Evaluation of Green Infrastructure Designs Using the Automated Geospatial Watershed Assessment Tool

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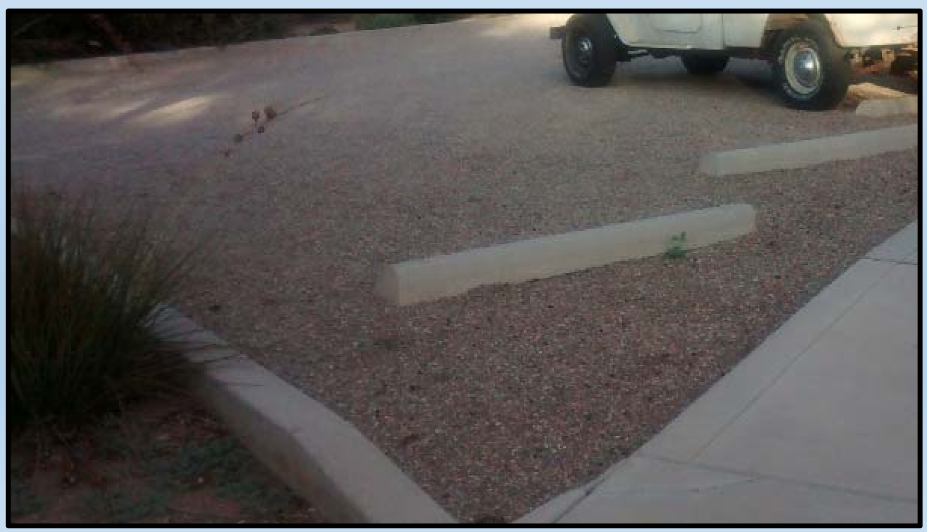
Outline

- Integrated Watershed Management in Arid Built Environments
- Urban Toolkit in the Automated Geospatial Watershed Assessment Tool
- Case Study in Sierra Vista, AZ
- Conclusions and Future Directions



Slide 2

YK1 Fixed spelling of integrated on Slide "Outline"

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YK2

Integrated Watershed Management

Integrated Watershed Management (IWM) is a comprehensive multi-resource management process, involving all stakeholders within the watershed, who together as a group, cooperatively work toward identifying the watershed's resource issues and concerns.

IWM addresses the interrelationships between:

Water Supply – The Primary Driver in Built Arid Environments

Flood Control

Water Quality

Biological Resources (Natural and Landscaping)

Sustainable Communities (Greenness)

Social/Economic Issues

Slide 3

YK2 Changed formatting
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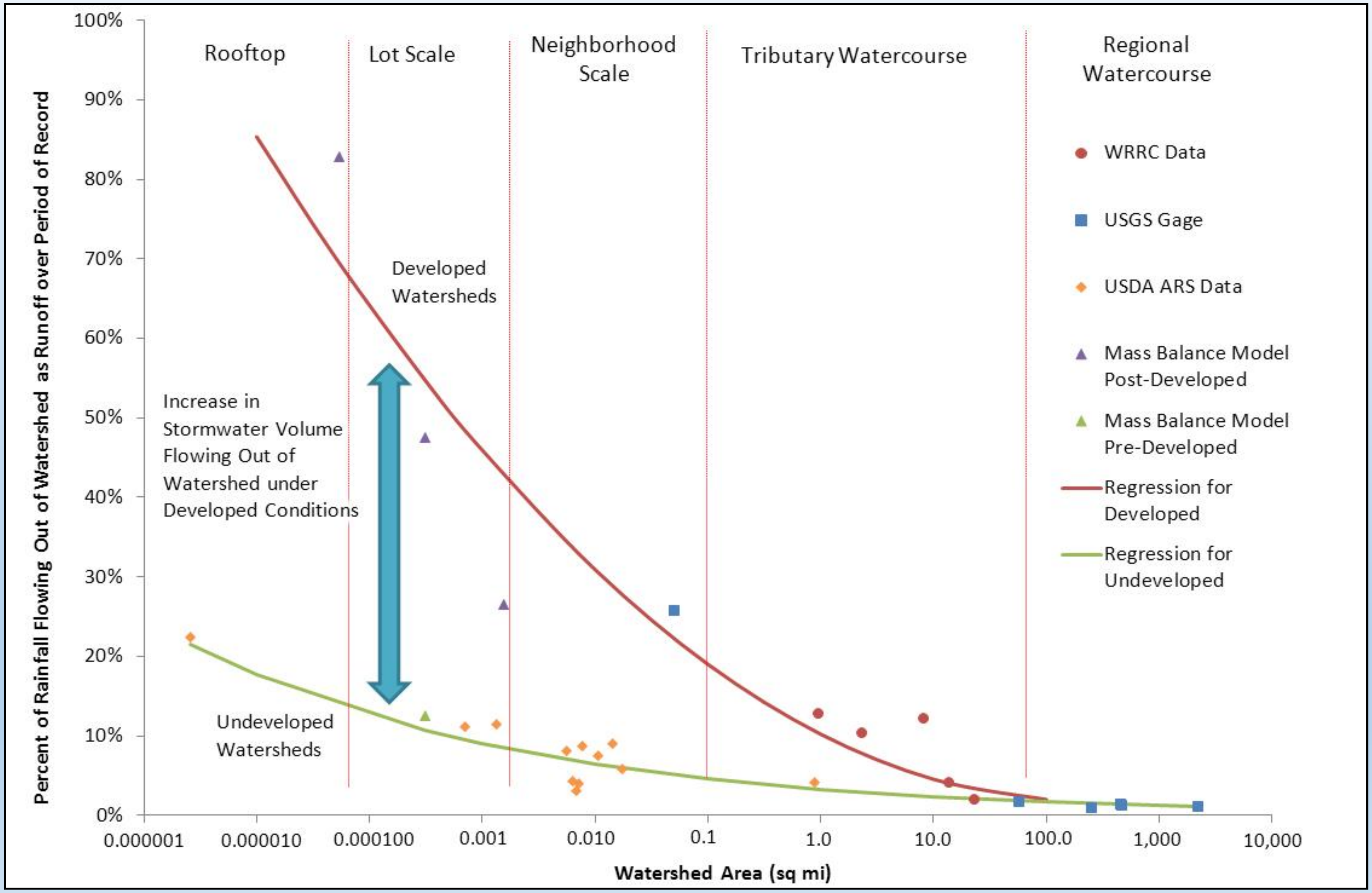
‘Harvestable’ Water (Rainwater/Stormwater) - Potential to Augment Water Supply (From: Dr. Evan Canfield – Pima County Flood Control)



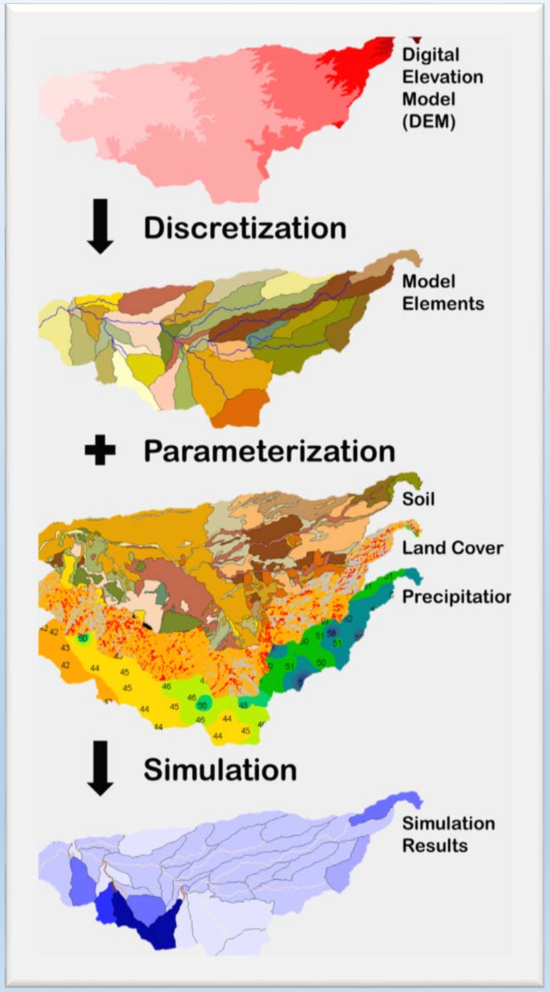
Low Impact Development (LID) Practices

- The effectiveness of a practice depends on your objective.
- If your objective is to capture stormwater to mitigate flood and water quality
  - Pervious Surfaces – driveways, roads, parking lots are very effective
- But if your primary goal is to augment water supplies then
  - Water Harvesting
  - Rain Gardens
  - Bio-retention Cells – with vegetation, are more effective
- **Need tools that can assess the effects of different combinations of LID practices and evaluate between different development designs.**

YK3

Automated Geospatial Watershed Assessment Tool AGWA

- Endpoints: volume & peak runoff, sediment, plus N and P
- Simple, direct method for model parameterization
- Provide repeatable results for relative change assessments
- Five hydrologic models to address multiple scales
  - SWAT (2000, 2005) for large basins, daily time steps
  - KINEROS2 and KINEROS-OPUS for small basins, sub-hour time steps
  - Hillslope Runoff and Erosion Models (RHEM)
- Basic GIS functionality
  - watershed delineation
  - watershed discretization
  - model parameterization
  - execute the models
  - visualize results spatially and difference results across multiple simulations



Slide 6

YK3 KINEROS2

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YK4

Urban Toolkit

- Within the KINEROS2 Model
- Flow Route Delineation – routing water down streets or swales
- Lot Representation – potential to uniquely represent each lot
  - Impervious Area
  - Contributing Area
  - Flow Off → Flow On Processes
  - LIDs on Lots
    - Basins
    - Water Harvesting
    - Pervious Surfaces
  - Gray Infrastructure
    - Detention/Retention Ponds
  - Visualization of Results

Slide 7

YK4 Formatting and slide layout
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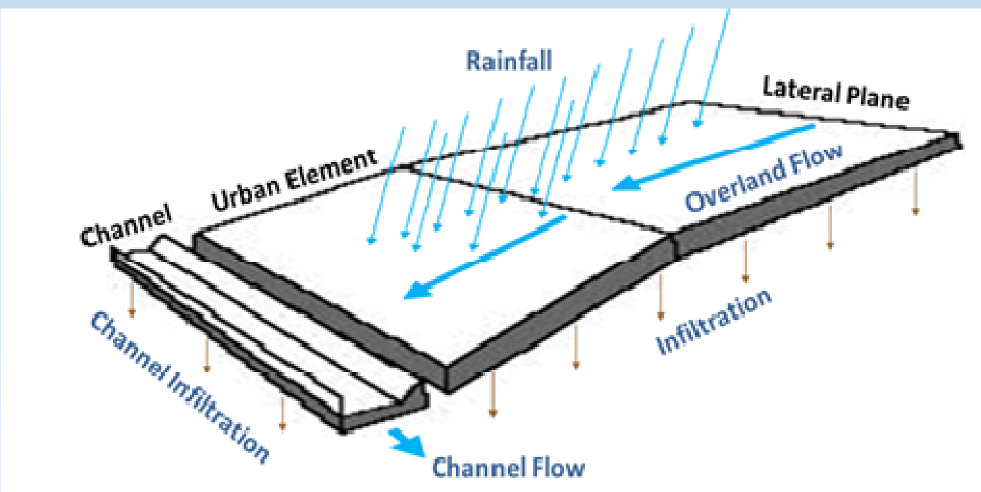
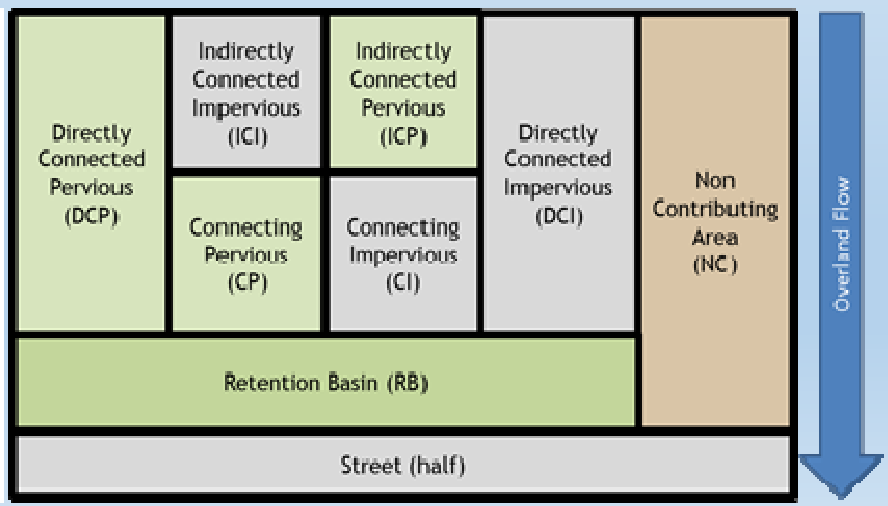
Lot Representation

- Each Home or Commercial Lot can have its own design.
- Based on the Lot Characteristics (setback, etc.) and LID practices, a lot is broken up into planes with difference input parameters.
- Flow Off → Flow On processes can be modeled. YK5
- Water can be captured and non-contributing areas can be identified.





Slide 8

YK5 fixed typos

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Case Study

- La Terraza Subdivision in Sierra Vista, AZ (13 ha)
- Two Events (SCS Type II Design Storm)
  - 10 year Return Period (34.29 mm; 1 hour)
  - 100 year Return Period (51.82 mm; 1 hour)
- Three LID Practices – Lot Only
  - Small Retention Basin (1.7 m^3; Ks = 201 mm/hr)
  - Pervious Driveway (Ks = 210 mm/hr)
  - Water Harvesting (1.9 m^3; Empty)
- Ten Scenarios
  - No LID Practices
  - Single LID Practice
  - Two LID Practices
  - All Three LID Practices

Slide 9

YK6 formatting
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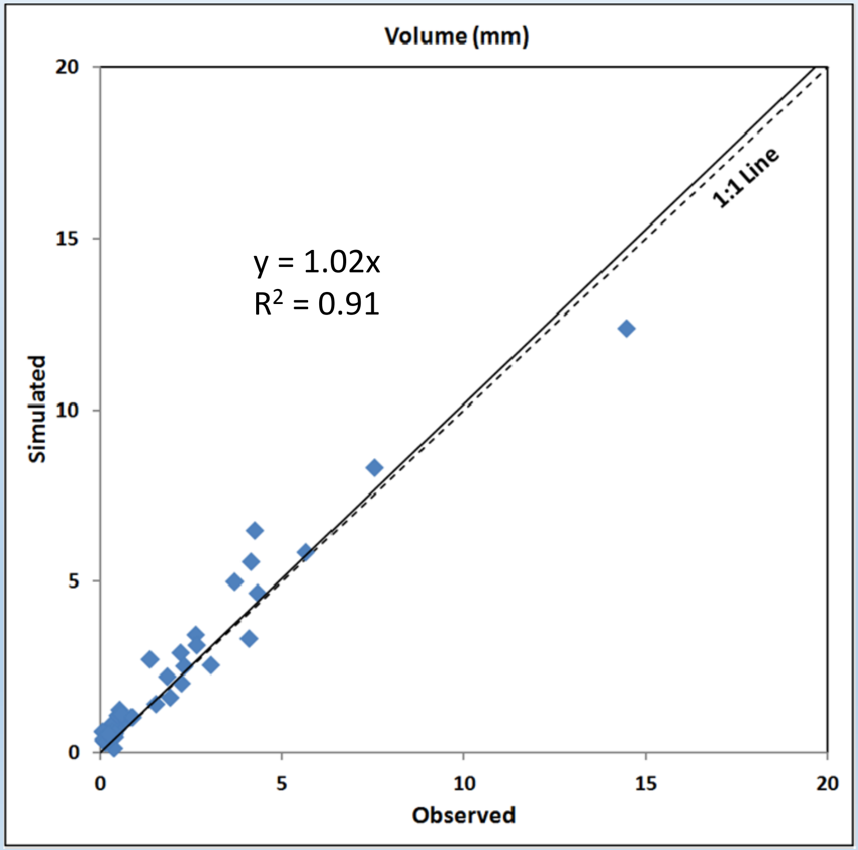
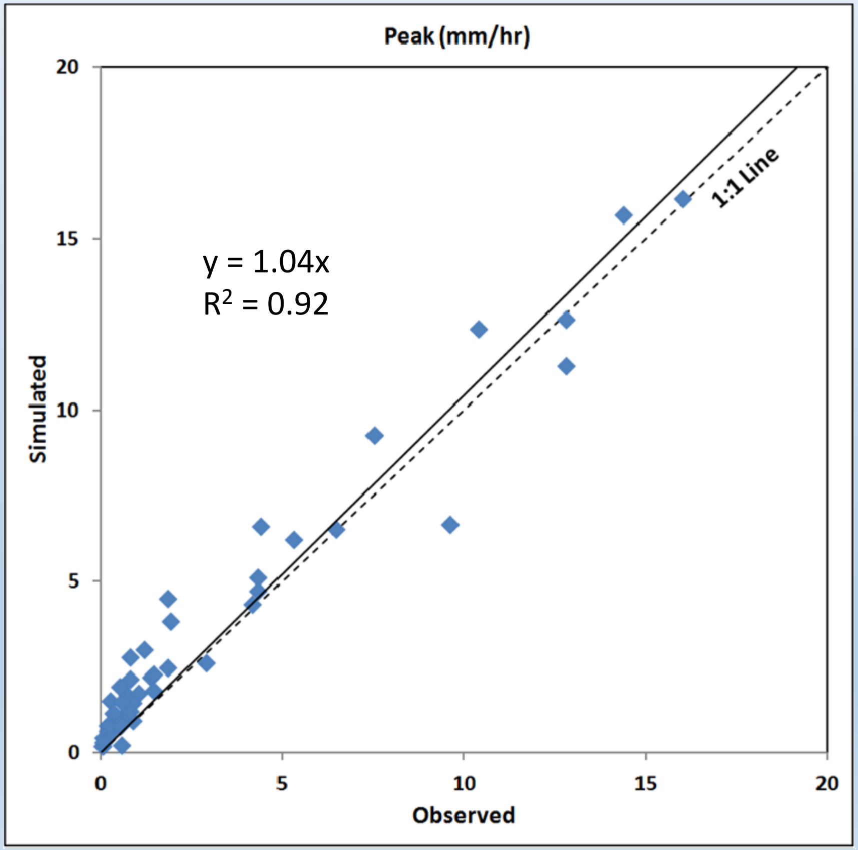
Results

- Post-Development Validation (Kennedy et al. 2013)





YK9

Results

10 Year Return Period

Scenario	Peak Runoff (m3/s)	% Change in Peak Runoff wrt Pre-development	% Change in Peak Runoff wrt Post-Development
Pre-development	1.49	NA	NA
Post-development without LID	2.28	53.37	NA
Retention Basin	2.24	50.26	-2.03
Permeable Pavements	2.25	51.21	-1.41
Rainwater Harvesting	2.12	42.29	-7.22
Retention Basin + Permeable Pavements	2.20	48.03	-3.48
Retention Basin + Rainwater Harvesting	2.07	38.88	-9.45
Permeable Pavements + Rainwater Harvesting	2.08	40.09	-8.66
All LID practices	2.03	36.66	-10.90

Slide 11

YK9 Layout
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YK8

Results

100 Year Return Period

Scenario	Peak Runoff (m3/s)	% Change in Peak Runoff wrt Pre-development	% Change in Peak Runoff wrt Post-Development
Pre-development	2.92	NA	NA
Post-development without LID	3.85	31.75	NA
Retention Basin	3.80	30.08	-1.27
Permeable Pavements	3.80	30.05	-1.29
Rainwater Harvesting	3.77	29.03	-2.06
Retention Basin + Permeable Pavements	3.75	28.37	-2.56
Retention Basin + Rainwater Harvesting	3.72	27.29	-3.38
Permeable Pavements + Rainwater Harvesting	3.72	27.33	-3.35
All LID practices	3.67	25.59	-4.67

Slide 12

YK8 Layout

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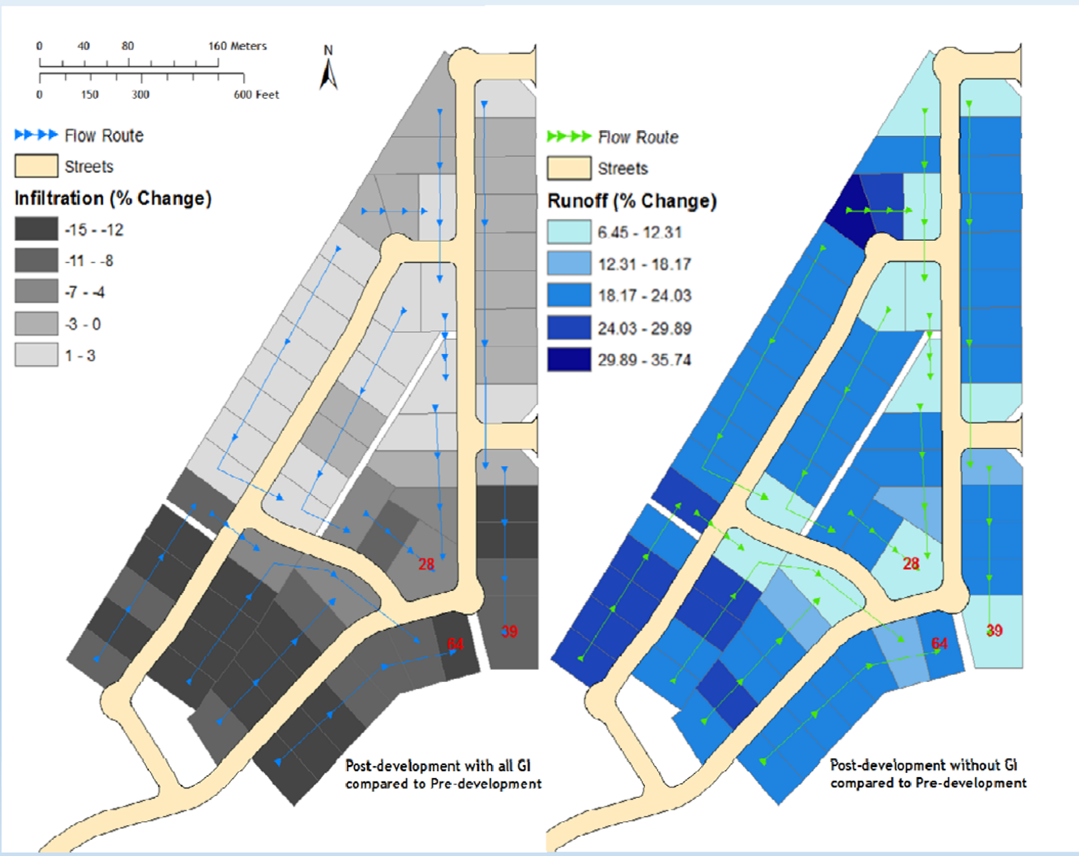
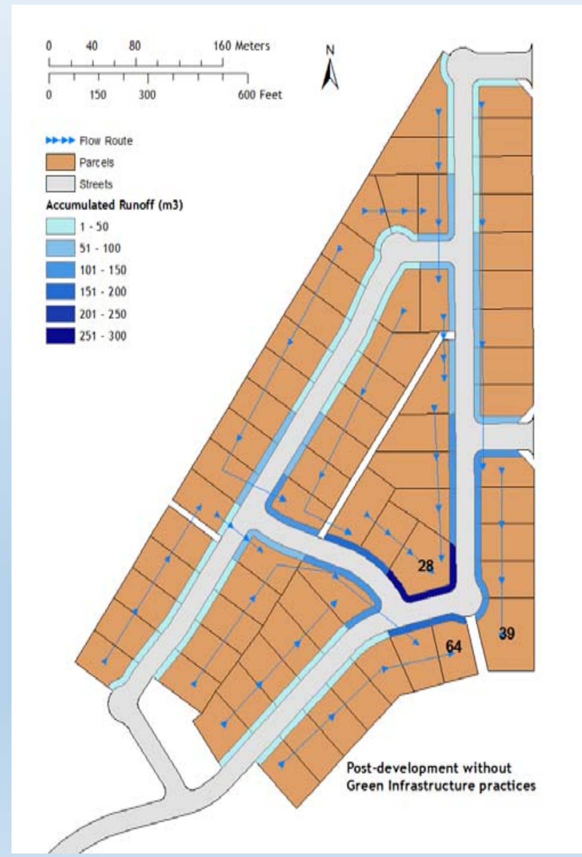
YK7

Results

Lot and Street Visualization





Slide 13

YK7 Layout

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Conclusions

- Modeling framework works well on developed watersheds
- Supports the evaluation of different designs.
- Supports the assessment of the accumulative impacts of LID practices.
- Supports detailed representation and modeling of lot and drainage features on a small catchment.
- Future research includes:
    - Adding more LID practices and gray infrastructure practices.
    - Improve the hydrological representation of LID practices.
    - Improve the parameterization for LID practices.
    - Validation of LID Simulation. Data Sets?
    - Provide linkages to other software (e.g. SWMM).
    - Add water quality (N & P) modeling capability.

Acknowledgements

- Special thanks are accorded to Dr. David Woolhiser and Dr. Roger Smith for their many contributions to the K2 model.
- A host of graduate students, too numerous to list here, are commended for their contributions to and testing of K2 and AGWA.
- The U.S. Environmental Protection Agency provided support for this research.