Executive Summary

Lessons learned from international stormwater beneficial use projects

Stormwater Non-Potable Beneficial Uses and Effects on Urban Infrastructure (INFR3SG09)

The Central Issue

Stormwater has traditionally been viewed as a nuisance requiring rapid and complete drainage from inhabited areas. Besides reducing stormwater discharges (and attendant receiving water impacts), many reuse options also benefit other components of the urban water infrastructure. If stormwater is stored and used to irrigate landscaped areas and to flush toilets, as is common in many locations today, less highly treated domestic water needs to be delivered. With the specter of increased stormwater regulation or shortages, municipalities are looking at ways to use it as another water source. This research found that collected runoff probably needs treatment before it can be reused beneficially.

Context and Background

While there have been many examples of beneficial uses of stormwater, a demonstration of how available tools can be used to design reuse systems and quantify benefits is lacking. In fact, there has been much unreliable information and excessive expectations associated with some stormwater programs. It is critical that reliable and accurate information be used when discussing these benefits with decision makers and in the design of reliable and sustainable urban water systems.

The research suggests that the growing use of highly treated water and the expensive treatment of wastewaters will be difficult to sustain in the future. Unfortunately, there are also potential problems associated with stormwater reuse. Critical issues that need to be examined relate to public health concerns associated with the use of stormwater including the potential for groundwater contamination.

Findings and Conclusions

This research examined case studies from developing countries in both arid and wet climates, developed countries in areas where future water conservation is necessary to support continued growth, and developed countries where sustainable use of water resources is already a high priority. It also examined typical water quality conditions from different stormwater sources in urban areas and desirable (or regulated) water quality requirements for the use of this water for different applications. Major findings from each of these categories include.

Rainwater harvesting is used throughout the world. Systems range from very simple as this one in Makanya, Tanzania to more sophisticated as shown on the next page in Annapolis, Maryland.

Heavily urbanized developing countries in water stressed areas (such as in China and India)

- Harvesting as much runoff as possible, with minimal concern related to water quality.
- All paved areas are used to harvest runoff water.
- Maximum volumes are needed to augment the poor quality and poorly available local sources.
- Water is stored in large ponds, and sometimes injected to shallow aquifers.

Developing countries with large rural populations in water-stressed areas (such as in Africa)

- Focused on collecting roof runoff for storage in tanks near the homes.
- Used for all domestic purposes.
- Used for irrigation of food subsistence crops during dry weather.
- Storage tanks are relatively large to provide seasonal storage.

Developed countries with large urban population centers in water scarce regions (such as Australia)

- Runoff harvesting has long been used to augment the water supplies.
- Runoff from roofs is collected and stored in large tanks adjacent to homes for non-potable uses.
- At large developments, water harvesting projects (e.g., large apartment buildings in urban city centers), runoff is collected from all areas and undergoes some pretreatment, such as filtering, before storage in large (usually underground) storage tanks.
- Water usually undergoes biological treatment and disinfection before use, but is still restricted to non-potable uses.

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Developed countries that currently are not undergoing water shortages (such as Germany)

- Runoff harvesting processes are similar to those used in Australia.
- The goals are to develop "sustainable" urban environments, where water conservation is a key factor.

This research also compared stormwater quality with the U.S. regulations and criteria for beneficial uses.

Constituents where the expected stormwater average values exceed the available criteria	BOD5, COD, TSS, turbidity, total coliforms, fecal coliforms, and *E. coli*
Additional constituents that may periodically exceed the available criteria	pH, ammonia, nitrate plus nitrite, arsenic, cadmium, chromium, copper, iron, selenium, and zinc
The most potentially problematic constituents (where the exceedances are the greatest and likely most frequent)	bacteria, solids, turbidity, cadmium, and zinc

Other findings from the research include:

- Water quality degradation associated with different storage options was reviewed, along with different water treatment options to meet the needed "finished" water quality before use. A list of these technologies is included in the report.
- A method to evaluate or size water storage tanks needed to optimize the beneficial uses of stormwater. Irrigation of land on the homeowner's property was considered the beneficial use of most interest.
- Guidance on plants that withstand a wide range of moisture conditions is also provided in order to maximize the use of the runoff water for irrigation.

Management and Policy Implications

Stormwater may need to be treated to meet non-potable beneficial use criteria.

- For simple irrigation use, bacteria reductions would be necessary, along with the prevention of excessive metal concentrations through careful selection of materials.
- Extended cistern and water tank storage can reduce most bacteria levels to close to the regulation's numeric values, although some additional treatment may be needed.
- Roof runoff can have excessive bacteria levels, especially during the non-winter months and if trees are over the roofs, which provide inviting habitat for birds and squirrels (shown to cause very large bacteria levels in roof runoff).

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WERF

Stormwater Non-Potable Beneficial Uses and Effects on Urban Infrastructure

Related WERF Research	
Project Title	**Research Focus**
Transforming Our Cities: High-Performance Green Infrastructure (INFR1R11)	Examines dynamic controls in various types of onsite stormwater systems. Projects will demonstrate dynamic models and cost analysis of high-performance green infrastructure.
Sustainable Stormwater Management: Infiltration vs. Surface Treatment Strategies (04SW3)	Aids in the planning for sustainable stormwater management, with a focus on infiltration devices. The report follows the process of stormwater management – from determining the appropriate regulatory authorities, laws, and guidance; calculating and estimating the volume and flow rates of water and pollutants needing treatment; to the final step of designing treatment devices.
Research Digest: Infiltration vs. Surface Water Discharge: Guidance for Stormwater Managers (04SW3a)	Provides a summary of the full 04SW3 report listed above.
Decentralized Stormwater Controls for Urban Retrofit and Combined Sewer Overflow Reduction (03SW3)	Focuses on the development of an overall strategy for selecting appropriate BMPs, and once selected, for selecting appropriate tools to design those BMPs. Addresses appropriateness, sizing, and prediction of the performance of infiltration devices.
Critical Assessment of Stormwater Treatment and Control Selection Issues (02SW1)	Provides guidance on choosing, sizing, and design of urban runoff controls as a function of mitigation goals, site-specific needs, and regional and local characteristics. Includes background on the theory and state-of-the-practice of stormwater management supported by methods, equations, and references useful for making stormwater management decisions.
Best Practices for the Treatment of Wet Weather Wastewater Flows (00CTS6)	Reviews available technologies to improve performance and efficiency of wet weather wastewater treatment and identifies potentially beneficial technologies and methodologies that are emerging. Assesses vortex separation, enhanced clarification, operational enhancements, flushing system, and disinfection technologies and includes O&M requirements and cost for each.

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