

# PERMEABLE / POROUS PAVEMENTS

LOW IMPACT DEVELOPMENT TRENDS IN THE SOUTHWEST

2013 LID Basics and Beyond

# Today's Outline

- LID and stormwater water refresher
- Past pavement types
- Water volumes and “C”
- Pervious / porous types of alternatives
- COG / ASU / NAU project histories (5-6 yrs. + in local environment)

# Low Impact Design (LID)

- “LID is an approach to land development/ re-development that works with nature to manage stormwater as close to it’s source as possible”
  - ▣ Recreating natural features to treat stormwater before it leaves the site
  - ▣ Minimizing imperviousness to create functional site attributes that treat stormwater as a RESOURCE rather than a WASTE product.
- ▣ (7200ciA) - **C?**



# Distinction of stormwater vs. treated water entering “waters of the US”

- Stormwater generated by (MS4) are regulated by ADEQ - EPA – stormwater enters waters of the US **untreated** by street flow etc. and must be managed on site !!!!!



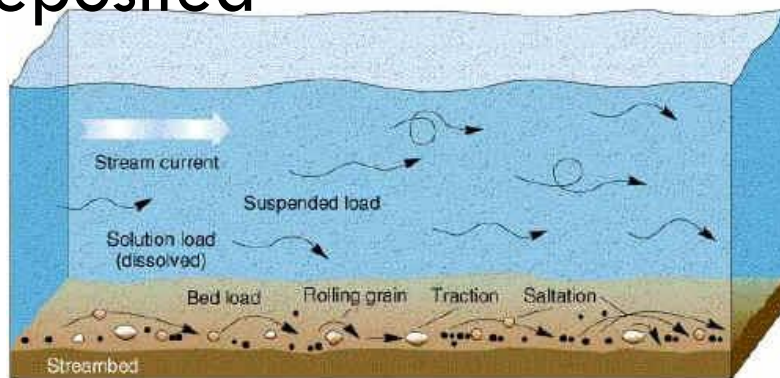
# Historical impermeable surface treatments

- Rigid pavements— Concrete / PCCP
- Flexible pavement – asphalt
  - ▣ HMA, dense graded, open graded
- Native soil surface treatments - chemical additives, emulsions- COG Thunderbird Parking Lots
- All lead to high potentially unfiltered and contaminated runoff volumes



# Environmental impacts from impervious surfaces

- Produce higher peak sheet flows (Q's)
- Produce landscaping, channel incision, erosion, increased sediment transport – heavy metals from automobiles etc.
- Reduces infiltration due to rapid movement
- Increases stormwater pollutant loads to aquifer – never deposited



# How much water from 1 acre+ ?

100 year rain event (design value) yields approximately 9918 cubic feet of water from only one acre of land = 74,200 gallons of water !!

Park and Ride in Glendale Arizona currently covers about 120,000 square feet of parking area = 2.75 acres = 204,000 gallons untreated water entering waters of the US

**C = Storage capacity** - LESS LAND for retention, vegetation, trees and MORE LAND for project space !!! Agencies are grappling with storage credit etc.

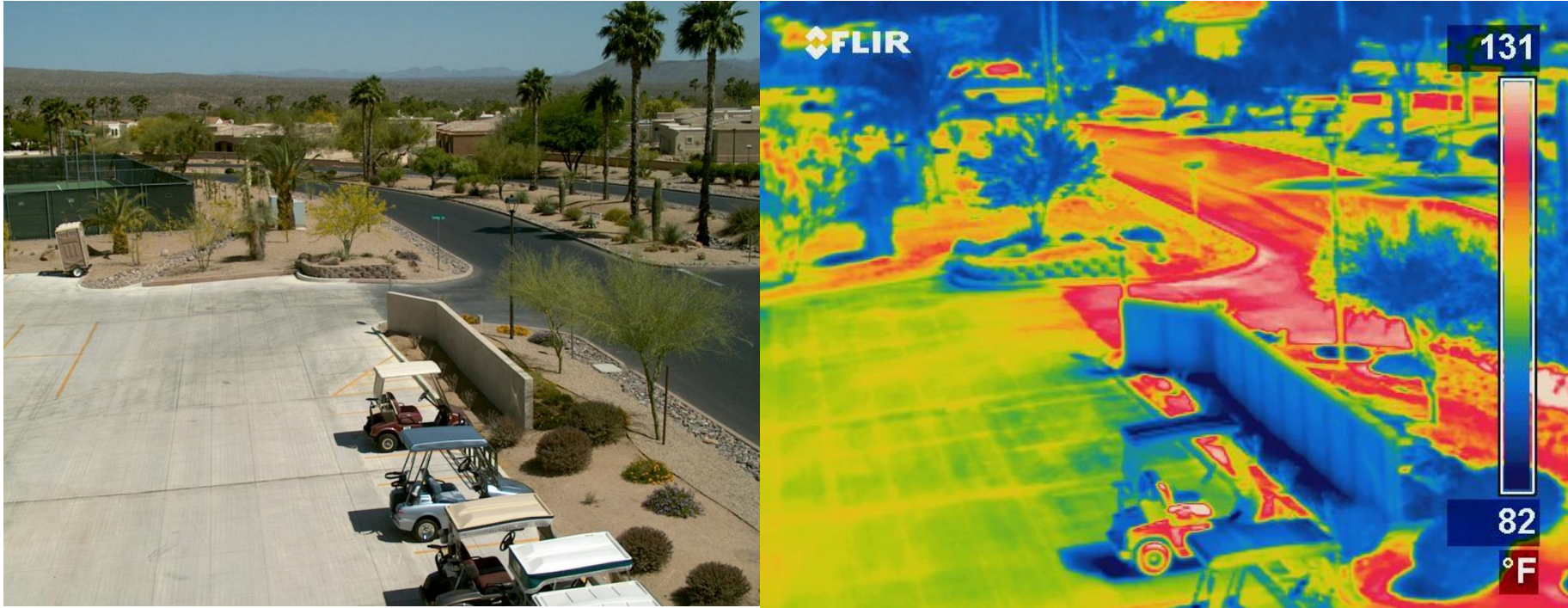


# Pollutant removal – one benefit

BMP Type	Typical Pollutant Removal (percent)				
	Suspended Solids	Nitrogen	Phosphorus	Pathogens	Metals
Dry Detention Basins	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Retention Basins	50 - 80	30 - 65	30 - 65	< 30	50 - 80
Constructed Wetlands	50 - 80	< 30	15 - 45	< 30	50 - 80
Infiltration Basins	50 - 80	50 - 80	50 - 80	65 - 100	50 - 80
Infiltration Trenches/ Dry Wells	50 - 80	50 - 80	15 - 45	65 - 100	50 - 80
Porous Pavement	65 - 100	65 - 100	30 - 65	65 - 100	65 - 100
Grassed Swales	30 - 65	15 - 45	15 - 45	< 30	15 - 45
Vegetated Filter Strips	50 - 80	50 - 80	50 - 80	< 30	30 - 65
Surface Sand Filters	50 - 80	< 30	50 - 80	< 30	50 - 80
Other Media Filters	65 - 100	15 - 45	< 30	< 30	50 - 80



# Additional benefit of pervious / permeable pavements – Mitigating heat island effect

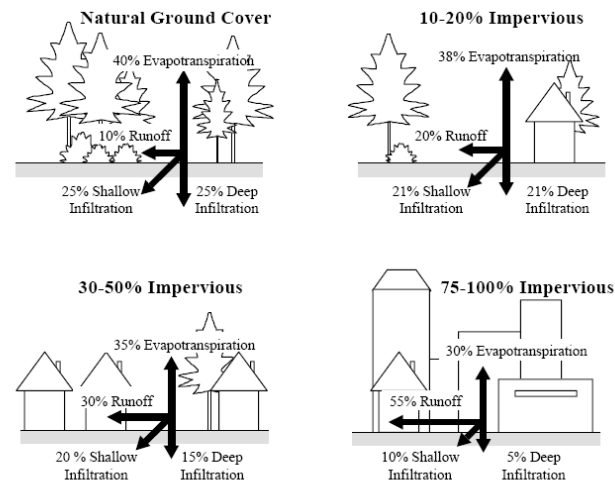


**HEAT ISLAND MITIGATION** Comparing surface temperatures between and Asphalt Road and Concrete Parking Lot in Rio Verde, Arizona. Max air temperature that day was 100F.

# Well which is it - permeable or porous ?? (or pervious) ??

- **Permeable surfaces** allows or directs the water to pass around the aggregate or paver – such as a paving block, paving stone, gravel / grass pave
- **Porous / Pervious surfaces** pavements allow or direct the water to pass “through” the medium such as pervious concrete or porous asphalt.

- Both reduce “c”



# Some types of pavement surfaces

- Wooden roadways / decks – 1900's - ground or elevated ???
- Open graded aggregates surfaces (base course)
- Open-celled paving grids (geocells)
- Open jointed paving blocks / pavers / grid pavers
- Pervious / porous concrete
- ~~□ Pervious / porous asphalt (arid SW not compatible)~~



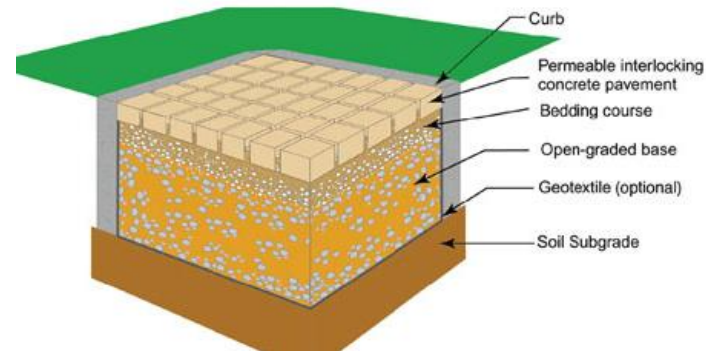
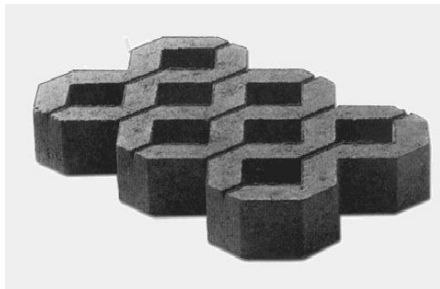
# Open graded aggregate surfaces i.e. ABC – chips etc...

Inexpensive / effective - can be highly permeable depending on gradation susceptible to degradation



# Open jointed paving blocks, block pavers, grid pavers

- Cost competitive with pervious concrete
- Repairs – individual units can be replaced
- **Initial infiltration rates reduced** due to void space
- High freeze-thaw, salt resistance
  - ▣ In the arid southwest?
- Medium to high urban heat island reduction
- LEEDS benefit - recycled component using flyash, slag, etc and can reused or re-crush upon removal
- Mechanically installed, no lag time for curing etc.



# Properties of Pervious Concrete

- Slumps 0 - 3/4" - DRY
- Unit weights 125-135pcf  
approx 70% of traditional
- Mix temperature (90F  
max) of concern as W/C  
ratio's low – cannot cool  
effectively
- Placement times and dates  
should be able to  
accommodate temperature  
constraints
- Permeability appx.  
288in/hr.-770in/hr.
  - = 24ft./hr. – 65ft./hr.
- Compressive strength  
appx.500-4000psi –  
2500 psi. avg.
  - Susceptible to wheel  
loads

# Pervious concrete examples in Arizona since 2006

- NAU-ARD Building  
Late 2006
- ASU Arts Building  
2007
- Glendale Park and Ride  
2008
- Super-lite Block facility
- Phoenix Cement Terminal
- NAU – ARD Building
- Pavement failed and has been overlaid / replaced with HMA due to rip hazards and is being redesigned for more compatible design (Dr. Jun Ho Chun).
- FREEZE / THAW?

# Pervious Concrete Limitations

- Slopes should be limited to 5% to reduce runoff
- Can assume 40% voids in rock bed - STORAGE
- Generally not for heavy loading – consider mixing pavement types to match vehicle types
  - ▣ PCCP for drive aisles, pervious for low usage areas
- Aggregates used in rock bed should be clean/well to maximize capacity
- GOOD CONTRACTOR / DESIGNERS



# City of Glendale Park and Ride Facility (99<sup>th</sup> Avenue and Glendale)

## □ Phase 1 Completed

- January 2007

- 388 spaces

## □ Phase 2

- 254 spaces

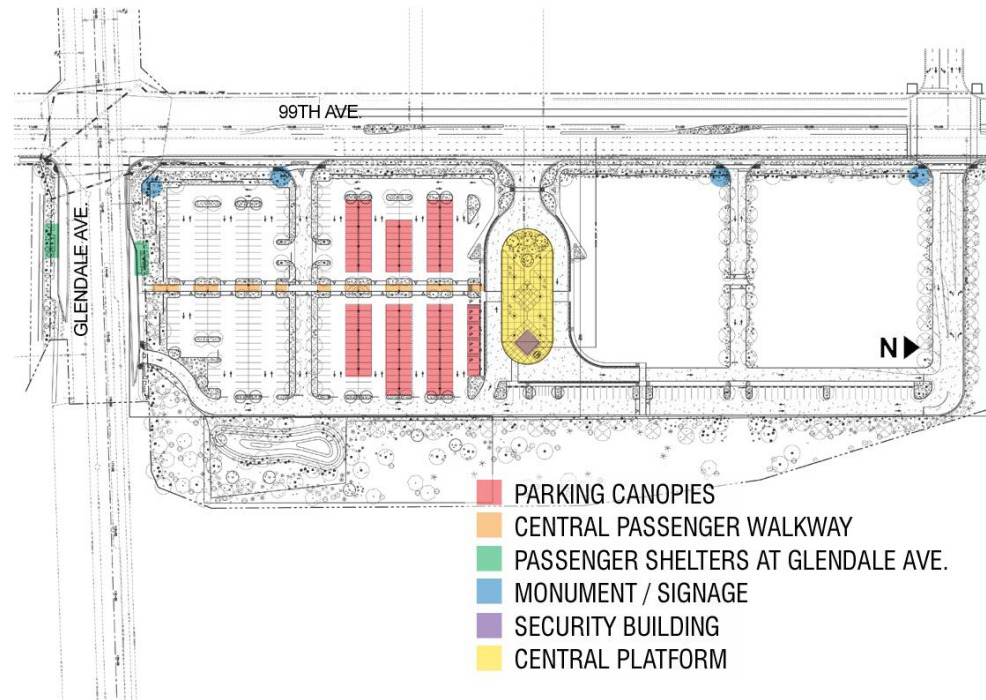
## □ 642 at build out

## □ Costs

- HMA = \$693,570

- Pervious = \$844,07

- 20 yr. HMA more than pervious



# Placement – August 2007



# 1 to 3 Year warranty items



# 5 year performance COG Park and Ride



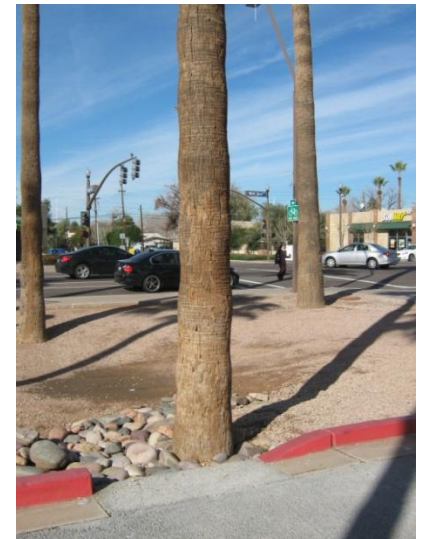
2013 LID Basics and Beyond – February 5<sup>th</sup>, 2013

# ASU construction 2006



2013 LID Basics and Beyond – February 5<sup>th</sup>, 2013

# 6 year performance - ASU



# ??? Maintenance ???

- ASU pavement – NO discernible maintenance to date.
  - ▣ Very satisfied with performance to date
- COG Park and Ride
  - ▣ 6 mos. hire contractor for vacuumed or brush work
  - ▣ Flush pavement - pores appear to be self cleaning due to dust size
  - ▣ Extremely satisfied to date with performance
  - ▣ Additional request for study in 2012

# Additional studies

- Pore cleaning April 2012 – 3 locations
  - 77.5 in./hr. to 131.5 in./hr. (+69.7%)
  - 181.7 in./hr to 191.0 in./hr. (+5.1%)
  - 118.7 in/hr. to 137.7 in./hr. (+16.1%)





# Closing / Questions?

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## Engineering Flowchart

