucks

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The length of a fire engine is also a concern since it affects maneuverability, the turning radius, which varies between vehicles, is based on wheelbase, steering gear geometry, axle placement and other factors. Many communities use single axle trucks less than 30 feet in length, which generally have a smaller turning radius. There is a trend toward using commercial chassis, including greater use of longer chassis, as well as more fire apparatus body work. LIDM's findings will result in clearer vehicle/truck and U.S. apparatus with narrower European designs to a greater degree (Caldwell, 2002).

### Innovative Neighborhood Design

In Davis, California, the Village Homes community, built in 1967, is an example of innovative neighborhood design. To build community character and maintain inspiration now, the streets are curvy, only 16-24 feet wide without on-street parking (off-street parking is allowed), and end in cul-de-sacs. These first homes occurred in job development and the city has benefited from the valuable income they provided. The curvy streets can be problematic when fire lanes are changed since lanes tend to stagnate and not follow the curvature of the street. This and the lack of on-street connectivity plus to cul-de-sacs can restrict access to other

emergency personnel after water is delivered to the fire. If a development similar to Village Homes were proposed today the design would look substantially different. Currently local officials try to work with developers to meet the goals of the community. Any new development is reviewed on a case-by-case basis. Twenty-foot wide streets with parking on one side and 16-foot streets without parking may be acceptable with other connecting streets (without cul-de-sacs). This flexible approach in Davis is a good model for finding a balance in meeting environmental concerns and emergency service requirements.



### Village Homes Community

To retain community character and minimize impervious cover, the streets are curvy, only 16-24 feet wide without on-street parking (off-street parking is allowed), and end in cul-de-sacs.

## Low Impact Development Principles

Infiltration of storm water + More permeable surfaces  
Less hardscape + Narrower streets

### Permeous Pavement

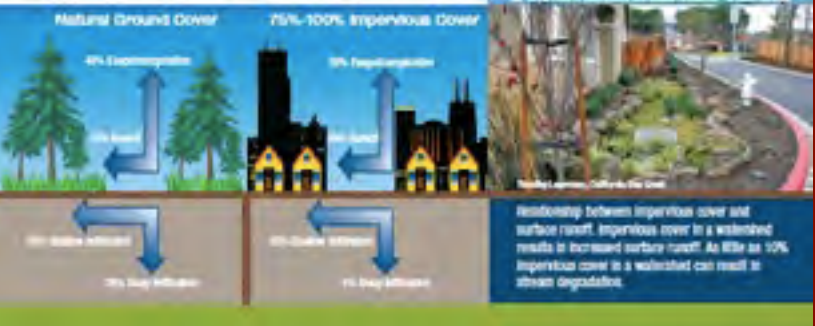
**Benefits:** Allows storm water to infiltrate into the ground, reduces flooding, helps save tires, can improve stopping ability of vehicles, and may separate curbside thereby reducing greenhouse gases.

**Drawbacks:** More costly looking, requires maintenance (vacuum sweeping), can erode, and currently difficult to find qualified contractors to install.

The use of permeous cement and asphalt concrete for infiltration can substantially reduce the storm water runoff from driveways, parking lots and driveways. US professionals expressed concern about the structural integrity of these surfaces when used in public access ways. The 2007 California Fire Code states that access roads should be of asphalt, concrete, or other approved driving surface capable of supporting a truck weighing at least 75,000 pounds. California allows the engines to have a single axle weight of 23,000 pounds on the driving axle (2 three/ten/ten axle) and 24,000 on the drive axle. Tandem axles can be up to 40,000 pounds and tridem axles up to 54,000 pounds\*. All fire engine drive axles have dual tires (at least one), so each steering tire can support up to 12,500 pounds (24,000 + 6).

Another key area of concern for US providers is the braking ability of vehicles on different surfaces. US vehicles need to be able to make "panic stops," and used resistance properties are important. Permeous overlays are often used to enhance highway safety and traffic flow. Tests show that permeous asphalt maintains the friction in both wet and dry weather conditions. Permeous pavement meets or exceeds the friction value for gravel, dense concrete and exceeds dense asphalt by a factor of four in wet conditions (Ferguson, 2006). These are important considerations that may provide an extra benefit for using permeous concrete. Based on these data, it does not appear that properly installed permeous concrete is an impediment to emergency services.

\* 2007 California Fire Code and Section 170900 of the California Building Code (California Building Code 2007) (California Building Code 2007) (California Building Code 2007)



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### Permeable Pavement

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**Drawbacks:** More maintenance (sweeping, cleaning, etc.), can erode, and currently difficult to find qualified contractors to install.

The use of permeable concrete and asphalt concrete for infiltration can substantially reduce the storm water runoff from streets, parking lots and driveways. US practitioners expressed concern about the structural integrity of these surfaces when used in public access ways. The 2007 California Fire Code<sup>1</sup> states that access roads should be of asphalt, concrete, or other approved driving surface capable of supporting a truck weighing at least 75,000 pounds. California allows the engines to have a single axle weight of 23,000 pounds on the steering axle (2 truck/trailing axle) and 24,000 on the drive axle. Tandem axles can be up to 48,500 pounds and tridem axles up to 54,000 pounds<sup>2</sup>. All full engine drive axles have dual tires (4 tires/axle), so each steering tire can support up to 13,500 pounds (54,000 ÷ 4).

Another key area of concern for US providers is the braking ability of vehicles on different surfaces. US vehicles need to be able to make "panic stops," and wet resistance properties are important. Permeable overlays are often used to enhance highway safety and traffic flow. Tests show that permeable asphalt maintains the friction in both wet and dry weather conditions. Permeable pavement meets or exceeds the friction value for gravel, dense concrete and exceeds dense asphalt by a factor of four in wet conditions (Ferguson, 2009). These are important considerations that may provide an extra benefit for using permeable concrete. Based on these data, it does not appear that properly installed permeable concrete is an impediment to emergency services.

<sup>1</sup> 2007 California Fire Code, Section 101.02 (b) (1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14) (15) (16) (17) (18) (19) (20) (21) (22) (23) (24) (25) (26) (27) (28) (29) (30) (31) (32) (33) (34) (35) (36) (37) (38) (39) (40) (41) (42) (43) (44) (45) (46) (47) (48) (49) (50) (51) (52) (53) (54) (55) (56) (57) (58) (59) (60) (61) (62) (63) (64) (65) (66) (67) (68) (69) (70) (71) (72) (73) (74) (75) (76) (77) (78) (79) (80) (81) (82) (83) (84) (85) (86) (87) (88) (89) (90) (91) (92) (93) (94) (95) (96) (97) (98) (99) (100) (101) (102) (103) (104) (105) (106) (107) (108) (109) (110) (111) (112) (113) (114) (115) (116) (117) (118) (119) (120) (121) (122) (123) (124) (125) (126) (127) (128) (129) (130) (131) (132) (133) (134) (135) (136) (137) (138) (139) (140) (141) (142) (143) (144) (145) (146) (147) (148) (149) (150) (151) (152) (153) (154) (155) (156) (157) (158) (159) (160) (161) (162) (163) (164) (165) (166) (167) (168) (169) (170) (171) (172) (173) (174) (175) 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Permeable concrete in Santa Monica, CA shows areas and infiltration. Gravel infiltration trenching with a subsurface in Davis, CA.

### Weight Distribution of Emergency Vehicles on Porous Concrete

Porous concrete driveways are suitable for a wide range of applications. Mixtures can develop compressive strength between 500-4,000 pounds per square inch (psi), with typical values at 2,500 psi. The general rule for porous pavement to handle occasional truck traffic is 6 inches of base (compacted to 90%) and 8 inches of concrete with an average joint space of 15-20%. Determining the support capability of any surface is based on the displacement of the weight over the surface area in direct contact with the vehicle tires. The contact surface area can vary by tire size, brand and inflation pressure. An example of the weight distribution of a tire engine is psi for a tire commonly found on fire engines is the Goodyear G261 (126G2.1 inflated to 90 psi, the average surface area of tire contact is 96 in<sup>2</sup> (6'3" x 3"). The weight displacement for each tire, if the maximum allowable load on a steering axle is 12,500 pounds or 3527.14 psi, gives a 7.848 safety factor for a typical porous concrete pavement rated at 2,500 psi.

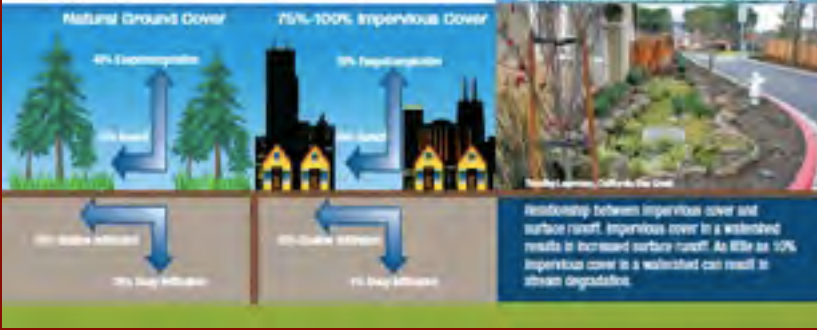
<sup>1</sup> Source: Southern Bell, Inc.

### Infiltration Systems

**Benefits:** Storm water infiltration, provides attractive green features.

**Drawbacks:** Maintenance requirement, need for structural support along the edges.

Landscape infiltration areas improve the aesthetics of a community and help slow traffic in residential areas. These areas usually are not a cause of major concern to US providers as long as they are placed in areas away from the access lanes and intersections and conform to rules governing access way requirements. When located along street frontages, they should be properly maintained and adequately marked with a defined edge, which allows inflow of storm water but provides a visual or structural traffic barrier. Some jurisdictions define the edge of the street with a malleable curb or concrete curb that clearly delineates the edge of the street. Installing easily recognizable demarcation or "access safe" signage, and incorporating this into US labeling, may help reduce problems and safe operation of these systems. Developing a universal standard that is incorporated into firefighter training programs should be a part of alternative storm water implementation programs.



[http://www.csgc.ucsd.edu/BOOKSTORE/Resources/LID\\_FACTSHEET.pdf](http://www.csgc.ucsd.edu/BOOKSTORE/Resources/LID_FACTSHEET.pdf)



Porous concrete in Santa Monica, CA shows access and infiltration.

Grass infiltration trench with a sidewalk in Davis, CA.

## Infiltration Systems

**Benefits:** Storm water infiltration, positive aesthetic green features.

**Drawbacks:** Maintenance requirement, need for structural support along the edges.

Landscape infiltration areas improve the aesthetics of a community and help slow traffic in residential areas. These areas usually are not a cause of major concern to CS providers as long as they are placed in areas away from the access lanes and intersections and conform to rules governing access way requirements. When located along street crossings, they should be properly maintained and adequately marked with a defined edge, which allows runoff of storm water but provides a visual or structural traffic barrier. Some jurisdictions define the edge of the street with a retractable curb or concrete edge that clearly delineates the edge of the street, indicating easily recognizable demarcation or "access safe" signage, and incorporating this into CS training may help lessen problems and site approval of these systems. Developing a universal standard that is incorporated into firefighter-training programs should be a part of alternative storm water implementation programs.

## Weight Distribution of Emergency Vehicles on Porous Concrete

Porous concrete sidewalks are suitable for a wide range of applications. Mediums can carrying compressive strength between 500–4,000 pounds per square inch (psi), with typical values of 2,500 psi. The general rule for porous pavement to handle occasional truck traffic is 6 inches of base (compacted to 95%) and 6 inches of concrete with an average joint space of 15–20%. Determining the support capability of any surface is based on the displacement of the weight over the surface area in direct contact with the vehicle tires. The contact surface area can vary by tire size, brand and inflation pressure. An example of the weight distribution of a tire weighs in psi for a tire commonly found on fire engines is the GoodYear (2006) 12R22.5, inflated to 90 psi, the average surface area of tire contact is 96 in<sup>2</sup> (6-ft x 3-in). The weight displacement for each tire, if the maximum allowable load on a steering axle is 17,500 pounds or 352.14 psi, gives a 7-fold safety factor for a typical (porous) concrete pavement rated at 2,500 psi.

<sup>7</sup> Source: GoodYear 2006, pp. 40.



DESIGNED BY GARDEN OFFERING AND PARTS BY THE AUTHOR TO BE USED TO DEMONSTRATE AN ALTERNATIVE TO TRADITIONAL INFILTRATION AREAS.  
FINDING LITERATURE, CALIFORNIA, 2008



Street Crossing, California

Done in 2008, this infiltration area is 11 months old, showing excellent performance.

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## Conclusions

Local jurisdictions face a difficult situation when addressing storm water runoff requirements and CS needs. The appropriate balance requires open and early dialog with local CS providers. It also requires all parties to have an understanding of the issues and concerns other Departments face in meeting storm water reduction objectives. The information provided here may be helpful when finding resolution in reaching across, use of alternative surface materials and infiltration basins. There is no one-size-fits-all solution; it is up to each community to determine the best approach based on their individual circumstances.

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It is an interesting dilemma: whether responding to a fire, the firefighter pretty much always will render emergency of natural disaster, how in it makes differences. Data response will always become key necessary to protect public health and safety, and to address properly through in the long term protection of the environment and water quality are important considerations. Through the use of alternative approaches and community design, it is possible to address both objectives.

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\*Oregon is SOUTH of Washington

Tuesday, November 9, 2010