Flood Routing and Groundwater Recharge Benefit Calculations

Three Case Studies

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Why are we talking about groundwater projects at a floodplain management conference anyway?
Urbanization and Floodplains

- Natural floodplains enhance groundwater recharge
- Infiltration removes pollutants from water bodies
- Concrete channelization protects against flooding, but lessens recharge
- Pollutants remain within surface water
Depletion of aquifers

- Most aquifers in southern California have less water now than they did 20 years ago.
- Falling water levels mean more expensive to drill and to pump.

*Figure 7. Comparison of SBBA, Yucaipa and Rialto-Colton Basin Cumulative Change in Storage*
Urbanization and Floodplains

Nuisance flows

- Overwatering of landscaping
- Water quality issues
  - Motor oil
  - Fertilizer
  - Pet waste
  - Trash
- Wasted water
  - Particularly poor optics during droughts
In southern California, we do Recharge Projects

- Spreading Grounds
- Infiltration Basins
- Subsurface Infiltration Chambers
How to Design

Key design factors:
- Rainfall
- Primary purpose
- Size of watershed
- Jurisdiction

Recharge Project
More rainfall intensity = larger BMP
Primary Purpose

- Low Impact Development (LID) (Water quality)
- LID + Hydromodification (Water quality)
- Stormwater Recharge (Water quality) (Water supply)
- Flood Storage (Water quality) (Water supply) (Flood protection)
Watershed Size of Neighborhood project
- Small regional project
- Large regional project
Jurisdiction

Los Angeles County
- Runoff method: MODRAT
- Runoff losses based on impervious area
- Unit hydrograph peak at 80% of storm

Santa Barbara
- Runoff method: SBUH
- Runoff losses based on SCS curve numbers
- Unit hydrograph peak at 42% of storm

San Bernardino County
- Runoff method: Rational Method or Unit Hydrograph Method
- Runoff losses based on SCS curve numbers
- Unit hydrograph peak at 67% of storm
Three projects

BONNETT PARK

JOHN ANSON FORD PARK

CACTUS BASIN NO. 4 & 5
Drainage Areas

- Area 1: 4.20 ac.
- Area 2: 1.65 ac.
Rainfall-Runoff
City of Santa Barbara Requirements

- SCS Type I rainfall distribution
- Santa Barbara Urban Hydrograph
Initial Abstraction

- \( I_a \) only a function of \( CN \)
- Small \( P \) (WQ design storm) = Almost no \( Q \)
- \( V_{WQ} = 5,686 \text{ cf} \)
- 75% of WQ rainfall lost due to \( I_a \)

Soil Conservation Service Runoff Equation

\[
Q = \frac{(P - I_a)^2}{(P - I_a) + S}
\]

where
- \( Q \) = runoff (in.)
- \( P \) = rainfall (in.)
- \( I_a \) = initial abstraction (in.)
- \( S \) = potential maximum retention after runoff begins (in.)
$$Q = c_i A$$

Modified Rational Method

Runoff Volume (cf)

<table>
<thead>
<tr>
<th>Area</th>
<th>SBUH</th>
<th>MODRAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5,000</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10,000</td>
<td>15,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>20,000</td>
</tr>
</tbody>
</table>

Increase of 174% over SBUH/SCS
Factoring in Infiltration Over 24 Hours

Storage Volume, Not Factoring Infiltration

Storage Volume, Factoring Infiltration
- Chamber system
- Diverts from storm drain
- Captures low flows
- Captures the one-inch, 24-hour storm
- Flood flows bypass upstream
- Fully infiltrates within 48 hours
- Pretreatment system for trash and sediment
How much water will recharge the Rialto-Colton groundwater subbasin in a year?
Drainage Areas

- 4.63 sq. mi.
- 2.85 sq. mi.
5 rain gauges, 90 years of daily rainfall data
Yield (fraction of daily precipitation that becomes runoff) calculated for each subarea and each day.

Yield * Precipitation = Runoff Volume
Land Use and Soils
Antecedent Moisture Condition

- CN varies depending on amount of moisture in the soil
- CN calculated as a function of precipitation in previous week
  - $<0.1''$ = AMC I
  - $>0.1''$ = AMC II
  - $>1.0''$ = AMC III
Calculation

Existing Model Run

Runoff from upper DA

Runoff from lower DA

Storage (previous/next day)

Outflow to Rialto Channel

Infiltration

1 2 3
Calculation

Proposed Model Run

- Runoff from upper DA
- Runoff from lower DA
- Storage (previous/next day)
- Incidental Infiltration
- Infiltration
- Outflow to Rialto Channel
## Groundwater Recharge Benefit

<table>
<thead>
<tr>
<th>Metric</th>
<th>Existing Conditions (no build)</th>
<th>Proposed Conditions (build)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Annual Infiltration</td>
<td>1,365 ac-ft/yr</td>
<td>1,535 ac-ft/yr</td>
</tr>
<tr>
<td>Average Annual Runoff to Rialto Channel</td>
<td>1,281 ac-ft/yr</td>
<td>1,110 ac-ft/yr</td>
</tr>
</tbody>
</table>

Difference of 170 ac-ft/yr

Enough water to supply 1,800 Southern Californians per year
Drainage Area: 3.6 Sq. Mi.
1,100 ac-ft per year on average: 11,500 Southern Californians
## Comparison

<table>
<thead>
<tr>
<th></th>
<th>Bohnett Park Project</th>
<th>Cactus Basins 4 &amp; 5</th>
<th>J.A. Ford Park Cistern Project</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>County</strong></td>
<td>Santa Barbara</td>
<td>San Bernardino</td>
<td>Los Angeles</td>
</tr>
<tr>
<td><strong>Purpose</strong></td>
<td>Water Quality</td>
<td>Flood Protection + Water Supply</td>
<td>Water Quality + Water Supply</td>
</tr>
<tr>
<td><strong>Watershed Size</strong></td>
<td>6 acres</td>
<td>2,963 acres</td>
<td>2,295 acres</td>
</tr>
<tr>
<td><strong>Rainfall</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Design Methodology</strong></td>
<td>Single-Event Design Storm</td>
<td>Continuous Hydrograph – 1-Day Increment</td>
<td>Continuous Hydrograph – 5-Min. Increment</td>
</tr>
<tr>
<td><strong>Storage</strong></td>
<td>0.26 ac-ft</td>
<td>1,200 ac-ft</td>
<td>100 ac-ft*</td>
</tr>
<tr>
<td><strong>Annual Groundwater Recharge</strong></td>
<td>~3 ac-ft</td>
<td>170 ac-ft</td>
<td>1,100 ac-ft*</td>
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</tbody>
</table>

*Ultimate condition
Questions?

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