# Appendix J

# Water Quality Management Plan

# WATER QUALITY MANAGEMENT PLAN (WQMP)

For compliance with Santa Ana Regional Water Quality Control Board

Order Number R8-2010-0036 (NPDES Permit No. CAS618036)

**for**

## Waterman Gardens

Prepared for:
**Housing Authority of the County of San Bernardino**
**Southeast Corner of Base Line Street & Waterman Avenue**
**San Bernardino, CA 92418**
**APN Nos. 0147-181-33, 35 and 0147-211-01, 02, 03 & 04**

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WQMP Preparation Date
**July 20, 2011**

# WATER QUALITY MANAGEMENT PLAN (WQMP)

## PROJECT SITE INFORMATION

Name of Project: Waterman Gardens

Project Location: Southeast Corner of Base Line Street and Waterman Avenue

Size of Significant Re-Development on an Already Developed Site (in feet$^2$): see below

Size of New Development (in feet$^2$): 1,608,235 square feet (36.92 Acres)

Number of Home Subdivisions: 411

SIC Codes: 7999, 8322, 8331, 8351

Erosive Site Conditions?: No

Natural Slope More Than 25%?: No

# WATER QUALITY MANAGEMENT PLAN (WQMP)

Check the appropriate project category below:

| ***Check below*** | **Project Categories** |
|---|---|
| ✓ | 1. All significant re-development projects. Significant re-development is defined as the addition or creation of 5,000 or more square feet of impervious surface on an already developed site. This includes, but is not limited to, additional buildings and/or structures, extension of existing footprint of a building, construction of parking lots, etc. Where redevelopment results in an increase of less than fifty percent of the impervious surfaces of a previously existing development, and the existing development was not subject to SUSMPs, the design standards apply only to the addition, and not the entire development. When the redevelopment results in an increase of more than fifty percent of the impervious surfaces, then a WQMP is required for the entire development (new and existing). |
| ✓ | 2. Home subdivisions of 10 units or more. This includes single family residences, multi-family residence, condominiums, apartments, etc. |
| | 3. Industrial/commercial developments of 100,000 square feet or more. Commercial developments include non-residential developments such as hospitals, educational institutions, recreational facilities, mini-malls, hotels, office buildings, warehouses, and light industrial facilities. |
| | 4. Automotive repair shops (with SIC codes 5013, 5014, 5541, 7532- 7534, 7536-7539). |
| | 5. Restaurants where the land area of development is 5,000 square feet or more. |
| | 6. Hillside developments of 10,000 square feet or more which are located on areas with known erosive soil conditions or where the natural slope is twenty-five percent or more. |
| | 7. Developments of 2,500 square feet of impervious surface or more adjacent to (within 200 feet) or discharging directly into environmentally sensitive areas such as areas designated in the Ocean Plan as areas of special biological significance or waterbodies listed on the CWA Section 303(d) list of impaired waters. |
| ✓ | 8. Parking lots of 5,000 square feet or more exposed to storm water. Parking lot is defined as land area or facility for the temporary storage of motor vehicles. |
| | The project does not fall into any of the categories described above. (If the project requires a precise plan of development [e.g. all commercial or industrial projects, residential projects of less than 10 dwelling units, and all other land development projects with potential for significant adverse water quality impacts] or subdivision of land, it is defined as a Non-Category Project.) |

# Section 1
# Introduction And Project Description

## 1.1 Project Information

- Name of project owner:
  Housing Authority of the County of San Bernardino

- Address of project owner:
  715 East Brier Drive,
  San Bernardino, CA 92408

- Telephone for project owner:
  (909) 890-0644

- Project site address:
  Southeast corner of Base Line Street and Waterman Avenue

## 1.2 Permits

- Tentative Tract No. 18829

## 1.3 Project Description

- The project consists of the demolition of 250 existing residential units and associated improvements on a 36.92 site originally constructed circa 1950 and replacing them with 411 residential units (including 74 Senior Units and 38 potential for sale units), and adding a new Community Center, Education Center and Administrative Facilities while converting an existing maintenance building into a Jobs Training Center. The current owner of the site is and will continue to be (with the exception of the for sale residential units) the Housing Authority of the County of San Bernardino. No homeowners association or property association will be formed for the project.

## 1.4 Site Description

- The project site is bounded on the north by Baseline Street, on the west by Waterman Avenue, on the south by Olive Street and on the east by La Junta Avenue in the City of San Bernardino, County of San Bernardino, State of California and lies within Zone 2 of San Bernardino County Flood Control District Comprehensive Storm Drain Plan Project No. 7.

# Section 2
# Pollutants of concern and hydrologic conditions of concern

## 2.1 Pollutants of Concern

- The proximate receiving water for the site is Twin Creek Channel and the downstream receiving water for the site is the Santa Ana River Reach 4, currently listed as an Impaired Waterbody for bacteria indicators/ pathogens.

***Pollutant of Concern Summary Table***

| Pollutant Type | Expected | Potential | Listed for Receiving Water |
|---|---|---|---|
| Bacteria/Virus | | ✓ | Santa Ana Reach 4 |
| Heavy Metals | ✓ | | |
| Nutrients | ✓ | | |
| Pesticides | ✓ | | |
| Organic Compounds | | ✓ | |
| Sediments | ✓ | | |
| Trash & Debris | ✓ | | |
| Oxygen Demanding Substances | | ✓ | |
| Oil & Grease | ✓ | | |
| Other—specify pollutant(s): | | | |

## 2.2 HYDROLOGIC CONDITIONS OF CONCERN (NOT REQUIRED FOR NON-CATEGORY PROJECTS)

All Category projects must identify any hydrologic condition of concern (HCOC) that will be caused by the project, and implement Site Design, Source Control, and/or Treatment Control BMPs to address identified impacts. Project proponents must follow the procedure for identifying HCOCs specified in Section 2.3 of the Model WQMP. Use the following Table and instructions as a guide.

| **1.** (from Section 2.3, Part 2):<br><br>Determine if the project will create a Hydrologic Condition of Concern.<br>Check "yes" or "no" as applicable and proceed to the appropriate section as outlined below. | **Yes** | **No** |
|---|---|---|
| **A.** All downstream conveyance channels, that will receive runoff from the project, are engineered, hardened (concrete, riprap or other), and regularly maintained to ensure design flow capacity, and no sensitive stream habitat areas will be affected. Engineered, hardened, and maintained channels include channel reaches that have been fully and properly approved (including CEQA review, and permitting by USACOE, RWQCB and California Dept. of Fish & Game) by June 1, 2004 for construction and hardening to achieve design capacity, whether construction of the channels is complete. Discharge from the project will be in full compliance with Agency requirements for connections and discharges to the MS4, including both quality and quantity requirements, and the project will be permitted by the Agency for the connection or discharge to the MS4. | ✓ | |
| **B.** Project runoff rates, volumes, velocities, and flow duration for the post-development condition will not exceed those of the pre-development condition for 1-year, 2-year and 5-year frequency storm events. This condition will be substantiated with hydrologic modeling methods that are acceptable to the Agency, to the U.S. Army Corps of Engineers (USACOE), and to local watershed authorities. See method described below in Parts B1- B3. | | ✓ |
| **C.** Can the conditions in part A or B above be demonstrated for the project? | ✓ | |
| ▪ If the answer for A, B, and/or C above is yes, then the project does not create a HCOC—in this case go to Section 3 (page A-12).<br><br>▪ If the answer for C above is no, the go to section 2.3. Part 3, below. | | |

B1.
To determine the projects' drainage characteristics, County of San Bernardino HCOC policy requires the project engineer to use the following guidelines:

5. The Design Storms to be considered include, as a minimum, the 5-year, 2 year, and 1-year return frequency storms, using the methods contained in the San Bernardino County Hydrology Manual (1986).

Project sites from 0-10 acres in size should use the Small Area Runoff Hydrograph method, found in Section J of the San Bernardino County Hydrology Manual (1986); sites greater than 10 acres should use the Unit Hydrograph Method, found in Section E of the San Bernardino County Hydrology Manual (1986). For each return frequency considered, and for both pre- and post-development conditions, determine the total runoff volume, the peak flow rate, and the time of duration, of runoff hydrograph flow rates that exceed the following flow rates: 90% of peak flow rate, 80% of peak flow rate, 70% of peak flow rate, 60% of peak flow rate, 50% of peak flow rate, 40% of peak flow rate, 30% of peak flow rate, 20% of peak flow rate, and 10% of peak flow rate (see Table B2-2, "Pre- and Post-development Hydrology Comparison Worksheet.")

b. Sediment supply is to be estimated for pre-and post-development conditions for the land altered by the subject project using Table 2-3, "Pre- and Post-development Hydrology Comparison Worksheet" or equivalent. The Universal Soil Loss Equation published by the USDA-Natural Resources Conservation Service may be considered as an estimate of changes in sediment yield due to development, if applicable. Flow velocities are to be estimated for the several return frequency design storms noted above, as a minimum, with flow velocities estimated for each percentage of the peak flow rate value listed above. Normal depth hydraulic estimates may be used unless significant backwater effects exist such that deposition of sediment is anticipated, in which case a standard backwater analysis is to be conducted.

c. Based upon the preceding task results, the project engineer shall evaluate the Project and its impact downstream and recommend other design storm return frequencies to be considered in order to satisfy the goals and intent of the HCOC document.

| N/A | | |
|---|---|---|
| **2.** (from Section 2.3, Part 3): The WQMP for projects that create a HCOC must include an evaluation of whether the project will adversely impact downstream erosion, sedimentation or stream habitat. The Agency may require that the evaluation be conducted by a registered civil engineer in the State of California, with experience in fluvial geomorphology. Perform the required evaluation asspecified in A – F below. Check the boxes "yes" or "no" to verify a complete report and proceed to appropriate section based on results. | | |
| **Does the evaluation include:** | Yes | No |
| **A.** An evaluation of potential impacts to all downstream channel reaches. | | |
| **B.** Consideration of the hydrology of the entire watershed. Review all applicable drainage area master plans to the extent available, to identify BMP requirements for new development that address cumulative inputs from development in the watershed. | | |
| **C.** Consultation with all applicable agencies including the USACOE; local watershed authorities (e.g. San Timoteo Watershed Management Authority and SAWPA [Santa Ana Watershed Project Authority]); U.S. Geological Survey (USGS); California Dept. of Fish & Game (CDFG); and the San Bernardino County Flood Control District; to determine any areas of potential hydrologic impact. | | |
| **D.** An evaluation of any available hydrologic modeling results. Modeling may have been performed by USGS, USACOE, local watershed authorities, the San Bernardino County Flood Control District, or other local jurisdiction. | | |
| **E.** A field reconnaissance to evaluate any natural or partially natural downstream reaches, or other sensitive habitat. The field reconnaissance must evaluate representative downstream conditions, including undercutting erosion, slope/bank stability, vegetative stress (due to flooding, erosion, water quality degradation, or loss of water supplies), and the area's susceptibility to adverse impacts resulting from an altered flow regime or change in sediment supply and/or sediment transport . | | |
| **F.** A report that summarizes the findings of evaluation components A through E above, and that considers the project's location, topography, soil and vegetation conditions, proportion of impervious surfaces, natural and infrastructure drainage features, and any other relevant hydrologic and environmental factors to be protected specific to the project's watershed. The report must provide a determination of whether the project will adversely impact any downstream erosion, sedimentation or stream habitat, and identify any areas where adverse impacts are expected. | | |
| ▪ Is the report required by 2.3, Part 3.f complete? (Attach the report) If not, perform the required evaluation and add to the report.<br>▪ Does the report determine that the project will have an adverse downstream impact?<br>▪ If yes, then go to Section 2.3, Part 4, below.<br>▪ If no, then go to Section 3. | | |

| **3.** (from Section 2.3, Part 4): If the evaluation specified in (3) above, determines that adverse impacts to downstream erosion, sedimentation or stream habitat will occur, then the project proponent must perform the requirements specified in A, B, and C, below. Check the boxes "yes" or "no" to verify all requirements have been completed. | **YES** | **NO** |
|---|---|---|
| **A.** Conduct hydrologic modeling of the project and the potentially impacted areas, according to modeling standards recommended by the Agency or local watershed authority, for the 1-year, 2-year, and 5-year frequency storm events, at a minimum. Hydrologic modeling results must include determination of peak flow rate, flow velocity, runoff volume, time of concentration, and retention volume for the project area. | | |
| **B.** Ensure that the project will be consistent with any approved master plans of drainage or analogous plans or programs. | | |
| **C.** Implement Site Design BMPs as specified in Section 2.5.1, and recommend any additional BMPs that will be implemented to mitigate the adverse impacts identified in (3.F) above. | | |

- Are the requirements for Section 2.3 Part 4 adequate? (Attach report/results)
- Has the project proponent recommended BMPs to mitigate any impacts based on the modeling?
- If yes, then list/describe BMPs:
- If no, then explain how mitigation will be achieved:
- Will the BMPs be effective?
- Does the Agency have any additional requirements?
- Verify with Agency before submitting the project WQMP.

## 2.3 WATERSHED IMPACT OF PROJECT

Potential (bacteria/virus, organic compounds and oxygen demanding substances) and Expected (heavy metals, nutrients, pesticides, sediments, trash and debris and oil and grease) pollutants of concern associated with the project are being effectively mitigated with the Implementation of Site Design, Source Control and Treatment Control BMP's as discussed in the attached plan.

# SECTION 3
# BEST MANAGEMENT PRACTICE SELECTION PROCESS

## 3.1 SITE DESIGN BMPS

For listed Site Design BMPs, indicate in the following table whether it will be used (yes/no) and describe how used, or, if not used, provide justification/alternative. Provide detailed descriptions of planned Site Design BMPs, if applicable.

| **1. Minimize Stormwater Runoff, Minimize Project's Impervious Footprint, and Conserve Natural Areas** | | |
|---|---|---|
| Maximize the permeable area. This can be achieved in various ways, including but not limited to, increasing building density (number of stories above or below ground) and developing land use regulations seeking to limit impervious surfaces. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Building density has been maximized using multistory construction and pervious concrete paving is being provided in appropriate parking and drive areas. | | |
| Runoff from developed areas may be reduced by using alternative materials or surfaces with a lower Coefficient of Runoff, or "C-Factor". | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Runoff has been reduced with the use of surfaces having a lower Coefficient of Runoff including pervious concrete, bioswales and vegetated swales. | | |
| Conserve natural areas. This can be achieved by concentrating or clustering development on the least environmentally sensitive portions of a site while leaving the remaining land in a natural, undisturbed condition. | | |
| Yes | No ✓ | |
| Describe actions taken or justification/alternative:<br><br>While there are no natural areas to conserve, generous landscape areas are being distributed throughout the project site. | | |

| | | |
|---|---|---|
| Construct walkways, trails, patios, overflow parking lots, alleys, driveways, low-traffic streets, and other low-traffic areas with open-jointed paving materials or permeable surfaces, such as pervious concrete, porous asphalt, unit pavers, and granular materials. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Pervious concrete paving is being provided in appropriate parking and drive areas. | | |
| Construct streets, sidewalks, and parking lot aisles to the minimum widths necessary, provided that public safety and a pedestrian friendly environment are not compromised[1]. Incorporate landscaped buffer areas between sidewalks and streets. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Sidewalks and parking areas have been proposed to minimum City, Public Safety and ADA requirements. | | |
| Reduce widths of street where off-street parking is available[2]. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Drive aisles have been designed to minimum City and Public Safety requirements. | | |
| Maximize canopy interception and water conservation by preserving existing native trees and shrubs, and planting additional native or drought tolerant trees and large shrubs. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Native trees are being retained where practical, and drought tolerant trees and shrubs have been incorporated into the new landscape palette. | | |

[1] Sidewalk widths must still comply with Americans with Disabilities Act regulations and other life safety requirements.

[2] However, street widths must still comply with life safety requirements for fire and emergency vehicle access.

| | | |
|---|---|---|
| Other comparable site design options that are equally effective. | | |
| Describe actions taken _or justification/alternative: | | |
| Minimize the use of impervious surfaces, such as decorative concrete, in the landscape design. | | |
| Yes ✓ | No | |
| Describe actions taken _or justification/alternative:<br><br>Hardscape is proposed to minimum City, Public Safety and ADA requirements. | | |
| Use natural drainage systems. | | |
| Yes | No ✓ | |
| Describe actions taken or justification/alternative:<br><br>Natural drainage systems are not available for this project, but bioswales and vegetated swales have been incorporated into the project design. | | |
| Where soils conditions are suitable, use perforated pipe or gravel filtration pits for low flow infiltration[3]. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Perforated storm drain pipes with gravel bedding are being proposed in the project design. | | |
| Construct onsite ponding areas, rain gardens, or retention facilities to increase opportunities for infiltration, while being cognizant of the need to prevent the development of vector breeding areas. | | |
| Yes ✓ | No | |
| Describe actions taken or justification/alternative:<br><br>Detention basins and green roofs are all being utilized on the project. | | |

[3]However, projects must still comply with hillside grading ordinances that limit or restrict infiltration of runoff. Infiltration areas may be subject to regulation as Class V injection wells and may require a report to the USEPA. Consult the Agency for more information on use of this type of facility.

## 2. Minimize Directly Connected Impervious Areas

Where landscaping is proposed, drain rooftops into adjacent landscaping prior to discharging to the storm drain.

| Yes ✓ | No | |
|---|---|---|

Describe actions taken or justification/alternative:

Where practical, roof drains will drain to landscaped areas prior to collection.

Where landscaping is proposed, drain impervious sidewalks, walkways, trails, and patios into adjacent landscaping.

| Yes ✓ | No | |
|---|---|---|

Describe actions taken or justification/alternative:

The main loop roadway and adjacent walkways on the project will drain to adjacent bioswale areas prior to collection.

Increase the use of vegetated drainage swales in lieu of underground piping or imperviously lined swales.

| Yes ✓ | No | |
|---|---|---|

Describe actions taken or justification/alternative:

Bioswales and vegetated swales are proposed throughout the project.

**Use one or more of the following:**

| Yes | No | Design Feature |
|---|---|---|
| | ✓ | Rural swale system: street sheet flows to vegetated swale or gravel shoulder, curbs at street corners, culverts under driveways and street crossings |
| ✓ | | Urban curb/swale system; street slopes to curb; periodic swale inlets drain to vegetated swale/biofilter. |
| | ✓ | Dual drainage system: First flush captured in street catch basins and discharged to adjacent vegetated swale or gravel shoulder, high flows connect directly to municipal storm drain systems. |
| ✓ | | Other comparable design concepts that are equally effective. |

Describe actions taken or justification/alternative:

First flush flows are being directed to vegetated swales, perforated storm drain pipes with gravel backfill, bioswales, pervious concrete paving and detention basins prior to collection.

**Use one or more of the following features for design of driveways and private residential parking areas:**

| Yes | No | Design Feature |
|---|---|---|
| | ✓ | ▪ Design driveways with shared access, flared (single lane at street) or wheel strips (paving only under tires); or, drain into landscaping prior to discharging to the municipal storm drain system. |
| ✓ | | ▪ Uncovered temporary or guest parking on private residential lots may be paved with a permeable surface; or designed to drain into landscaping prior to discharging to the municipal storm drain system. |
| ✓ | | ▪ Other comparable design concepts that are equally effective. |

Describe actions taken_or justification/alternative:

The project provides for utilization of pervious concrete paving and street drainage to bioswale areas prior to collection.

**Use one or more of the following design concepts for the design of parking areas:**

| **Yes** | **No** | Design Feature |
|---|---|---|
| ✓ | | Where landscaping is proposed in parking areas, incorporate landscape areas into the drainage design. |
| ✓ | | Overflow parking (parking stalls provided in excess of the Agency's minimum parking requirements) may be constructed with permeable paving. |
| ✓ | | Other comparable design concepts that are equally effective. |

Describe actions taken_or justification/alternative:

Bioswale and vegetated swales along with pervious concrete paving are all being utilized on the project.

## 3.2 SOURCE CONTROL BMPS

Complete the following selection table for Source Control BMPs, by checking boxes that are applicable. All listed BMPs shall be implemented for the project. Where a required Source Control BMP is not applicable to the project due to project characteristics, justification and/or alternative practices for preventing pollutants must be provided. In addition to completing the following tables, provide detailed descriptions on the implementation of planned Source Control BMPs.

***Source Control BMP Selection Matrix****

| Project Category | Source Control BMPs | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Education of Property Owners* | *Activity Restrictions* | *Spill Contingency Plan* | *Employee Training/Education Program* | *Street Sweeping Private Street and Parking Lots* | *Common Areas Catch Basin Inspection* | *Landscape Planning (SD-10)* | *Hillside Landscaping* | *Roof Runoff Controls (SD-11)* | *Efficient Irrigation (SD-12)* | *Protect Slopes and Channels* | *Storm Drain Signage (SD-13)* | *Inlet Trash Racks* | *Energy Dissipaters* | *Trash Storage Areas (SD-32) and Litter Control* | *Fueling Areas (SD-30)* | *Air/Water Supply Area Drainage* | *Maintenance Bays and Docks (SD-31)* | *Vehicle Washing Areas (SD-33)* | *Outdoor Material Storage Areas (SD-34)* | *Outdoor Work Areas (SD-35)* | *Outdoor Processing Areas (SD-36)* | *Wash Water Controls for Food Preparation Areas* | *Pervious Pavement (SD-20)* | *Alternative Building Materials (SD-21)* |
| **Significant Re-development** | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | | | | | | | | | ✓ | |
| **Home subdivisions of 10 or more units** | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | | | | | | | | | ✓ | |
| **Commercial/ Industrial Development >100,000 ft$^2$** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Automotive Repair Shop** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Restaurants** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Hillside Development >10,000 ft$^2$** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Development of impervious surface >2,500 ft$^2$** | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Parking Lots >5,000 ft$^2$ of exposed storm water** | ✓ | ✓ | | | ✓ | ✓ | ✓ | | ✓ | ✓ | | ✓ | | | ✓ | | | | | | | | | ✓ | |

* Provide justification of each Source Control BMP that will not be incorporated in the project WQMP, or explanation of proposed equally effective alternatives in the following table.

| Justification for Source Control BMPs not incorporated into the project WQMP | | | |
|---|---|---|---|
| Source Control BMP | Used in Project (yes/no)? | Justification/Alternative* | Implementation Description |
| Education of Property Owners | Yes | | See Attached |
| Activity Restrictions | Yes | | See Attached |
| Spill Contingency Plan | No | N/A – spill Contingency Plan is not required | |
| Employee Training/Education Program | No | N/A – See Education of Property Owners. | |
| Street Sweeping Private Street and Parking Lots | Yes | | See Attached |
| Common Areas Catch Basin Inspection | Yes | | See Attached |
| Landscape Planning (SD-10) | Yes | | See Attached |
| Hillside Landscaping | No | N/A – There are no hillsides | |
| Roof Runoff Controls (SD-11) | Yes | | See Attached |
| Efficient Irrigation (SD-12) | Yes | | See Attached |
| Protect Slopes and Channels | No | N/A – There are no slopes or channels on the project. | |
| Storm Drain Signage (SD-13) | Yes | | See Attached |
| Inlet Trash Racks | No | N/A – There are no inlet trash racks. | |
| Energy Dissipaters | No | N/A – There are no energy dissipaters. | |
| Trash Storage Areas (SD-32) and Litter Control | Yes | | See Attached |
| Fueling Areas (SD-30) | No | N/A – There are no fueling areas. | |
| Air/Water Supply Area Drainage | No | N/A – There is no air/water supply. | |
| Maintenance Bays and Docks (SD-31) | No | N/A – There are no maintenance bays and docks. | |
| Vehicle Washing Areas (SD-33) | No | N/A – There are no vehicle washing areas. | |
| Outdoor Material Storage Areas (SD-34) | No | N/A – There are no outdoor material storage areas. | |
| Outdoor Work Areas (SD-35) | No | N/A – There are no outdoor work areas. | |
| Outdoor Processing Areas (SD-36) | No | N/A – There are no outdoor processing areas. | |
| Wash Water Controls for Food Preparation Areas | No | N/A – There are no wash water controls for food preparation areas. | |
| Pervious Pavement (SD-20) | Yes | | See Attached |
| Alternative Building Materials (SD-21) | No | N/A – Alternative building materials are not utilized. | |
| *Attach additional sheets if necessary for justification. | | | |

## Education for Property Owners and Occupants

Practical information material will be provided to the owner on general good housekeeping practices for each type of site occupancy that contributes to protection of storm water quality. Such information will include, but not limited to the attachments the attachments provided at the end of this report. In addition to the attachments, the following resource can be contacted to obtain updated education information and pertinent ordinances free of charge:

American Oceans website – **www.americanoceans.org/runoff/epa-bro.htm**. This website provides a listing of the brochures available from various State of California county and city agencies. The phone numbers of each of the agencies are also provided on this website.

## Activity Restrictions

The following is a list of activity restrictions for the project site:

No car washing will be permitted on the premises.

No changing of oil or other auto repairs will be permitted on the premises.

Do not sweep grass clippings, dead leaves into catch basins, or other landscaping related debris into catch basins.

Do not perform paint cleanup activities in paved areas or allow rinse water from these activities to enter the storm drain system. Clean brushes containing water-based paint in a sink that is connected to the sanitary sewer system.

Do not use detergents or other chemical additives when washing concrete sidewalks or building exteriors, use potable water only and collect wash water runoff using a vacuum truck for proper offsite disposal.

Keep premises, as well as trash container areas, free of litter.

## Street Sweeping Private Streets and Parking Lots

Drive aisles and parking lots shall be swept on a regular basis using a vacuum sweeper to reduce the discharge of pollutants into the storm drain system from paved surfaces.

**Catch Basin Inspection**

On-site, privately owned catch basins will be inspected and cleaned prior to the storm season and no later than October 15 of each year. Cleaning shall include the removal of debris and sediment accumulated in the basin.

**Common Area Landscape Management/Landscape Planning**

Management of landscaped areas shall be performed consistent with the following:

"Management Guidelines for Use of Fertilizers and Pesticides" (DAMP Section 5.5); items discussed in Structural BMPs: and the inspection and maintenance activities outlined in the WQMP.

Landscape planning for the project will be undertaken in accordance with applicable provisions of attached SD-10.

**Roof Runoff Control**

Roof runoff should be diverted away from the paved areas and drained toward the landscaping areas where practical. This will be incorporated into the site grading design.

Roof Runoff Control for the project will be undertaken in accordance with applicable provisions of attached SD-11.

**Efficient Irrigation**

Efficient Irrigation for the project will be undertaken in accordance with applicable provisions of attached SD-12.

**Storm Drain Signage**

Curb opening storm drains and catch basins will be marked with painted "Keep Gutters Clean For Those Downstream" in accordance with City of San Bernardino guidelines.

**Trash Storage Areas**

Trash Storage Areas for the project will be undertaken in accordance with applicable provisions of attached SD-32.

**Outdoor Material Storage Areas**

Outdoor Material Storage Areas shall be administered in accordance with applicable provisions of the attached SD-34.

**Pervious Pavement**

Pervious pavement is being utilized in low traffic parking areas in accordance with applicable provisions of the attached SD-20.

## ADDITIONAL SOURCE CONTROL FACILITIES

**Gravel Infiltration Drain (Perforated Storm Drain pipe with gravel backfill)**

The project is proposing the use of Infiltration Trenches in the form of gravel infiltration drains and Vegetated Swales in the form of surface bioswales in accordance with applicable provisions of the attached TC-10 and TC-30 respectively.

## 3.3 TREATMENT CONTROL BMPS (Not required for Non-Category projects)

- Complete the following Treatment Control BMPs Selection Matrix. For each pollutant of concern enter "yes" if identified in Section 2.1, above, or "no" if not identified for the project. Check the boxes of selected BMPs that will be implemented for the project to address each pollutant of concern from the project as listed above in section 2.1. Treatment Control BMPs must be selected and installed with respect to identified pollutant characteristics and concentrations that will be discharged from the site. For any identified pollutants of concern not listed in the Treatment Control BMP Selection Matrix, provide an explanation of how they will be addressed by Treatment Control BMPs. For identified pollutants of concern that are causing an impairment in receiving waters (as identified in Section 2.1, above), the project WQMP shall incorporate one or more Treatment Control BMPs of medium or high effectiveness in reducing those pollutants. It is the responsibility of the project proponent to demonstrate, and document in the project WQMP, that all pollutants of concern will be fully addressed. The Agency may require information beyond the minimum requirements of this WQMP to demonstrate that adequate pollutant treatment is being accomplished.

- In addition to completing the Selection Matrix, provide detailed descriptions on the location, implementation, installation, and long-term O&M of planned Treatment Control BMPs.

## *Treatment Control BMP Selection Matrix*

| Pollutant of Concern | | Treatment Control BMP Categories | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Biofilters (bioswales & grass swales) | Detention Basins[2] | Infiltration Basins[3] (pervious concrete & perforated storm drain w/gravel) | Wet Ponds or Wetlands | Filtration | Water Quality Inlets | Hydrodynamic Separator Systems [4] | Manufactured/ Proprietary Devices |
| **Sediment/Turbidity** | | H/M | M | H/M | H/M | H/M | L | H/M (L for turbidity) | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Nutrients** | | L | M | H/M | H/M | L/M | L | L | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Organic Compounds** | | U | U | U | U | H/M | L | L | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Trash & Debris** | | L | M | U | U | H/M | M | H/M | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Oxygen Demanding Substances** | | L | M | H/M | H/M | H/M | L | L | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Bacteria & Viruses** | | U | U | H/M | U | H/M | L | L | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Oils & Grease** | | H/M | M | U | U | H/M | M | L/M | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Pesticides (non-soil bound)** | | U | U | U | U | U | L | L | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |
| **Metals** | | H/M | M | H | H | H | L | L | U |
| Yes/No? | Yes | ✓ | ✓ | ✓ | | | | | |

## 3.4 BMP DESIGN CRITERIA

- The following Treatment Control BMP(s) (Flow Based or Volume Based) will be implemented for this project (***check "Implemented" box, if used***):

***Design Basis of Treatment Control BMPs***

| Implemented | Treatment Control BMP | Design Basis |
|---|---|---|
| ✓ (bioswales) | Vegetated Buffer Strips | Flow Based |
| ✓ (grass swales) | Vegetated Swale | |
| | Multiple Systems | |
| | Manufactured/Proprietary | |
| | Bioretention | Volume Based |
| | Wet Pond | |
| | Constructed Wetland | |
| ✓ (detention basins) | Extended Detention Basin | |
| | Water Quality Inlet | |
| | Retention/Irrigation | |
| ✓ (pervious concrete) | Infiltration Basin | |
| ✓ (perforated storm drain with gravel backfill) | Infiltration Trench | |
| | Media Filter | |
| | Manufactured/Proprietary | |

### 3.4.1 Flow Based Design Criteria

- Calculate the BMP design flow by using the method described in Attachment D, Section A. Show calculations in detail—attach a separate sheet of calculations.

### 3.4.2 Volume-Based Design Criteria

- Calculate the required capture volume of the BMP using the method described in Attachment D, Section B. Show calculations in detail—attach a separate sheet of calculations.

# SECTION 4

## Operations and Maintenance

The following table lists and identifies all Source Control, Site Design and Treatment Control BMP's that require Operation and Maintenance (including Maintenance Schedules) which the Owner is responsible for funding and maintaining.

| BMP ID # | Description of BMP |
|---|---|
| SD-10 | **Landscaping** The landscaping shall be maintained weekly and inspected for free drainage. If standing water within a landscaped swale is noticed and does not drain over 72 hours, then maintenance shall be performed to restore good drainage. |
| SD-12 | **Efficient Irrigation** Provide and install water efficient landscape systems, which may include water efficient emitters, automatic rain sensors, programmable valve control pads, and regular leak inspections. Efficient irrigation shall be maintained with regular monthly inspections to verify the programming, make any adjustments, setting the proper time interval or adjust the irrigation intervals for the season. Leaks in the system should be corrected as soon as possible. |
| SD-13 | **Storm Drain Signage** Inlets stencils with the phrase "Keep Gutters Clean for Those Downstream" (or other City approved wording). Stenciling and signage shall be inspected annually and repainted or replaced as required. |
| SD-20 | **Pervious Pavement** Maintenance of pervious pavement surfaces shall be performed in accordance with Table 1 contained in the attached SD-20. |
| SD-32 | **Trash Container (dumpster) Areas** Trash enclosures shall have the following maintenance and inspection checks performed at least weekly:<br>▪ Accumulated litter and debris shall be cleaned. The enclosure area shall be cleaned of any debris by sweeping to prevent trash from escaping the enclosure.<br>▪ Dumpsters shall be inspected and replaced if damaged and/or leaking.<br>▪ If the enclosure area is to be washed, the wash water shall be contained and disposed of offsite by an approved collection method. The wash water shall NOT be allowed to overflow offsite or into the storm drain system.<br>The purpose of these controls is to prevent any bacteria from making its way to the already impaired downstream waters. |
| SC-41 | **Building and Grounds Maintenance** Buildings and grounds maintenance shall be performed on a weekly basis so as to prevent or reduce the discharge of pollutants from cleaning activities and maintenance of the site. |
| SC-42 | **Building Repair and Construction** Building repair, remodeling, painting, etc. shall be performed as required to reduce the discharge of pollutants into storm water inlets on this site. |
| SC-43 | **Parking/Storage Area Maintenance** Parking lots and drive aisle areas shall be vacuum swept on a regular basis. |

| | |
|---|---|
| SC-44 | **Drainage System Maintenance** The drainage system shall be inspected and maintained annually prior to October 15 by the property owner. Maintenance will include clearing of debris and sediment in the system as well as repair and replacement of damaged parts. Maintenance shall include the removal of sediment and large debris from storm water inlets, repair of any deteriorated storm drain pipes or structures, cleaning of any catch basin sumps, cleaning of all conveyance structures to remove sediment and debris accumulated during the summer, conduct more frequent inspections of problem areas during the wet season, and report any evidence of illegal discharges or illicit connections such as evidence of paint spills, oil disposal, oil spills or discoloring. |
| TC-10 | **Infiltration Trench (Gravel Infiltration Drain)** Inspection and maintenance of Infiltration Trench areas shall be performed in accordance with the attached TC-10. |
| TC-30 | **Vegetated Swale (Grass Swale)** Inspection and maintenance of Vegetated Swale areas shall be performed in accordance with the attached TC-30. |
| TC-31 | **Vegetated Buffer Strips (Bioswale)** Inspection and maintenance of Vegetated Buffer Strip areas shall be performed in accordance with the attached TC-31. |

## Responsible Parties

The party responsible for operation and maintenance of all project BMPs is the Owner:

Housing Authority of the County of San Bernardino
715 East Brier Drive
San Bernardino, CA 92408
(909) 890-0644

# SECTION 5

## Funding Services

Funding for all of the project's BMPs (including initial capital costs and operating and maintenance expenses) will be provided by and be the ongoing responsibility of the Owner:

Housing Authority of the County of San Bernardino
715 East Brier Drive
San Bernardino, CA 92408
(909) 890-0644

## SECTION 6
## WQMP Certification

### 6.1 Certification

- The applicant is required to sign and certify that the WQMP is in conformance with Santa Ana Regional Water Quality Control Board Order Number R8-2010-0036 (NPDES Permit No. CAS618036).

- The applicant is required to sign and date the following statement 'word-for-word' certifying that the provisions of the WQMP have been accepted by the applicant and that the applicant will have the plan transferred to future successors (transferability statement). The certification must be signed by the property owner, unless a written designation by the owner allows a designee to sign on the owner's behalf.

"This Water Quality Management Plan has been prepared for (Owner/Developer Name) by (Consulting /Engineering Firm Name). It is intended to comply with the requirements of the City of (name city or county) for Tract/Parcel Map No. _____, Condition Number(s) _____ requiring the preparation of a Water Quality Management Plan (WQMP). The undersigned is aware that Best Management Practices (BMPs) are enforceable pursuant to the City's/County's Water Quality Ordinance No. _____. The undersigned, while it owns the subject property, is responsible for the implementation of the provisions of this plan and will ensure that this plan is amended as appropriate to reflect up-to-date conditions on the site consistent with San Bernardino County's Municipal Stormwater Management Program and the intent of the NPDES Permit for San Bernardino County and the incorporated cities of San Bernardino County within the Santa Ana Region. Once the undersigned transfers its interest in the property, its successors in interest and the city/county shall be notified of the transfer. The new owner will be informed of its responsibility under this WQMP. A copy of the approved WQMP shall be available on the subject site in perpetuity. "

"I certify under a penalty of law that the provisions (implementation, operation, maintenance, and funding) of the WQMP have been accepted and that the plan will be transferred to future successors."

| _____ | _____ |
|---|---|
| Applicant's Signature | Date |
| _____ | _____ |
| Applicant's Name | Applicant's Telephone Number |

# Attachment A-2

**Water Quality Management Plan and Stormwater BMP Transfer, Access and Maintenance Agreement (adapted from documents from the Ventura County Stormwater Management Program)**

Recorded at the request of:

City of _____

After recording, return to:

City of _____

City Clerk _____

**Water Quality Management Plan and Stormwater BMP Transfer, Access and Maintenance Agreement**

**OWNER:** _____

**PROPERTY ADDRESS:** _____

_____

**APN:** _____

**THIS AGREEMENT** is made and entered into in

_____, California, this _____ day of

_____ , by and between

_____, herein after

referred to as "Owner" and the CITY OF _____, a municipal corporation, located in the County of San Bernardino, State of California hereinafter referred to as "CITY";

**WHEREAS,** the Owner owns real property ("Property") in the City of

_____, County of San Bernardino, State of California, more specifically described in Exhibit "A" and depicted in Exhibit "B", each of which exhibits is attached hereto and incorporated herein by this reference;

**WHEREAS,** at the time of initial approval of development project known as

_____ within the Property described herein, the City required the project to employ Best Management Practices, hereinafter referred to as "BMPs," to minimize pollutants in urban runoff;

**WHEREAS,** the Owner has chosen to install and/or implement BMPs as described in the Water Quality Management Plan, on file with the City, hereinafter referred to as "WQMP", to minimize pollutants in urban runoff and to minimize other adverse impacts of urban runoff;

**WHEREAS,** said WQMP has been certified by the Owner and reviewed and approved by the City;

**WHEREAS,** said BMPs, with installation and/or implementation on private property and draining only private property, are part of a private facility with all maintenance or replacement, therefore, the sole responsibility of the Owner in accordance with the terms of this Agreement;

**WHEREAS,** the Owner is aware that periodic and continuous maintenance, including, but not necessarily limited to, filter material replacement and sediment removal, is required to assure peak performance of all BMPs in the WQMP and that, furthermore, such maintenance activity will require compliance with all Local, State, or Federal laws and regulations, including those pertaining to confined space and waste disposal methods, in effect at the time such maintenance occurs;

**NOW THEREFORE,** it is mutually stipulated and agreed as follows:

1. Owner hereby provides the City of City's designee complete access, of any duration, to the BMPs and their immediate vicinity at any time, upon reasonable notice, or in the event of emergency, as determined by City's Director of Public Works no advance notice, for the purpose of inspection, sampling, testing of the Device, and in case of emergency, to undertake all necessary repairs or other preventative measures at owner's expense as provided in paragraph 3 below. City shall make every effort at all times to minimize or avoid interference with Owner's use of the Property.

2. Owner shall use its best efforts diligently to maintain all BMPs in a manner assuring peak performance at all times. All reasonable precautions shall be exercised by Owner and Owner's representative or contractor in the removal and extraction of any material(s) from the BMPs and the ultimate disposal of the material(s) in a manner consistent with all relevant laws and regulations in effect at the time. As may be requested from time to time by the City, the Owner shall provide the City with documentation identifying the material(s) removed, the quantity, and disposal destination.

3. In the event Owner, or its successors or assigns, fails to accomplish the necessary maintenance contemplated by this Agreement, within five (5) days of being given written notice by the City, the City is hereby authorized to cause any maintenance necessary to be done and charge the entire cost and expense to the Owner or Owner's successors or assigns, including administrative costs, attorneys fees and interest thereon at the maximum rate authorized by the Civil Code from the date of the notice of expense until paid in full.

4. The City may require the owner to post security in form and for a time period satisfactory to the city to guarantee the performance of the obligations state herein. Should the Owner fail to perform the obligations under the Agreement, the City may, in the case of a cash bond, act for the Owner using the proceeds from it, or in the case of a surety bond, require the sureties to perform the obligations of the Agreement. As an additional remedy, the Director may withdraw any previous stormwater-related approval with respect to the property on which BMPs have been installed and/or implemented until such time as Owner repays to City its reasonable costs incurred in accordance with paragraph 3 above.

5. This agreement shall be recorded in the Office of the Recorder of San Bernardino County, California, at the expense of the Owner and shall constitute notice to all successors and assigns of the title to said Property of the obligation herein set forth, and also a lien in such amount as will fully reimburse the City, including interest as herein above set forth, subject to foreclosure in event of default in payment.

6. In event of legal action occasioned by any default or action of the Owner, or its successors or assigns, then the Owner and its successors or assigns agree(s) to pay all costs incurred by the City in enforcing the terms of this Agreement, including reasonable attorney's fees and costs, and that the same shall become a part of the lien against said Property.

7. It is the intent of the parties hereto that burdens and benefits herein undertaken shall constitute covenants that run with said Property and constitute a lien there against.

8. The obligations herein undertaken shall be binding upon the heirs, successors, executors, administrators and assigns of the parties hereto. The term "Owner" shall include not only the present Owner, but also its heirs, successors, executors, administrators, and assigns. Owner shall notify any successor to title of all or part of the Property about the existence of this Agreement. Owner shall provide such notice prior to such successor obtaining an interest in all or part of the Property. Owner shall provide a copy of such notice to the City at the same time such notice is provided to the successor.

9. Time is of the essence in the performance of this Agreement.

10. Any notice to a party required or called for in this Agreement shall be served in person, or by deposit in the U.S. Mail, first class postage prepaid, to the address set forth below. Notice(s) shall be deemed effective upon receipt, or seventy-two (72) hours after deposit in the U.S. Mail, whichever is earlier. A party may change a notice address only by providing written notice thereof to the other party.

**IF TO CITY:**

_____

_____

_____

_____

**IF TO OWNER:**

_____

_____

_____

_____

**IN WITNESS THEREOF,** the parties hereto have affixed their signatures as of the date first written above.

**APPROVED AS TO FORM:**

_____
City Attorney

_____
CITY OF

_____
Name

_____
Title

**ATTEST:**

_____
City Clerk Date

**OWNER:**

_____
Name

_____
Title

**OWNER:**

_____
Name

_____
Title

**NOTARIES ON FOLLOWING PAGE**

**EXHIBIT A**
***(Legal Description)***

Real property in the San Bernardino County of San Bernardino, State of California, described as follow:

PARCEL 1: (APN: 0147-211-01-0-000 THROUGH 0147-211-04-0-000)

LOTS 11, 12, 13 AND 14, IN BLOCK 42, RANCHO SAN BERNARDINO, IN THE COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS PER PLAT RECORDED IN BOOK 7 OF MAPS, PAGE 2, RECORDS OF SAID COUNTY.

EXCEPTING THEREFROM A PARCEL 150 FEET BY 150 FEET IN THE NORTHWEST CORNER OF LOT 11; AND THE EAST 300 FEET OF LOT 14.

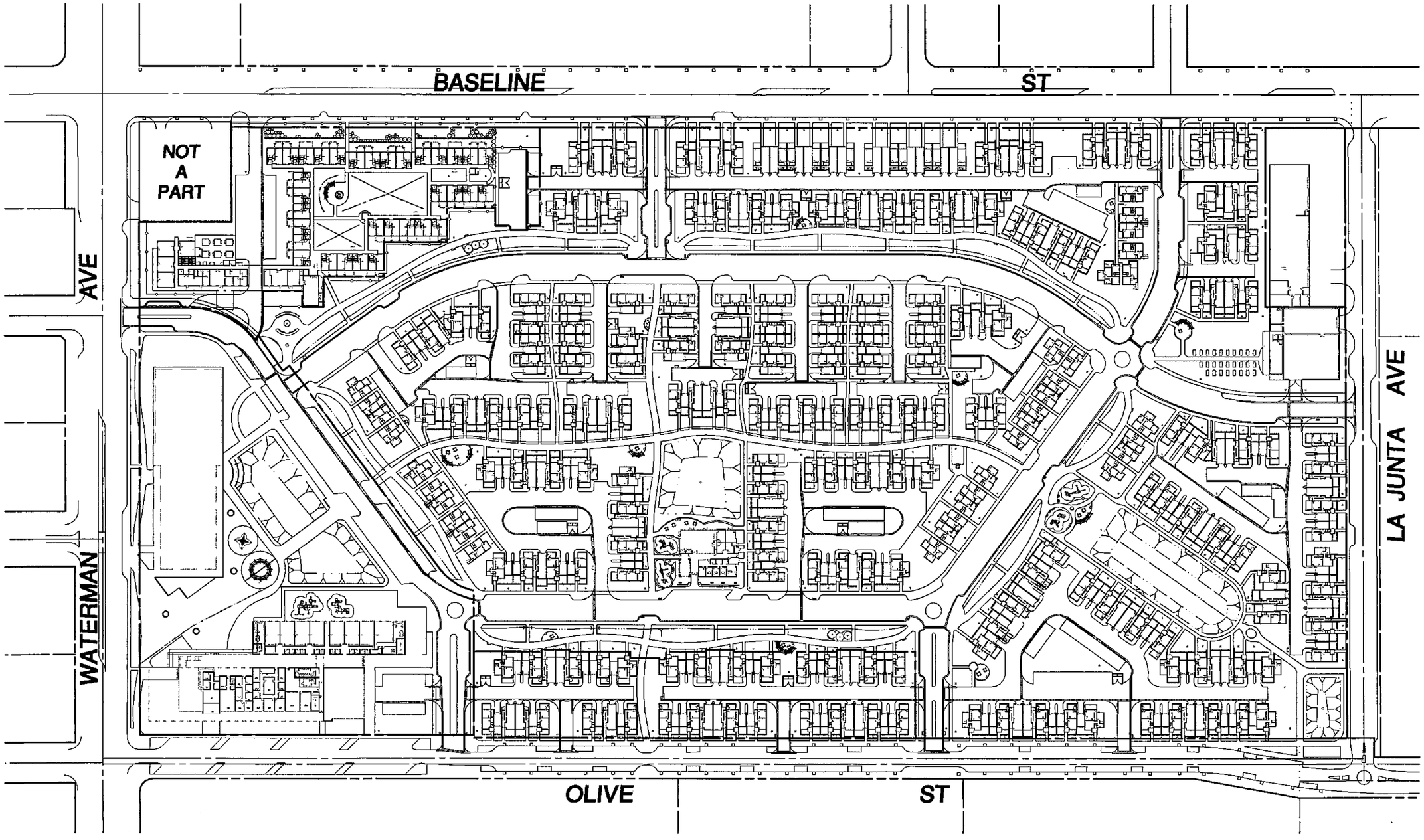
PARCEL B: (APN: 0147-181-33-0-000)

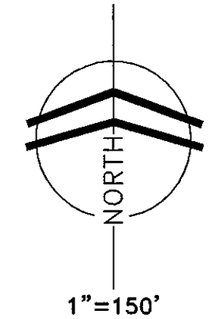
THE WEST 40 FEET OF PARCEL 1 OF PARCEL MAP NO. 14951, IN THE CITY OF SAN BERNARDINO, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS SHOWN ON MAP ON FILE IN BOOK 185, PAGES 85 AND 86 OF PARCEL MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

PARCEL B: (APN: 0147-181-35-0-000)

THE WEST 40 FEET OF PARCEL 2 OF PARCEL MAP NO. 14951, IN THE CITY OF SAN BERNARDINO, COUNTY OF SAN BERNARDINO, STATE OF CALIFORNIA, AS SHOWN ON MAP ON FILE IN BOOK 185, PAGES 85 AND 86 OF PARCEL MAPS, IN THE OFFICE OF THE COUNTY RECORDER OF SAID COUNTY.

**EXHIBIT B**
***(Map/Illustration)***

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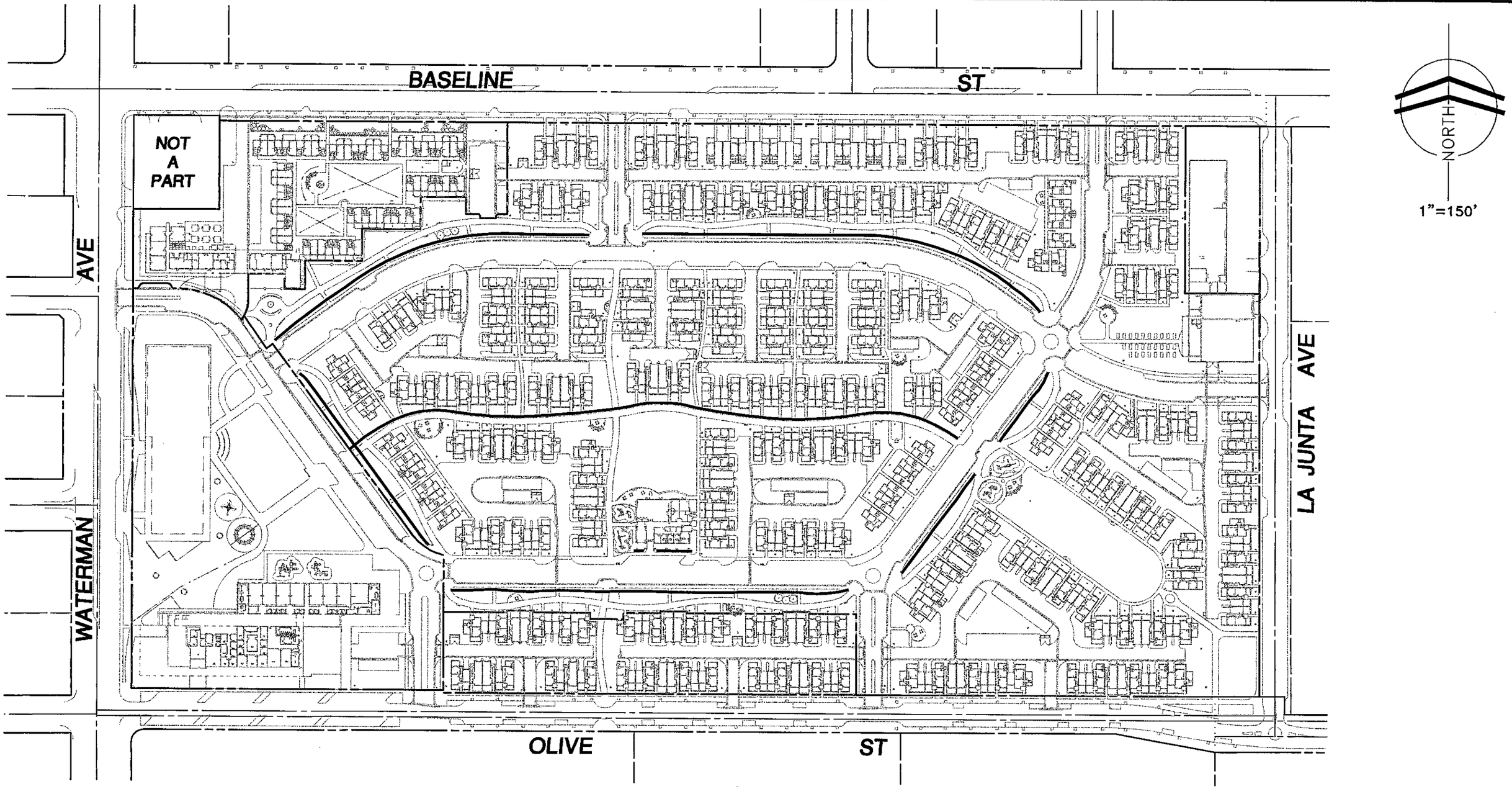
RANCHO CUCAMONGA, CA 91730
Ph. (909) 987-4306 Fax (909) 941-1528
info@dgandassoc.com

# Waterman Gardens
## Site Base

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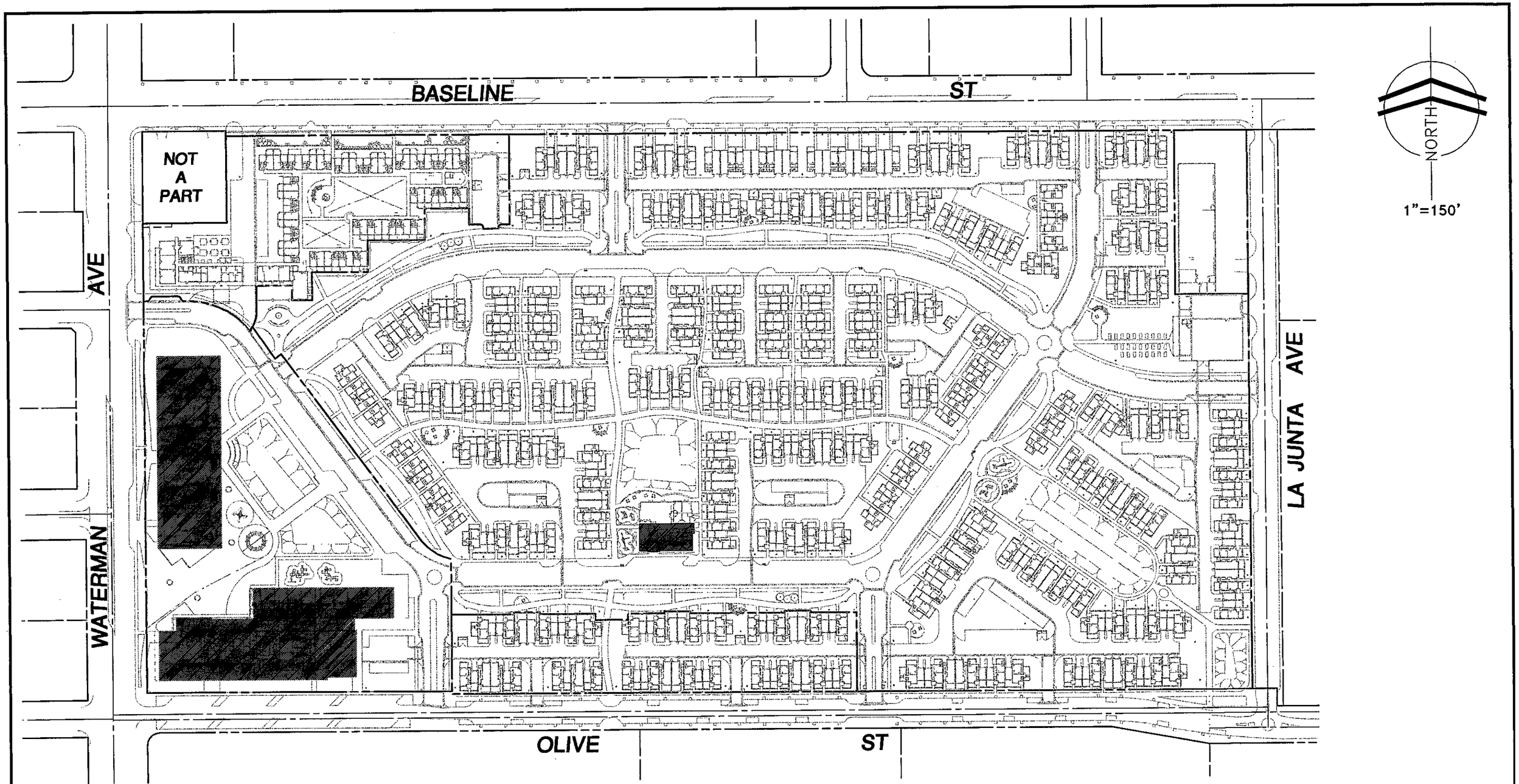
Denotes Proposed Lot Line

Denotes Proposed Bio Swale Area

# Waterman Gardens
## Bio Swales Exhibit

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Denotes Proposed Lot Line

Denotes Proposed Green Roof Areas

# Waterman Gardens
## Green Roofs Exhibit

BASELINE ST

NOT A PART

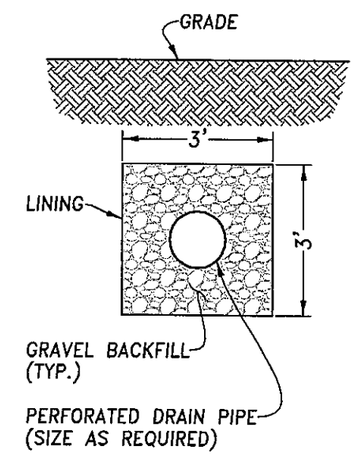
WATERMAN AVE

LA JUNTA AVE

OLIVE ST

NORTH

1"=150'




Typical Section
Perforated Drain Pipe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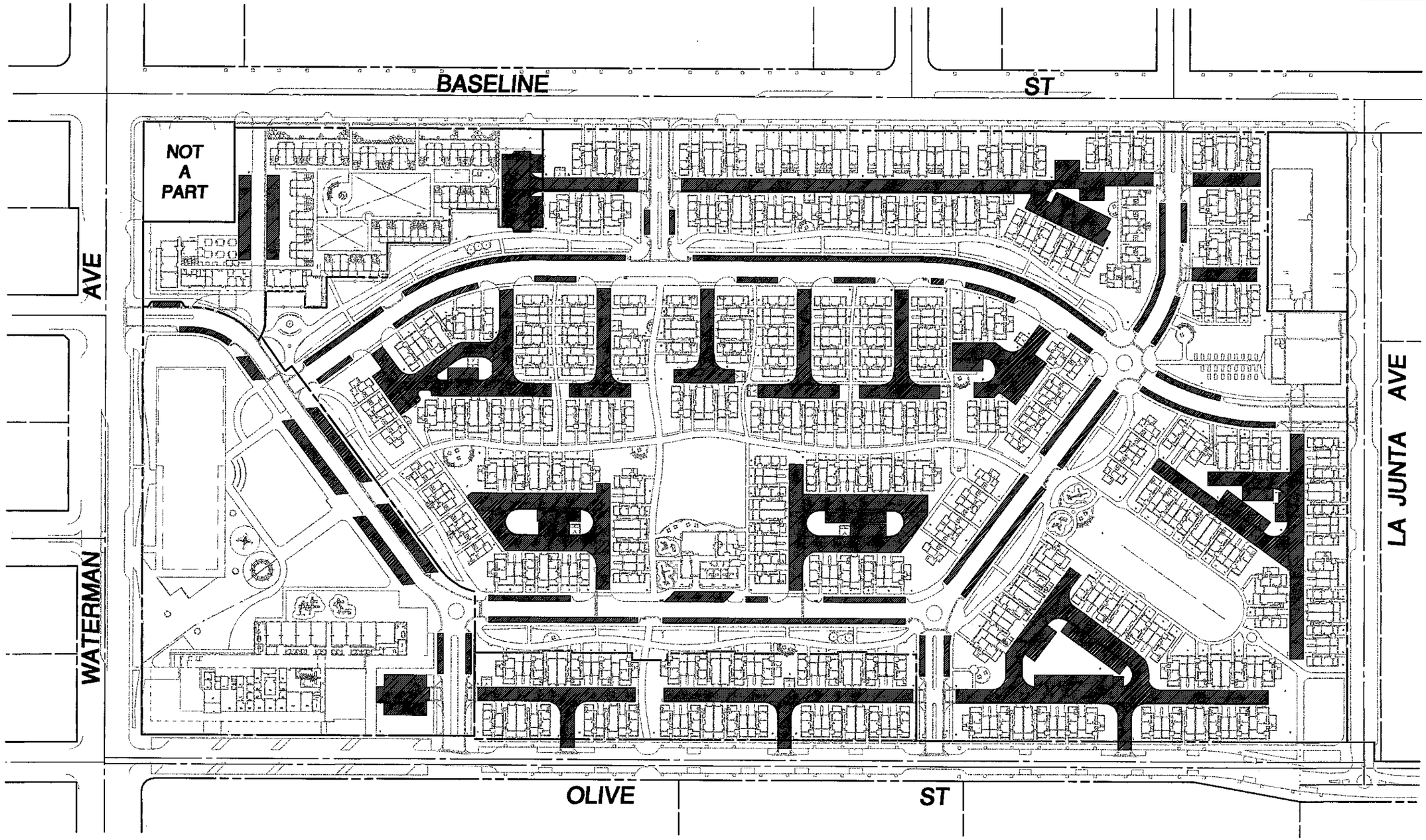
Denotes Proposed Lot Line

Denotes Proposed Perforated Drain Pipe

# Waterman Gardens
## Perforated Drain Pipe Exhibit

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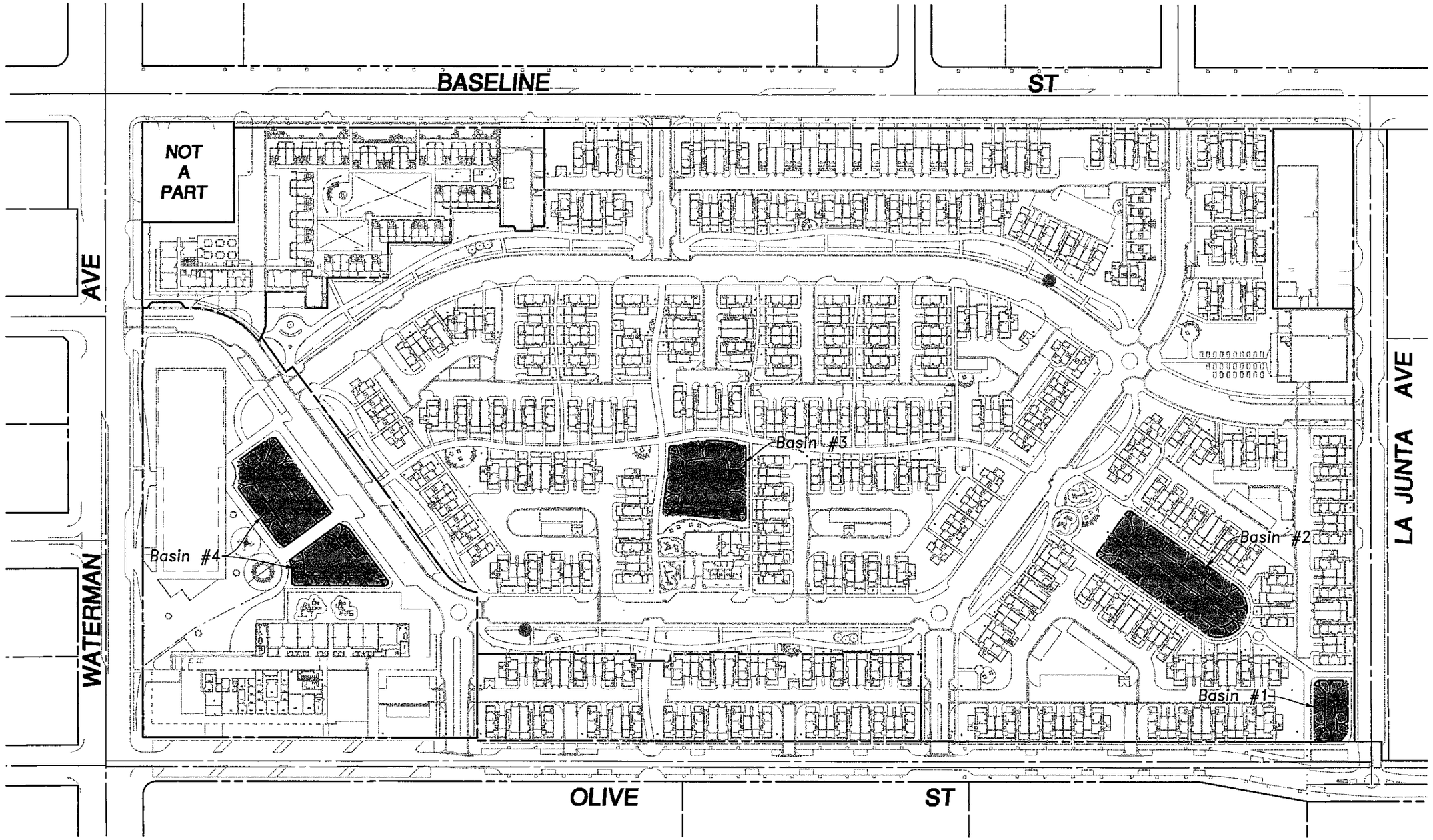
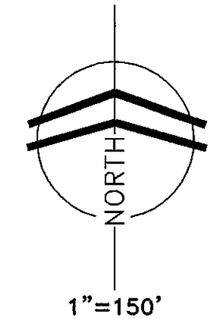
Denotes Proposed Lot Line

Denotes Proposed Pervious Concrete Paving Areas

# Waterman Gardens
## Pervious Concrete Paving Exhibit

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Denotes Proposed Lot Line

Denotes Proposed Detention Basin Areas

# Waterman Gardens
## Detention Basins Exhibit

# Attachment B
# Tables

**Table B-1**
**303(d) List of Impaired Water Bodies**

| Waterbody | Pollutant | | | | | |
|---|---|---|---|---|---|---|
| | Bacteria Indicators/ Pathogens | Metals | Nutrients | Organic Enrichment | Sedimentation/Siltation | Suspended Solids |
| Big Bear Lake | | X | X | X | X | |
| Canyon Lake (Railroad Canyon Reservoir) | X | | X | | | |
| Chino Creek Reach 1 | X | | X | | | |
| Chino Creek Reach 2 | X | | | | | |
| Cucamonga Creek, Valley Reach | X | | | | | |
| Grout Creek | | X | X | | | |
| Knickerbocker Creek | X | X | | | | |
| Lytle Creek | X | | | | | |
| Mill Creek (Prado Area) | X | | X | | | X |
| Mill Creek Reach 1 | X | | | | | |
| Mill Creek Reach 2 | X | | | | | |
| Mountain Home Creek | X | | | | | |
| Mountain Home Creek, East Fork | X | | | | | |
| Prado Park Lake | X | | X | | | |
| Rathbone (Rathbun Creek) | | | X | | X | |
| Santa Ana River, Reach 3 | X | | | | | |
| Santa Ana River, Reach 4 | X | | | | | |
| Summit Creek | | | X | | | |

**NOTES:**

1) Summary of the 2006 303(d) Listed Water Bodies and Associated Pollutants of Concern from RWQCB Region 8. Check for updated lists from the RWQCB.

2) Chlorides, pesticides, salinity, total dissolved solids (TDS), toxicity, and trash are listed impairments within the 303(d) table, however, they are not impairments in the above waterbodies.

**Table B-2**
**C Values Based on Impervious/Pervious Area Ratios**

| % Impervious | % Pervious | C |
|---|---|---|
| 0 | 100 | 0.15 |
| 5 | 95 | 0.19 |
| 10 | 90 | 0.23 |
| 15 | 85 | 0.26 |
| 20 | 80 | 0.30 |
| 25 | 75 | 0.34 |
| 30 | 70 | 0.38 |
| 35 | 65 | 0.41 |
| 40 | 60 | 0.45 |
| 45 | 55 | 0.49 |
| 50 | 50 | 0.53 |
| 55 | 45 | 0.56 |
| 60 | 40 | 0.60 |
| 65 | 35 | 0.64 |
| 70 | 30 | 0.68 |
| 75 | 25 | 0.71 |
| 80 | 20 | 0.75 |
| 85 | 15 | 0.79 |
| 90 | 10 | 0.83 |
| 95 | 5 | 0.86 |
| 100 | 0 | 0.90 |

**NOTE:**

Obtain individual runoff coefficient C-Factors from the local agency or from the local flood control district.

If C-Factors are not available locally, obtain factors from hydrology text books or estimate using this table.

Composite the individual C-Factors using area-weighted averages to calculate the Composite C Factor for the area draining to a treatment control BMP.

Do not use the C-Factors in this table for flood control design or related work.

# Attachment C
# Pollutants of Concern

## *Pollutants of Concern*

- *Bacteria and Viruses* – Bacteria and Viruses are ubiquitous microorganisms that thrive under certain environmental conditions. Their proliferation is typically cause by the transport of animal or human fecal wastes from the watershed. Water, containing excessive bacteria and viruses, can alter the aquatic habitat and create a harmful environment for humans and aquatic life. Also, the decomposition of excess organic waste causes increased growth of undesirable organisms in the water.

- *Metals* – The primary source of metal pollution in stormwater is typically commercially available metals and metal products. Metals of concern include cadmium, chromium, copper, lead, mercury, and zinc. Lead and chromium have been used as corrosion inhibitors in primer coatings and cooling tower systems. Metals are also raw material components in non-metal products such as fuels, adhesives, paints, and other coatings. At low concentrations naturally occurring in soil, metals may not be toxic. However, at higher concentrations, certain metals can be toxic to aquatic life. Humans can be impacted from contaminated groundwater resources, and bioaccumulation of metals in fish and shellfish. Environmental concerns, regarding the potential for release of metals to the environment, have already led to restricted metal usage in certain applications (OC 2003).

- *Nutrients* – Nutrients are inorganic substances, such as nitrogen and phosphorus. Excessive discharge of nutrients to water bodies and streams causes eutrophication, where aquatic plants and algae growth can lead to excessive decay of organic matter in the water body, loss of oxygen in the water, release of toxins in sediment, and the eventual death of aquatic organisms. Primary sources of nutrients in urban runoff are fertilizers and eroded soils.

- *Pesticides* -- Pesticides (including herbicides) are chemical compounds commonly used to control nuisance growth or prevalence of organisms. Relatively low levels of the active component of pesticides can result in conditions of aquatic toxicity. Excessive or improper application of a pesticide may result in runoff containing toxic levels of its active ingredient (OC 2003).

- *Organic Compounds* – Organic compounds are carbon-based. Commercially available or naturally occurring organic compounds are found in pesticides, solvents, and hydrocarbons. Organic compounds can, at certain concentrations, indirectly or directly constitute a hazard to life or health. When rinsing off objects, toxic levels of solvents and cleaning compounds can be discharged to storm drains. Dirt, grease, and grime retained in the cleaning fluid or rinse water may also adsorb levels of organic compounds that are harmful or hazardous to aquatic life (OC 2003).

- *Sediments* – Sediments are solid materials that are eroded from the land surface. Sediments can increase turbidity, clog fish gills, reduce spawning habitat, lower young aquatic organisms survival rates, smother bottom dwelling organisms, and suppress aquatic vegetation growth.

- *Trash and Debris* – Trash (such as paper, plastic, polystyrene packing foam, and aluminum materials) and biodegradable organic matter (such as leaves, grass cuttings, and food waste) are general waste products on the landscape. The presence of trash and debris may

have a significant impact on the recreational value of a water body and aquatic habitat. Trash impacts water quality by increasing biochemical oxygen demand.

- *Oxygen-Demanding Substances* – This category includes biodegradable organic material as well as chemicals that react with dissolved oxygen in water to form other compounds. Proteins, carbohydrates, and fats are examples of biodegradable organic compounds. Compounds such as ammonia and hydrogen sulfide are examples of oxygen-demanding compounds. The oxygen demand of a substance can lead to depletion of dissolved oxygen in a water body and possibly the development of septic conditions. A reduction of dissolved oxygen is detrimental to aquatic life and can generate hazardous compounds such as hydrogen sulfides.

- *Oil and Grease* – Oil and grease in water bodies decreases the aesthetic value of the water body, as well as the water quality. Primary sources of oil and grease are petroleum hydrocarbon products, motor products from leaking vehicles, esters, oils, fats, waxes, and high molecular-weight fatty acids.

# Attachment D
# Flow- and Volume-Based BMP Design Calculations

## INSTRUCTIONS FOR ESTIMATING VOLUME- AND FLOW-BASED BMP DESIGN RUNOFF QUANTITIES[4]

1) Identify the "BMP Drainage Area" that drains to the proposed BMP element. This includes all areas that will drain to the proposed BMP element, including pervious areas, impervious areas, and off-site areas, whether or not they are directly or indirectly connected to the BMP element. Calculate the BMP Drainage Area (A) in acres.

2) Outline the Drainage Area on the NOAA Atlas 14 Precipitation Depths (2-year 1-hour Rainfall) map (Figure D-1).

3) Determine the area-averaged 2-year 1-hour rainfall value for the Drainage Area outlined above.

### A. Flow-Based BMP Design

1) Calculate the composite runoff coefficient, $C_{BMP}$, as defined in part A.2, above.

2) Determine which Region the BMP Drainage Area is located in (Valley, Mountain or Desert).

3) Determine BMP design rainfall intensity, $I_{BMP}$, by multiplying the area-averaged 2-year 1-hour value from the NOAA Atlas 14 map by the appropriate regression coefficient from Table D-1 ("I"), and then multiplying by the safety factor specified in the criteria—usually a factor of 2.

---

[4] Rainfall analysis to develop regression coefficients in Table D-1 and modifications to the NOAA Atlas 14 map were conducted by:

Hromadka II, T.V., Professor Emeritus, Department of Mathematics, California State University, Fullerton, and Adjunct Professor, Department of Mathematical Sciences, United States Military Academy, West Point, NY

Laton, W.R , Assistant Professor, Department of Geological Sciences, California State University, Fullerton

Picciuto J.A.., Assistant Professor, Department of Mathematical Sciences, United States Military Academy, West Point, NY

With assistance from:

Rene Perez, M.S. Candidate, Department of Geological Sciences, California State University, Fullerton, and

Jim Friel, Ph.D. Professor Emeritus, Department of Mathematics, California State University, Fullerton

Reported as follows:

1. Hromadka II, T.V., Laton, W.R., and Picciuto J.A., 2005. Estimating Runoff Quantities for Flow and Volume-based BMP Design. Final Report to the San Bernardino County Flood Control District.
2. Laton, W.R., Hromadka II, T.V., and Picciuto J.A., 2005. Estimating Runoff Quantities for Flow and Volume-based BMP Design (submitted). Journal of the American Water Resources Association.

4) Calculate the target BMP flow rate, Q, by using the following formula (see Table D-2 below for limitations on the use of this formula):

$$Q = C_{BMP} \cdot I_{BMP} \cdot A$$

where: $Q$ = flow in $ft^3/s$

$I_{BMP}$ = BMP design rainfall intensity, in inches/hour

$A$ = Drainage Area in acres

$C_{BMP}$ = composite runoff coefficient

**Table D-1:** Regression Coefficients for Intensity (I) and 6-hour mean storm rainfall ($P_6$).

| Quantity | Valley 85% upper confidence limit | Mountain 85% upper confidence limit | Desert 85% upper confidence limit |
|---|---|---|---|
| I | 0.2787 | 0.3614 | 0.3250 |
| $P_6$ | 1.4807 | 1.9090 | 1.2371 |

**Table D-2**: Use of the flow-based formula for BMP Design (CASQA 2003).

| | Composite Runoff Coefficient, "C" | | | |
|---|---|---|---|---|
| **BMP Drainage Area (Acres)** | **0.00 to 0.25** | **0.26 to 0.50** | **0.51 to 0.75** | **0.76 to 1.00** |
| **0 to 25** | **Caution** | **Yes** | **Yes** | **Yes** |
| **26 to 50** | **High Caution** | **Caution** | **Yes** | **Yes** |
| **51 to 75** | **Not Recommended** | **High Caution** | **Caution** | **Yes** |
| **76 to 100** | **Not Recommended** | **High Caution** | **Caution** | **Yes** |

If the flow-based BMP formula use case, as determined by Table D-2, shows "Caution," "High Caution," or "Not Recommended," considering the project's characteristics, then he project proponent must calculate the BMP design flow using the unit hydrograph method, as specified in the most current version of the San Bernardino County Hydrology Manual, using the design storm pattern with rainfall return frequency such that the peak one hour rainfall depth equals the 85th-percentile 1-hour rainfall multiplied by two.

**B. Volume-Based BMP Design**

1) Calculate the "Watershed Imperviousness Ratio", i, which is equal to the percent of impervious area in the BMP Drainage Area divided by 100.

2) Calculate the composite runoff coefficient $C_{BMP}$ for the Drainage Area above using the following equation:

$$\mathbf{C_{BMP} = 0.858i^3 - 0.78i^2 + 0.774i + 0.04}$$

where: $\mathbf{C_{BMP}}$ = composite runoff coefficient; and,

**i** = watershed imperviousness ratio.

3) Determine which Region the Drainage Area is located in (Valley, Mountain or Desert).

4) Determine the area-averaged "6-hour Mean Storm Rainfall", $P_6$, for the Drainage Area. This is calculated by multiplying the area averaged 2-year 1-hour value by the appropriate regression coefficient from Table 1.

5) Determine the appropriate drawdown time. Use the regression constant a = 1.582 for 24 hours and a = 1.963 for 48 hours. *Note: Regression constants are provided for both 24 hour and 48 hour drawdown times; however, 48 hour drawdown times should be used in most areas of California. Drawdown times in excess of 48 hours should be used with caution as vector breeding can be a problem after water has stood in excess of 72 hours. (Use of the 24 hour drawdown time should be limited to drainage areas with coarse soils that readily settle and to watersheds where warming may be detrimental to downstream fisheries.)*

6) Calculate the "Maximized Detention Volume", $P_0$, using the following equation:

$$\mathbf{P_0 = a \cdot C_{BMP} \cdot P_6}$$

where: $\mathbf{P_0}$ = Maximized Detention Volume, in inches

**a** = 1.582 for 24 hour and a = 1.963 for 48 hour drawdown,

$\mathbf{C_{BMP}}$ = composite runoff coefficient; and,

$\mathbf{P_6}$ = 6-hour Mean Storm Rainfall, in inches

7) Calculate the "Target Capture Volume", $V_0$, using the following equation:

$$\mathbf{V_0 = (P_0 \cdot A) / 12}$$

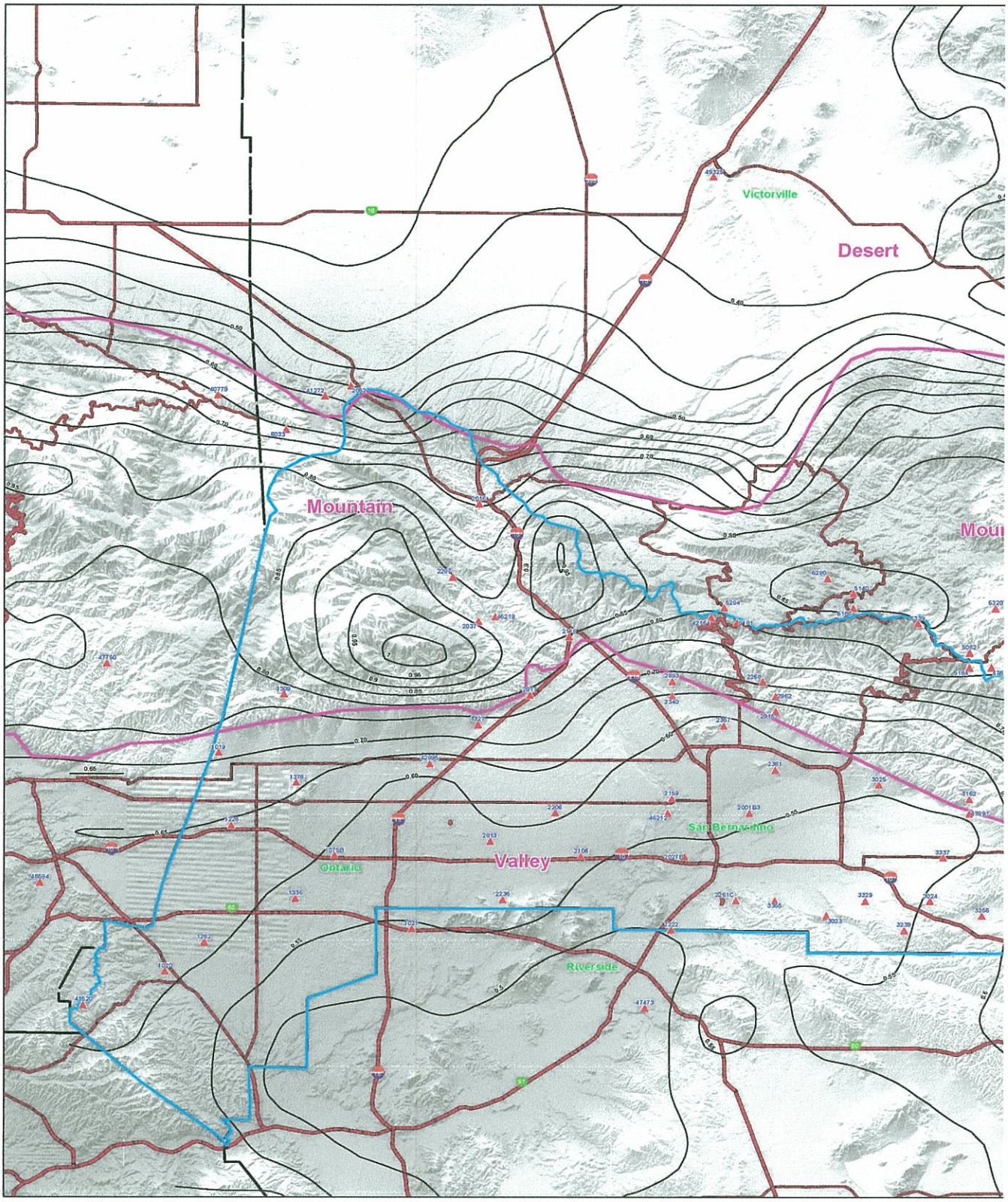
where:

$\mathbf{V_0}$ = Target Capture Volume, in acre-feet

$\mathbf{P_0}$ = Maximized Detention Volume, in inches; and,

**A** = BMP Drainage Area, in acres

**Figure D-1**: NOAA Atlas 14 Inset Map.


Victorville
Desert
Mountain
Valley
Ontario
San Bernardino
Riverside

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## Table B2.2: Pre- and Post-development Hydrology Comparison Worksheet

### Westerly Areas (To Waterman)

| Return Period | | Total Volume | | Peak Flow | | Flow Time Duration | | | Sediment Transport | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | % of Peak | Pre | Post | Pre | Post |
| 1 yr | | **1.77** | **1.77** | **11.4** | **7.3** | 90 | | | | |
| | Bypass | | 0.35 | | 2.1 | 80 | | | | |
| | | | | | | 70 | | | | |
| | | | | | | 60 | | | | |
| | Basin 3 | | 0.77 | | 3.6 | 50 | | | | |
| | Basin 4 | | 0.65 | | 1.6 | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |
| 2 yr | | **2.54** | **2.5** | **16.8** | **10.3** | 90 | | | | |
| | Bypass | | 0.5 | | 3 | 80 | | | | |
| | | | | | | 70 | | | | |
| | | | | | | 60 | | | | |
| | Basin 3 | | 1.08 | | 4.9 | 50 | | | | |
| | Basin 4 | | 0.92 | | 2.4 | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |
| 5 yr | | **4.65** | **3.55** | **23.6** | **13.6** | 90 | | | | |
| | Bypass | | 0.71 | | 4 | 80 | | | | |
| | | | | | | 70 | | | | |
| | | | | | | 60 | | | | |
| | Basin 3 | | 1.53 | | 6.1 | 50 | | | | |
| | Basin 4 | | 1.31 | | 3.5 | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |

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## Table B2.2: Pre- and Post-development Hydrology Comparison Worksheet

Easterly Areas (To La Junta)

| Return Period | | Total Volume | | Peak Flow | | Flow Time Duration | | | Sediment Transport | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | % of Peak | Pre | Post | Pre | Post |
| | | **0.76** | **1.45** | **7.5** | **6.3** | 90 | | | | |
| | Bypass | | 0.08 | | 1.1 | 80 | | | | |
| **1 yr** | Basin 1 | | 0.43 | | 2.2 | 70 | | | | |
| | Basin 2 | | 0.94 | | 3 | 60 | | | | |
| | | | | | | 50 | | | | |
| | | | | | | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |
| | | **1.07** | **2.05** | **10.1** | **8.2** | 90 | | | | |
| | Bypass | | 0.11 | | 1.4 | 80 | | | | |
| **2 yr** | Basin 1 | | 0.61 | | 3.2 | 70 | | | | |
| | Basin 2 | | 1.33 | | 3.6 | 60 | | | | |
| | | | | | | 50 | | | | |
| | | | | | | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |
| | | **1.51** | **2.91** | **13.4** | **10.1** | 90 | | | | |
| | Bypass | | 0.16 | | 1.8 | 80 | | | | |
| **5 yr** | Basin 1 | | 0.87 | | 4.2 | 70 | | | | |
| | Basin 2 | | 1.88 | | 4.1 | 60 | | | | |
| | | | | | | 50 | | | | |
| | | | | | | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |

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## Table B2.2: Pre- and Post-development Hydrology Comparison Worksheet

Combined

| Return Period | | Total Volume | | Peak Flow | | Flow Time Duration | | | Sediment Transport | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Pre | Post | Pre | Post | % of Peak | Pre | Post | Pre | Post |
| | | **2.53** | **3.22** | **18.9** | **13.6** | 90 | | | | |
| | Bypass | | 0.43 | | 3.2 | 80 | | | | |
| **1 yr** | Basin 1 | | 0.43 | | 2.2 | 70 | | | | |
| | Basin 2 | | 0.94 | | 3 | 60 | | | | |
| | Basin 3 | | 0.77 | | 3.6 | 50 | | | | |
| | Basin 4 | | 0.65 | | 1.6 | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |
| | | **3.61** | **4.55** | **26.9** | **18.5** | 90 | | | | |
| | Bypass | | 0.61 | | 4.4 | 80 | | | | |
| **2 yr** | Basin 1 | | 0.61 | | 3.2 | 70 | | | | |
| | Basin 2 | | 1.33 | | 3.6 | 60 | | | | |
| | Basin 3 | | 1.08 | | 4.9 | 50 | | | | |
| | Basin 4 | | 0.92 | | 2.4 | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |
| | | **6.16** | **6.46** | **37** | **23.7** | 90 | | | | |
| | Bypass | | 0.87 | | 5.8 | 80 | | | | |
| **5 yr** | Basin 1 | | 0.87 | | 4.2 | 70 | | | | |
| | Basin 2 | | 1.88 | | 4.1 | 60 | | | | |
| | Basin 3 | | 1.53 | | 6.1 | 50 | | | | |
| | Basin 4 | | 1.31 | | 3.5 | 40 | | | | |
| | | | | | | 30 | | | | |
| | | | | | | 20 | | | | |
| | | | | | | 10 | | | | |

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**Westerly Areas (To Waterman)**

| Return Period | | Total Volume Pre | Total Volume Post | Volume Difference | Infiltration |
|---|---|---|---|---|---|
| 1 yr | | 1.77 | 1.77 | 0 ac-ft | 0.5 in/hr |
| | Bypass | | 0.35 | 0 cf | 1 ft/24hr |
| | | | | **Volume needed to eliminate via infiltration** | |
| | Basin 3 | | 0.77 | V = SA * I | **0 cf** |
| | Basin 4 | | 0.65 | | |
| | | | | **Surface area needed to eliminate via infiltration** | |
| | | | | SA = V / I | **0 sf** |
| 2 yr | | 2.54 | 2.5 | -0.04 ac-ft | 0.5 in/hr |
| | Bypass | | 0.5 | -1742.4 cf | 1 ft/24hr |
| | | | | **Volume needed to eliminate via infiltration** | |
| | Basin 3 | | 1.08 | V = SA * I | **-1742.4 cf** |
| | Basin 4 | | 0.92 | | |
| | | | | **Surface area needed to eliminate via infiltration** | |
| | | | | SA = V / I | **-1742.4 sf** |
| 5 yr | | 4.65 | 3.55 | -1.1 ac-ft | 0.5 in/hr |
| | Bypass | | 0.71 | -47916 cf | 1 ft/24hr |
| | | | | **Volume needed to eliminate via infiltration** | |
| | Basin 3 | | 1.53 | V = SA * I | **-47916 cf** |
| | Basin 4 | | 1.31 | | |
| | | | | **Surface area needed to eliminate via infiltration** | |
| | | | | SA = V / I | **-47916 sf** |

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## Easterly Areas (To La Junta)

| Return Period | | Total Volume Pre | Total Volume Post | Volume Difference | Infiltration | |
|---|---|---|---|---|---|---|
| | | **0.76** | **1.45** | 0.69 ac-ft | 0.5 in/hr | |
| | Bypass | | 0.08 | 30056.4 cf | 1 ft/24hr | |
| **1 yr** | Basin 1 | | 0.43 | | | |
| | Basin 2 | | 0.94 | | | **Volume needed to eliminate via infiltration** |
| | | | | | | V = SA * I: **30056.4 cf** |
| | | | | | | **Surface area needed to eliminate via infiltration** |
| | | | | | | SA = V / I **30056.4 sf** |
| | | **1.07** | **2.05** | 0.98 ac-ft | 0.5 in/hr | |
| | Bypass | | 0.11 | 42688.8 cf | 1 ft/24hr | |
| **2 yr** | Basin 1 | | 0.61 | | | |
| | Basin 2 | | 1.33 | | | **Volume needed to eliminate via infiltration** |
| | | | | | | V = SA * I: **42688.8 cf** |
| | | | | | | **Surface area needed to eliminate via infiltration** |
| | | | | | | SA = V / I **42688.8 sf** |
| | | **1.51** | **2.91** | 1.4 ac-ft | 0.5 in/hr | |
| | Bypass | | 0.16 | 60984 cf | 1 ft/24hr | |
| **5 yr** | Basin 1 | | 0.87 | | | |
| | Basin 2 | | 1.88 | | | **Volume needed to eliminate via infiltration** |
| | | | | | | V = SA * I: **60984 cf** |
| | | | | | | **Surface area needed to eliminate via infiltration** |
| | | | | | | SA = V / I **60984 sf** |

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**Combined**

| Return Period | | Total Volume Pre | Total Volume Post | Volume Difference | Infiltration | |
|---|---|---|---|---|---|---|
| | | **2.53** | **3.22** | 0.69 ac-ft | 0.5 in/hr | |
| | Bypass | | 0.43 | 30056.4 cf | 1 ft/24hr | |
| **1 yr** | Basin 1 | | 0.43 | | | |
| | Basin 2 | | 0.94 | **Volume needed to eliminate via infiltration** | | |
| | Basin 3 | | 0.77 | V = SA * I | **30056.4 cf** | |
| | Basin 4 | | 0.65 | | | |
| | | | | **Surface area needed to eliminate via infiltration** | | |
| | | | | SA = V / I | **30056.4 sf** | |
| | | **3.61** | **4.55** | 0.94 ac-ft | 0.5 in/hr | |
| | Bypass | | 0.61 | 40946.4 cf | 1 ft/24hr | |
| **2 yr** | Basin 1 | | 0.61 | | | |
| | Basin 2 | | 1.33 | **Volume needed to eliminate via infiltration** | | |
| | Basin 3 | | 1.08 | V = SA * I | **40946.4 cf** | |
| | Basin 4 | | 0.92 | | | |
| | | | | **Surface area needed to eliminate via infiltration** | | |
| | | | | SA = V / I | **40946.4 sf** | |
| | | **6.16** | **6.46** | 0.3 ac-ft | 0.5 in/hr | |
| | Bypass | | 0.87 | 13068 cf | 1 ft/24hr | |
| **5 yr** | Basin 1 | | 0.87 | | | |
| | Basin 2 | | 1.88 | **Volume needed to eliminate via infiltration** | | |
| | Basin 3 | | 1.53 | V = SA * I | **13068 cf** | |
| | Basin 4 | | 1.31 | | | |
| | | | | **Surface area needed to eliminate via infiltration** | | |
| | | | | SA = V / I | **13068 sf** | |

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| Sheet No. | | of | |
| Calculated by: | | Date | 6/8/2011 |
| Checked by: | | Date | |
| | | Scale | |

List of hydrographs required for WQMP

| | | Yr | |
|---|---|---|---|
| Pre-Dev | West | 1 | |
| | | 2 | |
| | | 5 | |
| | East | 1 | |
| | | 2 | |
| | | 5 | |
| Post | West-bypa: | 1 | |
| | | 2 | |
| | | 5 | |
| | East-bypas: | 1 | |
| | | 2 | |
| | | 5 | |
| | Basin 1 | 1 | |
| | | 2 | (need because AMC II) |
| | | 5 | |
| | Basin 2 | 1 | |
| | | 2 | (need because AMC II) |
| | | 5 | |
| | Basin 3 | 1 | |
| | | 2 | (need because AMC II) |
| | | 5 | |
| | Basin 4 | 1 | |
| | | 2 | (need because AMC II) |
| | | 5 | |
| | **Total** | **24** | |

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|---|---|---|---|
| Job | Waterman Gardens | | 149-205 |
| Sheet No. | 1 | of | 1 |
| Calculated by: | ATS | Date | 6/13/11 |
| Checked by: | | Date | |
| | | Scale | |

***California BMP - Site Design - SD 20 - "Pervious Pavement"***

**Total Site**

**BMP Drainage Area** **A= 36.90 acres**

1 **Rainfall to Runoff Losses**

| Cover Descr. | Area | Ap (%) | | Ai | i(wt) |
|---|---|---|---|---|---|
| Condominiums | 36.90 | 35% | | 65% | 23.985 |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| Σ= | 36.90 | | | Σi= | 0.65 |

**i= 0.65**

2 **Loss factor, C-BMP**

C-BMP = .858i^3 - .78i^2 +.774i+.04 **C-BMP= 0.45**

3 **Valley**

4 **Mean 6-yr rainfall, P-6** **P-6= 0.83 in**

From T.D-1 1.4807
2-yr 1-hr From F.D-1 0.56

5 **Drawdown time** **a= 1.58**

24 1.582

6 **Maximum Detention Volume**

P-0 = a C-BMP P-6 **P-0= 0.59 in**

7 **Target Capture Volume, Vo**

Vo = Po A / 12 **V-0= 1.81 ac-ft**
79029 cf

8 **Pervious Pavement Storage**

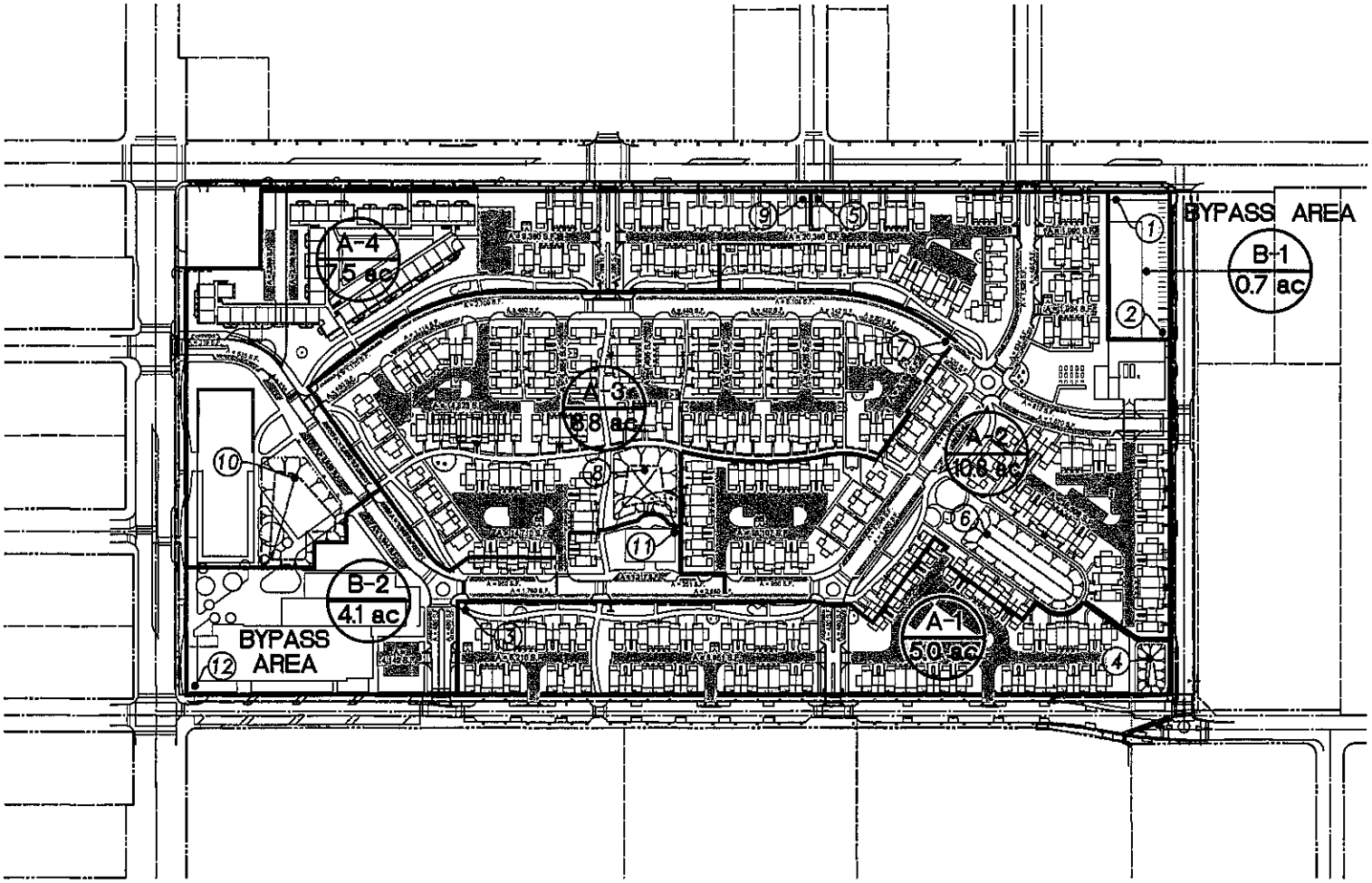
Location (Gutter-adjcnt)):

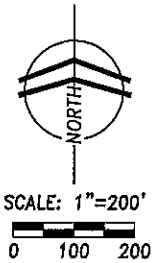
| | #1 (E'ly) | #2 (W'ly) | | |
|---|---|---|---|---|
| Trib Area | 16.5 | 20.40 | | ft |
| Top Width | 1 | 1 | | ft |
| Top Length | 103632 | 113548 | | ft |
| Infiltration Rate | 0.5 | 0.5 | 0.5 | in/hr |

| | | |
|---|---|---|
| Conc. Thick. | 0.5 | ft |
| Porosity | 20% | |
| Subbase Thick. | 0.75 | ft |
| Porosity | 40% | |

| | | | | | Totals | | FS= |
|---|---|---|---|---|---|---|---|
| Surface Area Required | *(for 72 hr drawdown, = WQV / (I x 72) ) | | | | 26343 | sf | 8.244344 |
| Surface Area Provided | 103632 | 113548 | 0 | | 217180 | sf | OK |
| Volume provided | 41453 | 45419 | 0 | | 86872 | cf | **OK** |
| Volume required | 35338 | 43691 | 0 | | | | |

***Method follows 11/12/10 WQMP Template and CA BMP handbook***




## LEGEND

| | |
|---|---|
| A-1 / 5.0 ac | SUBAREA DESIGNATION / AREA (ACRES) |
| 1 | NODE NUMBER |

| NODE | ELEVATION | FLOW LENGTH |
|---|---|---|
| 1 | 1095.6 | |
| | | 290' |
| 2 | 1089.0 | |
| 3 | 1082.5 | |
| | | 1410' |
| 4 | 1076.8 | |
| 5 | 1096.3 | |
| | | 940' |
| 6 | 1079.0 | |
| 7 | 1089.7 | |
| | | 655' |
| 8 | 1082.7 | |
| 9 | 1096.3 | |
| | | 1360' |
| 10 | 1082.8 | |
| 11 | 1086.0 | |
| | | 1220' |
| 12 | 1080.6 | |

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# WATERMAN GARDENS

## HYDROLOGY EXHIBIT - PROPOSED CONDITION

June 2, 2011

# RATIONAL METHOD

# HYDROLOGY

```
****************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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                          Analysis prepared by:

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 ************************* DESCRIPTION OF STUDY *************************
* WATERMAN GARDENS - SAN BERNARDINO                                      *
* PRELIMINARY HYDROLOGY                                                  *
* EXISTING CONDITION - 1 YR                                              *
 ************************************************************************

  FILE NAME: WTRMPQ01.DAT
  TIME/DATE OF STUDY: 18:48 06/07/2011
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                     --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    1.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.4600

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  =====  =====  =====  =======
  1   14.0      7.0   0.020/0.020/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

+---------------------------------------------------------------------------+
| BEGIN EASTERLY WATERSHED                                                  |
| SUBAREAS A-1 AND A-2                                                      |
|                                                                           |
```

```
+----------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   660.00
  ELEVATION DATA: UPSTREAM(FEET) =   1087.00  DOWNSTREAM(FEET) =   1077.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.748
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.224
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        6.50      0.75     0.400    56   11.75
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =      5.41
  TOTAL AREA(ACRES) =      6.50   PEAK FLOW RATE(CFS) =      5.41

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   11.75
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.224
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                 B        2.00      0.75     0.100    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    2.00      SUBAREA RUNOFF(CFS) =    2.07
  EFFECTIVE AREA(ACRES) =      8.50   AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.33
  TOTAL AREA(ACRES) =        8.5       PEAK FLOW RATE(CFS) =       7.48

+----------------------------------------------------------------------------+
| END EASTERLY WATERSHED                                                     |
| BEGIN WESTERLY WATERSHED                                                   |
| SUBAREAS B AND C                                                           |
+----------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      4.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   900.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.50  DOWNSTREAM(FEET) =   1089.00
```

```
Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   14.805
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.065
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
RESIDENTIAL
"8-10 DWELLINGS/ACRE"      B        2.70      0.75     0.400    56   14.80
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA RUNOFF(CFS) =      1.86
TOTAL AREA(ACRES) =      2.70   PEAK FLOW RATE(CFS) =      1.86

****************************************************************************
FLOW PROCESS FROM NODE      4.10 TO NODE      5.00 IS CODE =  62
----------------------------------------------------------------------------
>>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
UPSTREAM ELEVATION(FEET) = 1089.00  DOWNSTREAM ELEVATION(FEET) = 1088.00
STREET LENGTH(FEET) =   400.00   CURB HEIGHT(INCHES) =  6.0
STREET HALFWIDTH(FEET) = 14.00

DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
INSIDE STREET CROSSFALL(DECIMAL) =  0.020
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       2.67
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.40
  HALFSTREET FLOOD WIDTH(FEET) =   13.70
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.34
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.54
STREET FLOW TRAVEL TIME(MIN.) =   4.98   Tc(MIN.) =   19.79
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.895
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"      B        3.00      0.75     0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =    3.00      SUBAREA RUNOFF(CFS) =    1.61
EFFECTIVE AREA(ACRES) =      5.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =        5.7        PEAK FLOW RATE(CFS) =       3.06

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.41   HALFSTREET FLOOD WIDTH(FEET) =  14.00
FLOW VELOCITY(FEET/SEC.) =  1.36   DEPTH*VELOCITY(FT*FT/SEC.) =   0.55
LONGEST FLOWPATH FROM NODE      4.00 TO NODE      5.00 =    1300.00 FEET.
```

```
****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE     13.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   19.79
  RAINFALL INTENSITY(INCH/HR) =   0.89
  AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.40
  EFFECTIVE STREAM AREA(ACRES) =       5.70
  TOTAL STREAM AREA(ACRES) =       5.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       3.06

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   610.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.50  DOWNSTREAM(FEET) =   1087.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.182
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.260
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"       B        2.70      0.75     0.400    56   11.18
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =       2.34
  TOTAL AREA(ACRES) =       2.70   PEAK FLOW RATE(CFS) =       2.34

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      9.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1087.00  DOWNSTREAM ELEVATION(FEET) = 1082.00
  STREET LENGTH(FEET) =   895.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200
```

```
  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       4.61
  ***STREET FLOW SPLITS OVER STREET-CROWN***
  FULL DEPTH(FEET) =    0.41   FLOOD WIDTH(FEET) =   14.00
  FULL HALF-STREET VELOCITY(FEET/SEC.) =    2.03
  SPLIT DEPTH(FEET) =    0.22   SPLIT FLOOD WIDTH(FEET) =    4.46
  SPLIT FLOW(CFS) =    0.39   SPLIT VELOCITY(FEET/SEC.) =    1.22
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.41
  HALFSTREET FLOOD WIDTH(FEET) =   14.00
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.03
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.83
STREET FLOW TRAVEL TIME(MIN.) =   7.34   Tc(MIN.) =   18.52
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.931
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"      B        8.00      0.75      0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =    8.00      SUBAREA RUNOFF(CFS) =    4.55
EFFECTIVE AREA(ACRES) =     10.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =       10.7        PEAK FLOW RATE(CFS) =       6.09

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.41   HALFSTREET FLOOD WIDTH(FEET) =  14.00
FLOW VELOCITY(FEET/SEC.) =  2.03   DEPTH*VELOCITY(FT*FT/SEC.) =   0.83
LONGEST FLOWPATH FROM NODE      6.00 TO NODE      9.00 =    1505.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE      9.00 TO NODE     11.00 IS CODE =  62
----------------------------------------------------------------------------
>>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
UPSTREAM ELEVATION(FEET) = 1082.00  DOWNSTREAM ELEVATION(FEET) = 1081.30
STREET LENGTH(FEET) =   290.00   CURB HEIGHT(INCHES) =  6.0
STREET HALFWIDTH(FEET) = 14.00

DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
INSIDE STREET CROSSFALL(DECIMAL) =  0.020
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       7.64
  ***STREET FLOWING FULL***
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.44
  HALFSTREET FLOOD WIDTH(FEET) =   14.00
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.52
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.66
STREET FLOW TRAVEL TIME(MIN.) =   3.18   Tc(MIN.) =   21.70
```

```
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.847
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"       B        6.30      0.75      0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =     6.30      SUBAREA RUNOFF(CFS) =     3.10
EFFECTIVE AREA(ACRES) =      17.00    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =        17.0        PEAK FLOW RATE(CFS) =       8.38

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.45   HALFSTREET FLOOD WIDTH(FEET) =  14.00
FLOW VELOCITY(FEET/SEC.) =  1.57   DEPTH*VELOCITY(FT*FT/SEC.) =   0.70
LONGEST FLOWPATH FROM NODE      6.00 TO NODE     11.00 =    1795.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE     11.00 TO NODE     13.00 IS CODE =  62
----------------------------------------------------------------------------
>>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
UPSTREAM ELEVATION(FEET) = 1081.30  DOWNSTREAM ELEVATION(FEET) = 1080.50
STREET LENGTH(FEET) =   600.00   CURB HEIGHT(INCHES) =  6.0
STREET HALFWIDTH(FEET) = 14.00

DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
INSIDE STREET CROSSFALL(DECIMAL) =  0.020
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       9.48
  ***STREET FLOWING FULL***
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.50
  HALFSTREET FLOOD WIDTH(FEET) =   14.16
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.38
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.69
STREET FLOW TRAVEL TIME(MIN.) =   7.25   Tc(MIN.) =   28.95
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.712
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"       B        5.70      0.75      0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
* RAINFALL INTENSITY IS LESS THAN AREA-AVERAGED Fp;
* IMPERVIOUS AREA USED FOR RUNOFF ESTIMATES.
SUBAREA AREA(ACRES) =     5.70      SUBAREA RUNOFF(CFS) =     2.19
EFFECTIVE AREA(ACRES) =      22.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
```

```
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  * RAINFALL INTENSITY IS LESS THAN AREA-AVERAGED Fp;
  * IMPERVIOUS AREA USED FOR RUNOFF ESTIMATES.
  TOTAL AREA(ACRES) =       22.7        PEAK FLOW RATE(CFS) =       8.73

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.49   HALFSTREET FLOOD WIDTH(FEET) =  14.00
  FLOW VELOCITY(FEET/SEC.) =  1.34   DEPTH*VELOCITY(FT*FT/SEC.) =   0.66
  LONGEST FLOWPATH FROM NODE      6.00 TO NODE     13.00 =    2395.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     13.00 TO NODE     13.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   28.95
  RAINFALL INTENSITY(INCH/HR) =   0.71
  AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.40
  EFFECTIVE STREAM AREA(ACRES) =      22.70
  TOTAL STREAM AREA(ACRES) =      22.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       8.73

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1        3.06   19.79    0.895  0.75( 0.30) 0.40       5.7       4.00
      2        8.73   28.95    0.712  0.75( 0.30) 0.40      22.7       6.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       11.37   19.79    0.895  0.75( 0.30) 0.40      21.2       4.00
      2       10.92   28.95    0.712  0.75( 0.30) 0.40      28.4       6.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      11.37    Tc(MIN.) =    19.79
  EFFECTIVE AREA(ACRES) =      21.21   AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  TOTAL AREA(ACRES) =       28.4
  LONGEST FLOWPATH FROM NODE      6.00 TO NODE     13.00 =    2395.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)      =       28.4  TC(MIN.) =     19.79
  EFFECTIVE AREA(ACRES) =     21.21  AREA-AVERAGED Fm(INCH/HR)=  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap = 0.400
  PEAK FLOW RATE(CFS)    =      11.37

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
```

| NUMBER | (CFS) | (MIN.) | (INCH/HR) | (INCH/HR) | | (ACRES) | NODE |
|---|---|---|---|---|---|---|---|
| 1 | 11.37 | 19.79 | 0.895 | 0.75( 0.30) | 0.40 | 21.2 | 4.00 |
| 2 | 10.92 | 28.95 | 0.712 | 0.75( 0.30) | 0.40 | 28.4 | 6.00 |

END OF RATIONAL METHOD ANALYSIS

```
****************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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                          Analysis prepared by:

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 ************************* DESCRIPTION OF STUDY *************************
* WATERMAN GARDENS - SAN BERNARDINO                                      *
* PRELIMINARY HYDROLOGY                                                  *
* EXISTING CONDITION - 2 YR                                              *
 ************************************************************************

  FILE NAME: WTRMPQ02.DAT
  TIME/DATE OF STUDY: 11:01 06/06/2011
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.5900

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  =====  ======  =====  =======
  1   14.0      7.0   0.020/0.020/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

+---------------------------------------------------------------------------+
| BEGIN EASTERLY WATERSHED                                                  |
| SUBAREAS A-1 AND A-2                                                      |
```

```
|                                                                                |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   660.00
  ELEVATION DATA: UPSTREAM(FEET) =   1087.00  DOWNSTREAM(FEET) =   1077.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.748
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.569
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        6.50      0.75     0.400    56   11.75
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =      7.43
  TOTAL AREA(ACRES) =      6.50   PEAK FLOW RATE(CFS) =      7.43

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   11.75
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.569
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                 B        2.00      0.75     0.100    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =    2.00      SUBAREA RUNOFF(CFS) =    2.69
  EFFECTIVE AREA(ACRES) =      8.50   AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.33
  TOTAL AREA(ACRES) =        8.5       PEAK FLOW RATE(CFS) =      10.12

+--------------------------------------------------------------------------------+
| END EASTERLY WATERSHED                                                         |
| BEGIN WESTERLY WATERSHED                                                       |
| SUBAREAS B AND C                                                               |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      4.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   900.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.50  DOWNSTREAM(FEET) =   1089.00
```

```
Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   14.805
*   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.366
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
RESIDENTIAL
"8-10 DWELLINGS/ACRE"       B        2.70      0.75     0.400    56   14.80
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA RUNOFF(CFS) =       2.59
TOTAL AREA(ACRES) =       2.70   PEAK FLOW RATE(CFS) =       2.59

****************************************************************************
FLOW PROCESS FROM NODE      4.10 TO NODE      5.00 IS CODE =  62
----------------------------------------------------------------------------
>>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
UPSTREAM ELEVATION(FEET) = 1089.00  DOWNSTREAM ELEVATION(FEET) = 1088.00
STREET LENGTH(FEET) =   400.00   CURB HEIGHT(INCHES) =  6.0
STREET HALFWIDTH(FEET) = 14.00

DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
INSIDE STREET CROSSFALL(DECIMAL) =  0.020
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       3.74
  ***STREET FLOW SPLITS OVER STREET-CROWN***
  FULL DEPTH(FEET) =    0.41   FLOOD WIDTH(FEET) =   14.00
  FULL HALF-STREET VELOCITY(FEET/SEC.) =    1.36
  SPLIT DEPTH(FEET) =    0.30   SPLIT FLOOD WIDTH(FEET) =    8.72
  SPLIT FLOW(CFS) =    0.92   SPLIT VELOCITY(FEET/SEC.) =    1.04
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.41
  HALFSTREET FLOOD WIDTH(FEET) =   14.00
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.36
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.55
STREET FLOW TRAVEL TIME(MIN.) =   4.90   Tc(MIN.) =   19.71
*   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.151
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"       B        3.00      0.75     0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =    3.00      SUBAREA RUNOFF(CFS) =    2.30
EFFECTIVE AREA(ACRES) =       5.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =         5.7        PEAK FLOW RATE(CFS) =       4.37
```

```
  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.41   HALFSTREET FLOOD WIDTH(FEET) =  14.00
  FLOW VELOCITY(FEET/SEC.) =  1.36   DEPTH*VELOCITY(FT*FT/SEC.) =   0.55
  LONGEST FLOWPATH FROM NODE      4.00 TO NODE      5.00 =    1300.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE     13.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   19.71
  RAINFALL INTENSITY(INCH/HR) =   1.15
  AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.40
  EFFECTIVE STREAM AREA(ACRES) =       5.70
  TOTAL STREAM AREA(ACRES) =       5.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       4.37

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   610.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.50  DOWNSTREAM(FEET) =   1087.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.182
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.617
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        2.70      0.75     0.400    56   11.18
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =      3.20
  TOTAL AREA(ACRES) =      2.70   PEAK FLOW RATE(CFS) =      3.20

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      9.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1087.00  DOWNSTREAM ELEVATION(FEET) = 1082.00
  STREET LENGTH(FEET) =   895.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020
```

```
SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       6.42
  ***STREET FLOW SPLITS OVER STREET-CROWN***
  FULL DEPTH(FEET) =    0.41   FLOOD WIDTH(FEET) =   14.00
  FULL HALF-STREET VELOCITY(FEET/SEC.) =    2.03
  SPLIT DEPTH(FEET) =    0.34   SPLIT FLOOD WIDTH(FEET) =   10.69
  SPLIT FLOW(CFS) =    2.20   SPLIT VELOCITY(FEET/SEC.) =    1.74
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.41
  HALFSTREET FLOOD WIDTH(FEET) =   14.00
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.03
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.83
STREET FLOW TRAVEL TIME(MIN.) =   7.34   Tc(MIN.) =   18.52
*   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.194
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"       B        8.00      0.75     0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =    8.00      SUBAREA RUNOFF(CFS) =    6.45
EFFECTIVE AREA(ACRES) =     10.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =       10.7        PEAK FLOW RATE(CFS) =       8.62

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.41   HALFSTREET FLOOD WIDTH(FEET) =  14.00
FLOW VELOCITY(FEET/SEC.) =  2.05   DEPTH*VELOCITY(FT*FT/SEC.) =   0.84
LONGEST FLOWPATH FROM NODE      6.00 TO NODE      9.00 =    1505.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE      9.00 TO NODE     11.00 IS CODE =  62
----------------------------------------------------------------------------
>>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
UPSTREAM ELEVATION(FEET) = 1082.00  DOWNSTREAM ELEVATION(FEET) = 1081.30
STREET LENGTH(FEET) =   290.00   CURB HEIGHT(INCHES) =  6.0
STREET HALFWIDTH(FEET) = 14.00

DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
INSIDE STREET CROSSFALL(DECIMAL) =  0.020
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      10.89
  ***STREET FLOWING FULL***
```

```
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.48
    HALFSTREET FLOOD WIDTH(FEET) =   14.00
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.75
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.84
  STREET FLOW TRAVEL TIME(MIN.) =   2.76   Tc(MIN.) =   21.28
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.099
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        6.30      0.75     0.400    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA AREA(ACRES) =    6.30      SUBAREA RUNOFF(CFS) =    4.53
  EFFECTIVE AREA(ACRES) =     17.00    AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  TOTAL AREA(ACRES) =       17.0        PEAK FLOW RATE(CFS) =      12.23

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.50   HALFSTREET FLOOD WIDTH(FEET) =  14.00
  FLOW VELOCITY(FEET/SEC.) =  1.83   DEPTH*VELOCITY(FT*FT/SEC.) =   0.91
  LONGEST FLOWPATH FROM NODE      6.00 TO NODE     11.00 =    1795.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     11.00 TO NODE     13.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1081.30  DOWNSTREAM ELEVATION(FEET) = 1080.50
  STREET LENGTH(FEET) =   600.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      13.88
    ***STREET FLOWING FULL***
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.57
    HALFSTREET FLOOD WIDTH(FEET) =   17.28
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.57
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.89
  STREET FLOW TRAVEL TIME(MIN.) =   6.36   Tc(MIN.) =   27.65
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  0.939
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        5.70      0.75     0.400    56
```

```
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =     5.70      SUBAREA RUNOFF(CFS) =     3.28
EFFECTIVE AREA(ACRES) =     22.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =       22.7        PEAK FLOW RATE(CFS) =      13.08

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.55   HALFSTREET FLOOD WIDTH(FEET) =  16.73
FLOW VELOCITY(FEET/SEC.) =  1.55   DEPTH*VELOCITY(FT*FT/SEC.) =   0.86
LONGEST FLOWPATH FROM NODE      6.00 TO NODE     13.00 =    2395.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE     13.00 TO NODE     13.00 IS CODE =   1
----------------------------------------------------------------------------
>>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
>>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
TOTAL NUMBER OF STREAMS =  2
CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
TIME OF CONCENTRATION(MIN.) =   27.65
RAINFALL INTENSITY(INCH/HR) =   0.94
AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75
AREA-AVERAGED Ap =  0.40
EFFECTIVE STREAM AREA(ACRES) =      22.70
TOTAL STREAM AREA(ACRES) =      22.70
PEAK FLOW RATE(CFS) AT CONFLUENCE =      13.08

** CONFLUENCE DATA **
 STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
 NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
    1        4.37   19.71    1.151  0.75( 0.30) 0.40       5.7       4.00
    2       13.08   27.65    0.939  0.75( 0.30) 0.40      22.7       6.00

RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
CONFLUENCE FORMULA USED FOR  2 STREAMS.

** PEAK FLOW RATE TABLE **
 STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
 NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
    1       16.77   19.71    1.151  0.75( 0.30) 0.40      21.9       4.00
    2       16.36   27.65    0.939  0.75( 0.30) 0.40      28.4       6.00

COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
PEAK FLOW RATE(CFS) =      16.77    Tc(MIN.) =    19.71
EFFECTIVE AREA(ACRES) =      21.88   AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =       28.4
LONGEST FLOWPATH FROM NODE      6.00 TO NODE     13.00 =    2395.00 FEET.
============================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)      =       28.4  TC(MIN.) =     19.71
EFFECTIVE AREA(ACRES) =     21.88  AREA-AVERAGED Fm(INCH/HR)=  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap = 0.400
PEAK FLOW RATE(CFS)    =      16.77
```

** PEAK FLOW RATE TABLE **

| STREAM NUMBER | Q (CFS) | Tc (MIN.) | Intensity (INCH/HR) | Fp(Fm) (INCH/HR) | Ap | Ae (ACRES) | HEADWATER NODE |
|---|---|---|---|---|---|---|---|
| 1 | 16.77 | 19.71 | 1.151 | 0.75( 0.30) | 0.40 | 21.9 | 4.00 |
| 2 | 16.36 | 27.65 | 0.939 | 0.75( 0.30) | 0.40 | 28.4 | 6.00 |

END OF RATIONAL METHOD ANALYSIS

```
****************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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                          Analysis prepared by:

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 ************************* DESCRIPTION OF STUDY *************************
* WATERMAN GARDENS - SAN BERNARDINO                                      *
* PRELIMINARY HYDROLOGY                                                  *
* EXISTING CONDITION - 5 YR                                              *
 ************************************************************************

  FILE NAME: WTRMPQ05.DAT
  TIME/DATE OF STUDY: 16:28 06/07/2011
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    5.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.7500

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  =====  =====  =====  =======
  1   14.0      7.0   0.020/0.020/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

+---------------------------------------------------------------------------+
| BEGIN EASTERLY WATERSHED                                                  |
| SUBAREAS A-1 AND A-2                                                      |
```

```
|                                                                                |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   660.00
  ELEVATION DATA: UPSTREAM(FEET) =   1087.00  DOWNSTREAM(FEET) =   1077.60

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.748
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.995
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"       B        6.50      0.75     0.400    56   11.75
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =       9.92
  TOTAL AREA(ACRES) =       6.50   PEAK FLOW RATE(CFS) =       9.92

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  81
----------------------------------------------------------------------------
  >>>>>ADDITION OF SUBAREA TO MAINLINE PEAK FLOW<<<<<
============================================================================
  MAINLINE Tc(MIN.) =   11.75
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.995
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  COMMERCIAL                 B        2.00      0.75     0.100    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA AREA(ACRES) =     2.00      SUBAREA RUNOFF(CFS) =     3.46
  EFFECTIVE AREA(ACRES) =       8.50   AREA-AVERAGED Fm(INCH/HR) =  0.25
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.33
  TOTAL AREA(ACRES) =        8.5       PEAK FLOW RATE(CFS) =      13.38

+--------------------------------------------------------------------------------+
| END EASTERLY WATERSHED                                                         |
| BEGIN WESTERLY WATERSHED                                                       |
| SUBAREAS B AND C                                                               |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      4.00 TO NODE      4.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   900.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.50  DOWNSTREAM(FEET) =   1089.00
```

```
  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   14.805
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.737
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"       B        2.70      0.75     0.400    56   14.80
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =       3.49
  TOTAL AREA(ACRES) =       2.70   PEAK FLOW RATE(CFS) =       3.49

****************************************************************************
  FLOW PROCESS FROM NODE      4.10 TO NODE      5.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1089.00  DOWNSTREAM ELEVATION(FEET) = 1088.00
  STREET LENGTH(FEET) =   400.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       5.06
    ***STREET FLOW SPLITS OVER STREET-CROWN***
    FULL DEPTH(FEET) =    0.41   FLOOD WIDTH(FEET) =   14.00
    FULL HALF-STREET VELOCITY(FEET/SEC.) =    1.36
    SPLIT DEPTH(FEET) =    0.38   SPLIT FLOOD WIDTH(FEET) =   12.71
    SPLIT FLOW(CFS) =    2.24   SPLIT VELOCITY(FEET/SEC.) =    1.29
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.41
    HALFSTREET FLOOD WIDTH(FEET) =   14.00
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.36
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.55
  STREET FLOW TRAVEL TIME(MIN.) =   4.90   Tc(MIN.) =   19.71
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.463
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"       B        3.00      0.75     0.400    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA AREA(ACRES) =    3.00      SUBAREA RUNOFF(CFS) =    3.14
  EFFECTIVE AREA(ACRES) =      5.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  TOTAL AREA(ACRES) =        5.7        PEAK FLOW RATE(CFS) =       5.97
```

```
  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.41   HALFSTREET FLOOD WIDTH(FEET) =  14.00
  FLOW VELOCITY(FEET/SEC.) =  1.38   DEPTH*VELOCITY(FT*FT/SEC.) =   0.57
  LONGEST FLOWPATH FROM NODE      4.00 TO NODE      5.00 =    1300.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE     13.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  1 ARE:
  TIME OF CONCENTRATION(MIN.) =   19.71
  RAINFALL INTENSITY(INCH/HR) =   1.46
  AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.40
  EFFECTIVE STREAM AREA(ACRES) =       5.70
  TOTAL STREAM AREA(ACRES) =       5.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =       5.97

****************************************************************************
  FLOW PROCESS FROM NODE      6.00 TO NODE      7.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   610.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.50  DOWNSTREAM(FEET) =   1087.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.182
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  2.055
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"      B        2.70      0.75     0.400    56   11.18
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA RUNOFF(CFS) =      4.27
  TOTAL AREA(ACRES) =      2.70   PEAK FLOW RATE(CFS) =      4.27

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      9.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1087.00  DOWNSTREAM ELEVATION(FEET) = 1082.00
  STREET LENGTH(FEET) =   895.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020
```

```
  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =       8.77
    ***STREET FLOWING FULL***
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.41
    HALFSTREET FLOOD WIDTH(FEET) =   14.00
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    2.07
    PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    0.85
  STREET FLOW TRAVEL TIME(MIN.) =   7.21   Tc(MIN.) =   18.39
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.525
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  RESIDENTIAL
  "8-10 DWELLINGS/ACRE"       B        8.00      0.75     0.400    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
  SUBAREA AREA(ACRES) =    8.00      SUBAREA RUNOFF(CFS) =    8.82
  EFFECTIVE AREA(ACRES) =     10.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  TOTAL AREA(ACRES) =       10.7        PEAK FLOW RATE(CFS) =      11.80

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.44   HALFSTREET FLOOD WIDTH(FEET) =  14.00
  FLOW VELOCITY(FEET/SEC.) =  2.32   DEPTH*VELOCITY(FT*FT/SEC.) =   1.02
  LONGEST FLOWPATH FROM NODE      6.00 TO NODE      9.00 =    1505.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE     11.00 IS CODE =  62
----------------------------------------------------------------------------
  >>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
  >>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
  UPSTREAM ELEVATION(FEET) = 1082.00  DOWNSTREAM ELEVATION(FEET) = 1081.30
  STREET LENGTH(FEET) =   290.00   CURB HEIGHT(INCHES) =  6.0
  STREET HALFWIDTH(FEET) = 14.00

  DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
  INSIDE STREET CROSSFALL(DECIMAL) =  0.020
  OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

  SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
  STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
  Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
  Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

    **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      14.96
    ***STREET FLOWING FULL***
    STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
    STREET FLOW DEPTH(FEET) =  0.53
    HALFSTREET FLOOD WIDTH(FEET) =   15.39
    AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.97
```

```
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.04
STREET FLOW TRAVEL TIME(MIN.) =   2.45   Tc(MIN.) =   20.85
*   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.414
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"      B        6.30      0.75     0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =    6.30      SUBAREA RUNOFF(CFS) =    6.32
EFFECTIVE AREA(ACRES) =     17.00    AREA-AVERAGED Fm(INCH/HR) =  0.30
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
TOTAL AREA(ACRES) =       17.0        PEAK FLOW RATE(CFS) =      17.06

END OF SUBAREA STREET FLOW HYDRAULICS:
DEPTH(FEET) = 0.55   HALFSTREET FLOOD WIDTH(FEET) =  16.48
FLOW VELOCITY(FEET/SEC.) =  2.06   DEPTH*VELOCITY(FT*FT/SEC.) =   1.13
LONGEST FLOWPATH FROM NODE      6.00 TO NODE     11.00 =    1795.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE     11.00 TO NODE     13.00 IS CODE =  62
----------------------------------------------------------------------------
>>>>>COMPUTE STREET FLOW TRAVEL TIME THRU SUBAREA<<<<<
>>>>>(STREET TABLE SECTION #  1 USED)<<<<<
============================================================================
UPSTREAM ELEVATION(FEET) = 1081.30  DOWNSTREAM ELEVATION(FEET) = 1080.50
STREET LENGTH(FEET) =   600.00   CURB HEIGHT(INCHES) =  6.0
STREET HALFWIDTH(FEET) = 14.00

DISTANCE FROM CROWN TO CROSSFALL GRADEBREAK(FEET) =   7.00
INSIDE STREET CROSSFALL(DECIMAL) =  0.020
OUTSIDE STREET CROSSFALL(DECIMAL)  =  0.020

SPECIFIED NUMBER OF HALFSTREETS CARRYING RUNOFF =  1
STREET PARKWAY CROSSFALL(DECIMAL)  =  0.020
Manning's FRICTION FACTOR for Streetflow Section(curb-to-curb) =   0.0150
Manning's FRICTION FACTOR for Back-of-Walk Flow Section =   0.0200

  **TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      19.43
  ***STREET FLOWING FULL***
  STREETFLOW MODEL RESULTS USING ESTIMATED FLOW:
  STREET FLOW DEPTH(FEET) =  0.63
  HALFSTREET FLOOD WIDTH(FEET) =   20.51
  AVERAGE FLOW VELOCITY(FEET/SEC.) =    1.72
  PRODUCT OF DEPTH&VELOCITY(FT*FT/SEC.) =    1.09
STREET FLOW TRAVEL TIME(MIN.) =   5.81   Tc(MIN.) =   26.65
*   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.220
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
RESIDENTIAL
"8-10 DWELLINGS/ACRE"      B        5.70      0.75     0.400    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.400
SUBAREA AREA(ACRES) =    5.70      SUBAREA RUNOFF(CFS) =    4.73
EFFECTIVE AREA(ACRES) =     22.70    AREA-AVERAGED Fm(INCH/HR) =  0.30
```

```
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  TOTAL AREA(ACRES) =       22.7        PEAK FLOW RATE(CFS) =      18.82

  END OF SUBAREA STREET FLOW HYDRAULICS:
  DEPTH(FEET) = 0.62   HALFSTREET FLOOD WIDTH(FEET) =  20.21
  FLOW VELOCITY(FEET/SEC.) =  1.71   DEPTH*VELOCITY(FT*FT/SEC.) =   1.07
  LONGEST FLOWPATH FROM NODE      6.00 TO NODE     13.00 =    2395.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     13.00 TO NODE     13.00 IS CODE =   1
----------------------------------------------------------------------------
  >>>>>DESIGNATE INDEPENDENT STREAM FOR CONFLUENCE<<<<<
  >>>>>AND COMPUTE VARIOUS CONFLUENCED STREAM VALUES<<<<<
============================================================================
  TOTAL NUMBER OF STREAMS =  2
  CONFLUENCE VALUES USED FOR INDEPENDENT STREAM  2 ARE:
  TIME OF CONCENTRATION(MIN.) =   26.65
  RAINFALL INTENSITY(INCH/HR) =   1.22
  AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75
  AREA-AVERAGED Ap =  0.40
  EFFECTIVE STREAM AREA(ACRES) =      22.70
  TOTAL STREAM AREA(ACRES) =      22.70
  PEAK FLOW RATE(CFS) AT CONFLUENCE =      18.82

  ** CONFLUENCE DATA **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1        5.97   19.71    1.463  0.75( 0.30) 0.40       5.7       4.00
      2       18.82   26.65    1.220  0.75( 0.30) 0.40      22.7       6.00

  RAINFALL INTENSITY AND TIME OF CONCENTRATION RATIO
  CONFLUENCE FORMULA USED FOR  2 STREAMS.

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       23.55   19.71    1.463  0.75( 0.30) 0.40      22.5       4.00
      2       23.55   26.65    1.220  0.75( 0.30) 0.40      28.4       6.00

  COMPUTED CONFLUENCE ESTIMATES ARE AS FOLLOWS:
  PEAK FLOW RATE(CFS) =      23.55    Tc(MIN.) =    26.65
  EFFECTIVE AREA(ACRES) =      28.40   AREA-AVERAGED Fm(INCH/HR) =  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap =  0.40
  TOTAL AREA(ACRES) =       28.4
  LONGEST FLOWPATH FROM NODE      6.00 TO NODE     13.00 =    2395.00 FEET.
============================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)     =       28.4  TC(MIN.) =     26.65
  EFFECTIVE AREA(ACRES) =     28.40  AREA-AVERAGED Fm(INCH/HR)=  0.30
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap = 0.400
  PEAK FLOW RATE(CFS)   =      23.55

  ** PEAK FLOW RATE TABLE **
   STREAM       Q      Tc   Intensity   Fp(Fm)     Ap     Ae     HEADWATER
   NUMBER     (CFS)  (MIN.) (INCH/HR) (INCH/HR)          (ACRES)    NODE
      1       23.55   19.71    1.463  0.75( 0.30) 0.40      22.5       4.00
```

```
     2        23.55   26.65    1.220  0.75( 0.30) 0.40      28.4        6.00
=================================================================================
=================================================================================
  END OF RATIONAL METHOD ANALYSIS
```

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****************************************************************************
             RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
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 ************************* DESCRIPTION OF STUDY *************************
* WATERMAN GARDENS - SAN BERNARDINO                                      *
* DEVELOPED CONDITION                                                    *
* 1-YEAR STORM                                                           *
 ************************************************************************

  FILE NAME: WTRMDQ01.DAT
  TIME/DATE OF STUDY: 18:49 06/07/2011
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    1.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.4600

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  ================  ======  ===== ====== ===== =======
  1   13.0      6.0   0.020/0.020/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   290.00
  ELEVATION DATA: UPSTREAM(FEET) =   1095.60  DOWNSTREAM(FEET) =   1089.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.258
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.786
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  B        0.70      0.75     0.100    56    6.26
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =       1.08
  TOTAL AREA(ACRES) =       0.70   PEAK FLOW RATE(CFS) =       1.08

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      3.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
==============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1082.50  DOWNSTREAM(FEET) =   1078.70

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.865
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.985
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        3.40      0.75     0.350    56   16.86
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =       2.21
  TOTAL AREA(ACRES) =       3.40   PEAK FLOW RATE(CFS) =       2.21

****************************************************************************
  FLOW PROCESS FROM NODE      3.10 TO NODE      4.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
==============================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1078.70
  DOWNSTREAM NODE ELEVATION(FEET) =   1076.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   460.00
  "V" GUTTER WIDTH(FEET) =   1.00   GUTTER HIKE(FEET) =  0.300
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.842
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS                B        1.60      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
```

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SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      2.63
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.52
AVERAGE FLOW DEPTH(FEET) =   0.50   FLOOD WIDTH(FEET) =   17.67
"V" GUTTER FLOW TRAVEL TIME(MIN.) =   5.05   Tc(MIN.) =   21.92
SUBAREA AREA(ACRES) =    1.60       SUBAREA RUNOFF(CFS) =    0.84
EFFECTIVE AREA(ACRES) =    5.00     AREA-AVERAGED Fm(INCH/HR) =   0.26
AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
TOTAL AREA(ACRES) =        5.0         PEAK FLOW RATE(CFS) =       2.61

END OF SUBAREA "V" GUTTER HYDRAULICS:
DEPTH(FEET) =  0.50   FLOOD WIDTH(FEET) =   17.54
FLOW VELOCITY(FEET/SEC.) =   1.52   DEPTH*VELOCITY(FT*FT/SEC) =   0.75
LONGEST FLOWPATH FROM NODE      3.00 TO NODE      4.00 =    1410.00 FEET.

****************************************************************************
FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  21
----------------------------------------------------------------------------
>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   940.00
ELEVATION DATA: UPSTREAM(FEET) =   1096.30  DOWNSTREAM(FEET) =   1079.00

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.376
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.186
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
CONDOMINIUMS               B       10.80      0.75     0.350    56   12.38
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
SUBAREA RUNOFF(CFS) =      8.98
TOTAL AREA(ACRES) =     10.80   PEAK FLOW RATE(CFS) =      8.98

****************************************************************************
FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   655.00
ELEVATION DATA: UPSTREAM(FEET) =   1089.70  DOWNSTREAM(FEET) =   1082.70

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.941
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  1.212
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
CONDOMINIUMS               B        8.80      0.75     0.350    56   11.94
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
SUBAREA RUNOFF(CFS) =      7.52
TOTAL AREA(ACRES) =      8.80   PEAK FLOW RATE(CFS) =      7.52
```

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****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE      9.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.30  DOWNSTREAM(FEET) =   1092.20

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.610
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.994
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        5.20      0.75     0.350    56   16.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =       3.43
  TOTAL AREA(ACRES) =       5.20   PEAK FLOW RATE(CFS) =       3.43

****************************************************************************
  FLOW PROCESS FROM NODE      9.10 TO NODE     10.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1092.20
  DOWNSTREAM NODE ELEVATION(FEET) =   1082.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   410.00
  "V" GUTTER WIDTH(FEET) =   2.00   GUTTER HIKE(FEET) =  0.340
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.943
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS                B        2.30      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      4.13
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   4.50
  AVERAGE FLOW DEPTH(FEET) =   0.45   FLOOD WIDTH(FEET) =   10.38
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.52   Tc(MIN.) =   18.13
  SUBAREA AREA(ACRES) =    2.30       SUBAREA RUNOFF(CFS) =    1.41
  EFFECTIVE AREA(ACRES) =    7.50     AREA-AVERAGED Fm(INCH/HR) =   0.26
  AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
  TOTAL AREA(ACRES) =        7.5         PEAK FLOW RATE(CFS) =       4.60

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.47   FLOOD WIDTH(FEET) =   11.55
  FLOW VELOCITY(FEET/SEC.) =   4.39   DEPTH*VELOCITY(FT*FT/SEC) =   2.04
  LONGEST FLOWPATH FROM NODE      9.00 TO NODE     10.00 =    1360.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     11.00 TO NODE     11.10 IS CODE =  21
----------------------------------------------------------------------------
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>>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
>>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
================================================================================
INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
ELEVATION DATA: UPSTREAM(FEET) =   1086.00  DOWNSTREAM(FEET) =   1084.80

Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   21.238
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.858
SUBAREA Tc AND LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
CONDOMINIUMS                B        3.20      0.75     0.350    56   21.24
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
SUBAREA RUNOFF(CFS) =      1.72
TOTAL AREA(ACRES) =      3.20   PEAK FLOW RATE(CFS) =      1.72

****************************************************************************
FLOW PROCESS FROM NODE     11.10 TO NODE     12.00 IS CODE =  91
----------------------------------------------------------------------------
>>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
================================================================================
UPSTREAM NODE ELEVATION(FEET) =   1084.80
DOWNSTREAM NODE ELEVATION(FEET) =   1080.60
CHANNEL LENGTH THRU SUBAREA(FEET) =   270.00
"V" GUTTER WIDTH(FEET) =   2.00   GUTTER HIKE(FEET) =  0.330
PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
MAXIMUM DEPTH(FEET) =   0.67
*   1 YEAR RAINFALL INTENSITY(INCH/HR) =  0.832
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
     LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
CONDOMINIUMS                B        0.90      0.75     0.350    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      1.95
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   4.04
AVERAGE FLOW DEPTH(FEET) =   0.39   FLOOD WIDTH(FEET) =    4.72
"V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.11   Tc(MIN.) =   22.35
SUBAREA AREA(ACRES) =    0.90       SUBAREA RUNOFF(CFS) =    0.46
EFFECTIVE AREA(ACRES) =    4.10     AREA-AVERAGED Fm(INCH/HR) =   0.26
AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
TOTAL AREA(ACRES) =        4.1         PEAK FLOW RATE(CFS) =       2.10

END OF SUBAREA "V" GUTTER HYDRAULICS:
DEPTH(FEET) =  0.40   FLOOD WIDTH(FEET) =    5.69
FLOW VELOCITY(FEET/SEC.) =   3.95   DEPTH*VELOCITY(FT*FT/SEC) =   1.57
LONGEST FLOWPATH FROM NODE     11.00 TO NODE     12.00 =    1220.00 FEET.
================================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)      =        4.1  TC(MIN.) =     22.35
EFFECTIVE AREA(ACRES) =      4.10  AREA-AVERAGED Fm(INCH/HR)=  0.26
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap = 0.350
PEAK FLOW RATE(CFS)   =       2.10
================================================================================
```

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==============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

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****************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
        (c) Copyright 1983-2010 Advanced Engineering Software (aes)
            Ver. 17.0  Release Date: 07/01/2010  License ID 1584

                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
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                          www.encompasscivil.com

 ************************* DESCRIPTION OF STUDY *************************
* WATERMAN GARDENS - SAN BERNARDINO                                      *
* DEVELOPED CONDITION                                                    *
* 2-YEAR STORM                                                           *
 ************************************************************************

  FILE NAME: WTRMDQ02.DAT
  TIME/DATE OF STUDY: 15:47 06/08/2011
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    2.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.5900

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  =========  =================  ======  =====  ====  ====  =====
  1   13.0      6.0   0.020/0.020/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

+---------------------------------------------------------------------------+
| SUBAREA B-1                                                               |
| BYPASS (EASTERLY DRAINAGE AREA)                                           |
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|                                                                                |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   290.00
  ELEVATION DATA: UPSTREAM(FEET) =   1095.60  DOWNSTREAM(FEET) =   1089.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.258
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  2.290
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  B        0.70      0.75     0.100    56    6.26
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =       1.40
  TOTAL AREA(ACRES) =       0.70   PEAK FLOW RATE(CFS) =      1.40

+--------------------------------------------------------------------------------+
| SUBAREA A-1                                                                    |
| BASIN 1                                                                        |
|                                                                                |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      3.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1082.50  DOWNSTREAM(FEET) =   1078.70

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.865
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.263
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        3.40      0.75     0.350    56   16.86
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =       3.07
  TOTAL AREA(ACRES) =       3.40   PEAK FLOW RATE(CFS) =      3.07

****************************************************************************
  FLOW PROCESS FROM NODE      3.10 TO NODE      4.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1078.70
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  DOWNSTREAM NODE ELEVATION(FEET) =   1076.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   460.00
  "V" GUTTER WIDTH(FEET) =   1.00   GUTTER HIKE(FEET) =  0.300
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.087
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS               B        1.60      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      3.66
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.60
  AVERAGE FLOW DEPTH(FEET) =  0.53   FLOOD WIDTH(FEET) =   20.59
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   4.80   Tc(MIN.) =   21.67
  SUBAREA AREA(ACRES) =    1.60       SUBAREA RUNOFF(CFS) =    1.19
  EFFECTIVE AREA(ACRES) =    5.00     AREA-AVERAGED Fm(INCH/HR) =   0.26
  AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
  TOTAL AREA(ACRES) =        5.0         PEAK FLOW RATE(CFS) =       3.71

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.53   FLOOD WIDTH(FEET) =   20.72
  FLOW VELOCITY(FEET/SEC.) =   1.60   DEPTH*VELOCITY(FT*FT/SEC) =   0.84
  LONGEST FLOWPATH FROM NODE      3.00 TO NODE      4.00 =    1410.00 FEET.

+----------------------------------------------------------------------------+
| SUBAREA A-2                                                                |
| BASIN 2                                                                    |
|                                                                            |
+----------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   940.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.30  DOWNSTREAM(FEET) =   1079.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.376
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.521
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS               B       10.80      0.75     0.350    56   12.38
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =     12.24
  TOTAL AREA(ACRES) =     10.80   PEAK FLOW RATE(CFS) =     12.24

+----------------------------------------------------------------------------+
| SUBAREA A-3                                                                |
| BASIN 3                                                                    |
```

```
|                                                                                |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   655.00
  ELEVATION DATA: UPSTREAM(FEET) =   1089.70  DOWNSTREAM(FEET) =   1082.70

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.941
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.554
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        8.80      0.75     0.350    56   11.94
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =      10.24
  TOTAL AREA(ACRES) =       8.80   PEAK FLOW RATE(CFS) =     10.24

+--------------------------------------------------------------------------------+
| SUBAREA A-4                                                                    |
| BASIN 4                                                                        |
|                                                                                |
+--------------------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE      9.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.30  DOWNSTREAM(FEET) =   1092.20

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.610
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.275
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        5.20      0.75     0.350    56   16.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =       4.74
  TOTAL AREA(ACRES) =       5.20   PEAK FLOW RATE(CFS) =      4.74

****************************************************************************
  FLOW PROCESS FROM NODE      9.10 TO NODE     10.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1092.20
```

```
  DOWNSTREAM NODE ELEVATION(FEET) =   1082.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   410.00
  "V" GUTTER WIDTH(FEET) =   2.00   GUTTER HIKE(FEET) =  0.340
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.208
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS               B        2.30      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      5.72
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   4.36
  AVERAGE FLOW DEPTH(FEET) =   0.49   FLOOD WIDTH(FEET) =   13.66
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.57   Tc(MIN.) =   18.18
  SUBAREA AREA(ACRES) =    2.30       SUBAREA RUNOFF(CFS) =    1.96
  EFFECTIVE AREA(ACRES) =    7.50     AREA-AVERAGED Fm(INCH/HR) =   0.26
  AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
  TOTAL AREA(ACRES) =        7.5         PEAK FLOW RATE(CFS) =       6.39

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.50   FLOOD WIDTH(FEET) =   14.83
  FLOW VELOCITY(FEET/SEC.) =   4.31   DEPTH*VELOCITY(FT*FT/SEC) =   2.15
  LONGEST FLOWPATH FROM NODE      9.00 TO NODE     10.00 =    1360.00 FEET.

+----------------------------------------------------------------------+
| SUBAREA B-2                                                          |
| BYPASS AREA TO WATERMAN                                              |
|                                                                      |
+----------------------------------------------------------------------+

****************************************************************************
  FLOW PROCESS FROM NODE     11.00 TO NODE     11.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1086.00  DOWNSTREAM(FEET) =   1084.80

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   21.238
  *   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.100
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS               B        3.20      0.75     0.350    56   21.24
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =      2.41
  TOTAL AREA(ACRES) =      3.20   PEAK FLOW RATE(CFS) =      2.41

****************************************************************************
  FLOW PROCESS FROM NODE     11.10 TO NODE     12.00 IS CODE =  91
----------------------------------------------------------------------------
```

```
>>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
================================================================================
UPSTREAM NODE ELEVATION(FEET) =   1084.80
DOWNSTREAM NODE ELEVATION(FEET) =   1080.60
CHANNEL LENGTH THRU SUBAREA(FEET) =   270.00
"V" GUTTER WIDTH(FEET) =   2.00   GUTTER HIKE(FEET) =  0.330
PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
MAXIMUM DEPTH(FEET) =   0.67
*   2 YEAR RAINFALL INTENSITY(INCH/HR) =  1.065
SUBAREA LOSS RATE DATA(AMC  II):
 DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap      SCS
     LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
CONDOMINIUMS               B        0.90      0.75     0.350    56
SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      2.74
TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.76
AVERAGE FLOW DEPTH(FEET) =   0.42   FLOOD WIDTH(FEET) =    8.48
"V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.20   Tc(MIN.) =   22.44
SUBAREA AREA(ACRES) =    0.90       SUBAREA RUNOFF(CFS) =    0.65
EFFECTIVE AREA(ACRES) =    4.10     AREA-AVERAGED Fm(INCH/HR) =   0.26
AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
TOTAL AREA(ACRES) =        4.1         PEAK FLOW RATE(CFS) =       2.96

END OF SUBAREA "V" GUTTER HYDRAULICS:
DEPTH(FEET) =  0.43   FLOOD WIDTH(FEET) =    9.21
FLOW VELOCITY(FEET/SEC.) =   3.73   DEPTH*VELOCITY(FT*FT/SEC) =   1.61
LONGEST FLOWPATH FROM NODE     11.00 TO NODE     12.00 =    1220.00 FEET.
================================================================================
END OF STUDY SUMMARY:
TOTAL AREA(ACRES)      =        4.1  TC(MIN.) =     22.44
EFFECTIVE AREA(ACRES) =      4.10  AREA-AVERAGED Fm(INCH/HR)=  0.26
AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap = 0.350
PEAK FLOW RATE(CFS)    =       2.96
================================================================================
================================================================================
END OF RATIONAL METHOD ANALYSIS
```

```
****************************************************************************
            RATIONAL METHOD HYDROLOGY COMPUTER PROGRAM PACKAGE
         (Reference: 1986 SAN BERNARDINO CO. HYDROLOGY CRITERION)
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                          Analysis prepared by:

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 ************************* DESCRIPTION OF STUDY *************************
* WATERMAN GARDENS - SAN BERNARDINO                                      *
* DEVELOPED CONDITION                                                    *
* 5-YEAR STORM                                                           *
 ************************************************************************

  FILE NAME: WTRMDQ05.DAT
  TIME/DATE OF STUDY: 18:50 06/07/2011
============================================================================
  USER SPECIFIED HYDROLOGY AND HYDRAULIC MODEL INFORMATION:
============================================================================
                    --*TIME-OF-CONCENTRATION MODEL*--

  USER SPECIFIED STORM EVENT(YEAR) =    5.00
  SPECIFIED MINIMUM PIPE SIZE(INCH) =  12.00
  SPECIFIED PERCENT OF GRADIENTS(DECIMAL) TO USE FOR FRICTION SLOPE = 0.95
  *USER-DEFINED LOGARITHMIC INTERPOLATION USED FOR RAINFALL*

  SLOPE OF INTENSITY DURATION CURVE(LOG(I;IN/HR) vs. LOG(Tc;MIN)) = 0.6000
  USER SPECIFIED 1-HOUR INTENSITY(INCH/HOUR) = 0.7500

  *ANTECEDENT MOISTURE CONDITION (AMC) II ASSUMED FOR RATIONAL METHOD*

  *USER-DEFINED STREET-SECTIONS FOR COUPLED PIPEFLOW AND STREETFLOW MODEL*
     HALF-  CROWN TO   STREET-CROSSFALL:   CURB  GUTTER-GEOMETRIES:  MANNING
     WIDTH  CROSSFALL  IN-  / OUT-/PARK-  HEIGHT  WIDTH  LIP   HIKE  FACTOR
NO.   (FT)     (FT)    SIDE / SIDE/ WAY    (FT)    (FT)  (FT)  (FT)    (n)
===  =====  ========  ================  ======  ===== ====== ===== =======
  1   13.0      6.0   0.020/0.020/0.020   0.50    1.50 0.0312 0.125 0.0150

  GLOBAL STREET FLOW-DEPTH CONSTRAINTS:
    1. Relative Flow-Depth =  0.00 FEET
       as (Maximum Allowable Street Flow Depth) - (Top-of-Curb)
    2. (Depth)*(Velocity) Constraint =  6.0 (FT*FT/S)
  *SIZE PIPE WITH A FLOW CAPACITY GREATER THAN
   OR EQUAL TO THE UPSTREAM TRIBUTARY PIPE.*
  *USER-SPECIFIED MINIMUM TOPOGRAPHIC SLOPE ADJUSTMENT NOT SELECTED

****************************************************************************
  FLOW PROCESS FROM NODE      1.00 TO NODE      2.00 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
================================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   290.00
  ELEVATION DATA: UPSTREAM(FEET) =   1095.60  DOWNSTREAM(FEET) =   1089.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =    6.258
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  2.911
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  COMMERCIAL                  B        0.70      0.75     0.100    56    6.26
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.100
  SUBAREA RUNOFF(CFS) =       1.79
  TOTAL AREA(ACRES) =       0.70   PEAK FLOW RATE(CFS) =       1.79

****************************************************************************
  FLOW PROCESS FROM NODE      3.00 TO NODE      3.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
================================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1082.50  DOWNSTREAM(FEET) =   1078.70

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.865
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.606
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        3.40      0.75     0.350    56   16.86
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =       4.11
  TOTAL AREA(ACRES) =       3.40   PEAK FLOW RATE(CFS) =       4.11

****************************************************************************
  FLOW PROCESS FROM NODE      3.10 TO NODE      4.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
================================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1078.70
  DOWNSTREAM NODE ELEVATION(FEET) =   1076.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   460.00
  "V" GUTTER WIDTH(FEET) =   1.00   GUTTER HIKE(FEET) =  0.300
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.393
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS                B        1.60      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
```

```
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      4.93
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   1.70
  AVERAGE FLOW DEPTH(FEET) =   0.55   FLOOD WIDTH(FEET) =   23.38
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   4.52   Tc(MIN.) =   21.38
  SUBAREA AREA(ACRES) =    1.60       SUBAREA RUNOFF(CFS) =    1.63
  EFFECTIVE AREA(ACRES) =    5.00     AREA-AVERAGED Fm(INCH/HR) =   0.26
  AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
  TOTAL AREA(ACRES) =        5.0         PEAK FLOW RATE(CFS) =       5.09

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.56   FLOOD WIDTH(FEET) =   23.64
  FLOW VELOCITY(FEET/SEC.) =   1.71   DEPTH*VELOCITY(FT*FT/SEC) =   0.95
  LONGEST FLOWPATH FROM NODE      3.00 TO NODE      4.00 =    1410.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE      5.00 TO NODE      6.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   940.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.30  DOWNSTREAM(FEET) =   1079.00

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   12.376
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.934
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS               B       10.80      0.75     0.350    56   12.38
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =     16.25
  TOTAL AREA(ACRES) =     10.80   PEAK FLOW RATE(CFS) =     16.25

****************************************************************************
  FLOW PROCESS FROM NODE      7.00 TO NODE      8.00 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   655.00
  ELEVATION DATA: UPSTREAM(FEET) =   1089.70  DOWNSTREAM(FEET) =   1082.70

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   11.941
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.976
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS               B        8.80      0.75     0.350    56   11.94
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =     13.57
  TOTAL AREA(ACRES) =      8.80   PEAK FLOW RATE(CFS) =     13.57
```

```
****************************************************************************
  FLOW PROCESS FROM NODE      9.00 TO NODE      9.10 IS CODE =  21
----------------------------------------------------------------------------
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
============================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1096.30  DOWNSTREAM(FEET) =   1092.20

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   16.610
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.621
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS   Tc
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS               B        5.20      0.75     0.350    56   16.61
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =      6.36
  TOTAL AREA(ACRES) =      5.20   PEAK FLOW RATE(CFS) =      6.36

****************************************************************************
  FLOW PROCESS FROM NODE      9.10 TO NODE     10.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
============================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1092.20
  DOWNSTREAM NODE ELEVATION(FEET) =   1082.80
  CHANNEL LENGTH THRU SUBAREA(FEET) =   410.00
  "V" GUTTER WIDTH(FEET) =   2.00   GUTTER HIKE(FEET) =  0.340
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.535
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/      SCS SOIL   AREA      Fp         Ap     SCS
       LAND USE            GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS               B        2.30      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      7.68
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   4.32
  AVERAGE FLOW DEPTH(FEET) =   0.52   FLOOD WIDTH(FEET) =   16.71
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.58   Tc(MIN.) =   18.19
  SUBAREA AREA(ACRES) =    2.30       SUBAREA RUNOFF(CFS) =    2.64
  EFFECTIVE AREA(ACRES) =    7.50     AREA-AVERAGED Fm(INCH/HR) =   0.26
  AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
  TOTAL AREA(ACRES) =        7.5         PEAK FLOW RATE(CFS) =       8.59

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.53   FLOOD WIDTH(FEET) =   17.88
  FLOW VELOCITY(FEET/SEC.) =   4.34   DEPTH*VELOCITY(FT*FT/SEC) =   2.30
  LONGEST FLOWPATH FROM NODE      9.00 TO NODE     10.00 =    1360.00 FEET.

****************************************************************************
  FLOW PROCESS FROM NODE     11.00 TO NODE     11.10 IS CODE =  21
----------------------------------------------------------------------------
```

```
  >>>>>RATIONAL METHOD INITIAL SUBAREA ANALYSIS<<<<<
  >>USE TIME-OF-CONCENTRATION NOMOGRAPH FOR INITIAL SUBAREA<<
================================================================================
  INITIAL SUBAREA FLOW-LENGTH(FEET) =   950.00
  ELEVATION DATA: UPSTREAM(FEET) =   1086.00  DOWNSTREAM(FEET) =   1084.80

  Tc = K*[(LENGTH** 3.00)/(ELEVATION CHANGE)]**0.20
  SUBAREA ANALYSIS USED MINIMUM Tc(MIN.) =   21.238
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.399
  SUBAREA Tc AND LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS   Tc
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN  (MIN.)
  CONDOMINIUMS                B        3.20      0.75     0.350    56   21.24
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  SUBAREA RUNOFF(CFS) =       3.27
  TOTAL AREA(ACRES) =       3.20   PEAK FLOW RATE(CFS) =       3.27

****************************************************************************
  FLOW PROCESS FROM NODE     11.10 TO NODE     12.00 IS CODE =  91
----------------------------------------------------------------------------
  >>>>>COMPUTE "V" GUTTER FLOW TRAVEL TIME THRU SUBAREA<<<<<
================================================================================
  UPSTREAM NODE ELEVATION(FEET) =   1084.80
  DOWNSTREAM NODE ELEVATION(FEET) =   1080.60
  CHANNEL LENGTH THRU SUBAREA(FEET) =   270.00
  "V" GUTTER WIDTH(FEET) =   2.00   GUTTER HIKE(FEET) =  0.330
  PAVEMENT LIP(FEET) =  0.030   MANNING'S N = .0150
  PAVEMENT CROSSFALL(DECIMAL NOTATION) = 0.02000
  MAXIMUM DEPTH(FEET) =   0.67
  *   5 YEAR RAINFALL INTENSITY(INCH/HR) =  1.351
  SUBAREA LOSS RATE DATA(AMC  II):
   DEVELOPMENT TYPE/       SCS SOIL   AREA      Fp         Ap      SCS
       LAND USE             GROUP   (ACRES)  (INCH/HR)  (DECIMAL)  CN
  CONDOMINIUMS                B        0.90      0.75     0.350    56
  SUBAREA AVERAGE PERVIOUS LOSS RATE, Fp(INCH/HR) =  0.75
  SUBAREA AVERAGE PERVIOUS AREA FRACTION, Ap =  0.350
  TRAVEL TIME COMPUTED USING ESTIMATED FLOW(CFS) =      3.71
  TRAVEL TIME THRU SUBAREA BASED ON VELOCITY(FEET/SEC.) =   3.60
  AVERAGE FLOW DEPTH(FEET) =   0.46   FLOOD WIDTH(FEET) =   11.51
  "V" GUTTER FLOW TRAVEL TIME(MIN.) =   1.25   Tc(MIN.) =   22.49
  SUBAREA AREA(ACRES) =    0.90       SUBAREA RUNOFF(CFS) =    0.88
  EFFECTIVE AREA(ACRES) =    4.10     AREA-AVERAGED Fm(INCH/HR) =   0.26
  AREA-AVERAGED Fp(INCH/HR) =   0.75  AREA-AVERAGED Ap =   0.35
  TOTAL AREA(ACRES) =        4.1         PEAK FLOW RATE(CFS) =       4.02

  END OF SUBAREA "V" GUTTER HYDRAULICS:
  DEPTH(FEET) =  0.46   FLOOD WIDTH(FEET) =   12.35
  FLOW VELOCITY(FEET/SEC.) =   3.55   DEPTH*VELOCITY(FT*FT/SEC) =   1.64
  LONGEST FLOWPATH FROM NODE     11.00 TO NODE     12.00 =    1220.00 FEET.
================================================================================
  END OF STUDY SUMMARY:
  TOTAL AREA(ACRES)      =        4.1  TC(MIN.) =     22.49
  EFFECTIVE AREA(ACRES) =      4.10  AREA-AVERAGED Fm(INCH/HR)=  0.26
  AREA-AVERAGED Fp(INCH/HR) =  0.75  AREA-AVERAGED Ap = 0.350
  PEAK FLOW RATE(CFS)    =       4.02
================================================================================
```

```
==============================================================================
  END OF RATIONAL METHOD ANALYSIS
```

# SYNTHETIC UNIT HYDROGRAPH

# CALCULATIONS

# AND

# DETENTION BASIN

# FLOOD ROUTING

# ANALYSIS

**Encompass Associates, Inc.**
*Civil Engineers*
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(909) 684-0093 Fax 586-6979

| | | | |
|---|---|---|---|
| Job | Waterman Gardens | | 149-205 |
| Sheet No. | | of | |
| Calculated by: | ATS | Date | 6/6/11 |
| Checked by: | | Date | |
| | | Scale | nts |

# Waterman Gardens
# San Bernardino

## Table 1: Basin Geometries

| Depth | Elevation | Area | ΔVol | Total V | |
|---|---|---|---|---|---|
| ft | ft | sq ft | cf | cf | ac-ft |
| **Basin 1** | | | | | |
| 0 | 0 | **844** | 0 | 0 | 0.000 |
| 0.5 | 0.5 | **1206** | 510 | 510 | 0.012 |
| 1 | 1 | **1606** | 701 | 1210 | 0.028 |
| 1.5 | 1.5 | **2046** | 911 | 2121 | 0.049 |
| 2 | 2 | **2525** | 1141 | 3262 | 0.075 |
| 2.5 | 2.5 | **3044** | 1390 | 4652 | 0.107 |
| 3 | 3 | **3601** | 1659 | 6311 | 0.145 |
| 3.5 | 3.5 | **3602** | 1801 | 8112 | 0.186 |
| 4 | 4 | **3603** | 1801 | 9913 | 0.228 |
| **Basin 2** | | | | | |
| 0 | 0 | **8853** | 0 | 0 | 0.000 |
| 1 | 1 | **10026** | 9433 | 9433 | 0.217 |
| 2 | 2 | **11239** | 10627 | 20060 | 0.461 |
| 3 | 3 | **12491** | 11859 | 31920 | 0.733 |
| 4 | 4 | **13782** | 13131 | 45051 | 1.034 |
| 5 | 5 | **15113** | 14442 | 59493 | 1.366 |
| 6 | 6 | **16483** | 15793 | 75286 | 1.728 |
| 7 | 7 | **16484** | 16483 | 91770 | 2.107 |
| 8 | 8 | **16485** | 16484 | 108254 | 2.485 |

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| | | | |
|---|---|---|---|
| Job | Waterman Gardens | | 149-205 |
| Sheet No. | | of | |
| Calculated by: | ATS | Date | 6/6/11 |
| Checked by: | | Date | |
| | | Scale | nts |

# Waterman Gardens
# San Bernardino

## Table 1: Basin Geometries

| Depth | Elevation | Area | ΔVol | Total V | |
|---|---|---|---|---|---|
| ft | ft | sq ft | cf | cf | ac-ft |
| | | | | | |
| **Basin 3** | | | | | |
| | | | | | |
| 0 | 0 | **4715** | 0 | 0 | 0.000 |
| 0.5 | 0.5 | **5426** | 2533 | 2533 | 0.058 |
| 1 | 1 | **6176** | 2898 | 5432 | 0.125 |
| 1.5 | 1.5 | **6965** | 3283 | 8715 | 0.200 |
| 2 | 2 | **7794** | 3688 | 12403 | 0.285 |
| 2.5 | 2.5 | **8661** | 4112 | 16515 | 0.379 |
| 3 | 3 | **9568** | 4555 | 21070 | 0.484 |
| 3.5 | 3.5 | **9569** | 4784 | 25854 | 0.594 |
| 4 | 4 | **9570** | 4785 | 30639 | 0.703 |
| | | | | | |
| | | | | | |
| **Basin 4** | | | | | |
| | | | | | |
| 0 | 0 | **12378** | 0 | 0 | 0.000 |
| 0.5 | 0.5 | **13622** | 6498 | 6498 | 0.149 |
| 1 | 1 | **14904** | 7129 | 13627 | 0.313 |
| 1.5 | 1.5 | **16225** | 7780 | 21407 | 0.491 |
| 2 | 2 | **17582** | 8449 | 29856 | 0.685 |
| 2.5 | 2.5 | **18975** | 9137 | 38993 | 0.895 |
| 3 | 3 | **20406** | 9843 | 48836 | 1.121 |
| 3.5 | 3.5 | **20407** | 10203 | 59039 | 1.355 |
| 4 | 4 | **20408** | 10204 | 69243 | 1.590 |
| | | | | | |

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Waterman Gardens
San Bernardino

149-205
6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate**

**Pre-dev condition** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-10du/ac | 6.5 | 0.76 | B | 6.5 | 0.76 | 56 | 76 | 0.4 | 0.31 | 7.86 | 0.75 | 0.3 | 0.23 |
| Commercial | 2 | 0.24 | B | 2 | 0.24 | 56 | 76 | 0.1 | 0.02 | 7.86 | 0.75 | 0.08 | 0.02 |
| (AutoCalc: Impervious) | | | | (5.7) | (0.67) | | 98 | 0 | 0.67 | 0.2 | | | |
| | 8.5 | | | 8.5 | | | | | | | | Fm= | 0.25 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| 8-10du/ac | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.03 | 1.57 | 0.29 | 0.09 |
| Commercial | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.00 | 1.57 | 0.11 | 0.00 | 1.57 | 0.29 | 0.01 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.60 | 0.04 | 0.91 | 0.61 | 0.04 | 0.93 | 0.62 | 0.04 | 0.96 | 0.64 |
| | | Y= | 0.60 | | Y= | 0.63 | | Y= | 0.66 | | Y= | 0.74 |
| Low Loss Fraction,Y-bar = | | | 0.40 | | | 0.37 | | | 0.34 | | | 0.26 |
| Est Vol (ac-ft)= | | | 1 | | | 1 | | | 2 | | | 3 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 | Catchment Lag time | | hrs | 0.16 | 0.16 | 0.16 | 0.00 |
| | | | Tc (min) | 11.75 | 11.75 | 11.75 | 0 |
| 3 | Catchment Area | acres 8.5 | | | | | |
| 4 | Base flow | cfs/sq mi 0 | | | | | |
| 5 | S-graph | n/a | | | | | |
| 6 | Maximum loss rate, Fm | in/hr 0.25 | | | | | |
| 7 | Low loss fraction, Y-bar | | | 0.40 | 0.37 | 0.34 | 0.26 |
| 8 | Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| | Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| | Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| | Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| | Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| | Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 | 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

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San Bernardino

149-205
6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate**

**Pre-dev condition-West** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-10du/ac | 28.4 | 1.00 | B | 28.4 | 1.00 | 56 | 76 | 0.4 | 0.40 | 7.86 | 0.75 | 0.3 | 0.30 |
| (AutoCalc: Impervious) | | | | (17) | (0.6) | | 98 | 0 | 0.60 | 0.2 | | | |
| | 28.4 | | | 28.4 | | | | | | | | Fm= | 0.30 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| 8-10du/ac | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.04 | 1.57 | 0.29 | 0.12 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.53 | 0.04 | 0.91 | 0.55 | 0.04 | 0.93 | 0.56 | 0.04 | 0.96 | 0.58 |
| | | Y= | 0.54 | | Y= | 0.57 | | Y= | 0.60 | | Y= | 0.69 |
| Low Loss Fraction,Y-bar = | | | 0.46 | | | 0.43 | | | 0.40 | | | 0.31 |
| Est Vol (ac-ft)= | | | 2 | | | 3.5 | | | 5 | | | 10 |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 | Catchment Lag time | | hrs | 0.26 | 0.26 | 0.36 | 0.00 |
| | | | Tc (min) | 19.79 | 19.71 | 26.65 | 0 |
| 3 | Catchment Area | acres 28.4 | | | | | |
| 4 | Base flow | cfs/sq mi 0 | | | | | |
| 5 | S-graph | n/a | | | | | |
| 6 | Maximum loss rate, Fm | in/hr 0.30 | | | | | |
| 7 | Low loss fraction, Y-bar | | | 0.46 | 0.43 | 0.40 | 0.31 |
| 8 | Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| | Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| | Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| | Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| | Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| | Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 | 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

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AMC Type II (I,II or III)

**Maximum Loss Rate**

**Post-dev East Bypass** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Commercial | 0.7 | 1.00 | B | 0.7 | 1.00 | 56 | 76 | 0.1 | 0.10 | 7.86 | 0.75 | 0.08 | 0.08 |
| (AutoCalc: Impervious) | | | | (0.6) | (0.86) | | 98 | 0 | 0.90 | 0.2 | | | |
| | 0.7 | | | 0.7 | | | | | | | | Fm= | 0.08 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| Commercial | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.01 | 1.57 | 0.11 | 0.01 | 1.57 | 0.29 | 0.03 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.80 | 0.04 | 0.91 | 0.82 | 0.04 | 0.93 | 0.84 | 0.04 | 0.96 | 0.86 |
| | | Y= | 0.80 | | Y= | 0.82 | | Y= | 0.85 | | Y= | 0.89 |
| Low Loss Fraction,Y-bar = | | | 0.20 | | | 0.18 | | | 0.15 | | | 0.11 |
| Est Vol (ac-ft)= | | | 0.09 | | | 0.12 | | | 0.17 | | | 0 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 1 Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 Catchment Lag time | | hrs | 0.08 | 0.08 | 0.08 | 0.00 |
| | | Tc (min) | 6.3 | 6.3 | 6.3 | 0 |
| 3 Catchment Area | acres 0.7 | | | | | |
| 4 Base flow | cfs/sq mi 0 | | | | | |
| 5 S-graph | n/a | | | | | |
| 6 Maximum loss rate, Fm | in/hr 0.08 | | | | | |
| 7 Low loss fraction, Y-bar | | | 0.20 | 0.18 | 0.15 | 0.11 |
| 8 Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

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Waterman Gardens
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6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate**

**Post-dev West Bypass** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Condominiums | 4.1 | 1.00 | B | 4.1 | 1.00 | 56 | 76 | 0.35 | 0.35 | 7.86 | 0.75 | 0.26 | 0.26 |
| (AutoCalc: Impervious) | | | | (2.7) | (0.66) | | 98 | 0 | 0.65 | 0.2 | | | |
| | 4.1 | | | 4.1 | | | | | | | | Fm= | 0.26 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| Condominiums | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.04 | 1.57 | 0.29 | 0.10 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.58 | 0.04 | 0.91 | 0.59 | 0.04 | 0.93 | 0.60 | 0.04 | 0.96 | 0.62 |
| | | Y= | 0.58 | | Y= | 0.61 | | Y= | 0.64 | | Y= | 0.73 |
| Low Loss Fraction,Y-bar = | | | 0.42 | | | 0.39 | | | 0.36 | | | 0.27 |
| Est Vol (ac-ft)= | | | 0 | | | 0.54 | | | 1 | | | 2 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 | Catchment Lag time | | hrs | 0.30 | 0.30 | 0.30 | 0.00 |
| | | | Tc (min) | 22.35 | 22.44 | 22.49 | 0 |
| 3 | Catchment Area | acres 4.1 | | | | | |
| 4 | Base flow | cfs/sq mi 0 | | | | | |
| 5 | S-graph | n/a | | | | | |
| 6 | Maximum loss rate, Fm | in/hr 0.26 | | | | | |
| 7 | Low loss fraction, Y-bar | | | 0.42 | 0.39 | 0.36 | 0.27 |
| 8 | Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| | Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| | Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| | Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| | Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| | Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 | 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

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Waterman Gardens
San Bernardino

149-205
6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate** **Basin 1** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Condominiums" | 5 | 1.00 | B | 5 | 1.00 | 56 | 76 | 0.35 | 0.35 | 7.86 | 0.75 | 0.26 | 0.26 |
| (AutoCalc: Impervious) | | | | (3.3) | (0.66) | | 98 | 0 | 0.65 | 0.2 | | | |
| | 5.0 | | | 5 | | | | | | | | Fm= | 0.26 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| "Condominiums" | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.04 | 1.57 | 0.29 | 0.10 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.58 | 0.04 | 0.91 | 0.59 | 0.04 | 0.93 | 0.60 | 0.04 | 0.96 | 0.62 |
| | | Y= | 0.58 | | Y= | 0.61 | | Y= | 0.64 | | Y= | 0.73 |
| Low Loss Fraction,Y-bar = | | | 0.42 | | | 0.39 | | | 0.36 | | | 0.27 |
| Est Vol (ac-ft)= | | | 0 | | | 1 | | | 1 | | | 2 |

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909-684-0093

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 | Catchment Lag time | | hrs | 0.29 | 0.29 | 0.29 | 0.00 |
| | | | Tc (min) | 21.67 | 21.92 | 21.38 | 0 |
| 3 | Catchment Area | acres 5 | | | | | |
| 4 | Base flow | cfs/sq mi 0 | | | | | |
| 5 | S-graph | n/a | | | | | |
| 6 | Maximum loss rate, Fm | in/hr 0.26 | | | | | |
| 7 | Low loss fraction, Y-bar | | | 0.42 | 0.39 | 0.36 | 0.27 |
| 8 | Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| | Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| | Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| | Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| | Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| | Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 | 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

# *Detention Basin Outlet Hydraulics*

**149-205**
**Waterman Gardens**
**6/6/2011**

| Orifice | | |
|---|---|---|
| C | 3.3 | weir |
| C | 0.62 | (orifice) |
| Dia | 1.34 | ft |
| Count | 1 | ea |
| Bottom EL | 0 | ft |

| | Orifice | | | | Summary | | |
|---|---|---|---|---|---|---|---|
| Elevation | Head | Weir | Orifice | Control | Orifice Outflow | Total Outflow | Volume |
| ft | ft | cfs | cfs | cfs | cfs | | ac-ft |
| 0 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 0.5 | 0.5 | 1.6 | n/a | 1.6 | 1.6 | 1.6 | 0.01 |
| 1 | 1 | 4.4 | n/a | 4.4 | 4.4 | 4.4 | 0.03 |
| 1.5 | 1.5 | 8.1 | 6.4 | 6.4 | 6.4 | 6.4 | 0.05 |
| 2 | 2 | 12.5 | 8.1 | 8.1 | 8.1 | 8.1 | 0.07 |
| 2.5 | 2.5 | n/a | 9.5 | 9.5 | 9.5 | 9.5 | 0.11 |
| 3 | 3 | n/a | 10.7 | 10.7 | 10.7 | 10.7 | 0.14 |
| 3.5 | 3.5 | n/a | 11.8 | 11.8 | 11.8 | 11.8 | 0.19 |
| 4 | 4 | n/a | 12.8 | 12.8 | 12.8 | 12.8 | 0.23 |

**Encompass Associates, Inc.**
5699 Cousins Place
Rancho Cucamonga, CA 91737
909-684-0093

Waterman Gardens
San Bernardino

149-205
6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate**

**Basin 2** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Condominiums" | 10.8 | 1.00 | B | 10.8 | 1.00 | 56 | 76 | 0.35 | 0.35 | 7.86 | 0.75 | 0.26 | 0.26 |
| (AutoCalc: Impervious) | | | | (7) | (0.65) | | 98 | 0 | 0.65 | 0.2 | | | |
| | 10.8 | | | 10.8 | | | | | | | | Fm= | 0.26 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| "Condominiums" | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.04 | 1.57 | 0.29 | 0.10 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.58 | 0.04 | 0.91 | 0.59 | 0.04 | 0.93 | 0.60 | 0.04 | 0.96 | 0.62 |
| | | Y= | 0.58 | | Y= | 0.61 | | Y= | 0.64 | | Y= | 0.73 |
| Low Loss Fraction,Y-bar = | | | 0.42 | | | 0.39 | | | 0.36 | | | 0.27 |
| Est Vol (ac-ft)= | | | 1 | | | 1 | | | 2 | | | 4 |

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Rancho Cucamonga, CA 91737
909-684-0093

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 Catchment Lag time | | hrs | 0.16 | 0.17 | 0.17 | 0.00 |
| | | Tc (min) | 12.2 | 12.4 | 12.4 | 0 |
| 3 Catchment Area | acres 10.8 | | | | | |
| 4 Base flow | cfs/sq mi 0 | | | | | |
| 5 S-graph | n/a | | | | | |
| 6 Maximum loss rate, Fm | in/hr 0.26 | | | | | |
| 7 Low loss fraction, Y-bar | | | 0.42 | 0.39 | 0.36 | 0.27 |
| 8 Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

# *Detention Basin Outlet Hydraulics*

**149-205**
**Waterman Gardens**
**6/6/2011**

| Orifice | | |
|---|---|---|
| C | 3.3 | weir |
| C | 0.62 | (orifice) |
| Dia | 1 | ft |
| Count | 1 | ea |
| Bottom EL | 0 | ft |

| | Orifice | | | | Summary | | |
|---|---|---|---|---|---|---|---|
| Elevation | Head | Weir | Orifice | Control | Orifice Outflow | Total Outflow | Volume |
| ft | ft | cfs | cfs | cfs | cfs | | ac-ft |
| 0 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 0.5 | 0.5 | 1.2 | n/a | 1.2 | 1.2 | 1.2 | 0.11 |
| 1 | 1 | 3.3 | n/a | 3.3 | 3.3 | 3.3 | 0.23 |
| 1.5 | 1.5 | 6.1 | 3.9 | 3.9 | 3.9 | 3.9 | 0.37 |
| 2 | 2 | 9.3 | 4.8 | 4.8 | 4.8 | 4.8 | 0.52 |
| 2.5 | 2.5 | n/a | 5.5 | 5.5 | 5.5 | 5.5 | 0.68 |
| 3 | 3 | n/a | 6.2 | 6.2 | 6.2 | 6.2 | 0.86 |
| 3.5 | 3.5 | n/a | 6.8 | 6.8 | 6.8 | 6.8 | 1.05 |
| 4 | 4 | n/a | 7.3 | 7.3 | 7.3 | 7.3 | 1.24 |

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Rancho Cucamonga, CA 91737
909-684-0093

Waterman Gardens
San Bernardino

149-205
6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate**

**Basin 3** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Condominiums" | 8.8 | 1.00 | B | 8.8 | 1.00 | 56 | 76 | 0.35 | 0.35 | 7.86 | 0.75 | 0.26 | 0.26 |
| (AutoCalc: Impervious) | | | | (5.7) | (0.65) | | 98 | 0 | 0.65 | 0.2 | | | |
| | 8.8 | | | 8.8 | | | | | | | | Fm= | 0.26 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| "Condominiums" | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.04 | 1.57 | 0.29 | 0.10 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.58 | 0.04 | 0.91 | 0.59 | 0.04 | 0.93 | 0.60 | 0.04 | 0.96 | 0.62 |
| | | Y= | 0.58 | | Y= | 0.61 | | Y= | 0.64 | | Y= | 0.73 |
| Low Loss Fraction,Y-bar = | | | 0.42 | | | 0.39 | | | 0.36 | | | 0.27 |
| Est Vol (ac-ft)= | | | 1 | | | 1 | | | 2 | | | 3 |

**Encompass Associates, Inc.**
5699 Cousins Place
Rancho Cucamonga, CA 91737
909-684-0093

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 Catchment Lag time | | hrs | 0.16 | 0.16 | 0.16 | 0.00 |
| | | Tc (min) | 11.94 | 11.94 | 11.94 | 0 |
| 3 Catchment Area | acres 8.8 | | | | | |
| 4 Base flow | cfs/sq mi 0 | | | | | |
| 5 S-graph | n/a | | | | | |
| 6 Maximum loss rate, Fm | in/hr 0.26 | | | | | |
| 7 Low loss fraction, Y-bar | | | 0.42 | 0.39 | 0.36 | 0.27 |
| 8 Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

# *Detention Basin Outlet Hydraulics*

**149-205**
**Waterman Gardens**
**6/6/2011**

| Orifice | | |
|---|---|---|
| C | 3.3 | weir |
| C | 0.62 | (orifice) |
| Dia | 1.33 | ft |
| Count | 1 | ea |
| Bottom EL | 0 | ft |

| | Orifice | | | | Summary | | |
|---|---|---|---|---|---|---|---|
| Elevation | Head | Weir | Orifice | Control | Orifice Outflow | Total Outflow | Volume |
| ft | ft | cfs | cfs | cfs | cfs | | ac-ft |
| 0 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 0.5 | 0.5 | 1.6 | n/a | 1.6 | 1.6 | 1.6 | 0.06 |
| 1 | 1 | 4.4 | n/a | 4.4 | 4.4 | 4.4 | 0.12 |
| 1.5 | 1.5 | 8.1 | 6.3 | 6.3 | 6.3 | 6.3 | 0.20 |
| 2 | 2 | 12.4 | 8.0 | 8.0 | 8.0 | 8.0 | 0.28 |
| 2.5 | 2.5 | n/a | 9.4 | 9.4 | 9.4 | 9.4 | 0.38 |
| 3 | 3 | n/a | 10.6 | 10.6 | 10.6 | 10.6 | 0.48 |
| 3.5 | 3.5 | n/a | 11.6 | 11.6 | 11.6 | 11.6 | 0.59 |
| 4 | 4 | n/a | 12.6 | 12.6 | 12.6 | 12.6 | 0.70 |

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Waterman Gardens
San Bernardino

149-205
6/6/11

AMC Type II (I,II or III)

**Maximum Loss Rate**

**Basin 4** Set # 1

| Cover | Area | % | Soil type | Area | % | CN-II | CN-III | Ap | % | S | Fp (F.C-6) | Fm | Fm (wt) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| "Condominiums" | 7.5 | 1.00 | B | 7.5 | 1.00 | 56 | 76 | 0.35 | 0.35 | 7.86 | 0.75 | 0.26 | 0.26 |
| (AutoCalc: Impervious) | | | | (4.9) | (0.65) | | 98 | 0 | 0.65 | 0.2 | | | |
| | 7.5 | | | 7.5 | | | | | | | | Fm= | 0.26 |

**Low Loss Fraction**

| Return Period | 1 | 1.93 in | | 2 | 2.60 in | | 5 | 3.49 in | | 100 | 6.40 in | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cover | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) | Ia | Y | Y (wt) |
| "Condominiums" | 1.57 | 0.01 | 0.00 | 1.57 | 0.05 | 0.02 | 1.57 | 0.11 | 0.04 | 1.57 | 0.29 | 0.10 |
| (AutoCalc: Impervious) | 0.04 | 0.89 | 0.58 | 0.04 | 0.91 | 0.59 | 0.04 | 0.93 | 0.60 | 0.04 | 0.96 | 0.62 |
| | | Y= | 0.58 | | Y= | 0.61 | | Y= | 0.64 | | Y= | 0.73 |
| Low Loss Fraction,Y-bar = | | | 0.42 | | | 0.39 | | | 0.36 | | | 0.27 |
| Est Vol (ac-ft)= | | | 1 | | | 1 | | | 1 | | | 3 |

**Encompass Associates, Inc.**
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Rancho Cucamonga, CA 91737
909-684-0093

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Design Storm | | yr | 1 | 2 | 5 | 100 |
| 2 | Catchment Lag time | | hrs | 0.24 | 0.24 | 0.24 | 0.00 |
| | | | Tc (min) | 18.18 | 18.13 | 18.19 | 0 |
| 3 | Catchment Area | acres 7.5 | | | | | |
| 4 | Base flow | cfs/sq mi 0 | | | | | |
| 5 | S-graph | n/a | | | | | |
| 6 | Maximum loss rate, Fm | in/hr 0.26 | | | | | |
| 7 | Low loss fraction, Y-bar | | | 0.42 | 0.39 | 0.36 | 0.27 |
| 8 | Watershed area-averaged 5-minute point rainfall | | inches | 0.17 | 0.22 | 0.28 | 0.48 |
| | Watershed area-averaged 30-minute point rainfall | | inches | 0.35 | 0.45 | 0.57 | 0.99 |
| | Watershed area-averaged 1-hour point rainfall | | inches | 0.46 | 0.59 | 0.75 | 1.30 |
| | Watershed area-averaged 3-hour point rainfall | | inches | 0.82 | 1.04 | 1.31 | 2.21 |
| | Watershed area-averaged 6-hour point rainfall | | inches | 1.19 | 1.48 | 1.86 | 3.10 |
| | Watershed area-averaged 24-hour point rainfall | | inches | 1.93 | 2.60 | 3.49 | 6.40 |
| 9 | 24-hour storm unit interval (use TC for Small UH) | | minutes | 5 | | | |

# *Detention Basin Outlet Hydraulics*

**149-205**
**Waterman Gardens**
**6/6/2011**

| Orifice | | |
|---|---|---|
| C | 3.3 | weir |
| C | 0.62 | (orifice) |
| Dia | 1.33 | ft |
| Count | 1 | ea |
| Bottom EL | 0 | ft |

| | Orifice | | | | Summary | | |
|---|---|---|---|---|---|---|---|
| Elevation | Head | Weir | Orifice | Control | Orifice Outflow | Total Outflow | Volume |
| ft | ft | cfs | cfs | cfs | cfs | | ac-ft |
| 0 | 0 | 0.0 | 0 | 0.0 | 0.0 | 0.0 | 0.00 |
| 0.5 | 0.5 | 1.6 | n/a | 1.6 | 1.6 | 1.6 | 0.15 |
| 1 | 1 | 4.4 | n/a | 4.4 | 4.4 | 4.4 | 0.31 |
| 1.5 | 1.5 | 8.1 | 6.3 | 6.3 | 6.3 | 6.3 | 0.49 |
| 2 | 2 | 12.4 | 8.0 | 8.0 | 8.0 | 8.0 | 0.69 |
| 2.5 | 2.5 | n/a | 9.4 | 9.4 | 9.4 | 9.4 | 0.90 |
| 3 | 3 | n/a | 10.6 | 10.6 | 10.6 | 10.6 | 1.12 |
| 3.5 | 3.5 | n/a | 11.6 | 11.6 | 11.6 | 11.6 | 1.36 |
| 4 | 4 | n/a | 12.6 | 12.6 | 12.6 | 12.6 | 1.59 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Pre East 1yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     8.50
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.248
    LOW LOSS FRACTION = 0.400
    TIME OF CONCENTRATION(MIN.) = 11.75
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93

----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.76
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.60

****************************************************************************
  TIME     VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)    (AF)      (CFS)
----------------------------------------------------------------------------
  0.14      0.0007     0.13  Q         .         .         .         .
  0.33      0.0028     0.13  Q         .         .         .         .
  0.53      0.0049     0.13  Q         .         .         .         .
  0.73      0.0071     0.13  Q         .         .         .         .
  0.92      0.0092     0.13  Q         .         .         .         .
  1.12      0.0114     0.13  Q         .         .         .         .
  1.31      0.0135     0.14  Q         .         .         .         .
  1.51      0.0157     0.14  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.70 | 0.0180 | 0.14 | Q | . | . | . | . |
| 1.90 | 0.0202 | 0.14 | Q | . | . | . | . |
| 2.10 | 0.0224 | 0.14 | Q | . | . | . | . |
| 2.29 | 0.0247 | 0.14 | Q | . | . | . | . |
| 2.49 | 0.0270 | 0.14 | Q | . | . | . | . |
| 2.68 | 0.0293 | 0.14 | Q | . | . | . | . |
| 2.88 | 0.0317 | 0.15 | Q | . | . | . | . |
| 3.08 | 0.0340 | 0.15 | Q | . | . | . | . |
| 3.27 | 0.0364 | 0.15 | Q | . | . | . | . |
| 3.47 | 0.0388 | 0.15 | Q | . | . | . | . |
| 3.66 | 0.0413 | 0.15 | Q | . | . | . | . |
| 3.86 | 0.0437 | 0.15 | Q | . | . | . | . |
| 4.05 | 0.0462 | 0.15 | Q | . | . | . | . |
| 4.25 | 0.0487 | 0.16 | Q | . | . | . | . |
| 4.45 | 0.0513 | 0.16 | Q | . | . | . | . |
| 4.64 | 0.0538 | 0.16 | Q | . | . | . | . |
| 4.84 | 0.0564 | 0.16 | Q | . | . | . | . |
| 5.03 | 0.0591 | 0.16 | Q | . | . | . | . |
| 5.23 | 0.0617 | 0.17 | Q | . | . | . | . |
| 5.43 | 0.0644 | 0.17 | Q | . | . | . | . |
| 5.62 | 0.0671 | 0.17 | Q | . | . | . | . |
| 5.82 | 0.0699 | 0.17 | Q | . | . | . | . |
| 6.01 | 0.0727 | 0.17 | Q | . | . | . | . |
| 6.21 | 0.0755 | 0.18 | Q | . | . | . | . |
| 6.40 | 0.0783 | 0.18 | Q | . | . | . | . |
| 6.60 | 0.0812 | 0.18 | Q | . | . | . | . |
| 6.80 | 0.0842 | 0.18 | Q | . | . | . | . |
| 6.99 | 0.0871 | 0.18 | Q | . | . | . | . |
| 7.19 | 0.0902 | 0.19 | Q | . | . | . | . |
| 7.38 | 0.0932 | 0.19 | Q | . | . | . | . |
| 7.58 | 0.0963 | 0.19 | Q | . | . | . | . |
| 7.78 | 0.0995 | 0.20 | Q | . | . | . | . |
| 7.97 | 0.1027 | 0.20 | Q | . | . | . | . |
| 8.17 | 0.1059 | 0.20 | Q | . | . | . | . |
| 8.36 | 0.1092 | 0.21 | Q | . | . | . | . |
| 8.56 | 0.1126 | 0.21 | Q | . | . | . | . |
| 8.75 | 0.1160 | 0.21 | Q | . | . | . | . |
| 8.95 | 0.1195 | 0.22 | Q | . | . | . | . |
| 9.15 | 0.1230 | 0.22 | Q | . | . | . | . |
| 9.34 | 0.1266 | 0.22 | Q | . | . | . | . |
| 9.54 | 0.1303 | 0.23 | Q | . | . | . | . |
| 9.73 | 0.1340 | 0.23 | Q | . | . | . | . |
| 9.93 | 0.1378 | 0.24 | Q | . | . | . | . |
| 10.12 | 0.1417 | 0.24 | Q | . | . | . | . |
| 10.32 | 0.1457 | 0.25 | Q | . | . | . | . |
| 10.52 | 0.1497 | 0.25 | .Q | . | . | . | . |
| 10.71 | 0.1539 | 0.26 | .Q | . | . | . | . |
| 10.91 | 0.1581 | 0.26 | .Q | . | . | . | . |
| 11.10 | 0.1625 | 0.27 | .Q | . | . | . | . |
| 11.30 | 0.1670 | 0.28 | .Q | . | . | . | . |
| 11.50 | 0.1716 | 0.29 | .Q | . | . | . | . |
| 11.69 | 0.1763 | 0.29 | .Q | . | . | . | . |
| 11.89 | 0.1811 | 0.31 | .Q | . | . | . | . |
| 12.08 | 0.1861 | 0.31 | .Q | . | . | . | . |
| 12.28 | 0.1926 | 0.49 | .Q | . | . | . | . |
| 12.48 | 0.2006 | 0.50 | .Q | . | . | . | . |
| 12.67 | 0.2089 | 0.52 | . Q | . | . | . | . |

| | | | |
|---|---|---|---|
| 12.87 | 0.2173 | 0.53 | . Q . . . . |
| 13.06 | 0.2260 | 0.55 | . Q . . . . |
| 13.26 | 0.2350 | 0.56 | . Q . . . . |
| 13.45 | 0.2442 | 0.58 | . Q . . . . |
| 13.65 | 0.2537 | 0.60 | . Q . . . . |
| 13.85 | 0.2637 | 0.63 | . Q . . . . |
| 14.04 | 0.2740 | 0.65 | . Q . . . . |
| 14.24 | 0.2848 | 0.69 | . Q . . . . |
| 14.43 | 0.2961 | 0.71 | . Q . . . . |
| 14.63 | 0.3080 | 0.77 | . Q . . . . |
| 14.82 | 0.3206 | 0.80 | . Q . . . . |
| 15.02 | 0.3343 | 0.88 | . Q . . . . |
| 15.22 | 0.3490 | 0.94 | . Q . . . . |
| 15.41 | 0.3651 | 1.05 | . Q . . . . |
| 15.61 | 0.3810 | 0.91 | . Q . . . . |
| 15.80 | 0.3989 | 1.31 | . Q . . . . |
| 16.00 | 0.4240 | 1.79 | . Q . . . . |
| 16.20 | 0.4989 | 7.46 | . . . Q. . |
| 16.39 | 0.5679 | 1.06 | . Q . . . . |
| 16.59 | 0.5846 | 1.00 | . Q . . . . |
| 16.78 | 0.5995 | 0.84 | . Q . . . . |
| 16.98 | 0.6122 | 0.74 | . Q . . . . |
| 17.17 | 0.6235 | 0.67 | . Q . . . . |
| 17.37 | 0.6339 | 0.61 | . Q . . . . |
| 17.57 | 0.6435 | 0.57 | . Q . . . . |
| 17.76 | 0.6524 | 0.54 | . Q . . . . |
| 17.96 | 0.6609 | 0.51 | . Q . . . . |
| 18.15 | 0.6684 | 0.42 | .Q . . . . |
| 18.35 | 0.6743 | 0.30 | .Q . . . . |
| 18.55 | 0.6790 | 0.28 | .Q . . . . |
| 18.74 | 0.6835 | 0.27 | .Q . . . . |
| 18.94 | 0.6877 | 0.26 | .Q . . . . |
| 19.13 | 0.6918 | 0.25 | Q . . . . |
| 19.33 | 0.6957 | 0.24 | Q . . . . |
| 19.52 | 0.6994 | 0.23 | Q . . . . |
| 19.72 | 0.7030 | 0.22 | Q . . . . |
| 19.92 | 0.7065 | 0.21 | Q . . . . |
| 20.11 | 0.7098 | 0.20 | Q . . . . |
| 20.31 | 0.7131 | 0.20 | Q . . . . |
| 20.50 | 0.7162 | 0.19 | Q . . . . |
| 20.70 | 0.7193 | 0.19 | Q . . . . |
| 20.90 | 0.7223 | 0.18 | Q . . . . |
| 21.09 | 0.7252 | 0.18 | Q . . . . |
| 21.29 | 0.7280 | 0.17 | Q . . . . |
| 21.48 | 0.7307 | 0.17 | Q . . . . |
| 21.68 | 0.7334 | 0.16 | Q . . . . |
| 21.88 | 0.7360 | 0.16 | Q . . . . |
| 22.07 | 0.7386 | 0.16 | Q . . . . |
| 22.27 | 0.7411 | 0.15 | Q . . . . |
| 22.46 | 0.7436 | 0.15 | Q . . . . |
| 22.66 | 0.7460 | 0.15 | Q . . . . |
| 22.85 | 0.7484 | 0.14 | Q . . . . |
| 23.05 | 0.7507 | 0.14 | Q . . . . |
| 23.25 | 0.7530 | 0.14 | Q . . . . |
| 23.44 | 0.7552 | 0.14 | Q . . . . |
| 23.64 | 0.7574 | 0.13 | Q . . . . |
| 23.83 | 0.7596 | 0.13 | Q . . . . |

```
 24.03      0.7617      0.13  Q          .          .          .          .
 24.23      0.7627      0.00  Q          .          .          .          .
----------------------------------------------------------------------------
------------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                  Duration
       Peak Flow Rate                       (minutes)
   ======================                   =========
             0%                              1445.2
            10%                               141.0
            20%                                23.5
            30%                                11.8
            40%                                11.8
            50%                                11.8
            60%                                11.8
            70%                                11.8
            80%                                11.8
            90%                                11.8

------------------------------------------------------------------------------
******************************************************************************
                        SMALL AREA UNIT HYDROGRAPH MODEL
==============================================================================
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
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                        RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

******************************************************************************
------------------------------------------------------------------------------

 Problem Descriptions:


  wq Pre East 2yr
------------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =    8.50
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.248
    LOW LOSS FRACTION = 0.373
    TIME OF CONCENTRATION(MIN.) = 11.75
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
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```
      3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
      6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
     24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

--------------------------------------------------------------------------------

   TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.07
   TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.77

******************************************************************************
  TIME     VOLUME       Q    0.        5.0      10.0      15.0      20.0
 (HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------------
  0.14      0.0012      0.21  Q         .         .         .         .
  0.33      0.0046      0.21  Q         .         .         .         .
  0.53      0.0081      0.21  Q         .         .         .         .
  0.73      0.0116      0.22  Q         .         .         .         .
  0.92      0.0151      0.22  Q         .         .         .         .
  1.12      0.0186      0.22  Q         .         .         .         .
  1.31      0.0221      0.22  Q         .         .         .         .
  1.51      0.0257      0.22  Q         .         .         .         .
  1.70      0.0293      0.22  Q         .         .         .         .
  1.90      0.0330      0.23  Q         .         .         .         .
  2.10      0.0367      0.23  Q         .         .         .         .
  2.29      0.0404      0.23  Q         .         .         .         .
  2.49      0.0441      0.23  Q         .         .         .         .
  2.68      0.0479      0.23  Q         .         .         .         .
  2.88      0.0517      0.24  Q         .         .         .         .
  3.08      0.0555      0.24  Q         .         .         .         .
  3.27      0.0594      0.24  Q         .         .         .         .
  3.47      0.0633      0.24  Q         .         .         .         .
  3.66      0.0672      0.24  Q         .         .         .         .
  3.86      0.0712      0.25  Q         .         .         .         .
  4.05      0.0752      0.25  Q         .         .         .         .
  4.25      0.0792      0.25  Q         .         .         .         .
  4.45      0.0833      0.25  Q         .         .         .         .
  4.64      0.0875      0.26  Q         .         .         .         .
  4.84      0.0916      0.26  Q         .         .         .         .
  5.03      0.0959      0.26  Q         .         .         .         .
  5.23      0.1001      0.27  Q         .         .         .         .
  5.43      0.1044      0.27  Q         .         .         .         .
  5.62      0.1088      0.27  Q         .         .         .         .
  5.82      0.1132      0.27  Q         .         .         .         .
  6.01      0.1176      0.28  Q         .         .         .         .
  6.21      0.1221      0.28  Q         .         .         .         .
  6.40      0.1267      0.28  Q         .         .         .         .
  6.60      0.1313      0.29  Q         .         .         .         .
  6.80      0.1360      0.29  Q         .         .         .         .
  6.99      0.1407      0.29  Q         .         .         .         .
  7.19      0.1455      0.30  Q         .         .         .         .
  7.38      0.1503      0.30  Q         .         .         .         .
  7.58      0.1552      0.31  Q         .         .         .         .
  7.78      0.1602      0.31  Q         .         .         .         .
  7.97      0.1653      0.31  Q         .         .         .         .
  8.17      0.1704      0.32  Q         .         .         .         .
  8.36      0.1756      0.32  Q         .         .         .         .
  8.56      0.1808      0.33  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8.75 | 0.1862 | 0.33 | Q | . | . | . | . |
| 8.95 | 0.1916 | 0.34 | Q | . | . | . | . |
| 9.15 | 0.1972 | 0.35 | Q | . | . | . | . |
| 9.34 | 0.2028 | 0.35 | Q | . | . | . | . |
| 9.54 | 0.2085 | 0.36 | Q | . | . | . | . |
| 9.73 | 0.2143 | 0.36 | Q | . | . | . | . |
| 9.93 | 0.2202 | 0.37 | Q | . | . | . | . |
| 10.12 | 0.2263 | 0.38 | Q | . | . | . | . |
| 10.32 | 0.2324 | 0.39 | Q | . | . | . | . |
| 10.52 | 0.2387 | 0.39 | Q | . | . | . | . |
| 10.71 | 0.2451 | 0.40 | Q | . | . | . | . |
| 10.91 | 0.2517 | 0.41 | Q | . | . | . | . |
| 11.10 | 0.2584 | 0.42 | Q | . | . | . | . |
| 11.30 | 0.2652 | 0.43 | Q | . | . | . | . |
| 11.50 | 0.2722 | 0.44 | Q | . | . | . | . |
| 11.69 | 0.2794 | 0.45 | Q | . | . | . | . |
| 11.89 | 0.2868 | 0.46 | Q | . | . | . | . |
| 12.08 | 0.2944 | 0.47 | Q | . | . | . | . |
| 12.28 | 0.3032 | 0.62 | .Q | . | . | . | . |
| 12.48 | 0.3133 | 0.63 | .Q | . | . | . | . |
| 12.67 | 0.3236 | 0.65 | .Q | . | . | . | . |
| 12.87 | 0.3343 | 0.66 | .Q | . | . | . | . |
| 13.06 | 0.3453 | 0.69 | .Q | . | . | . | . |
| 13.26 | 0.3565 | 0.71 | .Q | . | . | . | . |
| 13.45 | 0.3682 | 0.74 | .Q | . | . | . | . |
| 13.65 | 0.3803 | 0.76 | .Q | . | . | . | . |
| 13.85 | 0.3929 | 0.80 | .Q | . | . | . | . |
| 14.04 | 0.4060 | 0.82 | .Q | . | . | . | . |
| 14.24 | 0.4197 | 0.87 | .Q | . | . | . | . |
| 14.43 | 0.4341 | 0.90 | .Q | . | . | . | . |
| 14.63 | 0.4493 | 0.98 | .Q | . | . | . | . |
| 14.82 | 0.4655 | 1.02 | . Q | . | . | . | . |
| 15.02 | 0.4830 | 1.13 | . Q | . | . | . | . |
| 15.22 | 0.5019 | 1.20 | . Q | . | . | . | . |
| 15.41 | 0.5227 | 1.37 | . Q | . | . | . | . |
| 15.61 | 0.5437 | 1.22 | . Q | . | . | . | . |
| 15.80 | 0.5677 | 1.75 | . Q | . | . | . | . |
| 16.00 | 0.6013 | 2.40 | . Q | . | . | . | . |
| 16.20 | 0.7025 | 10.11 | . | . | Q | . | . |
| 16.39 | 0.7959 | 1.42 | . Q | . | . | . | . |
| 16.59 | 0.8178 | 1.29 | . Q | . | . | . | . |
| 16.78 | 0.8370 | 1.07 | . Q | . | . | . | . |
| 16.98 | 0.8533 | 0.94 | .Q | . | . | . | . |
| 17.17 | 0.8677 | 0.85 | .Q | . | . | . | . |
| 17.37 | 0.8808 | 0.78 | .Q | . | . | . | . |
| 17.57 | 0.8930 | 0.72 | .Q | . | . | . | . |
| 17.76 | 0.9043 | 0.68 | .Q | . | . | . | . |
| 17.96 | 0.9149 | 0.64 | .Q | . | . | . | . |
| 18.15 | 0.9247 | 0.56 | .Q | . | . | . | . |
| 18.35 | 0.9329 | 0.46 | Q | . | . | . | . |
| 18.55 | 0.9401 | 0.43 | Q | . | . | . | . |
| 18.74 | 0.9469 | 0.41 | Q | . | . | . | . |
| 18.94 | 0.9535 | 0.40 | Q | . | . | . | . |
| 19.13 | 0.9598 | 0.38 | Q | . | . | . | . |
| 19.33 | 0.9658 | 0.37 | Q | . | . | . | . |
| 19.52 | 0.9716 | 0.35 | Q | . | . | . | . |
| 19.72 | 0.9772 | 0.34 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19.92 | 0.9827 | 0.33 | Q | . | . | . | . |
| 20.11 | 0.9880 | 0.32 | Q | . | . | . | . |
| 20.31 | 0.9931 | 0.31 | Q | . | . | . | . |
| 20.50 | 0.9981 | 0.30 | Q | . | . | . | . |
| 20.70 | 1.0029 | 0.30 | Q | . | . | . | . |
| 20.90 | 1.0076 | 0.29 | Q | . | . | . | . |
| 21.09 | 1.0122 | 0.28 | Q | . | . | . | . |
| 21.29 | 1.0167 | 0.27 | Q | . | . | . | . |
| 21.48 | 1.0212 | 0.27 | Q | . | . | . | . |
| 21.68 | 1.0255 | 0.26 | Q | . | . | . | . |
| 21.88 | 1.0297 | 0.26 | Q | . | . | . | . |
| 22.07 | 1.0338 | 0.25 | Q | . | . | . | . |
| 22.27 | 1.0379 | 0.25 | Q | . | . | . | . |
| 22.46 | 1.0418 | 0.24 | Q | . | . | . | . |
| 22.66 | 1.0457 | 0.24 | Q | . | . | . | . |
| 22.85 | 1.0496 | 0.23 | Q | . | . | . | . |
| 23.05 | 1.0533 | 0.23 | Q | . | . | . | . |
| 23.25 | 1.0570 | 0.23 | Q | . | . | . | . |
| 23.44 | 1.0607 | 0.22 | Q | . | . | . | . |
| 23.64 | 1.0643 | 0.22 | Q | . | . | . | . |
| 23.83 | 1.0678 | 0.22 | Q | . | . | . | . |
| 24.03 | 1.0713 | 0.21 | Q | . | . | . | . |
| 24.23 | 1.0730 | 0.00 | Q | . | . | . | . |

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1445.2 |
| 10% | 129.2 |
| 20% | 23.5 |
| 30% | 11.8 |
| 40% | 11.8 |
| 50% | 11.8 |
| 60% | 11.8 |
| 70% | 11.8 |
| 80% | 11.8 |
| 90% | 11.8 |

**********
SMALL AREA UNIT HYDROGRAPH MODEL

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*****************************************************************************
-----------------------------------------------------------------------------

 Problem Descriptions:

  wq Pre East 5yr
-----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =    8.50
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.248
    LOW LOSS FRACTION = 0.340
    TIME OF CONCENTRATION(MIN.) = 11.75
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   5
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

-----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.51
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.96

*****************************************************************************
  TIME      VOLUME       Q    0.        5.0      10.0      15.0      20.0
 (HOURS)     (AF)      (CFS)
-----------------------------------------------------------------------------
  0.14      0.0019      0.33  Q         .         .         .         .
  0.33      0.0073      0.33  Q         .         .         .         .
  0.53      0.0127      0.34  Q         .         .         .         .
  0.73      0.0182      0.34  Q         .         .         .         .
  0.92      0.0237      0.34  Q         .         .         .         .
  1.12      0.0293      0.34  Q         .         .         .         .
  1.31      0.0349      0.35  Q         .         .         .         .
  1.51      0.0405      0.35  Q         .         .         .         .
  1.70      0.0462      0.35  Q         .         .         .         .
  1.90      0.0519      0.35  Q         .         .         .         .
  2.10      0.0577      0.36  Q         .         .         .         .
  2.29      0.0635      0.36  Q         .         .         .         .
  2.49      0.0694      0.36  Q         .         .         .         .
  2.68      0.0753      0.37  Q         .         .         .         .
  2.88      0.0812      0.37  Q         .         .         .         .
  3.08      0.0872      0.37  Q         .         .         .         .
  3.27      0.0933      0.38  Q         .         .         .         .
  3.47      0.0993      0.38  Q         .         .         .         .
  3.66      0.1055      0.38  Q         .         .         .         .
  3.86      0.1117      0.38  Q         .         .         .         .
  4.05      0.1179      0.39  Q         .         .         .         .
  4.25      0.1243      0.39  Q         .         .         .         .
  4.45      0.1306      0.40  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4.64 | 0.1370 | 0.40 | Q | . | . | . | . |
| 4.84 | 0.1435 | 0.40 | Q | . | . | . | . |
| 5.03 | 0.1501 | 0.41 | Q | . | . | . | . |
| 5.23 | 0.1567 | 0.41 | Q | . | . | . | . |
| 5.43 | 0.1633 | 0.41 | Q | . | . | . | . |
| 5.62 | 0.1701 | 0.42 | Q | . | . | . | . |
| 5.82 | 0.1769 | 0.42 | Q | . | . | . | . |
| 6.01 | 0.1838 | 0.43 | Q | . | . | . | . |
| 6.21 | 0.1907 | 0.43 | Q | . | . | . | . |
| 6.40 | 0.1978 | 0.44 | Q | . | . | . | . |
| 6.60 | 0.2049 | 0.44 | Q | . | . | . | . |
| 6.80 | 0.2120 | 0.45 | Q | . | . | . | . |
| 6.99 | 0.2193 | 0.45 | Q | . | . | . | . |
| 7.19 | 0.2267 | 0.46 | Q | . | . | . | . |
| 7.38 | 0.2341 | 0.46 | Q | . | . | . | . |
| 7.58 | 0.2416 | 0.47 | Q | . | . | . | . |
| 7.78 | 0.2493 | 0.47 | Q | . | . | . | . |
| 7.97 | 0.2570 | 0.48 | Q | . | . | . | . |
| 8.17 | 0.2648 | 0.49 | Q | . | . | . | . |
| 8.36 | 0.2727 | 0.49 | Q | . | . | . | . |
| 8.56 | 0.2808 | 0.50 | Q | . | . | . | . |
| 8.75 | 0.2889 | 0.51 | .Q | . | . | . | . |
| 8.95 | 0.2972 | 0.51 | .Q | . | . | . | . |
| 9.15 | 0.3056 | 0.52 | .Q | . | . | . | . |
| 9.34 | 0.3141 | 0.53 | .Q | . | . | . | . |
| 9.54 | 0.3228 | 0.54 | .Q | . | . | . | . |
| 9.73 | 0.3316 | 0.55 | .Q | . | . | . | . |
| 9.93 | 0.3405 | 0.56 | .Q | . | . | . | . |
| 10.12 | 0.3496 | 0.57 | .Q | . | . | . | . |
| 10.32 | 0.3589 | 0.58 | .Q | . | . | . | . |
| 10.52 | 0.3683 | 0.59 | .Q | . | . | . | . |
| 10.71 | 0.3780 | 0.60 | .Q | . | . | . | . |
| 10.91 | 0.3878 | 0.61 | .Q | . | . | . | . |
| 11.10 | 0.3978 | 0.63 | .Q | . | . | . | . |
| 11.30 | 0.4080 | 0.64 | .Q | . | . | . | . |
| 11.50 | 0.4185 | 0.66 | .Q | . | . | . | . |
| 11.69 | 0.4291 | 0.67 | .Q | . | . | . | . |
| 11.89 | 0.4401 | 0.69 | .Q | . | . | . | . |
| 12.08 | 0.4513 | 0.70 | .Q | . | . | . | . |
| 12.28 | 0.4635 | 0.81 | .Q | . | . | . | . |
| 12.48 | 0.4767 | 0.82 | .Q | . | . | . | . |
| 12.67 | 0.4903 | 0.85 | .Q | . | . | . | . |
| 12.87 | 0.5042 | 0.87 | .Q | . | . | . | . |
| 13.06 | 0.5185 | 0.90 | .Q | . | . | . | . |
| 13.26 | 0.5333 | 0.92 | .Q | . | . | . | . |
| 13.45 | 0.5486 | 0.97 | .Q | . | . | . | . |
| 13.65 | 0.5645 | 0.99 | .Q | . | . | . | . |
| 13.85 | 0.5810 | 1.05 | . Q | . | . | . | . |
| 14.04 | 0.5981 | 1.08 | . Q | . | . | . | . |
| 14.24 | 0.6161 | 1.15 | . Q | . | . | . | . |
| 14.43 | 0.6350 | 1.19 | . Q | . | . | . | . |
| 14.63 | 0.6551 | 1.29 | . Q | . | . | . | . |
| 14.82 | 0.6764 | 1.35 | . Q | . | . | . | . |
| 15.02 | 0.6993 | 1.49 | . Q | . | . | . | . |
| 15.22 | 0.7243 | 1.59 | .  Q | . | . | . | . |
| 15.41 | 0.7518 | 1.81 | .  Q | . | . | . | . |
| 15.61 | 0.7797 | 1.64 | .  Q | . | . | . | . |

```
 15.80      0.8118      2.34  .   Q     .         .         .         .
 16.00      0.8568      3.22  .     Q   .         .         .         .
 16.20      0.9910     13.36  .         .         .     Q   .         .
 16.39      1.1145      1.91  .  Q      .         .         .         .
 16.59      1.1438      1.71  .  Q      .         .         .         .
 16.78      1.1690      1.41  . Q       .         .         .         .
 16.98      1.1904      1.23  . Q       .         .         .         .
 17.17      1.2094      1.11  . Q       .         .         .         .
 17.37      1.2266      1.02  . Q       .         .         .         .
 17.57      1.2425      0.94  .Q        .         .         .         .
 17.76      1.2573      0.89  .Q        .         .         .         .
 17.96      1.2712      0.84  .Q        .         .         .         .
 18.15      1.2842      0.77  .Q        .         .         .         .
 18.35      1.2959      0.68  .Q        .         .         .         .
 18.55      1.3066      0.65  .Q        .         .         .         .
 18.74      1.3168      0.62  .Q        .         .         .         .
 18.94      1.3266      0.59  .Q        .         .         .         .
 19.13      1.3361      0.57  .Q        .         .         .         .
 19.33      1.3452      0.55  .Q        .         .         .         .
 19.52      1.3540      0.54  .Q        .         .         .         .
 19.72      1.3625      0.52  .Q        .         .         .         .
 19.92      1.3708      0.50  .Q        .         .         .         .
 20.11      1.3788      0.49  Q         .         .         .         .
 20.31      1.3866      0.48  Q         .         .         .         .
 20.50      1.3943      0.47  Q         .         .         .         .
 20.70      1.4017      0.45  Q         .         .         .         .
 20.90      1.4090      0.44  Q         .         .         .         .
 21.09      1.4161      0.43  Q         .         .         .         .
 21.29      1.4230      0.43  Q         .         .         .         .
 21.48      1.4298      0.42  Q         .         .         .         .
 21.68      1.4365      0.41  Q         .         .         .         .
 21.88      1.4431      0.40  Q         .         .         .         .
 22.07      1.4495      0.39  Q         .         .         .         .
 22.27      1.4558      0.39  Q         .         .         .         .
 22.46      1.4620      0.38  Q         .         .         .         .
 22.66      1.4681      0.37  Q         .         .         .         .
 22.85      1.4741      0.37  Q         .         .         .         .
 23.05      1.4800      0.36  Q         .         .         .         .
 23.25      1.4858      0.36  Q         .         .         .         .
 23.44      1.4915      0.35  Q         .         .         .         .
 23.64      1.4971      0.35  Q         .         .         .         .
 23.83      1.5027      0.34  Q         .         .         .         .
 24.03      1.5082      0.34  Q         .         .         .         .
 24.23      1.5109      0.00  Q         .         .         .         .
-------------------------------------------------------------------------
-----------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated          Duration
       Peak Flow Rate               (minutes)
   ======================           =========
             0%                      1445.2
            10%                       129.2
            20%                        23.5
            30%                        11.8
```

```
          40%                              11.8
          50%                              11.8
          60%                              11.8
          70%                              11.8
          80%                              11.8
          90%                              11.8

****************************************************************************
                      SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
                            5699 COUSINS PLACE
                        RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Pre West 1yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.70
    TOTAL CATCHMENT AREA(ACRES) =   28.40
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.300
    LOW LOSS FRACTION = 0.462
    TIME OF CONCENTRATION(MIN.) = 19.79
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93

----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.77
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     2.80

****************************************************************************
  TIME      VOLUME       Q    0.        5.0       10.0      15.0      20.0
 (HOURS)     (AF)      (CFS)
----------------------------------------------------------------------------
  0.17      0.0000      0.00  Q         .         .         .         .
  0.50      0.0041      0.30  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.83 | 0.0124 | 0.31 | Q | . | . | . | . |
| 1.16 | 0.0209 | 0.31 | Q | . | . | . | . |
| 1.49 | 0.0294 | 0.32 | Q | . | . | . | . |
| 1.82 | 0.0381 | 0.32 | Q | . | . | . | . |
| 2.15 | 0.0469 | 0.32 | Q | . | . | . | . |
| 2.48 | 0.0558 | 0.33 | Q | . | . | . | . |
| 2.81 | 0.0649 | 0.33 | Q | . | . | . | . |
| 3.14 | 0.0741 | 0.34 | Q | . | . | . | . |
| 3.47 | 0.0835 | 0.35 | Q | . | . | . | . |
| 3.80 | 0.0930 | 0.35 | Q | . | . | . | . |
| 4.13 | 0.1027 | 0.36 | Q | . | . | . | . |
| 4.46 | 0.1126 | 0.37 | Q | . | . | . | . |
| 4.79 | 0.1227 | 0.37 | Q | . | . | . | . |
| 5.12 | 0.1329 | 0.38 | Q | . | . | . | . |
| 5.45 | 0.1434 | 0.39 | Q | . | . | . | . |
| 5.78 | 0.1540 | 0.40 | Q | . | . | . | . |
| 6.11 | 0.1649 | 0.40 | Q | . | . | . | . |
| 6.43 | 0.1760 | 0.41 | Q | . | . | . | . |
| 6.76 | 0.1873 | 0.42 | Q | . | . | . | . |
| 7.09 | 0.1989 | 0.43 | Q | . | . | . | . |
| 7.42 | 0.2108 | 0.44 | Q | . | . | . | . |
| 7.75 | 0.2230 | 0.45 | Q | . | . | . | . |
| 8.08 | 0.2355 | 0.46 | Q | . | . | . | . |
| 8.41 | 0.2483 | 0.48 | Q | . | . | . | . |
| 8.74 | 0.2615 | 0.49 | Q | . | . | . | . |
| 9.07 | 0.2751 | 0.51 | .Q | . | . | . | . |
| 9.40 | 0.2890 | 0.52 | .Q | . | . | . | . |
| 9.73 | 0.3034 | 0.54 | .Q | . | . | . | . |
| 10.06 | 0.3183 | 0.55 | .Q | . | . | . | . |
| 10.39 | 0.3337 | 0.58 | .Q | . | . | . | . |
| 10.72 | 0.3497 | 0.59 | .Q | . | . | . | . |
| 11.05 | 0.3664 | 0.63 | .Q | . | . | . | . |
| 11.38 | 0.3837 | 0.64 | .Q | . | . | . | . |
| 11.71 | 0.4018 | 0.68 | .Q | . | . | . | . |
| 12.04 | 0.4208 | 0.71 | .Q | . | . | . | . |
| 12.37 | 0.4460 | 1.15 | . Q | . | . | . | . |
| 12.70 | 0.4777 | 1.18 | . Q | . | . | . | . |
| 13.03 | 0.5108 | 1.25 | . Q | . | . | . | . |
| 13.36 | 0.5455 | 1.29 | . Q | . | . | . | . |
| 13.69 | 0.5822 | 1.40 | . Q | . | . | . | . |
| 14.02 | 0.6211 | 1.46 | . Q | . | . | . | . |
| 14.35 | 0.6629 | 1.61 | . Q | . | . | . | . |
| 14.68 | 0.7081 | 1.71 | . Q | . | . | . | . |
| 15.01 | 0.7582 | 1.98 | . Q | . | . | . | . |
| 15.34 | 0.8148 | 2.17 | . Q | . | . | . | . |
| 15.67 | 0.8747 | 2.22 | . Q | . | . | . | . |
| 16.00 | 0.9467 | 3.06 | . Q | . | . | . | . |
| 16.33 | 1.1495 | 11.83 | . | . | . Q | . | . |
| 16.66 | 1.3438 | 2.43 | . Q | . | . | . | . |
| 16.99 | 1.4017 | 1.83 | . Q | . | . | . | . |
| 17.32 | 1.4474 | 1.53 | . Q | . | . | . | . |
| 17.65 | 1.4865 | 1.34 | . Q | . | . | . | . |
| 17.98 | 1.5213 | 1.21 | . Q | . | . | . | . |
| 18.31 | 1.5489 | 0.81 | .Q | . | . | . | . |
| 18.64 | 1.5689 | 0.66 | .Q | . | . | . | . |
| 18.97 | 1.5862 | 0.61 | .Q | . | . | . | . |
| 19.30 | 1.6023 | 0.57 | .Q | . | . | . | . |

```
 19.63      1.6172      0.53  .Q        .         .         .         .
 19.96      1.6311      0.50  Q         .         .         .         .
 20.29      1.6443      0.47  Q         .         .         .         .
 20.62      1.6568      0.45  Q         .         .         .         .
 20.95      1.6687      0.43  Q         .         .         .         .
 21.28      1.6801      0.41  Q         .         .         .         .
 21.61      1.6909      0.39  Q         .         .         .         .
 21.94      1.7014      0.38  Q         .         .         .         .
 22.27      1.7115      0.36  Q         .         .         .         .
 22.60      1.7212      0.35  Q         .         .         .         .
 22.93      1.7305      0.34  Q         .         .         .         .
 23.26      1.7396      0.33  Q         .         .         .         .
 23.59      1.7484      0.32  Q         .         .         .         .
 23.92      1.7570      0.31  Q         .         .         .         .
 24.25      1.7653      0.30  Q         .         .         .         .
 24.58      1.7694      0.00  Q         .         .         .         .
----------------------------------------------------------------------------
------------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                  Duration
       Peak Flow Rate                       (minutes)
   ======================                   =========
             0%                              1444.7
            10%                               316.6
            20%                                59.4
            30%                                19.8
            40%                                19.8
            50%                                19.8
            60%                                19.8
            70%                                19.8
            80%                                19.8
            90%                                19.8

------------------------------------------------------------------------------
******************************************************************************
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                              Analysis prepared by:

                            ENCOMPASS ASSOCIATES, INC.
                                5699 COUSINS PLACE
                            RANCHO CUCAMONGA CA 91737
                              www.encompasscivil.com

******************************************************************************
------------------------------------------------------------------------------

 Problem Descriptions:


  wq Pre West 2yr
```

```
---------------------------------------------------------------------------

   RATIONAL METHOD CALIBRATION COEFFICIENT = 0.70
   TOTAL CATCHMENT AREA(ACRES) =   28.40
   SOIL-LOSS RATE, Fm,(INCH/HR) =  0.300
   LOW LOSS FRACTION = 0.434
   TIME OF CONCENTRATION(MIN.) = 19.71
   SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
   USER SPECIFIED RAINFALL VALUES ARE USED
   RETURN FREQUENCY(YEARS) =   2
      5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
     30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
      1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
      3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
      6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
     24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

---------------------------------------------------------------------------

   TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     2.54
   TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     3.62

***************************************************************************
  TIME      VOLUME       Q    0.        5.0       10.0      15.0      20.0
 (HOURS)     (AF)      (CFS)
---------------------------------------------------------------------------
  0.23      0.0067      0.50  Q         .         .         .         .
  0.56      0.0203      0.50  .Q        .         .         .         .
  0.89      0.0339      0.51  .Q        .         .         .         .
  1.22      0.0478      0.51  .Q        .         .         .         .
  1.55      0.0618      0.52  .Q        .         .         .         .
  1.87      0.0761      0.53  .Q        .         .         .         .
  2.20      0.0905      0.53  .Q        .         .         .         .
  2.53      0.1051      0.54  .Q        .         .         .         .
  2.86      0.1199      0.55  .Q        .         .         .         .
  3.19      0.1350      0.56  .Q        .         .         .         .
  3.52      0.1503      0.57  .Q        .         .         .         .
  3.85      0.1658      0.58  .Q        .         .         .         .
  4.17      0.1815      0.58  .Q        .         .         .         .
  4.50      0.1975      0.60  .Q        .         .         .         .
  4.83      0.2138      0.60  .Q        .         .         .         .
  5.16      0.2304      0.62  .Q        .         .         .         .
  5.49      0.2472      0.62  .Q        .         .         .         .
  5.82      0.2644      0.64  .Q        .         .         .         .
  6.14      0.2818      0.65  .Q        .         .         .         .
  6.47      0.2997      0.66  .Q        .         .         .         .
  6.80      0.3178      0.67  .Q        .         .         .         .
  7.13      0.3364      0.69  .Q        .         .         .         .
  7.46      0.3553      0.70  .Q        .         .         .         .
  7.79      0.3747      0.72  .Q        .         .         .         .
  8.12      0.3946      0.74  .Q        .         .         .         .
  8.44      0.4149      0.76  .Q        .         .         .         .
  8.77      0.4357      0.77  .Q        .         .         .         .
  9.10      0.4571      0.80  .Q        .         .         .         .
  9.43      0.4790      0.82  .Q        .         .         .         .
  9.76      0.5016      0.85  .Q        .         .         .         .
```

```
 10.09      0.5249      0.87  .Q        .         .         .         .
 10.42      0.5490      0.90  .Q        .         .         .         .
 10.74      0.5738      0.93  .Q        .         .         .         .
 11.07      0.5995      0.97  .Q        .         .         .         .
 11.40      0.6263      1.00  .Q        .         .         .         .
 11.73      0.6541      1.05  . Q       .         .         .         .
 12.06      0.6831      1.09  . Q       .         .         .         .
 12.39      0.7176      1.45  . Q       .         .         .         .
 12.72      0.7577      1.50  . Q       .         .         .         .
 13.04      0.7996      1.59  .  Q      .         .         .         .
 13.37      0.8437      1.65  .  Q      .         .         .         .
 13.70      0.8903      1.78  .  Q      .         .         .         .
 14.03      0.9399      1.87  .  Q      .         .         .         .
 14.36      0.9933      2.07  .   Q     .         .         .         .
 14.69      1.0512      2.20  .   Q     .         .         .         .
 15.01      1.1157      2.56  .    Q    .         .         .         .
 15.34      1.1888      2.82  .    Q    .         .         .         .
 15.67      1.2679      3.01  .     Q   .         .         .         .
 16.00      1.3649      4.14  .       Q .         .         .         .
 16.33      1.6506     16.91  .         .         .         .  Q      .
 16.66      1.9230      3.16  .     Q   .         .         .         .
 16.99      1.9979      2.36  .   Q     .         .         .         .
 17.31      2.0565      1.96  .  Q      .         .         .         .
 17.64      2.1063      1.71  .  Q      .         .         .         .
 17.97      2.1505      1.54  .  Q      .         .         .         .
 18.30      2.1877      1.20  . Q       .         .         .         .
 18.63      2.2179      1.02  . Q       .         .         .         .
 18.96      2.2447      0.95  .Q        .         .         .         .
 19.28      2.2696      0.88  .Q        .         .         .         .
 19.61      2.2929      0.83  .Q        .         .         .         .
 19.94      2.3148      0.79  .Q        .         .         .         .
 20.27      2.3357      0.75  .Q        .         .         .         .
 20.60      2.3555      0.71  .Q        .         .         .         .
 20.93      2.3745      0.68  .Q        .         .         .         .
 21.26      2.3927      0.66  .Q        .         .         .         .
 21.58      2.4102      0.63  .Q        .         .         .         .
 21.91      2.4270      0.61  .Q        .         .         .         .
 22.24      2.4433      0.59  .Q        .         .         .         .
 22.57      2.4590      0.57  .Q        .         .         .         .
 22.90      2.4743      0.55  .Q        .         .         .         .
 23.23      2.4892      0.54  .Q        .         .         .         .
 23.56      2.5036      0.52  .Q        .         .         .         .
 23.88      2.5176      0.51  .Q        .         .         .         .
 24.21      2.5313      0.50  Q         .         .         .         .
 24.54      2.5381      0.00  Q         .         .         .         .
 ---------------------------------------------------------------------------
-----------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    ======================                   =========
              0%                              1458.5
             10%                               256.2
             20%                                39.4
```

```
            30%                              19.7
            40%                              19.7
            50%                              19.7
            60%                              19.7
            70%                              19.7
            80%                              19.7
            90%                              19.7

*****************************************************************************
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
                            5699 COUSINS PLACE
                        RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

*****************************************************************************
-----------------------------------------------------------------------------

 Problem Descriptions:


  wq Pre West 5yr
-----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =   28.40
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.300
    LOW LOSS FRACTION = 0.398
    TIME OF CONCENTRATION(MIN.) = 26.65
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   5
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

-----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     4.65
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     3.61

*****************************************************************************
  TIME      VOLUME       Q    0.        7.5       15.0      22.5      30.0
 (HOURS)     (AF)      (CFS)
-----------------------------------------------------------------------------
  0.01      0.0000      0.00  Q         .         .         .         .
```

```
 0.45      0.0187      1.02  .Q        .         .         .         .
 0.90      0.0564      1.03  .Q        .         .         .         .
 1.34      0.0947      1.05  .Q        .         .         .         .
 1.79      0.1336      1.07  .Q        .         .         .         .
 2.23      0.1732      1.09  .Q        .         .         .         .
 2.68      0.2134      1.10  .Q        .         .         .         .
 3.12      0.2544      1.13  .Q        .         .         .         .
 3.56      0.2961      1.14  .Q        .         .         .         .
 4.01      0.3386      1.17  .Q        .         .         .         .
 4.45      0.3820      1.19  .Q        .         .         .         .
 4.90      0.4262      1.22  .Q        .         .         .         .
 5.34      0.4714      1.24  .Q        .         .         .         .
 5.78      0.5176      1.28  .Q        .         .         .         .
 6.23      0.5649      1.30  .Q        .         .         .         .
 6.67      0.6133      1.34  .Q        .         .         .         .
 7.12      0.6630      1.36  .Q        .         .         .         .
 7.56      0.7139      1.41  .Q        .         .         .         .
 8.01      0.7663      1.44  .Q        .         .         .         .
 8.45      0.8203      1.50  .Q        .         .         .         .
 8.89      0.8759      1.53  . Q       .         .         .         .
 9.34      0.9334      1.60  . Q       .         .         .         .
 9.78      0.9928      1.64  . Q       .         .         .         .
10.23      1.0546      1.72  . Q       .         .         .         .
10.67      1.1187      1.77  . Q       .         .         .         .
11.11      1.1858      1.88  . Q       .         .         .         .
11.56      1.2559      1.94  . Q       .         .         .         .
12.00      1.3298      2.08  . Q       .         .         .         .
12.45      1.4102      2.30  .  Q      .         .         .         .
12.89      1.5003      2.62  .  Q      .         .         .         .
13.34      1.5987      2.74  .  Q      .         .         .         .
13.78      1.7047      3.04  .   Q     .         .         .         .
14.22      1.8199      3.23  .   Q     .         .         .         .
14.67      1.9484      3.77  .    Q    .         .         .         .
15.11      2.0940      4.16  .    Q    .         .         .         .
15.56      2.2672      5.27  .      Q  .         .         .         .
16.00      2.4741      6.00  .       Q .         .         .         .
16.44      3.0160     23.53  .         .         .         .Q        .
16.89      3.5344      4.72  .     Q   .         .         .         .
17.33      3.6847      3.47  .   Q     .         .         .         .
17.78      3.8013      2.88  .  Q      .         .         .         .
18.22      3.9002      2.51  .  Q      .         .         .         .
18.67      3.9832      2.01  . Q       .         .         .         .
19.11      4.0535      1.82  . Q       .         .         .         .
19.55      4.1178      1.68  . Q       .         .         .         .
20.00      4.1774      1.56  . Q       .         .         .         .
20.44      4.2331      1.47  .Q        .         .         .         .
20.89      4.2855      1.39  .Q        .         .         .         .
21.33      4.3352      1.32  .Q        .         .         .         .
21.77      4.3825      1.26  .Q        .         .         .         .
22.22      4.4277      1.21  .Q        .         .         .         .
22.66      4.4711      1.16  .Q        .         .         .         .
23.11      4.5128      1.12  .Q        .         .         .         .
23.55      4.5531      1.08  .Q        .         .         .         .
23.99      4.5920      1.04  .Q        .         .         .         .
24.44      4.6298      1.02  .Q        .         .         .         .
24.88      4.6484      0.00  Q         .         .         .         .
-----------------------------------------------------------------------
```

```
----------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                Duration
       Peak Flow Rate                     (minutes)
   ======================                 =========
             0%                            1465.8
            10%                             346.4
            20%                             106.6
            30%                              26.6
            40%                              26.6
            50%                              26.6
            60%                              26.6
            70%                              26.6
            80%                              26.6
            90%                              26.6

----------------------------------------------------------------------------
****************************************************************************
                        SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                              Analysis prepared by:

                            ENCOMPASS ASSOCIATES, INC.
                                5699 COUSINS PLACE
                            RANCHO CUCAMONGA CA 91737
                              www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Post East Bypass 1yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =    0.70
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.080
    LOW LOSS FRACTION = 0.198
    TIME OF CONCENTRATION(MIN.) =  6.30
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93
```

```
--------------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.08
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.03

********************************************************************************
  TIME      VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)     (AF)      (CFS)
--------------------------------------------------------------------------------
  0.04      0.0000      0.00  Q         .         .         .         .
  0.14      0.0001      0.01  Q         .         .         .         .
  0.25      0.0002      0.01  Q         .         .         .         .
  0.35      0.0003      0.01  Q         .         .         .         .
  0.46      0.0004      0.01  Q         .         .         .         .
  0.56      0.0006      0.01  Q         .         .         .         .
  0.67      0.0007      0.01  Q         .         .         .         .
  0.77      0.0008      0.01  Q         .         .         .         .
  0.88      0.0009      0.01  Q         .         .         .         .
  0.98      0.0011      0.01  Q         .         .         .         .
  1.09      0.0012      0.01  Q         .         .         .         .
  1.19      0.0013      0.01  Q         .         .         .         .
  1.30      0.0015      0.01  Q         .         .         .         .
  1.40      0.0016      0.01  Q         .         .         .         .
  1.51      0.0017      0.02  Q         .         .         .         .
  1.61      0.0018      0.02  Q         .         .         .         .
  1.72      0.0020      0.02  Q         .         .         .         .
  1.82      0.0021      0.02  Q         .         .         .         .
  1.93      0.0022      0.02  Q         .         .         .         .
  2.03      0.0024      0.02  Q         .         .         .         .
  2.14      0.0025      0.02  Q         .         .         .         .
  2.24      0.0026      0.02  Q         .         .         .         .
  2.35      0.0028      0.02  Q         .         .         .         .
  2.45      0.0029      0.02  Q         .         .         .         .
  2.56      0.0030      0.02  Q         .         .         .         .
  2.66      0.0032      0.02  Q         .         .         .         .
  2.77      0.0033      0.02  Q         .         .         .         .
  2.87      0.0035      0.02  Q         .         .         .         .
  2.98      0.0036      0.02  Q         .         .         .         .
  3.08      0.0037      0.02  Q         .         .         .         .
  3.19      0.0039      0.02  Q         .         .         .         .
  3.29      0.0040      0.02  Q         .         .         .         .
  3.40      0.0042      0.02  Q         .         .         .         .
  3.50      0.0043      0.02  Q         .         .         .         .
  3.61      0.0045      0.02  Q         .         .         .         .
  3.71      0.0046      0.02  Q         .         .         .         .
  3.82      0.0047      0.02  Q         .         .         .         .
  3.92      0.0049      0.02  Q         .         .         .         .
  4.03      0.0050      0.02  Q         .         .         .         .
  4.13      0.0052      0.02  Q         .         .         .         .
  4.24      0.0053      0.02  Q         .         .         .         .
  4.34      0.0055      0.02  Q         .         .         .         .
  4.45      0.0056      0.02  Q         .         .         .         .
  4.55      0.0058      0.02  Q         .         .         .         .
  4.66      0.0059      0.02  Q         .         .         .         .
  4.76      0.0061      0.02  Q         .         .         .         .
  4.87      0.0063      0.02  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4.97 | 0.0064 | 0.02 | Q | . | . | . | . |
| 5.08 | 0.0066 | 0.02 | Q | . | . | . | . |
| 5.18 | 0.0067 | 0.02 | Q | . | . | . | . |
| 5.29 | 0.0069 | 0.02 | Q | . | . | . | . |
| 5.39 | 0.0070 | 0.02 | Q | . | . | . | . |
| 5.50 | 0.0072 | 0.02 | Q | . | . | . | . |
| 5.61 | 0.0074 | 0.02 | Q | . | . | . | . |
| 5.71 | 0.0075 | 0.02 | Q | . | . | . | . |
| 5.82 | 0.0077 | 0.02 | Q | . | . | . | . |
| 5.92 | 0.0079 | 0.02 | Q | . | . | . | . |
| 6.02 | 0.0080 | 0.02 | Q | . | . | . | . |
| 6.13 | 0.0082 | 0.02 | Q | . | . | . | . |
| 6.23 | 0.0084 | 0.02 | Q | . | . | . | . |
| 6.34 | 0.0085 | 0.02 | Q | . | . | . | . |
| 6.44 | 0.0087 | 0.02 | Q | . | . | . | . |
| 6.55 | 0.0089 | 0.02 | Q | . | . | . | . |
| 6.65 | 0.0090 | 0.02 | Q | . | . | . | . |
| 6.76 | 0.0092 | 0.02 | Q | . | . | . | . |
| 6.86 | 0.0094 | 0.02 | Q | . | . | . | . |
| 6.97 | 0.0096 | 0.02 | Q | . | . | . | . |
| 7.07 | 0.0097 | 0.02 | Q | . | . | . | . |
| 7.18 | 0.0099 | 0.02 | Q | . | . | . | . |
| 7.28 | 0.0101 | 0.02 | Q | . | . | . | . |
| 7.39 | 0.0103 | 0.02 | Q | . | . | . | . |
| 7.49 | 0.0105 | 0.02 | Q | . | . | . | . |
| 7.60 | 0.0107 | 0.02 | Q | . | . | . | . |
| 7.70 | 0.0108 | 0.02 | Q | . | . | . | . |
| 7.81 | 0.0110 | 0.02 | Q | . | . | . | . |
| 7.91 | 0.0112 | 0.02 | Q | . | . | . | . |
| 8.02 | 0.0114 | 0.02 | Q | . | . | . | . |
| 8.12 | 0.0116 | 0.02 | Q | . | . | . | . |
| 8.23 | 0.0118 | 0.02 | Q | . | . | . | . |
| 8.34 | 0.0120 | 0.02 | Q | . | . | . | . |
| 8.44 | 0.0122 | 0.02 | Q | . | . | . | . |
| 8.55 | 0.0124 | 0.02 | Q | . | . | . | . |
| 8.65 | 0.0126 | 0.02 | Q | . | . | . | . |
| 8.76 | 0.0128 | 0.02 | Q | . | . | . | . |
| 8.86 | 0.0130 | 0.02 | Q | . | . | . | . |
| 8.96 | 0.0132 | 0.02 | Q | . | . | . | . |
| 9.07 | 0.0134 | 0.02 | Q | . | . | . | . |
| 9.18 | 0.0136 | 0.02 | Q | . | . | . | . |
| 9.28 | 0.0138 | 0.02 | Q | . | . | . | . |
| 9.38 | 0.0141 | 0.03 | Q | . | . | . | . |
| 9.49 | 0.0143 | 0.03 | Q | . | . | . | . |
| 9.60 | 0.0145 | 0.03 | Q | . | . | . | . |
| 9.70 | 0.0147 | 0.03 | Q | . | . | . | . |
| 9.80 | 0.0149 | 0.03 | Q | . | . | . | . |
| 9.91 | 0.0152 | 0.03 | Q | . | . | . | . |
| 10.01 | 0.0154 | 0.03 | Q | . | . | . | . |
| 10.12 | 0.0156 | 0.03 | Q | . | . | . | . |
| 10.23 | 0.0159 | 0.03 | Q | . | . | . | . |
| 10.33 | 0.0161 | 0.03 | Q | . | . | . | . |
| 10.43 | 0.0163 | 0.03 | Q | . | . | . | . |
| 10.54 | 0.0166 | 0.03 | Q | . | . | . | . |
| 10.65 | 0.0168 | 0.03 | Q | . | . | . | . |
| 10.75 | 0.0171 | 0.03 | Q | . | . | . | . |
| 10.85 | 0.0173 | 0.03 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 10.96 | 0.0176 | 0.03 | Q | . | . | . | . |
| 11.06 | 0.0179 | 0.03 | Q | . | . | . | . |
| 11.17 | 0.0181 | 0.03 | Q | . | . | . | . |
| 11.27 | 0.0184 | 0.03 | Q | . | . | . | . |
| 11.38 | 0.0187 | 0.03 | Q | . | . | . | . |
| 11.48 | 0.0189 | 0.03 | Q | . | . | . | . |
| 11.59 | 0.0192 | 0.03 | Q | . | . | . | . |
| 11.70 | 0.0195 | 0.03 | Q | . | . | . | . |
| 11.80 | 0.0198 | 0.03 | Q | . | . | . | . |
| 11.90 | 0.0201 | 0.03 | Q | . | . | . | . |
| 12.01 | 0.0204 | 0.03 | Q | . | . | . | . |
| 12.11 | 0.0208 | 0.05 | Q | . | . | . | . |
| 12.22 | 0.0212 | 0.05 | Q | . | . | . | . |
| 12.32 | 0.0217 | 0.05 | Q | . | . | . | . |
| 12.43 | 0.0222 | 0.06 | Q | . | . | . | . |
| 12.53 | 0.0227 | 0.06 | Q | . | . | . | . |
| 12.64 | 0.0231 | 0.06 | Q | . | . | . | . |
| 12.74 | 0.0236 | 0.06 | Q | . | . | . | . |
| 12.85 | 0.0241 | 0.06 | Q | . | . | . | . |
| 12.95 | 0.0247 | 0.06 | Q | . | . | . | . |
| 13.06 | 0.0252 | 0.06 | Q | . | . | . | . |
| 13.16 | 0.0257 | 0.06 | Q | . | . | . | . |
| 13.27 | 0.0263 | 0.06 | Q | . | . | . | . |
| 13.38 | 0.0268 | 0.06 | Q | . | . | . | . |
| 13.48 | 0.0274 | 0.06 | Q | . | . | . | . |
| 13.59 | 0.0279 | 0.07 | Q | . | . | . | . |
| 13.69 | 0.0285 | 0.07 | Q | . | . | . | . |
| 13.80 | 0.0291 | 0.07 | Q | . | . | . | . |
| 13.90 | 0.0297 | 0.07 | Q | . | . | . | . |
| 14.01 | 0.0303 | 0.07 | Q | . | . | . | . |
| 14.11 | 0.0310 | 0.07 | Q | . | . | . | . |
| 14.22 | 0.0316 | 0.08 | Q | . | . | . | . |
| 14.32 | 0.0323 | 0.08 | Q | . | . | . | . |
| 14.43 | 0.0330 | 0.08 | Q | . | . | . | . |
| 14.53 | 0.0337 | 0.08 | Q | . | . | . | . |
| 14.63 | 0.0344 | 0.09 | Q | . | . | . | . |
| 14.74 | 0.0352 | 0.09 | Q | . | . | . | . |
| 14.85 | 0.0359 | 0.09 | Q | . | . | . | . |
| 14.95 | 0.0368 | 0.10 | Q | . | . | . | . |
| 15.05 | 0.0376 | 0.10 | Q | . | . | . | . |
| 15.16 | 0.0385 | 0.10 | Q | . | . | . | . |
| 15.27 | 0.0395 | 0.11 | Q | . | . | . | . |
| 15.37 | 0.0405 | 0.12 | Q | . | . | . | . |
| 15.48 | 0.0414 | 0.10 | Q | . | . | . | . |
| 15.58 | 0.0423 | 0.11 | Q | . | . | . | . |
| 15.68 | 0.0433 | 0.13 | Q | . | . | . | . |
| 15.79 | 0.0445 | 0.15 | Q | . | . | . | . |
| 15.90 | 0.0461 | 0.21 | Q | . | . | . | . |
| 16.00 | 0.0483 | 0.31 | .Q | . | . | . | . |
| 16.10 | 0.0543 | 1.07 | . Q | . | . | . | . |
| 16.21 | 0.0597 | 0.17 | Q | . | . | . | . |
| 16.32 | 0.0609 | 0.12 | Q | . | . | . | . |
| 16.42 | 0.0619 | 0.11 | Q | . | . | . | . |
| 16.52 | 0.0628 | 0.11 | Q | . | . | . | . |
| 16.63 | 0.0637 | 0.10 | Q | . | . | . | . |
| 16.73 | 0.0645 | 0.09 | Q | . | . | . | . |
| 16.84 | 0.0653 | 0.08 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16.94 | 0.0660 | 0.08 | Q | . | . | . | . |
| 17.05 | 0.0667 | 0.07 | Q | . | . | . | . |
| 17.16 | 0.0673 | 0.07 | Q | . | . | . | . |
| 17.26 | 0.0679 | 0.07 | Q | . | . | . | . |
| 17.36 | 0.0685 | 0.07 | Q | . | . | . | . |
| 17.47 | 0.0690 | 0.06 | Q | . | . | . | . |
| 17.58 | 0.0696 | 0.06 | Q | . | . | . | . |
| 17.68 | 0.0701 | 0.06 | Q | . | . | . | . |
| 17.78 | 0.0706 | 0.06 | Q | . | . | . | . |
| 17.89 | 0.0711 | 0.06 | Q | . | . | . | . |
| 17.99 | 0.0716 | 0.05 | Q | . | . | . | . |
| 18.10 | 0.0720 | 0.04 | Q | . | . | . | . |
| 18.20 | 0.0723 | 0.03 | Q | . | . | . | . |
| 18.31 | 0.0726 | 0.03 | Q | . | . | . | . |
| 18.42 | 0.0729 | 0.03 | Q | . | . | . | . |
| 18.52 | 0.0731 | 0.03 | Q | . | . | . | . |
| 18.62 | 0.0734 | 0.03 | Q | . | . | . | . |
| 18.73 | 0.0737 | 0.03 | Q | . | . | . | . |
| 18.83 | 0.0739 | 0.03 | Q | . | . | . | . |
| 18.94 | 0.0741 | 0.03 | Q | . | . | . | . |
| 19.05 | 0.0744 | 0.03 | Q | . | . | . | . |
| 19.15 | 0.0746 | 0.03 | Q | . | . | . | . |
| 19.26 | 0.0748 | 0.03 | Q | . | . | . | . |
| 19.36 | 0.0751 | 0.03 | Q | . | . | . | . |
| 19.47 | 0.0753 | 0.02 | Q | . | . | . | . |
| 19.57 | 0.0755 | 0.02 | Q | . | . | . | . |
| 19.67 | 0.0757 | 0.02 | Q | . | . | . | . |
| 19.78 | 0.0759 | 0.02 | Q | . | . | . | . |
| 19.89 | 0.0761 | 0.02 | Q | . | . | . | . |
| 19.99 | 0.0763 | 0.02 | Q | . | . | . | . |
| 20.09 | 0.0765 | 0.02 | Q | . | . | . | . |
| 20.20 | 0.0767 | 0.02 | Q | . | . | . | . |
| 20.31 | 0.0769 | 0.02 | Q | . | . | . | . |
| 20.41 | 0.0771 | 0.02 | Q | . | . | . | . |
| 20.52 | 0.0773 | 0.02 | Q | . | . | . | . |
| 20.62 | 0.0774 | 0.02 | Q | . | . | . | . |
| 20.73 | 0.0776 | 0.02 | Q | . | . | . | . |
| 20.83 | 0.0778 | 0.02 | Q | . | . | . | . |
| 20.93 | 0.0780 | 0.02 | Q | . | . | . | . |
| 21.04 | 0.0781 | 0.02 | Q | . | . | . | . |
| 21.14 | 0.0783 | 0.02 | Q | . | . | . | . |
| 21.25 | 0.0785 | 0.02 | Q | . | . | . | . |
| 21.36 | 0.0786 | 0.02 | Q | . | . | . | . |
| 21.46 | 0.0788 | 0.02 | Q | . | . | . | . |
| 21.57 | 0.0789 | 0.02 | Q | . | . | . | . |
| 21.67 | 0.0791 | 0.02 | Q | . | . | . | . |
| 21.77 | 0.0792 | 0.02 | Q | . | . | . | . |
| 21.88 | 0.0794 | 0.02 | Q | . | . | . | . |
| 21.98 | 0.0795 | 0.02 | Q | . | . | . | . |
| 22.09 | 0.0797 | 0.02 | Q | . | . | . | . |
| 22.19 | 0.0798 | 0.02 | Q | . | . | . | . |
| 22.30 | 0.0800 | 0.02 | Q | . | . | . | . |
| 22.41 | 0.0801 | 0.02 | Q | . | . | . | . |
| 22.51 | 0.0803 | 0.02 | Q | . | . | . | . |
| 22.61 | 0.0804 | 0.02 | Q | . | . | . | . |
| 22.72 | 0.0806 | 0.02 | Q | . | . | . | . |
| 22.83 | 0.0807 | 0.02 | Q | . | . | . | . |

```
 22.93      0.0808      0.02  Q          .          .          .          .
 23.03      0.0810      0.02  Q          .          .          .          .
 23.14      0.0811      0.02  Q          .          .          .          .
 23.25      0.0812      0.02  Q          .          .          .          .
 23.35      0.0814      0.02  Q          .          .          .          .
 23.45      0.0815      0.01  Q          .          .          .          .
 23.56      0.0816      0.01  Q          .          .          .          .
 23.67      0.0818      0.01  Q          .          .          .          .
 23.77      0.0819      0.01  Q          .          .          .          .
 23.88      0.0820      0.01  Q          .          .          .          .
 23.98      0.0821      0.01  Q          .          .          .          .
 24.08      0.0823      0.01  Q          .          .          .          .
 24.19      0.0823      0.00  Q          .          .          .          .
----------------------------------------------------------------------------
------------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                  Duration
       Peak Flow Rate                       (minutes)
   ======================                   =========
             0%                              1442.7
            10%                                75.6
            20%                                12.6
            30%                                 6.3
            40%                                 6.3
            50%                                 6.3
            60%                                 6.3
            70%                                 6.3
            80%                                 6.3
            90%                                 6.3

____________________________________________________________________________
****************************************************************************
                      SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
                            5699 COUSINS PLACE
                        RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Post East Bypass 2yr
----------------------------------------------------------------------------
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```
RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) =    0.70
SOIL-LOSS RATE, Fm,(INCH/HR) =  0.080
LOW LOSS FRACTION = 0.176
TIME OF CONCENTRATION(MIN.) =  6.30
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) =   2
   5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
  30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
   1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
   3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
   6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
  24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

--------------------------------------------------------------------------

TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.11
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.04

**************************************************************************
 TIME     VOLUME       Q    0.        2.5       5.0       7.5      10.0
(HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------
 0.04     0.0000      0.00  Q         .         .         .         .
 0.14     0.0001      0.02  Q         .         .         .         .
 0.25     0.0003      0.02  Q         .         .         .         .
 0.35     0.0005      0.02  Q         .         .         .         .
 0.46     0.0007      0.02  Q         .         .         .         .
 0.56     0.0009      0.02  Q         .         .         .         .
 0.67     0.0011      0.02  Q         .         .         .         .
 0.77     0.0013      0.02  Q         .         .         .         .
 0.88     0.0015      0.02  Q         .         .         .         .
 0.98     0.0017      0.02  Q         .         .         .         .
 1.09     0.0019      0.02  Q         .         .         .         .
 1.19     0.0021      0.02  Q         .         .         .         .
 1.30     0.0023      0.02  Q         .         .         .         .
 1.40     0.0025      0.02  Q         .         .         .         .
 1.51     0.0028      0.02  Q         .         .         .         .
 1.61     0.0030      0.02  Q         .         .         .         .
 1.72     0.0032      0.02  Q         .         .         .         .
 1.82     0.0034      0.02  Q         .         .         .         .
 1.93     0.0036      0.02  Q         .         .         .         .
 2.03     0.0038      0.02  Q         .         .         .         .
 2.14     0.0040      0.02  Q         .         .         .         .
 2.24     0.0042      0.02  Q         .         .         .         .
 2.35     0.0045      0.03  Q         .         .         .         .
 2.45     0.0047      0.03  Q         .         .         .         .
 2.56     0.0049      0.03  Q         .         .         .         .
 2.66     0.0051      0.03  Q         .         .         .         .
 2.77     0.0053      0.03  Q         .         .         .         .
 2.87     0.0056      0.03  Q         .         .         .         .
 2.98     0.0058      0.03  Q         .         .         .         .
 3.08     0.0060      0.03  Q         .         .         .         .
 3.19     0.0062      0.03  Q         .         .         .         .
 3.29     0.0065      0.03  Q         .         .         .         .
 3.40     0.0067      0.03  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 3.50 | 0.0069 | 0.03 | Q | . | . | . | . |
| 3.61 | 0.0071 | 0.03 | Q | . | . | . | . |
| 3.71 | 0.0074 | 0.03 | Q | . | . | . | . |
| 3.82 | 0.0076 | 0.03 | Q | . | . | . | . |
| 3.92 | 0.0078 | 0.03 | Q | . | . | . | . |
| 4.03 | 0.0081 | 0.03 | Q | . | . | . | . |
| 4.13 | 0.0083 | 0.03 | Q | . | . | . | . |
| 4.24 | 0.0085 | 0.03 | Q | . | . | . | . |
| 4.34 | 0.0088 | 0.03 | Q | . | . | . | . |
| 4.45 | 0.0090 | 0.03 | Q | . | . | . | . |
| 4.55 | 0.0093 | 0.03 | Q | . | . | . | . |
| 4.66 | 0.0095 | 0.03 | Q | . | . | . | . |
| 4.76 | 0.0097 | 0.03 | Q | . | . | . | . |
| 4.87 | 0.0100 | 0.03 | Q | . | . | . | . |
| 4.97 | 0.0102 | 0.03 | Q | . | . | . | . |
| 5.08 | 0.0105 | 0.03 | Q | . | . | . | . |
| 5.18 | 0.0107 | 0.03 | Q | . | . | . | . |
| 5.29 | 0.0110 | 0.03 | Q | . | . | . | . |
| 5.39 | 0.0112 | 0.03 | Q | . | . | . | . |
| 5.50 | 0.0115 | 0.03 | Q | . | . | . | . |
| 5.61 | 0.0117 | 0.03 | Q | . | . | . | . |
| 5.71 | 0.0120 | 0.03 | Q | . | . | . | . |
| 5.82 | 0.0122 | 0.03 | Q | . | . | . | . |
| 5.92 | 0.0125 | 0.03 | Q | . | . | . | . |
| 6.02 | 0.0128 | 0.03 | Q | . | . | . | . |
| 6.13 | 0.0130 | 0.03 | Q | . | . | . | . |
| 6.23 | 0.0133 | 0.03 | Q | . | . | . | . |
| 6.34 | 0.0136 | 0.03 | Q | . | . | . | . |
| 6.44 | 0.0138 | 0.03 | Q | . | . | . | . |
| 6.55 | 0.0141 | 0.03 | Q | . | . | . | . |
| 6.65 | 0.0144 | 0.03 | Q | . | . | . | . |
| 6.76 | 0.0146 | 0.03 | Q | . | . | . | . |
| 6.86 | 0.0149 | 0.03 | Q | . | . | . | . |
| 6.97 | 0.0152 | 0.03 | Q | . | . | . | . |
| 7.07 | 0.0155 | 0.03 | Q | . | . | . | . |
| 7.18 | 0.0157 | 0.03 | Q | . | . | . | . |
| 7.28 | 0.0160 | 0.03 | Q | . | . | . | . |
| 7.39 | 0.0163 | 0.03 | Q | . | . | . | . |
| 7.49 | 0.0166 | 0.03 | Q | . | . | . | . |
| 7.60 | 0.0169 | 0.03 | Q | . | . | . | . |
| 7.70 | 0.0172 | 0.03 | Q | . | . | . | . |
| 7.81 | 0.0175 | 0.03 | Q | . | . | . | . |
| 7.91 | 0.0178 | 0.03 | Q | . | . | . | . |
| 8.02 | 0.0181 | 0.03 | Q | . | . | . | . |
| 8.12 | 0.0184 | 0.03 | Q | . | . | . | . |
| 8.23 | 0.0187 | 0.03 | Q | . | . | . | . |
| 8.34 | 0.0190 | 0.04 | Q | . | . | . | . |
| 8.44 | 0.0193 | 0.04 | Q | . | . | . | . |
| 8.55 | 0.0196 | 0.04 | Q | . | . | . | . |
| 8.65 | 0.0199 | 0.04 | Q | . | . | . | . |
| 8.76 | 0.0202 | 0.04 | Q | . | . | . | . |
| 8.86 | 0.0205 | 0.04 | Q | . | . | . | . |
| 8.96 | 0.0208 | 0.04 | Q | . | . | . | . |
| 9.07 | 0.0212 | 0.04 | Q | . | . | . | . |
| 9.18 | 0.0215 | 0.04 | Q | . | . | . | . |
| 9.28 | 0.0218 | 0.04 | Q | . | . | . | . |
| 9.38 | 0.0221 | 0.04 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 9.49 | 0.0225 | 0.04 | Q | . | . | . | . |
| 9.60 | 0.0228 | 0.04 | Q | . | . | . | . |
| 9.70 | 0.0232 | 0.04 | Q | . | . | . | . |
| 9.80 | 0.0235 | 0.04 | Q | . | . | . | . |
| 9.91 | 0.0238 | 0.04 | Q | . | . | . | . |
| 10.01 | 0.0242 | 0.04 | Q | . | . | . | . |
| 10.12 | 0.0246 | 0.04 | Q | . | . | . | . |
| 10.23 | 0.0249 | 0.04 | Q | . | . | . | . |
| 10.33 | 0.0253 | 0.04 | Q | . | . | . | . |
| 10.43 | 0.0256 | 0.04 | Q | . | . | . | . |
| 10.54 | 0.0260 | 0.04 | Q | . | . | . | . |
| 10.65 | 0.0264 | 0.04 | Q | . | . | . | . |
| 10.75 | 0.0268 | 0.04 | Q | . | . | . | . |
| 10.85 | 0.0271 | 0.04 | Q | . | . | . | . |
| 10.96 | 0.0275 | 0.04 | Q | . | . | . | . |
| 11.06 | 0.0279 | 0.05 | Q | . | . | . | . |
| 11.17 | 0.0283 | 0.05 | Q | . | . | . | . |
| 11.27 | 0.0287 | 0.05 | Q | . | . | . | . |
| 11.38 | 0.0291 | 0.05 | Q | . | . | . | . |
| 11.48 | 0.0295 | 0.05 | Q | . | . | . | . |
| 11.59 | 0.0300 | 0.05 | Q | . | . | . | . |
| 11.70 | 0.0304 | 0.05 | Q | . | . | . | . |
| 11.80 | 0.0308 | 0.05 | Q | . | . | . | . |
| 11.90 | 0.0313 | 0.05 | Q | . | . | . | . |
| 12.01 | 0.0317 | 0.05 | Q | . | . | . | . |
| 12.11 | 0.0322 | 0.07 | Q | . | . | . | . |
| 12.22 | 0.0328 | 0.07 | Q | . | . | . | . |
| 12.32 | 0.0334 | 0.07 | Q | . | . | . | . |
| 12.43 | 0.0340 | 0.07 | Q | . | . | . | . |
| 12.53 | 0.0346 | 0.07 | Q | . | . | . | . |
| 12.64 | 0.0352 | 0.07 | Q | . | . | . | . |
| 12.74 | 0.0358 | 0.07 | Q | . | . | . | . |
| 12.85 | 0.0364 | 0.07 | Q | . | . | . | . |
| 12.95 | 0.0370 | 0.07 | Q | . | . | . | . |
| 13.06 | 0.0377 | 0.08 | Q | . | . | . | . |
| 13.16 | 0.0384 | 0.08 | Q | . | . | . | . |
| 13.27 | 0.0390 | 0.08 | Q | . | . | . | . |
| 13.38 | 0.0397 | 0.08 | Q | . | . | . | . |
| 13.48 | 0.0404 | 0.08 | Q | . | . | . | . |
| 13.59 | 0.0411 | 0.08 | Q | . | . | . | . |
| 13.69 | 0.0418 | 0.08 | Q | . | . | . | . |
| 13.80 | 0.0426 | 0.09 | Q | . | . | . | . |
| 13.90 | 0.0433 | 0.09 | Q | . | . | . | . |
| 14.01 | 0.0441 | 0.09 | Q | . | . | . | . |
| 14.11 | 0.0449 | 0.09 | Q | . | . | . | . |
| 14.22 | 0.0457 | 0.10 | Q | . | . | . | . |
| 14.32 | 0.0466 | 0.10 | Q | . | . | . | . |
| 14.43 | 0.0474 | 0.10 | Q | . | . | . | . |
| 14.53 | 0.0483 | 0.10 | Q | . | . | . | . |
| 14.63 | 0.0492 | 0.11 | Q | . | . | . | . |
| 14.74 | 0.0502 | 0.11 | Q | . | . | . | . |
| 14.85 | 0.0512 | 0.12 | Q | . | . | . | . |
| 14.95 | 0.0522 | 0.12 | Q | . | . | . | . |
| 15.05 | 0.0533 | 0.13 | Q | . | . | . | . |
| 15.16 | 0.0544 | 0.13 | Q | . | . | . | . |
| 15.27 | 0.0556 | 0.14 | Q | . | . | . | . |
| 15.37 | 0.0569 | 0.15 | Q | . | . | . | . |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 15.48 | 0.0581 | 0.13 | Q | | . | . | . | . |
| 15.58 | 0.0593 | 0.14 | Q | | . | . | . | . |
| 15.68 | 0.0606 | 0.17 | Q | | . | . | . | . |
| 15.79 | 0.0622 | 0.19 | Q | | . | . | . | . |
| 15.90 | 0.0643 | 0.28 | .Q | | . | . | . | . |
| 16.00 | 0.0673 | 0.41 | .Q | | . | . | . | . |
| 16.10 | 0.0751 | 1.39 | . | Q | . | . | . | . |
| 16.21 | 0.0820 | 0.22 | Q | | . | . | . | . |
| 16.32 | 0.0837 | 0.15 | Q | | . | . | . | . |
| 16.42 | 0.0850 | 0.14 | Q | | . | . | . | . |
| 16.52 | 0.0862 | 0.14 | Q | | . | . | . | . |
| 16.63 | 0.0873 | 0.12 | Q | | . | . | . | . |
| 16.73 | 0.0883 | 0.11 | Q | | . | . | . | . |
| 16.84 | 0.0893 | 0.11 | Q | | . | . | . | . |
| 16.94 | 0.0902 | 0.10 | Q | | . | . | . | . |
| 17.05 | 0.0910 | 0.09 | Q | | . | . | . | . |
| 17.16 | 0.0918 | 0.09 | Q | | . | . | . | . |
| 17.26 | 0.0926 | 0.09 | Q | | . | . | . | . |
| 17.36 | 0.0933 | 0.08 | Q | | . | . | . | . |
| 17.47 | 0.0940 | 0.08 | Q | | . | . | . | . |
| 17.58 | 0.0947 | 0.08 | Q | | . | . | . | . |
| 17.68 | 0.0953 | 0.07 | Q | | . | . | . | . |
| 17.78 | 0.0959 | 0.07 | Q | | . | . | . | . |
| 17.89 | 0.0965 | 0.07 | Q | | . | . | . | . |
| 17.99 | 0.0971 | 0.07 | Q | | . | . | . | . |
| 18.10 | 0.0977 | 0.05 | Q | | . | . | . | . |
| 18.20 | 0.0981 | 0.05 | Q | | . | . | . | . |
| 18.31 | 0.0985 | 0.05 | Q | | . | . | . | . |
| 18.42 | 0.0990 | 0.05 | Q | | . | . | . | . |
| 18.52 | 0.0994 | 0.05 | Q | | . | . | . | . |
| 18.62 | 0.0998 | 0.05 | Q | | . | . | . | . |
| 18.73 | 0.1002 | 0.04 | Q | | . | . | . | . |
| 18.83 | 0.1005 | 0.04 | Q | | . | . | . | . |
| 18.94 | 0.1009 | 0.04 | Q | | . | . | . | . |
| 19.05 | 0.1013 | 0.04 | Q | | . | . | . | . |
| 19.15 | 0.1016 | 0.04 | Q | | . | . | . | . |
| 19.26 | 0.1020 | 0.04 | Q | | . | . | . | . |
| 19.36 | 0.1023 | 0.04 | Q | | . | . | . | . |
| 19.47 | 0.1026 | 0.04 | Q | | . | . | . | . |
| 19.57 | 0.1030 | 0.04 | Q | | . | . | . | . |
| 19.67 | 0.1033 | 0.04 | Q | | . | . | . | . |
| 19.78 | 0.1036 | 0.04 | Q | | . | . | . | . |
| 19.89 | 0.1039 | 0.04 | Q | | . | . | . | . |
| 19.99 | 0.1042 | 0.03 | Q | | . | . | . | . |
| 20.09 | 0.1045 | 0.03 | Q | | . | . | . | . |
| 20.20 | 0.1048 | 0.03 | Q | | . | . | . | . |
| 20.31 | 0.1051 | 0.03 | Q | | . | . | . | . |
| 20.41 | 0.1054 | 0.03 | Q | | . | . | . | . |
| 20.52 | 0.1057 | 0.03 | Q | | . | . | . | . |
| 20.62 | 0.1060 | 0.03 | Q | | . | . | . | . |
| 20.73 | 0.1062 | 0.03 | Q | | . | . | . | . |
| 20.83 | 0.1065 | 0.03 | Q | | . | . | . | . |
| 20.93 | 0.1068 | 0.03 | Q | | . | . | . | . |
| 21.04 | 0.1070 | 0.03 | Q | | . | . | . | . |
| 21.14 | 0.1073 | 0.03 | Q | | . | . | . | . |
| 21.25 | 0.1076 | 0.03 | Q | | . | . | . | . |
| 21.36 | 0.1078 | 0.03 | Q | | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 21.46 | 0.1081 | 0.03 | Q | . | . | . | . |
| 21.57 | 0.1083 | 0.03 | Q | . | . | . | . |
| 21.67 | 0.1086 | 0.03 | Q | . | . | . | . |
| 21.77 | 0.1088 | 0.03 | Q | . | . | . | . |
| 21.88 | 0.1091 | 0.03 | Q | . | . | . | . |
| 21.98 | 0.1093 | 0.03 | Q | . | . | . | . |
| 22.09 | 0.1095 | 0.03 | Q | . | . | . | . |
| 22.19 | 0.1098 | 0.03 | Q | . | . | . | . |
| 22.30 | 0.1100 | 0.03 | Q | . | . | . | . |
| 22.41 | 0.1102 | 0.03 | Q | . | . | . | . |
| 22.51 | 0.1105 | 0.03 | Q | . | . | . | . |
| 22.61 | 0.1107 | 0.03 | Q | . | . | . | . |
| 22.72 | 0.1109 | 0.03 | Q | . | . | . | . |
| 22.83 | 0.1111 | 0.03 | Q | . | . | . | . |
| 22.93 | 0.1113 | 0.03 | Q | . | . | . | . |
| 23.03 | 0.1116 | 0.02 | Q | . | . | . | . |
| 23.14 | 0.1118 | 0.02 | Q | . | . | . | . |
| 23.25 | 0.1120 | 0.02 | Q | . | . | . | . |
| 23.35 | 0.1122 | 0.02 | Q | . | . | . | . |
| 23.45 | 0.1124 | 0.02 | Q | . | . | . | . |
| 23.56 | 0.1126 | 0.02 | Q | . | . | . | . |
| 23.67 | 0.1128 | 0.02 | Q | . | . | . | . |
| 23.77 | 0.1130 | 0.02 | Q | . | . | . | . |
| 23.88 | 0.1132 | 0.02 | Q | . | . | . | . |
| 23.98 | 0.1134 | 0.02 | Q | . | . | . | . |
| 24.08 | 0.1136 | 0.02 | Q | . | . | . | . |
| 24.19 | 0.1137 | 0.00 | Q | . | . | . | . |

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1442.7 |
| 10% | 69.3 |
| 20% | 18.9 |
| 30% | 6.3 |
| 40% | 6.3 |
| 50% | 6.3 |
| 60% | 6.3 |
| 70% | 6.3 |
| 80% | 6.3 |
| 90% | 6.3 |

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SMALL AREA UNIT HYDROGRAPH MODEL

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Ver. 17.0 Release Date: 07/01/2010 License ID 1584

Analysis prepared by:

ENCOMPASS ASSOCIATES, INC.

5699 COUSINS PLACE
RANCHO CUCAMONGA CA 91737
www.encompasscivil.com

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Problem Descriptions:

wq Post East Bypass 5yr
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RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 0.70
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.080
LOW LOSS FRACTION = 0.152
TIME OF CONCENTRATION(MIN.) = 6.30
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 5
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.28
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.57
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.75
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.31
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.86
24-HOUR POINT RAINFALL VALUE(INCHES) = 3.49

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TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.16
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.05

**********

| TIME (HOURS) | VOLUME (AF) | Q (CFS) | 0. | 2.5 | 5.0 | 7.5 | 10.0 |
|---|---|---|---|---|---|---|---|
| 0.04 | 0.0000 | 0.00 | Q | . | . | . | . |
| 0.14 | 0.0002 | 0.04 | Q | . | . | . | . |
| 0.25 | 0.0005 | 0.04 | Q | . | . | . | . |
| 0.35 | 0.0008 | 0.04 | Q | . | . | . | . |
| 0.46 | 0.0011 | 0.04 | Q | . | . | . | . |
| 0.56 | 0.0014 | 0.04 | Q | . | . | . | . |
| 0.67 | 0.0017 | 0.04 | Q | . | . | . | . |
| 0.77 | 0.0020 | 0.04 | Q | . | . | . | . |
| 0.88 | 0.0023 | 0.04 | Q | . | . | . | . |
| 0.98 | 0.0026 | 0.04 | Q | . | . | . | . |
| 1.09 | 0.0030 | 0.04 | Q | . | . | . | . |
| 1.19 | 0.0033 | 0.04 | Q | . | . | . | . |
| 1.30 | 0.0036 | 0.04 | Q | . | . | . | . |
| 1.40 | 0.0039 | 0.04 | Q | . | . | . | . |
| 1.51 | 0.0042 | 0.04 | Q | . | . | . | . |
| 1.61 | 0.0046 | 0.04 | Q | . | . | . | . |
| 1.72 | 0.0049 | 0.04 | Q | . | . | . | . |
| 1.82 | 0.0052 | 0.04 | Q | . | . | . | . |
| 1.93 | 0.0055 | 0.04 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.03 | 0.0059 | 0.04 | Q | . | . | . | . |
| 2.14 | 0.0062 | 0.04 | Q | . | . | . | . |
| 2.24 | 0.0065 | 0.04 | Q | . | . | . | . |
| 2.35 | 0.0069 | 0.04 | Q | . | . | . | . |
| 2.45 | 0.0072 | 0.04 | Q | . | . | . | . |
| 2.56 | 0.0075 | 0.04 | Q | . | . | . | . |
| 2.66 | 0.0079 | 0.04 | Q | . | . | . | . |
| 2.77 | 0.0082 | 0.04 | Q | . | . | . | . |
| 2.87 | 0.0085 | 0.04 | Q | . | . | . | . |
| 2.98 | 0.0089 | 0.04 | Q | . | . | . | . |
| 3.08 | 0.0092 | 0.04 | Q | . | . | . | . |
| 3.19 | 0.0096 | 0.04 | Q | . | . | . | . |
| 3.29 | 0.0099 | 0.04 | Q | . | . | . | . |
| 3.40 | 0.0103 | 0.04 | Q | . | . | . | . |
| 3.50 | 0.0106 | 0.04 | Q | . | . | . | . |
| 3.61 | 0.0110 | 0.04 | Q | . | . | . | . |
| 3.71 | 0.0113 | 0.04 | Q | . | . | . | . |
| 3.82 | 0.0117 | 0.04 | Q | . | . | . | . |
| 3.92 | 0.0120 | 0.04 | Q | . | . | . | . |
| 4.03 | 0.0124 | 0.04 | Q | . | . | . | . |
| 4.13 | 0.0127 | 0.04 | Q | . | . | . | . |
| 4.24 | 0.0131 | 0.04 | Q | . | . | . | . |
| 4.34 | 0.0134 | 0.04 | Q | . | . | . | . |
| 4.45 | 0.0138 | 0.04 | Q | . | . | . | . |
| 4.55 | 0.0142 | 0.04 | Q | . | . | . | . |
| 4.66 | 0.0145 | 0.04 | Q | . | . | . | . |
| 4.76 | 0.0149 | 0.04 | Q | . | . | . | . |
| 4.87 | 0.0153 | 0.04 | Q | . | . | . | . |
| 4.97 | 0.0157 | 0.04 | Q | . | . | . | . |
| 5.08 | 0.0160 | 0.04 | Q | . | . | . | . |
| 5.18 | 0.0164 | 0.04 | Q | . | . | . | . |
| 5.29 | 0.0168 | 0.04 | Q | . | . | . | . |
| 5.39 | 0.0172 | 0.04 | Q | . | . | . | . |
| 5.50 | 0.0175 | 0.04 | Q | . | . | . | . |
| 5.61 | 0.0179 | 0.04 | Q | . | . | . | . |
| 5.71 | 0.0183 | 0.04 | Q | . | . | . | . |
| 5.82 | 0.0187 | 0.04 | Q | . | . | . | . |
| 5.92 | 0.0191 | 0.05 | Q | . | . | . | . |
| 6.02 | 0.0195 | 0.05 | Q | . | . | . | . |
| 6.13 | 0.0199 | 0.05 | Q | . | . | . | . |
| 6.23 | 0.0203 | 0.05 | Q | . | . | . | . |
| 6.34 | 0.0207 | 0.05 | Q | . | . | . | . |
| 6.44 | 0.0211 | 0.05 | Q | . | . | . | . |
| 6.55 | 0.0215 | 0.05 | Q | . | . | . | . |
| 6.65 | 0.0219 | 0.05 | Q | . | . | . | . |
| 6.76 | 0.0223 | 0.05 | Q | . | . | . | . |
| 6.86 | 0.0227 | 0.05 | Q | . | . | . | . |
| 6.97 | 0.0231 | 0.05 | Q | . | . | . | . |
| 7.07 | 0.0235 | 0.05 | Q | . | . | . | . |
| 7.18 | 0.0240 | 0.05 | Q | . | . | . | . |
| 7.28 | 0.0244 | 0.05 | Q | . | . | . | . |
| 7.39 | 0.0248 | 0.05 | Q | . | . | . | . |
| 7.49 | 0.0252 | 0.05 | Q | . | . | . | . |
| 7.60 | 0.0257 | 0.05 | Q | . | . | . | . |
| 7.70 | 0.0261 | 0.05 | Q | . | . | . | . |
| 7.81 | 0.0265 | 0.05 | Q | . | . | . | . |
| 7.91 | 0.0270 | 0.05 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 8.02 | 0.0274 | 0.05 | Q | . | . | . | . |
| 8.12 | 0.0279 | 0.05 | Q | . | . | . | . |
| 8.23 | 0.0283 | 0.05 | Q | . | . | . | . |
| 8.34 | 0.0288 | 0.05 | Q | . | . | . | . |
| 8.44 | 0.0292 | 0.05 | Q | . | . | . | . |
| 8.55 | 0.0297 | 0.05 | Q | . | . | . | . |
| 8.65 | 0.0302 | 0.05 | Q | . | . | . | . |
| 8.76 | 0.0306 | 0.05 | Q | . | . | . | . |
| 8.86 | 0.0311 | 0.05 | Q | . | . | . | . |
| 8.96 | 0.0316 | 0.05 | Q | . | . | . | . |
| 9.07 | 0.0320 | 0.06 | Q | . | . | . | . |
| 9.18 | 0.0325 | 0.06 | Q | . | . | . | . |
| 9.28 | 0.0330 | 0.06 | Q | . | . | . | . |
| 9.38 | 0.0335 | 0.06 | Q | . | . | . | . |
| 9.49 | 0.0340 | 0.06 | Q | . | . | . | . |
| 9.60 | 0.0345 | 0.06 | Q | . | . | . | . |
| 9.70 | 0.0350 | 0.06 | Q | . | . | . | . |
| 9.80 | 0.0355 | 0.06 | Q | . | . | . | . |
| 9.91 | 0.0360 | 0.06 | Q | . | . | . | . |
| 10.01 | 0.0365 | 0.06 | Q | . | . | . | . |
| 10.12 | 0.0371 | 0.06 | Q | . | . | . | . |
| 10.23 | 0.0376 | 0.06 | Q | . | . | . | . |
| 10.33 | 0.0381 | 0.06 | Q | . | . | . | . |
| 10.43 | 0.0387 | 0.06 | Q | . | . | . | . |
| 10.54 | 0.0392 | 0.06 | Q | . | . | . | . |
| 10.65 | 0.0398 | 0.06 | Q | . | . | . | . |
| 10.75 | 0.0403 | 0.06 | Q | . | . | . | . |
| 10.85 | 0.0409 | 0.07 | Q | . | . | . | . |
| 10.96 | 0.0414 | 0.07 | Q | . | . | . | . |
| 11.06 | 0.0420 | 0.07 | Q | . | . | . | . |
| 11.17 | 0.0426 | 0.07 | Q | . | . | . | . |
| 11.27 | 0.0432 | 0.07 | Q | . | . | . | . |
| 11.38 | 0.0438 | 0.07 | Q | . | . | . | . |
| 11.48 | 0.0444 | 0.07 | Q | . | . | . | . |
| 11.59 | 0.0450 | 0.07 | Q | . | . | . | . |
| 11.70 | 0.0456 | 0.07 | Q | . | . | . | . |
| 11.80 | 0.0462 | 0.07 | Q | . | . | . | . |
| 11.90 | 0.0468 | 0.07 | Q | . | . | . | . |
| 12.01 | 0.0475 | 0.07 | Q | . | . | . | . |
| 12.11 | 0.0482 | 0.08 | Q | . | . | . | . |
| 12.22 | 0.0489 | 0.09 | Q | . | . | . | . |
| 12.32 | 0.0497 | 0.09 | Q | . | . | . | . |
| 12.43 | 0.0504 | 0.09 | Q | . | . | . | . |
| 12.53 | 0.0512 | 0.09 | Q | . | . | . | . |
| 12.64 | 0.0520 | 0.09 | Q | . | . | . | . |
| 12.74 | 0.0527 | 0.09 | Q | . | . | . | . |
| 12.85 | 0.0535 | 0.09 | Q | . | . | . | . |
| 12.95 | 0.0544 | 0.09 | Q | . | . | . | . |
| 13.06 | 0.0552 | 0.10 | Q | . | . | . | . |
| 13.16 | 0.0560 | 0.10 | Q | . | . | . | . |
| 13.27 | 0.0569 | 0.10 | Q | . | . | . | . |
| 13.38 | 0.0578 | 0.10 | Q | . | . | . | . |
| 13.48 | 0.0587 | 0.10 | Q | . | . | . | . |
| 13.59 | 0.0596 | 0.11 | Q | . | . | . | . |
| 13.69 | 0.0605 | 0.11 | Q | . | . | . | . |
| 13.80 | 0.0614 | 0.11 | Q | . | . | . | . |
| 13.90 | 0.0624 | 0.11 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14.01 | 0.0634 | 0.12 | Q | . | . | . | . |
| 14.11 | 0.0644 | 0.12 | Q | . | . | . | . |
| 14.22 | 0.0655 | 0.12 | Q | . | . | . | . |
| 14.32 | 0.0665 | 0.12 | Q | . | . | . | . |
| 14.43 | 0.0677 | 0.13 | Q | . | . | . | . |
| 14.53 | 0.0688 | 0.13 | Q | . | . | . | . |
| 14.63 | 0.0700 | 0.14 | Q | . | . | . | . |
| 14.74 | 0.0712 | 0.14 | Q | . | . | . | . |
| 14.85 | 0.0725 | 0.15 | Q | . | . | . | . |
| 14.95 | 0.0738 | 0.15 | Q | . | . | . | . |
| 15.05 | 0.0752 | 0.17 | Q | . | . | . | . |
| 15.16 | 0.0766 | 0.17 | Q | . | . | . | . |
| 15.27 | 0.0782 | 0.19 | Q | . | . | . | . |
| 15.37 | 0.0798 | 0.19 | Q | . | . | . | . |
| 15.48 | 0.0814 | 0.17 | Q | . | . | . | . |
| 15.58 | 0.0830 | 0.19 | Q | . | . | . | . |
| 15.68 | 0.0847 | 0.22 | Q | . | . | . | . |
| 15.79 | 0.0868 | 0.25 | .Q | . | . | . | . |
| 15.90 | 0.0895 | 0.37 | .Q | . | . | . | . |
| 16.00 | 0.0934 | 0.53 | . Q | . | . | . | . |
| 16.10 | 0.1035 | 1.78 | . | Q . | . | . | . |
| 16.21 | 0.1125 | 0.30 | .Q | . | . | . | . |
| 16.32 | 0.1146 | 0.20 | Q | . | . | . | . |
| 16.42 | 0.1163 | 0.18 | Q | . | . | . | . |
| 16.52 | 0.1178 | 0.18 | Q | . | . | . | . |
| 16.63 | 0.1193 | 0.16 | Q | . | . | . | . |
| 16.73 | 0.1206 | 0.15 | Q | . | . | . | . |
| 16.84 | 0.1218 | 0.14 | Q | . | . | . | . |
| 16.94 | 0.1230 | 0.13 | Q | . | . | . | . |
| 17.05 | 0.1241 | 0.12 | Q | . | . | . | . |
| 17.16 | 0.1251 | 0.11 | Q | . | . | . | . |
| 17.26 | 0.1261 | 0.11 | Q | . | . | . | . |
| 17.36 | 0.1270 | 0.10 | Q | . | . | . | . |
| 17.47 | 0.1279 | 0.10 | Q | . | . | . | . |
| 17.58 | 0.1287 | 0.10 | Q | . | . | . | . |
| 17.68 | 0.1296 | 0.09 | Q | . | . | . | . |
| 17.78 | 0.1304 | 0.09 | Q | . | . | . | . |
| 17.89 | 0.1311 | 0.09 | Q | . | . | . | . |
| 17.99 | 0.1319 | 0.09 | Q | . | . | . | . |
| 18.10 | 0.1326 | 0.08 | Q | . | . | . | . |
| 18.20 | 0.1332 | 0.07 | Q | . | . | . | . |
| 18.31 | 0.1339 | 0.07 | Q | . | . | . | . |
| 18.42 | 0.1345 | 0.07 | Q | . | . | . | . |
| 18.52 | 0.1351 | 0.07 | Q | . | . | . | . |
| 18.62 | 0.1357 | 0.07 | Q | . | . | . | . |
| 18.73 | 0.1362 | 0.06 | Q | . | . | . | . |
| 18.83 | 0.1368 | 0.06 | Q | . | . | . | . |
| 18.94 | 0.1373 | 0.06 | Q | . | . | . | . |
| 19.05 | 0.1379 | 0.06 | Q | . | . | . | . |
| 19.15 | 0.1384 | 0.06 | Q | . | . | . | . |
| 19.26 | 0.1389 | 0.06 | Q | . | . | . | . |
| 19.36 | 0.1394 | 0.06 | Q | . | . | . | . |
| 19.47 | 0.1399 | 0.06 | Q | . | . | . | . |
| 19.57 | 0.1404 | 0.06 | Q | . | . | . | . |
| 19.67 | 0.1408 | 0.05 | Q | . | . | . | . |
| 19.78 | 0.1413 | 0.05 | Q | . | . | . | . |
| 19.89 | 0.1418 | 0.05 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19.99 | 0.1422 | 0.05 | Q | . | . | . | . |
| 20.09 | 0.1427 | 0.05 | Q | . | . | . | . |
| 20.20 | 0.1431 | 0.05 | Q | . | . | . | . |
| 20.31 | 0.1436 | 0.05 | Q | . | . | . | . |
| 20.41 | 0.1440 | 0.05 | Q | . | . | . | . |
| 20.52 | 0.1444 | 0.05 | Q | . | . | . | . |
| 20.62 | 0.1448 | 0.05 | Q | . | . | . | . |
| 20.73 | 0.1453 | 0.05 | Q | . | . | . | . |
| 20.83 | 0.1457 | 0.05 | Q | . | . | . | . |
| 20.93 | 0.1461 | 0.05 | Q | . | . | . | . |
| 21.04 | 0.1465 | 0.05 | Q | . | . | . | . |
| 21.14 | 0.1469 | 0.05 | Q | . | . | . | . |
| 21.25 | 0.1473 | 0.04 | Q | . | . | . | . |
| 21.36 | 0.1476 | 0.04 | Q | . | . | . | . |
| 21.46 | 0.1480 | 0.04 | Q | . | . | . | . |
| 21.57 | 0.1484 | 0.04 | Q | . | . | . | . |
| 21.67 | 0.1488 | 0.04 | Q | . | . | . | . |
| 21.77 | 0.1492 | 0.04 | Q | . | . | . | . |
| 21.88 | 0.1495 | 0.04 | Q | . | . | . | . |
| 21.98 | 0.1499 | 0.04 | Q | . | . | . | . |
| 22.09 | 0.1502 | 0.04 | Q | . | . | . | . |
| 22.19 | 0.1506 | 0.04 | Q | . | . | . | . |
| 22.30 | 0.1510 | 0.04 | Q | . | . | . | . |
| 22.41 | 0.1513 | 0.04 | Q | . | . | . | . |
| 22.51 | 0.1516 | 0.04 | Q | . | . | . | . |
| 22.61 | 0.1520 | 0.04 | Q | . | . | . | . |
| 22.72 | 0.1523 | 0.04 | Q | . | . | . | . |
| 22.83 | 0.1527 | 0.04 | Q | . | . | . | . |
| 22.93 | 0.1530 | 0.04 | Q | . | . | . | . |
| 23.03 | 0.1533 | 0.04 | Q | . | . | . | . |
| 23.14 | 0.1537 | 0.04 | Q | . | . | . | . |
| 23.25 | 0.1540 | 0.04 | Q | . | . | . | . |
| 23.35 | 0.1543 | 0.04 | Q | . | . | . | . |
| 23.45 | 0.1546 | 0.04 | Q | . | . | . | . |
| 23.56 | 0.1550 | 0.04 | Q | . | . | . | . |
| 23.67 | 0.1553 | 0.04 | Q | . | . | . | . |
| 23.77 | 0.1556 | 0.04 | Q | . | . | . | . |
| 23.88 | 0.1559 | 0.04 | Q | . | . | . | . |
| 23.98 | 0.1562 | 0.04 | Q | . | . | . | . |
| 24.08 | 0.1565 | 0.04 | Q | . | . | . | . |
| 24.19 | 0.1567 | 0.00 | Q | . | . | . | . |

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1442.7 |
| 10% | 75.6 |
| 20% | 18.9 |
| 30% | 12.6 |
| 40% | 6.3 |
| 50% | 6.3 |
| 60% | 6.3 |

| | |
|---|---|
| 70% | 6.3 |
| 80% | 6.3 |
| 90% | 6.3 |

```
****************************************************************************
                        SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                              Analysis prepared by:

                            ENCOMPASS ASSOCIATES, INC.
                                5699 COUSINS PLACE
                            RANCHO CUCAMONGA CA 91737
                              www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Post West Bypass 1yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     4.10
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.418
    TIME OF CONCENTRATION(MIN.) = 22.35
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93

----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.35
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.31

****************************************************************************
  TIME      VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)     (AF)      (CFS)
----------------------------------------------------------------------------
  0.35      0.0009      0.06  Q         .         .         .         .
  0.73      0.0028      0.06  Q         .         .         .         .
  1.10      0.0047      0.06  Q         .         .         .         .
  1.47      0.0066      0.06  Q         .         .         .         .
  1.84      0.0086      0.06  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 2.22 | 0.0106 | 0.07 | Q | . | . | . | . |
| 2.59 | 0.0126 | 0.07 | Q | . | . | . | . |
| 2.96 | 0.0147 | 0.07 | Q | . | . | . | . |
| 3.33 | 0.0168 | 0.07 | Q | . | . | . | . |
| 3.71 | 0.0190 | 0.07 | Q | . | . | . | . |
| 4.08 | 0.0211 | 0.07 | Q | . | . | . | . |
| 4.45 | 0.0234 | 0.07 | Q | . | . | . | . |
| 4.82 | 0.0256 | 0.07 | Q | . | . | . | . |
| 5.20 | 0.0280 | 0.08 | Q | . | . | . | . |
| 5.57 | 0.0304 | 0.08 | Q | . | . | . | . |
| 5.94 | 0.0328 | 0.08 | Q | . | . | . | . |
| 6.32 | 0.0353 | 0.08 | Q | . | . | . | . |
| 6.69 | 0.0378 | 0.08 | Q | . | . | . | . |
| 7.06 | 0.0404 | 0.09 | Q | . | . | . | . |
| 7.43 | 0.0431 | 0.09 | Q | . | . | . | . |
| 7.80 | 0.0459 | 0.09 | Q | . | . | . | . |
| 8.18 | 0.0487 | 0.09 | Q | . | . | . | . |
| 8.55 | 0.0517 | 0.10 | Q | . | . | . | . |
| 8.92 | 0.0547 | 0.10 | Q | . | . | . | . |
| 9.30 | 0.0578 | 0.10 | Q | . | . | . | . |
| 9.67 | 0.0610 | 0.11 | Q | . | . | . | . |
| 10.04 | 0.0644 | 0.11 | Q | . | . | . | . |
| 10.41 | 0.0679 | 0.12 | Q | . | . | . | . |
| 10.78 | 0.0715 | 0.12 | Q | . | . | . | . |
| 11.16 | 0.0753 | 0.13 | Q | . | . | . | . |
| 11.53 | 0.0793 | 0.13 | Q | . | . | . | . |
| 11.90 | 0.0834 | 0.14 | Q | . | . | . | . |
| 12.27 | 0.0880 | 0.15 | Q | . | . | . | . |
| 12.65 | 0.0940 | 0.24 | Q | . | . | . | . |
| 13.02 | 0.1015 | 0.25 | Q | . | . | . | . |
| 13.39 | 0.1093 | 0.26 | .Q | . | . | . | . |
| 13.77 | 0.1176 | 0.28 | .Q | . | . | . | . |
| 14.14 | 0.1266 | 0.31 | .Q | . | . | . | . |
| 14.51 | 0.1363 | 0.32 | .Q | . | . | . | . |
| 14.88 | 0.1470 | 0.37 | .Q | . | . | . | . |
| 15.26 | 0.1591 | 0.41 | .Q | . | . | . | . |
| 15.63 | 0.1725 | 0.46 | .Q | . | . | . | . |
| 16.00 | 0.1883 | 0.57 | . Q | . | . | . | . |
| 16.37 | 0.2295 | 2.11 | . | Q . | . | . | . |
| 16.75 | 0.2692 | 0.46 | .Q | . | . | . | . |
| 17.12 | 0.2816 | 0.35 | .Q | . | . | . | . |
| 17.49 | 0.2914 | 0.29 | .Q | . | . | . | . |
| 17.86 | 0.2998 | 0.25 | .Q | . | . | . | . |
| 18.23 | 0.3073 | 0.23 | Q | . | . | . | . |
| 18.61 | 0.3129 | 0.14 | Q | . | . | . | . |
| 18.98 | 0.3169 | 0.12 | Q | . | . | . | . |
| 19.35 | 0.3205 | 0.11 | Q | . | . | . | . |
| 19.73 | 0.3239 | 0.10 | Q | . | . | . | . |
| 20.10 | 0.3270 | 0.10 | Q | . | . | . | . |
| 20.47 | 0.3299 | 0.09 | Q | . | . | . | . |
| 20.84 | 0.3327 | 0.09 | Q | . | . | . | . |
| 21.22 | 0.3353 | 0.08 | Q | . | . | . | . |
| 21.59 | 0.3378 | 0.08 | Q | . | . | . | . |
| 21.96 | 0.3402 | 0.08 | Q | . | . | . | . |
| 22.33 | 0.3424 | 0.07 | Q | . | . | . | . |
| 22.70 | 0.3446 | 0.07 | Q | . | . | . | . |
| 23.08 | 0.3467 | 0.07 | Q | . | . | . | . |

```
 23.45      0.3488      0.06  Q          .          .          .          .
 23.82      0.3507      0.06  Q          .          .          .          .
 24.19      0.3526      0.06  Q          .          .          .          .
 24.57      0.3536      0.00  Q          .          .          .          .
----------------------------------------------------------------------------
----------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                Duration
       Peak Flow Rate                     (minutes)
   =======================                =========
             0%                            1452.8
            10%                             357.6
            20%                              89.4
            30%                              22.4
            40%                              22.4
            50%                              22.4
            60%                              22.4
            70%                              22.4
            80%                              22.4
            90%                              22.4

----------------------------------------------------------------------------
****************************************************************************
                      SMALL AREA UNIT HYDROGRAPH MODEL
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
                            5699 COUSINS PLACE
                        RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Post West Bypass 2yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     4.10
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.391
    TIME OF CONCENTRATION(MIN.) = 22.44
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
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30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
 1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
 3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
 6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

--------------------------------------------------------------------------------

TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.50
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.39

********************************************************************************
 TIME     VOLUME       Q    0.        2.5       5.0       7.5      10.0
(HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------------
 0.29     0.0015      0.10  Q         .         .         .         .
 0.67     0.0046      0.10  Q         .         .         .         .
 1.04     0.0077      0.10  Q         .         .         .         .
 1.41     0.0109      0.10  Q         .         .         .         .
 1.79     0.0141      0.10  Q         .         .         .         .
 2.16     0.0174      0.11  Q         .         .         .         .
 2.54     0.0207      0.11  Q         .         .         .         .
 2.91     0.0241      0.11  Q         .         .         .         .
 3.28     0.0275      0.11  Q         .         .         .         .
 3.66     0.0310      0.11  Q         .         .         .         .
 4.03     0.0345      0.12  Q         .         .         .         .
 4.41     0.0381      0.12  Q         .         .         .         .
 4.78     0.0418      0.12  Q         .         .         .         .
 5.15     0.0456      0.12  Q         .         .         .         .
 5.53     0.0494      0.12  Q         .         .         .         .
 5.90     0.0533      0.13  Q         .         .         .         .
 6.28     0.0573      0.13  Q         .         .         .         .
 6.65     0.0614      0.13  Q         .         .         .         .
 7.02     0.0656      0.14  Q         .         .         .         .
 7.40     0.0698      0.14  Q         .         .         .         .
 7.77     0.0742      0.14  Q         .         .         .         .
 8.15     0.0787      0.15  Q         .         .         .         .
 8.52     0.0833      0.15  Q         .         .         .         .
 8.89     0.0881      0.16  Q         .         .         .         .
 9.27     0.0930      0.16  Q         .         .         .         .
 9.64     0.0981      0.17  Q         .         .         .         .
10.02     0.1033      0.17  Q         .         .         .         .
10.39     0.1087      0.18  Q         .         .         .         .
10.76     0.1143      0.18  Q         .         .         .         .
11.14     0.1202      0.19  Q         .         .         .         .
11.51     0.1263      0.20  Q         .         .         .         .
11.89     0.1327      0.21  Q         .         .         .         .
12.26     0.1395      0.22  Q         .         .         .         .
12.63     0.1476      0.30  .Q        .         .         .         .
13.01     0.1570      0.31  .Q        .         .         .         .
13.38     0.1669      0.33  .Q        .         .         .         .
13.76     0.1775      0.35  .Q        .         .         .         .
14.13     0.1889      0.39  .Q        .         .         .         .
14.50     0.2013      0.41  .Q        .         .         .         .
14.88     0.2150      0.48  .Q        .         .         .         .
15.25     0.2306      0.53  . Q       .         .         .         .
15.63     0.2482      0.60  . Q       .         .         .         .
```

```
16.00      0.2693      0.76  .  Q      .         .         .         .
16.37      0.3270      2.97  .         .Q        .         .         .
16.75      0.3821      0.60  . Q       .         .         .         .
17.12      0.3982      0.44  .Q        .         .         .         .
17.50      0.4107      0.37  .Q        .         .         .         .
17.87      0.4213      0.32  .Q        .         .         .         .
18.24      0.4308      0.29  .Q        .         .         .         .
18.62      0.4385      0.21  Q         .         .         .         .
18.99      0.4446      0.19  Q         .         .         .         .
19.37      0.4502      0.18  Q         .         .         .         .
19.74      0.4555      0.16  Q         .         .         .         .
20.11      0.4604      0.15  Q         .         .         .         .
20.49      0.4650      0.15  Q         .         .         .         .
20.86      0.4694      0.14  Q         .         .         .         .
21.24      0.4736      0.13  Q         .         .         .         .
21.61      0.4775      0.13  Q         .         .         .         .
21.98      0.4814      0.12  Q         .         .         .         .
22.36      0.4851      0.12  Q         .         .         .         .
22.73      0.4886      0.11  Q         .         .         .         .
23.11      0.4920      0.11  Q         .         .         .         .
23.48      0.4953      0.11  Q         .         .         .         .
23.85      0.4986      0.10  Q         .         .         .         .
24.23      0.5017      0.10  Q         .         .         .         .
24.60      0.5032      0.00  Q         .         .         .         .
-------------------------------------------------------------------------
-----------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)
```

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1458.6 |
| 10% | 336.6 |
| 20% | 89.8 |
| 30% | 22.4 |
| 40% | 22.4 |
| 50% | 22.4 |
| 60% | 22.4 |
| 70% | 22.4 |
| 80% | 22.4 |
| 90% | 22.4 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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            Ver. 17.0  Release Date: 07/01/2010  License ID 1584

                          Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com
```

```
*******************************************************************************
-------------------------------------------------------------------------------

 Problem Descriptions:

  wq Post West Bypass 5yr
-------------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =    4.10
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.357
    TIME OF CONCENTRATION(MIN.) = 22.49
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   5
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

-------------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.71
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.48

*******************************************************************************
  TIME      VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)     (AF)      (CFS)
-------------------------------------------------------------------------------
  0.26      0.0024      0.16  Q         .         .         .         .
  0.63      0.0073      0.16  Q         .         .         .         .
  1.01      0.0122      0.16  Q         .         .         .         .
  1.38      0.0173      0.16  Q         .         .         .         .
  1.76      0.0223      0.16  Q         .         .         .         .
  2.13      0.0275      0.17  Q         .         .         .         .
  2.51      0.0327      0.17  Q         .         .         .         .
  2.88      0.0380      0.17  Q         .         .         .         .
  3.26      0.0434      0.17  Q         .         .         .         .
  3.63      0.0488      0.18  Q         .         .         .         .
  4.01      0.0544      0.18  Q         .         .         .         .
  4.38      0.0600      0.18  Q         .         .         .         .
  4.76      0.0658      0.19  Q         .         .         .         .
  5.13      0.0716      0.19  Q         .         .         .         .
  5.50      0.0776      0.19  Q         .         .         .         .
  5.88      0.0837      0.20  Q         .         .         .         .
  6.25      0.0898      0.20  Q         .         .         .         .
  6.63      0.0962      0.21  Q         .         .         .         .
  7.00      0.1026      0.21  Q         .         .         .         .
  7.38      0.1092      0.22  Q         .         .         .         .
  7.75      0.1160      0.22  Q         .         .         .         .
  8.13      0.1229      0.23  Q         .         .         .         .
```

```
  8.50      0.1300      0.23  Q         .         .         .         .
  8.88      0.1372      0.24  Q         .         .         .         .
  9.25      0.1447      0.24  Q         .         .         .         .
  9.63      0.1524      0.25  .Q        .         .         .         .
 10.00      0.1604      0.26  .Q        .         .         .         .
 10.38      0.1686      0.27  .Q        .         .         .         .
 10.75      0.1771      0.28  .Q        .         .         .         .
 11.13      0.1859      0.29  .Q        .         .         .         .
 11.50      0.1950      0.30  .Q        .         .         .         .
 11.88      0.2046      0.32  .Q        .         .         .         .
 12.25      0.2146      0.33  .Q        .         .         .         .
 12.63      0.2258      0.39  .Q        .         .         .         .
 13.00      0.2381      0.41  .Q        .         .         .         .
 13.38      0.2512      0.44  .Q        .         .         .         .
 13.75      0.2651      0.46  .Q        .         .         .         .
 14.13      0.2801      0.51  . Q       .         .         .         .
 14.50      0.2964      0.54  . Q       .         .         .         .
 14.88      0.3146      0.63  . Q       .         .         .         .
 15.25      0.3352      0.70  . Q       .         .         .         .
 15.63      0.3585      0.81  .  Q      .         .         .         .
 16.00      0.3869      1.02  .   Q     .         .         .         .
 16.37      0.4651      4.03  .         .     Q   .         .         .
 16.75      0.5398      0.79  .  Q      .         .         .         .
 17.12      0.5610      0.58  . Q       .         .         .         .
 17.50      0.5775      0.48  .Q        .         .         .         .
 17.87      0.5915      0.42  .Q        .         .         .         .
 18.25      0.6039      0.38  .Q        .         .         .         .
 18.62      0.6146      0.31  .Q        .         .         .         .
 19.00      0.6237      0.28  .Q        .         .         .         .
 19.37      0.6322      0.26  .Q        .         .         .         .
 19.75      0.6402      0.25  Q         .         .         .         .
 20.12      0.6477      0.23  Q         .         .         .         .
 20.50      0.6548      0.22  Q         .         .         .         .
 20.87      0.6615      0.21  Q         .         .         .         .
 21.25      0.6680      0.20  Q         .         .         .         .
 21.62      0.6742      0.20  Q         .         .         .         .
 22.00      0.6801      0.19  Q         .         .         .         .
 22.37      0.6859      0.18  Q         .         .         .         .
 22.75      0.6914      0.18  Q         .         .         .         .
 23.12      0.6968      0.17  Q         .         .         .         .
 23.50      0.7020      0.17  Q         .         .         .         .
 23.87      0.7071      0.16  Q         .         .         .         .
 24.25      0.7120      0.16  Q         .         .         .         .
 24.62      0.7145      0.00  Q         .         .         .         .
 ------------------------------------------------------------------------
-----------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                  Duration
       Peak Flow Rate                       (minutes)
   ======================                   =========
             0%                              1461.8
            10%                               314.9
            20%                                67.5
            30%                                22.5
```

| | |
|---|---|
| 40% | 22.5 |
| 50% | 22.5 |
| 60% | 22.5 |
| 70% | 22.5 |
| 80% | 22.5 |
| 90% | 22.5 |

```
****************************************************************************
                      SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                        ENCOMPASS ASSOCIATES, INC.
                            5699 COUSINS PLACE
                        RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin1 1yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =    5.00
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.418
    TIME OF CONCENTRATION(MIN.) = 21.67
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93

----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.43
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.37

****************************************************************************
  TIME      VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)     (AF)      (CFS)
----------------------------------------------------------------------------
  0.11      0.0000      0.00  Q         .         .         .         .
  0.47      0.0011      0.07  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0.83 | 0.0033 | 0.07 | Q | . | . | . | . |
| 1.19 | 0.0056 | 0.08 | Q | . | . | . | . |
| 1.55 | 0.0079 | 0.08 | Q | . | . | . | . |
| 1.91 | 0.0102 | 0.08 | Q | . | . | . | . |
| 2.28 | 0.0126 | 0.08 | Q | . | . | . | . |
| 2.64 | 0.0150 | 0.08 | Q | . | . | . | . |
| 3.00 | 0.0174 | 0.08 | Q | . | . | . | . |
| 3.36 | 0.0199 | 0.08 | Q | . | . | . | . |
| 3.72 | 0.0225 | 0.09 | Q | . | . | . | . |
| 4.08 | 0.0251 | 0.09 | Q | . | . | . | . |
| 4.44 | 0.0277 | 0.09 | Q | . | . | . | . |
| 4.80 | 0.0304 | 0.09 | Q | . | . | . | . |
| 5.16 | 0.0332 | 0.09 | Q | . | . | . | . |
| 5.53 | 0.0360 | 0.10 | Q | . | . | . | . |
| 5.89 | 0.0388 | 0.10 | Q | . | . | . | . |
| 6.25 | 0.0418 | 0.10 | Q | . | . | . | . |
| 6.61 | 0.0448 | 0.10 | Q | . | . | . | . |
| 6.97 | 0.0478 | 0.10 | Q | . | . | . | . |
| 7.33 | 0.0510 | 0.11 | Q | . | . | . | . |
| 7.69 | 0.0542 | 0.11 | Q | . | . | . | . |
| 8.05 | 0.0576 | 0.11 | Q | . | . | . | . |
| 8.42 | 0.0610 | 0.12 | Q | . | . | . | . |
| 8.78 | 0.0645 | 0.12 | Q | . | . | . | . |
| 9.14 | 0.0682 | 0.12 | Q | . | . | . | . |
| 9.50 | 0.0719 | 0.13 | Q | . | . | . | . |
| 9.86 | 0.0758 | 0.13 | Q | . | . | . | . |
| 10.22 | 0.0799 | 0.14 | Q | . | . | . | . |
| 10.58 | 0.0841 | 0.14 | Q | . | . | . | . |
| 10.94 | 0.0885 | 0.15 | Q | . | . | . | . |
| 11.30 | 0.0930 | 0.16 | Q | . | . | . | . |
| 11.67 | 0.0978 | 0.16 | Q | . | . | . | . |
| 12.03 | 0.1029 | 0.18 | Q | . | . | . | . |
| 12.39 | 0.1091 | 0.24 | Q | . | . | . | . |
| 12.75 | 0.1170 | 0.29 | .Q | . | . | . | . |
| 13.11 | 0.1260 | 0.30 | .Q | . | . | . | . |
| 13.47 | 0.1354 | 0.33 | .Q | . | . | . | . |
| 13.83 | 0.1454 | 0.34 | .Q | . | . | . | . |
| 14.19 | 0.1561 | 0.38 | .Q | . | . | . | . |
| 14.56 | 0.1677 | 0.40 | .Q | . | . | . | . |
| 14.92 | 0.1806 | 0.46 | .Q | . | . | . | . |
| 15.28 | 0.1951 | 0.51 | . Q | . | . | . | . |
| 15.64 | 0.2110 | 0.55 | . Q | . | . | . | . |
| 16.00 | 0.2298 | 0.71 | . Q | . | . | . | . |
| 16.36 | 0.2798 | 2.64 | . | Q | . | . | . |
| 16.72 | 0.3279 | 0.57 | . Q | . | . | . | . |
| 17.08 | 0.3428 | 0.43 | .Q | . | . | . | . |
| 17.44 | 0.3546 | 0.36 | .Q | . | . | . | . |
| 17.81 | 0.3646 | 0.31 | .Q | . | . | . | . |
| 18.17 | 0.3736 | 0.28 | .Q | . | . | . | . |
| 18.53 | 0.3803 | 0.17 | Q | . | . | . | . |
| 18.89 | 0.3851 | 0.15 | Q | . | . | . | . |
| 19.25 | 0.3895 | 0.14 | Q | . | . | . | . |
| 19.61 | 0.3936 | 0.13 | Q | . | . | . | . |
| 19.97 | 0.3973 | 0.12 | Q | . | . | . | . |
| 20.33 | 0.4009 | 0.11 | Q | . | . | . | . |
| 20.70 | 0.4042 | 0.11 | Q | . | . | . | . |
| 21.06 | 0.4074 | 0.10 | Q | . | . | . | . |

```
 21.42      0.4104      0.10  Q          .          .          .          .
 21.78      0.4132      0.09  Q          .          .          .          .
 22.14      0.4160      0.09  Q          .          .          .          .
 22.50      0.4186      0.09  Q          .          .          .          .
 22.86      0.4212      0.08  Q          .          .          .          .
 23.22      0.4236      0.08  Q          .          .          .          .
 23.58      0.4260      0.08  Q          .          .          .          .
 23.95      0.4283      0.08  Q          .          .          .          .
 24.31      0.4305      0.07  Q          .          .          .          .
 24.67      0.4316      0.00  Q          .          .          .          .
 ------------------------------------------------------------------------------
-------------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    =======================                  =========
              0%                              1451.9
             10%                               346.7
             20%                                86.7
             30%                                21.7
             40%                                21.7
             50%                                21.7
             60%                                21.7
             70%                                21.7
             80%                                21.7
             90%                                21.7

  Problem Descriptions:


   wq Basin1 1yr


===============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   21.670
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                 INFLOW
                   |
                   |
                   |
                   V                 __effective depth
             -------------           |   (and volume)
             |           |     |     |
             | detention |     |....V.............
             |   basin   |<-->|          outflow
             |           |     |.........________
```

```
             -------------    |          |   \
                   |          | storage |     basin outlet
                   V          -----------
                OUTFLOW
```

DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES = 9

| *BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) ** | **BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) * |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000** | 0.500 | 0.010 | 1.560* |
| 1.000 | 0.030 | 4.420** | 1.500 | 0.050 | 6.390* |
| 2.000 | 0.070 | 8.090** | 2.500 | 0.110 | 9.490* |
| 3.000 | 0.140 | 10.710** | 3.500 | 0.190 | 11.800* |
| 4.000 | 0.230 | 12.800** | | | |

---

BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:

| INTERVAL NUMBER | DEPTH (FEET) | {S-O*DT/2} (ACRE-FEET) | {S+O*DT/2} (ACRE-FEET) |
|---|---|---|---|
| 1 | 0.00 | 0.00000 | 0.00000 |
| 2 | 0.50 | -0.01328 | 0.03328 |
| 3 | 1.00 | -0.03597 | 0.09597 |
| 4 | 1.50 | -0.04537 | 0.14537 |
| 5 | 2.00 | -0.05074 | 0.19074 |
| 6 | 2.50 | -0.03163 | 0.25163 |
| 7 | 3.00 | -0.01984 | 0.29984 |
| 8 | 3.50 | 0.01389 | 0.36611 |
| 9 | 4.00 | 0.03897 | 0.42103 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

---

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.109 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 0.470 | 0.000 | 0.07 | 0.03 | 0.05 | 0.001 |
| 0.831 | 0.000 | 0.07 | 0.03 | 0.10 | 0.001 |
| 1.192 | 0.000 | 0.08 | 0.03 | 0.11 | 0.001 |
| 1.553 | 0.000 | 0.08 | 0.03 | 0.11 | 0.001 |
| 1.914 | 0.000 | 0.08 | 0.04 | 0.11 | 0.001 |
| 2.276 | 0.000 | 0.08 | 0.04 | 0.11 | 0.001 |
| 2.637 | 0.000 | 0.08 | 0.04 | 0.11 | 0.001 |
| 2.998 | 0.000 | 0.08 | 0.04 | 0.11 | 0.001 |
| 3.359 | 0.000 | 0.08 | 0.04 | 0.12 | 0.001 |
| 3.720 | 0.000 | 0.09 | 0.04 | 0.12 | 0.001 |
| 4.082 | 0.000 | 0.09 | 0.04 | 0.12 | 0.001 |
| 4.443 | 0.000 | 0.09 | 0.04 | 0.12 | 0.001 |
| 4.804 | 0.000 | 0.09 | 0.04 | 0.13 | 0.001 |
| 5.165 | 0.000 | 0.09 | 0.04 | 0.13 | 0.001 |
| 5.526 | 0.000 | 0.10 | 0.04 | 0.13 | 0.001 |
| 5.887 | 0.000 | 0.10 | 0.04 | 0.13 | 0.001 |
| 6.248 | 0.000 | 0.10 | 0.04 | 0.14 | 0.001 |
| 6.610 | 0.000 | 0.10 | 0.05 | 0.14 | 0.001 |

| | | | | | |
|---|---|---|---|---|---|
| 6.971 | 0.000 | 0.10 | 0.05 | 0.14 | 0.001 |
| 7.332 | 0.000 | 0.11 | 0.05 | 0.15 | 0.001 |
| 7.693 | 0.000 | 0.11 | 0.05 | 0.15 | 0.001 |
| 8.054 | 0.000 | 0.11 | 0.05 | 0.16 | 0.001 |
| 8.415 | 0.000 | 0.12 | 0.05 | 0.16 | 0.001 |
| 8.777 | 0.000 | 0.12 | 0.05 | 0.17 | 0.001 |
| 9.138 | 0.000 | 0.12 | 0.06 | 0.17 | 0.001 |
| 9.499 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 9.860 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 10.221 | 0.000 | 0.14 | 0.06 | 0.19 | 0.001 |
| 10.583 | 0.000 | 0.14 | 0.06 | 0.20 | 0.001 |
| 10.944 | 0.000 | 0.15 | 0.07 | 0.21 | 0.001 |
| 11.305 | 0.000 | 0.16 | 0.07 | 0.21 | 0.001 |
| 11.666 | 0.000 | 0.16 | 0.07 | 0.22 | 0.001 |
| 12.027 | 0.000 | 0.18 | 0.08 | 0.24 | 0.002 |
| 12.388 | 0.000 | 0.24 | 0.11 | 0.29 | 0.002 |
| 12.749 | 0.000 | 0.29 | 0.13 | 0.37 | 0.003 |
| 13.111 | 0.000 | 0.30 | 0.14 | 0.42 | 0.003 |
| 13.472 | 0.000 | 0.33 | 0.15 | 0.44 | 0.003 |
| 13.833 | 0.000 | 0.34 | 0.15 | 0.47 | 0.003 |
| 14.194 | 0.000 | 0.38 | 0.17 | 0.50 | 0.003 |
| 14.555 | 0.000 | 0.40 | 0.18 | 0.54 | 0.004 |
| 14.917 | 0.000 | 0.46 | 0.21 | 0.60 | 0.004 |
| 15.278 | 0.000 | 0.51 | 0.23 | 0.68 | 0.005 |
| 15.639 | 0.000 | 0.55 | 0.25 | 0.74 | 0.005 |
| 16.000 | 0.000 | 0.71 | 0.32 | 0.88 | 0.006 |
| 16.361 | 0.000 | 2.64 | 0.86 | 2.32 | 0.025 |
| 16.722 | 0.000 | 0.57 | 0.26 | 2.22 | 0.005 |
| 17.083 | 0.000 | 0.43 | 0.19 | 0.70 | 0.004 |
| 17.445 | 0.000 | 0.36 | 0.16 | 0.55 | 0.003 |
| 17.806 | 0.000 | 0.31 | 0.14 | 0.47 | 0.003 |
| 18.167 | 0.000 | 0.28 | 0.13 | 0.42 | 0.003 |
| 18.528 | 0.000 | 0.17 | 0.08 | 0.32 | 0.002 |
| 18.889 | 0.000 | 0.15 | 0.07 | 0.23 | 0.001 |
| 19.250 | 0.000 | 0.14 | 0.06 | 0.21 | 0.001 |
| 19.612 | 0.000 | 0.13 | 0.06 | 0.19 | 0.001 |
| 19.973 | 0.000 | 0.12 | 0.05 | 0.18 | 0.001 |
| 20.334 | 0.000 | 0.11 | 0.05 | 0.17 | 0.001 |
| 20.695 | 0.000 | 0.11 | 0.05 | 0.16 | 0.001 |
| 21.056 | 0.000 | 0.10 | 0.05 | 0.15 | 0.001 |
| 21.418 | 0.000 | 0.10 | 0.04 | 0.14 | 0.001 |
| 21.779 | 0.000 | 0.09 | 0.04 | 0.13 | 0.001 |
| 22.140 | 0.000 | 0.09 | 0.04 | 0.13 | 0.001 |
| 22.501 | 0.000 | 0.09 | 0.04 | 0.12 | 0.001 |
| 22.862 | 0.000 | 0.08 | 0.04 | 0.12 | 0.001 |
| 23.223 | 0.000 | 0.08 | 0.04 | 0.11 | 0.001 |
| 23.584 | 0.000 | 0.08 | 0.04 | 0.11 | 0.001 |
| 23.946 | 0.000 | 0.08 | 0.03 | 0.11 | 0.001 |
| 24.307 | 0.000 | 0.07 | 0.03 | 0.10 | 0.001 |
| 24.668 | 0.000 | 0.00 | 0.00 | 0.05 | 0.000 |

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SMALL AREA UNIT HYDROGRAPH MODEL

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Ver. 17.0 Release Date: 07/01/2010 License ID 1584

Analysis prepared by:

ENCOMPASS ASSOCIATES, INC.
5699 COUSINS PLACE
RANCHO CUCAMONGA CA 91737
www.encompasscivil.com

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*****************************************************************************
-----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin1 2yr
-----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     5.00
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.391
    TIME OF CONCENTRATION(MIN.) = 21.92
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

-----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.61
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.47

*****************************************************************************
  TIME      VOLUME       Q    0.        2.5       5.0       7.5       10.0
 (HOURS)     (AF)      (CFS)
-----------------------------------------------------------------------------
  0.29      0.0015      0.12  Q         .         .         .         .
  0.66      0.0051      0.12  Q         .         .         .         .
  1.02      0.0088      0.12  Q         .         .         .         .
  1.39      0.0126      0.13  Q         .         .         .         .
  1.75      0.0164      0.13  Q         .         .         .         .
  2.12      0.0203      0.13  Q         .         .         .         .
  2.48      0.0243      0.13  Q         .         .         .         .
  2.85      0.0283      0.13  Q         .         .         .         .
  3.21      0.0323      0.14  Q         .         .         .         .
  3.58      0.0365      0.14  Q         .         .         .         .
  3.94      0.0407      0.14  Q         .         .         .         .
  4.31      0.0450      0.14  Q         .         .         .         .
  4.67      0.0493      0.15  Q         .         .         .         .
  5.04      0.0538      0.15  Q         .         .         .         .
```

```
  5.41      0.0583      0.15  Q          .          .          .          .
  5.77      0.0629      0.15  Q          .          .          .          .
  6.14      0.0677      0.16  Q          .          .          .          .
  6.50      0.0725      0.16  Q          .          .          .          .
  6.87      0.0774      0.17  Q          .          .          .          .
  7.23      0.0825      0.17  Q          .          .          .          .
  7.60      0.0876      0.17  Q          .          .          .          .
  7.96      0.0929      0.18  Q          .          .          .          .
  8.33      0.0983      0.18  Q          .          .          .          .
  8.69      0.1039      0.19  Q          .          .          .          .
  9.06      0.1097      0.19  Q          .          .          .          .
  9.42      0.1156      0.20  Q          .          .          .          .
  9.79      0.1217      0.21  Q          .          .          .          .
 10.15      0.1280      0.21  Q          .          .          .          .
 10.52      0.1346      0.22  Q          .          .          .          .
 10.89      0.1414      0.23  Q          .          .          .          .
 11.25      0.1485      0.24  Q          .          .          .          .
 11.62      0.1558      0.25  Q          .          .          .          .
 11.98      0.1636      0.26  .Q         .          .          .          .
 12.35      0.1722      0.30  .Q         .          .          .          .
 12.71      0.1823      0.37  .Q         .          .          .          .
 13.08      0.1937      0.38  .Q         .          .          .          .
 13.44      0.2057      0.41  .Q         .          .          .          .
 13.81      0.2184      0.43  .Q         .          .          .          .
 14.17      0.2321      0.48  .Q         .          .          .          .
 14.54      0.2470      0.51  . Q        .          .          .          .
 14.90      0.2636      0.59  . Q        .          .          .          .
 15.27      0.2824      0.65  . Q        .          .          .          .
 15.63      0.3034      0.74  . Q        .          .          .          .
 16.00      0.3287      0.95  .  Q       .          .          .          .
 16.37      0.3987      3.69  .          .  Q       .          .          .
 16.73      0.4655      0.74  . Q        .          .          .          .
 17.10      0.4849      0.55  . Q        .          .          .          .
 17.46      0.5000      0.45  .Q         .          .          .          .
 17.83      0.5128      0.40  .Q         .          .          .          .
 18.19      0.5241      0.36  .Q         .          .          .          .
 18.56      0.5334      0.26  .Q         .          .          .          .
 18.92      0.5408      0.23  Q          .          .          .          .
 19.29      0.5476      0.22  Q          .          .          .          .
 19.65      0.5539      0.20  Q          .          .          .          .
 20.02      0.5599      0.19  Q          .          .          .          .
 20.38      0.5655      0.18  Q          .          .          .          .
 20.75      0.5707      0.17  Q          .          .          .          .
 21.11      0.5758      0.16  Q          .          .          .          .
 21.48      0.5806      0.16  Q          .          .          .          .
 21.85      0.5852      0.15  Q          .          .          .          .
 22.21      0.5897      0.14  Q          .          .          .          .
 22.58      0.5940      0.14  Q          .          .          .          .
 22.94      0.5981      0.13  Q          .          .          .          .
 23.31      0.6021      0.13  Q          .          .          .          .
 23.67      0.6060      0.13  Q          .          .          .          .
 24.04      0.6098      0.12  Q          .          .          .          .
 24.40      0.6116      0.00  Q          .          .          .          .
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
```

an instantaneous time duration)

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1446.7 |
| 10% | 306.9 |
| 20% | 65.8 |
| 30% | 21.9 |
| 40% | 21.9 |
| 50% | 21.9 |
| 60% | 21.9 |
| 70% | 21.9 |
| 80% | 21.9 |
| 90% | 21.9 |

Problem Descriptions:

wq Basin1 2yr

```
==============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   21.920
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                 INFLOW
                   |
                   |
                   |
                   V                 __effective depth
             -------------           |   (and volume)
             |           |     |     |
             | detention |     |....V.............
             |   basin   |<-->|          outflow
             |           |     |.........__________
             -------------     |         |   \
                   |           | storage |     basin outlet
                   V           -----------
                OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
     *   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
     *      0.000      0.000      0.000**      0.500      0.010      1.560*
     *      1.000      0.030      4.420**      1.500      0.050      6.390*
     *      2.000      0.070      8.090**      2.500      0.110      9.490*
     *      3.000      0.140     10.710**      3.500      0.190     11.800*
```

```
*      4.000      0.230     12.800**
-----------------------------------------------------------------------------
BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:
 INTERVAL   DEPTH   {S-O*DT/2}   {S+O*DT/2}
  NUMBER   (FEET)   (ACRE-FEET)  (ACRE-FEET)
      1     0.00       0.00000      0.00000
      2     0.50      -0.01355      0.03355
      3     1.00      -0.03673      0.09673
      4     1.50      -0.04647      0.14647
      5     2.00      -0.05213      0.19213
      6     2.50      -0.03327      0.25326
      7     3.00      -0.02168      0.30168
      8     3.50       0.01186      0.36814
      9     4.00       0.03677      0.42323
WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)
-----------------------------------------------------------------------------
DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES
      OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE
      AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.
```

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.291 | 0.000 | 0.12 | 0.05 | 0.08 | 0.001 |
| 0.656 | 0.000 | 0.12 | 0.05 | 0.17 | 0.001 |
| 1.021 | 0.000 | 0.12 | 0.06 | 0.17 | 0.001 |
| 1.387 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 1.752 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 2.117 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 2.483 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 2.848 | 0.000 | 0.13 | 0.06 | 0.19 | 0.001 |
| 3.213 | 0.000 | 0.14 | 0.06 | 0.19 | 0.001 |
| 3.579 | 0.000 | 0.14 | 0.06 | 0.19 | 0.001 |
| 3.944 | 0.000 | 0.14 | 0.06 | 0.20 | 0.001 |
| 4.309 | 0.000 | 0.14 | 0.06 | 0.20 | 0.001 |
| 4.675 | 0.000 | 0.15 | 0.07 | 0.20 | 0.001 |
| 5.040 | 0.000 | 0.15 | 0.07 | 0.21 | 0.001 |
| 5.405 | 0.000 | 0.15 | 0.07 | 0.21 | 0.001 |
| 5.771 | 0.000 | 0.15 | 0.07 | 0.21 | 0.001 |
| 6.136 | 0.000 | 0.16 | 0.07 | 0.22 | 0.001 |
| 6.501 | 0.000 | 0.16 | 0.07 | 0.22 | 0.001 |
| 6.867 | 0.000 | 0.17 | 0.07 | 0.23 | 0.001 |
| 7.232 | 0.000 | 0.17 | 0.08 | 0.23 | 0.002 |
| 7.597 | 0.000 | 0.17 | 0.08 | 0.24 | 0.002 |
| 7.963 | 0.000 | 0.18 | 0.08 | 0.25 | 0.002 |
| 8.328 | 0.000 | 0.18 | 0.08 | 0.25 | 0.002 |
| 8.693 | 0.000 | 0.19 | 0.08 | 0.26 | 0.002 |
| 9.059 | 0.000 | 0.19 | 0.09 | 0.27 | 0.002 |
| 9.424 | 0.000 | 0.20 | 0.09 | 0.28 | 0.002 |
| 9.789 | 0.000 | 0.21 | 0.09 | 0.28 | 0.002 |
| 10.155 | 0.000 | 0.21 | 0.10 | 0.29 | 0.002 |
| 10.520 | 0.000 | 0.22 | 0.10 | 0.30 | 0.002 |
| 10.885 | 0.000 | 0.23 | 0.10 | 0.32 | 0.002 |
| 11.251 | 0.000 | 0.24 | 0.11 | 0.33 | 0.002 |
| 11.616 | 0.000 | 0.25 | 0.11 | 0.34 | 0.002 |
| 11.981 | 0.000 | 0.26 | 0.12 | 0.36 | 0.002 |

| | | | | | |
|---|---|---|---|---|---|
| 12.347 | 0.000 | 0.30 | 0.14 | 0.40 | 0.003 |
| 12.712 | 0.000 | 0.37 | 0.17 | 0.47 | 0.003 |
| 13.077 | 0.000 | 0.38 | 0.17 | 0.53 | 0.003 |
| 13.443 | 0.000 | 0.41 | 0.19 | 0.56 | 0.004 |
| 13.808 | 0.000 | 0.43 | 0.19 | 0.59 | 0.004 |
| 14.173 | 0.000 | 0.48 | 0.22 | 0.64 | 0.004 |
| 14.539 | 0.000 | 0.51 | 0.23 | 0.69 | 0.005 |
| 14.904 | 0.000 | 0.59 | 0.27 | 0.77 | 0.005 |
| 15.269 | 0.000 | 0.65 | 0.29 | 0.87 | 0.006 |
| 15.635 | 0.000 | 0.74 | 0.33 | 0.97 | 0.007 |
| 16.000 | 0.000 | 0.95 | 0.43 | 1.18 | 0.009 |
| 16.365 | 0.000 | 3.69 | 1.15 | 3.16 | 0.036 |
| 16.731 | 0.000 | 0.74 | 0.33 | 3.02 | 0.007 |
| 17.096 | 0.000 | 0.55 | 0.25 | 0.90 | 0.005 |
| 17.461 | 0.000 | 0.45 | 0.20 | 0.70 | 0.004 |
| 17.827 | 0.000 | 0.40 | 0.18 | 0.60 | 0.004 |
| 18.192 | 0.000 | 0.36 | 0.16 | 0.53 | 0.003 |
| 18.557 | 0.000 | 0.26 | 0.12 | 0.43 | 0.002 |
| 18.923 | 0.000 | 0.23 | 0.11 | 0.34 | 0.002 |
| 19.288 | 0.000 | 0.22 | 0.10 | 0.32 | 0.002 |
| 19.653 | 0.000 | 0.20 | 0.09 | 0.29 | 0.002 |
| 20.019 | 0.000 | 0.19 | 0.09 | 0.28 | 0.002 |
| 20.384 | 0.000 | 0.18 | 0.08 | 0.26 | 0.002 |
| 20.749 | 0.000 | 0.17 | 0.08 | 0.25 | 0.002 |
| 21.115 | 0.000 | 0.16 | 0.07 | 0.23 | 0.001 |
| 21.480 | 0.000 | 0.16 | 0.07 | 0.22 | 0.001 |
| 21.845 | 0.000 | 0.15 | 0.07 | 0.22 | 0.001 |
| 22.211 | 0.000 | 0.14 | 0.07 | 0.21 | 0.001 |
| 22.576 | 0.000 | 0.14 | 0.06 | 0.20 | 0.001 |
| 22.941 | 0.000 | 0.13 | 0.06 | 0.19 | 0.001 |
| 23.307 | 0.000 | 0.13 | 0.06 | 0.19 | 0.001 |
| 23.672 | 0.000 | 0.13 | 0.06 | 0.18 | 0.001 |
| 24.037 | 0.000 | 0.12 | 0.06 | 0.18 | 0.001 |
| 24.403 | 0.000 | 0.00 | 0.00 | 0.09 | 0.000 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                         Analysis prepared by:

                      ENCOMPASS ASSOCIATES, INC.
                          5699 COUSINS PLACE
                      RANCHO CUCAMONGA CA 91737
                        www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin1 5yr
```

```
---------------------------------------------------------------------------

   RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
   TOTAL CATCHMENT AREA(ACRES) =    5.00
   SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
   LOW LOSS FRACTION = 0.357
   TIME OF CONCENTRATION(MIN.) = 21.38
   SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
   USER SPECIFIED RAINFALL VALUES ARE USED
   RETURN FREQUENCY(YEARS) =   5
      5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
     30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
      1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
      3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
      6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
     24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

---------------------------------------------------------------------------

   TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.87
   TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.58

***************************************************************************
  TIME      VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)     (AF)      (CFS)
---------------------------------------------------------------------------
  0.32      0.0028      0.19  Q         .         .         .         .
  0.68      0.0085      0.19  Q         .         .         .         .
  1.03      0.0142      0.20  Q         .         .         .         .
  1.39      0.0200      0.20  Q         .         .         .         .
  1.75      0.0259      0.20  Q         .         .         .         .
  2.10      0.0319      0.20  Q         .         .         .         .
  2.46      0.0379      0.21  Q         .         .         .         .
  2.82      0.0441      0.21  Q         .         .         .         .
  3.17      0.0503      0.21  Q         .         .         .         .
  3.53      0.0566      0.22  Q         .         .         .         .
  3.88      0.0630      0.22  Q         .         .         .         .
  4.24      0.0695      0.22  Q         .         .         .         .
  4.60      0.0761      0.23  Q         .         .         .         .
  4.95      0.0829      0.23  Q         .         .         .         .
  5.31      0.0897      0.23  Q         .         .         .         .
  5.67      0.0967      0.24  Q         .         .         .         .
  6.02      0.1038      0.24  Q         .         .         .         .
  6.38      0.1110      0.25  Q         .         .         .         .
  6.74      0.1184      0.25  .Q        .         .         .         .
  7.09      0.1259      0.26  .Q        .         .         .         .
  7.45      0.1336      0.26  .Q        .         .         .         .
  7.80      0.1415      0.27  .Q        .         .         .         .
  8.16      0.1495      0.28  .Q        .         .         .         .
  8.52      0.1578      0.28  .Q        .         .         .         .
  8.87      0.1662      0.29  .Q        .         .         .         .
  9.23      0.1749      0.30  .Q        .         .         .         .
  9.59      0.1838      0.31  .Q        .         .         .         .
  9.94      0.1930      0.32  .Q        .         .         .         .
 10.30      0.2024      0.32  .Q        .         .         .         .
 10.65      0.2122      0.34  .Q        .         .         .         .
```

```
 11.01      0.2223      0.35  .Q        .         .         .         .
 11.37      0.2328      0.37  .Q        .         .         .         .
 11.72      0.2438      0.38  .Q        .         .         .         .
 12.08      0.2552      0.40  .Q        .         .         .         .
 12.44      0.2677      0.45  .Q        .         .         .         .
 12.79      0.2815      0.49  .Q        .         .         .         .
 13.15      0.2962      0.51  . Q       .         .         .         .
 13.51      0.3118      0.55  . Q       .         .         .         .
 13.86      0.3283      0.57  . Q       .         .         .         .
 14.22      0.3461      0.64  . Q       .         .         .         .
 14.57      0.3655      0.68  . Q       .         .         .         .
 14.93      0.3871      0.79  .  Q      .         .         .         .
 15.29      0.4116      0.87  .  Q      .         .         .         .
 15.64      0.4389      0.98  .  Q      .         .         .         .
 16.00      0.4723      1.29  .    Q    .         .         .         .
 16.36      0.5664      5.10  .         .         Q         .         .
 16.71      0.6560      0.99  .  Q      .         .         .         .
 17.07      0.6813      0.73  . Q       .         .         .         .
 17.43      0.7009      0.60  . Q       .         .         .         .
 17.78      0.7175      0.53  . Q       .         .         .         .
 18.14      0.7322      0.47  .Q        .         .         .         .
 18.49      0.7449      0.39  .Q        .         .         .         .
 18.85      0.7558      0.36  .Q        .         .         .         .
 19.21      0.7660      0.33  .Q        .         .         .         .
 19.56      0.7755      0.31  .Q        .         .         .         .
 19.92      0.7844      0.29  .Q        .         .         .         .
 20.28      0.7928      0.28  .Q        .         .         .         .
 20.63      0.8009      0.27  .Q        .         .         .         .
 20.99      0.8086      0.26  .Q        .         .         .         .
 21.34      0.8160      0.25  Q         .         .         .         .
 21.70      0.8231      0.24  Q         .         .         .         .
 22.06      0.8299      0.23  Q         .         .         .         .
 22.41      0.8365      0.22  Q         .         .         .         .
 22.77      0.8429      0.21  Q         .         .         .         .
 23.13      0.8492      0.21  Q         .         .         .         .
 23.48      0.8552      0.20  Q         .         .         .         .
 23.84      0.8611      0.20  Q         .         .         .         .
 24.20      0.8668      0.19  Q         .         .         .         .
 24.55      0.8697      0.00  Q         .         .         .         .
 ---------------------------------------------------------------------------
-----------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    ======================                   =========
              0%                              1453.8
             10%                               277.9
             20%                                42.8
             30%                                21.4
             40%                                21.4
             50%                                21.4
             60%                                21.4
             70%                                21.4
             80%                                21.4
```

```
            90%                                 21.4

  Problem Descriptions:


   wq Basin1 5yr


==========================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   21.380
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                  INFLOW
                    |
                    |
                    |
                    V                 __effective depth
               -------------          |   (and volume)
               |           |     |    |
               | detention |     |....V.............
               |   basin   |<-->|          outflow
               |           |     |.........________
               -------------     |         |   \
                    |            | storage |     basin outlet
                    V            -----------
                 OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
     *   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
     *      0.000      0.000      0.000**      0.500      0.010      1.560*
     *      1.000      0.030      4.420**      1.500      0.050      6.390*
     *      2.000      0.070      8.090**      2.500      0.110      9.490*
     *      3.000      0.140     10.710**      3.500      0.190     11.800*
     *      4.000      0.230     12.800**
--------------------------------------------------------------------------
     BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:
      INTERVAL   DEPTH   {S-O*DT/2}   {S+O*DT/2}
       NUMBER   (FEET)   (ACRE-FEET)  (ACRE-FEET)
          1     0.00       0.00000      0.00000
          2     0.50      -0.01297      0.03297
          3     1.00      -0.03508      0.09508
          4     1.50      -0.04409      0.14409
          5     2.00      -0.04912      0.18912
          6     2.50      -0.02974      0.24974
          7     3.00      -0.01770      0.29770
          8     3.50       0.01625      0.36375
          9     4.00       0.04153      0.41847
```

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.321 | 0.000 | 0.19 | 0.09 | 0.13 | 0.002 |
| 0.678 | 0.000 | 0.19 | 0.09 | 0.27 | 0.002 |
| 1.034 | 0.000 | 0.20 | 0.09 | 0.27 | 0.002 |
| 1.390 | 0.000 | 0.20 | 0.09 | 0.27 | 0.002 |
| 1.747 | 0.000 | 0.20 | 0.09 | 0.28 | 0.002 |
| 2.103 | 0.000 | 0.20 | 0.09 | 0.28 | 0.002 |
| 2.459 | 0.000 | 0.21 | 0.09 | 0.29 | 0.002 |
| 2.816 | 0.000 | 0.21 | 0.09 | 0.29 | 0.002 |
| 3.172 | 0.000 | 0.21 | 0.09 | 0.29 | 0.002 |
| 3.528 | 0.000 | 0.22 | 0.10 | 0.30 | 0.002 |
| 3.885 | 0.000 | 0.22 | 0.10 | 0.30 | 0.002 |
| 4.241 | 0.000 | 0.22 | 0.10 | 0.31 | 0.002 |
| 4.597 | 0.000 | 0.23 | 0.10 | 0.31 | 0.002 |
| 4.954 | 0.000 | 0.23 | 0.10 | 0.32 | 0.002 |
| 5.310 | 0.000 | 0.23 | 0.10 | 0.32 | 0.002 |
| 5.666 | 0.000 | 0.24 | 0.11 | 0.33 | 0.002 |
| 6.023 | 0.000 | 0.24 | 0.11 | 0.34 | 0.002 |
| 6.379 | 0.000 | 0.25 | 0.11 | 0.34 | 0.002 |
| 6.735 | 0.000 | 0.25 | 0.11 | 0.35 | 0.002 |
| 7.092 | 0.000 | 0.26 | 0.12 | 0.36 | 0.002 |
| 7.448 | 0.000 | 0.26 | 0.12 | 0.36 | 0.002 |
| 7.804 | 0.000 | 0.27 | 0.12 | 0.37 | 0.002 |
| 8.161 | 0.000 | 0.28 | 0.12 | 0.38 | 0.002 |
| 8.517 | 0.000 | 0.28 | 0.13 | 0.39 | 0.003 |
| 8.873 | 0.000 | 0.29 | 0.13 | 0.40 | 0.003 |
| 9.230 | 0.000 | 0.30 | 0.13 | 0.41 | 0.003 |
| 9.586 | 0.000 | 0.31 | 0.14 | 0.42 | 0.003 |
| 9.942 | 0.000 | 0.32 | 0.14 | 0.43 | 0.003 |
| 10.299 | 0.000 | 0.32 | 0.14 | 0.45 | 0.003 |
| 10.655 | 0.000 | 0.34 | 0.15 | 0.46 | 0.003 |
| 11.011 | 0.000 | 0.35 | 0.16 | 0.48 | 0.003 |
| 11.368 | 0.000 | 0.37 | 0.16 | 0.50 | 0.003 |
| 11.724 | 0.000 | 0.38 | 0.17 | 0.52 | 0.003 |
| 12.080 | 0.000 | 0.40 | 0.18 | 0.54 | 0.004 |
| 12.437 | 0.000 | 0.45 | 0.20 | 0.59 | 0.004 |
| 12.793 | 0.000 | 0.49 | 0.22 | 0.66 | 0.004 |
| 13.149 | 0.000 | 0.51 | 0.23 | 0.69 | 0.005 |
| 13.506 | 0.000 | 0.55 | 0.25 | 0.74 | 0.005 |
| 13.862 | 0.000 | 0.57 | 0.26 | 0.78 | 0.005 |
| 14.218 | 0.000 | 0.64 | 0.28 | 0.84 | 0.006 |
| 14.575 | 0.000 | 0.68 | 0.30 | 0.92 | 0.006 |
| 14.931 | 0.000 | 0.79 | 0.35 | 1.02 | 0.007 |
| 15.287 | 0.000 | 0.87 | 0.39 | 1.16 | 0.008 |
| 15.644 | 0.000 | 0.98 | 0.44 | 1.29 | 0.009 |
| 16.000 | 0.000 | 1.29 | 0.54 | 1.58 | 0.012 |
| 16.356 | 0.000 | 5.10 | 1.57 | 4.20 | 0.053 |
| 16.713 | 0.000 | 0.99 | 0.44 | 4.00 | 0.009 |

| | | | | | |
|---|---|---|---|---|---|
| 17.069 | 0.000 | 0.73 | 0.32 | 1.20 | 0.006 |
| 17.425 | 0.000 | 0.60 | 0.27 | 0.93 | 0.005 |
| 17.782 | 0.000 | 0.53 | 0.24 | 0.79 | 0.005 |
| 18.138 | 0.000 | 0.47 | 0.21 | 0.70 | 0.004 |
| 18.494 | 0.000 | 0.39 | 0.17 | 0.60 | 0.003 |
| 18.851 | 0.000 | 0.36 | 0.16 | 0.52 | 0.003 |
| 19.207 | 0.000 | 0.33 | 0.15 | 0.48 | 0.003 |
| 19.563 | 0.000 | 0.31 | 0.14 | 0.45 | 0.003 |
| 19.920 | 0.000 | 0.29 | 0.13 | 0.42 | 0.003 |
| 20.276 | 0.000 | 0.28 | 0.12 | 0.40 | 0.002 |
| 20.632 | 0.000 | 0.27 | 0.12 | 0.38 | 0.002 |
| 20.989 | 0.000 | 0.26 | 0.11 | 0.36 | 0.002 |
| 21.345 | 0.000 | 0.25 | 0.11 | 0.35 | 0.002 |
| 21.701 | 0.000 | 0.24 | 0.11 | 0.34 | 0.002 |
| 22.058 | 0.000 | 0.23 | 0.10 | 0.32 | 0.002 |
| 22.414 | 0.000 | 0.22 | 0.10 | 0.31 | 0.002 |
| 22.770 | 0.000 | 0.21 | 0.10 | 0.30 | 0.002 |
| 23.127 | 0.000 | 0.21 | 0.09 | 0.29 | 0.002 |
| 23.483 | 0.000 | 0.20 | 0.09 | 0.29 | 0.002 |
| 23.839 | 0.000 | 0.20 | 0.09 | 0.28 | 0.002 |
| 24.196 | 0.000 | 0.19 | 0.09 | 0.27 | 0.002 |
| 24.552 | 0.000 | 0.00 | 0.00 | 0.13 | 0.000 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                         Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin2 lyr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =   10.80
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.418
    TIME OF CONCENTRATION(MIN.) = 12.20
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
```

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30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
 1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
 3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
 6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93
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TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.94
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.79
```

**********

| TIME (HOURS) | VOLUME (AF) | Q (CFS) | 0. | | 2.5 | | 5.0 | | 7.5 | | 10.0 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.14 | 0.0013 | 0.16 | Q | . | | . | | . | | . | |
| 0.34 | 0.0040 | 0.16 | Q | . | | . | | . | | . | |
| 0.55 | 0.0067 | 0.16 | Q | . | | . | | . | | . | |
| 0.75 | 0.0094 | 0.16 | Q | . | | . | | . | | . | |
| 0.95 | 0.0122 | 0.16 | Q | . | | . | | . | | . | |
| 1.16 | 0.0149 | 0.17 | Q | . | | . | | . | | . | |
| 1.36 | 0.0177 | 0.17 | Q | . | | . | | . | | . | |
| 1.56 | 0.0205 | 0.17 | Q | . | | . | | . | | . | |
| 1.77 | 0.0234 | 0.17 | Q | . | | . | | . | | . | |
| 1.97 | 0.0263 | 0.17 | Q | . | | . | | . | | . | |
| 2.17 | 0.0292 | 0.17 | Q | . | | . | | . | | . | |
| 2.38 | 0.0321 | 0.18 | Q | . | | . | | . | | . | |
| 2.58 | 0.0350 | 0.18 | Q | . | | . | | . | | . | |
| 2.78 | 0.0380 | 0.18 | Q | . | | . | | . | | . | |
| 2.99 | 0.0410 | 0.18 | Q | . | | . | | . | | . | |
| 3.19 | 0.0441 | 0.18 | Q | . | | . | | . | | . | |
| 3.39 | 0.0471 | 0.18 | Q | . | | . | | . | | . | |
| 3.60 | 0.0502 | 0.19 | Q | . | | . | | . | | . | |
| 3.80 | 0.0534 | 0.19 | Q | . | | . | | . | | . | |
| 4.00 | 0.0565 | 0.19 | Q | . | | . | | . | | . | |
| 4.21 | 0.0597 | 0.19 | Q | . | | . | | . | | . | |
| 4.41 | 0.0630 | 0.19 | Q | . | | . | | . | | . | |
| 4.61 | 0.0663 | 0.20 | Q | . | | . | | . | | . | |
| 4.82 | 0.0696 | 0.20 | Q | . | | . | | . | | . | |
| 5.02 | 0.0729 | 0.20 | Q | . | | . | | . | | . | |
| 5.22 | 0.0763 | 0.20 | Q | . | | . | | . | | . | |
| 5.43 | 0.0798 | 0.21 | Q | . | | . | | . | | . | |
| 5.63 | 0.0832 | 0.21 | Q | . | | . | | . | | . | |
| 5.83 | 0.0868 | 0.21 | Q | . | | . | | . | | . | |
| 6.04 | 0.0903 | 0.21 | Q | . | | . | | . | | . | |
| 6.24 | 0.0939 | 0.22 | Q | . | | . | | . | | . | |
| 6.44 | 0.0976 | 0.22 | Q | . | | . | | . | | . | |
| 6.65 | 0.1013 | 0.22 | Q | . | | . | | . | | . | |
| 6.85 | 0.1051 | 0.23 | Q | . | | . | | . | | . | |
| 7.05 | 0.1089 | 0.23 | Q | . | | . | | . | | . | |
| 7.26 | 0.1128 | 0.23 | Q | . | | . | | . | | . | |
| 7.46 | 0.1167 | 0.24 | Q | . | | . | | . | | . | |
| 7.66 | 0.1207 | 0.24 | Q | . | | . | | . | | . | |
| 7.87 | 0.1248 | 0.24 | Q | . | | . | | . | | . | |
| 8.07 | 0.1289 | 0.25 | Q | . | | . | | . | | . | |
| 8.27 | 0.1331 | 0.25 | .Q | . | | . | | . | | . | |
| 8.48 | 0.1373 | 0.26 | .Q | . | | . | | . | | . | |

| | | | |
|---|---|---|---|
| 8.68 | 0.1417 | 0.26 | .Q . . . . |
| 8.88 | 0.1461 | 0.27 | .Q . . . . |
| 9.09 | 0.1506 | 0.27 | .Q . . . . |
| 9.29 | 0.1551 | 0.28 | .Q . . . . |
| 9.49 | 0.1598 | 0.28 | .Q . . . . |
| 9.70 | 0.1646 | 0.29 | .Q . . . . |
| 9.90 | 0.1694 | 0.29 | .Q . . . . |
| 10.10 | 0.1744 | 0.30 | .Q . . . . |
| 10.31 | 0.1795 | 0.30 | .Q . . . . |
| 10.51 | 0.1847 | 0.31 | .Q . . . . |
| 10.71 | 0.1900 | 0.32 | .Q . . . . |
| 10.92 | 0.1954 | 0.33 | .Q . . . . |
| 11.12 | 0.2010 | 0.33 | .Q . . . . |
| 11.32 | 0.2067 | 0.35 | .Q . . . . |
| 11.53 | 0.2126 | 0.35 | .Q . . . . |
| 11.73 | 0.2187 | 0.37 | .Q . . . . |
| 11.93 | 0.2249 | 0.38 | .Q . . . . |
| 12.14 | 0.2322 | 0.50 | .Q . . . . |
| 12.34 | 0.2414 | 0.61 | . Q . . . . |
| 12.54 | 0.2518 | 0.63 | . Q . . . . |
| 12.75 | 0.2624 | 0.64 | . Q . . . . |
| 12.95 | 0.2733 | 0.66 | . Q . . . . |
| 13.15 | 0.2846 | 0.68 | . Q . . . . |
| 13.36 | 0.2962 | 0.71 | . Q . . . . |
| 13.56 | 0.3082 | 0.72 | . Q . . . . |
| 13.76 | 0.3207 | 0.76 | . Q . . . . |
| 13.97 | 0.3336 | 0.78 | . Q . . . . |
| 14.17 | 0.3472 | 0.83 | . Q . . . . |
| 14.37 | 0.3614 | 0.86 | . Q . . . . |
| 14.58 | 0.3764 | 0.93 | . Q . . . . |
| 14.78 | 0.3923 | 0.97 | . Q . . . . |
| 14.98 | 0.4094 | 1.07 | . Q . . . . |
| 15.19 | 0.4279 | 1.13 | . Q . . . . |
| 15.39 | 0.4484 | 1.31 | . Q . . . . |
| 15.59 | 0.4689 | 1.13 | . Q . . . . |
| 15.80 | 0.4916 | 1.57 | . Q . . . . |
| 16.00 | 0.5230 | 2.16 | . Q . . . . |
| 16.20 | 0.6176 | 9.10 | . . . . Q . |
| 16.41 | 0.7048 | 1.28 | . Q . . . . |
| 16.61 | 0.7258 | 1.21 | . Q . . . . |
| 16.81 | 0.7445 | 1.01 | . Q . . . . |
| 17.02 | 0.7605 | 0.89 | . Q . . . . |
| 17.22 | 0.7747 | 0.81 | . Q . . . . |
| 17.42 | 0.7877 | 0.74 | . Q . . . . |
| 17.63 | 0.7998 | 0.69 | . Q . . . . |
| 17.83 | 0.8110 | 0.65 | . Q . . . . |
| 18.03 | 0.8217 | 0.62 | . Q . . . . |
| 18.24 | 0.8300 | 0.38 | .Q . . . . |
| 18.44 | 0.8363 | 0.36 | .Q . . . . |
| 18.64 | 0.8422 | 0.34 | .Q . . . . |
| 18.85 | 0.8478 | 0.32 | .Q . . . . |
| 19.05 | 0.8531 | 0.31 | .Q . . . . |
| 19.25 | 0.8581 | 0.30 | .Q . . . . |
| 19.46 | 0.8630 | 0.28 | .Q . . . . |
| 19.66 | 0.8677 | 0.27 | .Q . . . . |
| 19.86 | 0.8722 | 0.26 | .Q . . . . |
| 20.07 | 0.8765 | 0.25 | .Q . . . . |

```
 20.27      0.8807      0.25  Q          .          .          .          .
 20.47      0.8848      0.24  Q          .          .          .          .
 20.68      0.8887      0.23  Q          .          .          .          .
 20.88      0.8925      0.22  Q          .          .          .          .
 21.08      0.8962      0.22  Q          .          .          .          .
 21.29      0.8998      0.21  Q          .          .          .          .
 21.49      0.9034      0.21  Q          .          .          .          .
 21.69      0.9068      0.20  Q          .          .          .          .
 21.90      0.9101      0.20  Q          .          .          .          .
 22.10      0.9134      0.19  Q          .          .          .          .
 22.30      0.9166      0.19  Q          .          .          .          .
 22.51      0.9198      0.18  Q          .          .          .          .
 22.71      0.9228      0.18  Q          .          .          .          .
 22.91      0.9258      0.18  Q          .          .          .          .
 23.12      0.9288      0.17  Q          .          .          .          .
 23.32      0.9317      0.17  Q          .          .          .          .
 23.52      0.9345      0.17  Q          .          .          .          .
 23.73      0.9373      0.16  Q          .          .          .          .
 23.93      0.9401      0.16  Q          .          .          .          .
 24.13      0.9428      0.16  Q          .          .          .          .
 24.34      0.9441      0.00  Q          .          .          .          .
 ----------------------------------------------------------------------------
-------------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    =======================                  =========
              0%                              1451.8
             10%                               146.4
             20%                                24.4
             30%                                12.2
             40%                                12.2
             50%                                12.2
             60%                                12.2
             70%                                12.2
             80%                                12.2
             90%                                12.2

  Problem Descriptions:


   wq Basin2 1yr


===============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   12.200
     DEAD STORAGE(AF) =        0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00
```

```
                INFLOW
                  |
                  |
                  |
                  V                 __effective depth
            -------------           |   (and volume)
            |           |     |     |
            | detention |     |....V.............
            |   basin   |<-->|          outflow
            |           |     |.........________
            -------------     |         |   \
                  |           | storage |     basin outlet
                  V           -----------
               OUTFLOW
```

DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES = 9

| *BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) ** | **BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) * |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000** | 0.500 | 0.110 | 1.170* |
| 1.000 | 0.230 | 3.300** | 1.500 | 0.370 | 3.910* |
| 2.000 | 0.520 | 4.790** | 2.500 | 0.680 | 5.530* |
| 3.000 | 0.860 | 6.180** | 3.500 | 1.050 | 6.770* |
| 4.000 | 1.240 | 7.310** | | | |

---

BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:

| INTERVAL NUMBER | DEPTH (FEET) | {S-O*DT/2} (ACRE-FEET) | {S+O*DT/2} (ACRE-FEET) |
|---|---|---|---|
| 1 | 0.00 | 0.00000 | 0.00000 |
| 2 | 0.50 | 0.10017 | 0.11983 |
| 3 | 1.00 | 0.20227 | 0.25773 |
| 4 | 1.50 | 0.33715 | 0.40285 |
| 5 | 2.00 | 0.47975 | 0.56025 |
| 6 | 2.50 | 0.63354 | 0.72646 |
| 7 | 3.00 | 0.80807 | 0.91193 |
| 8 | 3.50 | 0.99312 | 1.10688 |
| 9 | 4.00 | 1.17858 | 1.30142 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

---

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.140 | 0.000 | 0.16 | 0.01 | 0.01 | 0.002 |
| 0.343 | 0.000 | 0.16 | 0.02 | 0.04 | 0.005 |
| 0.547 | 0.000 | 0.16 | 0.03 | 0.06 | 0.006 |
| 0.750 | 0.000 | 0.16 | 0.04 | 0.07 | 0.008 |
| 0.953 | 0.000 | 0.16 | 0.04 | 0.09 | 0.009 |
| 1.157 | 0.000 | 0.17 | 0.05 | 0.10 | 0.010 |
| 1.360 | 0.000 | 0.17 | 0.05 | 0.11 | 0.011 |
| 1.563 | 0.000 | 0.17 | 0.05 | 0.12 | 0.012 |

| | | | | | |
|---|---|---|---|---|---|
| 1.767 | 0.000 | 0.17 | 0.06 | 0.13 | 0.012 |
| 1.970 | 0.000 | 0.17 | 0.06 | 0.14 | 0.013 |
| 2.173 | 0.000 | 0.17 | 0.06 | 0.14 | 0.014 |
| 2.377 | 0.000 | 0.18 | 0.06 | 0.15 | 0.014 |
| 2.580 | 0.000 | 0.18 | 0.07 | 0.15 | 0.014 |
| 2.783 | 0.000 | 0.18 | 0.07 | 0.16 | 0.015 |
| 2.987 | 0.000 | 0.18 | 0.07 | 0.16 | 0.015 |
| 3.190 | 0.000 | 0.18 | 0.07 | 0.16 | 0.016 |
| 3.393 | 0.000 | 0.18 | 0.07 | 0.17 | 0.016 |
| 3.597 | 0.000 | 0.19 | 0.07 | 0.17 | 0.016 |
| 3.800 | 0.000 | 0.19 | 0.07 | 0.17 | 0.016 |
| 4.003 | 0.000 | 0.19 | 0.08 | 0.17 | 0.017 |
| 4.207 | 0.000 | 0.19 | 0.08 | 0.18 | 0.017 |
| 4.410 | 0.000 | 0.19 | 0.08 | 0.18 | 0.017 |
| 4.613 | 0.000 | 0.20 | 0.08 | 0.18 | 0.017 |
| 4.817 | 0.000 | 0.20 | 0.08 | 0.18 | 0.018 |
| 5.020 | 0.000 | 0.20 | 0.08 | 0.19 | 0.018 |
| 5.223 | 0.000 | 0.20 | 0.08 | 0.19 | 0.018 |
| 5.427 | 0.000 | 0.21 | 0.08 | 0.19 | 0.018 |
| 5.630 | 0.000 | 0.21 | 0.08 | 0.19 | 0.018 |
| 5.833 | 0.000 | 0.21 | 0.08 | 0.20 | 0.019 |
| 6.037 | 0.000 | 0.21 | 0.09 | 0.20 | 0.019 |
| 6.240 | 0.000 | 0.22 | 0.09 | 0.20 | 0.019 |
| 6.443 | 0.000 | 0.22 | 0.09 | 0.20 | 0.019 |
| 6.647 | 0.000 | 0.22 | 0.09 | 0.21 | 0.020 |
| 6.850 | 0.000 | 0.23 | 0.09 | 0.21 | 0.020 |
| 7.053 | 0.000 | 0.23 | 0.09 | 0.21 | 0.020 |
| 7.257 | 0.000 | 0.23 | 0.09 | 0.22 | 0.020 |
| 7.460 | 0.000 | 0.24 | 0.09 | 0.22 | 0.021 |
| 7.663 | 0.000 | 0.24 | 0.10 | 0.22 | 0.021 |
| 7.867 | 0.000 | 0.24 | 0.10 | 0.23 | 0.021 |
| 8.070 | 0.000 | 0.25 | 0.10 | 0.23 | 0.022 |
| 8.273 | 0.000 | 0.25 | 0.10 | 0.23 | 0.022 |
| 8.477 | 0.000 | 0.26 | 0.10 | 0.24 | 0.022 |
| 8.680 | 0.000 | 0.26 | 0.10 | 0.24 | 0.023 |
| 8.883 | 0.000 | 0.27 | 0.10 | 0.24 | 0.023 |
| 9.087 | 0.000 | 0.27 | 0.11 | 0.25 | 0.023 |
| 9.290 | 0.000 | 0.28 | 0.11 | 0.25 | 0.024 |
| 9.493 | 0.000 | 0.28 | 0.11 | 0.26 | 0.024 |
| 9.697 | 0.000 | 0.29 | 0.11 | 0.26 | 0.025 |
| 9.900 | 0.000 | 0.29 | 0.11 | 0.26 | 0.025 |
| 10.103 | 0.000 | 0.30 | 0.12 | 0.27 | 0.026 |
| 10.307 | 0.000 | 0.30 | 0.12 | 0.28 | 0.026 |
| 10.510 | 0.000 | 0.31 | 0.12 | 0.28 | 0.027 |
| 10.713 | 0.000 | 0.32 | 0.12 | 0.29 | 0.027 |
| 10.917 | 0.000 | 0.33 | 0.13 | 0.29 | 0.028 |
| 11.120 | 0.000 | 0.33 | 0.13 | 0.30 | 0.028 |
| 11.323 | 0.000 | 0.35 | 0.13 | 0.31 | 0.029 |
| 11.527 | 0.000 | 0.35 | 0.14 | 0.31 | 0.030 |
| 11.730 | 0.000 | 0.37 | 0.14 | 0.32 | 0.031 |
| 11.933 | 0.000 | 0.38 | 0.14 | 0.33 | 0.031 |
| 12.137 | 0.000 | 0.50 | 0.15 | 0.35 | 0.034 |
| 12.340 | 0.000 | 0.61 | 0.17 | 0.38 | 0.038 |
| 12.543 | 0.000 | 0.63 | 0.19 | 0.42 | 0.041 |
| 12.747 | 0.000 | 0.64 | 0.20 | 0.45 | 0.044 |
| 12.950 | 0.000 | 0.66 | 0.21 | 0.49 | 0.047 |
| 13.153 | 0.000 | 0.68 | 0.23 | 0.52 | 0.050 |

| | | | | | |
|---|---|---|---|---|---|
| 13.357 | 0.000 | 0.71 | 0.24 | 0.54 | 0.053 |
| 13.560 | 0.000 | 0.72 | 0.25 | 0.57 | 0.055 |
| 13.763 | 0.000 | 0.76 | 0.26 | 0.60 | 0.058 |
| 13.967 | 0.000 | 0.78 | 0.27 | 0.63 | 0.060 |
| 14.170 | 0.000 | 0.83 | 0.29 | 0.66 | 0.063 |
| 14.373 | 0.000 | 0.86 | 0.30 | 0.69 | 0.066 |
| 14.577 | 0.000 | 0.93 | 0.32 | 0.72 | 0.070 |
| 14.780 | 0.000 | 0.97 | 0.33 | 0.76 | 0.073 |
| 14.983 | 0.000 | 1.07 | 0.35 | 0.80 | 0.078 |
| 15.187 | 0.000 | 1.13 | 0.37 | 0.85 | 0.082 |
| 15.390 | 0.000 | 1.31 | 0.40 | 0.91 | 0.089 |
| 15.593 | 0.000 | 1.13 | 0.42 | 0.96 | 0.092 |
| 15.797 | 0.000 | 1.57 | 0.46 | 1.03 | 0.101 |
| 16.000 | 0.000 | 2.16 | 0.53 | 1.19 | 0.117 |
| 16.203 | 0.000 | 9.10 | 1.01 | 2.30 | 0.232 |
| 16.407 | 0.000 | 1.28 | 0.88 | 3.05 | 0.202 |
| 16.610 | 0.000 | 1.21 | 0.79 | 2.59 | 0.179 |
| 16.813 | 0.000 | 1.01 | 0.70 | 2.21 | 0.159 |
| 17.017 | 0.000 | 0.89 | 0.63 | 1.88 | 0.142 |
| 17.220 | 0.000 | 0.81 | 0.58 | 1.61 | 0.128 |
| 17.423 | 0.000 | 0.74 | 0.53 | 1.40 | 0.117 |
| 17.627 | 0.000 | 0.69 | 0.49 | 1.22 | 0.108 |
| 17.830 | 0.000 | 0.65 | 0.46 | 1.11 | 0.101 |
| 18.033 | 0.000 | 0.62 | 0.43 | 1.03 | 0.094 |
| 18.237 | 0.000 | 0.38 | 0.38 | 0.94 | 0.084 |
| 18.440 | 0.000 | 0.36 | 0.34 | 0.85 | 0.076 |
| 18.643 | 0.000 | 0.34 | 0.31 | 0.77 | 0.069 |
| 18.847 | 0.000 | 0.32 | 0.28 | 0.70 | 0.062 |
| 19.050 | 0.000 | 0.31 | 0.26 | 0.63 | 0.057 |
| 19.253 | 0.000 | 0.30 | 0.24 | 0.58 | 0.052 |
| 19.457 | 0.000 | 0.28 | 0.22 | 0.53 | 0.048 |
| 19.660 | 0.000 | 0.27 | 0.20 | 0.49 | 0.044 |
| 19.863 | 0.000 | 0.26 | 0.19 | 0.45 | 0.041 |
| 20.067 | 0.000 | 0.25 | 0.17 | 0.42 | 0.038 |
| 20.270 | 0.000 | 0.25 | 0.16 | 0.39 | 0.036 |
| 20.473 | 0.000 | 0.24 | 0.15 | 0.37 | 0.034 |
| 20.677 | 0.000 | 0.23 | 0.14 | 0.35 | 0.032 |
| 20.880 | 0.000 | 0.22 | 0.14 | 0.33 | 0.030 |
| 21.083 | 0.000 | 0.22 | 0.13 | 0.31 | 0.028 |
| 21.287 | 0.000 | 0.21 | 0.12 | 0.29 | 0.027 |
| 21.490 | 0.000 | 0.21 | 0.12 | 0.28 | 0.026 |
| 21.693 | 0.000 | 0.20 | 0.11 | 0.27 | 0.025 |
| 21.897 | 0.000 | 0.20 | 0.11 | 0.26 | 0.024 |
| 22.100 | 0.000 | 0.19 | 0.10 | 0.25 | 0.023 |
| 22.303 | 0.000 | 0.19 | 0.10 | 0.24 | 0.022 |
| 22.507 | 0.000 | 0.18 | 0.10 | 0.23 | 0.021 |
| 22.710 | 0.000 | 0.18 | 0.09 | 0.22 | 0.020 |
| 22.913 | 0.000 | 0.18 | 0.09 | 0.21 | 0.020 |
| 23.117 | 0.000 | 0.17 | 0.09 | 0.21 | 0.019 |
| 23.320 | 0.000 | 0.17 | 0.09 | 0.20 | 0.019 |
| 23.523 | 0.000 | 0.17 | 0.08 | 0.20 | 0.018 |
| 23.727 | 0.000 | 0.16 | 0.08 | 0.19 | 0.018 |
| 23.930 | 0.000 | 0.16 | 0.08 | 0.19 | 0.017 |
| 24.133 | 0.000 | 0.16 | 0.08 | 0.18 | 0.017 |
| 24.337 | 0.000 | 0.00 | 0.06 | 0.17 | 0.014 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

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----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin2 2yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =   10.80
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.391
    TIME OF CONCENTRATION(MIN.) = 12.40
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.33
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     1.01

****************************************************************************
  TIME      VOLUME       Q    0.        5.0       10.0      15.0      20.0
 (HOURS)     (AF)      (CFS)
----------------------------------------------------------------------------
  0.09      0.0009      0.26  Q         .         .         .         .
  0.29      0.0054      0.26  Q         .         .         .         .
  0.50      0.0099      0.26  Q         .         .         .         .
  0.71      0.0144      0.27  Q         .         .         .         .
  0.91      0.0190      0.27  Q         .         .         .         .
  1.12      0.0236      0.27  Q         .         .         .         .
  1.33      0.0282      0.27  Q         .         .         .         .
  1.53      0.0329      0.27  Q         .         .         .         .
  1.74      0.0376      0.28  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.95 | 0.0423 | 0.28 | Q | . | . | . | . |
| 2.15 | 0.0471 | 0.28 | Q | . | . | . | . |
| 2.36 | 0.0520 | 0.28 | Q | . | . | . | . |
| 2.57 | 0.0569 | 0.29 | Q | . | . | . | . |
| 2.77 | 0.0618 | 0.29 | Q | . | . | . | . |
| 2.98 | 0.0667 | 0.29 | Q | . | . | . | . |
| 3.19 | 0.0718 | 0.29 | Q | . | . | . | . |
| 3.39 | 0.0768 | 0.30 | Q | . | . | . | . |
| 3.60 | 0.0819 | 0.30 | Q | . | . | . | . |
| 3.81 | 0.0871 | 0.30 | Q | . | . | . | . |
| 4.01 | 0.0923 | 0.31 | Q | . | . | . | . |
| 4.22 | 0.0976 | 0.31 | Q | . | . | . | . |
| 4.43 | 0.1029 | 0.31 | Q | . | . | . | . |
| 4.63 | 0.1083 | 0.32 | Q | . | . | . | . |
| 4.84 | 0.1137 | 0.32 | Q | . | . | . | . |
| 5.05 | 0.1192 | 0.32 | Q | . | . | . | . |
| 5.25 | 0.1248 | 0.33 | Q | . | . | . | . |
| 5.46 | 0.1304 | 0.33 | Q | . | . | . | . |
| 5.67 | 0.1361 | 0.33 | Q | . | . | . | . |
| 5.87 | 0.1418 | 0.34 | Q | . | . | . | . |
| 6.08 | 0.1476 | 0.34 | Q | . | . | . | . |
| 6.29 | 0.1535 | 0.35 | Q | . | . | . | . |
| 6.49 | 0.1595 | 0.35 | Q | . | . | . | . |
| 6.70 | 0.1655 | 0.36 | Q | . | . | . | . |
| 6.91 | 0.1716 | 0.36 | Q | . | . | . | . |
| 7.11 | 0.1778 | 0.37 | Q | . | . | . | . |
| 7.32 | 0.1841 | 0.37 | Q | . | . | . | . |
| 7.53 | 0.1905 | 0.38 | Q | . | . | . | . |
| 7.73 | 0.1969 | 0.38 | Q | . | . | . | . |
| 7.94 | 0.2035 | 0.39 | Q | . | . | . | . |
| 8.15 | 0.2102 | 0.39 | Q | . | . | . | . |
| 8.35 | 0.2169 | 0.40 | Q | . | . | . | . |
| 8.56 | 0.2238 | 0.40 | Q | . | . | . | . |
| 8.77 | 0.2308 | 0.41 | Q | . | . | . | . |
| 8.97 | 0.2378 | 0.42 | Q | . | . | . | . |
| 9.18 | 0.2451 | 0.43 | Q | . | . | . | . |
| 9.39 | 0.2524 | 0.43 | Q | . | . | . | . |
| 9.59 | 0.2599 | 0.44 | Q | . | . | . | . |
| 9.80 | 0.2675 | 0.45 | Q | . | . | . | . |
| 10.01 | 0.2753 | 0.46 | Q | . | . | . | . |
| 10.21 | 0.2832 | 0.47 | Q | . | . | . | . |
| 10.42 | 0.2913 | 0.48 | Q | . | . | . | . |
| 10.63 | 0.2995 | 0.49 | Q | . | . | . | . |
| 10.83 | 0.3080 | 0.50 | .Q | . | . | . | . |
| 11.04 | 0.3166 | 0.51 | .Q | . | . | . | . |
| 11.25 | 0.3255 | 0.53 | .Q | . | . | . | . |
| 11.45 | 0.3345 | 0.54 | .Q | . | . | . | . |
| 11.66 | 0.3439 | 0.56 | .Q | . | . | . | . |
| 11.87 | 0.3534 | 0.57 | .Q | . | . | . | . |
| 12.07 | 0.3633 | 0.59 | .Q | . | . | . | . |
| 12.28 | 0.3748 | 0.76 | .Q | . | . | . | . |
| 12.49 | 0.3880 | 0.78 | .Q | . | . | . | . |
| 12.69 | 0.4015 | 0.80 | .Q | . | . | . | . |
| 12.90 | 0.4154 | 0.83 | .Q | . | . | . | . |
| 13.11 | 0.4298 | 0.85 | .Q | . | . | . | . |
| 13.31 | 0.4446 | 0.89 | .Q | . | . | . | . |
| 13.52 | 0.4599 | 0.91 | .Q | . | . | . | . |

```
13.73      0.4759      0.96  .Q        .         .         .         .
13.93      0.4925      0.99  .Q        .         .         .         .
14.14      0.5099      1.05  . Q       .         .         .         .
14.35      0.5282      1.09  . Q       .         .         .         .
14.55      0.5475      1.18  . Q       .         .         .         .
14.76      0.5681      1.23  . Q       .         .         .         .
14.97      0.5902      1.36  . Q       .         .         .         .
15.17      0.6142      1.45  . Q       .         .         .         .
15.38      0.6410      1.69  .  Q      .         .         .         .
15.59      0.6684      1.53  .  Q      .         .         .         .
15.79      0.6993      2.09  .   Q     .         .         .         .
16.00      0.7417      2.87  .    Q    .         .         .         .
16.21      0.8708     12.24  .         .         .   Q     .         .
16.41      0.9899      1.70  .  Q      .         .         .         .
16.62      1.0177      1.55  .  Q      .         .         .         .
16.83      1.0420      1.29  . Q       .         .         .         .
17.03      1.0626      1.13  . Q       .         .         .         .
17.24      1.0810      1.02  . Q       .         .         .         .
17.45      1.0976      0.93  .Q        .         .         .         .
17.65      1.1130      0.87  .Q        .         .         .         .
17.86      1.1274      0.81  .Q        .         .         .         .
18.07      1.1409      0.77  .Q        .         .         .         .
18.27      1.1524      0.58  .Q        .         .         .         .
18.48      1.1620      0.55  .Q        .         .         .         .
18.69      1.1711      0.52  .Q        .         .         .         .
18.89      1.1797      0.49  Q         .         .         .         .
19.10      1.1880      0.47  Q         .         .         .         .
19.31      1.1959      0.45  Q         .         .         .         .
19.51      1.2035      0.44  Q         .         .         .         .
19.72      1.2109      0.42  Q         .         .         .         .
19.93      1.2179      0.41  Q         .         .         .         .
20.13      1.2248      0.40  Q         .         .         .         .
20.34      1.2315      0.38  Q         .         .         .         .
20.55      1.2379      0.37  Q         .         .         .         .
20.75      1.2442      0.36  Q         .         .         .         .
20.96      1.2503      0.35  Q         .         .         .         .
21.17      1.2563      0.34  Q         .         .         .         .
21.37      1.2621      0.34  Q         .         .         .         .
21.58      1.2678      0.33  Q         .         .         .         .
21.79      1.2734      0.32  Q         .         .         .         .
21.99      1.2788      0.31  Q         .         .         .         .
22.20      1.2841      0.31  Q         .         .         .         .
22.41      1.2893      0.30  Q         .         .         .         .
22.61      1.2944      0.30  Q         .         .         .         .
22.82      1.2995      0.29  Q         .         .         .         .
23.03      1.3044      0.29  Q         .         .         .         .
23.23      1.3092      0.28  Q         .         .         .         .
23.44      1.3140      0.28  Q         .         .         .         .
23.65      1.3186      0.27  Q         .         .         .         .
23.85      1.3232      0.27  Q         .         .         .         .
24.06      1.3278      0.26  Q         .         .         .         .
24.27      1.3300      0.00  Q         .         .         .         .
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)
```

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1450.8 |
| 10% | 136.4 |
| 20% | 24.8 |
| 30% | 12.4 |
| 40% | 12.4 |
| 50% | 12.4 |
| 60% | 12.4 |
| 70% | 12.4 |
| 80% | 12.4 |
| 90% | 12.4 |

Problem Descriptions:

wq Basin2 2yr

```
==============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   12.400
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                  INFLOW
                    |
                    |
                    |
                    V                __effective depth
                -------------        |   (and volume)
                |           |    |    |
                | detention |    |....V.............
                |   basin   |<-->|          outflow
                |           |    |.........________
                -------------    |         |   \
                      |          | storage |     basin outlet
                      V          -----------
                   OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
     *   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
     *      0.000      0.000      0.000**      0.500      0.110      1.170*
     *      1.000      0.230      3.300**      1.500      0.370      3.910*
     *      2.000      0.520      4.790**      2.500      0.680      5.530*
     *      3.000      0.860      6.180**      3.500      1.050      6.770*
     *      4.000      1.240      7.310**
```

BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:

| INTERVAL NUMBER | DEPTH (FEET) | {S-O*DT/2} (ACRE-FEET) | {S+O*DT/2} (ACRE-FEET) |
|---|---|---|---|
| 1 | 0.00 | 0.00000 | 0.00000 |
| 2 | 0.50 | 0.10001 | 0.11999 |
| 3 | 1.00 | 0.20182 | 0.25818 |
| 4 | 1.50 | 0.33661 | 0.40339 |
| 5 | 2.00 | 0.47909 | 0.56091 |
| 6 | 2.50 | 0.63277 | 0.72723 |
| 7 | 3.00 | 0.80722 | 0.91278 |
| 8 | 3.50 | 0.99218 | 1.10782 |
| 9 | 4.00 | 1.17757 | 1.30243 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

DETENTION BASIN ROUTING RESULTS:

NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.087 | 0.000 | 0.26 | 0.02 | 0.02 | 0.004 |
| 0.293 | 0.000 | 0.26 | 0.03 | 0.06 | 0.007 |
| 0.500 | 0.000 | 0.26 | 0.05 | 0.10 | 0.010 |
| 0.707 | 0.000 | 0.27 | 0.06 | 0.12 | 0.013 |
| 0.913 | 0.000 | 0.27 | 0.07 | 0.15 | 0.015 |
| 1.120 | 0.000 | 0.27 | 0.08 | 0.17 | 0.017 |
| 1.327 | 0.000 | 0.27 | 0.08 | 0.18 | 0.018 |
| 1.533 | 0.000 | 0.27 | 0.09 | 0.20 | 0.019 |
| 1.740 | 0.000 | 0.28 | 0.09 | 0.21 | 0.021 |
| 1.947 | 0.000 | 0.28 | 0.10 | 0.22 | 0.021 |
| 2.153 | 0.000 | 0.28 | 0.10 | 0.23 | 0.022 |
| 2.360 | 0.000 | 0.28 | 0.10 | 0.24 | 0.023 |
| 2.567 | 0.000 | 0.29 | 0.11 | 0.25 | 0.024 |
| 2.773 | 0.000 | 0.29 | 0.11 | 0.26 | 0.024 |
| 2.980 | 0.000 | 0.29 | 0.11 | 0.26 | 0.025 |
| 3.187 | 0.000 | 0.29 | 0.12 | 0.27 | 0.025 |
| 3.393 | 0.000 | 0.30 | 0.12 | 0.27 | 0.026 |
| 3.600 | 0.000 | 0.30 | 0.12 | 0.28 | 0.026 |
| 3.807 | 0.000 | 0.30 | 0.12 | 0.28 | 0.027 |
| 4.013 | 0.000 | 0.31 | 0.12 | 0.28 | 0.027 |
| 4.220 | 0.000 | 0.31 | 0.12 | 0.29 | 0.027 |
| 4.427 | 0.000 | 0.31 | 0.13 | 0.29 | 0.028 |
| 4.633 | 0.000 | 0.32 | 0.13 | 0.30 | 0.028 |
| 4.840 | 0.000 | 0.32 | 0.13 | 0.30 | 0.028 |
| 5.047 | 0.000 | 0.32 | 0.13 | 0.30 | 0.029 |
| 5.253 | 0.000 | 0.33 | 0.13 | 0.31 | 0.029 |
| 5.460 | 0.000 | 0.33 | 0.13 | 0.31 | 0.029 |
| 5.667 | 0.000 | 0.33 | 0.14 | 0.31 | 0.030 |
| 5.873 | 0.000 | 0.34 | 0.14 | 0.32 | 0.030 |
| 6.080 | 0.000 | 0.34 | 0.14 | 0.32 | 0.030 |
| 6.287 | 0.000 | 0.35 | 0.14 | 0.33 | 0.031 |
| 6.493 | 0.000 | 0.35 | 0.14 | 0.33 | 0.031 |
| 6.700 | 0.000 | 0.36 | 0.14 | 0.33 | 0.032 |
| 6.907 | 0.000 | 0.36 | 0.15 | 0.34 | 0.032 |

| | | | | | |
|---|---|---|---|---|---|
| 7.113 | 0.000 | 0.37 | 0.15 | 0.34 | 0.032 |
| 7.320 | 0.000 | 0.37 | 0.15 | 0.35 | 0.033 |
| 7.527 | 0.000 | 0.38 | 0.15 | 0.35 | 0.033 |
| 7.733 | 0.000 | 0.38 | 0.15 | 0.36 | 0.034 |
| 7.940 | 0.000 | 0.39 | 0.15 | 0.36 | 0.034 |
| 8.147 | 0.000 | 0.39 | 0.16 | 0.36 | 0.035 |
| 8.353 | 0.000 | 0.40 | 0.16 | 0.37 | 0.035 |
| 8.560 | 0.000 | 0.40 | 0.16 | 0.38 | 0.036 |
| 8.767 | 0.000 | 0.41 | 0.16 | 0.38 | 0.036 |
| 8.973 | 0.000 | 0.42 | 0.17 | 0.39 | 0.037 |
| 9.180 | 0.000 | 0.43 | 0.17 | 0.39 | 0.037 |
| 9.387 | 0.000 | 0.43 | 0.17 | 0.40 | 0.038 |
| 9.593 | 0.000 | 0.44 | 0.17 | 0.41 | 0.038 |
| 9.800 | 0.000 | 0.45 | 0.18 | 0.41 | 0.039 |
| 10.007 | 0.000 | 0.46 | 0.18 | 0.42 | 0.040 |
| 10.213 | 0.000 | 0.47 | 0.18 | 0.43 | 0.040 |
| 10.420 | 0.000 | 0.48 | 0.19 | 0.43 | 0.041 |
| 10.627 | 0.000 | 0.49 | 0.19 | 0.44 | 0.042 |
| 10.833 | 0.000 | 0.50 | 0.19 | 0.45 | 0.043 |
| 11.040 | 0.000 | 0.51 | 0.20 | 0.46 | 0.044 |
| 11.247 | 0.000 | 0.53 | 0.20 | 0.47 | 0.045 |
| 11.453 | 0.000 | 0.54 | 0.21 | 0.48 | 0.046 |
| 11.660 | 0.000 | 0.56 | 0.21 | 0.49 | 0.047 |
| 11.867 | 0.000 | 0.57 | 0.22 | 0.50 | 0.048 |
| 12.073 | 0.000 | 0.59 | 0.22 | 0.52 | 0.049 |
| 12.280 | 0.000 | 0.76 | 0.24 | 0.54 | 0.053 |
| 12.487 | 0.000 | 0.78 | 0.26 | 0.58 | 0.056 |
| 12.693 | 0.000 | 0.80 | 0.27 | 0.61 | 0.059 |
| 12.900 | 0.000 | 0.83 | 0.28 | 0.65 | 0.063 |
| 13.107 | 0.000 | 0.85 | 0.30 | 0.68 | 0.065 |
| 13.313 | 0.000 | 0.89 | 0.31 | 0.71 | 0.068 |
| 13.520 | 0.000 | 0.91 | 0.32 | 0.74 | 0.071 |
| 13.727 | 0.000 | 0.96 | 0.34 | 0.77 | 0.074 |
| 13.933 | 0.000 | 0.99 | 0.35 | 0.81 | 0.077 |
| 14.140 | 0.000 | 1.05 | 0.37 | 0.84 | 0.081 |
| 14.347 | 0.000 | 1.09 | 0.38 | 0.88 | 0.085 |
| 14.553 | 0.000 | 1.18 | 0.40 | 0.92 | 0.089 |
| 14.760 | 0.000 | 1.23 | 0.42 | 0.97 | 0.093 |
| 14.967 | 0.000 | 1.36 | 0.45 | 1.02 | 0.099 |
| 15.173 | 0.000 | 1.45 | 0.48 | 1.09 | 0.105 |
| 15.380 | 0.000 | 1.69 | 0.52 | 1.18 | 0.114 |
| 15.587 | 0.000 | 1.53 | 0.53 | 1.28 | 0.118 |
| 15.793 | 0.000 | 2.09 | 0.58 | 1.42 | 0.130 |
| 16.000 | 0.000 | 2.87 | 0.67 | 1.70 | 0.150 |
| 16.207 | 0.000 | 12.24 | 1.29 | 2.77 | 0.312 |
| 16.413 | 0.000 | 1.70 | 1.18 | 3.59 | 0.279 |
| 16.620 | 0.000 | 1.55 | 1.06 | 3.45 | 0.247 |
| 16.827 | 0.000 | 1.29 | 0.94 | 3.20 | 0.215 |
| 17.033 | 0.000 | 1.13 | 0.82 | 2.78 | 0.186 |
| 17.240 | 0.000 | 1.02 | 0.73 | 2.33 | 0.164 |
| 17.447 | 0.000 | 0.93 | 0.65 | 1.97 | 0.146 |
| 17.653 | 0.000 | 0.87 | 0.59 | 1.69 | 0.132 |
| 17.860 | 0.000 | 0.81 | 0.55 | 1.47 | 0.121 |
| 18.067 | 0.000 | 0.77 | 0.51 | 1.29 | 0.112 |
| 18.273 | 0.000 | 0.58 | 0.47 | 1.15 | 0.102 |
| 18.480 | 0.000 | 0.55 | 0.43 | 1.04 | 0.094 |
| 18.687 | 0.000 | 0.52 | 0.39 | 0.96 | 0.086 |

| | | | | | |
|---|---|---|---|---|---|
| 18.893 | 0.000 | 0.49 | 0.36 | 0.88 | 0.080 |
| 19.100 | 0.000 | 0.47 | 0.34 | 0.82 | 0.074 |
| 19.307 | 0.000 | 0.45 | 0.31 | 0.76 | 0.069 |
| 19.513 | 0.000 | 0.44 | 0.29 | 0.71 | 0.064 |
| 19.720 | 0.000 | 0.42 | 0.27 | 0.66 | 0.060 |
| 19.927 | 0.000 | 0.41 | 0.26 | 0.62 | 0.056 |
| 20.133 | 0.000 | 0.40 | 0.24 | 0.58 | 0.053 |
| 20.340 | 0.000 | 0.38 | 0.23 | 0.55 | 0.050 |
| 20.547 | 0.000 | 0.37 | 0.22 | 0.52 | 0.048 |
| 20.753 | 0.000 | 0.36 | 0.21 | 0.50 | 0.046 |
| 20.960 | 0.000 | 0.35 | 0.20 | 0.47 | 0.043 |
| 21.167 | 0.000 | 0.34 | 0.19 | 0.45 | 0.042 |
| 21.373 | 0.000 | 0.34 | 0.18 | 0.43 | 0.040 |
| 21.580 | 0.000 | 0.33 | 0.17 | 0.42 | 0.038 |
| 21.787 | 0.000 | 0.32 | 0.17 | 0.40 | 0.037 |
| 21.993 | 0.000 | 0.31 | 0.16 | 0.39 | 0.036 |
| 22.200 | 0.000 | 0.31 | 0.16 | 0.38 | 0.035 |
| 22.407 | 0.000 | 0.30 | 0.15 | 0.36 | 0.034 |
| 22.613 | 0.000 | 0.30 | 0.15 | 0.35 | 0.033 |
| 22.820 | 0.000 | 0.29 | 0.14 | 0.34 | 0.032 |
| 23.027 | 0.000 | 0.29 | 0.14 | 0.33 | 0.031 |
| 23.233 | 0.000 | 0.28 | 0.14 | 0.33 | 0.030 |
| 23.440 | 0.000 | 0.28 | 0.13 | 0.32 | 0.030 |
| 23.647 | 0.000 | 0.27 | 0.13 | 0.31 | 0.029 |
| 23.853 | 0.000 | 0.27 | 0.13 | 0.30 | 0.028 |
| 24.060 | 0.000 | 0.26 | 0.13 | 0.30 | 0.028 |
| 24.267 | 0.000 | 0.00 | 0.10 | 0.27 | 0.023 |

```
**************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
==========================================================================
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                         Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

**************************************************************************
--------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin2 5yr
--------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =   10.80
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.357
```

```
TIME OF CONCENTRATION(MIN.) = 12.40
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) =   5
   5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
  30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
   1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
   3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
   6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
  24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

--------------------------------------------------------------------------

TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.88
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     1.26

**************************************************************************
 TIME     VOLUME       Q    0.        5.0      10.0      15.0      20.0
(HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------
 0.09     0.0015      0.41  Q         .         .         .         .
 0.29     0.0085      0.41  Q         .         .         .         .
 0.50     0.0156      0.42  Q         .         .         .         .
 0.71     0.0228      0.42  Q         .         .         .         .
 0.91     0.0300      0.42  Q         .         .         .         .
 1.12     0.0373      0.43  Q         .         .         .         .
 1.33     0.0446      0.43  Q         .         .         .         .
 1.53     0.0519      0.43  Q         .         .         .         .
 1.74     0.0594      0.44  Q         .         .         .         .
 1.95     0.0668      0.44  Q         .         .         .         .
 2.15     0.0744      0.44  Q         .         .         .         .
 2.36     0.0820      0.45  Q         .         .         .         .
 2.57     0.0897      0.45  Q         .         .         .         .
 2.77     0.0974      0.45  Q         .         .         .         .
 2.98     0.1052      0.46  Q         .         .         .         .
 3.19     0.1131      0.46  Q         .         .         .         .
 3.39     0.1210      0.47  Q         .         .         .         .
 3.60     0.1290      0.47  Q         .         .         .         .
 3.81     0.1371      0.48  Q         .         .         .         .
 4.01     0.1452      0.48  Q         .         .         .         .
 4.22     0.1534      0.48  Q         .         .         .         .
 4.43     0.1617      0.49  Q         .         .         .         .
 4.63     0.1701      0.49  Q         .         .         .         .
 4.84     0.1786      0.50  Q         .         .         .         .
 5.05     0.1871      0.50  .Q        .         .         .         .
 5.25     0.1958      0.51  .Q        .         .         .         .
 5.46     0.2045      0.51  .Q        .         .         .         .
 5.67     0.2133      0.52  .Q        .         .         .         .
 5.87     0.2222      0.53  .Q        .         .         .         .
 6.08     0.2313      0.53  .Q        .         .         .         .
 6.29     0.2404      0.54  .Q        .         .         .         .
 6.49     0.2496      0.54  .Q        .         .         .         .
 6.70     0.2589      0.55  .Q        .         .         .         .
 6.91     0.2684      0.55  .Q        .         .         .         .
 7.11     0.2779      0.56  .Q        .         .         .         .
 7.32     0.2876      0.57  .Q        .         .         .         .
 7.53     0.2974      0.58  .Q        .         .         .         .
```

| | | | |
|---|---|---|---|
| 7.73 | 0.3073 | 0.58 | .Q . . . . |
| 7.94 | 0.3174 | 0.59 | .Q . . . . |
| 8.15 | 0.3276 | 0.60 | .Q . . . . |
| 8.35 | 0.3379 | 0.61 | .Q . . . . |
| 8.56 | 0.3484 | 0.62 | .Q . . . . |
| 8.77 | 0.3591 | 0.63 | .Q . . . . |
| 8.97 | 0.3699 | 0.64 | .Q . . . . |
| 9.18 | 0.3809 | 0.65 | .Q . . . . |
| 9.39 | 0.3920 | 0.66 | .Q . . . . |
| 9.59 | 0.4034 | 0.67 | .Q . . . . |
| 9.80 | 0.4149 | 0.68 | .Q . . . . |
| 10.01 | 0.4267 | 0.70 | .Q . . . . |
| 10.21 | 0.4387 | 0.71 | .Q . . . . |
| 10.42 | 0.4509 | 0.72 | .Q . . . . |
| 10.63 | 0.4633 | 0.73 | .Q . . . . |
| 10.83 | 0.4760 | 0.75 | .Q . . . . |
| 11.04 | 0.4890 | 0.76 | .Q . . . . |
| 11.25 | 0.5023 | 0.79 | .Q . . . . |
| 11.45 | 0.5158 | 0.80 | .Q . . . . |
| 11.66 | 0.5297 | 0.83 | .Q . . . . |
| 11.87 | 0.5440 | 0.84 | .Q . . . . |
| 12.07 | 0.5586 | 0.88 | .Q . . . . |
| 12.28 | 0.5746 | 0.99 | .Q . . . . |
| 12.49 | 0.5918 | 1.03 | . Q . . . . |
| 12.69 | 0.6095 | 1.05 | . Q . . . . |
| 12.90 | 0.6278 | 1.09 | . Q . . . . |
| 13.11 | 0.6466 | 1.11 | . Q . . . . |
| 13.31 | 0.6661 | 1.17 | . Q . . . . |
| 13.52 | 0.6862 | 1.20 | . Q . . . . |
| 13.73 | 0.7072 | 1.26 | . Q . . . . |
| 13.93 | 0.7290 | 1.30 | . Q . . . . |
| 14.14 | 0.7519 | 1.38 | . Q . . . . |
| 14.35 | 0.7760 | 1.43 | . Q . . . . |
| 14.55 | 0.8015 | 1.55 | . Q . . . . |
| 14.76 | 0.8286 | 1.62 | . Q . . . . |
| 14.97 | 0.8578 | 1.80 | . Q . . . . |
| 15.17 | 0.8895 | 1.92 | . Q . . . . |
| 15.38 | 0.9250 | 2.23 | . Q . . . . |
| 15.59 | 0.9615 | 2.04 | . Q . . . . |
| 15.79 | 1.0029 | 2.80 | . Q . . . . |
| 16.00 | 1.0598 | 3.86 | . Q . . . . |
| 16.21 | 1.2315 | 16.25 | . . . . Q . |
| 16.41 | 1.3897 | 2.28 | . Q . . . . |
| 16.62 | 1.4268 | 2.06 | . Q . . . . |
| 16.83 | 1.4589 | 1.70 | . Q . . . . |
| 17.03 | 1.4862 | 1.49 | . Q . . . . |
| 17.24 | 1.5103 | 1.34 | . Q . . . . |
| 17.45 | 1.5322 | 1.23 | . Q . . . . |
| 17.65 | 1.5524 | 1.14 | . Q . . . . |
| 17.86 | 1.5713 | 1.07 | . Q . . . . |
| 18.07 | 1.5890 | 1.01 | . Q . . . . |
| 18.27 | 1.6049 | 0.86 | .Q . . . . |
| 18.48 | 1.6192 | 0.81 | .Q . . . . |
| 18.69 | 1.6328 | 0.78 | .Q . . . . |
| 18.89 | 1.6457 | 0.74 | .Q . . . . |
| 19.10 | 1.6582 | 0.71 | .Q . . . . |
| 19.31 | 1.6702 | 0.69 | .Q . . . . |

```
19.51      1.6817      0.66  .Q        .         .         .         .
19.72      1.6929      0.64  .Q        .         .         .         .
19.93      1.7037      0.62  .Q        .         .         .         .
20.13      1.7142      0.61  .Q        .         .         .         .
20.34      1.7244      0.59  .Q        .         .         .         .
20.55      1.7343      0.57  .Q        .         .         .         .
20.75      1.7440      0.56  .Q        .         .         .         .
20.96      1.7534      0.55  .Q        .         .         .         .
21.17      1.7627      0.53  .Q        .         .         .         .
21.37      1.7717      0.52  .Q        .         .         .         .
21.58      1.7805      0.51  .Q        .         .         .         .
21.79      1.7891      0.50  .Q        .         .         .         .
21.99      1.7976      0.49  Q         .         .         .         .
22.20      1.8059      0.48  Q         .         .         .         .
22.41      1.8141      0.47  Q         .         .         .         .
22.61      1.8221      0.46  Q         .         .         .         .
22.82      1.8299      0.46  Q         .         .         .         .
23.03      1.8377      0.45  Q         .         .         .         .
23.23      1.8453      0.44  Q         .         .         .         .
23.44      1.8527      0.43  Q         .         .         .         .
23.65      1.8601      0.43  Q         .         .         .         .
23.85      1.8674      0.42  Q         .         .         .         .
24.06      1.8745      0.42  Q         .         .         .         .
24.27      1.8781      0.00  Q         .         .         .         .
-------------------------------------------------------------------------
-------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                Duration
       Peak Flow Rate                     (minutes)
   =======================                =========
             0%                            1450.8
            10%                             124.0
            20%                              24.8
            30%                              12.4
            40%                              12.4
            50%                              12.4
            60%                              12.4
            70%                              12.4
            80%                              12.4
            90%                              12.4

  Problem Descriptions:


  wq Basin2 5yr


=========================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   12.400
     DEAD STORAGE(AF) =       0.00
```

```
SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                INFLOW
                  |
                  |
                  |
                  V                 __effective depth
            -------------           |   (and volume)
            |           |     |     |
            | detention |     |....V.............
            |   basin   |<-->|          outflow
            |           |     |.........________
            -------------     |         |   \
                  |           | storage |     basin outlet
                  V           -----------
               OUTFLOW
```

DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES = 9

| *BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) ** | **BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) * |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000** | 0.500 | 0.110 | 1.170* |
| 1.000 | 0.230 | 3.300** | 1.500 | 0.370 | 3.910* |
| 2.000 | 0.520 | 4.790** | 2.500 | 0.680 | 5.530* |
| 3.000 | 0.860 | 6.180** | 3.500 | 1.050 | 6.770* |
| 4.000 | 1.240 | 7.310** | | | |

---

BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:

| INTERVAL NUMBER | DEPTH (FEET) | {S-O*DT/2} (ACRE-FEET) | {S+O*DT/2} (ACRE-FEET) |
|---|---|---|---|
| 1 | 0.00 | 0.00000 | 0.00000 |
| 2 | 0.50 | 0.10001 | 0.11999 |
| 3 | 1.00 | 0.20182 | 0.25818 |
| 4 | 1.50 | 0.33661 | 0.40339 |
| 5 | 2.00 | 0.47909 | 0.56091 |
| 6 | 2.50 | 0.63277 | 0.72723 |
| 7 | 3.00 | 0.80722 | 0.91278 |
| 8 | 3.50 | 0.99218 | 1.10782 |
| 9 | 4.00 | 1.17757 | 1.30243 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

---

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.087 | 0.000 | 0.41 | 0.03 | 0.03 | 0.006 |
| 0.293 | 0.000 | 0.41 | 0.05 | 0.10 | 0.012 |
| 0.500 | 0.000 | 0.42 | 0.07 | 0.15 | 0.016 |
| 0.707 | 0.000 | 0.42 | 0.09 | 0.20 | 0.020 |
| 0.913 | 0.000 | 0.42 | 0.11 | 0.23 | 0.024 |

| | | | | | |
|---|---|---|---|---|---|
| 1.120 | 0.000 | 0.43 | 0.12 | 0.26 | 0.026 |
| 1.327 | 0.000 | 0.43 | 0.13 | 0.29 | 0.029 |
| 1.533 | 0.000 | 0.43 | 0.14 | 0.32 | 0.031 |
| 1.740 | 0.000 | 0.44 | 0.15 | 0.34 | 0.032 |
| 1.947 | 0.000 | 0.44 | 0.15 | 0.35 | 0.034 |
| 2.153 | 0.000 | 0.44 | 0.16 | 0.37 | 0.035 |
| 2.360 | 0.000 | 0.45 | 0.17 | 0.38 | 0.036 |
| 2.567 | 0.000 | 0.45 | 0.17 | 0.39 | 0.037 |
| 2.773 | 0.000 | 0.45 | 0.17 | 0.40 | 0.038 |
| 2.980 | 0.000 | 0.46 | 0.18 | 0.41 | 0.039 |
| 3.187 | 0.000 | 0.46 | 0.18 | 0.42 | 0.040 |
| 3.393 | 0.000 | 0.47 | 0.18 | 0.43 | 0.040 |
| 3.600 | 0.000 | 0.47 | 0.19 | 0.43 | 0.041 |
| 3.807 | 0.000 | 0.48 | 0.19 | 0.44 | 0.042 |
| 4.013 | 0.000 | 0.48 | 0.19 | 0.45 | 0.042 |
| 4.220 | 0.000 | 0.48 | 0.19 | 0.45 | 0.043 |
| 4.427 | 0.000 | 0.49 | 0.20 | 0.46 | 0.043 |
| 4.633 | 0.000 | 0.49 | 0.20 | 0.46 | 0.044 |
| 4.840 | 0.000 | 0.50 | 0.20 | 0.47 | 0.044 |
| 5.047 | 0.000 | 0.50 | 0.20 | 0.47 | 0.045 |
| 5.253 | 0.000 | 0.51 | 0.21 | 0.48 | 0.045 |
| 5.460 | 0.000 | 0.51 | 0.21 | 0.48 | 0.046 |
| 5.667 | 0.000 | 0.52 | 0.21 | 0.49 | 0.046 |
| 5.873 | 0.000 | 0.53 | 0.21 | 0.50 | 0.047 |
| 6.080 | 0.000 | 0.53 | 0.22 | 0.50 | 0.047 |
| 6.287 | 0.000 | 0.54 | 0.22 | 0.51 | 0.048 |
| 6.493 | 0.000 | 0.54 | 0.22 | 0.51 | 0.048 |
| 6.700 | 0.000 | 0.55 | 0.22 | 0.52 | 0.049 |
| 6.907 | 0.000 | 0.55 | 0.22 | 0.52 | 0.049 |
| 7.113 | 0.000 | 0.56 | 0.23 | 0.53 | 0.050 |
| 7.320 | 0.000 | 0.57 | 0.23 | 0.54 | 0.051 |
| 7.527 | 0.000 | 0.58 | 0.23 | 0.54 | 0.051 |
| 7.733 | 0.000 | 0.58 | 0.24 | 0.55 | 0.052 |
| 7.940 | 0.000 | 0.59 | 0.24 | 0.56 | 0.053 |
| 8.147 | 0.000 | 0.60 | 0.24 | 0.56 | 0.053 |
| 8.353 | 0.000 | 0.61 | 0.24 | 0.57 | 0.054 |
| 8.560 | 0.000 | 0.62 | 0.25 | 0.58 | 0.055 |
| 8.767 | 0.000 | 0.63 | 0.25 | 0.58 | 0.055 |
| 8.973 | 0.000 | 0.64 | 0.26 | 0.59 | 0.056 |
| 9.180 | 0.000 | 0.65 | 0.26 | 0.60 | 0.057 |
| 9.387 | 0.000 | 0.66 | 0.26 | 0.61 | 0.058 |
| 9.593 | 0.000 | 0.67 | 0.27 | 0.62 | 0.059 |
| 9.800 | 0.000 | 0.68 | 0.27 | 0.63 | 0.060 |
| 10.007 | 0.000 | 0.70 | 0.28 | 0.64 | 0.061 |
| 10.213 | 0.000 | 0.71 | 0.28 | 0.65 | 0.061 |
| 10.420 | 0.000 | 0.72 | 0.28 | 0.66 | 0.063 |
| 10.627 | 0.000 | 0.73 | 0.29 | 0.67 | 0.064 |
| 10.833 | 0.000 | 0.75 | 0.29 | 0.68 | 0.065 |
| 11.040 | 0.000 | 0.76 | 0.30 | 0.70 | 0.066 |
| 11.247 | 0.000 | 0.79 | 0.31 | 0.71 | 0.067 |
| 11.453 | 0.000 | 0.80 | 0.31 | 0.72 | 0.069 |
| 11.660 | 0.000 | 0.83 | 0.32 | 0.74 | 0.070 |
| 11.867 | 0.000 | 0.84 | 0.33 | 0.75 | 0.072 |
| 12.073 | 0.000 | 0.88 | 0.33 | 0.77 | 0.073 |
| 12.280 | 0.000 | 0.99 | 0.35 | 0.80 | 0.077 |
| 12.487 | 0.000 | 1.03 | 0.36 | 0.83 | 0.080 |
| 12.693 | 0.000 | 1.05 | 0.38 | 0.87 | 0.083 |

| | | | | | |
|---|---|---|---|---|---|
| 12.900 | 0.000 | 1.09 | 0.39 | 0.90 | 0.086 |
| 13.107 | 0.000 | 1.11 | 0.41 | 0.93 | 0.089 |
| 13.313 | 0.000 | 1.17 | 0.42 | 0.97 | 0.093 |
| 13.520 | 0.000 | 1.20 | 0.44 | 1.00 | 0.096 |
| 13.727 | 0.000 | 1.26 | 0.45 | 1.04 | 0.100 |
| 13.933 | 0.000 | 1.30 | 0.47 | 1.08 | 0.103 |
| 14.140 | 0.000 | 1.38 | 0.49 | 1.12 | 0.108 |
| 14.347 | 0.000 | 1.43 | 0.51 | 1.18 | 0.112 |
| 14.553 | 0.000 | 1.55 | 0.53 | 1.25 | 0.117 |
| 14.760 | 0.000 | 1.62 | 0.55 | 1.34 | 0.122 |
| 14.967 | 0.000 | 1.80 | 0.58 | 1.44 | 0.128 |
| 15.173 | 0.000 | 1.92 | 0.60 | 1.55 | 0.135 |
| 15.380 | 0.000 | 2.23 | 0.64 | 1.69 | 0.144 |
| 15.587 | 0.000 | 2.04 | 0.66 | 1.81 | 0.148 |
| 15.793 | 0.000 | 2.80 | 0.72 | 1.97 | 0.162 |
| 16.000 | 0.000 | 3.86 | 0.83 | 2.33 | 0.188 |
| 16.207 | 0.000 | 16.25 | 1.63 | 3.35 | 0.409 |
| 16.413 | 0.000 | 2.28 | 1.53 | 4.05 | 0.378 |
| 16.620 | 0.000 | 2.06 | 1.42 | 3.89 | 0.347 |
| 16.827 | 0.000 | 1.70 | 1.29 | 3.74 | 0.313 |
| 17.033 | 0.000 | 1.49 | 1.17 | 3.58 | 0.277 |
| 17.240 | 0.000 | 1.34 | 1.04 | 3.43 | 0.241 |
| 17.447 | 0.000 | 1.23 | 0.91 | 3.13 | 0.209 |
| 17.653 | 0.000 | 1.14 | 0.80 | 2.68 | 0.182 |
| 17.860 | 0.000 | 1.07 | 0.72 | 2.27 | 0.162 |
| 18.067 | 0.000 | 1.01 | 0.65 | 1.94 | 0.146 |
| 18.273 | 0.000 | 0.86 | 0.59 | 1.68 | 0.132 |
| 18.480 | 0.000 | 0.81 | 0.54 | 1.46 | 0.121 |
| 18.687 | 0.000 | 0.78 | 0.51 | 1.28 | 0.112 |
| 18.893 | 0.000 | 0.74 | 0.48 | 1.16 | 0.105 |
| 19.100 | 0.000 | 0.71 | 0.45 | 1.08 | 0.099 |
| 19.307 | 0.000 | 0.69 | 0.42 | 1.02 | 0.093 |
| 19.513 | 0.000 | 0.66 | 0.40 | 0.96 | 0.088 |
| 19.720 | 0.000 | 0.64 | 0.38 | 0.91 | 0.083 |
| 19.927 | 0.000 | 0.62 | 0.36 | 0.86 | 0.079 |
| 20.133 | 0.000 | 0.61 | 0.34 | 0.82 | 0.075 |
| 20.340 | 0.000 | 0.59 | 0.33 | 0.79 | 0.072 |
| 20.547 | 0.000 | 0.57 | 0.31 | 0.75 | 0.069 |
| 20.753 | 0.000 | 0.56 | 0.30 | 0.72 | 0.066 |
| 20.960 | 0.000 | 0.55 | 0.29 | 0.69 | 0.064 |
| 21.167 | 0.000 | 0.53 | 0.28 | 0.67 | 0.062 |
| 21.373 | 0.000 | 0.52 | 0.27 | 0.64 | 0.059 |
| 21.580 | 0.000 | 0.51 | 0.26 | 0.62 | 0.058 |
| 21.787 | 0.000 | 0.50 | 0.25 | 0.60 | 0.056 |
| 21.993 | 0.000 | 0.49 | 0.25 | 0.59 | 0.054 |
| 22.200 | 0.000 | 0.48 | 0.24 | 0.57 | 0.053 |
| 22.407 | 0.000 | 0.47 | 0.23 | 0.55 | 0.051 |
| 22.613 | 0.000 | 0.46 | 0.23 | 0.54 | 0.050 |
| 22.820 | 0.000 | 0.46 | 0.22 | 0.53 | 0.049 |
| 23.027 | 0.000 | 0.45 | 0.22 | 0.51 | 0.048 |
| 23.233 | 0.000 | 0.44 | 0.21 | 0.50 | 0.047 |
| 23.440 | 0.000 | 0.43 | 0.21 | 0.49 | 0.046 |
| 23.647 | 0.000 | 0.43 | 0.20 | 0.48 | 0.045 |
| 23.853 | 0.000 | 0.42 | 0.20 | 0.47 | 0.044 |
| 24.060 | 0.000 | 0.42 | 0.20 | 0.46 | 0.043 |
| 24.267 | 0.000 | 0.00 | 0.16 | 0.42 | 0.036 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin3 1yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     8.80
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.418
    TIME OF CONCENTRATION(MIN.) = 11.94
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93

----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.77
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.65

****************************************************************************
  TIME     VOLUME       Q    0.        2.5       5.0       7.5      10.0
 (HOURS)    (AF)      (CFS)
----------------------------------------------------------------------------
  0.08      0.0000      0.00  Q         .         .         .         .
  0.28      0.0011      0.13  Q         .         .         .         .
  0.48      0.0032      0.13  Q         .         .         .         .
  0.68      0.0054      0.13  Q         .         .         .         .
  0.88      0.0076      0.13  Q         .         .         .         .
  1.08      0.0098      0.13  Q         .         .         .         .
  1.27      0.0120      0.14  Q         .         .         .         .
  1.47      0.0142      0.14  Q         .         .         .         .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.67 | 0.0165 | 0.14 | Q | . | . | . | . |
| 1.87 | 0.0188 | 0.14 | Q | . | . | . | . |
| 2.07 | 0.0211 | 0.14 | Q | . | . | . | . |
| 2.27 | 0.0234 | 0.14 | Q | . | . | . | . |
| 2.47 | 0.0257 | 0.14 | Q | . | . | . | . |
| 2.67 | 0.0281 | 0.14 | Q | . | . | . | . |
| 2.87 | 0.0305 | 0.15 | Q | . | . | . | . |
| 3.07 | 0.0329 | 0.15 | Q | . | . | . | . |
| 3.26 | 0.0353 | 0.15 | Q | . | . | . | . |
| 3.46 | 0.0378 | 0.15 | Q | . | . | . | . |
| 3.66 | 0.0403 | 0.15 | Q | . | . | . | . |
| 3.86 | 0.0428 | 0.15 | Q | . | . | . | . |
| 4.06 | 0.0453 | 0.15 | Q | . | . | . | . |
| 4.26 | 0.0479 | 0.16 | Q | . | . | . | . |
| 4.46 | 0.0505 | 0.16 | Q | . | . | . | . |
| 4.66 | 0.0531 | 0.16 | Q | . | . | . | . |
| 4.86 | 0.0557 | 0.16 | Q | . | . | . | . |
| 5.06 | 0.0584 | 0.16 | Q | . | . | . | . |
| 5.25 | 0.0611 | 0.17 | Q | . | . | . | . |
| 5.45 | 0.0639 | 0.17 | Q | . | . | . | . |
| 5.65 | 0.0666 | 0.17 | Q | . | . | . | . |
| 5.85 | 0.0695 | 0.17 | Q | . | . | . | . |
| 6.05 | 0.0723 | 0.17 | Q | . | . | . | . |
| 6.25 | 0.0752 | 0.18 | Q | . | . | . | . |
| 6.45 | 0.0781 | 0.18 | Q | . | . | . | . |
| 6.65 | 0.0811 | 0.18 | Q | . | . | . | . |
| 6.85 | 0.0841 | 0.18 | Q | . | . | . | . |
| 7.05 | 0.0871 | 0.19 | Q | . | . | . | . |
| 7.24 | 0.0902 | 0.19 | Q | . | . | . | . |
| 7.44 | 0.0933 | 0.19 | Q | . | . | . | . |
| 7.64 | 0.0965 | 0.19 | Q | . | . | . | . |
| 7.84 | 0.0998 | 0.20 | Q | . | . | . | . |
| 8.04 | 0.1030 | 0.20 | Q | . | . | . | . |
| 8.24 | 0.1064 | 0.20 | Q | . | . | . | . |
| 8.44 | 0.1098 | 0.21 | Q | . | . | . | . |
| 8.64 | 0.1132 | 0.21 | Q | . | . | . | . |
| 8.84 | 0.1167 | 0.21 | Q | . | . | . | . |
| 9.04 | 0.1203 | 0.22 | Q | . | . | . | . |
| 9.23 | 0.1239 | 0.22 | Q | . | . | . | . |
| 9.43 | 0.1276 | 0.23 | Q | . | . | . | . |
| 9.63 | 0.1314 | 0.23 | Q | . | . | . | . |
| 9.83 | 0.1352 | 0.24 | Q | . | . | . | . |
| 10.03 | 0.1392 | 0.24 | Q | . | . | . | . |
| 10.23 | 0.1432 | 0.25 | Q | . | . | . | . |
| 10.43 | 0.1473 | 0.25 | .Q | . | . | . | . |
| 10.63 | 0.1515 | 0.26 | .Q | . | . | . | . |
| 10.83 | 0.1558 | 0.26 | .Q | . | . | . | . |
| 11.02 | 0.1602 | 0.27 | .Q | . | . | . | . |
| 11.22 | 0.1647 | 0.28 | .Q | . | . | . | . |
| 11.42 | 0.1693 | 0.29 | .Q | . | . | . | . |
| 11.62 | 0.1741 | 0.29 | .Q | . | . | . | . |
| 11.82 | 0.1790 | 0.30 | .Q | . | . | . | . |
| 12.02 | 0.1840 | 0.31 | .Q | . | . | . | . |
| 12.22 | 0.1906 | 0.49 | .Q | . | . | . | . |
| 12.42 | 0.1987 | 0.50 | .Q | . | . | . | . |
| 12.62 | 0.2070 | 0.52 | . Q | . | . | . | . |
| 12.82 | 0.2156 | 0.52 | . Q | . | . | . | . |

| | | | |
|---|---|---|---|
| 13.02 | 0.2244 | 0.55 | . Q . . . . |
| 13.21 | 0.2334 | 0.56 | . Q . . . . |
| 13.41 | 0.2428 | 0.58 | . Q . . . . |
| 13.61 | 0.2525 | 0.60 | . Q . . . . |
| 13.81 | 0.2625 | 0.63 | . Q . . . . |
| 14.01 | 0.2730 | 0.64 | . Q . . . . |
| 14.21 | 0.2839 | 0.68 | . Q . . . . |
| 14.41 | 0.2953 | 0.71 | . Q . . . . |
| 14.61 | 0.3074 | 0.76 | . Q . . . . |
| 14.81 | 0.3202 | 0.80 | . Q . . . . |
| 15.01 | 0.3340 | 0.88 | . Q . . . . |
| 15.20 | 0.3489 | 0.93 | . Q . . . . |
| 15.40 | 0.3654 | 1.07 | . Q . . . . |
| 15.60 | 0.3817 | 0.91 | . Q . . . . |
| 15.80 | 0.3998 | 1.30 | . Q . . . . |
| 16.00 | 0.4252 | 1.78 | . Q . . . . |
| 16.20 | 0.5018 | 7.54 | . . . Q . |
| 16.40 | 0.5725 | 1.06 | . Q . . . . |
| 16.60 | 0.5894 | 1.00 | . Q . . . . |
| 16.80 | 0.6045 | 0.83 | . Q . . . . |
| 17.00 | 0.6174 | 0.73 | . Q . . . . |
| 17.19 | 0.6288 | 0.66 | . Q . . . . |
| 17.39 | 0.6393 | 0.61 | . Q . . . . |
| 17.59 | 0.6490 | 0.57 | . Q . . . . |
| 17.79 | 0.6581 | 0.53 | . Q . . . . |
| 17.99 | 0.6666 | 0.51 | . Q . . . . |
| 18.19 | 0.6736 | 0.34 | .Q . . . . |
| 18.39 | 0.6789 | 0.30 | .Q . . . . |
| 18.59 | 0.6836 | 0.28 | .Q . . . . |
| 18.79 | 0.6881 | 0.27 | .Q . . . . |
| 18.98 | 0.6924 | 0.26 | .Q . . . . |
| 19.18 | 0.6965 | 0.24 | Q . . . . |
| 19.38 | 0.7005 | 0.23 | Q . . . . |
| 19.58 | 0.7042 | 0.23 | Q . . . . |
| 19.78 | 0.7079 | 0.22 | Q . . . . |
| 19.98 | 0.7114 | 0.21 | Q . . . . |
| 20.18 | 0.7148 | 0.20 | Q . . . . |
| 20.38 | 0.7181 | 0.20 | Q . . . . |
| 20.58 | 0.7212 | 0.19 | Q . . . . |
| 20.78 | 0.7243 | 0.19 | Q . . . . |
| 20.98 | 0.7273 | 0.18 | Q . . . . |
| 21.17 | 0.7302 | 0.18 | Q . . . . |
| 21.37 | 0.7331 | 0.17 | Q . . . . |
| 21.57 | 0.7359 | 0.17 | Q . . . . |
| 21.77 | 0.7386 | 0.16 | Q . . . . |
| 21.97 | 0.7412 | 0.16 | Q . . . . |
| 22.17 | 0.7438 | 0.16 | Q . . . . |
| 22.37 | 0.7464 | 0.15 | Q . . . . |
| 22.57 | 0.7489 | 0.15 | Q . . . . |
| 22.77 | 0.7513 | 0.15 | Q . . . . |
| 22.97 | 0.7537 | 0.14 | Q . . . . |
| 23.16 | 0.7560 | 0.14 | Q . . . . |
| 23.36 | 0.7583 | 0.14 | Q . . . . |
| 23.56 | 0.7606 | 0.14 | Q . . . . |
| 23.76 | 0.7628 | 0.13 | Q . . . . |
| 23.96 | 0.7650 | 0.13 | Q . . . . |
| 24.16 | 0.7671 | 0.13 | Q . . . . |

```
 24.36      0.7682      0.00  Q          .          .          .          .
 ---------------------------------------------------------------------------
-----------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    ======================                   =========
              0%                              1444.7
             10%                               143.3
             20%                                23.9
             30%                                11.9
             40%                                11.9
             50%                                11.9
             60%                                11.9
             70%                                11.9
             80%                                11.9
             90%                                11.9

  Problem Descriptions:


   wq Basin3 1yr


=============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   11.940
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                  INFLOW
                    |
                    |
                    |
                    V                 __effective depth
               -------------          |   (and volume)
               |           |     |    |
               | detention |     |....V.............
               |   basin   |<-->|          outflow
               |           |     |.........________
               -------------     |         |   \
                    |            | storage |     basin outlet
                    V            -----------
                 OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
```

```
*   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
*     0.000      0.000     0.000**     0.500      0.060     1.550*
*     1.000      0.120     4.390**     1.500      0.200     6.320*
*     2.000      0.280     7.990**     2.500      0.380     9.360*
*     3.000      0.480    10.560**     3.500      0.590    11.640*
*     4.000      0.700    12.620**
-------------------------------------------------------------------------
BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:
 INTERVAL   DEPTH   {S-O*DT/2}   {S+O*DT/2}
  NUMBER   (FEET)   (ACRE-FEET)  (ACRE-FEET)
      1     0.00       0.00000      0.00000
      2     0.50       0.04725      0.07275
      3     1.00       0.08390      0.15610
      4     1.50       0.14803      0.25197
      5     2.00       0.21430      0.34570
      6     2.50       0.30303      0.45697
      7     3.00       0.39316      0.56684
      8     3.50       0.49428      0.68572
      9     4.00       0.59622      0.80378
WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)
-------------------------------------------------------------------------
DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES
      OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE
      AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.
```

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.080 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 0.279 | 0.000 | 0.13 | 0.01 | 0.02 | 0.002 |
| 0.478 | 0.000 | 0.13 | 0.02 | 0.06 | 0.003 |
| 0.677 | 0.000 | 0.13 | 0.03 | 0.09 | 0.004 |
| 0.876 | 0.000 | 0.13 | 0.04 | 0.10 | 0.004 |
| 1.075 | 0.000 | 0.13 | 0.04 | 0.11 | 0.005 |
| 1.274 | 0.000 | 0.14 | 0.04 | 0.12 | 0.005 |
| 1.473 | 0.000 | 0.14 | 0.04 | 0.13 | 0.005 |
| 1.672 | 0.000 | 0.14 | 0.04 | 0.13 | 0.005 |
| 1.871 | 0.000 | 0.14 | 0.04 | 0.13 | 0.005 |
| 2.070 | 0.000 | 0.14 | 0.04 | 0.14 | 0.005 |
| 2.269 | 0.000 | 0.14 | 0.04 | 0.14 | 0.005 |
| 2.468 | 0.000 | 0.14 | 0.05 | 0.14 | 0.005 |
| 2.667 | 0.000 | 0.14 | 0.05 | 0.14 | 0.005 |
| 2.866 | 0.000 | 0.15 | 0.05 | 0.14 | 0.006 |
| 3.065 | 0.000 | 0.15 | 0.05 | 0.14 | 0.006 |
| 3.264 | 0.000 | 0.15 | 0.05 | 0.15 | 0.006 |
| 3.463 | 0.000 | 0.15 | 0.05 | 0.15 | 0.006 |
| 3.662 | 0.000 | 0.15 | 0.05 | 0.15 | 0.006 |
| 3.861 | 0.000 | 0.15 | 0.05 | 0.15 | 0.006 |
| 4.060 | 0.000 | 0.15 | 0.05 | 0.15 | 0.006 |
| 4.259 | 0.000 | 0.16 | 0.05 | 0.15 | 0.006 |
| 4.458 | 0.000 | 0.16 | 0.05 | 0.15 | 0.006 |
| 4.657 | 0.000 | 0.16 | 0.05 | 0.16 | 0.006 |
| 4.856 | 0.000 | 0.16 | 0.05 | 0.16 | 0.006 |
| 5.055 | 0.000 | 0.16 | 0.05 | 0.16 | 0.006 |
| 5.254 | 0.000 | 0.17 | 0.05 | 0.16 | 0.006 |
| 5.453 | 0.000 | 0.17 | 0.05 | 0.16 | 0.006 |

| | | | | | |
|---|---|---|---|---|---|
| 5.652 | 0.000 | 0.17 | 0.05 | 0.17 | 0.006 |
| 5.851 | 0.000 | 0.17 | 0.05 | 0.17 | 0.007 |
| 6.050 | 0.000 | 0.17 | 0.05 | 0.17 | 0.007 |
| 6.249 | 0.000 | 0.18 | 0.06 | 0.17 | 0.007 |
| 6.448 | 0.000 | 0.18 | 0.06 | 0.17 | 0.007 |
| 6.647 | 0.000 | 0.18 | 0.06 | 0.18 | 0.007 |
| 6.846 | 0.000 | 0.18 | 0.06 | 0.18 | 0.007 |
| 7.045 | 0.000 | 0.19 | 0.06 | 0.18 | 0.007 |
| 7.244 | 0.000 | 0.19 | 0.06 | 0.18 | 0.007 |
| 7.443 | 0.000 | 0.19 | 0.06 | 0.19 | 0.007 |
| 7.642 | 0.000 | 0.19 | 0.06 | 0.19 | 0.007 |
| 7.841 | 0.000 | 0.20 | 0.06 | 0.19 | 0.007 |
| 8.040 | 0.000 | 0.20 | 0.06 | 0.19 | 0.008 |
| 8.239 | 0.000 | 0.20 | 0.06 | 0.20 | 0.008 |
| 8.438 | 0.000 | 0.21 | 0.07 | 0.20 | 0.008 |
| 8.637 | 0.000 | 0.21 | 0.07 | 0.20 | 0.008 |
| 8.836 | 0.000 | 0.21 | 0.07 | 0.21 | 0.008 |
| 9.035 | 0.000 | 0.22 | 0.07 | 0.21 | 0.008 |
| 9.234 | 0.000 | 0.22 | 0.07 | 0.21 | 0.008 |
| 9.433 | 0.000 | 0.23 | 0.07 | 0.22 | 0.009 |
| 9.632 | 0.000 | 0.23 | 0.07 | 0.22 | 0.009 |
| 9.831 | 0.000 | 0.24 | 0.07 | 0.23 | 0.009 |
| 10.030 | 0.000 | 0.24 | 0.08 | 0.23 | 0.009 |
| 10.229 | 0.000 | 0.25 | 0.08 | 0.24 | 0.009 |
| 10.428 | 0.000 | 0.25 | 0.08 | 0.24 | 0.009 |
| 10.627 | 0.000 | 0.26 | 0.08 | 0.25 | 0.010 |
| 10.826 | 0.000 | 0.26 | 0.08 | 0.25 | 0.010 |
| 11.025 | 0.000 | 0.27 | 0.08 | 0.26 | 0.010 |
| 11.224 | 0.000 | 0.28 | 0.09 | 0.26 | 0.010 |
| 11.423 | 0.000 | 0.29 | 0.09 | 0.27 | 0.011 |
| 11.622 | 0.000 | 0.29 | 0.09 | 0.28 | 0.011 |
| 11.821 | 0.000 | 0.30 | 0.09 | 0.28 | 0.011 |
| 12.020 | 0.000 | 0.31 | 0.10 | 0.29 | 0.011 |
| 12.219 | 0.000 | 0.49 | 0.12 | 0.33 | 0.014 |
| 12.418 | 0.000 | 0.50 | 0.13 | 0.39 | 0.016 |
| 12.617 | 0.000 | 0.52 | 0.14 | 0.43 | 0.017 |
| 12.816 | 0.000 | 0.52 | 0.15 | 0.46 | 0.018 |
| 13.015 | 0.000 | 0.55 | 0.16 | 0.49 | 0.019 |
| 13.214 | 0.000 | 0.56 | 0.17 | 0.51 | 0.020 |
| 13.413 | 0.000 | 0.58 | 0.17 | 0.53 | 0.021 |
| 13.612 | 0.000 | 0.60 | 0.18 | 0.55 | 0.022 |
| 13.811 | 0.000 | 0.63 | 0.19 | 0.57 | 0.023 |
| 14.010 | 0.000 | 0.64 | 0.19 | 0.59 | 0.023 |
| 14.209 | 0.000 | 0.68 | 0.20 | 0.62 | 0.024 |
| 14.408 | 0.000 | 0.71 | 0.21 | 0.65 | 0.025 |
| 14.607 | 0.000 | 0.76 | 0.22 | 0.68 | 0.027 |
| 14.806 | 0.000 | 0.80 | 0.24 | 0.71 | 0.028 |
| 15.005 | 0.000 | 0.88 | 0.25 | 0.76 | 0.030 |
| 15.204 | 0.000 | 0.93 | 0.27 | 0.81 | 0.032 |
| 15.403 | 0.000 | 1.07 | 0.30 | 0.88 | 0.036 |
| 15.602 | 0.000 | 0.91 | 0.30 | 0.92 | 0.035 |
| 15.801 | 0.000 | 1.30 | 0.34 | 0.98 | 0.041 |
| 16.000 | 0.000 | 1.78 | 0.42 | 1.18 | 0.051 |
| 16.199 | 0.000 | 7.54 | 1.04 | 2.93 | 0.126 |
| 16.398 | 0.000 | 1.06 | 0.70 | 3.62 | 0.084 |
| 16.597 | 0.000 | 1.00 | 0.53 | 2.22 | 0.064 |
| 16.796 | 0.000 | 0.83 | 0.44 | 1.55 | 0.052 |

| | | | | | |
|---|---|---|---|---|---|
| 16.995 | 0.000 | 0.73 | 0.37 | 1.24 | 0.044 |
| 17.194 | 0.000 | 0.66 | 0.31 | 1.05 | 0.038 |
| 17.393 | 0.000 | 0.61 | 0.27 | 0.91 | 0.033 |
| 17.592 | 0.000 | 0.57 | 0.24 | 0.80 | 0.029 |
| 17.791 | 0.000 | 0.53 | 0.22 | 0.71 | 0.026 |
| 17.990 | 0.000 | 0.51 | 0.20 | 0.64 | 0.024 |
| 18.189 | 0.000 | 0.34 | 0.17 | 0.57 | 0.020 |
| 18.388 | 0.000 | 0.30 | 0.14 | 0.48 | 0.017 |
| 18.587 | 0.000 | 0.28 | 0.12 | 0.41 | 0.015 |
| 18.786 | 0.000 | 0.27 | 0.11 | 0.36 | 0.013 |
| 18.985 | 0.000 | 0.26 | 0.10 | 0.33 | 0.012 |
| 19.184 | 0.000 | 0.24 | 0.09 | 0.30 | 0.011 |
| 19.383 | 0.000 | 0.23 | 0.09 | 0.28 | 0.010 |
| 19.582 | 0.000 | 0.23 | 0.08 | 0.26 | 0.010 |
| 19.781 | 0.000 | 0.22 | 0.08 | 0.25 | 0.009 |
| 19.980 | 0.000 | 0.21 | 0.07 | 0.24 | 0.009 |
| 20.179 | 0.000 | 0.20 | 0.07 | 0.23 | 0.009 |
| 20.378 | 0.000 | 0.20 | 0.07 | 0.22 | 0.008 |
| 20.577 | 0.000 | 0.19 | 0.07 | 0.21 | 0.008 |
| 20.776 | 0.000 | 0.19 | 0.06 | 0.20 | 0.008 |
| 20.975 | 0.000 | 0.18 | 0.06 | 0.19 | 0.007 |
| 21.174 | 0.000 | 0.18 | 0.06 | 0.19 | 0.007 |
| 21.373 | 0.000 | 0.17 | 0.06 | 0.18 | 0.007 |
| 21.572 | 0.000 | 0.17 | 0.06 | 0.18 | 0.007 |
| 21.771 | 0.000 | 0.16 | 0.06 | 0.17 | 0.007 |
| 21.970 | 0.000 | 0.16 | 0.05 | 0.17 | 0.006 |
| 22.169 | 0.000 | 0.16 | 0.05 | 0.17 | 0.006 |
| 22.368 | 0.000 | 0.15 | 0.05 | 0.16 | 0.006 |
| 22.567 | 0.000 | 0.15 | 0.05 | 0.16 | 0.006 |
| 22.766 | 0.000 | 0.15 | 0.05 | 0.15 | 0.006 |
| 22.965 | 0.000 | 0.14 | 0.05 | 0.15 | 0.006 |
| 23.164 | 0.000 | 0.14 | 0.05 | 0.15 | 0.006 |
| 23.363 | 0.000 | 0.14 | 0.05 | 0.15 | 0.006 |
| 23.562 | 0.000 | 0.14 | 0.05 | 0.14 | 0.005 |
| 23.761 | 0.000 | 0.13 | 0.04 | 0.14 | 0.005 |
| 23.960 | 0.000 | 0.13 | 0.04 | 0.14 | 0.005 |
| 24.159 | 0.000 | 0.13 | 0.04 | 0.13 | 0.005 |
| 24.358 | 0.000 | 0.00 | 0.03 | 0.11 | 0.003 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                          Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                          www.encompasscivil.com

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Problem Descriptions:

wq Basin3 2yr

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RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
TOTAL CATCHMENT AREA(ACRES) = 8.80
SOIL-LOSS RATE, Fm,(INCH/HR) = 0.260
LOW LOSS FRACTION = 0.391
TIME OF CONCENTRATION(MIN.) = 11.94
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) = 2
5-MINUTE POINT RAINFALL VALUE(INCHES) = 0.22
30-MINUTE POINT RAINFALL VALUE(INCHES) = 0.45
1-HOUR POINT RAINFALL VALUE(INCHES) = 0.59
3-HOUR POINT RAINFALL VALUE(INCHES) = 1.04
6-HOUR POINT RAINFALL VALUE(INCHES) = 1.48
24-HOUR POINT RAINFALL VALUE(INCHES) = 2.60

---

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 1.08
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.82

**********

| TIME (HOURS) | VOLUME (AF) | Q (CFS) | 0. | 5.0 | 10.0 | 15.0 | 20.0 |
|---|---|---|---|---|---|---|---|
| 0.08 | 0.0000 | 0.00 | Q | . | . | . | . |
| 0.28 | 0.0018 | 0.21 | Q | . | . | . | . |
| 0.48 | 0.0053 | 0.21 | Q | . | . | . | . |
| 0.68 | 0.0088 | 0.22 | Q | . | . | . | . |
| 0.88 | 0.0124 | 0.22 | Q | . | . | . | . |
| 1.08 | 0.0160 | 0.22 | Q | . | . | . | . |
| 1.27 | 0.0196 | 0.22 | Q | . | . | . | . |
| 1.47 | 0.0233 | 0.22 | Q | . | . | . | . |
| 1.67 | 0.0270 | 0.22 | Q | . | . | . | . |
| 1.87 | 0.0307 | 0.23 | Q | . | . | . | . |
| 2.07 | 0.0345 | 0.23 | Q | . | . | . | . |
| 2.27 | 0.0382 | 0.23 | Q | . | . | . | . |
| 2.47 | 0.0420 | 0.23 | Q | . | . | . | . |
| 2.67 | 0.0459 | 0.24 | Q | . | . | . | . |
| 2.87 | 0.0498 | 0.24 | Q | . | . | . | . |
| 3.07 | 0.0537 | 0.24 | Q | . | . | . | . |
| 3.26 | 0.0576 | 0.24 | Q | . | . | . | . |
| 3.46 | 0.0616 | 0.24 | Q | . | . | . | . |
| 3.66 | 0.0657 | 0.25 | Q | . | . | . | . |
| 3.86 | 0.0697 | 0.25 | Q | . | . | . | . |
| 4.06 | 0.0738 | 0.25 | Q | . | . | . | . |
| 4.26 | 0.0780 | 0.25 | Q | . | . | . | . |
| 4.46 | 0.0821 | 0.26 | Q | . | . | . | . |
| 4.66 | 0.0864 | 0.26 | Q | . | . | . | . |
| 4.86 | 0.0906 | 0.26 | Q | . | . | . | . |
| 5.06 | 0.0950 | 0.26 | Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.25 | 0.0993 | 0.27 | Q | . | . | . | . |
| 5.45 | 0.1037 | 0.27 | Q | . | . | . | . |
| 5.65 | 0.1082 | 0.27 | Q | . | . | . | . |
| 5.85 | 0.1127 | 0.28 | Q | . | . | . | . |
| 6.05 | 0.1172 | 0.28 | Q | . | . | . | . |
| 6.25 | 0.1219 | 0.28 | Q | . | . | . | . |
| 6.45 | 0.1265 | 0.28 | Q | . | . | . | . |
| 6.65 | 0.1312 | 0.29 | Q | . | . | . | . |
| 6.85 | 0.1360 | 0.29 | Q | . | . | . | . |
| 7.05 | 0.1409 | 0.30 | Q | . | . | . | . |
| 7.24 | 0.1458 | 0.30 | Q | . | . | . | . |
| 7.44 | 0.1508 | 0.31 | Q | . | . | . | . |
| 7.64 | 0.1558 | 0.31 | Q | . | . | . | . |
| 7.84 | 0.1609 | 0.31 | Q | . | . | . | . |
| 8.04 | 0.1661 | 0.32 | Q | . | . | . | . |
| 8.24 | 0.1714 | 0.32 | Q | . | . | . | . |
| 8.44 | 0.1767 | 0.33 | Q | . | . | . | . |
| 8.64 | 0.1821 | 0.33 | Q | . | . | . | . |
| 8.84 | 0.1876 | 0.34 | Q | . | . | . | . |
| 9.04 | 0.1932 | 0.34 | Q | . | . | . | . |
| 9.23 | 0.1989 | 0.35 | Q | . | . | . | . |
| 9.43 | 0.2047 | 0.36 | Q | . | . | . | . |
| 9.63 | 0.2106 | 0.36 | Q | . | . | . | . |
| 9.83 | 0.2166 | 0.37 | Q | . | . | . | . |
| 10.03 | 0.2227 | 0.37 | Q | . | . | . | . |
| 10.23 | 0.2289 | 0.38 | Q | . | . | . | . |
| 10.43 | 0.2353 | 0.39 | Q | . | . | . | . |
| 10.63 | 0.2418 | 0.40 | Q | . | . | . | . |
| 10.83 | 0.2484 | 0.41 | Q | . | . | . | . |
| 11.02 | 0.2552 | 0.42 | Q | . | . | . | . |
| 11.22 | 0.2621 | 0.42 | Q | . | . | . | . |
| 11.42 | 0.2692 | 0.44 | Q | . | . | . | . |
| 11.62 | 0.2765 | 0.45 | Q | . | . | . | . |
| 11.82 | 0.2840 | 0.46 | Q | . | . | . | . |
| 12.02 | 0.2917 | 0.47 | Q | . | . | . | . |
| 12.22 | 0.3006 | 0.62 | .Q | . | . | . | . |
| 12.42 | 0.3108 | 0.63 | .Q | . | . | . | . |
| 12.62 | 0.3214 | 0.65 | .Q | . | . | . | . |
| 12.82 | 0.3321 | 0.66 | .Q | . | . | . | . |
| 13.02 | 0.3433 | 0.69 | .Q | . | . | . | . |
| 13.21 | 0.3547 | 0.70 | .Q | . | . | . | . |
| 13.41 | 0.3666 | 0.74 | .Q | . | . | . | . |
| 13.61 | 0.3788 | 0.76 | .Q | . | . | . | . |
| 13.81 | 0.3916 | 0.80 | .Q | . | . | . | . |
| 14.01 | 0.4049 | 0.82 | .Q | . | . | . | . |
| 14.21 | 0.4188 | 0.87 | .Q | . | . | . | . |
| 14.41 | 0.4334 | 0.90 | .Q | . | . | . | . |
| 14.61 | 0.4488 | 0.98 | .Q | . | . | . | . |
| 14.81 | 0.4653 | 1.02 | . Q | . | . | . | . |
| 15.01 | 0.4830 | 1.13 | . Q | . | . | . | . |
| 15.20 | 0.5022 | 1.20 | . Q | . | . | . | . |
| 15.40 | 0.5235 | 1.39 | . Q | . | . | . | . |
| 15.60 | 0.5449 | 1.22 | . Q | . | . | . | . |
| 15.80 | 0.5693 | 1.74 | .  Q | . | . | . | . |
| 16.00 | 0.6033 | 2.40 | .  Q | . | . | . | . |
| 16.20 | 0.7073 | 10.25 | . | . | Q | . | . |
| 16.40 | 0.8033 | 1.42 | . Q | . | . | . | . |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 16.60 | 0.8255 | 1.29 | . Q | . | . | . | . |
| 16.80 | 0.8450 | 1.07 | . Q | . | . | . | . |
| 17.00 | 0.8615 | 0.94 | .Q | . | . | . | . |
| 17.19 | 0.8761 | 0.84 | .Q | . | . | . | . |
| 17.39 | 0.8894 | 0.77 | .Q | . | . | . | . |
| 17.59 | 0.9017 | 0.72 | .Q | . | . | . | . |
| 17.79 | 0.9132 | 0.68 | .Q | . | . | . | . |
| 17.99 | 0.9240 | 0.64 | .Q | . | . | . | . |
| 18.19 | 0.9334 | 0.50 | Q | . | . | . | . |
| 18.39 | 0.9412 | 0.45 | Q | . | . | . | . |
| 18.59 | 0.9485 | 0.43 | Q | . | . | . | . |
| 18.79 | 0.9554 | 0.41 | Q | . | . | . | . |
| 18.98 | 0.9621 | 0.39 | Q | . | . | . | . |
| 19.18 | 0.9684 | 0.38 | Q | . | . | . | . |
| 19.38 | 0.9745 | 0.36 | Q | . | . | . | . |
| 19.58 | 0.9804 | 0.35 | Q | . | . | . | . |
| 19.78 | 0.9861 | 0.34 | Q | . | . | . | . |
| 19.98 | 0.9916 | 0.33 | Q | . | . | . | . |
| 20.18 | 0.9970 | 0.32 | Q | . | . | . | . |
| 20.38 | 1.0022 | 0.31 | Q | . | . | . | . |
| 20.58 | 1.0072 | 0.30 | Q | . | . | . | . |
| 20.78 | 1.0121 | 0.29 | Q | . | . | . | . |
| 20.98 | 1.0169 | 0.29 | Q | . | . | . | . |
| 21.17 | 1.0216 | 0.28 | Q | . | . | . | . |
| 21.37 | 1.0261 | 0.27 | Q | . | . | . | . |
| 21.57 | 1.0306 | 0.27 | Q | . | . | . | . |
| 21.77 | 1.0349 | 0.26 | Q | . | . | . | . |
| 21.97 | 1.0392 | 0.26 | Q | . | . | . | . |
| 22.17 | 1.0434 | 0.25 | Q | . | . | . | . |
| 22.37 | 1.0475 | 0.25 | Q | . | . | . | . |
| 22.57 | 1.0515 | 0.24 | Q | . | . | . | . |
| 22.77 | 1.0555 | 0.24 | Q | . | . | . | . |
| 22.97 | 1.0594 | 0.23 | Q | . | . | . | . |
| 23.16 | 1.0632 | 0.23 | Q | . | . | . | . |
| 23.36 | 1.0669 | 0.23 | Q | . | . | . | . |
| 23.56 | 1.0706 | 0.22 | Q | . | . | . | . |
| 23.76 | 1.0742 | 0.22 | Q | . | . | . | . |
| 23.96 | 1.0778 | 0.22 | Q | . | . | . | . |
| 24.16 | 1.0813 | 0.21 | Q | . | . | . | . |
| 24.36 | 1.0831 | 0.00 | Q | . | . | . | . |

TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
(Note: 100% of Peak Flow Rate estimate assumed to have
an instantaneous time duration)

| Percentile of Estimated Peak Flow Rate | Duration (minutes) |
|---|---|
| 0% | 1444.7 |
| 10% | 119.4 |
| 20% | 23.9 |
| 30% | 11.9 |
| 40% | 11.9 |
| 50% | 11.9 |
| 60% | 11.9 |
| 70% | 11.9 |

```
            80%                                 11.9
            90%                                 11.9

  Problem Descriptions:


   wq Basin3 2yr



==============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   11.940
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                  INFLOW
                    |
                    |
                    |
                    V                 __effective depth
               -------------          |   (and volume)
               |           |     |     |
               | detention |     |....V.............
               |   basin   |<-->|          outflow
               |           |     |.........________
               -------------     |         |   \
                    |            | storage |     basin outlet
                    V            -----------
                 OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
     *   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
     *      0.000      0.000      0.000**      0.500      0.060      1.550*
     *      1.000      0.120      4.390**      1.500      0.200      6.320*
     *      2.000      0.280      7.990**      2.500      0.380      9.360*
     *      3.000      0.480     10.560**      3.500      0.590     11.640*
     *      4.000      0.700     12.620**
------------------------------------------------------------------------------
     BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:
      INTERVAL   DEPTH   {S-O*DT/2}   {S+O*DT/2}
       NUMBER   (FEET)   (ACRE-FEET)  (ACRE-FEET)
           1     0.00       0.00000      0.00000
           2     0.50       0.04725      0.07275
           3     1.00       0.08390      0.15610
           4     1.50       0.14803      0.25197
           5     2.00       0.21430      0.34570
           6     2.50       0.30303      0.45697
           7     3.00       0.39316      0.56684
           8     3.50       0.49428      0.68572
```

```
        9     4.00       0.59622      0.80378
    WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)
--------------------------------------------------------------------------
    DETENTION BASIN ROUTING RESULTS:
    NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES
          OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE
          AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.
```

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.080 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 0.279 | 0.000 | 0.21 | 0.02 | 0.04 | 0.003 |
| 0.478 | 0.000 | 0.21 | 0.04 | 0.10 | 0.005 |
| 0.677 | 0.000 | 0.22 | 0.05 | 0.14 | 0.006 |
| 0.876 | 0.000 | 0.22 | 0.06 | 0.17 | 0.007 |
| 1.075 | 0.000 | 0.22 | 0.06 | 0.19 | 0.007 |
| 1.274 | 0.000 | 0.22 | 0.07 | 0.20 | 0.008 |
| 1.473 | 0.000 | 0.22 | 0.07 | 0.21 | 0.008 |
| 1.672 | 0.000 | 0.22 | 0.07 | 0.21 | 0.008 |
| 1.871 | 0.000 | 0.23 | 0.07 | 0.22 | 0.008 |
| 2.070 | 0.000 | 0.23 | 0.07 | 0.22 | 0.009 |
| 2.269 | 0.000 | 0.23 | 0.07 | 0.22 | 0.009 |
| 2.468 | 0.000 | 0.23 | 0.07 | 0.23 | 0.009 |
| 2.667 | 0.000 | 0.24 | 0.07 | 0.23 | 0.009 |
| 2.866 | 0.000 | 0.24 | 0.08 | 0.23 | 0.009 |
| 3.065 | 0.000 | 0.24 | 0.08 | 0.23 | 0.009 |
| 3.264 | 0.000 | 0.24 | 0.08 | 0.24 | 0.009 |
| 3.463 | 0.000 | 0.24 | 0.08 | 0.24 | 0.009 |
| 3.662 | 0.000 | 0.25 | 0.08 | 0.24 | 0.009 |
| 3.861 | 0.000 | 0.25 | 0.08 | 0.24 | 0.009 |
| 4.060 | 0.000 | 0.25 | 0.08 | 0.25 | 0.010 |
| 4.259 | 0.000 | 0.25 | 0.08 | 0.25 | 0.010 |
| 4.458 | 0.000 | 0.26 | 0.08 | 0.25 | 0.010 |
| 4.657 | 0.000 | 0.26 | 0.08 | 0.25 | 0.010 |
| 4.856 | 0.000 | 0.26 | 0.08 | 0.25 | 0.010 |
| 5.055 | 0.000 | 0.26 | 0.08 | 0.26 | 0.010 |
| 5.254 | 0.000 | 0.27 | 0.08 | 0.26 | 0.010 |
| 5.453 | 0.000 | 0.27 | 0.09 | 0.26 | 0.010 |
| 5.652 | 0.000 | 0.27 | 0.09 | 0.27 | 0.010 |
| 5.851 | 0.000 | 0.28 | 0.09 | 0.27 | 0.010 |
| 6.050 | 0.000 | 0.28 | 0.09 | 0.27 | 0.011 |
| 6.249 | 0.000 | 0.28 | 0.09 | 0.27 | 0.011 |
| 6.448 | 0.000 | 0.28 | 0.09 | 0.28 | 0.011 |
| 6.647 | 0.000 | 0.29 | 0.09 | 0.28 | 0.011 |
| 6.846 | 0.000 | 0.29 | 0.09 | 0.28 | 0.011 |
| 7.045 | 0.000 | 0.30 | 0.09 | 0.29 | 0.011 |
| 7.244 | 0.000 | 0.30 | 0.09 | 0.29 | 0.011 |
| 7.443 | 0.000 | 0.31 | 0.10 | 0.30 | 0.012 |
| 7.642 | 0.000 | 0.31 | 0.10 | 0.30 | 0.012 |
| 7.841 | 0.000 | 0.31 | 0.10 | 0.30 | 0.012 |
| 8.040 | 0.000 | 0.32 | 0.10 | 0.31 | 0.012 |
| 8.239 | 0.000 | 0.32 | 0.10 | 0.31 | 0.012 |
| 8.438 | 0.000 | 0.33 | 0.10 | 0.32 | 0.012 |
| 8.637 | 0.000 | 0.33 | 0.10 | 0.32 | 0.013 |
| 8.836 | 0.000 | 0.34 | 0.11 | 0.33 | 0.013 |
| 9.035 | 0.000 | 0.34 | 0.11 | 0.33 | 0.013 |

| | | | | | |
|---|---|---|---|---|---|
| 9.234 | 0.000 | 0.35 | 0.11 | 0.34 | 0.013 |
| 9.433 | 0.000 | 0.36 | 0.11 | 0.34 | 0.013 |
| 9.632 | 0.000 | 0.36 | 0.11 | 0.35 | 0.014 |
| 9.831 | 0.000 | 0.37 | 0.12 | 0.35 | 0.014 |
| 10.030 | 0.000 | 0.37 | 0.12 | 0.36 | 0.014 |
| 10.229 | 0.000 | 0.38 | 0.12 | 0.37 | 0.014 |
| 10.428 | 0.000 | 0.39 | 0.12 | 0.37 | 0.015 |
| 10.627 | 0.000 | 0.40 | 0.12 | 0.38 | 0.015 |
| 10.826 | 0.000 | 0.41 | 0.13 | 0.39 | 0.015 |
| 11.025 | 0.000 | 0.42 | 0.13 | 0.40 | 0.016 |
| 11.224 | 0.000 | 0.42 | 0.13 | 0.41 | 0.016 |
| 11.423 | 0.000 | 0.44 | 0.14 | 0.41 | 0.016 |
| 11.622 | 0.000 | 0.45 | 0.14 | 0.42 | 0.017 |
| 11.821 | 0.000 | 0.46 | 0.14 | 0.44 | 0.017 |
| 12.020 | 0.000 | 0.47 | 0.15 | 0.45 | 0.017 |
| 12.219 | 0.000 | 0.62 | 0.16 | 0.48 | 0.020 |
| 12.418 | 0.000 | 0.63 | 0.18 | 0.53 | 0.021 |
| 12.617 | 0.000 | 0.65 | 0.19 | 0.57 | 0.023 |
| 12.816 | 0.000 | 0.66 | 0.20 | 0.60 | 0.024 |
| 13.015 | 0.000 | 0.69 | 0.21 | 0.63 | 0.025 |
| 13.214 | 0.000 | 0.70 | 0.21 | 0.65 | 0.026 |
| 13.413 | 0.000 | 0.74 | 0.22 | 0.68 | 0.027 |
| 13.612 | 0.000 | 0.76 | 0.23 | 0.70 | 0.028 |
| 13.811 | 0.000 | 0.80 | 0.24 | 0.73 | 0.029 |
| 14.010 | 0.000 | 0.82 | 0.25 | 0.75 | 0.030 |
| 14.209 | 0.000 | 0.87 | 0.26 | 0.79 | 0.031 |
| 14.408 | 0.000 | 0.90 | 0.27 | 0.82 | 0.032 |
| 14.607 | 0.000 | 0.98 | 0.29 | 0.86 | 0.034 |
| 14.806 | 0.000 | 1.02 | 0.30 | 0.91 | 0.036 |
| 15.005 | 0.000 | 1.13 | 0.32 | 0.97 | 0.039 |
| 15.204 | 0.000 | 1.20 | 0.35 | 1.04 | 0.042 |
| 15.403 | 0.000 | 1.39 | 0.38 | 1.13 | 0.046 |
| 15.602 | 0.000 | 1.22 | 0.39 | 1.19 | 0.046 |
| 15.801 | 0.000 | 1.74 | 0.45 | 1.29 | 0.054 |
| 16.000 | 0.000 | 2.40 | 0.55 | 1.62 | 0.066 |
| 16.199 | 0.000 | 10.25 | 1.33 | 3.76 | 0.173 |
| 16.398 | 0.000 | 1.42 | 0.96 | 4.92 | 0.115 |
| 16.597 | 0.000 | 1.29 | 0.68 | 3.37 | 0.081 |
| 16.796 | 0.000 | 1.07 | 0.53 | 2.14 | 0.064 |
| 16.995 | 0.000 | 0.94 | 0.45 | 1.55 | 0.054 |
| 17.194 | 0.000 | 0.84 | 0.39 | 1.29 | 0.046 |
| 17.393 | 0.000 | 0.77 | 0.34 | 1.12 | 0.041 |
| 17.592 | 0.000 | 0.72 | 0.30 | 0.99 | 0.036 |
| 17.791 | 0.000 | 0.68 | 0.27 | 0.89 | 0.033 |
| 17.990 | 0.000 | 0.64 | 0.25 | 0.81 | 0.030 |
| 18.189 | 0.000 | 0.50 | 0.22 | 0.72 | 0.026 |
| 18.388 | 0.000 | 0.45 | 0.19 | 0.64 | 0.023 |
| 18.587 | 0.000 | 0.43 | 0.17 | 0.57 | 0.021 |
| 18.786 | 0.000 | 0.41 | 0.16 | 0.52 | 0.019 |
| 18.985 | 0.000 | 0.39 | 0.15 | 0.48 | 0.018 |
| 19.184 | 0.000 | 0.38 | 0.14 | 0.45 | 0.017 |
| 19.383 | 0.000 | 0.36 | 0.13 | 0.42 | 0.016 |
| 19.582 | 0.000 | 0.35 | 0.13 | 0.40 | 0.015 |
| 19.781 | 0.000 | 0.34 | 0.12 | 0.38 | 0.014 |
| 19.980 | 0.000 | 0.33 | 0.12 | 0.36 | 0.014 |
| 20.179 | 0.000 | 0.32 | 0.11 | 0.35 | 0.013 |
| 20.378 | 0.000 | 0.31 | 0.11 | 0.34 | 0.013 |

| | | | | | |
|---|---|---|---|---|---|
| 20.577 | 0.000 | 0.30 | 0.10 | 0.33 | 0.012 |
| 20.776 | 0.000 | 0.29 | 0.10 | 0.32 | 0.012 |
| 20.975 | 0.000 | 0.29 | 0.10 | 0.31 | 0.012 |
| 21.174 | 0.000 | 0.28 | 0.10 | 0.30 | 0.011 |
| 21.373 | 0.000 | 0.27 | 0.09 | 0.29 | 0.011 |
| 21.572 | 0.000 | 0.27 | 0.09 | 0.28 | 0.011 |
| 21.771 | 0.000 | 0.26 | 0.09 | 0.28 | 0.011 |
| 21.970 | 0.000 | 0.26 | 0.09 | 0.27 | 0.010 |
| 22.169 | 0.000 | 0.25 | 0.08 | 0.27 | 0.010 |
| 22.368 | 0.000 | 0.25 | 0.08 | 0.26 | 0.010 |
| 22.567 | 0.000 | 0.24 | 0.08 | 0.25 | 0.010 |
| 22.766 | 0.000 | 0.24 | 0.08 | 0.25 | 0.010 |
| 22.965 | 0.000 | 0.23 | 0.08 | 0.24 | 0.009 |
| 23.164 | 0.000 | 0.23 | 0.08 | 0.24 | 0.009 |
| 23.363 | 0.000 | 0.23 | 0.08 | 0.24 | 0.009 |
| 23.562 | 0.000 | 0.22 | 0.07 | 0.23 | 0.009 |
| 23.761 | 0.000 | 0.22 | 0.07 | 0.23 | 0.009 |
| 23.960 | 0.000 | 0.22 | 0.07 | 0.22 | 0.009 |
| 24.159 | 0.000 | 0.21 | 0.07 | 0.22 | 0.008 |
| 24.358 | 0.000 | 0.00 | 0.05 | 0.18 | 0.006 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                         Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

****************************************************************************
----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin3 5yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =    8.80
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.357
    TIME OF CONCENTRATION(MIN.) = 11.94
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   5
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
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      3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
      6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
     24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

--------------------------------------------------------------------------------

   TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.53
   TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     1.03

********************************************************************************
  TIME     VOLUME       Q    0.        5.0      10.0      15.0      20.0
 (HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------------
  0.08      0.0000      0.00  Q         .         .         .         .
  0.28      0.0028      0.34  Q         .         .         .         .
  0.48      0.0083      0.34  Q         .         .         .         .
  0.68      0.0140      0.34  Q         .         .         .         .
  0.88      0.0196      0.34  Q         .         .         .         .
  1.08      0.0253      0.35  Q         .         .         .         .
  1.27      0.0310      0.35  Q         .         .         .         .
  1.47      0.0368      0.35  Q         .         .         .         .
  1.67      0.0426      0.35  Q         .         .         .         .
  1.87      0.0485      0.36  Q         .         .         .         .
  2.07      0.0544      0.36  Q         .         .         .         .
  2.27      0.0603      0.36  Q         .         .         .         .
  2.47      0.0663      0.37  Q         .         .         .         .
  2.67      0.0724      0.37  Q         .         .         .         .
  2.87      0.0784      0.37  Q         .         .         .         .
  3.07      0.0846      0.38  Q         .         .         .         .
  3.26      0.0908      0.38  Q         .         .         .         .
  3.46      0.0970      0.38  Q         .         .         .         .
  3.66      0.1033      0.38  Q         .         .         .         .
  3.86      0.1097      0.39  Q         .         .         .         .
  4.06      0.1161      0.39  Q         .         .         .         .
  4.26      0.1226      0.40  Q         .         .         .         .
  4.46      0.1291      0.40  Q         .         .         .         .
  4.66      0.1357      0.40  Q         .         .         .         .
  4.86      0.1423      0.41  Q         .         .         .         .
  5.06      0.1490      0.41  Q         .         .         .         .
  5.25      0.1558      0.41  Q         .         .         .         .
  5.45      0.1627      0.42  Q         .         .         .         .
  5.65      0.1696      0.42  Q         .         .         .         .
  5.85      0.1766      0.43  Q         .         .         .         .
  6.05      0.1836      0.43  Q         .         .         .         .
  6.25      0.1908      0.44  Q         .         .         .         .
  6.45      0.1980      0.44  Q         .         .         .         .
  6.65      0.2053      0.45  Q         .         .         .         .
  6.85      0.2127      0.45  Q         .         .         .         .
  7.05      0.2201      0.46  Q         .         .         .         .
  7.24      0.2277      0.46  Q         .         .         .         .
  7.44      0.2354      0.47  Q         .         .         .         .
  7.64      0.2431      0.47  Q         .         .         .         .
  7.84      0.2510      0.48  Q         .         .         .         .
  8.04      0.2589      0.49  Q         .         .         .         .
  8.24      0.2670      0.49  Q         .         .         .         .
  8.44      0.2751      0.50  Q         .         .         .         .
  8.64      0.2834      0.51  .Q        .         .         .         .
```

| | | | |
|---|---|---|---|
| 8.84 | 0.2918 | 0.51 | .Q . . . . |
| 9.04 | 0.3004 | 0.52 | .Q . . . . |
| 9.23 | 0.3090 | 0.53 | .Q . . . . |
| 9.43 | 0.3178 | 0.54 | .Q . . . . |
| 9.63 | 0.3268 | 0.55 | .Q . . . . |
| 9.83 | 0.3359 | 0.56 | .Q . . . . |
| 10.03 | 0.3451 | 0.57 | .Q . . . . |
| 10.23 | 0.3545 | 0.58 | .Q . . . . |
| 10.43 | 0.3641 | 0.59 | .Q . . . . |
| 10.63 | 0.3739 | 0.60 | .Q . . . . |
| 10.83 | 0.3839 | 0.61 | .Q . . . . |
| 11.02 | 0.3940 | 0.63 | .Q . . . . |
| 11.22 | 0.4044 | 0.64 | .Q . . . . |
| 11.42 | 0.4150 | 0.66 | .Q . . . . |
| 11.62 | 0.4259 | 0.67 | .Q . . . . |
| 11.82 | 0.4370 | 0.69 | .Q . . . . |
| 12.02 | 0.4485 | 0.70 | .Q . . . . |
| 12.22 | 0.4609 | 0.81 | .Q . . . . |
| 12.42 | 0.4743 | 0.82 | .Q . . . . |
| 12.62 | 0.4881 | 0.85 | .Q . . . . |
| 12.82 | 0.5022 | 0.87 | .Q . . . . |
| 13.02 | 0.5168 | 0.90 | .Q . . . . |
| 13.21 | 0.5319 | 0.92 | .Q . . . . |
| 13.41 | 0.5474 | 0.97 | .Q . . . . |
| 13.61 | 0.5635 | 0.99 | .Q . . . . |
| 13.81 | 0.5803 | 1.05 | . Q . . . . |
| 14.01 | 0.5978 | 1.08 | . Q . . . . |
| 14.21 | 0.6161 | 1.15 | . Q . . . . |
| 14.41 | 0.6353 | 1.19 | . Q . . . . |
| 14.61 | 0.6557 | 1.29 | . Q . . . . |
| 14.81 | 0.6773 | 1.35 | . Q . . . . |
| 15.01 | 0.7007 | 1.49 | . Q . . . . |
| 15.20 | 0.7260 | 1.59 | . Q . . . . |
| 15.40 | 0.7543 | 1.84 | . Q . . . . |
| 15.60 | 0.7829 | 1.64 | . Q . . . . |
| 15.80 | 0.8156 | 2.34 | . Q . . . . |
| 16.00 | 0.8612 | 3.21 | . Q . . . . |
| 16.20 | 0.9994 | 13.59 | . . . Q . . |
| 16.40 | 1.1268 | 1.90 | . Q . . . . |
| 16.60 | 1.1565 | 1.71 | . Q . . . . |
| 16.80 | 1.1822 | 1.41 | . Q . . . . |
| 17.00 | 1.2040 | 1.24 | . Q . . . . |
| 17.19 | 1.2233 | 1.11 | . Q . . . . |
| 17.39 | 1.2408 | 1.02 | . Q . . . . |
| 17.59 | 1.2569 | 0.95 | .Q . . . . |
| 17.79 | 1.2720 | 0.89 | .Q . . . . |
| 17.99 | 1.2862 | 0.84 | .Q . . . . |
| 18.19 | 1.2990 | 0.72 | .Q . . . . |
| 18.39 | 1.3105 | 0.68 | .Q . . . . |
| 18.59 | 1.3214 | 0.65 | .Q . . . . |
| 18.79 | 1.3318 | 0.62 | .Q . . . . |
| 18.98 | 1.3418 | 0.59 | .Q . . . . |
| 19.18 | 1.3514 | 0.57 | .Q . . . . |
| 19.38 | 1.3606 | 0.55 | .Q . . . . |
| 19.58 | 1.3696 | 0.54 | .Q . . . . |
| 19.78 | 1.3782 | 0.52 | .Q . . . . |
| 19.98 | 1.3866 | 0.50 | .Q . . . . |

```
 20.18      1.3948      0.49  Q          .          .          .          .
 20.38      1.4028      0.48  Q          .          .          .          .
 20.58      1.4105      0.47  Q          .          .          .          .
 20.78      1.4181      0.45  Q          .          .          .          .
 20.98      1.4255      0.44  Q          .          .          .          .
 21.17      1.4327      0.43  Q          .          .          .          .
 21.37      1.4398      0.42  Q          .          .          .          .
 21.57      1.4467      0.42  Q          .          .          .          .
 21.77      1.4535      0.41  Q          .          .          .          .
 21.97      1.4601      0.40  Q          .          .          .          .
 22.17      1.4666      0.39  Q          .          .          .          .
 22.37      1.4730      0.39  Q          .          .          .          .
 22.57      1.4793      0.38  Q          .          .          .          .
 22.77      1.4855      0.37  Q          .          .          .          .
 22.97      1.4916      0.37  Q          .          .          .          .
 23.16      1.4976      0.36  Q          .          .          .          .
 23.36      1.5035      0.36  Q          .          .          .          .
 23.56      1.5093      0.35  Q          .          .          .          .
 23.76      1.5151      0.35  Q          .          .          .          .
 23.96      1.5207      0.34  Q          .          .          .          .
 24.16      1.5263      0.34  Q          .          .          .          .
 24.36      1.5291      0.00  Q          .          .          .          .
 ----------------------------------------------------------------------------
-------------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    ========================                 =========
              0%                              1444.7
             10%                               119.4
             20%                                23.9
             30%                                11.9
             40%                                11.9
             50%                                11.9
             60%                                11.9
             70%                                11.9
             80%                                11.9
             90%                                11.9

  Problem Descriptions:


   wq Basin3 5yr


===============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   11.940
     DEAD STORAGE(AF) =        0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00
```

```
                INFLOW
                  |
                  |
                  |
                  V                 __effective depth
            -------------           |   (and volume)
            |           |     |     |
            | detention |     |....V.............
            |   basin   |<-->|          outflow
            |           |     |.........________
            -------------     |         |   \
                  |           | storage |     basin outlet
                  V           -----------
               OUTFLOW
```

DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES = 9

| *BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) ** | **BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) * |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000** | 0.500 | 0.060 | 1.550* |
| 1.000 | 0.120 | 4.390** | 1.500 | 0.200 | 6.320* |
| 2.000 | 0.280 | 7.990** | 2.500 | 0.380 | 9.360* |
| 3.000 | 0.480 | 10.560** | 3.500 | 0.590 | 11.640* |
| 4.000 | 0.700 | 12.620** | | | |

---

BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:

| INTERVAL NUMBER | DEPTH (FEET) | {S-O*DT/2} (ACRE-FEET) | {S+O*DT/2} (ACRE-FEET) |
|---|---|---|---|
| 1 | 0.00 | 0.00000 | 0.00000 |
| 2 | 0.50 | 0.04725 | 0.07275 |
| 3 | 1.00 | 0.08390 | 0.15610 |
| 4 | 1.50 | 0.14803 | 0.25197 |
| 5 | 2.00 | 0.21430 | 0.34570 |
| 6 | 2.50 | 0.30303 | 0.45697 |
| 7 | 3.00 | 0.39316 | 0.56684 |
| 8 | 3.50 | 0.49428 | 0.68572 |
| 9 | 4.00 | 0.59622 | 0.80378 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

---

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.080 | 0.000 | 0.00 | 0.00 | 0.00 | 0.000 |
| 0.279 | 0.000 | 0.34 | 0.04 | 0.06 | 0.005 |
| 0.478 | 0.000 | 0.34 | 0.06 | 0.16 | 0.008 |
| 0.677 | 0.000 | 0.34 | 0.08 | 0.22 | 0.010 |
| 0.876 | 0.000 | 0.34 | 0.09 | 0.26 | 0.011 |
| 1.075 | 0.000 | 0.35 | 0.10 | 0.29 | 0.012 |
| 1.274 | 0.000 | 0.35 | 0.10 | 0.31 | 0.012 |

| | | | | | |
|---|---|---|---|---|---|
| 1.473 | 0.000 | 0.35 | 0.11 | 0.33 | 0.013 |
| 1.672 | 0.000 | 0.35 | 0.11 | 0.34 | 0.013 |
| 1.871 | 0.000 | 0.36 | 0.11 | 0.34 | 0.013 |
| 2.070 | 0.000 | 0.36 | 0.11 | 0.35 | 0.014 |
| 2.269 | 0.000 | 0.36 | 0.11 | 0.35 | 0.014 |
| 2.468 | 0.000 | 0.37 | 0.12 | 0.36 | 0.014 |
| 2.667 | 0.000 | 0.37 | 0.12 | 0.36 | 0.014 |
| 2.866 | 0.000 | 0.37 | 0.12 | 0.36 | 0.014 |
| 3.065 | 0.000 | 0.38 | 0.12 | 0.37 | 0.014 |
| 3.264 | 0.000 | 0.38 | 0.12 | 0.37 | 0.014 |
| 3.463 | 0.000 | 0.38 | 0.12 | 0.37 | 0.015 |
| 3.662 | 0.000 | 0.38 | 0.12 | 0.38 | 0.015 |
| 3.861 | 0.000 | 0.39 | 0.12 | 0.38 | 0.015 |
| 4.060 | 0.000 | 0.39 | 0.12 | 0.38 | 0.015 |
| 4.259 | 0.000 | 0.40 | 0.13 | 0.39 | 0.015 |
| 4.458 | 0.000 | 0.40 | 0.13 | 0.39 | 0.015 |
| 4.657 | 0.000 | 0.40 | 0.13 | 0.39 | 0.015 |
| 4.856 | 0.000 | 0.41 | 0.13 | 0.40 | 0.015 |
| 5.055 | 0.000 | 0.41 | 0.13 | 0.40 | 0.016 |
| 5.254 | 0.000 | 0.41 | 0.13 | 0.41 | 0.016 |
| 5.453 | 0.000 | 0.42 | 0.13 | 0.41 | 0.016 |
| 5.652 | 0.000 | 0.42 | 0.13 | 0.41 | 0.016 |
| 5.851 | 0.000 | 0.43 | 0.14 | 0.42 | 0.016 |
| 6.050 | 0.000 | 0.43 | 0.14 | 0.42 | 0.016 |
| 6.249 | 0.000 | 0.44 | 0.14 | 0.43 | 0.017 |
| 6.448 | 0.000 | 0.44 | 0.14 | 0.43 | 0.017 |
| 6.647 | 0.000 | 0.45 | 0.14 | 0.44 | 0.017 |
| 6.846 | 0.000 | 0.45 | 0.14 | 0.44 | 0.017 |
| 7.045 | 0.000 | 0.46 | 0.14 | 0.45 | 0.017 |
| 7.244 | 0.000 | 0.46 | 0.15 | 0.45 | 0.018 |
| 7.443 | 0.000 | 0.47 | 0.15 | 0.46 | 0.018 |
| 7.642 | 0.000 | 0.47 | 0.15 | 0.46 | 0.018 |
| 7.841 | 0.000 | 0.48 | 0.15 | 0.47 | 0.018 |
| 8.040 | 0.000 | 0.49 | 0.15 | 0.47 | 0.018 |
| 8.239 | 0.000 | 0.49 | 0.16 | 0.48 | 0.019 |
| 8.438 | 0.000 | 0.50 | 0.16 | 0.49 | 0.019 |
| 8.637 | 0.000 | 0.51 | 0.16 | 0.49 | 0.019 |
| 8.836 | 0.000 | 0.51 | 0.16 | 0.50 | 0.019 |
| 9.035 | 0.000 | 0.52 | 0.16 | 0.51 | 0.020 |
| 9.234 | 0.000 | 0.53 | 0.17 | 0.51 | 0.020 |
| 9.433 | 0.000 | 0.54 | 0.17 | 0.52 | 0.020 |
| 9.632 | 0.000 | 0.55 | 0.17 | 0.53 | 0.021 |
| 9.831 | 0.000 | 0.56 | 0.17 | 0.54 | 0.021 |
| 10.030 | 0.000 | 0.57 | 0.18 | 0.55 | 0.021 |
| 10.229 | 0.000 | 0.58 | 0.18 | 0.56 | 0.022 |
| 10.428 | 0.000 | 0.59 | 0.18 | 0.57 | 0.022 |
| 10.627 | 0.000 | 0.60 | 0.19 | 0.58 | 0.022 |
| 10.826 | 0.000 | 0.61 | 0.19 | 0.59 | 0.023 |
| 11.025 | 0.000 | 0.63 | 0.19 | 0.60 | 0.023 |
| 11.224 | 0.000 | 0.64 | 0.20 | 0.61 | 0.024 |
| 11.423 | 0.000 | 0.66 | 0.20 | 0.62 | 0.024 |
| 11.622 | 0.000 | 0.67 | 0.21 | 0.64 | 0.025 |
| 11.821 | 0.000 | 0.69 | 0.21 | 0.65 | 0.025 |
| 12.020 | 0.000 | 0.70 | 0.22 | 0.67 | 0.026 |
| 12.219 | 0.000 | 0.81 | 0.23 | 0.70 | 0.028 |
| 12.418 | 0.000 | 0.82 | 0.24 | 0.74 | 0.029 |
| 12.617 | 0.000 | 0.85 | 0.25 | 0.77 | 0.031 |

| | | | | | |
|---|---|---|---|---|---|
| 12.816 | 0.000 | 0.87 | 0.26 | 0.80 | 0.032 |
| 13.015 | 0.000 | 0.90 | 0.27 | 0.83 | 0.033 |
| 13.214 | 0.000 | 0.92 | 0.28 | 0.86 | 0.034 |
| 13.413 | 0.000 | 0.97 | 0.29 | 0.89 | 0.035 |
| 13.612 | 0.000 | 0.99 | 0.30 | 0.92 | 0.036 |
| 13.811 | 0.000 | 1.05 | 0.31 | 0.96 | 0.038 |
| 14.010 | 0.000 | 1.08 | 0.33 | 0.99 | 0.039 |
| 14.209 | 0.000 | 1.15 | 0.34 | 1.04 | 0.041 |
| 14.408 | 0.000 | 1.19 | 0.36 | 1.08 | 0.043 |
| 14.607 | 0.000 | 1.29 | 0.38 | 1.14 | 0.045 |
| 14.806 | 0.000 | 1.35 | 0.40 | 1.20 | 0.048 |
| 15.005 | 0.000 | 1.49 | 0.43 | 1.28 | 0.051 |
| 15.204 | 0.000 | 1.59 | 0.46 | 1.37 | 0.055 |
| 15.403 | 0.000 | 1.84 | 0.50 | 1.50 | 0.061 |
| 15.602 | 0.000 | 1.64 | 0.51 | 1.59 | 0.061 |
| 15.801 | 0.000 | 2.34 | 0.58 | 1.81 | 0.070 |
| 16.000 | 0.000 | 3.21 | 0.70 | 2.35 | 0.084 |
| 16.199 | 0.000 | 13.59 | 1.68 | 4.80 | 0.229 |
| 16.398 | 0.000 | 1.90 | 1.24 | 6.13 | 0.159 |
| 16.597 | 0.000 | 1.71 | 0.92 | 4.64 | 0.111 |
| 16.796 | 0.000 | 1.41 | 0.67 | 3.24 | 0.081 |
| 16.995 | 0.000 | 1.24 | 0.54 | 2.17 | 0.065 |
| 17.194 | 0.000 | 1.11 | 0.47 | 1.64 | 0.057 |
| 17.393 | 0.000 | 1.02 | 0.42 | 1.39 | 0.051 |
| 17.592 | 0.000 | 0.95 | 0.38 | 1.25 | 0.046 |
| 17.791 | 0.000 | 0.89 | 0.35 | 1.13 | 0.042 |
| 17.990 | 0.000 | 0.84 | 0.32 | 1.04 | 0.038 |
| 18.189 | 0.000 | 0.72 | 0.29 | 0.95 | 0.035 |
| 18.388 | 0.000 | 0.68 | 0.26 | 0.86 | 0.032 |
| 18.587 | 0.000 | 0.65 | 0.25 | 0.79 | 0.029 |
| 18.786 | 0.000 | 0.62 | 0.23 | 0.74 | 0.027 |
| 18.985 | 0.000 | 0.59 | 0.22 | 0.69 | 0.026 |
| 19.184 | 0.000 | 0.57 | 0.21 | 0.65 | 0.025 |
| 19.383 | 0.000 | 0.55 | 0.20 | 0.62 | 0.023 |
| 19.582 | 0.000 | 0.54 | 0.19 | 0.59 | 0.023 |
| 19.781 | 0.000 | 0.52 | 0.18 | 0.57 | 0.022 |
| 19.980 | 0.000 | 0.50 | 0.17 | 0.55 | 0.021 |
| 20.179 | 0.000 | 0.49 | 0.17 | 0.53 | 0.020 |
| 20.378 | 0.000 | 0.48 | 0.16 | 0.51 | 0.020 |
| 20.577 | 0.000 | 0.47 | 0.16 | 0.50 | 0.019 |
| 20.776 | 0.000 | 0.45 | 0.15 | 0.49 | 0.019 |
| 20.975 | 0.000 | 0.44 | 0.15 | 0.47 | 0.018 |
| 21.174 | 0.000 | 0.43 | 0.15 | 0.46 | 0.018 |
| 21.373 | 0.000 | 0.42 | 0.14 | 0.45 | 0.017 |
| 21.572 | 0.000 | 0.42 | 0.14 | 0.44 | 0.017 |
| 21.771 | 0.000 | 0.41 | 0.14 | 0.43 | 0.016 |
| 21.970 | 0.000 | 0.40 | 0.13 | 0.42 | 0.016 |
| 22.169 | 0.000 | 0.39 | 0.13 | 0.41 | 0.016 |
| 22.368 | 0.000 | 0.39 | 0.13 | 0.40 | 0.016 |
| 22.567 | 0.000 | 0.38 | 0.13 | 0.40 | 0.015 |
| 22.766 | 0.000 | 0.37 | 0.12 | 0.39 | 0.015 |
| 22.965 | 0.000 | 0.37 | 0.12 | 0.38 | 0.015 |
| 23.164 | 0.000 | 0.36 | 0.12 | 0.38 | 0.014 |
| 23.363 | 0.000 | 0.36 | 0.12 | 0.37 | 0.014 |
| 23.562 | 0.000 | 0.35 | 0.12 | 0.36 | 0.014 |
| 23.761 | 0.000 | 0.35 | 0.11 | 0.36 | 0.014 |
| 23.960 | 0.000 | 0.34 | 0.11 | 0.35 | 0.014 |

```
     24.159        0.000     0.34      0.11      0.35      0.013
     24.358        0.000     0.00      0.07      0.29      0.009
-----------------------------------------------------------------------

*****************************************************************************
                        SMALL AREA UNIT HYDROGRAPH MODEL
=============================================================================
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                              Analysis prepared by:

                            ENCOMPASS ASSOCIATES, INC.
                                5699 COUSINS PLACE
                            RANCHO CUCAMONGA CA 91737
                              www.encompasscivil.com

*****************************************************************************
-----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin4 1yr
-----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     7.50
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.418
    TIME OF CONCENTRATION(MIN.) = 18.18
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.17
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.35
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.46
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  0.82
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.19
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  1.93

-----------------------------------------------------------------------------

    TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     0.65
    TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.55

*****************************************************************************
  TIME      VOLUME        Q    0.         2.5        5.0        7.5       10.0
 (HOURS)     (AF)       (CFS)
-----------------------------------------------------------------------------
  0.24      0.0014      0.11  Q          .          .          .          .
  0.55      0.0042      0.11  Q          .          .          .          .
  0.85      0.0070      0.11  Q          .          .          .          .
  1.15      0.0098      0.11  Q          .          .          .          .
  1.46      0.0127      0.12  Q          .          .          .          .
```

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1.76 | 0.0156 | 0.12 | Q | . | . | . | . |
| 2.06 | 0.0186 | 0.12 | Q | . | . | . | . |
| 2.37 | 0.0216 | 0.12 | Q | . | . | . | . |
| 2.67 | 0.0246 | 0.12 | Q | . | . | . | . |
| 2.97 | 0.0277 | 0.12 | Q | . | . | . | . |
| 3.27 | 0.0309 | 0.13 | Q | . | . | . | . |
| 3.58 | 0.0341 | 0.13 | Q | . | . | . | . |
| 3.88 | 0.0373 | 0.13 | Q | . | . | . | . |
| 4.18 | 0.0406 | 0.13 | Q | . | . | . | . |
| 4.49 | 0.0439 | 0.13 | Q | . | . | . | . |
| 4.79 | 0.0473 | 0.14 | Q | . | . | . | . |
| 5.09 | 0.0508 | 0.14 | Q | . | . | . | . |
| 5.39 | 0.0543 | 0.14 | Q | . | . | . | . |
| 5.70 | 0.0579 | 0.14 | Q | . | . | . | . |
| 6.00 | 0.0615 | 0.15 | Q | . | . | . | . |
| 6.30 | 0.0653 | 0.15 | Q | . | . | . | . |
| 6.61 | 0.0691 | 0.15 | Q | . | . | . | . |
| 6.91 | 0.0729 | 0.16 | Q | . | . | . | . |
| 7.21 | 0.0769 | 0.16 | Q | . | . | . | . |
| 7.52 | 0.0810 | 0.16 | Q | . | . | . | . |
| 7.82 | 0.0851 | 0.17 | Q | . | . | . | . |
| 8.12 | 0.0893 | 0.17 | Q | . | . | . | . |
| 8.43 | 0.0937 | 0.18 | Q | . | . | . | . |
| 8.73 | 0.0981 | 0.18 | Q | . | . | . | . |
| 9.03 | 0.1027 | 0.19 | Q | . | . | . | . |
| 9.33 | 0.1074 | 0.19 | Q | . | . | . | . |
| 9.64 | 0.1122 | 0.20 | Q | . | . | . | . |
| 9.94 | 0.1172 | 0.20 | Q | . | . | . | . |
| 10.24 | 0.1224 | 0.21 | Q | . | . | . | . |
| 10.55 | 0.1277 | 0.21 | Q | . | . | . | . |
| 10.85 | 0.1332 | 0.22 | Q | . | . | . | . |
| 11.15 | 0.1389 | 0.23 | Q | . | . | . | . |
| 11.45 | 0.1448 | 0.24 | Q | . | . | . | . |
| 11.76 | 0.1510 | 0.25 | .Q | . | . | . | . |
| 12.06 | 0.1574 | 0.27 | .Q | . | . | . | . |
| 12.36 | 0.1656 | 0.39 | .Q | . | . | . | . |
| 12.67 | 0.1760 | 0.44 | .Q | . | . | . | . |
| 12.97 | 0.1871 | 0.45 | .Q | . | . | . | . |
| 13.27 | 0.1987 | 0.48 | .Q | . | . | . | . |
| 13.58 | 0.2109 | 0.49 | .Q | . | . | . | . |
| 13.88 | 0.2238 | 0.53 | . Q | . | . | . | . |
| 14.18 | 0.2374 | 0.56 | . Q | . | . | . | . |
| 14.48 | 0.2521 | 0.62 | . Q | . | . | . | . |
| 14.79 | 0.2680 | 0.65 | . Q | . | . | . | . |
| 15.09 | 0.2856 | 0.75 | .  Q | . | . | . | . |
| 15.39 | 0.3054 | 0.83 | .  Q | . | . | . | . |
| 15.70 | 0.3266 | 0.86 | .  Q | . | . | . | . |
| 16.00 | 0.3522 | 1.18 | .  Q | . | . | . | . |
| 16.30 | 0.4246 | 4.60 | . | . | Q . | . | . |
| 16.61 | 0.4930 | 0.86 | .  Q | . | . | . | . |
| 16.91 | 0.5125 | 0.70 | . Q | . | . | . | . |
| 17.21 | 0.5286 | 0.58 | . Q | . | . | . | . |
| 17.52 | 0.5423 | 0.51 | . Q | . | . | . | . |
| 17.82 | 0.5545 | 0.46 | .Q | . | . | . | . |
| 18.12 | 0.5657 | 0.43 | .Q | . | . | . | . |
| 18.42 | 0.5743 | 0.26 | .Q | . | . | . | . |
| 18.73 | 0.5805 | 0.24 | Q | . | . | . | . |

```
 19.03      0.5862      0.22  Q          .          .          .          .
 19.33      0.5915      0.21  Q          .          .          .          .
 19.64      0.5965      0.19  Q          .          .          .          .
 19.94      0.6012      0.18  Q          .          .          .          .
 20.24      0.6056      0.17  Q          .          .          .          .
 20.55      0.6099      0.17  Q          .          .          .          .
 20.85      0.6139      0.16  Q          .          .          .          .
 21.15      0.6178      0.15  Q          .          .          .          .
 21.45      0.6215      0.15  Q          .          .          .          .
 21.76      0.6251      0.14  Q          .          .          .          .
 22.06      0.6286      0.14  Q          .          .          .          .
 22.36      0.6319      0.13  Q          .          .          .          .
 22.67      0.6351      0.13  Q          .          .          .          .
 22.97      0.6383      0.12  Q          .          .          .          .
 23.27      0.6413      0.12  Q          .          .          .          .
 23.58      0.6443      0.12  Q          .          .          .          .
 23.88      0.6472      0.11  Q          .          .          .          .
 24.18      0.6500      0.11  Q          .          .          .          .
 24.48      0.6514      0.00  Q          .          .          .          .
 ------------------------------------------------------------------------------
-------------------------------------------------------------------------------
    TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
    (Note: 100% of Peak Flow Rate estimate assumed to have
    an instantaneous time duration)

    Percentile of Estimated                  Duration
        Peak Flow Rate                       (minutes)
    ======================                   =========
              0%                              1454.4
             10%                               290.9
             20%                                36.4
             30%                                18.2
             40%                                18.2
             50%                                18.2
             60%                                18.2
             70%                                18.2
             80%                                18.2
             90%                                18.2

  Problem Descriptions:


   wq Basin4 1yr


===============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   18.180
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                    INFLOW
```

```
                 |
                 |
                 |
                 V                 __effective depth
            -------------          |   (and volume)
            |           |    |     |
            | detention |    |....V.............
            |   basin   |<-->|          outflow
            |           |    |.........________
            -------------    |         |   \
                 |           | storage |     basin outlet
                 V           -----------
              OUTFLOW
```

DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES = 9

| *BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) ** | **BASIN-DEPTH (FEET) | STORAGE (ACRE-FEET) | OUTFLOW (CFS) * |
|---|---|---|---|---|---|
| 0.000 | 0.000 | 0.000** | 0.500 | 0.150 | 1.550* |
| 1.000 | 0.310 | 4.390** | 1.500 | 0.490 | 6.320* |
| 2.000 | 0.690 | 7.990** | 2.500 | 0.900 | 9.360* |
| 3.000 | 1.120 | 10.560** | 3.500 | 1.360 | 11.640* |
| 4.000 | 1.590 | 12.620** | | | |

---

BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:

| INTERVAL NUMBER | DEPTH (FEET) | {S-O*DT/2} (ACRE-FEET) | {S+O*DT/2} (ACRE-FEET) |
|---|---|---|---|
| 1 | 0.00 | 0.00000 | 0.00000 |
| 2 | 0.50 | 0.13059 | 0.16941 |
| 3 | 1.00 | 0.25503 | 0.36497 |
| 4 | 1.50 | 0.41087 | 0.56913 |
| 5 | 2.00 | 0.58996 | 0.79004 |
| 6 | 2.50 | 0.78281 | 1.01719 |
| 7 | 3.00 | 0.98778 | 1.25222 |
| 8 | 3.50 | 1.21426 | 1.50574 |
| 9 | 4.00 | 1.43199 | 1.74801 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

---

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.244 | 0.000 | 0.11 | 0.01 | 0.01 | 0.002 |
| 0.547 | 0.000 | 0.11 | 0.01 | 0.04 | 0.004 |
| 0.850 | 0.000 | 0.11 | 0.02 | 0.05 | 0.006 |
| 1.153 | 0.000 | 0.11 | 0.02 | 0.07 | 0.007 |
| 1.456 | 0.000 | 0.12 | 0.03 | 0.08 | 0.008 |
| 1.759 | 0.000 | 0.12 | 0.03 | 0.09 | 0.009 |
| 2.062 | 0.000 | 0.12 | 0.03 | 0.09 | 0.009 |
| 2.365 | 0.000 | 0.12 | 0.03 | 0.10 | 0.010 |
| 2.668 | 0.000 | 0.12 | 0.03 | 0.10 | 0.010 |
| 2.971 | 0.000 | 0.12 | 0.04 | 0.11 | 0.011 |

| | | | | | |
|---|---|---|---|---|---|
| 3.274 | 0.000 | 0.13 | 0.04 | 0.11 | 0.011 |
| 3.577 | 0.000 | 0.13 | 0.04 | 0.12 | 0.011 |
| 3.880 | 0.000 | 0.13 | 0.04 | 0.12 | 0.012 |
| 4.183 | 0.000 | 0.13 | 0.04 | 0.12 | 0.012 |
| 4.486 | 0.000 | 0.13 | 0.04 | 0.12 | 0.012 |
| 4.789 | 0.000 | 0.14 | 0.04 | 0.13 | 0.012 |
| 5.092 | 0.000 | 0.14 | 0.04 | 0.13 | 0.013 |
| 5.395 | 0.000 | 0.14 | 0.04 | 0.13 | 0.013 |
| 5.698 | 0.000 | 0.14 | 0.04 | 0.13 | 0.013 |
| 6.001 | 0.000 | 0.15 | 0.04 | 0.14 | 0.013 |
| 6.304 | 0.000 | 0.15 | 0.05 | 0.14 | 0.014 |
| 6.607 | 0.000 | 0.15 | 0.05 | 0.14 | 0.014 |
| 6.910 | 0.000 | 0.16 | 0.05 | 0.15 | 0.014 |
| 7.213 | 0.000 | 0.16 | 0.05 | 0.15 | 0.015 |
| 7.516 | 0.000 | 0.16 | 0.05 | 0.15 | 0.015 |
| 7.819 | 0.000 | 0.17 | 0.05 | 0.15 | 0.015 |
| 8.122 | 0.000 | 0.17 | 0.05 | 0.16 | 0.015 |
| 8.425 | 0.000 | 0.18 | 0.05 | 0.16 | 0.016 |
| 8.728 | 0.000 | 0.18 | 0.05 | 0.17 | 0.016 |
| 9.031 | 0.000 | 0.19 | 0.06 | 0.17 | 0.017 |
| 9.334 | 0.000 | 0.19 | 0.06 | 0.17 | 0.017 |
| 9.637 | 0.000 | 0.20 | 0.06 | 0.18 | 0.017 |
| 9.940 | 0.000 | 0.20 | 0.06 | 0.18 | 0.018 |
| 10.243 | 0.000 | 0.21 | 0.06 | 0.19 | 0.018 |
| 10.546 | 0.000 | 0.21 | 0.06 | 0.19 | 0.019 |
| 10.849 | 0.000 | 0.22 | 0.07 | 0.20 | 0.020 |
| 11.152 | 0.000 | 0.23 | 0.07 | 0.21 | 0.020 |
| 11.455 | 0.000 | 0.24 | 0.07 | 0.21 | 0.021 |
| 11.758 | 0.000 | 0.25 | 0.07 | 0.22 | 0.022 |
| 12.061 | 0.000 | 0.27 | 0.08 | 0.23 | 0.023 |
| 12.364 | 0.000 | 0.39 | 0.09 | 0.25 | 0.026 |
| 12.667 | 0.000 | 0.44 | 0.10 | 0.29 | 0.030 |
| 12.970 | 0.000 | 0.45 | 0.11 | 0.32 | 0.033 |
| 13.273 | 0.000 | 0.48 | 0.12 | 0.36 | 0.036 |
| 13.576 | 0.000 | 0.49 | 0.13 | 0.39 | 0.039 |
| 13.879 | 0.000 | 0.53 | 0.14 | 0.42 | 0.042 |
| 14.182 | 0.000 | 0.56 | 0.15 | 0.45 | 0.044 |
| 14.485 | 0.000 | 0.62 | 0.16 | 0.48 | 0.048 |
| 14.788 | 0.000 | 0.65 | 0.17 | 0.51 | 0.051 |
| 15.091 | 0.000 | 0.75 | 0.19 | 0.56 | 0.056 |
| 15.394 | 0.000 | 0.83 | 0.21 | 0.61 | 0.062 |
| 15.697 | 0.000 | 0.86 | 0.22 | 0.66 | 0.067 |
| 16.000 | 0.000 | 1.18 | 0.26 | 0.75 | 0.078 |
| 16.303 | 0.000 | 4.60 | 0.53 | 1.27 | 0.161 |
| 16.606 | 0.000 | 0.86 | 0.47 | 1.61 | 0.142 |
| 16.909 | 0.000 | 0.70 | 0.42 | 1.38 | 0.125 |
| 17.212 | 0.000 | 0.58 | 0.36 | 1.21 | 0.109 |
| 17.515 | 0.000 | 0.51 | 0.32 | 1.06 | 0.096 |
| 17.818 | 0.000 | 0.46 | 0.28 | 0.93 | 0.084 |
| 18.121 | 0.000 | 0.43 | 0.25 | 0.82 | 0.074 |
| 18.424 | 0.000 | 0.26 | 0.21 | 0.71 | 0.063 |
| 18.727 | 0.000 | 0.24 | 0.18 | 0.60 | 0.054 |
| 19.030 | 0.000 | 0.22 | 0.15 | 0.52 | 0.046 |
| 19.333 | 0.000 | 0.21 | 0.13 | 0.45 | 0.040 |
| 19.636 | 0.000 | 0.19 | 0.12 | 0.39 | 0.035 |
| 19.939 | 0.000 | 0.18 | 0.10 | 0.34 | 0.031 |
| 20.242 | 0.000 | 0.17 | 0.09 | 0.31 | 0.028 |

| | | | | | |
|---|---|---|---|---|---|
| 20.545 | 0.000 | 0.17 | 0.08 | 0.27 | 0.025 |
| 20.848 | 0.000 | 0.16 | 0.08 | 0.25 | 0.023 |
| 21.151 | 0.000 | 0.15 | 0.07 | 0.23 | 0.021 |
| 21.454 | 0.000 | 0.15 | 0.06 | 0.21 | 0.019 |
| 21.757 | 0.000 | 0.14 | 0.06 | 0.19 | 0.018 |
| 22.060 | 0.000 | 0.14 | 0.06 | 0.18 | 0.017 |
| 22.363 | 0.000 | 0.13 | 0.05 | 0.17 | 0.016 |
| 22.666 | 0.000 | 0.13 | 0.05 | 0.16 | 0.015 |
| 22.969 | 0.000 | 0.12 | 0.05 | 0.15 | 0.014 |
| 23.272 | 0.000 | 0.12 | 0.05 | 0.15 | 0.014 |
| 23.575 | 0.000 | 0.12 | 0.04 | 0.14 | 0.013 |
| 23.878 | 0.000 | 0.11 | 0.04 | 0.13 | 0.013 |
| 24.181 | 0.000 | 0.11 | 0.04 | 0.13 | 0.012 |
| 24.484 | 0.000 | 0.00 | 0.03 | 0.11 | 0.009 |

```
****************************************************************************
                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                         Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
                           5699 COUSINS PLACE
                       RANCHO CUCAMONGA CA 91737
                         www.encompasscivil.com

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----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin4 2yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     7.50
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.391
    TIME OF CONCENTRATION(MIN.) = 18.13
    SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
    USER SPECIFIED RAINFALL VALUES ARE USED
    RETURN FREQUENCY(YEARS) =   2
       5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.22
      30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.45
       1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.59
       3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.04
       6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.48
      24-HOUR   POINT RAINFALL VALUE(INCHES) =  2.60

----------------------------------------------------------------------------
```

TOTAL CATCHMENT RUNOFF VOLUME(ACRE-FEET) = 0.92
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) = 0.70

**********

| TIME (HOURS) | VOLUME (AF) | Q (CFS) | 0. | 2.5 | 5.0 | 7.5 | 10.0 |
|---|---|---|---|---|---|---|---|
| 0.29 | 0.0023 | 0.18 | Q | . | . | . | . |
| 0.59 | 0.0068 | 0.18 | Q | . | . | . | . |
| 0.89 | 0.0114 | 0.19 | Q | . | . | . | . |
| 1.19 | 0.0161 | 0.19 | Q | . | . | . | . |
| 1.50 | 0.0208 | 0.19 | Q | . | . | . | . |
| 1.80 | 0.0256 | 0.19 | Q | . | . | . | . |
| 2.10 | 0.0304 | 0.19 | Q | . | . | . | . |
| 2.40 | 0.0353 | 0.20 | Q | . | . | . | . |
| 2.70 | 0.0403 | 0.20 | Q | . | . | . | . |
| 3.01 | 0.0453 | 0.20 | Q | . | . | . | . |
| 3.31 | 0.0504 | 0.20 | Q | . | . | . | . |
| 3.61 | 0.0555 | 0.21 | Q | . | . | . | . |
| 3.91 | 0.0608 | 0.21 | Q | . | . | . | . |
| 4.22 | 0.0661 | 0.21 | Q | . | . | . | . |
| 4.52 | 0.0715 | 0.22 | Q | . | . | . | . |
| 4.82 | 0.0769 | 0.22 | Q | . | . | . | . |
| 5.12 | 0.0825 | 0.22 | Q | . | . | . | . |
| 5.42 | 0.0882 | 0.23 | Q | . | . | . | . |
| 5.73 | 0.0939 | 0.23 | Q | . | . | . | . |
| 6.03 | 0.0998 | 0.24 | Q | . | . | . | . |
| 6.33 | 0.1057 | 0.24 | Q | . | . | . | . |
| 6.63 | 0.1118 | 0.25 | Q | . | . | . | . |
| 6.94 | 0.1179 | 0.25 | Q | . | . | . | . |
| 7.24 | 0.1242 | 0.26 | .Q | . | . | . | . |
| 7.54 | 0.1307 | 0.26 | .Q | . | . | . | . |
| 7.84 | 0.1372 | 0.27 | .Q | . | . | . | . |
| 8.14 | 0.1439 | 0.27 | .Q | . | . | . | . |
| 8.45 | 0.1507 | 0.28 | .Q | . | . | . | . |
| 8.75 | 0.1577 | 0.28 | .Q | . | . | . | . |
| 9.05 | 0.1649 | 0.29 | .Q | . | . | . | . |
| 9.35 | 0.1723 | 0.30 | .Q | . | . | . | . |
| 9.65 | 0.1798 | 0.31 | .Q | . | . | . | . |
| 9.96 | 0.1876 | 0.31 | .Q | . | . | . | . |
| 10.26 | 0.1956 | 0.33 | .Q | . | . | . | . |
| 10.56 | 0.2038 | 0.33 | .Q | . | . | . | . |
| 10.86 | 0.2123 | 0.35 | .Q | . | . | . | . |
| 11.17 | 0.2210 | 0.36 | .Q | . | . | . | . |
| 11.47 | 0.2301 | 0.37 | .Q | . | . | . | . |
| 11.77 | 0.2396 | 0.38 | .Q | . | . | . | . |
| 12.07 | 0.2494 | 0.40 | .Q | . | . | . | . |
| 12.37 | 0.2608 | 0.51 | . Q | . | . | . | . |
| 12.68 | 0.2741 | 0.55 | . Q | . | . | . | . |
| 12.98 | 0.2881 | 0.57 | . Q | . | . | . | . |
| 13.28 | 0.3028 | 0.61 | . Q | . | . | . | . |
| 13.58 | 0.3182 | 0.63 | . Q | . | . | . | . |
| 13.88 | 0.3345 | 0.68 | . Q | . | . | . | . |
| 14.19 | 0.3519 | 0.71 | . Q | . | . | . | . |
| 14.49 | 0.3706 | 0.79 | . Q | . | . | . | . |
| 14.79 | 0.3908 | 0.84 | . Q | . | . | . | . |
| 15.09 | 0.4134 | 0.97 | . Q | . | . | . | . |

```
 15.40      0.4390      1.07  .   Q     .         .         .         .
 15.70      0.4668      1.16  .   Q     .         .         .         .
 16.00      0.5011      1.59  .     Q   .         .         .         .
 16.30      0.6010      6.41  .         .         .    Q    .         .
 16.60      0.6951      1.13  .   Q     .         .         .         .
 16.91      0.7204      0.90  .  Q      .         .         .         .
 17.21      0.7409      0.75  . Q       .         .         .         .
 17.51      0.7584      0.65  . Q       .         .         .         .
 17.81      0.7738      0.59  . Q       .         .         .         .
 18.12      0.7879      0.54  . Q       .         .         .         .
 18.42      0.7995      0.39  .Q        .         .         .         .
 18.72      0.8090      0.36  .Q        .         .         .         .
 19.02      0.8178      0.34  .Q        .         .         .         .
 19.32      0.8260      0.32  .Q        .         .         .         .
 19.63      0.8338      0.30  .Q        .         .         .         .
 19.93      0.8411      0.29  .Q        .         .         .         .
 20.23      0.8481      0.27  .Q        .         .         .         .
 20.53      0.8548      0.26  .Q        .         .         .         .
 20.83      0.8613      0.25  .Q        .         .         .         .
 21.14      0.8674      0.24  Q         .         .         .         .
 21.44      0.8734      0.23  Q         .         .         .         .
 21.74      0.8791      0.23  Q         .         .         .         .
 22.04      0.8847      0.22  Q         .         .         .         .
 22.35      0.8901      0.21  Q         .         .         .         .
 22.65      0.8953      0.21  Q         .         .         .         .
 22.95      0.9004      0.20  Q         .         .         .         .
 23.25      0.9054      0.20  Q         .         .         .         .
 23.55      0.9102      0.19  Q         .         .         .         .
 23.86      0.9149      0.19  Q         .         .         .         .
 24.16      0.9195      0.18  Q         .         .         .         .
 24.46      0.9218      0.00  Q         .         .         .         .
-------------------------------------------------------------------------
-------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated                  Duration
       Peak Flow Rate                       (minutes)
   ======================                   =========
             0%                              1450.4
            10%                               235.7
            20%                                36.3
            30%                                18.1
            40%                                18.1
            50%                                18.1
            60%                                18.1
            70%                                18.1
            80%                                18.1
            90%                                18.1

 Problem Descriptions:


  wq Basin4 2yr
```

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==========================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   18.130
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                    INFLOW
                      |
                      |
                      |
                      V                __effective depth
                -------------          |   (and volume)
                |           |    |     |
                | detention |    |....V.............
                |   basin   |<-->|          outflow
                |           |    |.........________
                -------------    |         |   \
                      |          | storage |     basin outlet
                      V          -----------
                   OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
     *   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
     *      0.000      0.000      0.000**      0.500      0.150      1.550*
     *      1.000      0.310      4.390**      1.500      0.490      6.320*
     *      2.000      0.690      7.990**      2.500      0.900      9.360*
     *      3.000      1.120     10.560**      3.500      1.360     11.640*
     *      4.000      1.590     12.620**
---------------------------------------------------------------------------
     BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:
      INTERVAL   DEPTH   {S-O*DT/2}   {S+O*DT/2}
       NUMBER   (FEET)   (ACRE-FEET)  (ACRE-FEET)
          1     0.00       0.00000      0.00000
          2     0.50       0.13065      0.16935
          3     1.00       0.25519      0.36481
          4     1.50       0.41109      0.56891
          5     2.00       0.59024      0.78976
          6     2.50       0.78313      1.01687
          7     3.00       0.98815      1.25185
          8     3.50       1.21466      1.50534
          9     4.00       1.43242      1.74758
     WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)
---------------------------------------------------------------------------
     DETENTION BASIN ROUTING RESULTS:
     NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES
           OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE
           AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

        TIME  DEAD-STORAGE  INFLOW  EFFECTIVE  OUTFLOW  EFFECTIVE
```

| (HRS) | FILLED(AF) | (CFS) | DEPTH(FT) | (CFS) | VOLUME(AF) |
|---|---|---|---|---|---|
| 0.287 | 0.000 | 0.18 | 0.01 | 0.02 | 0.004 |
| 0.590 | 0.000 | 0.18 | 0.02 | 0.06 | 0.007 |
| 0.892 | 0.000 | 0.19 | 0.03 | 0.09 | 0.010 |
| 1.194 | 0.000 | 0.19 | 0.04 | 0.11 | 0.012 |
| 1.496 | 0.000 | 0.19 | 0.04 | 0.13 | 0.013 |
| 1.798 | 0.000 | 0.19 | 0.05 | 0.14 | 0.014 |
| 2.100 | 0.000 | 0.19 | 0.05 | 0.15 | 0.015 |
| 2.403 | 0.000 | 0.20 | 0.05 | 0.16 | 0.016 |
| 2.705 | 0.000 | 0.20 | 0.06 | 0.17 | 0.017 |
| 3.007 | 0.000 | 0.20 | 0.06 | 0.18 | 0.018 |
| 3.309 | 0.000 | 0.20 | 0.06 | 0.18 | 0.018 |
| 3.611 | 0.000 | 0.21 | 0.06 | 0.19 | 0.019 |
| 3.913 | 0.000 | 0.21 | 0.06 | 0.19 | 0.019 |
| 4.216 | 0.000 | 0.21 | 0.06 | 0.20 | 0.019 |
| 4.518 | 0.000 | 0.22 | 0.07 | 0.20 | 0.020 |
| 4.820 | 0.000 | 0.22 | 0.07 | 0.21 | 0.020 |
| 5.122 | 0.000 | 0.22 | 0.07 | 0.21 | 0.020 |
| 5.424 | 0.000 | 0.23 | 0.07 | 0.21 | 0.021 |
| 5.726 | 0.000 | 0.23 | 0.07 | 0.22 | 0.021 |
| 6.029 | 0.000 | 0.24 | 0.07 | 0.22 | 0.022 |
| 6.331 | 0.000 | 0.24 | 0.07 | 0.23 | 0.022 |
| 6.633 | 0.000 | 0.25 | 0.07 | 0.23 | 0.022 |
| 6.935 | 0.000 | 0.25 | 0.08 | 0.23 | 0.023 |
| 7.237 | 0.000 | 0.26 | 0.08 | 0.24 | 0.023 |
| 7.539 | 0.000 | 0.26 | 0.08 | 0.24 | 0.024 |
| 7.842 | 0.000 | 0.27 | 0.08 | 0.25 | 0.024 |
| 8.144 | 0.000 | 0.27 | 0.08 | 0.25 | 0.025 |
| 8.446 | 0.000 | 0.28 | 0.08 | 0.26 | 0.025 |
| 8.748 | 0.000 | 0.28 | 0.09 | 0.26 | 0.026 |
| 9.050 | 0.000 | 0.29 | 0.09 | 0.27 | 0.026 |
| 9.352 | 0.000 | 0.30 | 0.09 | 0.27 | 0.027 |
| 9.655 | 0.000 | 0.31 | 0.09 | 0.28 | 0.027 |
| 9.957 | 0.000 | 0.31 | 0.09 | 0.29 | 0.028 |
| 10.259 | 0.000 | 0.33 | 0.10 | 0.29 | 0.029 |
| 10.561 | 0.000 | 0.33 | 0.10 | 0.30 | 0.030 |
| 10.863 | 0.000 | 0.35 | 0.10 | 0.31 | 0.031 |
| 11.165 | 0.000 | 0.36 | 0.10 | 0.32 | 0.031 |
| 11.467 | 0.000 | 0.37 | 0.11 | 0.33 | 0.032 |
| 11.770 | 0.000 | 0.38 | 0.11 | 0.34 | 0.034 |
| 12.072 | 0.000 | 0.40 | 0.12 | 0.35 | 0.035 |
| 12.374 | 0.000 | 0.51 | 0.13 | 0.38 | 0.038 |
| 12.676 | 0.000 | 0.55 | 0.14 | 0.41 | 0.042 |
| 12.978 | 0.000 | 0.57 | 0.15 | 0.45 | 0.045 |
| 13.281 | 0.000 | 0.61 | 0.16 | 0.48 | 0.048 |
| 13.583 | 0.000 | 0.63 | 0.17 | 0.51 | 0.051 |
| 13.885 | 0.000 | 0.68 | 0.18 | 0.54 | 0.054 |
| 14.187 | 0.000 | 0.71 | 0.19 | 0.58 | 0.058 |
| 14.489 | 0.000 | 0.79 | 0.21 | 0.62 | 0.062 |
| 14.791 | 0.000 | 0.84 | 0.22 | 0.66 | 0.066 |
| 15.094 | 0.000 | 0.97 | 0.24 | 0.72 | 0.073 |
| 15.396 | 0.000 | 1.07 | 0.27 | 0.79 | 0.080 |
| 15.698 | 0.000 | 1.16 | 0.29 | 0.86 | 0.087 |
| 16.000 | 0.000 | 1.59 | 0.34 | 0.98 | 0.102 |
| 16.302 | 0.000 | 6.41 | 0.70 | 1.88 | 0.215 |
| 16.604 | 0.000 | 1.13 | 0.60 | 2.42 | 0.183 |

| | | | | | |
|---|---|---|---|---|---|
| 16.906 | 0.000 | 0.90 | 0.52 | 1.91 | 0.158 |
| 17.209 | 0.000 | 0.75 | 0.46 | 1.55 | 0.138 |
| 17.511 | 0.000 | 0.65 | 0.40 | 1.33 | 0.121 |
| 17.813 | 0.000 | 0.59 | 0.35 | 1.17 | 0.106 |
| 18.115 | 0.000 | 0.54 | 0.31 | 1.03 | 0.094 |
| 18.417 | 0.000 | 0.39 | 0.27 | 0.90 | 0.081 |
| 18.720 | 0.000 | 0.36 | 0.23 | 0.78 | 0.070 |
| 19.022 | 0.000 | 0.34 | 0.21 | 0.68 | 0.062 |
| 19.324 | 0.000 | 0.32 | 0.18 | 0.60 | 0.055 |
| 19.626 | 0.000 | 0.30 | 0.16 | 0.54 | 0.049 |
| 19.928 | 0.000 | 0.29 | 0.15 | 0.48 | 0.044 |
| 20.230 | 0.000 | 0.27 | 0.13 | 0.44 | 0.040 |
| 20.532 | 0.000 | 0.26 | 0.12 | 0.40 | 0.037 |
| 20.835 | 0.000 | 0.25 | 0.11 | 0.37 | 0.034 |
| 21.137 | 0.000 | 0.24 | 0.11 | 0.34 | 0.032 |
| 21.439 | 0.000 | 0.23 | 0.10 | 0.32 | 0.030 |
| 21.741 | 0.000 | 0.23 | 0.09 | 0.30 | 0.028 |
| 22.043 | 0.000 | 0.22 | 0.09 | 0.28 | 0.026 |
| 22.345 | 0.000 | 0.21 | 0.08 | 0.26 | 0.025 |
| 22.648 | 0.000 | 0.21 | 0.08 | 0.25 | 0.024 |
| 22.950 | 0.000 | 0.20 | 0.08 | 0.24 | 0.023 |
| 23.252 | 0.000 | 0.20 | 0.07 | 0.23 | 0.022 |
| 23.554 | 0.000 | 0.19 | 0.07 | 0.22 | 0.021 |
| 23.856 | 0.000 | 0.19 | 0.07 | 0.21 | 0.020 |
| 24.159 | 0.000 | 0.18 | 0.07 | 0.21 | 0.020 |
| 24.461 | 0.000 | 0.00 | 0.05 | 0.18 | 0.015 |

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                    SMALL AREA UNIT HYDROGRAPH MODEL
============================================================================
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                         Analysis prepared by:

                       ENCOMPASS ASSOCIATES, INC.
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----------------------------------------------------------------------------

 Problem Descriptions:


  wq Basin4 5yr
----------------------------------------------------------------------------


    RATIONAL METHOD CALIBRATION COEFFICIENT = 0.90
    TOTAL CATCHMENT AREA(ACRES) =     7.50
    SOIL-LOSS RATE, Fm,(INCH/HR) =  0.260
    LOW LOSS FRACTION = 0.357
    TIME OF CONCENTRATION(MIN.) = 18.19
```

```
SMALL AREA PEAK Q COMPUTED USING PEAK FLOW RATE FORMULA
USER SPECIFIED RAINFALL VALUES ARE USED
RETURN FREQUENCY(YEARS) =   5
   5-MINUTE POINT RAINFALL VALUE(INCHES) =  0.28
  30-MINUTE POINT RAINFALL VALUE(INCHES) =  0.57
   1-HOUR   POINT RAINFALL VALUE(INCHES) =  0.75
   3-HOUR   POINT RAINFALL VALUE(INCHES) =  1.31
   6-HOUR   POINT RAINFALL VALUE(INCHES) =  1.86
  24-HOUR   POINT RAINFALL VALUE(INCHES) =  3.49

--------------------------------------------------------------------------

TOTAL CATCHMENT   RUNOFF  VOLUME(ACRE-FEET) =     1.31
TOTAL CATCHMENT SOIL-LOSS VOLUME(ACRE-FEET) =     0.87

**************************************************************************
 TIME     VOLUME       Q    0.        2.5       5.0       7.5      10.0
(HOURS)    (AF)      (CFS)
--------------------------------------------------------------------------
 0.24     0.0036      0.29  .Q        .         .         .         .
 0.54     0.0108      0.29  .Q        .         .         .         .
 0.84     0.0181      0.29  .Q        .         .         .         .
 1.14     0.0255      0.30  .Q        .         .         .         .
 1.45     0.0329      0.30  .Q        .         .         .         .
 1.75     0.0405      0.30  .Q        .         .         .         .
 2.05     0.0481      0.31  .Q        .         .         .         .
 2.36     0.0558      0.31  .Q        .         .         .         .
 2.66     0.0636      0.31  .Q        .         .         .         .
 2.96     0.0715      0.32  .Q        .         .         .         .
 3.27     0.0795      0.32  .Q        .         .         .         .
 3.57     0.0876      0.33  .Q        .         .         .         .
 3.87     0.0958      0.33  .Q        .         .         .         .
 4.18     0.1041      0.33  .Q        .         .         .         .
 4.48     0.1125      0.34  .Q        .         .         .         .
 4.78     0.1211      0.34  .Q        .         .         .         .
 5.09     0.1297      0.35  .Q        .         .         .         .
 5.39     0.1385      0.35  .Q        .         .         .         .
 5.69     0.1475      0.36  .Q        .         .         .         .
 6.00     0.1566      0.37  .Q        .         .         .         .
 6.30     0.1658      0.37  .Q        .         .         .         .
 6.60     0.1752      0.38  .Q        .         .         .         .
 6.90     0.1847      0.38  .Q        .         .         .         .
 7.21     0.1944      0.39  .Q        .         .         .         .
 7.51     0.2043      0.40  .Q        .         .         .         .
 7.81     0.2144      0.41  .Q        .         .         .         .
 8.12     0.2247      0.41  .Q        .         .         .         .
 8.42     0.2352      0.42  .Q        .         .         .         .
 8.72     0.2459      0.43  .Q        .         .         .         .
 9.03     0.2569      0.44  .Q        .         .         .         .
 9.33     0.2681      0.45  .Q        .         .         .         .
 9.63     0.2796      0.47  .Q        .         .         .         .
 9.94     0.2913      0.47  .Q        .         .         .         .
10.24     0.3034      0.49  .Q        .         .         .         .
10.54     0.3158      0.50  . Q       .         .         .         .
10.85     0.3286      0.52  . Q       .         .         .         .
11.15     0.3418      0.53  . Q       .         .         .         .
11.45     0.3555      0.56  . Q       .         .         .         .
```

```
11.76      0.3696      0.57  . Q       .         .         .         .
12.06      0.3842      0.60  . Q       .         .         .         .
12.36      0.4001      0.67  . Q       .         .         .         .
12.67      0.4176      0.72  . Q       .         .         .         .
12.97      0.4361      0.75  . Q       .         .         .         .
13.27      0.4554      0.80  .  Q      .         .         .         .
13.57      0.4756      0.82  .  Q      .         .         .         .
13.88      0.4971      0.89  .  Q      .         .         .         .
14.18      0.5200      0.93  .  Q      .         .         .         .
14.48      0.5446      1.04  .   Q     .         .         .         .
14.79      0.5714      1.10  .   Q     .         .         .         .
15.09      0.6013      1.28  .    Q    .         .         .         .
15.39      0.6351      1.42  .    Q    .         .         .         .
15.70      0.6723      1.55  .     Q   .         .         .         .
16.00      0.7183      2.13  .       Q .         .         .         .
16.30      0.8528      8.60  .         .         .         .   Q     .
16.61      0.9794      1.50  .     Q   .         .         .         .
16.91      1.0130      1.18  .   Q     .         .         .         .
17.21      1.0401      0.98  .  Q      .         .         .         .
17.52      1.0631      0.86  .  Q      .         .         .         .
17.82      1.0835      0.77  .  Q      .         .         .         .
18.12      1.1019      0.71  . Q       .         .         .         .
18.43      1.1181      0.58  . Q       .         .         .         .
18.73      1.1322      0.54  . Q       .         .         .         .
19.03      1.1454      0.51  . Q       .         .         .         .
19.33      1.1578      0.48  .Q        .         .         .         .
19.64      1.1696      0.46  .Q        .         .         .         .
19.94      1.1809      0.44  .Q        .         .         .         .
20.24      1.1916      0.42  .Q        .         .         .         .
20.55      1.2019      0.40  .Q        .         .         .         .
20.85      1.2118      0.39  .Q        .         .         .         .
21.15      1.2213      0.37  .Q        .         .         .         .
21.46      1.2305      0.36  .Q        .         .         .         .
21.76      1.2395      0.35  .Q        .         .         .         .
22.06      1.2482      0.34  .Q        .         .         .         .
22.37      1.2566      0.33  .Q        .         .         .         .
22.67      1.2648      0.32  .Q        .         .         .         .
22.97      1.2728      0.32  .Q        .         .         .         .
23.28      1.2806      0.31  .Q        .         .         .         .
23.58      1.2882      0.30  .Q        .         .         .         .
23.88      1.2957      0.29  .Q        .         .         .         .
24.19      1.3029      0.29  .Q        .         .         .         .
24.49      1.3066      0.00  Q         .         .         .         .
-------------------------------------------------------------------------
-----------------------------------------------------------------------------
   TIME DURATION(minutes) OF PERCENTILES OF ESTIMATED PEAK FLOW RATE:
   (Note: 100% of Peak Flow Rate estimate assumed to have
   an instantaneous time duration)

   Percentile of Estimated          Duration
       Peak Flow Rate               (minutes)
   ======================           =========
             0%                      1455.2
            10%                       218.3
            20%                        36.4
            30%                        18.2
            40%                        18.2
```

| | |
|---|---|
| 50% | 18.2 |
| 60% | 18.2 |
| 70% | 18.2 |
| 80% | 18.2 |
| 90% | 18.2 |

Problem Descriptions:

wq Basin4 5yr

```
==============================================================================
     FLOW-THROUGH DETENTION BASIN MODEL

     SPECIFIED BASIN CONDITIONS ARE AS FOLLOWS:
     CONSTANT HYDROGRAPH TIME UNIT(MINUTES) =   18.190
     DEAD STORAGE(AF) =       0.00
     SPECIFIED DEAD STORAGE(AF) FILLED =       0.00
     ASSUMED INITIAL DEPTH(FEET) IN STORAGE BASIN =    0.00


                    INFLOW
                      |
                      |
                      |
                      V                __effective depth
                -------------          |   (and volume)
                |           |     |    |
                | detention |     |....V.............
                |   basin   |<-->|          outflow
                |           |     |.........__________
                -------------     |         |   \
                      |           | storage |     basin outlet
                      V           -----------
                   OUTFLOW


     DEPTH-VS.-STORAGE AND DEPTH-VS.-DISCHARGE INFORMATION:
     TOTAL NUMBER OF BASIN DEPTH INFORMATION ENTRIES =   9
     *BASIN-DEPTH  STORAGE    OUTFLOW  **BASIN-DEPTH  STORAGE    OUTFLOW  *
     *   (FEET)  (ACRE-FEET)   (CFS)   **   (FEET)  (ACRE-FEET)   (CFS)   *
     *      0.000      0.000      0.000**      0.500      0.150      1.550*
     *      1.000      0.310      4.390**      1.500      0.490      6.320*
     *      2.000      0.690      7.990**      2.500      0.900      9.360*
     *      3.000      1.120     10.560**      3.500      1.360     11.640*
     *      4.000      1.590     12.620**
------------------------------------------------------------------------------
     BASIN STORAGE, OUTFLOW AND DEPTH ROUTING VALUES:
      INTERVAL   DEPTH   {S-O*DT/2}   {S+O*DT/2}
       NUMBER   (FEET)   (ACRE-FEET)  (ACRE-FEET)
          1      0.00       0.00000      0.00000
          2      0.50       0.13058      0.16942
          3      1.00       0.25500      0.36500
          4      1.50       0.41083      0.56917
          5      2.00       0.58990      0.79010
```

| | | | |
|---|---|---|---|
| 6 | 2.50 | 0.78274 | 1.01726 |
| 7 | 3.00 | 0.98771 | 1.25229 |
| 8 | 3.50 | 1.21418 | 1.50582 |
| 9 | 4.00 | 1.43190 | 1.74810 |

WHERE S=STORAGE(AF);O=OUTFLOW(AF/MIN.);DT=UNIT INTERVAL(MIN.)

---

DETENTION BASIN ROUTING RESULTS:
NOTE: COMPUTED BASIN DEPTH, OUTFLOW, AND STORAGE QUANTITIES OCCUR AT THE GIVEN TIME. BASIN INFLOW VALUES REPRESENT THE AVERAGE INFLOW DURING THE RECENT HYDROGRAPH UNIT INTERVAL.

| TIME (HRS) | DEAD-STORAGE FILLED(AF) | INFLOW (CFS) | EFFECTIVE DEPTH(FT) | OUTFLOW (CFS) | EFFECTIVE VOLUME(AF) |
|---|---|---|---|---|---|
| 0.235 | 0.000 | 0.29 | 0.02 | 0.03 | 0.006 |
| 0.538 | 0.000 | 0.29 | 0.04 | 0.09 | 0.011 |
| 0.842 | 0.000 | 0.29 | 0.05 | 0.14 | 0.015 |
| 1.145 | 0.000 | 0.30 | 0.06 | 0.17 | 0.018 |
| 1.448 | 0.000 | 0.30 | 0.07 | 0.20 | 0.021 |
| 1.751 | 0.000 | 0.30 | 0.08 | 0.22 | 0.023 |
| 2.054 | 0.000 | 0.31 | 0.08 | 0.24 | 0.024 |
| 2.357 | 0.000 | 0.31 | 0.09 | 0.26 | 0.026 |
| 2.661 | 0.000 | 0.31 | 0.09 | 0.27 | 0.027 |
| 2.964 | 0.000 | 0.32 | 0.09 | 0.28 | 0.028 |
| 3.267 | 0.000 | 0.32 | 0.09 | 0.29 | 0.028 |
| 3.570 | 0.000 | 0.33 | 0.10 | 0.30 | 0.029 |
| 3.873 | 0.000 | 0.33 | 0.10 | 0.30 | 0.030 |
| 4.176 | 0.000 | 0.33 | 0.10 | 0.31 | 0.030 |
| 4.480 | 0.000 | 0.34 | 0.10 | 0.32 | 0.031 |
| 4.783 | 0.000 | 0.34 | 0.10 | 0.32 | 0.031 |
| 5.086 | 0.000 | 0.35 | 0.11 | 0.33 | 0.032 |
| 5.389 | 0.000 | 0.35 | 0.11 | 0.33 | 0.033 |
| 5.692 | 0.000 | 0.36 | 0.11 | 0.34 | 0.033 |
| 5.995 | 0.000 | 0.37 | 0.11 | 0.34 | 0.034 |
| 6.299 | 0.000 | 0.37 | 0.11 | 0.35 | 0.034 |
| 6.602 | 0.000 | 0.38 | 0.12 | 0.36 | 0.035 |
| 6.905 | 0.000 | 0.38 | 0.12 | 0.36 | 0.035 |
| 7.208 | 0.000 | 0.39 | 0.12 | 0.37 | 0.036 |
| 7.511 | 0.000 | 0.40 | 0.12 | 0.37 | 0.036 |
| 7.814 | 0.000 | 0.41 | 0.12 | 0.38 | 0.037 |
| 8.118 | 0.000 | 0.41 | 0.13 | 0.39 | 0.038 |
| 8.421 | 0.000 | 0.42 | 0.13 | 0.39 | 0.039 |
| 8.724 | 0.000 | 0.43 | 0.13 | 0.40 | 0.039 |
| 9.027 | 0.000 | 0.44 | 0.13 | 0.41 | 0.040 |
| 9.330 | 0.000 | 0.45 | 0.14 | 0.42 | 0.041 |
| 9.634 | 0.000 | 0.47 | 0.14 | 0.43 | 0.042 |
| 9.937 | 0.000 | 0.47 | 0.14 | 0.44 | 0.043 |
| 10.240 | 0.000 | 0.49 | 0.15 | 0.45 | 0.044 |
| 10.543 | 0.000 | 0.50 | 0.15 | 0.46 | 0.045 |
| 10.846 | 0.000 | 0.52 | 0.15 | 0.47 | 0.046 |
| 11.149 | 0.000 | 0.53 | 0.16 | 0.48 | 0.047 |
| 11.452 | 0.000 | 0.56 | 0.16 | 0.50 | 0.049 |
| 11.756 | 0.000 | 0.57 | 0.17 | 0.51 | 0.050 |
| 12.059 | 0.000 | 0.60 | 0.17 | 0.53 | 0.052 |
| 12.362 | 0.000 | 0.67 | 0.18 | 0.55 | 0.055 |
| 12.665 | 0.000 | 0.72 | 0.20 | 0.59 | 0.059 |
| 12.968 | 0.000 | 0.75 | 0.21 | 0.62 | 0.062 |

| | | | | | |
|---|---|---|---|---|---|
| 13.271 | 0.000 | 0.80 | 0.22 | 0.66 | 0.065 |
| 13.575 | 0.000 | 0.82 | 0.23 | 0.69 | 0.068 |
| 13.878 | 0.000 | 0.89 | 0.24 | 0.73 | 0.073 |
| 14.181 | 0.000 | 0.93 | 0.26 | 0.77 | 0.077 |
| 14.484 | 0.000 | 1.04 | 0.27 | 0.82 | 0.082 |
| 14.787 | 0.000 | 1.10 | 0.29 | 0.88 | 0.088 |
| 15.090 | 0.000 | 1.28 | 0.32 | 0.95 | 0.096 |
| 15.394 | 0.000 | 1.42 | 0.35 | 1.04 | 0.105 |
| 15.697 | 0.000 | 1.55 | 0.39 | 1.14 | 0.116 |
| 16.000 | 0.000 | 2.13 | 0.45 | 1.30 | 0.136 |
| 16.303 | 0.000 | 8.60 | 0.92 | 2.68 | 0.285 |
| 16.606 | 0.000 | 1.50 | 0.77 | 3.50 | 0.235 |
| 16.910 | 0.000 | 1.18 | 0.65 | 2.71 | 0.196 |
| 17.213 | 0.000 | 0.98 | 0.56 | 2.12 | 0.168 |
| 17.516 | 0.000 | 0.86 | 0.49 | 1.69 | 0.147 |
| 17.819 | 0.000 | 0.77 | 0.43 | 1.43 | 0.130 |
| 18.122 | 0.000 | 0.71 | 0.39 | 1.27 | 0.116 |
| 18.425 | 0.000 | 0.58 | 0.34 | 1.13 | 0.102 |
| 18.728 | 0.000 | 0.54 | 0.30 | 1.00 | 0.091 |
| 19.032 | 0.000 | 0.51 | 0.27 | 0.89 | 0.081 |
| 19.335 | 0.000 | 0.48 | 0.24 | 0.80 | 0.073 |
| 19.638 | 0.000 | 0.46 | 0.22 | 0.72 | 0.067 |
| 19.941 | 0.000 | 0.44 | 0.20 | 0.66 | 0.061 |
| 20.244 | 0.000 | 0.42 | 0.19 | 0.61 | 0.056 |
| 20.547 | 0.000 | 0.40 | 0.17 | 0.56 | 0.052 |
| 20.851 | 0.000 | 0.39 | 0.16 | 0.52 | 0.049 |
| 21.154 | 0.000 | 0.37 | 0.15 | 0.49 | 0.046 |
| 21.457 | 0.000 | 0.36 | 0.15 | 0.46 | 0.044 |
| 21.760 | 0.000 | 0.35 | 0.14 | 0.44 | 0.041 |
| 22.063 | 0.000 | 0.34 | 0.13 | 0.42 | 0.039 |
| 22.366 | 0.000 | 0.33 | 0.13 | 0.40 | 0.038 |
| 22.670 | 0.000 | 0.32 | 0.12 | 0.38 | 0.036 |
| 22.973 | 0.000 | 0.32 | 0.12 | 0.37 | 0.035 |
| 23.276 | 0.000 | 0.31 | 0.11 | 0.36 | 0.034 |
| 23.579 | 0.000 | 0.30 | 0.11 | 0.34 | 0.033 |
| 23.882 | 0.000 | 0.29 | 0.11 | 0.33 | 0.032 |
| 24.185 | 0.000 | 0.29 | 0.10 | 0.32 | 0.031 |
| 24.489 | 0.000 | 0.00 | 0.08 | 0.28 | 0.024 |

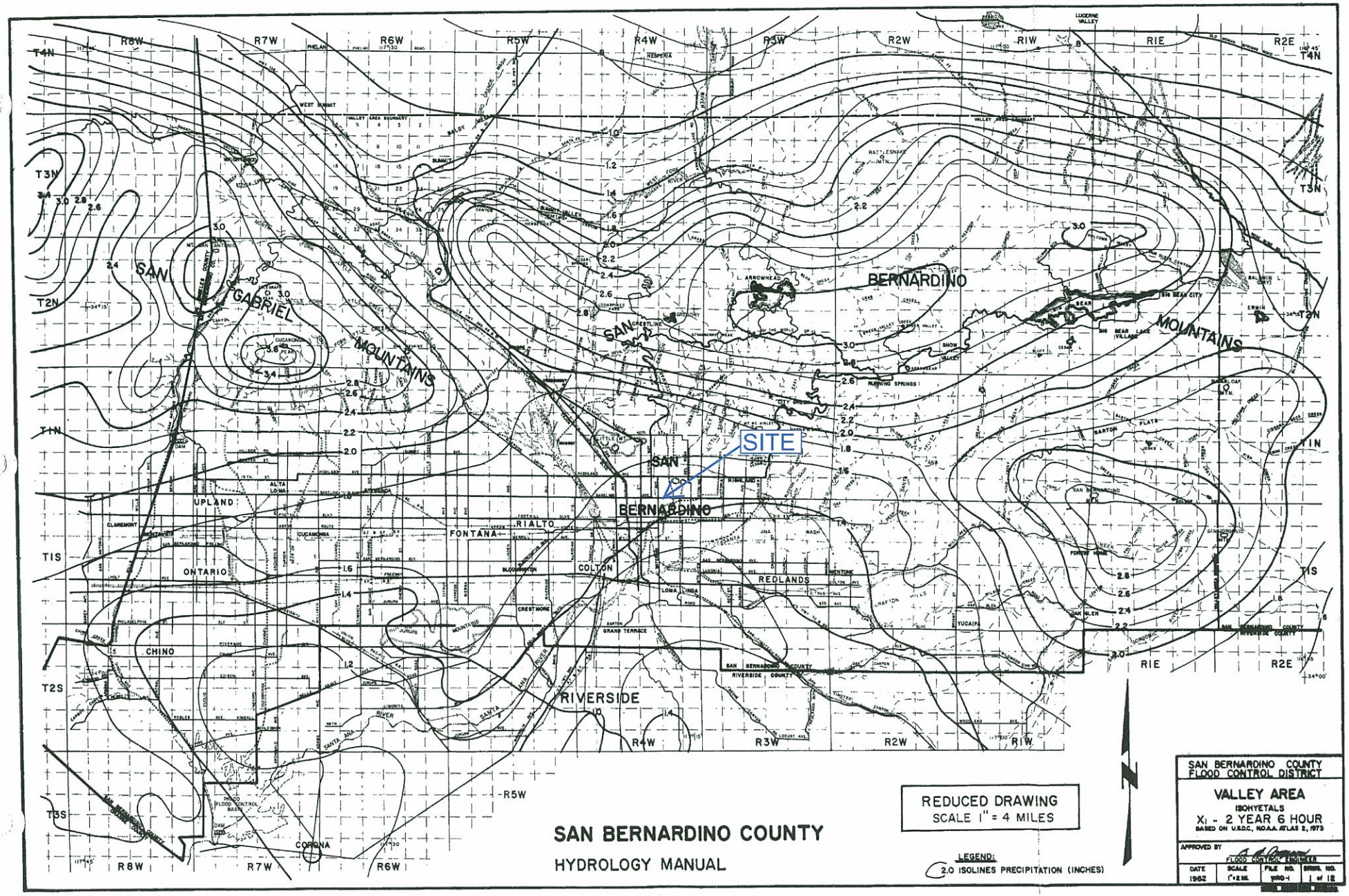
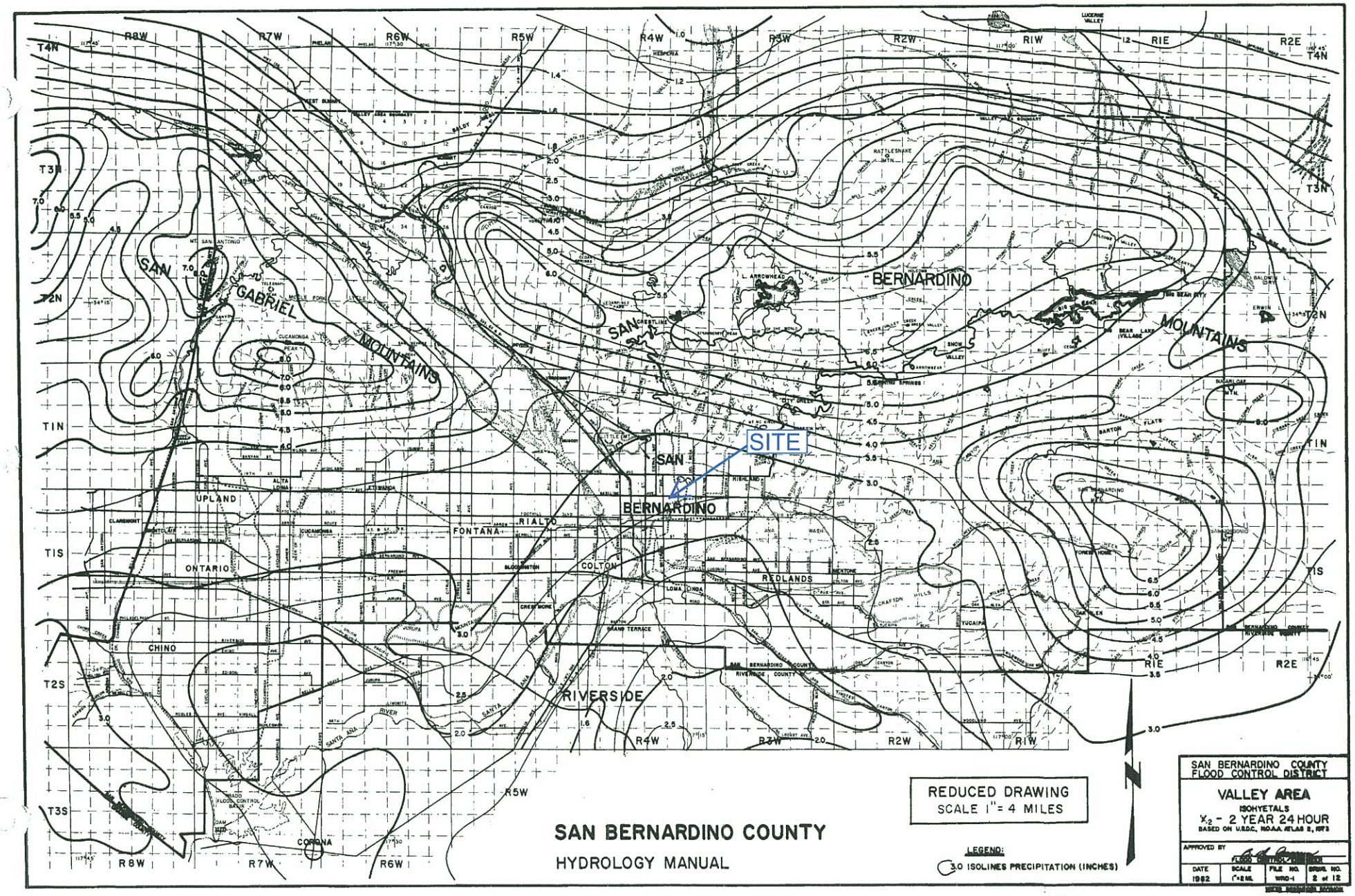

SITE
SAN BERNARDINO
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
UPLAND
ONTARIO
CHINO
CORONA
RIALTO
FONTANA
COLTON
REDLANDS
RIVERSIDE
T4N
T3N
T2N
T1N
T1S
T2S
T3S
R8W
R7W
R6W
R5W
R4W
R3W
R2W
R1W
R1E
R2E
REDUCED DRAWING
SCALE 1" = 4 MILES
LEGEND:
2.0 ISOLINES PRECIPITATION (INCHES)
SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
X1 - 2 YEAR 6 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1962
SCALE 1" = 2 MI.
FILE NO. WRD-1
DRWG. NO. 1 of 12



FIGURE B-1


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
REDUCED DRAWING
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LEGEND:
3.0 ISOLINES PRECIPITATION (INCHES)
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SAN BERNARDINO MOUNTAINS
SAN BERNARDINO
RIVERSIDE
UPLAND
ONTARIO
CHINO
FONTANA
RIALTO
COLTON
REDLANDS
CORONA
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN BERNARDINO COUNTY FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
½ - 2 YEAR 24 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
SCALE 1"=2 MI.
FILE NO. WRD-1
DRWG. NO. 2 of 12



FIGURE B-2

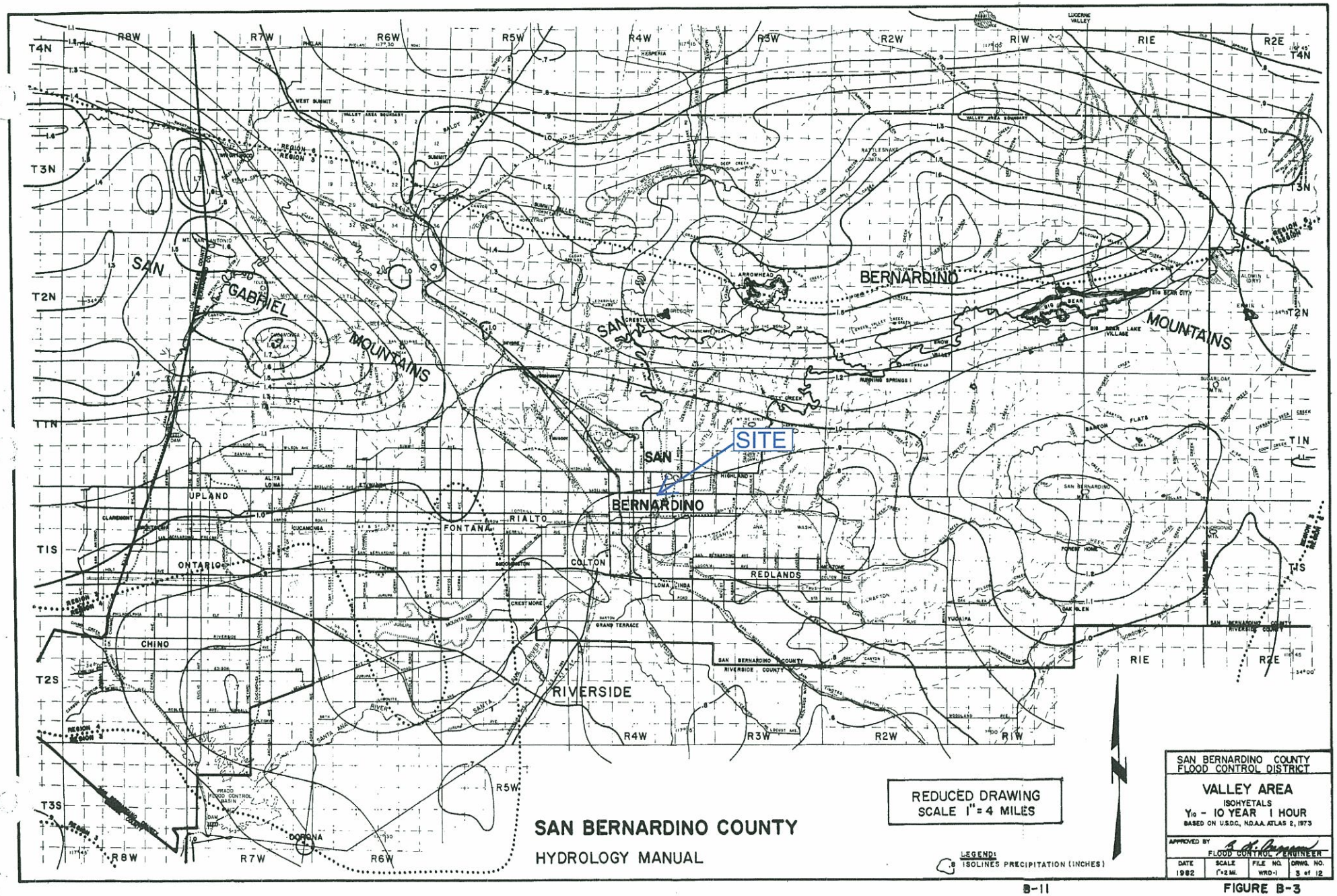
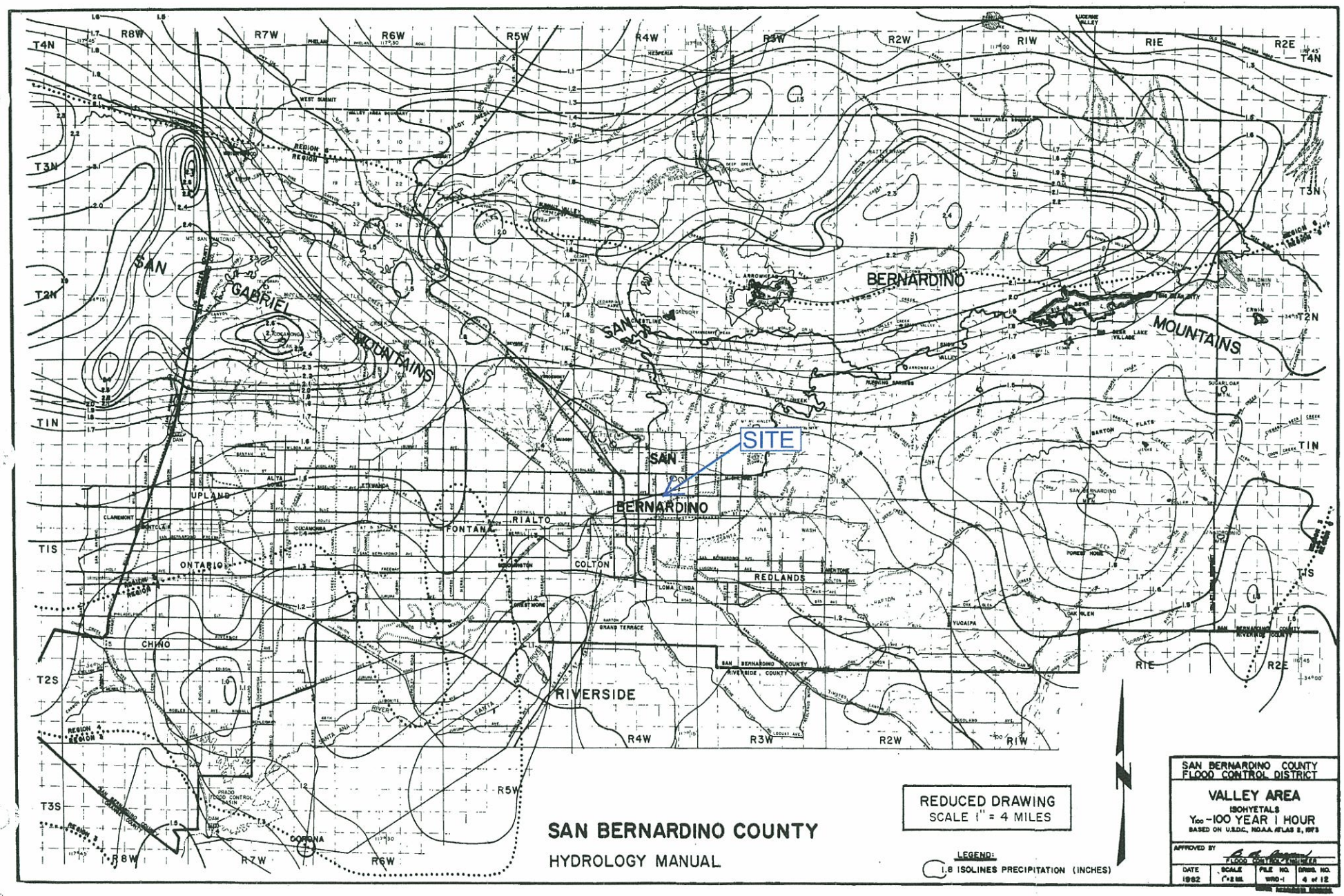

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
REDUCED DRAWING
SCALE 1" = 4 MILES
LEGEND:
.8 ISOLINES PRECIPITATION (INCHES)
SITE
SAN BERNARDINO
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
UPLAND
ONTARIO
CHINO
FONTANA
RIALTO
COLTON
REDLANDS
RIVERSIDE
CORONA
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
Y10 - 10 YEAR 1 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
SCALE 1"=2 MI.
FILE NO. WRD-1
DRWG. NO. 3 of 12



FIGURE B-3


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
REDUCED DRAWING
SCALE 1" = 4 MILES
LEGEND:
1.8 ISOLINES PRECIPITATION (INCHES)
SITE
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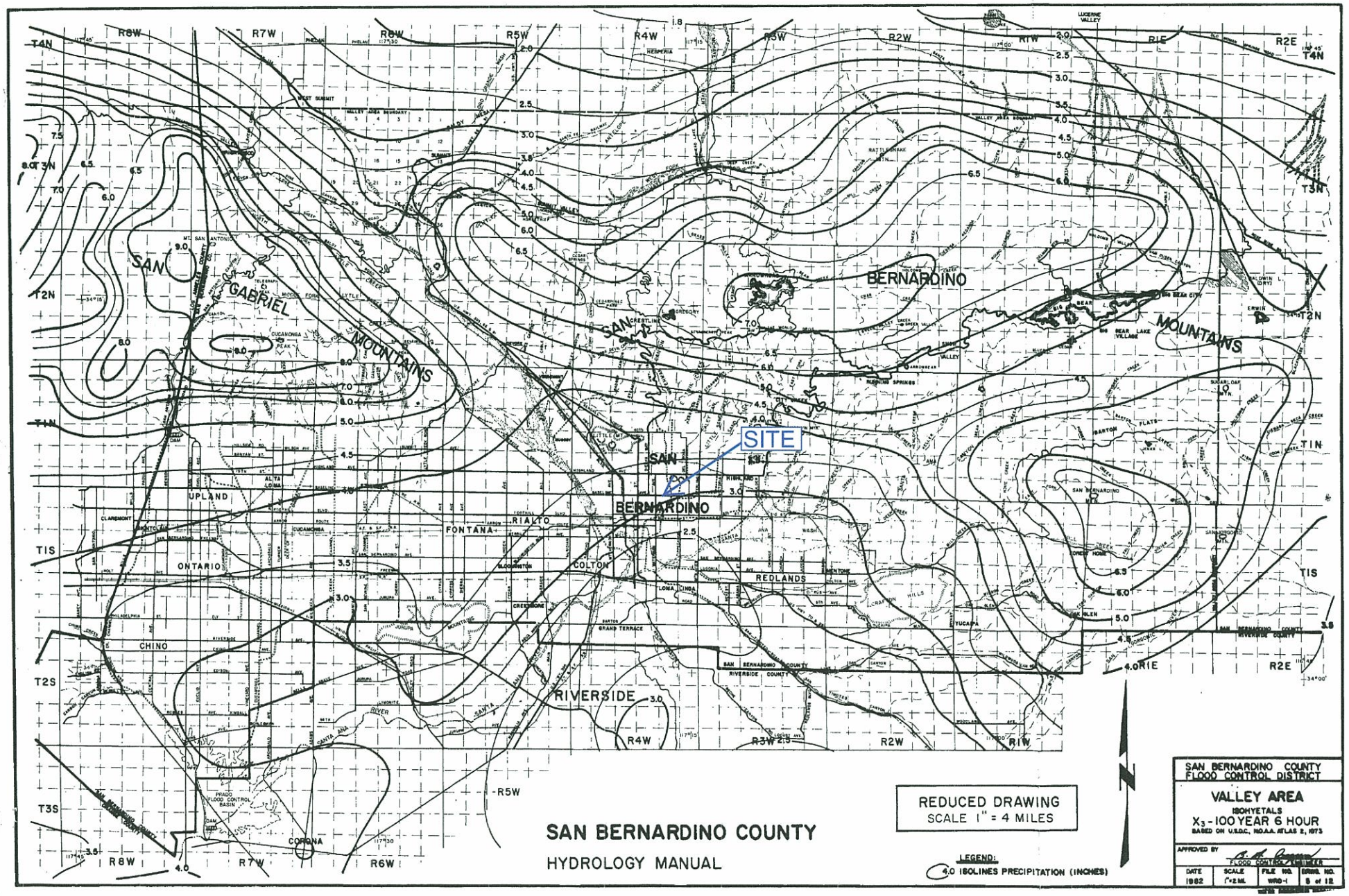
SAN BERNARDINO MOUNTAINS
SAN BERNARDINO
RIVERSIDE
UPLAND
ONTARIO
CHINO
FONTANA
RIALTO
COLTON
REDLANDS
CORONA
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
Y100 -100 YEAR 1 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
SCALE 1"=2 MI.
FILE NO. WRD-1
DRWG. NO. 4 of 12



FIGURE B-4


SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
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LEGEND:
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SITE
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SAN BERNARDINO MOUNTAINS
SAN BERNARDINO
RIVERSIDE
UPLAND
ONTARIO
CHINO
FONTANA
RIALTO
COLTON
REDLANDS
CORONA
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
X3 - 100 YEAR 6 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
SCALE 1"=2 MI.
FILE NO. WRD-1
DRWG. NO. 5 of 12



FIGURE B-5

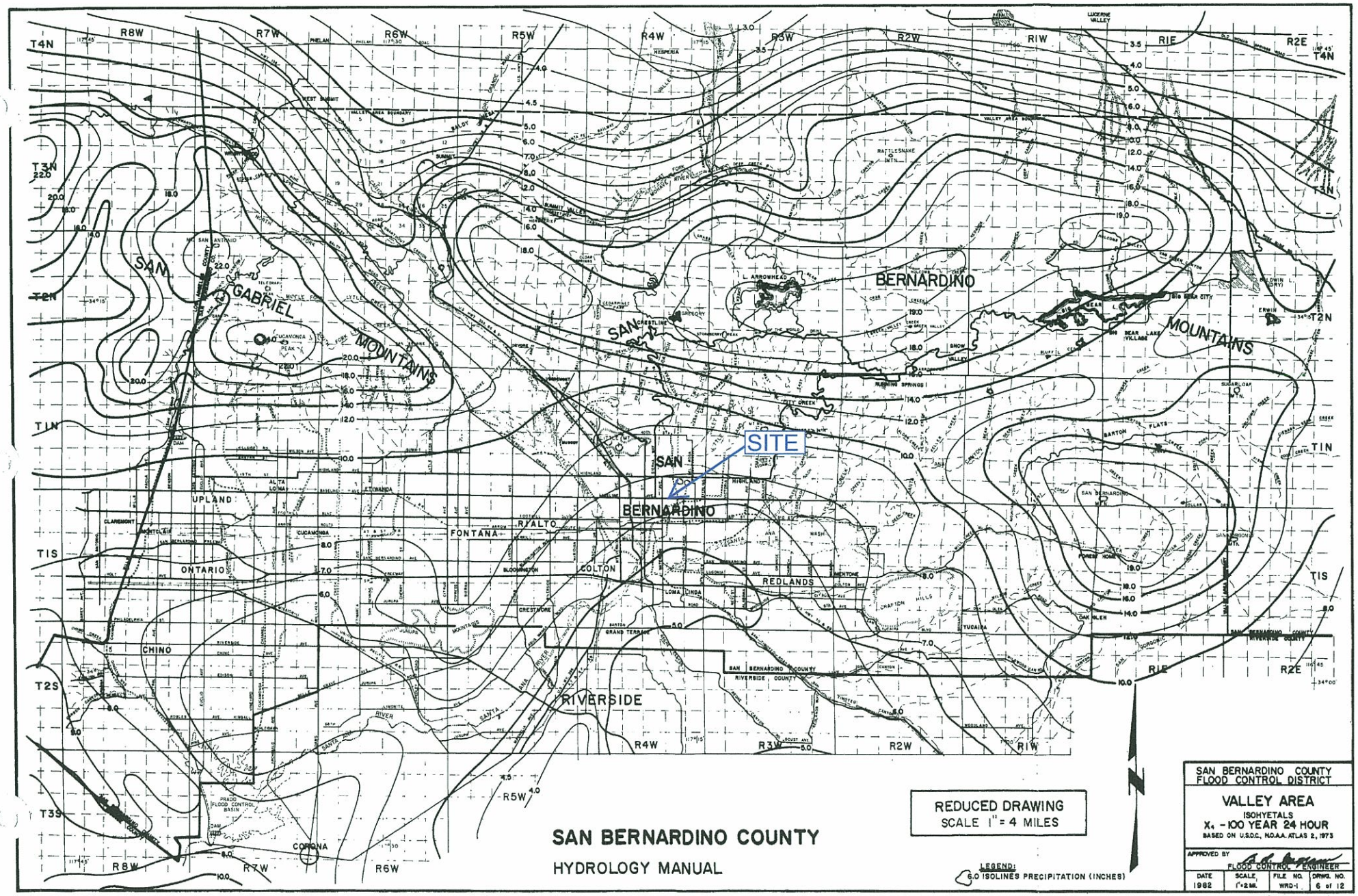
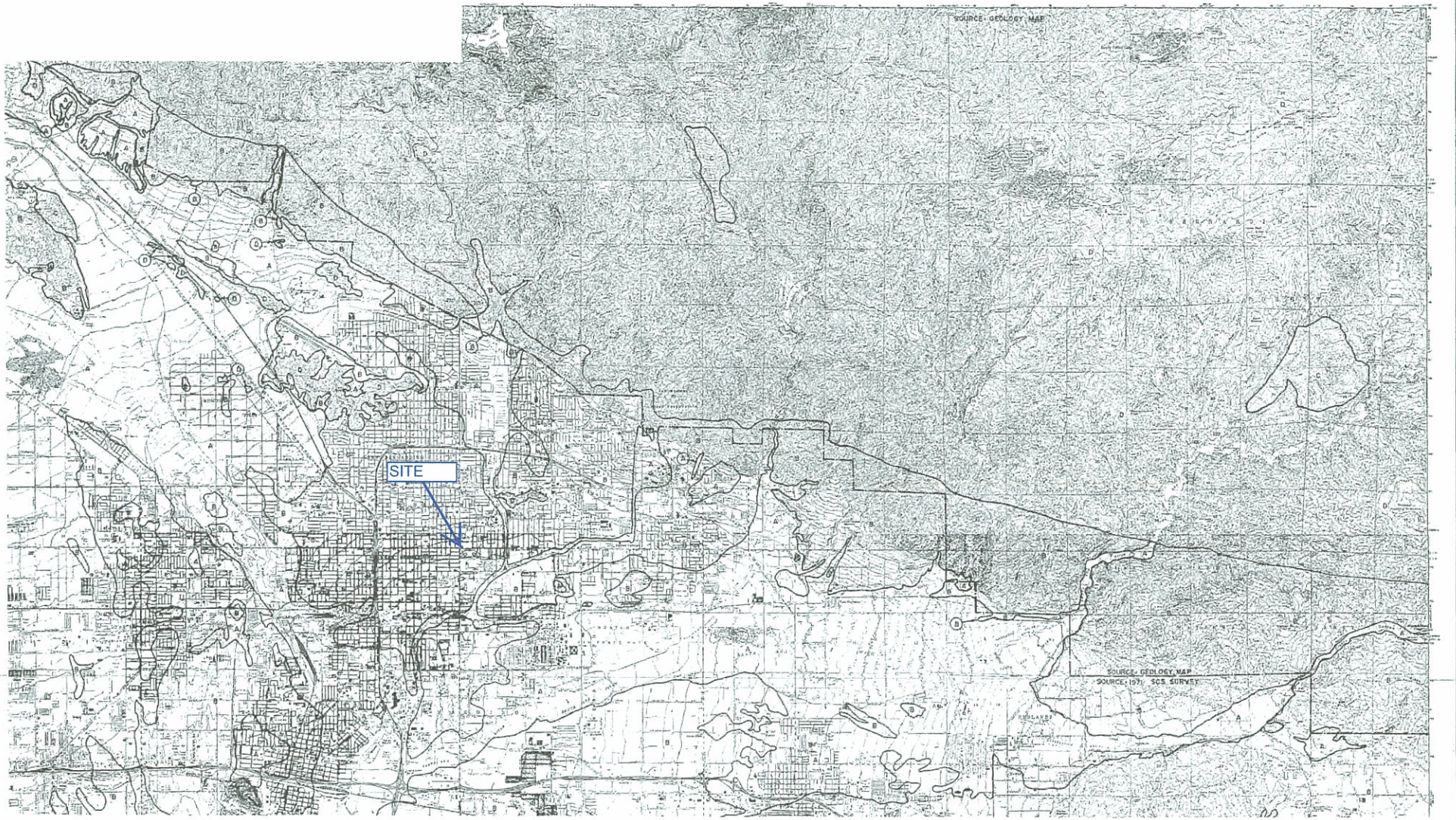
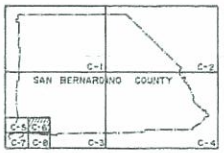

SAN BERNARDINO COUNTY
HYDROLOGY MANUAL
REDUCED DRAWING
SCALE 1" = 4 MILES
LEGEND:
6.0 ISOLINES PRECIPITATION (INCHES)
SITE
SAN BERNARDINO
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
UPLAND
ONTARIO
CHINO
FONTANA
RIALTO
COLTON
REDLANDS
RIVERSIDE
CORONA
SAN BERNARDINO COUNTY
RIVERSIDE COUNTY
SAN BERNARDINO COUNTY
FLOOD CONTROL DISTRICT
VALLEY AREA
ISOHYETALS
X4 - 100 YEAR 24 HOUR
BASED ON U.S.D.C., N.O.A.A. ATLAS 2, 1973
APPROVED BY
FLOOD CONTROL ENGINEER
DATE 1982
SCALE 1"=2 MI.
FILE NO. WRD-1
DRWG. NO. 6 of 12



FIGURE B-6




INDEX MAP

LEGEND

SOIL GROUP BOUNDARY

A SOIL GROUP DESIGNATION

BOUNDARY OF INDICATED SOURCE

SCALE 1:48,000

**SCALE REDUCED BY 1/2**

**SAN BERNARDINO COUNTY**

HYDROLOGY MANUAL

HYDROLOGIC SOILS GROUP MAP
FOR
SOUTHWEST-B AREA



FIGURE C-14

# WQMP EDUCATION MATERIALS

# Pesticide Tips to Prevent Pollution

Water that runs off your lawn and garden can carry pesticide into the San Bernardino County storm drain system, and it does not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

- Read the product label and follow the directions carefully, using only as directed.
- Spot apply rather than blanketing an entire area.
- Don't apply pesticide before a rain.
- Use non-toxic products for your garden and lawn whenever possible.
- Take unwanted lawn or garden chemicals to a household hazardous waste collection facility. Call (800) 253-2687 for the location of your city's facility.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping or for more information on Stormwater pollution prevention, call:

**1 (800) CLEANUP**

www.1800cleanup.org

English side

# Consejos de Prevención Para la Contaminación de Pesticidas.

El desagüe del jardín puede llevar pesticidas que acaben por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

- Leer las etiquetas del producto y seguir las instrucciones cuidadosamente, usarlas tal como se indica.
- Apliqua solo parte por parte, no en areas grandes.
- No aplique los pesticidas antes de que llueva.
- Trata de usar productos no-toxicos para tu jardín cada vez que sea posible.
- Desechalos en unlugar de colección de desechos peligrosos. Llama al (800) 253-2687 para información de un centro cerca a ti.

San Bernardino County STORMWATER PROGRAM

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al:

**1 (800) CLEANUP**

www.1800cleanup.org

Spanish side

**Item:** Pesticide bill insert **Actual size:** 3.625" x 8.5" **Advertiser:** San Bernardino County Storm Water Program
**Agency:** Industrial Strength Advertising **Date:** 8/29/03

# Paint Tips to Prevent Pollution

Washing a paint brush or dumping rinse water in the gutter allows toxic chemicals to flow into the San Bernardino County storm drain system, and they do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

- Use water-based paints whenever possible. They are less toxic than oil-based paints and easier to clean up. Look for products labeled "latex" or "cleans with water."
- Don't clean brushes or rinse paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink and oil-based paints with thinner.
- Recycle leftover paint at a household hazardous waste collection facility. Call (800) 253-2687 for the location of your city's facility.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping or for more information on Stormwater pollution prevention, call:

**1 (800) CLEANUP**

www.1800cleanup.org

English side

# Consejos de Prevención Para la Contaminación de Pintura.

Lavar las brochas de pintura o arrojar agua sucia en el desagüe acaba por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

- Usa pinturas de agua cuando sea posible. Son menos toxicas que las pinturas de aceite y mas faciles para limpiar. Busca los productos "latex" or "cleans with water".
- Nunca laves las brochas ni los contenedores de pintura en la calle, coladeras o desagües. Las de pintura de agua limpialas en el labavo y las de pintura de aceite con thiner.
- Recicla la pintura que sobra en un lugar de colección de materiales peligrosos. Llama al (800) 253-2687 para información de un centro cerca a ti.

San Bernardino County STORMWATER PROGRAM

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al:

**1 (800) CLEANUP**

www.1800cleanup.org

Spanish side

**Item:** Paint bill insert **Actual size:** 3.625" x 8.5" **Advertiser:** San Bernardino County Storm Water Program
**Agency:** Industrial Strength Advertising **Date:** 8/29/03

# Fertilizer Tips to Prevent Pollution

Water that runs off your lawn and garden can carry fertilizer into the San Bernardino County storm drain system, and it does not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

- Read the product label and follow the directions carefully, using only as directed.
- Avoid applying near driveways or gutters.
- Never apply fertilizer before a rain.
- Store fertilizers and chemicals in a covered area and in sealed, waterproof containers.
- Take unwanted lawn or garden chemicals to a household hazardous waste collection facility. Call (800) 253-2687 for the location of your city's facility.
- Use non-toxic products for your garden and lawn whenever possible.

San Bernardino County STORMWATER PROGRAM

To report illegal dumping or for more information on Stormwater pollution prevention, call:

**1 (800) CLEANUP**

www.1800cleanup.org

English side

# Consejos de Prevención Para la Contaminación de Fertilizantes.

El desagüe del jardín puede llevar fertilizantes que acaben por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

- Leer las etiquetas del producto y seguir las instrucciones cuidadosamente, usarlas tal como se indica.
- Evita aplicarlos cerca de la cocheras o las alcantarillas.
- Nunca aplicar el fertilizante antes de llover.
- Guarda los fertilizantes y otros quimicos en un lugar cuvierto y en contenedores contra agua.
- Desechalos en unlugar de colección de desechos peligrosos. Llama al (800) 253-2687 para información de un centro cerca a ti.
- Trata de usar productos no-toxicos para tu jardín cada vez que sea posible.

San Bernardino County STORMWATER PROGRAM

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al:

**1 (800) CLEANUP**

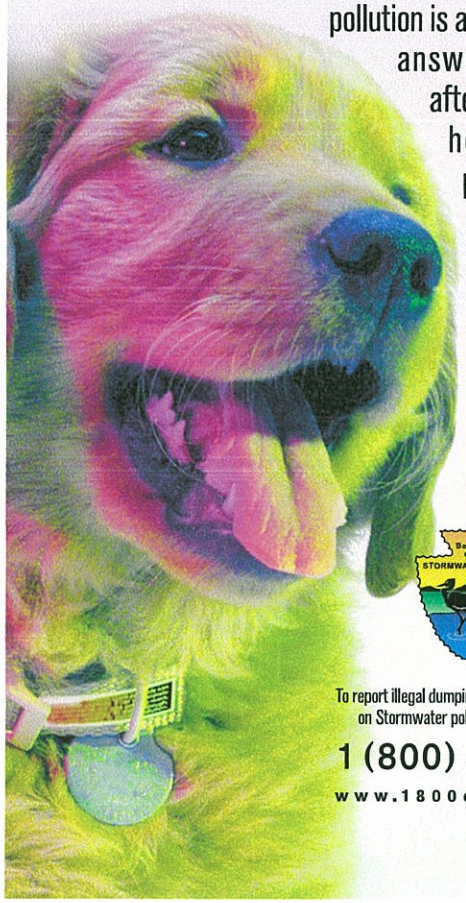
www.1800cleanup.org

Spanish side

**Item:** Fertilizer bill insert **Actual size:** 3.625" x 8.5" **Advertiser:** San Bernardino County Storm Water Program
**Agency:** Industrial Strength Advertising **Date:** 8/29/03

# Pick Up After Your Pooch to Curb Pollution.

Maybe you weren't aware, but dog waste left on the ground gets into storm drains, polluting rivers, lakes and beaches. The bacteria and risk of disease threatens the health of our kids and communities. Wherever you live in San Bernardino County, this pollution is a problem. The answer? Pick up after your dog, to help prevent pollution and protect our health. It's in your hands.



San Bernardino County STORMWATER PROGRAM

To report illegal dumping or for more information on Stormwater pollution prevention, call:

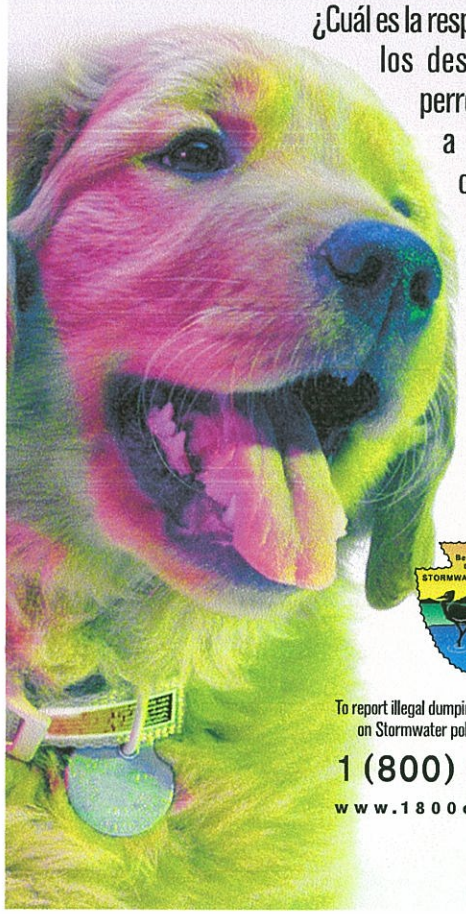
**1 (800) CLEANUP**

www.1800cleanup.org

English side

# Recoge los desperdicios de tu mascota para prevenir la contaminación de la calle.

Quizás usted no lo sepa, pero el excremento de perro que se deja en el suelo va a las alcantarillas, contaminando nuestros ríos, lagos y playas. Las bacterias y el riesgo de enfermedades amenazan la salud de nuestros niños y comunidades. No importa donde usted resida, esta contaminación es un problema. ¿Cuál es la respuesta? Recoja los desechos de su perro, para ayudar a prevenir la contaminación y proteger nuestra salud.



San Bernardino County STORMWATER PROGRAM

To report illegal dumping or for more information on Stormwater pollution prevention, call:

**1 (800) CLEANUP**

www.1800cleanup.org

Spanish side

**Item:** Dog waste bill insert **Actual size:** 3.625" x 8.5" **Advertiser:** San Bernardino County Storm Water Program
**Agency:** Industrial Strength Advertising **Date:** 9/10/03

PRESORTED
STANDARD
U.S. POSTAGE
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SACRAMENTO, CA
PERMIT# 000

**San Bernardino County Stormwater Program**
825 East Third Street · Room 127
San Bernardino, CA 94215-0835

# STORMWATER Pollution Prevention

## LANDSCAPE MAINTENANCE

# Pollution Prevention STORMWATER

## Stormwater Management Practices for Commercial Landscape Maintenance

Yard waste, sediments, and toxic lawn/garden chemicals used in commercial landscape maintenance often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

### Recycle Yard Waste

Recycle leaves, grass clippings and other yard waste. Do not blow, sweep, rake or hose yard waste into the street. Try grasscycling - the natural recycling of grass by leaving clippings on the lawn when mowing. Grass clippings will quickly decompose, returning valuable nutrients to the soil. Further information can be obtained at www.ciwmb.ca.gov/Organics.

### Use Fertilizers, Herbicides and Pesticides Safely

Fertilizers, herbicides and pesticides are often carried into the storm drain system by sprinkler runoff. Use of natural, non-toxic alternatives to the traditional fertilizers, herbicides and pesticides is highly recommended. If you must use chemical fertilizers, herbicides, or pesticides:

- Spot apply pesticides and herbicides, rather than blanketing entire areas.
- Avoid applying near curbs and driveways, and never apply before a rain.
- Apply fertilizers as needed, when plants can best use it, and when the potential for it being carried away by runoff is low.

### Recycle Hazardous Waste

Pesticides, fertilizers, herbicides and motor oil contaminate landfills and should be disposed of through a Hazardous Waste Facility, which accepts these types of materials. For information on proper disposal call, (909) 386-8401.

### Use Water Wisely

Conserve water and prevent runoff by controlling the amount of water and direction of sprinklers. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff. Periodically inspect, fix leaks and realign sprinkler heads. Plant native vegetation to reduce the need of water, fertilizers, herbicides, and pesticides.

### Prevent Erosion

Erosion washes sediments, debris and toxic runoff into the storm drain system, polluting waterways.

- Prevent erosion and sediment runoff by using ground cover, berms and vegetation down-slope to capture runoff.
- Avoid excavation or grading during wet weather.

### Store Materials Safely

Keep landscaping materials and debris away from the street, gutter and storm drains. On-site stockpiles of materials must be covered with plastic sheeting to protect from rain, wind and runoff.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

or visit our websites:

**www.co.san-bernardino.ca.us/flood/npdes**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

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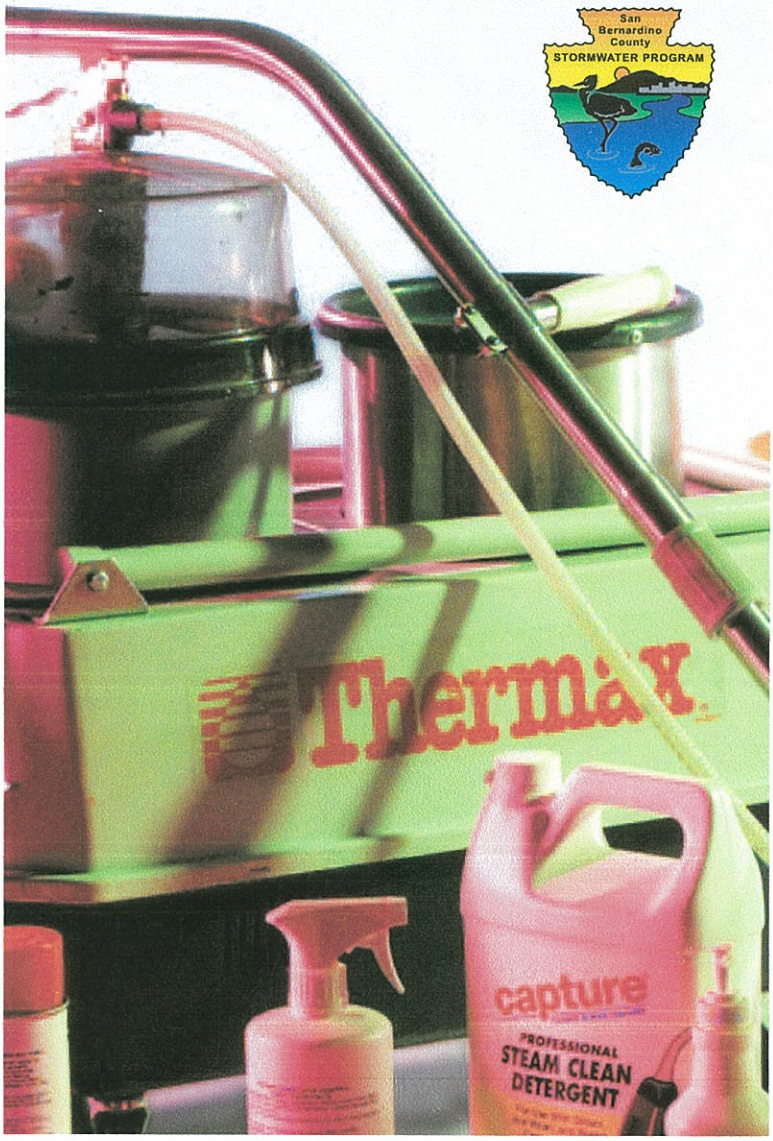
# STORMWATER Pollution Prevention

## CARPET CLEANING ACTIVITIES



# Pollution Prevention STORMWATER

## Stormwater Management Practices for Carpet Cleaning Activities

Toxic chemicals and discharged waste water from carpet, drapery, furniture and window cleaning often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates local waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

These guidelines apply even if the cleaning products are labeled "nontoxic" or "biodegradable". Although these products may be less harmful to the environment, they can still have harmful effects if they enter the storm drain untreated.

### Dispose of Wastewater Properly

Wastewater from cleaning equipment must be discharged into a sink, toilet, or other drain connected to the sanitary sewer system within sanitary sewer discharge limits, hauled off and disposed of properly, or may be discharged to a pervious area, for example, a lawn area, as long as it does not overflow into the street, gutter, parking lot or storm drain. Wastewater should never be discharged into a street, gutter, parking lot or storm drain.

### Filter Wastewater

Carpet cleaning wastewater should be filtered before discharging it to the sanitary sewer since fibers and other debris in the wastewater can clog pipes. The filtered material can be disposed of in the garbage, provided that the waste is not contaminated with hazardous pollutants.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

or visit our websites:

**www.co.san-bernardino.ca.us/flood/npdes**

**www.1800cleanup.org**

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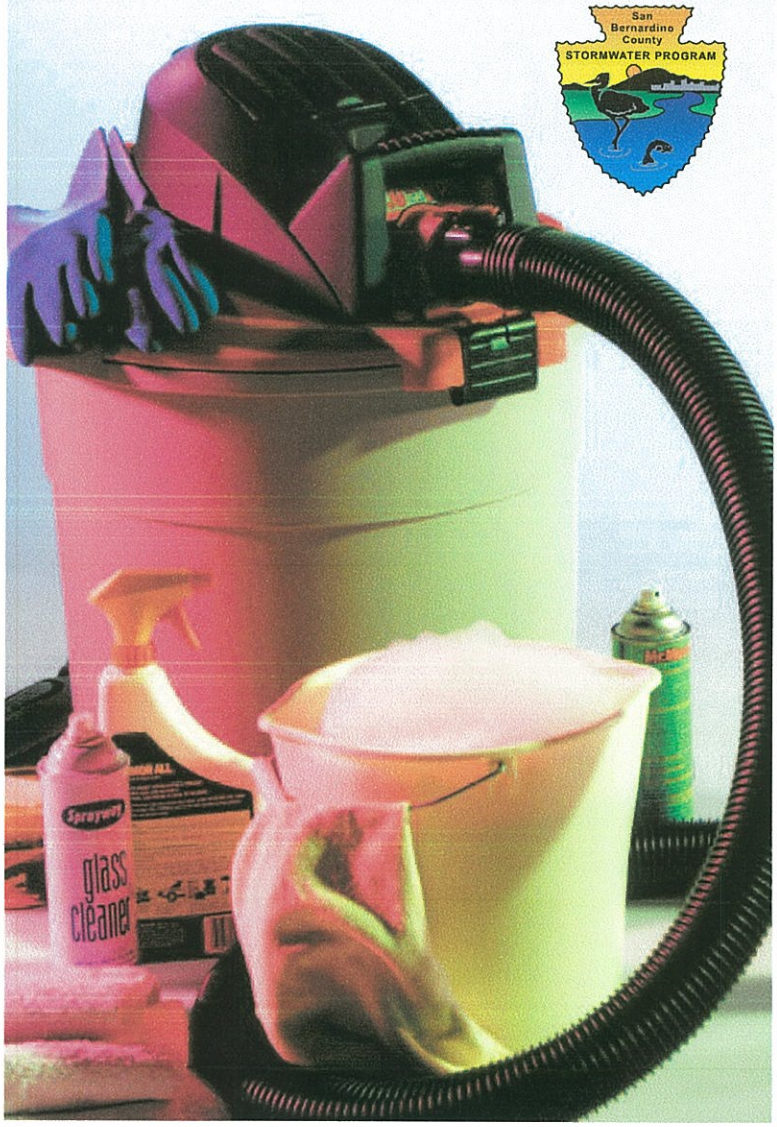
# STORMWATER Pollution Prevention

## MOBILE VEHICLE CLEANING



# Pollution Prevention STORMWATER

## Stormwater Management Practices for Mobile Vehicle Cleaning

Pollutants from mobile vehicle cleaning including heavy metals (copper, lead, nickel and zinc), hydrocarbons (oil and grease), toxic chemicals (solvents, chlorinated compounds, glycols), acids and alkalis often make their way into the San Bernardino County storm drain system, and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Following these best management practices will prevent pollution, comply with regulations and protect public health.

### Vehicle Cleaning

Wash water (wastewater) should be disposed of correctly and legally. Never discharge or allow wastewater to runoff into the street, gutter or storm drains.

- When washing items not contaminated by hazardous materials wastewater should be discharged to the sanitary sewer with the property owner's permission within sanitary sewer discharge limits or collected and hauled offsite for proper disposal. Discharges to the sewer should not contain grease, grit, or any material that could clog piping.
- Wash in customers wash bay or pump wastewater to the wash bays' pretreatment system, or
- Wash in a designated area that has been bermed up to contain the wash water.
- Common water control devices are: recycling systems; pretreatment or sewer discharge systems; limited recycling systems; wash pits(portable vinyl wash pads), vacuum sludge filtering systems; wet-dry vacuums, sump pumps; drain covers; portable dams; vacu-brooms; oil absorbent pads, booms, pillows, and tubes; plastic sheeting; filter tubs; buckets; pans; and squeegees.

### Engine Cleaning

When cleaning engines using chemical additives like soaps, solvents or degreasers:

- Service must be performed at a facility that has the equipment to properly process the contaminated wastewater runoff, or
- Service must be performed using a leak-proof ground cover device that will catch and contain all contaminated wastewater runoff for later disposal in a manner that complies with all city, county, state and federal codes.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

or visit our websites:

**www.co.san-bernardino.ca.us/flood/npdes**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## Important Phone Numbers

**San Bernardino County Flood Control**
(909) 387-8112

**County of San Bernardino**
(909) 387-8109

**City of Big Bear Lake**
(909) 866-5831

**City of Chino** (909) 591-9850

**City of Chino Hills** (909) 364-2722

**City of Colton** (909) 370-6128

**City of Fontana** (909) 350-6772

**City of Grand Terrace**
(909) 824-6671 x 226

**City of Highland** (909) 864-8732 x 230

**City of Loma Linda** (909) 799-4405

**City of Montclair** (909) 625-9470

**City of Ontario** (909) 395-2025

**City of Rancho Cucamonga**
(909) 477-2740 x 4063

**City of Redlands** (909) 798-7655

**City of Rialto** (909) 421-4921

**City of San Bernardino** (909) 384-5154

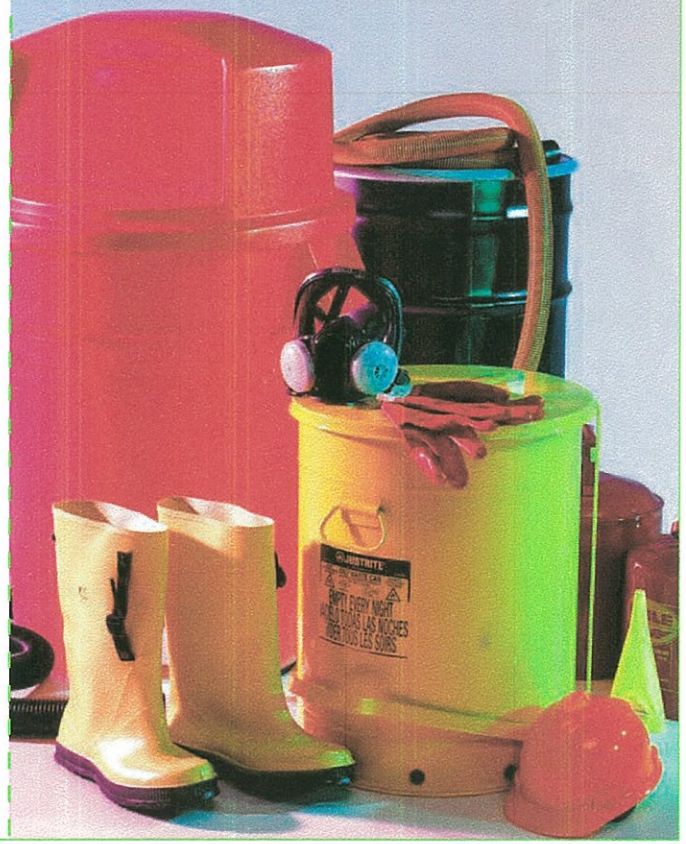
**City of Upland** (909) 931-4370

**City of Yucaipa** (909) 797-2489 x 243


**San Bernardino County Stormwater Program**
825 East Third Street • Room 201
San Bernardino, CA 94215-0835


# STORMWATER Pollution Prevention

## INDUSTRIAL AND COMMERCIAL FACILITIES



# Pollution Prevention

STORMWATER

To reduce the amount of pollutants reaching our storm drain system, which leads to the Santa Ana River and Pacific Ocean, the San Bernardino County Stormwater Program has developed Best Management Practices (BMPs) for Industrial and Commercial Facilities. City and County ordinances require that businesses comply with these BMPs, where applicable, to protect local water quality. Local cities and the County are required to verify implementation of these BMPs by performing regular facility inspections.

**Prohibited Discharges**

- Discontinue all non-stormwater discharges to the storm drain system. It is prohibited to discharge any chemicals, wastes or wastewater into the gutter, street or storm drain.

**Outdoor Storage**

- Install covers and secondary containment areas for all hazardous materials and wastes stored outdoors in accordance with County and/or City standards.
- Keep all temporary waste containers covered, except when in direct use.
- Sweep outdoor areas instead of using a hose or pressure washer.

**Outdoor Processes**

- Move all process operations including vehicle and equipment maintenance inside of the building or into a covered and contained area.
- Wash equipment and vehicles in a contained and covered wash bay which is closed-loop or connected to a clarifier sized to city standards, then discharged to a sanitary sewer or take them to a commercial car wash.

**Spills and Clean Ups**

- Clean up spills immediately when they occur, using dry clean up methods such as absorbent materials and followed by proper disposal of materials.
- Always have a spill kit available near chemical loading dock doors, vehicle maintenance and fueling areas.
- Follow your Business Emergency Plan, as filed with the County Fire Department at (909) 386-8401.

## Industrial and Commercial Facilities

- Report all prohibited discharges and non-implementation of BMPs to your local Stormwater Coordinator either at (800) CLEANUP or as listed at www.sbcounty.gov/stormwater.
- Report hazardous materials spills to (800) 33 TOXIC and your local Fire Department Hazmat Team at 911.

**Training**

Train employees in spill response procedures and prohibited discharges to the storm drain system, as prescribed in your local Stormwater Ordinance and in applicable Best Management Practices available at www.cabmphandbooks.com and www. sbcounty.gov/stormwater.

**Permitting**

Stormwater discharges associated with specific categories of commercial and industrial facilities are regulated by the State Water Resources Control Board (SWRCB) through an Industrial Storm Water General Permit. A copy of the General Permit and application forms are available at:
www.waterboards.ca.gov/stormwtr/industrial.html

To report illegal dumping or for more information on stormwater pollution prevention, call:

1 (800) CLEANUP

or visit our websites at:

**www.sbcounty.gov/stormwater**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## FRESH CONCRETE & MORTAR APPLICATION

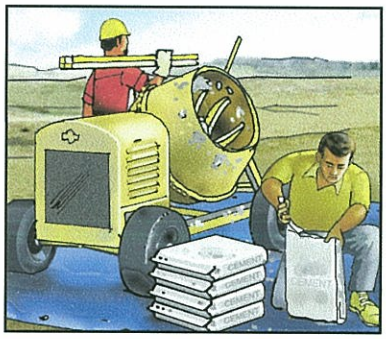
Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

### Storing Materials

Keep construction materials and debris away from the street, gutter and storm drains. Secure open bags of cement and cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

### Ordering Materials & Recycling Waste

Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. When breaking up paving, recycle the pieces at a crushing company. You can also recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. Call (909) 386-8401 for recycling and disposal information.

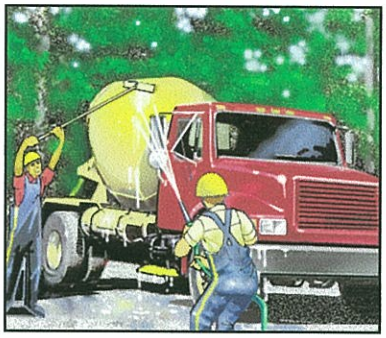


### During Construction

Schedule excavation and grading during dry weather. Prevent mortar and cement from entering the street and storm drains by placing erosion controls. Setup small mixers on tarps or drop cloths, for easy cleanup of debris. Never bury waste material. Recycle or dispose of it as hazardous waste.

### Cleaning Up

Wash concrete dust onto designated dirt areas, not down driveways or into the street or storm drains. Wash out concrete mixers and equipment in specified washout areas, where water can flow into a containment pond. Cement washwater can be recycled by pumping it back into cement mixers for reuse. Never dispose of cement washout into driveways, streets, gutters, storm drains or drainage ditches.



To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

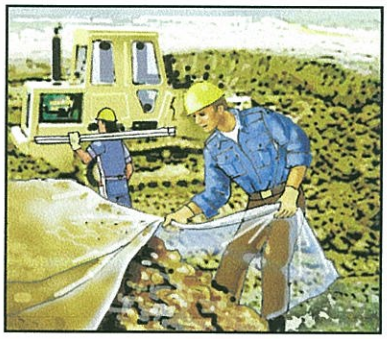
**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# Prevención de Contaminación del Desagüe

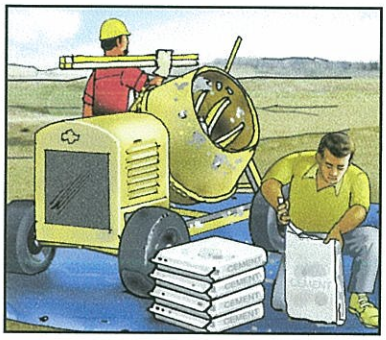
## APLICANDO CONCRETO FRESCO

Cemento, grava, asfalto y liquidos de auto, tierra y residuos peligrosos de lugares de concreto fresco por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



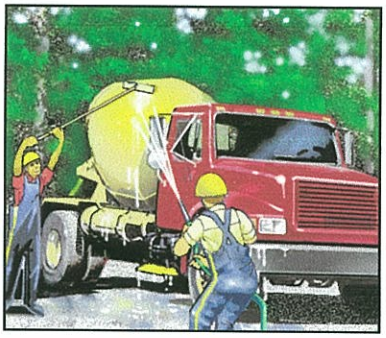
**Almacenando Materiales**
Manten materiales de construcción y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y herramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.

**Ordenando Materiales & Reciclando**
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales recicables cuando sea posible. Cuando estes rompiendo el pavimento, recicla los pedasos en la compañia demolidora. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deverian llevar a lugares de desechos peligrosos. llama al (909) 386-8401 para más información.



**Durante Construcción**
Planea las excavaciones durante clima seco. No dejes que el cemento o la cal lleguen hasta las calles o drenajes, evita esto con plantas temporales para detener el desagüe. Cubre las maquinas de mesclar con alguna garra para que se facilite la limpieza de residuos. Nunca entierres los desechos. Recicla todos los desechos peligrosos.

**Limpiando**
Lava la cal en un area designada, no la eches hacia la cochera o en la calle. Lava las mescladoras y las herramientas en un lugar especifico, donde el agua llegue a un contenedor. El agua de cemento se puede reciclar volviendola a usar en las mescladoras. Nunca dejes el agua de cemento que corra hacia las calles, alcantarillas o drenajes.



Para reportar actividadas ilegales u obtener
más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## CONSTRUCTION

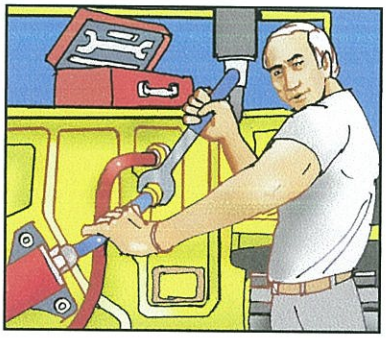
Cement wash, sediment, vehicle fluids, dust and hazardous debris from construction sites often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

**Store Materials Safely**
Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

**Ordering Materials & Recycling Waste**
Reduce waste by ordering only the amounts of materials needed for the job. Use recycled or recyclable materials whenever possible. You can recycle broken asphalt, concrete, wood, and cleared vegetation. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.

**Cleaning & Preventing Spills**
Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. To report serious spills, call 911.

**Preventing Erosion**
Avoid excavation or grading during wet weather. Plant temporary vegetation or add hydromulch on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff to a detention basin and around the construction site. Channels can be lined with grass or roughened pavement to reduce runoff velocity.



**Maintaining Vehicles & Equipment**
Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

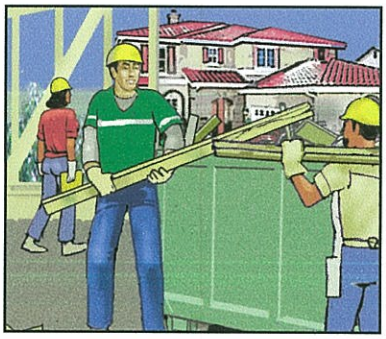
# Prevención de Contaminación del Desagüe

## CONSTRUCCIÓN

Cemento, sedimentos, liquidos de auto, polvos y residuos peligrosos acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

### Almacenando Materiales Cuidadosamente

Manten materiales de construcción y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y herramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.



### Ordenando Materiales & Reciclando Desechos

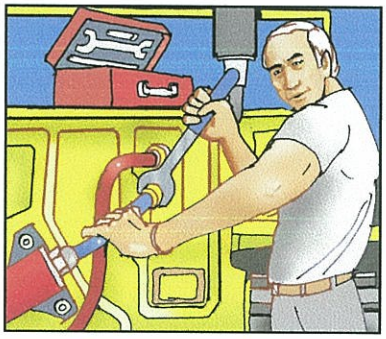
Reduce la cantidad al ordenar el material, solo ordena lo necesario. Usa materiales que se puedan reciclar cuando sea posible. Se puede reciclar el aspfalto, concreto, madera y la vegetacion. Materiales no reciclados se deven llevar a lugares de desechos peligrosos. Para mas información llama al (909) 386-8401.

### Previniendo Erosiones

Evita las excavaciones durante lluvia. Planta vegetacion temporal en colinas donde aun no hay planes de construccion y planta vegetacion permanente al terminar las excavaciones. Construye algunos canales para el desagüe. Estos pueden ser creados con pasto y cemento para reducir la velocidad del desagüe.

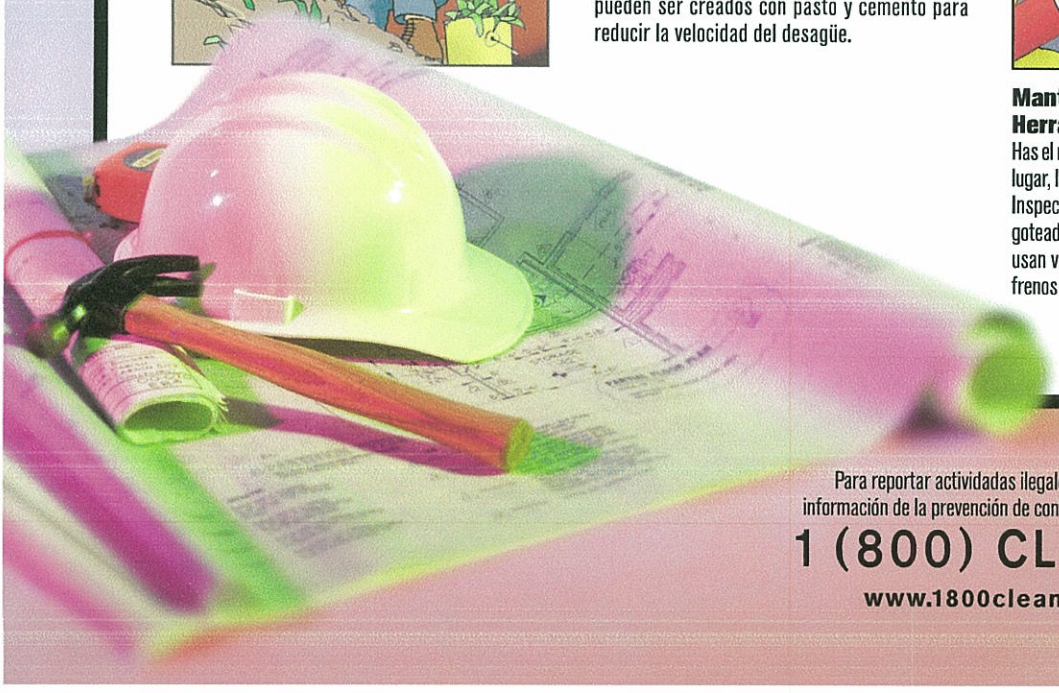
### Limpiando & Previniendo Derrames

Usa siempre un enbudo al vaciar liquidos. Barre los derrames en ves de lavarlos con la manguera. Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin. Para reportar derrames llama al 911.



### Mantenimiento de Vehiculos & Herramientas

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y preveen goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.



Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

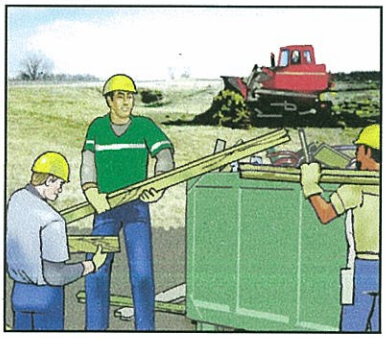
**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

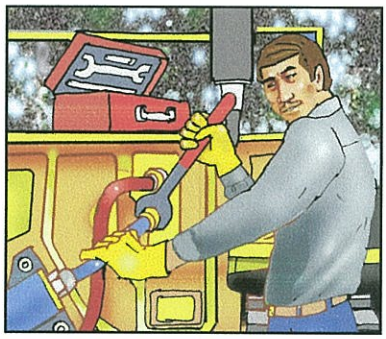
## EXCAVATION AND GRADING

Sediment, cement wash, asphalt and vehicle fluids from soil excavation and grading often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.



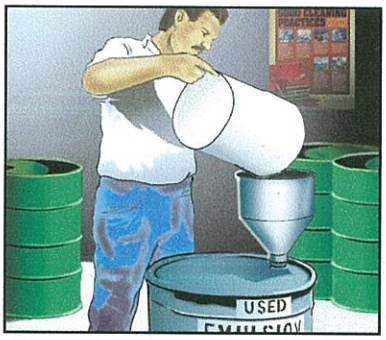
### Recycling Waste

Recycle broken asphalt, concrete, wood, and cleared vegetation whenever possible. Non-recyclable materials should be taken to a landfill or disposed of as hazardous waste. For recycling and disposal information, call (909) 386-8401.



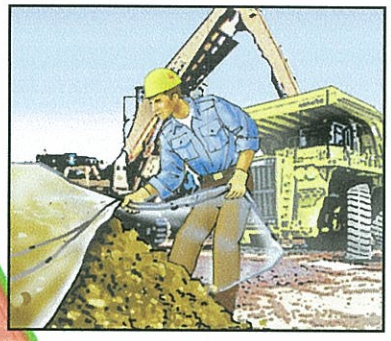
### Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutters and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks. Use gravel approaches where truck traffic is heavy to reduce soil compaction and limit the tracking of sediment into the street.



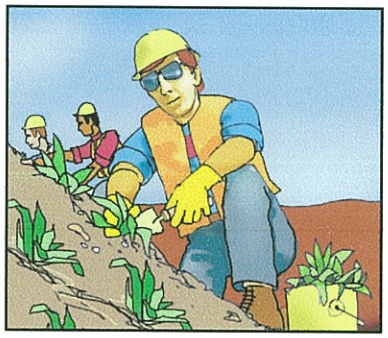

### Cleaning & Preventing Spills

Use a drip pan and funnel when draining or pouring fluids. Sweep up dry spills, instead of hosing. Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids. To report serious spills, call 911.



### Storing Materials

Keep construction materials and debris away from the street, gutter and storm drains. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.



### Preventing Erosion

Avoid excavation or grading during wet weather. Plant temporary vegetation on slopes where construction is not immediately planned, and permanent vegetation once excavation and grading are complete. Construct diversion dikes to channel runoff. Channels can be lined with grass or roughened pavement to reduce runoff velocity.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

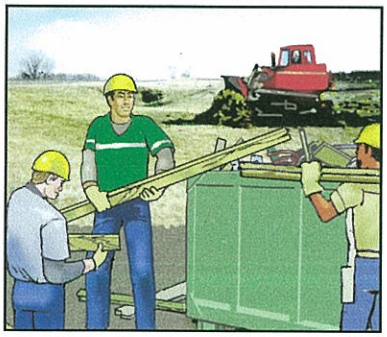
**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# Prevención de Contaminación del Desagüe

## EXCAVACIONES

Sedimento, cemento, asfalto y liquidos de auto, tierra y residuos peligrosos de lugares de construcción acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

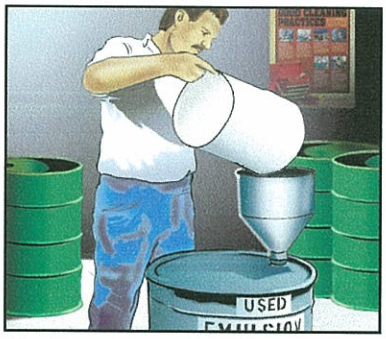


**Reciclando Desechos**

Recicla el aspfalto, concreto, madera y la vegetacion cuando sea posible. Materiales no reciclados se deverian llevar a lugares de desechos peligrosos. Para màs informacion llama al (909) 386-8401.

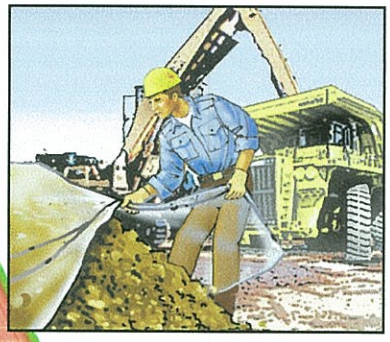
**Manteniendo Vehiculos & Herramientas**

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura. Usa grava donde mayormente se consentra el trafico de camiones para y reducir el sedimento en las calles.



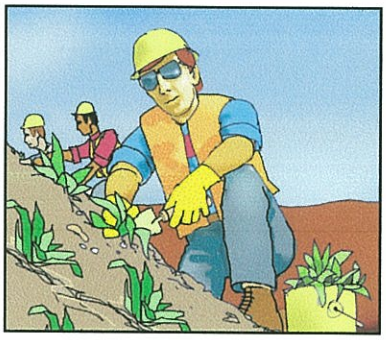

**Limpiando & Previniendo Derrames**

Usa siempre un enbudo al vaciar liquidos. Barre los derrames en ves de lavarlos con la manguera. Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin. Preveen goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador. Para reportar derrames llama al 911.



**Almacenando Materiales**

Manten materiales de construccion y residuos lejos de las calles, coladeras y desagües. Manten tapados los bultos de arena, grava y erramientas para excavar cuviertos con algun plastico para protejerlos de la lluvia, el aire y el desagüe.



**Previniendo Erosiones**

Evita las excavaciones durante lluvia. Planta vegetacion temporal en colinas donde aun no hay planes de construcción y planta vegetacion permanente al terminar las excavaciones. Construye algunos canales para el desagüe. Estos pueden ser creados con pasto y cemento para reducir la velocidad del desagüe.

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

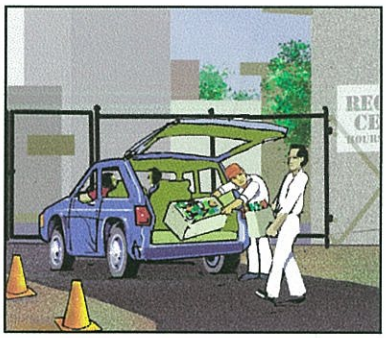
**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## HOME & GARDEN

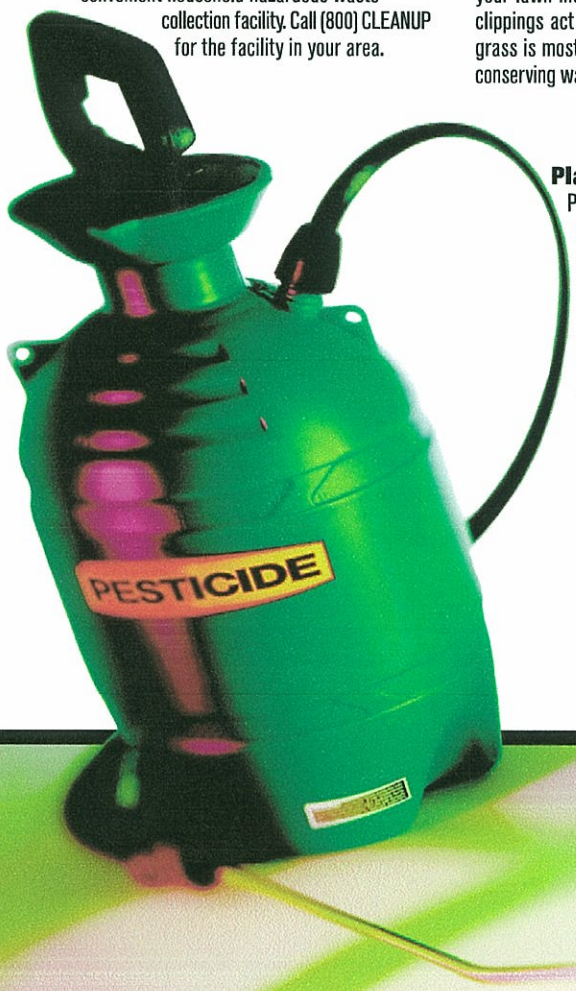
Yard waste and household toxics like paints and pesticides often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.



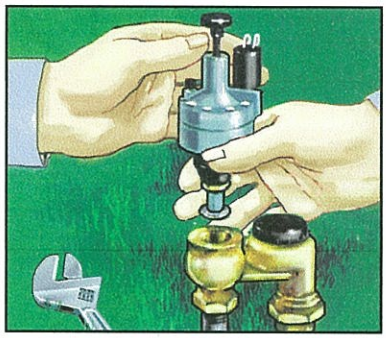
**Recycle Household Hazardous Waste**
Household products like paint, pesticides, solvents and cleaners are too dangerous to dump and too toxic to trash. Take them to be recycled at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

**Disposing of Yard Waste**
Recycle leaves, grass clippings and other yard waste, instead of blowing, sweeping or hosing into the street. Try grasscycling, leaving grass clippings on your lawn instead of using a grass catcher. The clippings act as a natural fertilizer, and because grass is mostly water, it also irrigates your lawn, conserving water.

**Use Fertilizers & Pesticides Safely**
Fertilizers and pesticides are often carried into the storm drain system by sprinkler runoff. Try using organic or non-toxic alternatives. If you use chemical fertilizers or pesticides, avoid applying near curbs and driveways and never apply before a rain.




**Planting in the Yard**
Produce less yard waste and save water by planting low maintenance, drought-tolerant trees and shrubs. Using drip irrigation, soaker hoses or micro-spray systems for flower beds and vegetation can also help reduce your water bill and prevent runoff.



**Use Water Wisely**
Cut your water costs and prevent runoff by controlling the amount of water and direction of sprinklers. The average lawn needs about an inch of water a week, including rainfall, or 10 to 20 minutes of watering. A half-inch per week is enough for fall and spring. Sprinklers should be on long enough to allow water to soak into the ground but not so long as to cause runoff.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# Prevención de Contaminación del Desagüe

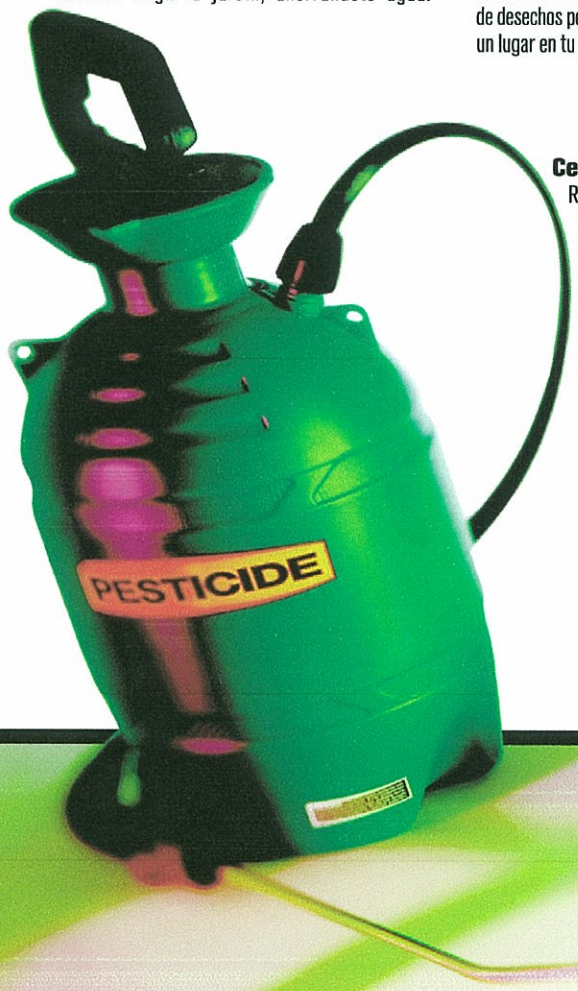
## JARDIN

Basura del jardín y otros toxicos caseros como pintura, pesticidas y otros mas acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

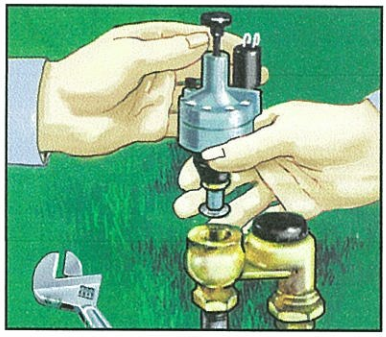
**Disponiendo Desechos del Jardin**
Recicla hojas, pasto y otras basuras del jardín en ves de soplarlas, barrerlas hacia la calle. El pasto sirve como fertilizante, y como el pasta es la mayoria agua tambien riega tu jardín, ahorrandote agua.

**Reciclando Materiales del Hogar Peligrosos**
Limpiadores del hogar como pintura, pesticidas, solventes y limpiadores son demasiado toxicos para tirarlos en la basura. Desechalos en unlugar de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.

**Usando Fertilizantes & Pesticidas Adecuadamente**
Fertilizantes y pesticidas muchas veces terminan en los drenajes. Usa alternativas que no sean toxicas. Si tu usas fertilizantes y pesticidas con quimicos, no los uses cerca de las banquetas y cocheras y nunca los uses en tiempos de lluvia.




**Cembrando en el Jardin**
Reduce la basura del jardín y ahorra agua plantando arboles y plantas de bajo mantenimiento. Riega moderadamente con mangueras u otros metodos para las flores o vegetacion asi reduciras tu pago del mes y previenes el desagüe.



**Usando el Agua Adecuadamente**
Reduce el pago del agua y previene el desagüe controlando la cantidad y direccion de tus regaderas para el jardin. Solo necesitas regar de 10 a 20 minutos a la semana. Durante la primavera y otoño es la mitad. Las regaderas del jardin deverian estar ajustadas a que rieguen lo suficinete y evitar el desagüe.

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## HOME REPAIR & REMODELING

Paints, solvents, adhesives and other toxic substances used in home repair and remodeling often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect your health.

### Construction Projects

Keep construction debris away from the street, gutter and storm drains. Schedule grading and excavation projects for dry weather. Cover excavated material and stockpiles of soil, sand or gravel, protected from rain, wind and runoff. Prevent erosion by planting fast-growing annual and perennial grass, which can shield and bind soil.

### Recycle Household Hazardous Waste

Household cleaners, paint and other home improvement products like wallpaper and tile adhesives are too toxic to trash. Recycle them instead, at a convenient household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

### Landscaping & Gardening

Avoid applying fertilizers or pesticide near curbs and driveways, and store covered, protected from rain, wind and runoff. Try using organic or non-toxic alternatives. Reduce runoff and lower your water bill by using drip irrigation, soaker hoses or micro-spray systems. Recycle leaves instead of blowing, sweeping or raking them into the street, gutter or storm drain.

### Paint Removal

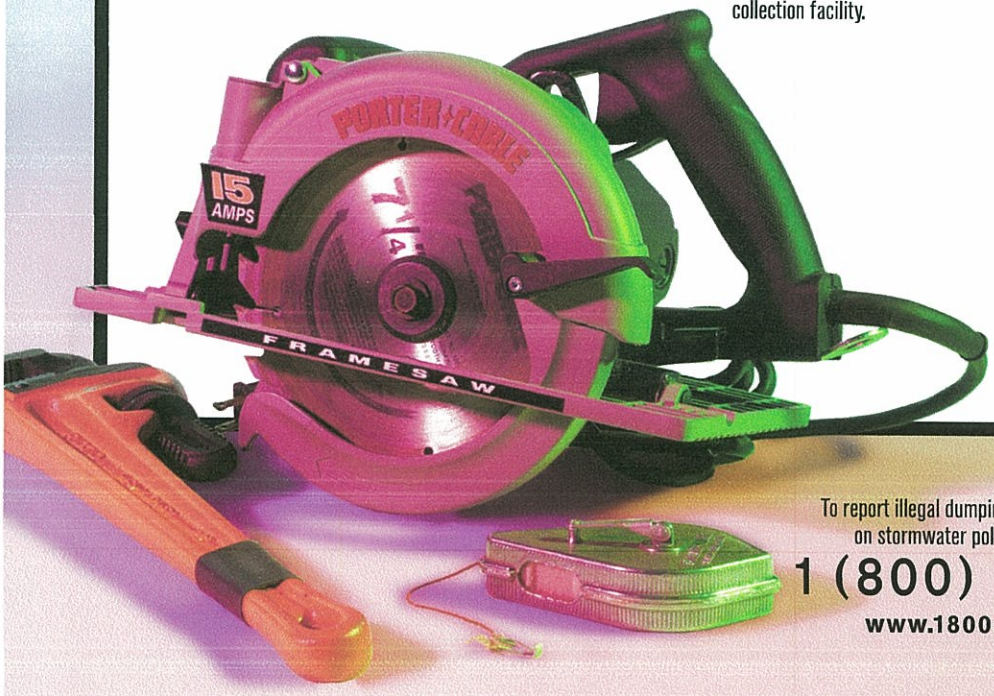
Paint stripping residue, chips and dust from marine paints and paints containing lead or tributyl tin are hazardous wastes. Sweep them up instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility.

### Painting Cleanup

Avoid cleaning brushes or rinsing paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which you can filter and reuse. Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.

### Concrete and Masonry

Store bags of cement and plaster away from gutters and storm drains, and cover them to protect against rain, wind and runoff. Sweep or scoop up cement washout or concrete dust instead of hosing into driveways, streets, gutters or storm drains.




To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# Prevención de Contaminación del Desagüe

## MEJORAS DEL HOGAR

Pintura, solventes y otros quimicos peligrosos que se usan al las mejoras del hogar acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

### Proyectos de Construcción

No dejes que los residuos de la construcción terminen en la calle, coladeras o desagües. Planea tus excavaciónes durante el clima seco. Cuvre tus materiales y tus bultos de tierra, arena, grava para protejerlos de la lluvia, el aire y el desagües. Planta pasto o plantas para evirtar las erosiones, estas pueden detener el derrame.

### Jardineria

Evita usar los fertilizantes o pesticidas cerca de la banqueta o cocheras, y tapalos bien para protejerlas de la lluvia, el aire y el desagües. Usa productos no toxicos u organicos. Reduce tu pago del agua usando otros tipos de erosiones. Recicla las hojas en ves de soplarlas o barrerlas asia la calle, coladeras o alcantarillas.

### Limpiando Pintura

Nunca laves las brochas ni los contenedores de pintura en la calle, coladeras o desagües. Las de pintura de agua limpialas en el labavo y las de pintura de aceite con thiner, y vuelvelas a guardar en un frasco, para un uso futuro. Envuelve los residuos de pintura en un periodico y tiralos a la basura.

### Reciclando Materiales del Hogar Peligrosos

Limpiadores del hogar, pintura y otros productos como la pegadura para el papel para las paredes y azulejo son demasiado toxicos para tirarlos a la basura. Desechalos en un lugar de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.

### Removiendo Pintura

Residuos de pintura, polvo de pintura y pinturas que contienen plomo son peligrosas. Barrelos en ves de lavarlos con la manguera y desechalos en unlugar de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.

### Concreto & Albañilería

Almacena bolsas de cemento y pegaduras lejos de las coladeras y alcantarillas, y cubrelos para protejerlos de la lluvia, viento y desagües. Barre o recoje el cemento o concreto en ves de lavarlos con la manguera hacia la cochera, calles o drenajes.

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## PAINTING

Paints, solvents, adhesives and other toxic chemicals used in painting often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these simple tips to prevent pollution and protect our health.

**Water-Based Paints**
Use water-based paints whenever possible. They are less toxic than oil-based paints and easier to clean up. Look for products labeled "latex" or "cleans with water."

**Paint Removal**
Sweep up paint stripping residue, chips and dust instead of hosing into the street and dispose of them safely at a household hazardous waste collection facility. Call (800) CLEANUP for the facility in your area.

**Painting Cleanup**
Never clean brushes or rinse paint containers in the street, gutter or near a storm drain. Clean water-based paints in the sink. Clean oil-based paints with thinner, which can be reused by putting it in a jar to settle out the paint particles and then pouring off the clear liquid for future use. Wrap dried paint residue in newspaper and dispose of it in the trash.

**Exterior Paint Removal**
When stripping or cleaning building exteriors with high-pressure water, block nearby storm drains and divert washwater onto a designated dirt area. Ask your local wastewater treatment authority if you can collect building cleaning water and discharge it to the sewer.

**Recycling Paint**
Recycle leftover paint at a household hazardous waste collection facility, save it for touch ups or give it to someone who can use it, like a theatre group, school, city or community organization.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# Prevención de Contaminación del Desagüe

## PINTURA

Pintura, solventes y otros quimicos peligrosos que se usan al pintar acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.

**Pinturas de Agua**

Usa pinturas de agua cuando sea posible. Son menos toxicas que las pinturas de aceite y mas faciles para limpiar. Busca los productos "latex" or "cleans with water".

**Removiendo Pintura**

Residuos de pintura, polvo de pintura y pinturas que contienen plomo son peligrosas. Barrelos en ves de lavarlos con la manguera y desechalos en unlugar de colección de desechos peligrosos. Llama al (800) CLEANUP para un lugar en tu area.

**Limpiando Pintura**

Nunca laves las brochas ni los contenedores de pintura en la calle, coladeras o desagües. Las de pintura de agua limpialas en el labavo y las de pintura de aceite con thiner, y vuelvelas a guardar en un frasco, para un uso futuro. Envuelve los residuos de pintura en un periodico y tiralos a la basura.

**Removiendo Pintura en Exteriores**

Al despintar o lavar exteriores de los edificios con agua de alta presión bloquea los drenajes cercanos y desvia el desagüe. Pregunta las autoridades si puedes desecharla en las alcantaillas.

**Reciclando Pintura**

Recicla la pintura que sobra en un lugar de colección de materiales peligrosos, guardala para re-toques or regalala a alguien que la use, como a un teatro, a la escuela, una oraganizacion de la ciudad o de la comunidad.

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# STORMWATER Pollution Prevention

## ROADWORK AND PAVING

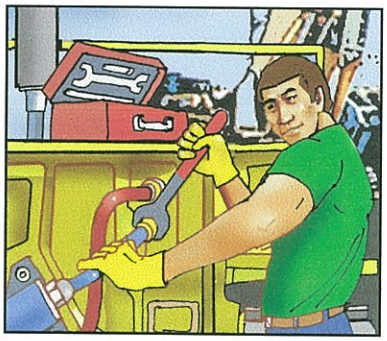
Asphalt, saw-cut slurry and excavated materials from road paving, surfacing and pavement removal often make their way into the San Bernardino County storm drain system and do not get treated before reaching the Santa Ana River. This pollutes our drinking water and contaminates waterways, making them unsafe for people and wildlife. Follow these best management practices to prevent pollution and protect public health.

### Preventing Erosion

Schedule excavation and grading work during dry weather. Develop and implement erosion and sediment control plans for excavated embankments. Cover exposed stockpiles of soil, sand or gravel and excavated material with plastic sheeting, protected from rain, wind and runoff.

### During Construction

Cover catch basins and maintenance holes when applying seal coat, slurry seal or fog seal. Use check dams, ditches or berms around excavations, and avoid over applying water for dust control. Never wash excess materials from exposed aggregate or concrete into the street, gutter or a storm drain.

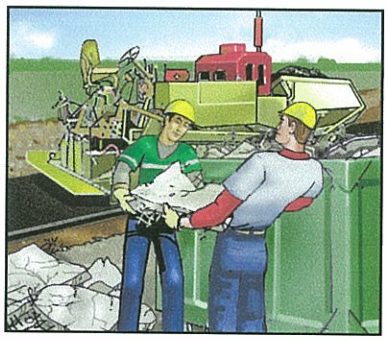


### Maintaining Vehicles & Equipment

Maintain and refuel vehicles and equipment at a single location on-site, away from the street, gutter and storm drains. Perform major equipment repairs and washings off-site. Inspect vehicles and equipment frequently for leaks, and prevent leaks from stored vehicles by draining gas, hydraulic oil, transmission, brake and radiator fluids.

### Asphalt & Concrete Removal

Barricade storm drain openings during saw-cutting, and recycle broken up pavement at a crushing company. For recycling information, call (909) 386-8401.



### Cleaning & Preventing Spills

Be ready for spills by preparing and using spill containment and cleanup kits that include safety equipment and dry cleanup materials such as kitty litter or sawdust. Sweep up dry spills, instead of hosing. Prevent spills from paver machines by using drip pans, or by placing absorbent materials like cloths or rags under the machines when not in use. To report serious spills, call 911.

To report illegal dumping or for more information on stormwater pollution prevention, call:

**1 (800) CLEANUP**

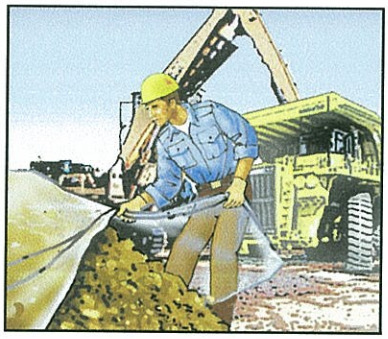
**www.1800cleanup.org**

San Bernardino County STORMWATER PROGRAM

# Prevención de Contaminación del Desagüe

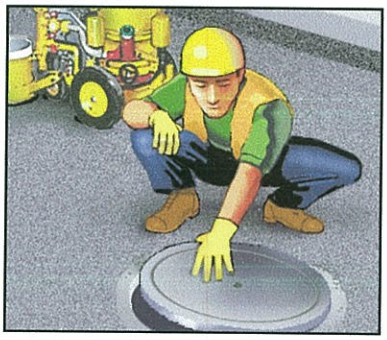
## TRABAJO DE CARRETERAS & PAVIMENTO

Asfalto, mezcla y materiales de excavaciones del pavimento acaban por llegar a los drenajes del Condado de San Bernardino y terminando en el Rio de Santa Ana. Esto contamina el agua que tomamos, haciendola peligorsa para la gente y la vida salvaje. Sigue estas practicas para prevenir la contaminación y protejer la salud publica.



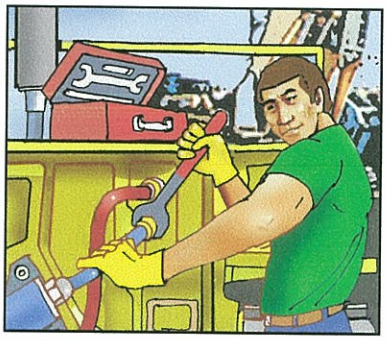
**Previniendo Erosiones**

Planea las excavaciones trabajo de jardineria durante el clima seco. Desarrolla e implementa planes de embancamientos de control de sedimento y excavaciones. Cubre montones de tierra, grava y otros materiales con un plastico para protejerlos de la llvia, aire y desagüe.



**Durante Construcción**

Cubre los lavados y da mantenimiento a los hoyos al aplicar selladura o mezcla. Revisa las areas de excavaciones, y evita pasarte de agua para preveenir polvadura. Nunca laves los materiales llenos de concreto en la calle, drenajes o en el desagüe.



**Mantenimiento de Vehiculos & Herramientas**

Has el mantenimiento y carga de vehiculos en el mismo lugar, lejos de la calle, las alcantarillas y los drenajes. Inspecciona los vehiculos y el equipo de cualquier goteadura y evita goteaduras de autos que no se usan vasiandoles la gasolina, aceite de transmision, frenos y liquidos del radiador.

**Removiendo Asfalto & Concreto**

Bloquea alrededor de los drenajes cuando estes usando las maquinas de sierra, tambien recicla todo el pavimento roto en la compañia demolidora. Para más información llama al (909) 386-8401.

**Limpiando & Previniendo Derrames**

Mantente siempre preparado para cualquier derrame, usa siempre las herramientas de seguridad al igual que materiales como, tierra para desechos de gato o aserrin Barre los derrames en ves de lavarlos con la manguera. Previene los derrames de las maquinas usando enbudos o colocanto garras para absorver cualquier liquido. Para reportar derrames llama al 911.

Para reportar actividadas ilegales u obtener más información de la prevención de contaminación llamar al :

**1 (800) CLEANUP**

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San Bernardino County STORMWATER PROGRAM

# Building & Grounds Maintenance SC-41

### Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

### Targeted Constituents

| | |
|---|---|
| Sediment | ✓ |
| Nutrients | ✓ |
| Trash | |
| Metals | ✓ |
| Bacteria | ✓ |
| Oil and Grease | |
| Organics | |

## Description

Stormwater runoff from building and grounds maintenance activities can be contaminated with toxic hydrocarbons in solvents, fertilizers and pesticides, suspended solids, heavy metals, abnormal pH, and oils and greases. Utilizing the protocols in this fact sheet will prevent or reduce the discharge of pollutants to stormwater from building and grounds maintenance activities by washing and cleaning up with as little water as possible, following good landscape management practices, preventing and cleaning up spills immediately, keeping debris from entering the storm drains, and maintaining the stormwater collection system.

## Approach

Reduce potential for pollutant discharge through source control pollution prevention and BMP implementation. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

### *Pollution Prevention*

- Switch to non-toxic chemicals for maintenance when possible.
- Choose cleaning agents that can be recycled.
- Encourage proper lawn management and landscaping, including use of native vegetation.

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- Encourage use of Integrated Pest Management techniques for pest control.
- Encourage proper onsite recycling of yard trimmings.
- Recycle residual paints, solvents, lumber, and other material as much as possible.

***Suggested Protocols***

*Pressure Washing of Buildings, Rooftops, and Other Large Objects*

- In situations where soaps or detergents are used and the surrounding area is paved, pressure washers must use a water collection device that enables collection of wash water and associated solids. A sump pump, wet vacuum or similarly effective device must be used to collect the runoff and loose materials. The collected runoff and solids must be disposed of properly.
- If soaps or detergents are not used, and the surrounding area is paved, wash runoff does not have to be collected but must be screened. Pressure washers must use filter fabric or some other type of screen on the ground and/or in the catch basin to trap the particles in wash water runoff.
- If you are pressure washing on a grassed area (with or without soap), runoff must be dispersed as sheet flow as much as possible, rather than as a concentrated stream. The wash runoff must remain on the grass and not drain to pavement.

*Landscaping Activities*

- Dispose of grass clippings, leaves, sticks, or other collected vegetation as garbage, or by composting. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures on exposed soils.

*Building Repair, Remodeling, and Construction*

- Do not dump any toxic substance or liquid waste on the pavement, the ground, or toward a storm drain.
- Use ground or drop cloths underneath outdoor painting, scraping, and sandblasting work, and properly dispose of collected material daily.
- Use a ground cloth or oversized tub for activities such as paint mixing and tool cleaning.
- Clean paintbrushes and tools covered with water-based paints in sinks connected to sanitary sewers or in portable containers that can be dumped into a sanitary sewer drain. Brushes and tools covered with non-water-based paints, finishes, or other materials must be cleaned in a manner that enables collection of used solvents (e.g., paint thinner, turpentine, etc.) for recycling or proper disposal.
- Use a storm drain cover, filter fabric, or similarly effective runoff control mechanism if dust, grit, wash water, or other pollutants may escape the work area and enter a catch basin. This is particularly necessary on rainy days. The containment device(s) must be in place at the beginning of the work day, and accumulated dirty runoff and solids must be collected and disposed of before removing the containment device(s) at the end of the work day.

- If you need to de-water an excavation site, you may need to filter the water before discharging to a catch basin or off-site. If directed off-site, you should direct the water through hay bales and filter fabric or use other sediment filters or traps.
- Store toxic material under cover during precipitation events and when not in use. A cover would include tarps or other temporary cover material.

*Mowing, Trimming, and Planting*

- Dispose of leaves, sticks, or other collected vegetation as garbage, by composting or at a permitted landfill. Do not dispose of collected vegetation into waterways or storm drainage systems.
- Use mulch or other erosion control measures when soils are exposed.
- Place temporarily stockpiled material away from watercourses and drain inlets, and berm or cover stockpiles to prevent material releases to the storm drain system.
- Consider an alternative approach when bailing out muddy water: do not put it in the storm drain; pour over landscaped areas.
- Use hand weeding where practical.

*Fertilizer and Pesticide Management*

- Follow all federal, state, and local laws and regulations governing the use, storage, and disposal of fertilizers and pesticides and training of applicators and pest control advisors.
- Use less toxic pesticides that will do the job when applicable. Avoid use of copper-based pesticides if possible.
- Do not use pesticides if rain is expected.
- Do not mix or prepare pesticides for application near storm drains.
- Use the minimum amount needed for the job.
- Calibrate fertilizer distributors to avoid excessive application.
- Employ techniques to minimize off-target application (e.g., spray drift) of pesticides, including consideration of alternative application techniques.
- Apply pesticides only when wind speeds are low.
- Fertilizers should be worked into the soil rather than dumped or broadcast onto the surface.
- Irrigate slowly to prevent runoff and then only as much as is needed.
- Clean pavement and sidewalk if fertilizer is spilled on these surfaces before applying irrigation water.
- Dispose of empty pesticide containers according to the instructions on the container label.

- Use up the pesticides. Rinse containers, and use rinse water as product. Dispose of unused pesticide as hazardous waste.
- Implement storage requirements for pesticide products with guidance from the local fire department and County Agricultural Commissioner. Provide secondary containment for pesticides.

*Inspection*

- Inspect irrigation system periodically to ensure that the right amount of water is being applied and that excessive runoff is not occurring. Minimize excess watering and repair leaks in the irrigation system as soon as they are observed.

***Training***

- Educate and train employees on pesticide use and in pesticide application techniques to prevent pollution.
- Train employees and contractors in proper techniques for spill containment and cleanup.
- Be sure the frequency of training takes into account the complexity of the operations and the nature of the staff.

***Spill Response and Prevention***

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials, such as brooms, dustpans, and vacuum sweepers (if desired) near the storage area where it will be readily accessible.
- Have employees trained in spill containment and cleanup present during the loading/unloading of dangerous wastes, liquid chemicals, or other materials.
- Familiarize employees with the Spill Prevention Control and Countermeasure Plan.
- Clean up spills immediately.

***Other Considerations***

Alternative pest/weed controls may not be available, suitable, or effective in many cases.

## Requirements

***Costs***

- Cost will vary depending on the type and size of facility.
- Overall costs should be low in comparison to other BMPs.

***Maintenance***

Sweep paved areas regularly to collect loose particles. Wipe up spills with rags and other absorbent material immediately, do not hose down the area to a storm drain.

## Supplemental Information

### *Further Detail of the BMP*

*Fire Sprinkler Line Flushing*

Building fire sprinkler line flushing may be a source of non-stormwater runoff pollution. The water entering the system is usually potable water, though in some areas it may be non-potable reclaimed wastewater. There are subsequent factors that may drastically reduce the quality of the water in such systems. Black iron pipe is usually used since it is cheaper than potable piping, but it is subject to rusting and results in lower quality water. Initially, the black iron pipe has an oil coating to protect it from rusting between manufacture and installation; this will contaminate the water from the first flush but not from subsequent flushes. Nitrates, polyphosphates and other corrosion inhibitors, as well as fire suppressants and antifreeze may be added to the sprinkler water system. Water generally remains in the sprinkler system a long time (typically a year) and between flushes may accumulate iron, manganese, lead, copper, nickel, and zinc. The water generally becomes anoxic and contains living and dead bacteria and breakdown products from chlorination. This may result in a significant BOD problem and the water often smells. Consequently dispose fire sprinkler line flush water into the sanitary sewer. Do not allow discharge to storm drain or infiltration due to potential high levels of pollutants in fire sprinkler line water.

## References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

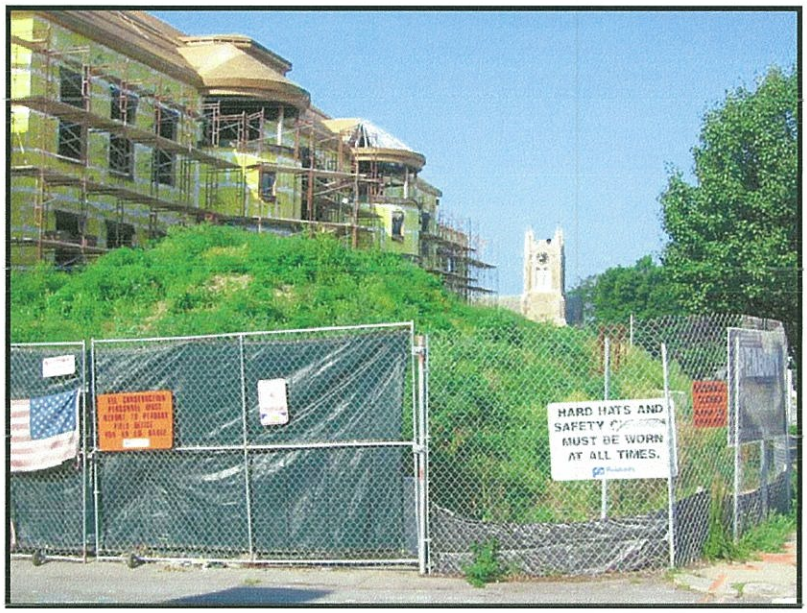
Mobile Cleaners Pilot Program: Final Report. 1997. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

# Building Repair and Construction SC-42




## Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Recycle

## Targeted Constituents

| | |
|---|---|
| Sediment | ✓ |
| Nutrients | |
| Trash | ✓ |
| Metals | ✓ |
| Bacteria | |
| Oil and Grease | ✓ |
| Organics | ✓ |

## Description

Modifications are common particularly at large industrial sites. The activity may vary from minor and normal building repair to major remodeling, or the construction of new facilities. These activities can generate pollutants including solvents, paints, paint and varnish removers, finishing residues, spent thinners, soap cleaners, kerosene, asphalt and concrete materials, adhesive residues, and old asbestos installation. Protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants to stormwater from building repair, remodeling, and construction by using soil erosion controls, enclosing or covering building material storage areas, using good housekeeping practices, using safer alternative products, and training employees.

## Approach

### *Pollution Prevention*

- Recycle residual paints, solvents, lumber, and other materials to the maximum extent practical.
- Buy recycled products to the maximum extent practical.
- Inform on-site contractors of company policy on these matters and include appropriate provisions in their contract to ensure certain proper housekeeping and disposal practices are implemented.

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- Make sure that nearby storm drains are well marked to minimize the chance of inadvertent disposal of residual paints and other liquids.

***Suggested Protocols***

*Repair & Remodeling*

- Follow BMPs identified in Construction BMP Handbook.
- Maintain good housekeeping practices while work is underway.
- Keep the work site clean and orderly. Remove debris in a timely fashion. Sweep the area.
- Cover materials of particular concern that must be left outside, particularly during the rainy season.
- Do not dump waste liquids down the storm drain.
- Dispose of wash water, sweepings, and sediments properly.
- Store materials properly that are normally used in repair and remodeling such as paints and solvents.
- Sweep out the gutter or wash the gutter and trap the particles at the outlet of the downspout if when repairing roofs, small particles have accumulated in the gutter. A sock or geofabric placed over the outlet may effectively trap the materials. If the downspout is tight lined, place a temporary plug at the first convenient point in the storm drain and pump out the water with a vactor truck, and clean the catch basin sump where you placed the plug.
- Properly store and dispose waste materials generated from construction activities. See Construction BMP Handbook.
- Clean the storm drain system in the immediate vicinity of the construction activity after it is completed.

*Painting*

- Enclose painting operations consistent with local air quality regulations and OSHA.
- Local air pollution regulations may, in many areas of the state, specify painting procedures which if properly carried out are usually sufficient to protect water quality.
- Develop paint handling procedures for proper use, storage, and disposal of paints.
- Transport paint and materials to and from job sites in containers with secure lids and tied down to the transport vehicle.
- Test and inspect spray equipment prior to starting to paint. Tighten all hoses and connections and do not overfill paint containers.
- Mix paint indoors before using so that any spill will not be exposed to rain. Do so even during dry weather because cleanup of a spill will never be 100% effective.
- Transfer and load paint and hot thermoplastic away from storm drain inlets.

- Do not transfer or load paint near storm drain inlets.
- Plug nearby storm drain inlets prior to starting painting and remove plugs when job is complete when there is significant risk of a spill reaching storm drains.
- Cover nearby storm drain inlets prior to starting work if sand blasting is used to remove paint.
- Use a ground cloth to collect the chips if painting requires scraping or sand blasting of the existing surface. Dispose the residue properly.
- Cover or enclose painting operations properly to avoid drift.
- Clean the application equipment in a sink that is connected to the sanitary sewer if using water based paints.
- Capture all cleanup-water and dispose of properly.
- Dispose of paints containing lead or tributyl tin and considered a hazardous waste properly.
- Store leftover paints if they are to be kept for the next job properly, or dispose properly.
- Recycle paint when possible. Dispose of paint at an appropriate household hazardous waste facility.

### *Training*

Proper education of off-site contractors is often overlooked. The conscientious efforts of well trained employees can be lost by unknowing off-site contractors, so make sure they are well informed about what they are expected to do.

### *Spill Response and Prevention*

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Clean up spills immediately.
- Excavate and remove the contaminated (stained) soil if a spill occurs on dirt.

### *Limitations*

- This BMP is for minor construction only. The State's General Construction Activity Stormwater Permit has more requirements for larger projects. The companion "Construction Best Management Practice Handbook" contains specific guidance and best management practices for larger-scale projects.
- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Be certain that actions to help stormwater quality are consistent with Cal- and Fed-OSHA and air quality regulations.

## Requirements

### *Costs*

These BMPs are generally low to modest in cost.

### *Maintenance*

N/A

## Supplemental Information

### *Further Detail of the BMP*

*Soil/Erosion Control*

If the work involves exposing large areas of soil, employ the appropriate soil erosion and control techniques. See the Construction Best Management Practice Handbook. If old buildings are being torn down and not replaced in the near future, stabilize the site using measures described in SC-40 Contaminated or Erodible Areas.

If a building is to be placed over an open area with a storm drainage system, make sure the storm inlets within the building are covered or removed, or the storm line is connected to the sanitary sewer. If because of the remodeling a new drainage system is to be installed or the existing system is to be modified, consider installing catch basins as they serve as effective "in-line" treatment devices. See Treatment Control Fact Sheet TC-20 Wet Pond/Basin in Section 5 of the New Development and Redevelopment Handbook regarding design criteria. Include in the catch basin a "turn-down" elbow or similar device to trap floatables.

## References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

# Parking/Storage Area Maintenance SC-43

### Objectives

- Cover
- Contain
- Educate
- Reduce/Minimize
- Product Substitution

### Targeted Constituents

| | |
|---|---|
| Sediment | ✓ |
| Nutrients | |
| Trash | ✓ |
| Metals | ✓ |
| Bacteria | |
| Oil and Grease | ✓ |
| Organics | ✓ |

## Description

Parking lots and storage areas can contribute a number of substances, such as trash, suspended solids, hydrocarbons, oil and grease, and heavy metals that can enter receiving waters through stormwater runoff or non-stormwater discharges. The protocols in this fact sheet are intended to prevent or reduce the discharge of pollutants from parking/storage areas and include using good housekeeping practices, following appropriate cleaning BMPs, and training employees.

## Approach

The goal of this program is to ensure stormwater pollution prevention practices are considered when conducting activities on or around parking areas and storage areas to reduce potential for pollutant discharge to receiving waters. Successful implementation depends on effective training of employees on applicable BMPs and general pollution prevention strategies and objectives.

### *Pollution Prevention*

- Encourage alternative designs and maintenance strategies for impervious parking lots. (See New Development and Redevelopment BMP Handbook)
- Keep accurate maintenance logs to evaluate BMP implementation.

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# SC-43 Parking/Storage Area Maintenance

***Suggested Protocols***

*General*

- Keep the parking and storage areas clean and orderly. Remove debris in a timely fashion.
- Allow sheet runoff to flow into biofilters (vegetated strip and swale) and/or infiltration devices.
- Utilize sand filters or oleophilic collectors for oily waste in low quantities.
- Arrange rooftop drains to prevent drainage directly onto paved surfaces.
- Design lot to include semi-permeable hardscape.
- Discharge soapy water remaining in mop or wash buckets to the sanitary sewer through a sink, toilet, clean-out, or wash area with drain.

*Controlling Litter*

- Post "No Littering" signs and enforce anti-litter laws.
- Provide an adequate number of litter receptacles.
- Clean out and cover litter receptacles frequently to prevent spillage.
- Provide trash receptacles in parking lots to discourage litter.
- Routinely sweep, shovel, and dispose of litter in the trash.

*Surface Cleaning*

- Use dry cleaning methods (e.g., sweeping, vacuuming) to prevent the discharge of pollutants into the stormwater conveyance system if possible.
- Establish frequency of public parking lot sweeping based on usage and field observations of waste accumulation.
- Sweep all parking lots at least once before the onset of the wet season.
- Follow the procedures below if water is used to clean surfaces:
  - Block the storm drain or contain runoff.
  - Collect and pump wash water to the sanitary sewer or discharge to a pervious surface. Do not allow wash water to enter storm drains.
  - Dispose of parking lot sweeping debris and dirt at a landfill.
- Follow the procedures below when cleaning heavy oily deposits:
  - Clean oily spots with absorbent materials.
  - Use a screen or filter fabric over inlet, then wash surfaces.

- Do not allow discharges to the storm drain.
- Vacuum/pump discharges to a tank or discharge to sanitary sewer.
- Appropriately dispose of spilled materials and absorbents.

*Surface Repair*

- Preheat, transfer or load hot bituminous material away from storm drain inlets.
- Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff.
- Cover and seal nearby storm drain inlets where applicable (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal.
- Use only as much water as necessary for dust control, to avoid runoff.
- Catch drips from paving equipment that is not in use with pans or absorbent material placed under the machines. Dispose of collected material and absorbents properly.

*Inspection*

- Have designated personnel conduct inspections of parking facilities and stormwater conveyance systems associated with parking facilities on a regular basis.
- Inspect cleaning equipment/sweepers for leaks on a regular basis.

***Training***

- Provide regular training to field employees and/or contractors regarding cleaning of paved areas and proper operation of equipment.
- Train employees and contractors in proper techniques for spill containment and cleanup.

***Spill Response and Prevention***

- Keep your Spill Prevention Control and Countermeasure (SPCC) Plan up-to-date.
- Place a stockpile of spill cleanup materials where it will be readily accessible or at a central location.
- Clean up fluid spills immediately with absorbent rags or material.
- Dispose of spilled material and absorbents properly.

***Other Considerations***

Limitations related to sweeping activities at large parking facilities may include high equipment costs, the need for sweeper operator training, and the inability of current sweeper technology to remove oil and grease.

# SC-43 Parking/Storage Area Maintenance

## Requirements

### *Costs*

Cleaning/sweeping costs can be quite large. Construction and maintenance of stormwater structural controls can be quite expensive as well.

### *Maintenance*

- Sweep parking lot regularly to minimize cleaning with water.
- Clean out oil/water/sand separators regularly, especially after heavy storms.
- Clean parking facilities regularly to prevent accumulated wastes and pollutants from being discharged into conveyance systems during rainy conditions.

## Supplemental Information

### *Further Detail of the BMP*

*Surface Repair*

Apply concrete, asphalt, and seal coat during dry weather to prevent contamination from contacting stormwater runoff. Where applicable, cover and seal nearby storm drain inlets (with waterproof material or mesh) and manholes before applying seal coat, slurry seal, etc. Leave covers in place until job is complete and all water from emulsified oil sealants has drained or evaporated. Clean any debris from these covered manholes and drains for proper disposal. Only use only as much water as is necessary for dust control to avoid runoff.

## References and Resources


California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

Pollution from Surface Cleaning Folder. 1996. Bay Area Stormwater Management Agencies Association (BASMAA). http://www.basmaa.org/

Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net/

# Drainage System Maintenance SC-44

**Objectives**

- Cover
- Contain
- Educate
- Reduce/Minimize

## Description

As a consequence of its function, the stormwater conveyance system collects and transports urban runoff and stormwater that may contain certain pollutants. The protocols in this fact sheet are intended to reduce pollutants reaching receiving waters through proper conveyance system operation and maintenance.

**Targeted Constituents**

| | |
|---|---|
| Sediment | ✓ |
| Nutrients | |
| Trash | ✓ |
| Metals | |
| Bacteria | ✓ |
| Oil and Grease | |
| Organics | |

## Approach

### *Pollution Prevention*

Maintain catch basins, stormwater inlets, and other stormwater conveyance structures on a regular basis to remove pollutants, reduce high pollutant concentrations during the first flush of storms, prevent clogging of the downstream conveyance system, restore catch basins' sediment trapping capacity, and ensure the system functions properly hydraulically to avoid flooding.

### *Suggested Protocols*

*Catch Basins/Inlet Structures*

- Staff should regularly inspect facilities to ensure compliance with the following:
  - Immediate repair of any deterioration threatening structural integrity.
  - Cleaning before the sump is 40% full. Catch basins should be cleaned as frequently as needed to meet this standard.
  - Stenciling of catch basins and inlets (see SC34 Waste Handling and Disposal).

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- Clean catch basins, storm drain inlets, and other conveyance structures before the wet season to remove sediments and debris accumulated during the summer.
- Conduct inspections more frequently during the wet season for problem areas where sediment or trash accumulates more often. Clean and repair as needed.
- Keep accurate logs of the number of catch basins cleaned.
- Store wastes collected from cleaning activities of the drainage system in appropriate containers or temporary storage sites in a manner that prevents discharge to the storm drain.
- Dewater the wastes if necessary with outflow into the sanitary sewer if permitted. Water should be treated with an appropriate filtering device prior to discharge to the sanitary sewer. If discharge to the sanitary sewer is not allowed, water should be pumped or vacuumed to a tank and properly disposed. Do not dewater near a storm drain or stream.

*Storm Drain Conveyance System*

- Locate reaches of storm drain with deposit problems and develop a flushing schedule that keeps the pipe clear of excessive buildup.
- Collect and pump flushed effluent to the sanitary sewer for treatment whenever possible.

*Pump Stations*

- Clean all storm drain pump stations prior to the wet season to remove silt and trash.
- Do not allow discharge to reach the storm drain system when cleaning a storm drain pump station or other facility.
- Conduct routine maintenance at each pump station.
- Inspect, clean, and repair as necessary all outlet structures prior to the wet season.

*Open Channel*

- Modify storm channel characteristics to improve channel hydraulics, increase pollutant removals, and enhance channel/creek aesthetic and habitat value.
- Conduct channel modification/improvement in accordance with existing laws. Any person, government agency, or public utility proposing an activity that will change the natural (emphasis added) state of any river, stream, or lake in California, must enter into a Steam or Lake Alteration Agreement with the Department of Fish and Game. The developer-applicant should also contact local governments (city, county, special districts), other state agencies (SWRCB, RWQCB, Department of Forestry, Department of Water Resources), and Federal Corps of Engineers and USFWS.

*Illicit Connections and Discharges*

- Look for evidence of illegal discharges or illicit connections during routine maintenance of conveyance system and drainage structures:
  - Is there evidence of spills such as paints, discoloring, etc?

- Are there any odors associated with the drainage system?
- Record locations of apparent illegal discharges/illicit connections?
- Track flows back to potential dischargers and conduct aboveground inspections. This can be done through visual inspection of upgradient manholes or alternate techniques including zinc chloride smoke testing, fluorometric dye testing, physical inspection testing, or television camera inspection.
- Eliminate the discharge once the origin of flow is established.

- Stencil or demarcate storm drains, where applicable, to prevent illegal disposal of pollutants. Storm drain inlets should have messages such as "Dump No Waste Drains to Stream" stenciled next to them to warn against ignorant or intentional dumping of pollutants into the storm drainage system.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

*Illegal Dumping*

- Inspect and clean up hot spots and other storm drainage areas regularly where illegal dumping and disposal occurs.
- Establish a system for tracking incidents. The system should be designed to identify the following:
  - Illegal dumping hot spots
  - Types and quantities (in some cases) of wastes
  - Patterns in time of occurrence (time of day/night, month, or year)
  - Mode of dumping (abandoned containers, "midnight dumping" from moving vehicles, direct dumping of materials, accidents/spills)
  - Responsible parties
- Post "No Dumping" signs in problem areas with a phone number for reporting dumping and disposal. Signs should also indicate fines and penalties for illegal dumping.
- Refer to fact sheet SC-10 Non-Stormwater Discharges.

***Training***

- Train crews in proper maintenance activities, including record keeping and disposal.
- Allow only properly trained individuals to handle hazardous materials/wastes.
- Have staff involved in detection and removal of illicit connections trained in the following:
  - OSHA-required Health and Safety Training (29 CFR 1910.120) plus annual refresher training (as needed).

- OSHA Confined Space Entry training (Cal-OSHA Confined Space, Title 8 and Federal OSHA 29 CFR 1910.146).
- Procedural training (field screening, sampling, smoke/dye testing, TV inspection).

***Spill Response and Prevention***

- Investigate all reports of spills, leaks, and/or illegal dumping promptly.
- Clean up all spills and leaks using "dry" methods (with absorbent materials and/or rags) or dig up, remove, and properly dispose of contaminated soil.
- Refer to fact sheet SC-11 Spill Prevention, Control, and Cleanup.

***Other Considerations (Limitations and Regulations)***

- Clean-up activities may create a slight disturbance for local aquatic species. Access to items and material on private property may be limited. Trade-offs may exist between channel hydraulics and water quality/riparian habitat. If storm channels or basins are recognized as wetlands, many activities, including maintenance, may be subject to regulation and permitting.
- Storm drain flushing is most effective in small diameter pipes (36-inch diameter pipe or less, depending on water supply and sediment collection capacity). Other considerations associated with storm drain flushing may include the availability of a water source, finding a downstream area to collect sediments, liquid/sediment disposal, and prohibition against disposal of flushed effluent to sanitary sewer in some areas.
- Regulations may include adoption of substantial penalties for illegal dumping and disposal.
- Local municipal codes may include sections prohibiting discharge of soil, debris, refuse, hazardous wastes, and other pollutants into the storm drain system.

## Requirements

***Costs***

- An aggressive catch basin cleaning program could require a significant capital and O&M budget.
- The elimination of illegal dumping is dependent on the availability, convenience, and cost of alternative means of disposal. The primary cost is for staff time. Cost depends on how aggressively a program is implemented. Other cost considerations for an illegal dumping program include:
  - Purchase and installation of signs.
  - Rental of vehicle(s) to haul illegally-disposed items and material to landfills.
  - Rental of heavy equipment to remove larger items (e.g., car bodies) from channels.
  - Purchase of landfill space to dispose of illegally-dumped items and material.

- Methods used for illicit connection detection (smoke testing, dye testing, visual inspection, and flow monitoring) can be costly and time-consuming. Site-specific factors, such as the level of impervious area, the density and ages of buildings, and type of land use will determine the level of investigation necessary.

***Maintenance***

- Two-person teams may be required to clean catch basins with vactor trucks.
- Teams of at least two people plus administrative personnel are required to identify illicit discharges, depending on the complexity of the storm sewer system.
- Arrangements must be made for proper disposal of collected wastes.
- Technical staff are required to detect and investigate illegal dumping violations.

## Supplemental Information

***Further Detail of the BMP***

*Storm Drain Flushing*

Flushing is a common maintenance activity used to improve pipe hydraulics and to remove pollutants in storm drainage systems. Flushing may be designed to hydraulically convey accumulated material to strategic locations, such as an open channel, another point where flushing will be initiated, or the sanitary sewer and the treatment facilities, thus preventing resuspension and overflow of a portion of the solids during storm events. Flushing prevents "plug flow" discharges of concentrated pollutant loadings and sediments. Deposits can hinder the designed conveyance capacity of the storm drain system and potentially cause backwater conditions in severe cases of clogging.

Storm drain flushing usually takes place along segments of pipe with grades that are too flat to maintain adequate velocity to keep particles in suspension. An upstream manhole is selected to place an inflatable device that temporarily plugs the pipe. Further upstream, water is pumped into the line to create a flushing wave. When the upstream reach of pipe is sufficiently full to cause a flushing wave, the inflated device is rapidly deflated with the assistance of a vacuum pump, thereby releasing the backed up water and resulting in the cleaning of the storm drain segment.

To further reduce impacts of stormwater pollution, a second inflatable device placed well downstream may be used to recollect the water after the force of the flushing wave has dissipated. A pump may then be used to transfer the water and accumulated material to the sanitary sewer for treatment. In some cases, an interceptor structure may be more practical or required to recollect the flushed waters.

It has been found that cleansing efficiency of periodic flush waves is dependent upon flush volume, flush discharge rate, sewer slope, sewer length, sewer flow rate, sewer diameter, and population density. As a rule of thumb, the length of line to be flushed should not exceed 700 feet. At this maximum recommended length, the percent removal efficiency ranges between 65-75% for organics and 55-65% for dry weather grit/inorganic material. The percent removal efficiency drops rapidly beyond that. Water is commonly supplied by a water truck, but fire hydrants can also supply water. To make the best use of water, it is recommended that reclaimed water be used or that fire hydrant line flushing coincide with storm sewer flushing.

## References and Resources

California's Nonpoint Source Program Plan http://www.swrcb.ca.gov/nps/index.html

Clark County Storm Water Pollution Control Manual
http://www.co.clark.wa.us/pubworks/bmpman.pdf

Ferguson, B.K. 1991. Urban Stream Reclamation, p. 324-322, Journal of Soil and Water Conservation.

King County Storm Water Pollution Control Manual http://dnr.metrokc.gov/wlr/dss/spcm.htm

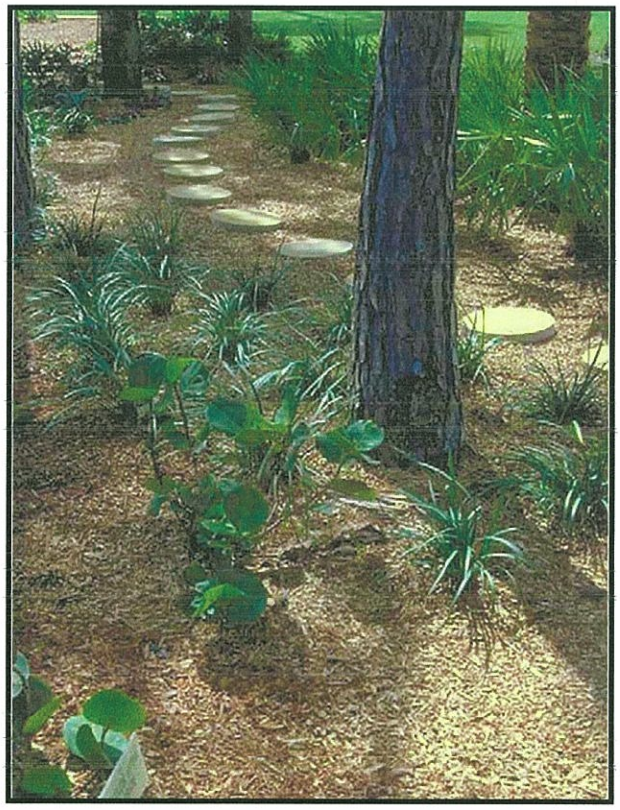
Oregon Association of Clean Water Agencies. Oregon Municipal Stormwater Toolbox for Maintenance Practices. June 1998.

Santa Clara Valley Urban Runoff Pollution Prevention Program http://www.scvurppp.org

The Storm Water Managers Resource Center http://www.stormwatercenter.net

United States Environmental Protection Agency (USEPA). 2002. Pollution Prevention/Good Housekeeping for Municipal Operations Storm Drain System Cleaning. On line:
http://www.epa.gov/npdes/menuofbmps/poll_16.htm

# Site Design & Landscape Planning SD-10



**Design Objectives**

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

## Description

Each project site possesses unique topographic, hydrologic, and vegetative features, some of which are more suitable for development than others. Integrating and incorporating appropriate landscape planning methodologies into the project design is the most effective action that can be done to minimize surface and groundwater contamination from stormwater.

## Approach

Landscape planning should couple consideration of land suitability for urban uses with consideration of community goals and projected growth. Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

## Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

## Design Considerations

Design requirements for site design and landscapes planning should conform to applicable standards and specifications of agencies with jurisdiction and be consistent with applicable General Plan and Local Area Plan policies.

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***Designing New Installations***

Begin the development of a plan for the landscape unit with attention to the following general principles:

- Formulate the plan on the basis of clearly articulated community goals. Carefully identify conflicts and choices between retaining and protecting desired resources and community growth.
- Map and assess land suitability for urban uses. Include the following landscape features in the assessment: wooded land, open unwooded land, steep slopes, erosion-prone soils, foundation suitability, soil suitability for waste disposal, aquifers, aquifer recharge areas, wetlands, floodplains, surface waters, agricultural lands, and various categories of urban land use. When appropriate, the assessment can highlight outstanding local or regional resources that the community determines should be protected (e.g., a scenic area, recreational area, threatened species habitat, farmland, fish run). Mapping and assessment should recognize not only these resources but also additional areas needed for their sustenance.

Project plan designs should conserve natural areas to the extent possible, maximize natural water storage and infiltration opportunities, and protect slopes and channels.

*Conserve Natural Areas during Landscape Planning*

If applicable, the following items are required and must be implemented in the site layout during the subdivision design and approval process, consistent with applicable General Plan and Local Area Plan policies:

- Cluster development on least-sensitive portions of a site while leaving the remaining land in a natural undisturbed condition.
- Limit clearing and grading of native vegetation at a site to the minimum amount needed to build lots, allow access, and provide fire protection.
- Maximize trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native and/or drought tolerant plants.
- Promote natural vegetation by using parking lot islands and other landscaped areas.
- Preserve riparian areas and wetlands.

*Maximize Natural Water Storage and Infiltration Opportunities Within the Landscape Unit*

- Promote the conservation of forest cover. Building on land that is already deforested affects basin hydrology to a lesser extent than converting forested land. Loss of forest cover reduces interception storage, detention in the organic forest floor layer, and water losses by evapotranspiration, resulting in large peak runoff increases and either their negative effects or the expense of countering them with structural solutions.
- Maintain natural storage reservoirs and drainage corridors, including depressions, areas of permeable soils, swales, and intermittent streams. Develop and implement policies and

regulations to discourage the clearing, filling, and channelization of these features. Utilize them in drainage networks in preference to pipes, culverts, and engineered ditches.

- Evaluating infiltration opportunities by referring to the stormwater management manual for the jurisdiction and pay particular attention to the selection criteria for avoiding groundwater contamination, poor soils, and hydrogeological conditions that cause these facilities to fail. If necessary, locate developments with large amounts of impervious surfaces or a potential to produce relatively contaminated runoff away from groundwater recharge areas.

*Protection of Slopes and Channels during Landscape Design*

- Convey runoff safely from the tops of slopes.
- Avoid disturbing steep or unstable slopes.
- Avoid disturbing natural channels.
- Stabilize disturbed slopes as quickly as possible.
- Vegetate slopes with native or drought tolerant vegetation.
- Control and treat flows in landscaping and/or other controls prior to reaching existing natural drainage systems.
- Stabilize temporary and permanent channel crossings as quickly as possible, and ensure that increases in run-off velocity and frequency caused by the project do not erode the channel.
- Install energy dissipaters, such as riprap, at the outlets of new storm drains, culverts, conduits, or channels that enter unlined channels in accordance with applicable specifications to minimize erosion. Energy dissipaters shall be installed in such a way as to minimize impacts to receiving waters.
- Line on-site conveyance channels where appropriate, to reduce erosion caused by increased flow velocity due to increases in tributary impervious area. The first choice for linings should be grass or some other vegetative surface, since these materials not only reduce runoff velocities, but also provide water quality benefits from filtration and infiltration. If velocities in the channel are high enough to erode grass or other vegetative linings, riprap, concrete, soil cement, or geo-grid stabilization are other alternatives.
- Consider other design principles that are comparable and equally effective.

### *Redeveloping Existing Installations*

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

Redevelopment may present significant opportunity to add features which had not previously been implemented. Examples include incorporation of depressions, areas of permeable soils, and swales in newly redeveloped areas. While some site constraints may exist due to the status of already existing infrastructure, opportunities should not be missed to maximize infiltration, slow runoff, reduce impervious areas, disconnect directly connected impervious areas.

### Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Stormwater Management Manual for Western Washington, Washington State Department of Ecology, August 2001.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

# Roof Runoff Controls SD-11

Rain Garden

**Design Objectives**

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

## Description

Various roof runoff controls are available to address stormwater that drains off rooftops. The objective is to reduce the total volume and rate of runoff from individual lots, and retain the pollutants on site that may be picked up from roofing materials and atmospheric deposition. Roof runoff controls consist of directing the roof runoff away from paved areas and mitigating flow to the storm drain system through one of several general approaches: cisterns or rain barrels; dry wells or infiltration trenches; pop-up emitters, and foundation planting. The first three approaches require the roof runoff to be contained in a gutter and downspout system. Foundation planting provides a vegetated strip under the drip line of the roof.

## Approach

Design of individual lots for single-family homes as well as lots for higher density residential and commercial structures should consider site design provisions for containing and infiltrating roof runoff or directing roof runoff to vegetative swales or buffer areas. Retained water can be reused for watering gardens, lawns, and trees. Benefits to the environment include reduced demand for potable water used for irrigation, improved stormwater quality, increased groundwater recharge, decreased runoff volume and peak flows, and decreased flooding potential.

## Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment.

## Design Considerations

### *Designing New Installations*

*Cisterns or Rain Barrels*

One method of addressing roof runoff is to direct roof downspouts to cisterns or rain barrels. A cistern is an above ground storage vessel with either a manually operated valve or a permanently open outlet. Roof runoff is temporarily stored and then released for irrigation or infiltration between storms. The number of rain

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barrels needed is a function of the rooftop area. Some low impact developers recommend that every house have at least 2 rain barrels, with a minimum storage capacity of 1000 liters. Roof barrels serve several purposes including mitigating the first flush from the roof which has a high volume, amount of contaminants, and thermal load. Several types of rain barrels are commercially available. Consideration must be given to selecting rain barrels that are vector proof and childproof. In addition, some barrels are designed with a bypass valve that filters out grit and other contaminants and routes overflow to a soak-away pit or rain garden.

If the cistern has an operable valve, the valve can be closed to store stormwater for irrigation or infiltration between storms. This system requires continual monitoring by the resident or grounds crews, but provides greater flexibility in water storage and metering. If a cistern is provided with an operable valve and water is stored inside for long periods, the cistern must be covered to prevent mosquitoes from breeding.

A cistern system with a permanently open outlet can also provide for metering stormwater runoff. If the cistern outlet is significantly smaller than the size of the downspout inlet (say ¼ to ½ inch diameter), runoff will build up inside the cistern during storms, and will empty out slowly after peak intensities subside. This is a feasible way to mitigate the peak flow increases caused by rooftop impervious land coverage, especially for the frequent, small storms.

*Dry wells and Infiltration Trenches*

Roof downspouts can be directed to dry wells or infiltration trenches. A dry well is constructed by excavating a hole in the ground and filling it with an open graded aggregate, and allowing the water to fill the dry well and infiltrate after the storm event. An underground connection from the downspout conveys water into the dry well, allowing it to be stored in the voids. To minimize sedimentation from lateral soil movement, the sides and top of the stone storage matrix can be wrapped in a permeable filter fabric, though the bottom may remain open. A perforated observation pipe can be inserted vertically into the dry well to allow for inspection and maintenance.

In practice, dry wells receiving runoff from single roof downspouts have been successful over long periods because they contain very little sediment. They must be sized according to the amount of rooftop runoff received, but are typically 4 to 5 feet square, and 2 to 3 feet deep, with a minimum of 1-foot soil cover over the top (maximum depth of 10 feet).

To protect the foundation, dry wells must be set away from the building at least 10 feet. They must be installed in solids that accommodate infiltration. In poorly drained soils, dry wells have very limited feasibility.

Infiltration trenches function in a similar manner and would be particularly effective for larger roof areas. An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. These are described under Treatment Controls.

*Pop-up Drainage Emitter*

Roof downspouts can be directed to an underground pipe that daylights some distance from the building foundation, releasing the roof runoff through a pop-up emitter. Similar to a pop-up irrigation head, the emitter only opens when there is flow from the roof. The emitter remains flush to the ground during dry periods, for ease of lawn or landscape maintenance.

*Foundation Planting*

Landscape planting can be provided around the base to allow increased opportunities for stormwater infiltration and protect the soil from erosion caused by concentrated sheet flow coming off the roof. Foundation plantings can reduce the physical impact of water on the soil and provide a subsurface matrix of roots that encourage infiltration. These plantings must be sturdy enough to tolerate the heavy runoff sheet flows, and periodic soil saturation.

***Redeveloping Existing Installations***

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

## Supplemental Information

***Examples***

- City of Ottawa's Water Links Surface –Water Quality Protection Program
- City of Toronto Downspout Disconnection Program
- City of Boston, MA, Rain Barrel Demonstration Program

## Other Resources

Hager, Marty Catherine, Stormwater, "Low-Impact Development", January/February 2003. www.stormh2o.com

Low Impact Urban Design Tools, Low Impact Development Design Center, Beltsville, MD. www.lid-stormwater.net

Start at the Source, Bay Area Stormwater Management Agencies Association, 1999 Edition

# Efficient Irrigation SD-12

**Design Objectives**

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

## Description

Irrigation water provided to landscaped areas may result in excess irrigation water being conveyed into stormwater drainage systems.

## Approach

Project plan designs for development and redevelopment should include application methods of irrigation water that minimize runoff of excess irrigation water into the stormwater conveyance system.

## Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

## Design Considerations

### *Designing New Installations*

The following methods to reduce excessive irrigation runoff should be considered, and incorporated and implemented where determined applicable and feasible by the Permittee:

- Employ rain-triggered shutoff devices to prevent irrigation after precipitation.
- Design irrigation systems to each landscape area's specific water requirements.
- Include design featuring flow reducers or shutoff valves triggered by a pressure drop to control water loss in the event of broken sprinkler heads or lines.
- Implement landscape plans consistent with County or City water conservation resolutions, which may include provision of water sensors, programmable irrigation times (for short cycles), etc.

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- Design timing and application methods of irrigation water to minimize the runoff of excess irrigation water into the storm water drainage system.
- Group plants with similar water requirements in order to reduce excess irrigation runoff and promote surface filtration. Choose plants with low irrigation requirements (for example, native or drought tolerant species). Consider design features such as:
  - Using mulches (such as wood chips or bar) in planter areas without ground cover to minimize sediment in runoff
  - Installing appropriate plant materials for the location, in accordance with amount of sunlight and climate, and use native plant materials where possible and/or as recommended by the landscape architect
  - Leaving a vegetative barrier along the property boundary and interior watercourses, to act as a pollutant filter, where appropriate and feasible
  - Choosing plants that minimize or eliminate the use of fertilizer or pesticides to sustain growth
- Employ other comparable, equally effective methods to reduce irrigation water runoff.

***Redeveloping Existing Installations***

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

## Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

# Storm Drain Signage SD-13

**Design Objectives**

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- ☑ Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

## Description

Waste materials dumped into storm drain inlets can have severe impacts on receiving and ground waters. Posting notices regarding discharge prohibitions at storm drain inlets can prevent waste dumping. Storm drain signs and stencils are highly visible source controls that are typically placed directly adjacent to storm drain inlets.

## Approach

The stencil or affixed sign contains a brief statement that prohibits dumping of improper materials into the urban runoff conveyance system. Storm drain messages have become a popular method of alerting the public about the effects of and the prohibitions against waste disposal.

## Suitable Applications

Stencils and signs alert the public to the destination of pollutants discharged to the storm drain. Signs are appropriate in residential, commercial, and industrial areas, as well as any other area where contributions or dumping to storm drains is likely.

## Design Considerations

Storm drain message markers or placards are recommended at all storm drain inlets within the boundary of a development project. The marker should be placed in clear sight facing toward anyone approaching the inlet from either side. All storm drain inlet locations should be identified on the development site map.

### *Designing New Installations*

The following methods should be considered for inclusion in the project design and show on project plans:

- Provide stenciling or labeling of all storm drain inlets and catch basins, constructed or modified, within the project area with prohibitive language. Examples include "NO DUMPING

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– DRAINS TO OCEAN" and/or other graphical icons to discourage illegal dumping.

- Post signs with prohibitive language and/or graphical icons, which prohibit illegal dumping at public access points along channels and creeks within the project area.

Note - Some local agencies have approved specific signage and/or storm drain message placards for use. Consult local agency stormwater staff to determine specific requirements for placard types and methods of application.

***Redeveloping Existing Installations***

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. If the project meets the definition of "redevelopment", then the requirements stated under " designing new installations" above should be included in all project design plans.

## Additional Information

***Maintenance Considerations***

- Legibility of markers and signs should be maintained. If required by the agency with jurisdiction over the project, the owner/operator or homeowner's association should enter into a maintenance agreement with the agency or record a deed restriction upon the property title to maintain the legibility of placards or signs.

***Placement***

- Signage on top of curbs tends to weather and fade.
- Signage on face of curbs tends to be worn by contact with vehicle tires and sweeper brooms.

## Supplemental Information

***Examples***

- Most MS4 programs have storm drain signage programs. Some MS4 programs will provide stencils, or arrange for volunteers to stencil storm drains as part of their outreach program.

## Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

# Pervious Pavements SD-20

**Design Objectives**

- ☑ Maximize Infiltration
- ☑ Provide Retention
- ☑ Slow Runoff
- ☑ Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- Contain Pollutants
- Collect and Convey

## Description

Pervious paving is used for light vehicle loading in parking areas. The term describes a system comprising a load-bearing, durable surface together with an underlying layered structure that temporarily stores water prior to infiltration or drainage to a controlled outlet. The surface can itself be porous such that water infiltrates across the entire surface of the material (e.g., grass and gravel surfaces, porous concrete and porous asphalt), or can be built up of impermeable blocks separated by spaces and joints, through which the water can drain. This latter system is termed 'permeable' paving. Advantages of pervious pavements is that they reduce runoff volume while providing treatment, and are unobtrusive resulting in a high level of acceptability.

## Approach

Attenuation of flow is provided by the storage within the underlying structure or sub base, together with appropriate flow controls. An underlying geotextile may permit groundwater recharge, thus contributing to the restoration of the natural water cycle. Alternatively, where infiltration is inappropriate (e.g., if the groundwater vulnerability is high, or the soil type is unsuitable), the surface can be constructed above an impermeable membrane. The system offers a valuable solution for drainage of spatially constrained urban areas.

Significant attenuation and improvement in water quality can be achieved by permeable pavements, whichever method is used. The surface and subsurface infrastructure can remove both the soluble and fine particulate pollutants that occur within urban runoff. Roof water can be piped into the storage area directly, adding areas from which the flow can be attenuated. Also, within lined systems, there is the opportunity for stored runoff to be piped out for reuse.

## Suitable Applications

Residential, commercial and industrial applications are possible. The use of permeable pavement may be restricted in cold regions, arid regions or regions with high wind erosion. There are some specific disadvantages associated with permeable pavement, which are as follows:

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- Permeable pavement can become clogged if improperly installed or maintained. However, this is countered by the ease with which small areas of paving can be cleaned or replaced when blocked or damaged.
- Their application should be limited to highways with low traffic volumes, axle loads and speeds (less than 30 mph limit), car parking areas and other lightly trafficked or non-trafficked areas. Permeable surfaces are currently not considered suitable for adoptable roads due to the risks associated with failure on high speed roads, the safety implications of ponding, and disruption arising from reconstruction.
- When using un-lined, infiltration systems, there is some risk of contaminating groundwater, depending on soil conditions and aquifer susceptibility. However, this risk is likely to be small because the areas drained tend to have inherently low pollutant loadings.
- The use of permeable pavement is restricted to gentle slopes.
- Porous block paving has a higher risk of abrasion and damage than solid blocks.

## Design Considerations

### *Designing New Installations*

If the grades, subsoils, drainage characteristics, and groundwater conditions are suitable, permeable paving may be substituted for conventional pavement on parking areas, cul de sacs and other areas with light traffic. Slopes should be flat or very gentle. Scottish experience has shown that permeable paving systems can be installed in a wide range of ground conditions, and the flow attenuation performance is excellent even when the systems are lined.

The suitability of a pervious system at a particular pavement site will, however, depend on the loading criteria required of the pavement.

Where the system is to be used for infiltrating drainage waters into the ground, the vulnerability of local groundwater sources to pollution from the site should be low, and the seasonal high water table should be at least 4 feet below the surface.

Ideally, the pervious surface should be horizontal in order to intercept local rainfall at source. On sloping sites, pervious surfaces may be terraced to accommodate differences in levels.

*Design Guidelines*

The design of each layer of the pavement must be determined by the likely traffic loadings and their required operational life. To provide satisfactory performance, the following criteria should be considered:

- The subgrade should be able to sustain traffic loading without excessive deformation.
- The granular capping and sub-base layers should give sufficient load-bearing to provide an adequate construction platform and base for the overlying pavement layers.
- The pavement materials should not crack of suffer excessive rutting under the influence of traffic. This is controlled by the horizontal tensile stress at the base of these layers.

There is no current structural design method specifically for pervious pavements. Allowances should be considered the following factors in the design and specification of materials:

- Pervious pavements use materials with high permeability and void space. All the current UK pavement design methods are based on the use of conventional materials that are dense and relatively impermeable. The stiffness of the materials must therefore be assessed.
- Water is present within the construction and can soften and weaken materials, and this must be allowed for.
- Existing design methods assume full friction between layers. Any geotextiles or geomembranes must be carefully specified to minimize loss of friction between layers.
- Porous asphalt loses adhesion and becomes brittle as air passes through the voids. Its durability is therefore lower than conventional materials.

The single sized grading of materials used means that care should be taken to ensure that loss of finer particles between unbound layers does not occur.

Positioning a geotextile near the surface of the pervious construction should enable pollutants to be trapped and retained close to the surface of the construction. This has both advantages and disadvantages. The main disadvantage is that the filtering of sediments and their associated pollutants at this level may hamper percolation of waters and can eventually lead to surface ponding. One advantage is that even if eventual maintenance is required to reinstate infiltration, only a limited amount of the construction needs to be disturbed, since the sub-base below the geotextile is protected. In addition, the pollutant concentration at a high level in the structure allows for its release over time. It is slowly transported in the stormwater to lower levels where chemical and biological processes may be operating to retain or degrade pollutants.

The design should ensure that sufficient void space exists for the storage of sediments to limit the period between remedial works.

- Pervious pavements require a single size grading to give open voids. The choice of materials is therefore a compromise between stiffness, permeability and storage capacity.
- Because the sub-base and capping will be in contact with water for a large part of the time, the strength and durability of the aggregate particles when saturated and subjected to wetting and drying should be assessed.
- A uniformly graded single size material cannot be compacted and is liable to move when construction traffic passes over it. This effect can be reduced by the use of angular crushed rock material with a high surface friction.

In pollution control terms, these layers represent the site of long term chemical and biological pollutant retention and degradation processes. The construction materials should be selected, in addition to their structural strength properties, for their ability to sustain such processes. In general, this means that materials should create neutral or slightly alkaline conditions and they should provide favorable sites for colonization by microbial populations.

*Construction/Inspection Considerations*

- Permeable surfaces can be laid without cross-falls or longitudinal gradients.
- The blocks should be lain level
- They should not be used for storage of site materials, unless the surface is well protected from deposition of silt and other spillages.
- The pavement should be constructed in a single operation, as one of the last items to be built, on a development site. Landscape development should be completed before pavement construction to avoid contamination by silt or soil from this source.
- Surfaces draining to the pavement should be stabilized before construction of the pavement.
- Inappropriate construction equipment should be kept away from the pavement to prevent damage to the surface, sub-base or sub-grade.

*Maintenance Requirements*

The maintenance requirements of a pervious surface should be reviewed at the time of design and should be clearly specified. Maintenance is required to prevent clogging of the pervious surface. The factors to be considered when defining maintenance requirements must include:

- Type of use
- Ownership
- Level of trafficking
- The local environment and any contributing catchments

Studies in the UK have shown satisfactory operation of porous pavement systems without maintenance for over 10 years and recent work by Imbe et al. at 9th ICUD, Portland, 2002 describes systems operating for over 20 years without maintenance. However, performance under such regimes could not be guaranteed, Table 1 shows typical recommended maintenance regimes:

| Table 1 Typical Recommended Maintenance Regimes | |
|---|---|
| **Activity** | **Schedule** |
| ■ Minimize use of salt or grit for de-icing<br>■ Keep landscaped areas well maintained<br>■ Prevent soil being washed onto pavement | Ongoing |
| ■ Vacuum clean surface using commercially available sweeping machines at the following times:<br>- End of winter (April)<br>- Mid-summer (July / August)<br>- After Autumn leaf-fall (November) | 2/3 x per year |
| ■ Inspect outlets | Annual |
| ■ If routine cleaning does not restore infiltration rates, then reconstruction of part of the whole of a pervious surface may be required.<br>■ The surface area affected by hydraulic failure should be lifted for inspection of the internal materials to identify the location and extent of the blockage.<br>■ Surface materials should be lifted and replaced after brush cleaning. Geotextiles may need complete replacement.<br>■ Sub-surface layers may need cleaning and replacing.<br>■ Removed silts may need to be disposed of as controlled waste. | As needed (infrequent)<br>Maximum 15-20 years |

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 1 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

### *Redeveloping Existing Installations*

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

## Additional Information

*Cost Considerations*

Permeable pavements are up to 25 % cheaper (or at least no more expensive than the traditional forms of pavement construction), when all construction and drainage costs are taken into account. (Accepting that the porous asphalt itself is a more expensive surfacing, the extra cost of which is offset by the savings in underground pipework etc.) (Niemczynowicz, et al., 1987)

Table 2 gives US cost estimates for capital and maintenance costs of porous pavements (Landphair et al., 2000)

**Table 2 Engineer's Estimate for Porous Pavement**

| Porous Pavement | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Item | Units | Price | Cycles/ Year | Quant. 1 Acre WS | Total | Quant. 2 Acre WS | Total | Quant. 3 Acre WS | Total | Quant. 4 Acre WS | Total | Quant. 5 Acre WS | Total |
| Grading | SY | $2.00 | | 604 | $1,208 | 1209 | $2,418 | 1812 | $3,624 | 2419 | $4,838 | 3020 | $6,040 |
| Paving | SY | $19.00 | | 212 | $4,028 | 424 | $8,056 | 636 | $12,084 | 848 | $16,112 | 1060 | $20,140 |
| Excavation | CY | $3.60 | | 201 | $724 | 403 | $1,451 | 604 | $2,174 | 806 | $2,902 | 1008 | $3,629 |
| Filter Fabric | SY | $1.15 | | 700 | $805 | 1400 | $1,610 | 2000 | $2,300 | 2800 | $3,220 | 3600 | $4,140 |
| Stone Fill | CY | $16.00 | | 201 | $3,216 | 403 | $6,448 | 604 | $9,664 | 806 | $12,896 | 1008 | $16,128 |
| Sand | CY | $7.00 | | 100 | $700 | 200 | $1,400 | 300 | $2,100 | 400 | $2,800 | 500 | $3,500 |
| Sight Well | EA | $300.00 | | 2 | $600 | 3 | $900 | 4 | $1,200 | 7 | $2,100 | 7 | $2,100 |
| Seeding | LF | $0.05 | | 644 | $32 | 1288 | $64 | 1932 | $97 | 2576 | $129 | 3220 | $161 |
| Check Dam | CY | $35.00 | | 0 | $0 | 0 | $0 | 0 | $0 | 0 | $0 | 0 | $0 |
| **Total Construction Costs** | | | | | **$10,105** | | **$19,929** | | **$28,619** | | **$40,158** | | **$49,798** |
| **Construction Costs Amortized for 20 Years** | | | | | **$505** | | **$996** | | **$1,431** | | **$2,008** | | **$2,490** |
| **Annual Maintenance Expense** | | | | | | | | | | | | | |
| Item | Units | Price | Cycles/ Year | Quant. 1 Acre WS | Total | Quant. 2 Acre WS | Total | Quant. 3 Acre WS | Total | Quant. 4 Acre WS | Total | Quant. 5 Acre WS | Total |
| Sweeping | AC | $250.00 | 6 | 1 | $1,500 | 2 | $3,000 | 3 | $4,500 | 4 | $6,000 | 5 | $7,500 |
| Washing | AC | $250.00 | 6 | 1 | $1,500 | 2 | $3,000 | 3 | $4,500 | 4 | $6,000 | 5 | $7,500 |
| Inspection | MH | $20.00 | 5 | 5 | $100 | 5 | $100 | 5 | $100 | 5 | $100 | 5 | $100 |
| Deep Clean | AC | $450.00 | 0.5 | 1 | $225 | 2 | $450 | 3 | $675 | 3.9 | $878 | 5 | $1,125 |
| **Total Annual Maintenance Expense** | | | | | **$3,950** | | **$7,792** | | **$11,651** | | **$15,483** | | **$19,370** |

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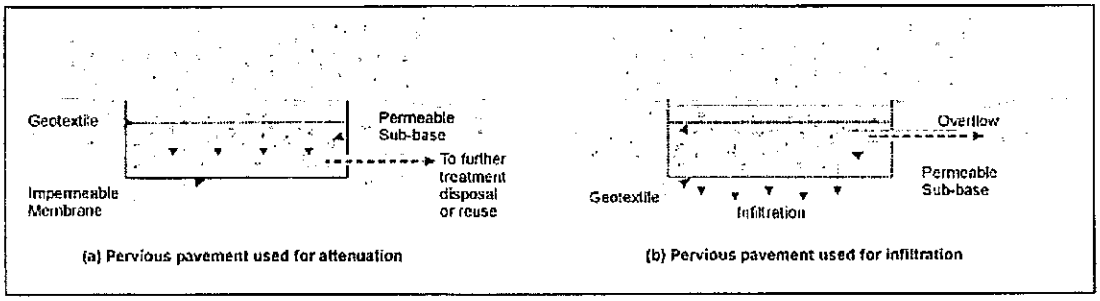


**Schematics of a Pervious Pavement System**

# Trash Storage Areas SD-32

**Design Objectives**

- Maximize Infiltration
- Provide Retention
- Slow Runoff
- Minimize Impervious Land Coverage
- Prohibit Dumping of Improper Materials
- ☑ Contain Pollutants
- Collect and Convey

## Description

Trash storage areas are areas where a trash receptacle (s) are located for use as a repository for solid wastes. Stormwater runoff from areas where trash is stored or disposed of can be polluted. In addition, loose trash and debris can be easily transported by water or wind into nearby storm drain inlets, channels, and/or creeks. Waste handling operations that may be sources of stormwater pollution include dumpsters, litter control, and waste piles.

## Approach

This fact sheet contains details on the specific measures required to prevent or reduce pollutants in stormwater runoff associated with trash storage and handling. Preventative measures including enclosures, containment structures, and impervious pavements to mitigate spills, should be used to reduce the likelihood of contamination.

## Suitable Applications

Appropriate applications include residential, commercial and industrial areas planned for development or redevelopment. (Detached residential single-family homes are typically excluded from this requirement.)

## Design Considerations

Design requirements for waste handling areas are governed by Building and Fire Codes, and by current local agency ordinances and zoning requirements. The design criteria described in this fact sheet are meant to enhance and be consistent with these code and ordinance requirements. Hazardous waste should be handled in accordance with legal requirements established in Title 22, California Code of Regulation.

Wastes from commercial and industrial sites are typically hauled by either public or commercial carriers that may have design or access requirements for waste storage areas. The design criteria in this fact sheet are recommendations and are not intended to be in conflict with requirements established by the waste hauler. The waste hauler should be contacted prior to the design of your site trash collection areas. Conflicts or issues should be discussed with the local agency.

### *Designing New Installations*

Trash storage areas should be designed to consider the following structural or treatment control BMPs:

- Design trash container areas so that drainage from adjoining roofs and pavement is diverted around the area(s) to avoid run-on. This might include berming or grading the waste handling area to prevent run-on of stormwater.
- Make sure trash container areas are screened or walled to prevent off-site transport of trash.

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- Use lined bins or dumpsters to reduce leaking of liquid waste.
- Provide roofs, awnings, or attached lids on all trash containers to minimize direct precipitation and prevent rainfall from entering containers.
- Pave trash storage areas with an impervious surface to mitigate spills.
- Do not locate storm drains in immediate vicinity of the trash storage area.
- Post signs on all dumpsters informing users that hazardous materials are not to be disposed of therein.

### *Redeveloping Existing Installations*

Various jurisdictional stormwater management and mitigation plans (SUSMP, WQMP, etc.) define "redevelopment" in terms of amounts of additional impervious area, increases in gross floor area and/or exterior construction, and land disturbing activities with structural or impervious surfaces. The definition of " redevelopment" must be consulted to determine whether or not the requirements for new development apply to areas intended for redevelopment. If the definition applies, the steps outlined under "designing new installations" above should be followed.

## Additional Information

### *Maintenance Considerations*

The integrity of structural elements that are subject to damage (i.e., screens, covers, and signs) must be maintained by the owner/operator. Maintenance agreements between the local agency and the owner/operator may be required. Some agencies will require maintenance deed restrictions to be recorded of the property title. If required by the local agency, maintenance agreements or deed restrictions must be executed by the owner/operator before improvement plans are approved.

## Other Resources

A Manual for the Standard Urban Stormwater Mitigation Plan (SUSMP), Los Angeles County Department of Public Works, May 2002.

Model Standard Urban Storm Water Mitigation Plan (SUSMP) for San Diego County, Port of San Diego, and Cities in San Diego County, February 14, 2002.

Model Water Quality Management Plan (WQMP) for County of Orange, Orange County Flood Control District, and the Incorporated Cities of Orange County, Draft February 2003.

Ventura Countywide Technical Guidance Manual for Stormwater Quality Control Measures, July 2002.

# Infiltration Trench TC-10

### Design Considerations

- Accumulation of Metals
- Clogged Soil Outlet Structures
- Vegetation/Landscape Maintenance

### Description

An infiltration trench is a long, narrow, rock-filled trench with no outlet that receives stormwater runoff. Runoff is stored in the void space between the stones and infiltrates through the bottom and into the soil matrix. Infiltration trenches perform well for removal of fine sediment and associated pollutants. Pretreatment using buffer strips, swales, or detention basins is important for limiting amounts of coarse sediment entering the trench which can clog and render the trench ineffective.

### California Experience

Caltrans constructed two infiltration trenches at highway maintenance stations in Southern California. Of these, one failed to operate to the design standard because of average soil infiltration rates lower than that measured in the single infiltration test. This highlights the critical need for appropriate evaluation of the site. Once in operation, little maintenance was required at either site.

### Advantages

- Provides 100% reduction in the load discharged to surface waters.
- An important benefit of infiltration trenches is the approximation of pre-development hydrology during which a significant portion of the average annual rainfall runoff is infiltrated rather than flushed directly to creeks.
- If the water quality volume is adequately sized, infiltration trenches can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

### Targeted Constituents

| | | |
|---|---|---|
| ☑ | Sediment | ■ |
| ☑ | Nutrients | ■ |
| ☑ | Trash | ■ |
| ☑ | Metals | ■ |
| ☑ | Bacteria | ■ |
| ☑ | Oil and Grease | ■ |
| ☑ | Organics | ■ |

**Legend** ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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- As an underground BMP, trenches are unobtrusive and have little impact of site aesthetics.

### Limitations

- Have a high failure rate if soil and subsurface conditions are not suitable.
- May not be appropriate for industrial sites or locations where spills may occur.
- The maximum contributing area to an individual infiltration practice should generally be less than 5 acres.
- Infiltration basins require a minimum soil infiltration rate of 0.5 inches/hour, not appropriate at sites with Hydrologic Soil Types C and D.
- If infiltration rates exceed 2.4 inches/hour, then the runoff should be fully treated prior to infiltration to protect groundwater quality.
- Not suitable on fill sites or steep slopes.
- Risk of groundwater contamination in very coarse soils.
- Upstream drainage area must be completely stabilized before construction.
- Difficult to restore functioning of infiltration trenches once clogged.

### Design and Sizing Guidelines

- Provide pretreatment for infiltration trenches in order to reduce the sediment load. Pretreatment refers to design features that provide settling of large particles before runoff reaches a management practice, easing the long-term maintenance burden. Pretreatment is important for all structural stormwater management practices, but it is particularly important for infiltration practices. To ensure that pretreatment mechanisms are effective, designers should incorporate practices such as grassed swales, vegetated filter strips, detention, or a plunge pool in series.
- Specify locally available trench rock that is 1.5 to 2.5 inches in diameter.
- Determine the trench volume by assuming the WQV will fill the void space based on the computed porosity of the rock matrix (normally about 35%).
- Determine the bottom surface area needed to drain the trench within 72 hr by dividing the WQV by the infiltration rate.

$$d = \frac{WQV + RFV}{SA}$$

- Calculate trench depth using the following equation:

where:

D = Trench depth

| | | |
|---|---|---|
| WQV | = | Water quality volume |
| RFV | = | Rock fill volume |
| SA | = | Surface area of the trench bottom |

- The use of vertical piping, either for distribution or infiltration enhancement shall not be allowed to avoid device classification as a Class V injection well per 40 CFR146.5(e)(4).
- Provide observation well to allow observation of drain time.
- May include a horizontal layer of filter fabric just below the surface of the trench to retain sediment and reduce the potential for clogging.

***Construction/Inspection Considerations***

Stabilize the entire area draining to the facility before construction begins. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction. Stabilize the entire contributing drainage area before allowing any runoff to enter once construction is complete.

## Performance

Infiltration trenches eliminate the discharge of the water quality volume to surface receiving waters and consequently can be considered to have 100% removal of all pollutants within this volume. Transport of some of these constituents to groundwater is likely, although the attenuation in the soil and subsurface layers will be substantial for many constituents.

Infiltration trenches can be expected to remove up to 90 percent of sediments, metals, coliform bacteria and organic matter, and up to 60 percent of phosphorus and nitrogen in the infiltrated runoff (Schueler, 1992). Biochemical oxygen demand (BOD) removal is estimated to be between 70 to 80 percent. Lower removal rates for nitrate, chlorides and soluble metals should be expected, especially in sandy soils (Schueler, 1992). Pollutant removal efficiencies may be improved by using washed aggregate and adding organic matter and loam to the subsoil. The stone aggregate should be washed to remove dirt and fines before placement in the trench. The addition of organic material and loam to the trench subsoil may enhance metals removal through adsorption.

## Siting Criteria

The use of infiltration trenches may be limited by a number of factors, including type of native soils, climate, and location of groundwater table. Site characteristics, such as excessive slope of the drainage area, fine-grained soil types, and proximate location of the water table and bedrock, may preclude the use of infiltration trenches. Generally, infiltration trenches are not suitable for areas with relatively impermeable soils containing clay and silt or in areas with fill.

As with any infiltration BMP, the potential for groundwater contamination must be carefully considered, especially if the groundwater is used for human consumption or agricultural purposes. The infiltration trench is not suitable for sites that use or store chemicals or hazardous materials unless hazardous and toxic materials are prevented from entering the trench. In these areas, other BMPs that do not allow interaction with the groundwater should be considered.

The potential for spills can be minimized by aggressive pollution prevention measures. Many municipalities and industries have developed comprehensive spill prevention control and countermeasure (SPCC) plans. These plans should be modified to include the infiltration trench and the contributing drainage area. For example, diversion structures can be used to prevent spills from entering the infiltration trench. Because of the potential to contaminate groundwater, extensive site investigation must be undertaken early in the site planning process to establish site suitability for the installation of an infiltration trench.

Longevity can be increased by careful geotechnical evaluation prior to construction and by designing and implementing an inspection and maintenance plan. Soil infiltration rates and the water table depth should be evaluated to ensure that conditions are satisfactory for proper operation of an infiltration trench. Pretreatment structures, such as a vegetated buffer strip or water quality inlet, can increase longevity by removing sediments, hydrocarbons, and other materials that may clog the trench. Regular maintenance, including the replacement of clogged aggregate, will also increase the effectiveness and life of the trench.

Evaluation of the viability of a particular site is the same as for infiltration basins and includes:

- Determine soil type (consider RCS soil type 'A, B or C' only) from mapping and consult USDA soil survey tables to review other parameters such as the amount of silt and clay, presence of a restrictive layer or seasonal high water table, and estimated permeability. The soil should not have more than 30 percent clay or more than 40 percent of clay and silt combined. Eliminate sites that are clearly unsuitable for infiltration.

- Groundwater separation should be at least 3 m from the basin invert to the measured ground water elevation. There is concern at the state and regional levels of the impact on groundwater quality from infiltrated runoff, especially when the separation between groundwater and the surface is small.

- Location away from buildings, slopes and highway pavement (greater than 6 m) and wells and bridge structures (greater than 30 m). Sites constructed of fill, having a base flow or with a slope greater than 15 percent should not be considered.

- Ensure that adequate head is available to operate flow splitter structures (to allow the basin to be offline) without ponding in the splitter structure or creating backwater upstream of the splitter.

- Base flow should not be present in the tributary watershed.

***Secondary Screening Based on Site Geotechnical Investigation***

- At least three in-hole conductivity tests shall be performed using USBR 7300-89 or Bouwer-Rice procedures (the latter if groundwater is encountered within the boring), two tests at different locations within the proposed basin and the third down gradient by no more than approximately 10 m. The tests shall measure permeability in the side slopes and the bed within a depth of 3 m of the invert.

- The minimum acceptable hydraulic conductivity as measured in any of the three required test holes is 13 mm/hr. If any test hole shows less than the minimum value, the site should be disqualified from further consideration.

- Exclude from consideration sites constructed in fill or partially in fill unless no silts or clays are present in the soil boring. Fill tends to be compacted, with clays in a dispersed rather than flocculated state, greatly reducing permeability.
- The geotechnical investigation should be such that a good understanding is gained as to how the stormwater runoff will move in the soil (horizontally or vertically) and if there are any geological conditions that could inhibit the movement of water.

## Maintenance

Infiltration trenches required the least maintenance of any of the BMPs evaluated in the Caltrans study, with approximately 17 field hours spent on the operation and maintenance of each site. Inspection of the infiltration trench was the largest field activity, requiring approximately 8 hr/yr.

In addition to reduced water quality performance, clogged infiltration trenches with surface standing water can become a nuisance due to mosquito breeding. If the trench takes more than 72 hours to drain, then the rock fill should be removed and all dimensions of the trench should be increased by 2 inches to provide a fresh surface for infiltration.

## Cost

### *Construction Cost*

Infiltration trenches are somewhat expensive, when compared to other stormwater practices, in terms of cost per area treated. Typical construction costs, including contingency and design costs, are about $5 per $ft^3$ of stormwater treated (SWRPC, 1991; Brown and Schueler, 1997). Actual construction costs may be much higher. The average construction cost of two infiltration trenches installed by Caltrans in southern California was about $50/$ft^3$; however, these were constructed as retrofit installations.

Infiltration trenches typically consume about 2 to 3 percent of the site draining to them, which is relatively small. In addition, infiltration trenches can fit into thin, linear areas. Thus, they can generally fit into relatively unusable portions of a site.

### *Maintenance Cost*

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly sited or maintained, infiltration trenches have a high failure rate. In general, maintenance costs for infiltration trenches are estimated at between 5 percent and 20 percent of the construction cost. More realistic values are probably closer to the 20-percent range, to ensure long-term functionality of the practice.

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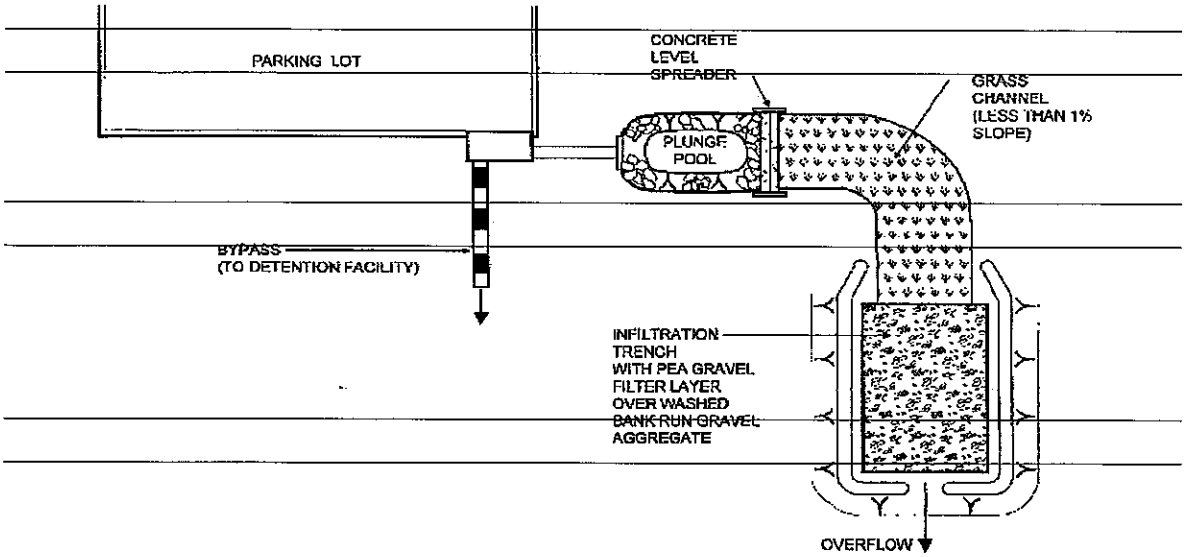
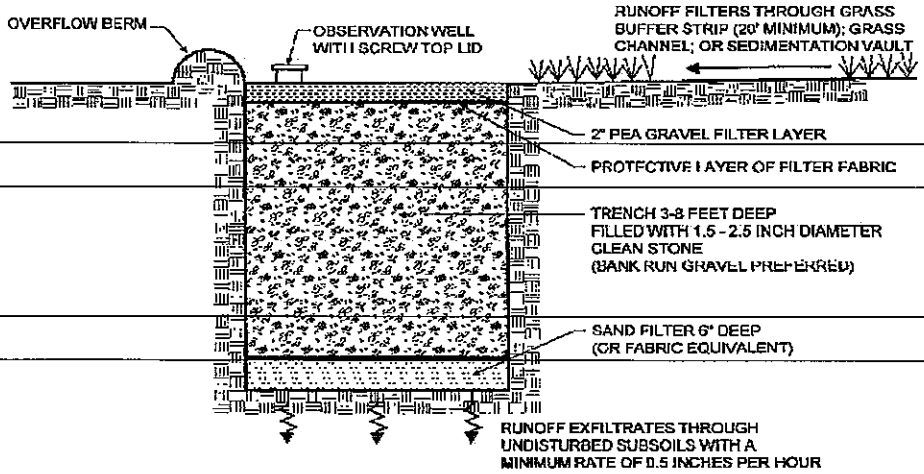
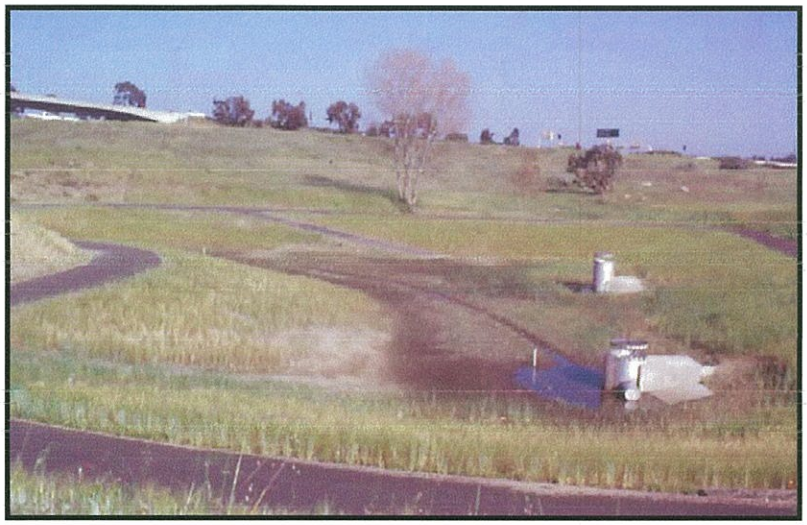



PLAN VIEW




SECTION

# Extended Detention Basin TC-22



## Design Considerations

- Tributary Area
- Area Required
- Hydraulic Head

## Description

Dry extended detention ponds (a.k.a. dry ponds, extended detention basins, detention ponds, extended detention ponds) are basins whose outlets have been designed to detain the stormwater runoff from a water quality design storm for some minimum time (e.g., 48 hours) to allow particles and associated pollutants to settle. Unlike wet ponds, these facilities do not have a large permanent pool. They can also be used to provide flood control by including additional flood detention storage.

## California Experience

Caltrans constructed and monitored 5 extended detention basins in southern California with design drain times of 72 hours. Four of the basins were earthen, less costly and had substantially better load reduction because of infiltration that occurred, than the concrete basin. The Caltrans study reaffirmed the flexibility and performance of this conventional technology. The small headloss and few siting constraints suggest that these devices are one of the most applicable technologies for stormwater treatment.

## Advantages

- Due to the simplicity of design, extended detention basins are relatively easy and inexpensive to construct and operate.
- Extended detention basins can provide substantial capture of sediment and the toxics fraction associated with particulates.
- Widespread application with sufficient capture volume can provide significant control of channel erosion and enlargement caused by changes to flow frequency

## Targeted Constituents

| | | |
|---|---|---|
| ☑ | Sediment | ▲ |
| ☑ | Nutrients | ● |
| ☑ | Trash | ■ |
| ☑ | Metals | ▲ |
| ☑ | Bacteria | ▲ |
| ☑ | Oil and Grease | ▲ |
| ☑ | Organics | ▲ |

**Legend** ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

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relationships resulting from the increase of impervious cover in a watershed.

### Limitations

- Limitation of the diameter of the orifice may not allow use of extended detention in watersheds of less than 5 acres (would require an orifice with a diameter of less than 0.5 inches that would be prone to clogging).
- Dry extended detention ponds have only moderate pollutant removal when compared to some other structural stormwater practices, and they are relatively ineffective at removing soluble pollutants.
- Although wet ponds can increase property values, dry ponds can actually detract from the value of a home due to the adverse aesthetics of dry, bare areas and inlet and outlet structures.

### Design and Sizing Guidelines

- Capture volume determined by local requirements or sized to treat 85% of the annual runoff volume.
- Outlet designed to discharge the capture volume over a period of hours.
- Length to width ratio of at least 1.5:1 where feasible.
- Basin depths optimally range from 2 to 5 feet.
- Include energy dissipation in the inlet design to reduce resuspension of accumulated sediment.
- A maintenance ramp and perimeter access should be included in the design to facilitate access to the basin for maintenance activities and for vector surveillance and control.
- Use a draw down time of 48 hours in most areas of California. Draw down times in excess of 48 hours may result in vector breeding, and should be used only after coordination with local vector control authorities. Draw down times of less than 48 hours should be limited to BMP drainage areas with coarse soils that readily settle and to watersheds where warming may be determined to downstream fisheries.

### Construction/Inspection Considerations

- Inspect facility after first large to storm to determine whether the desired residence time has been achieved.
- When constructed with small tributary area, orifice sizing is critical and inspection should verify that flow through additional openings such as bolt holes does not occur.

### Performance

One objective of stormwater management practices can be to reduce the flood hazard associated with large storm events by reducing the peak flow associated with these storms. Dry extended detention basins can easily be designed for flood control, and this is actually the primary purpose of most detention ponds.

Dry extended detention basins provide moderate pollutant removal, provided that the recommended design features are incorporated. Although they can be effective at removing some pollutants through settling, they are less effective at removing soluble pollutants because of the absence of a permanent pool. Several studies are available on the effectiveness of dry extended detention ponds including one recently concluded by Caltrans (2002).

The load reduction is greater than the concentration reduction because of the substantial infiltration that occurs. Although the infiltration of stormwater is clearly beneficial to surface receiving waters, there is the potential for groundwater contamination. Previous research on the effects of incidental infiltration on groundwater quality indicated that the risk of contamination is minimal.

There were substantial differences in the amount of infiltration that were observed in the earthen basins during the Caltrans study. On average, approximately 40 percent of the runoff entering the unlined basins infiltrated and was not discharged. The percentage ranged from a high of about 60 percent to a low of only about 8 percent for the different facilities. Climatic conditions and local water table elevation are likely the principal causes of this difference. The least infiltration occurred at a site located on the coast where humidity is higher and the basin invert is within a few meters of sea level. Conversely, the most infiltration occurred at a facility located well inland in Los Angeles County where the climate is much warmer and the humidity is less, resulting in lower soil moisture content in the basin floor at the beginning of storms.

Vegetated detention basins appear to have greater pollutant removal than concrete basins. In the Caltrans study, the concrete basin exported sediment and associated pollutants during a number of storms. Export was not as common in the earthen basins, where the vegetation appeared to help stabilize the retained sediment.

### Siting Criteria

Dry extended detention ponds are among the most widely applicable stormwater management practices and are especially useful in retrofit situations where their low hydraulic head requirements allow them to be sited within the constraints of the existing storm drain system. In addition, many communities have detention basins designed for flood control. It is possible to modify these facilities to incorporate features that provide water quality treatment and/or channel protection. Although dry extended detention ponds can be applied rather broadly, designers need to ensure that they are feasible at the site in question. This section provides basic guidelines for siting dry extended detention ponds.

In general, dry extended detention ponds should be used on sites with a minimum area of 5 acres. With this size catchment area, the orifice size can be on the order of 0.5 inches. On smaller sites, it can be challenging to provide channel or water quality control because the orifice diameter at the outlet needed to control relatively small storms becomes very small and thus prone to clogging. In addition, it is generally more cost-effective to control larger drainage areas due to the economies of scale.

Extended detention basins can be used with almost all soils and geology, with minor design adjustments for regions of rapidly percolating soils such as sand. In these areas, extended detention ponds may need an impermeable liner to prevent ground water contamination.

The base of the extended detention facility should not intersect the water table. A permanently wet bottom may become a mosquito breeding ground. Research in Southwest Florida (Santana et al., 1994) demonstrated that intermittently flooded systems, such as dry extended detention ponds, produce more mosquitoes than other pond systems, particularly when the facilities remained wet for more than 3 days following heavy rainfall.

A study in Prince George's County, Maryland, found that stormwater management practices can increase stream temperatures (Galli, 1990). Overall, dry extended detention ponds increased temperature by about 5°F. In cold water streams, dry ponds should be designed to detain stormwater for a relatively short time (i.e., 24 hours) to minimize the amount of warming that occurs in the basin.

### Additional Design Guidelines

In order to enhance the effectiveness of extended detention basins, the dimensions of the basin must be sized appropriately. Merely providing the required storage volume will not ensure maximum constituent removal. By effectively configuring the basin, the designer will create a long flow path, promote the establishment of low velocities, and avoid having stagnant areas of the basin. To promote settling and to attain an appealing environment, the design of the basin should consider the length to width ratio, cross-sectional areas, basin slopes and pond configuration, and aesthetics (Young et al., 1996).

Energy dissipation structures should be included for the basin inlet to prevent resuspension of accumulated sediment. The use of stilling basins for this purpose should be avoided because the standing water provides a breeding area for mosquitoes.

Extended detention facilities should be sized to completely capture the water quality volume. A micropool is often recommended for inclusion in the design and one is shown in the schematic diagram. These small permanent pools greatly increase the potential for mosquito breeding and complicate maintenance activities; consequently, they are not recommended for use in California.

A large aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W) where feasible. Basin depths optimally range from 2 to 5 feet.

The facility's drawdown time should be regulated by an orifice or weir. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes. The outlet design implemented by Caltrans in the facilities constructed in San Diego County used an outlet riser with orifices

**Figure 1**
**Example of Extended Detention Outlet Structure**

sized to discharge the water quality volume, and the riser overflow height was set to the design storm elevation. A stainless steel screen was placed around the outlet riser to ensure that the orifices would not become clogged with debris. Sites either used a separate riser or broad crested weir for overflow of runoff for the 25 and greater year storms. A picture of a typical outlet is presented in Figure 1.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure can be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed.

***Summary of Design Recommendations***

(1) Facility Sizing - The required water quality volume is determined by local regulations or the basin should be sized to capture and treat 85% of the annual runoff volume. See Section 5.5.1 of the handbook for a discussion of volume-based design.

Basin Configuration – A high aspect ratio may improve the performance of detention basins; consequently, the outlets should be placed to maximize the flowpath through the facility. The ratio of flowpath length to width from the inlet to the outlet should be at least 1.5:1 (L:W). The flowpath length is defined as the distance from the inlet to the outlet as measured at the surface. The width is defined as the mean width of the basin. Basin depths optimally range from 2 to 5 feet. The basin may include a sediment forebay to provide the opportunity for larger particles to settle out.

A micropool should not be incorporated in the design because of vector concerns. For online facilities, the principal and emergency spillways must be sized to provide 1.0 foot of freeboard during the 25-year event and to safely pass the flow from 100-year storm.

(2) Pond Side Slopes - Side slopes of the pond should be 3:1 (H:V) or flatter for grass stabilized slopes. Slopes steeper than 3:1 (H:V) must be stabilized with an appropriate slope stabilization practice.

(3) Basin Lining – Basins must be constructed to prevent possible contamination of groundwater below the facility.

(4) Basin Inlet – Energy dissipation is required at the basin inlet to reduce resuspension of accumulated sediment and to reduce the tendency for short-circuiting.

(5) Outflow Structure - The facility's drawdown time should be regulated by a gate valve or orifice plate. In general, the outflow structure should have a trash rack or other acceptable means of preventing clogging at the entrance to the outflow pipes.

The outflow structure should be sized to allow for complete drawdown of the water quality volume in 72 hours. No more than 50% of the water quality volume should drain from the facility within the first 24 hours. The outflow structure should be fitted with a valve so that discharge from the basin can be halted in case of an accidental spill in the watershed. This same valve also can be used to regulate the rate of discharge from the basin.

The discharge through a control orifice is calculated from:

$$Q = CA(2g(H-H_o))^{0.5}$$

where:
- Q = discharge ($ft^3/s$)
- C = orifice coefficient
- A = area of the orifice ($ft^2$)
- g = gravitational constant (32.2)
- H = water surface elevation (ft)
- $H_o$= orifice elevation (ft)

Recommended values for C are 0.66 for thin materials and 0.80 when the material is thicker than the orifice diameter. This equation can be implemented in spreadsheet form with the pond stage/volume relationship to calculate drain time. To do this, use the initial height of the water above the orifice for the water quality volume. Calculate the discharge and assume that it remains constant for approximately 10 minutes. Based on that discharge, estimate the total discharge during that interval and the new elevation based on the stage volume relationship. Continue to iterate until H is approximately equal to $H_o$. When using multiple orifices the discharge from each is summed.

(6) Splitter Box - When the pond is designed as an offline facility, a splitter structure is used to isolate the water quality volume. The splitter box, or other flow diverting approach, should be designed to convey the 25-year storm event while providing at least 1.0 foot of freeboard along pond side slopes.

(7) Erosion Protection at the Outfall - For online facilities, special consideration should be given to the facility's outfall location. Flared pipe end sections that discharge at or near the stream invert are preferred. The channel immediately below the pond outfall should be modified to conform to natural dimensions, and lined with large stone riprap placed over filter cloth. Energy dissipation may be required to reduce flow velocities from the primary spillway to non-erosive velocities.

(8) Safety Considerations - Safety is provided either by fencing of the facility or by managing the contours of the pond to eliminate dropoffs and other hazards. Earthen side slopes should not exceed 3:1 (H:V) and should terminate on a flat safety bench area. Landscaping can be used to impede access to the facility. The primary spillway opening must not permit access by small children. Outfall pipes above 48 inches in diameter should be fenced.

## Maintenance

Routine maintenance activity is often thought to consist mostly of sediment and trash and debris removal; however, these activities often constitute only a small fraction of the maintenance hours. During a recent study by Caltrans, 72 hours of maintenance was performed annually, but only a little over 7 hours was spent on sediment and trash removal. The largest recurring activity was vegetation management, routine mowing. The largest absolute number of hours was associated with vector control because of mosquito breeding that occurred in the stilling basins (example of standing water to be avoided) installed as energy dissipaters. In most cases, basic housekeeping practices such as removal of debris accumulations and vegetation

management to ensure that the basin dewaters completely in 48-72 hours is sufficient to prevent creating mosquito and other vector habitats.

Consequently, maintenance costs should be estimated based primarily on the mowing frequency and the time required. Mowing should be done at least annually to avoid establishment of woody vegetation, but may need to be performed much more frequently if aesthetics are an important consideration.

Typical activities and frequencies include:

- Schedule semiannual inspection for the beginning and end of the wet season for standing water, slope stability, sediment accumulation, trash and debris, and presence of burrows.
- Remove accumulated trash and debris in the basin and around the riser pipe during the semiannual inspections. The frequency of this activity may be altered to meet specific site conditions.
- Trim vegetation at the beginning and end of the wet season and inspect monthly to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and re-grade about every 10 years or when the accumulated sediment volume exceeds 10 percent of the basin volume. Inspect the basin each year for accumulated sediment volume.

## Cost

### *Construction Cost*

The construction costs associated with extended detention basins vary considerably. One recent study evaluated the cost of all pond systems (Brown and Schueler, 1997). Adjusting for inflation, the cost of dry extended detention ponds can be estimated with the equation:

$$C = 12.4V^{0.760}$$

where: C = Construction, design, and permitting cost, and
V = Volume ($ft^3$).

Using this equation, typical construction costs are:

$ 41,600 for a 1 acre-foot pond

$ 239,000 for a 10 acre-foot pond

$ 1,380,000 for a 100 acre-foot pond

Interestingly, these costs are generally slightly higher than the predicted cost of wet ponds (according to Brown and Schueler, 1997) on a cost per total volume basis, which highlights the difficulty of developing reasonably accurate construction estimates. In addition, a typical facility constructed by Caltrans cost about $160,000 with a capture volume of only 0.3 ac-ft.

An economic concern associated with dry ponds is that they might detract slightly from the value of adjacent properties. One study found that dry ponds can actually detract from the

perceived value of homes adjacent to a dry pond by between 3 and 10 percent (Emmerling-Dinovo, 1995).

### *Maintenance Cost*

For ponds, the annual cost of routine maintenance is typically estimated at about 3 to 5 percent of the construction cost (EPA website). Alternatively, a community can estimate the cost of the maintenance activities outlined in the maintenance section. Table 1 presents the maintenance costs estimated by Caltrans based on their experience with five basins located in southern California. Again, it should be emphasized that the vast majority of hours are related to vegetation management (mowing).

**Table 1 Estimated Average Annual Maintenance Effort**

| Activity | Labor Hours | Equipment & Material ($) | Cost |
|---|---|---|---|
| Inspections | 4 | 7 | 183 |
| Maintenance | 49 | 126 | 2282 |
| Vector Control | 0 | 0 | 0 |
| Administration | 3 | 0 | 132 |
| Materials | - | 535 | 535 |
| **Total** | **56** | **$668** | **$3,132** |

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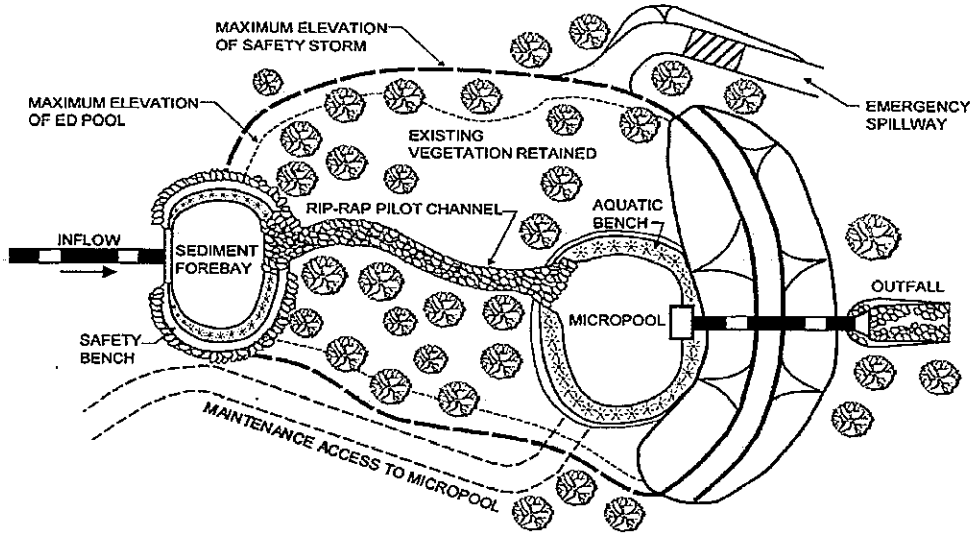
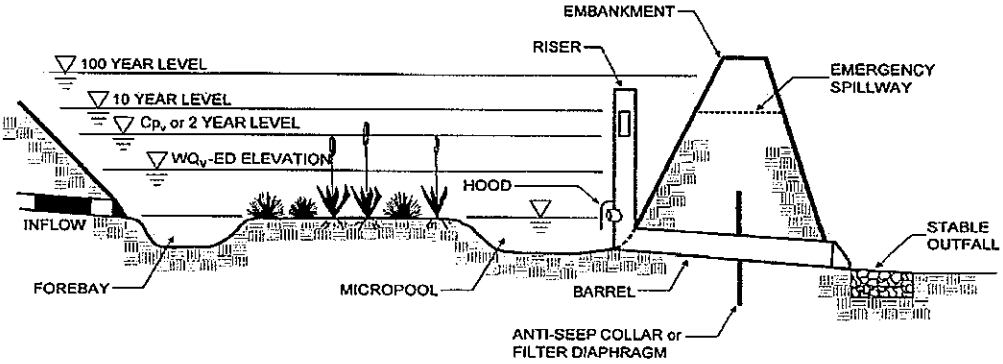



PLAN VIEW




PROFILE

**Schematic of an Extended Detention Basin (MDE, 2000)**

# Vegetated Swale TC-30

## Design Considerations

- Tributary Area
- Area Required
- Slope
- Water Availability

## Description

Vegetated swales are open, shallow channels with vegetation covering the side slopes and bottom that collect and slowly convey runoff flow to downstream discharge points. They are designed to treat runoff through filtering by the vegetation in the channel, filtering through a subsoil matrix, and/or infiltration into the underlying soils. Swales can be natural or manmade. They trap particulate pollutants (suspended solids and trace metals), promote infiltration, and reduce the flow velocity of stormwater runoff. Vegetated swales can serve as part of a stormwater drainage system and can replace curbs, gutters and storm sewer systems.

## Targeted Constituents

| | | |
|---|---|---|
| ☑ | Sediment | ▲ |
| ☑ | Nutrients | ● |
| ☑ | Trash | ● |
| ☑ | Metals | ▲ |
| ☑ | Bacteria | ● |
| ☑ | Oil and Grease | ▲ |
| ☑ | Organics | ▲ |

**Legend** ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

## California Experience

Caltrans constructed and monitored six vegetated swales in southern California. These swales were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

## Advantages

- If properly designed, vegetated, and operated, swales can serve as an aesthetic, potentially inexpensive urban development or roadway drainage conveyance measure with significant collateral water quality benefits.

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- Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible.

### Limitations

- Can be difficult to avoid channelization.
- May not be appropriate for industrial sites or locations where spills may occur
- Grassed swales cannot treat a very large drainage area. Large areas may be divided and treated using multiple swales.
- A thick vegetative cover is needed for these practices to function properly.
- They are impractical in areas with steep topography.
- They are not effective and may even erode when flow velocities are high, if the grass cover is not properly maintained.
- In some places, their use is restricted by law: many local municipalities require curb and gutter systems in residential areas.
- Swales are mores susceptible to failure if not properly maintained than other treatment BMPs.

### Design and Sizing Guidelines

- Flow rate based design determined by local requirements or sized so that 85% of the annual runoff volume is discharged at less than the design rainfall intensity.
- Swale should be designed so that the water level does not exceed 2/3rds the height of the grass or 4 inches, which ever is less, at the design treatment rate.
- Longitudinal slopes should not exceed 2.5%
- Trapezoidal channels are normally recommended but other configurations, such as parabolic, can also provide substantial water quality improvement and may be easier to mow than designs with sharp breaks in slope.
- Swales constructed in cut are preferred, or in fill areas that are far enough from an adjacent slope to minimize the potential for gopher damage. Do not use side slopes constructed of fill, which are prone to structural damage by gophers and other burrowing animals.
- A diverse selection of low growing, plants that thrive under the specific site, climatic, and watering conditions should be specified. Vegetation whose growing season corresponds to the wet season are preferred. Drought tolerant vegetation should be considered especially for swales that are not part of a regularly irrigated landscaped area.
- The width of the swale should be determined using Manning's Equation using a value of 0.25 for Manning's n.

***Construction/Inspection Considerations***

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install swales at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be used.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the swale or strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.
- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

## Performance

The literature suggests that vegetated swales represent a practical and potentially effective technique for controlling urban runoff quality. While limited quantitative performance data exists for vegetated swales, it is known that check dams, slight slopes, permeable soils, dense grass cover, increased contact time, and small storm events all contribute to successful pollutant removal by the swale system. Factors decreasing the effectiveness of swales include compacted soils, short runoff contact time, large storm events, frozen ground, short grass heights, steep slopes, and high runoff velocities and discharge rates.

Conventional vegetated swale designs have achieved mixed results in removing particulate pollutants. A study performed by the Nationwide Urban Runoff Program (NURP) monitored three grass swales in the Washington, D.C., area and found no significant improvement in urban runoff quality for the pollutants analyzed. However, the weak performance of these swales was attributed to the high flow velocities in the swales, soil compaction, steep slopes, and short grass height.

Another project in Durham, NC, monitored the performance of a carefully designed artificial swale that received runoff from a commercial parking lot. The project tracked 11 storms and concluded that particulate concentrations of heavy metals (Cu, Pb, Zn, and Cd) were reduced by approximately 50 percent. However, the swale proved largely ineffective for removing soluble nutrients.

The effectiveness of vegetated swales can be enhanced by adding check dams at approximately 17 meter (50 foot) increments along their length (See Figure 1). These dams maximize the retention time within the swale, decrease flow velocities, and promote particulate settling. Finally, the incorporation of vegetated filter strips parallel to the top of the channel banks can help to treat sheet flows entering the swale.

Only 9 studies have been conducted on all grassed channels designed for water quality (Table 1). The data suggest relatively high removal rates for some pollutants, but negative removals for some bacteria, and fair performance for phosphorus.

**Table 1 Grassed swale pollutant removal efficiency data**

| Removal Efficiencies (% Removal) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Study | TSS | TP | TN | $NO_3$ | Metals | Bacteria | Type |
| Caltrans 2002 | 77 | 8 | 67 | 66 | 83-90 | -33 | dry swales |
| Goldberg 1993 | 67.8 | 4.5 | - | 31.4 | 42–62 | -100 | grassed channel |
| Seattle Metro and Washington Department of Ecology 1992 | 60 | 45 | - | -25 | 2–16 | -25 | grassed channel |
| Seattle Metro and Washington Department of Ecology, 1992 | 83 | 29 | - | -25 | 46–73 | -25 | grassed channel |
| Wang et al., 1981 | 80 | - | - | - | 70–80 | - | dry swale |
| Dorman et al., 1989 | 98 | 18 | - | 45 | 37–81 | - | dry swale |
| Harper, 1988 | 87 | 83 | 84 | 80 | 88–90 | - | dry swale |
| Kercher et al., 1983 | 99 | 99 | 99 | 99 | 99 | - | dry swale |
| Harper, 1988. | 81 | 17 | 40 | 52 | 37–69 | - | wet swale |
| Koon, 1995 | 67 | 39 | - | 9 | -35 to 6 | - | wet swale |

While it is difficult to distinguish between different designs based on the small amount of available data, grassed channels generally have poorer removal rates than wet and dry swales, although some swales appear to export soluble phosphorus (Harper, 1988; Koon, 1995). It is not clear why swales export bacteria. One explanation is that bacteria thrive in the warm swale soils.

## Siting Criteria

The suitability of a swale at a site will depend on land use, size of the area serviced, soil type, slope, imperviousness of the contributing watershed, and dimensions and slope of the swale system (Schueler et al., 1992). In general, swales can be used to serve areas of less than 10 acres, with slopes no greater than 5 %. Use of natural topographic lows is encouraged and natural drainage courses should be regarded as significant local resources to be kept in use (Young et al., 1996).

### *Selection Criteria (NCTCOG, 1993)*

- Comparable performance to wet basins
- Limited to treating a few acres
- Availability of water during dry periods to maintain vegetation
- Sufficient available land area

Research in the Austin area indicates that vegetated controls are effective at removing pollutants even when dormant. Therefore, irrigation is not required to maintain growth during dry periods, but may be necessary only to prevent the vegetation from dying.

The topography of the site should permit the design of a channel with appropriate slope and cross-sectional area. Site topography may also dictate a need for additional structural controls. Recommendations for longitudinal slopes range between 2 and 6 percent. Flatter slopes can be used, if sufficient to provide adequate conveyance. Steep slopes increase flow velocity, decrease detention time, and may require energy dissipating and grade check. Steep slopes also can be managed using a series of check dams to terrace the swale and reduce the slope to within acceptable limits. The use of check dams with swales also promotes infiltration.

### Additional Design Guidelines

Most of the design guidelines adopted for swale design specify a minimum hydraulic residence time of 9 minutes. This criterion is based on the results of a single study conducted in Seattle, Washington (Seattle Metro and Washington Department of Ecology, 1992), and is not well supported. Analysis of the data collected in that study indicates that pollutant removal at a residence time of 5 minutes was not significantly different, although there is more variability in that data. Therefore, additional research in the design criteria for swales is needed. Substantial pollutant removal has also been observed for vegetated controls designed solely for conveyance (Barrett et al, 1998); consequently, some flexibility in the design is warranted.

Many design guidelines recommend that grass be frequently mowed to maintain dense coverage near the ground surface. Recent research (Colwell et al., 2000) has shown mowing frequency or grass height has little or no effect on pollutant removal.

#### *Summary of Design Recommendations*

1) The swale should have a length that provides a minimum hydraulic residence time of at least 10 minutes. The maximum bottom width should not exceed 10 feet unless a dividing berm is provided. The depth of flow should not exceed 2/3rds the height of the grass at the peak of the water quality design storm intensity. The channel slope should not exceed 2.5%.

2) A design grass height of 6 inches is recommended.

3) Regardless of the recommended detention time, the swale should be not less than 100 feet in length.

4) The width of the swale should be determined using Manning's Equation, at the peak of the design storm, using a Manning's n of 0.25.

5) The swale can be sized as both a treatment facility for the design storm and as a conveyance system to pass the peak hydraulic flows of the 100-year storm if it is located "on-line." The side slopes should be no steeper than 3:1 (H:V).

6) Roadside ditches should be regarded as significant potential swale/buffer strip sites and should be utilized for this purpose whenever possible. If flow is to be introduced through curb cuts, place pavement slightly above the elevation of the vegetated areas. Curb cuts should be at least 12 inches wide to prevent clogging.

7) Swales must be vegetated in order to provide adequate treatment of runoff. It is important to maximize water contact with vegetation and the soil surface. For general purposes, select fine, close-growing, water-resistant grasses. If possible, divert runoff (other than necessary irrigation) during the period of vegetation

establishment. Where runoff diversion is not possible, cover graded and seeded areas with suitable erosion control materials.

### Maintenance

The useful life of a vegetated swale system is directly proportional to its maintenance frequency. If properly designed and regularly maintained, vegetated swales can last indefinitely. The maintenance objectives for vegetated swale systems include keeping up the hydraulic and removal efficiency of the channel and maintaining a dense, healthy grass cover.

Maintenance activities should include periodic mowing (with grass never cut shorter than the design flow depth), weed control, watering during drought conditions, reseeding of bare areas, and clearing of debris and blockages. Cuttings should be removed from the channel and disposed in a local composting facility. Accumulated sediment should also be removed manually to avoid concentrated flows in the swale. The application of fertilizers and pesticides should be minimal.

Another aspect of a good maintenance plan is repairing damaged areas within a channel. For example, if the channel develops ruts or holes, it should be repaired utilizing a suitable soil that is properly tamped and seeded. The grass cover should be thick; if it is not, reseed as necessary. Any standing water removed during the maintenance operation must be disposed to a sanitary sewer at an approved discharge location. Residuals (e.g., silt, grass cuttings) must be disposed in accordance with local or State requirements. Maintenance of grassed swales mostly involves maintenance of the grass or wetland plant cover. Typical maintenance activities are summarized below:

- Inspect swales at least twice annually for erosion, damage to vegetation, and sediment and debris accumulation preferably at the end of the wet season to schedule summer maintenance and before major fall runoff to be sure the swale is ready for winter. However, additional inspection after periods of heavy runoff is desirable. The swale should be checked for debris and litter, and areas of sediment accumulation.

- Grass height and mowing frequency may not have a large impact on pollutant removal. Consequently, mowing may only be necessary once or twice a year for safety or aesthetics or to suppress weeds and woody vegetation.

- Trash tends to accumulate in swale areas, particularly along highways. The need for litter removal is determined through periodic inspection, but litter should always be removed prior to mowing.

- Sediment accumulating near culverts and in channels should be removed when it builds up to 75 mm (3 in.) at any spot, or covers vegetation.

- Regularly inspect swales for pools of standing water. Swales can become a nuisance due to mosquito breeding in standing water if obstructions develop (e.g. debris accumulation, invasive vegetation) and/or if proper drainage slopes are not implemented and maintained.

## Cost

### *Construction Cost*

Little data is available to estimate the difference in cost between various swale designs. One study (SWRPC, 1991) estimated the construction cost of grassed channels at approximately \$0.25 per $ft^2$. This price does not include design costs or contingencies. Brown and Schueler (1997) estimate these costs at approximately 32 percent of construction costs for most stormwater management practices. For swales, however, these costs would probably be significantly higher since the construction costs are so low compared with other practices. A more realistic estimate would be a total cost of approximately \$0.50 per $ft^2$, which compares favorably with other stormwater management practices.

**Table 2 Swale Cost Estimate (SEWRPC, 1991)**

| Component | Unit | Extent | Unit Cost | | | Total Cost | | |
|---|---|---|---|---|---|---|---|---|
| | | | Low | Moderate | High | Low | Moderate | High |
| Mobilization / Demobilization-Light | Swale | 1 | $107 | $274 | $441 | $107 | $274 | $441 |
| Site Preparation | | | | | | | | |
| Clearing[b] | Acre | 0.5 | $2,200 | $3,800 | $5,400 | $1,100 | $1,900 | $2,700 |
| Grubbing[c] | Acre | 0.25 | $3,800 | $5,200 | $6,600 | $950 | $1,300 | $1,650 |
| General Excavation[d] | $Yd^3$ | 372 | $2.10 | $3.70 | $5.30 | $781 | $1,376 | $1,972 |
| Level and Till[e] | $Yd^2$ | 1,210 | $0.20 | $0.35 | $0.50 | $242 | $424 | $605 |
| Sites Development | | | | | | | | |
| Salvaged Topsoil Seed, and Mulch[f] | $Yd^2$ | 1,210 | $0.40 | $1.00 | $1.60 | $484 | $1,210 | $1,936 |
| Sod[g] | $Yd^2$ | 1,210 | $1.20 | $2.40 | $3.60 | $1,452 | $2,904 | $4,356 |
| Subtotal | -- | -- | -- | -- | -- | $5,116 | $9,388 | $13,660 |
| Contingencies | Swale | 1 | 25% | 25% | 25% | $1,279 | $2,347 | $3,415 |
| Total | -- | -- | -- | -- | -- | $6,395 | $11,735 | $17,075 |

Source: (SEWRPC, 1991)

Note: Mobilization/demobilization refers to the organization and planning involved in establishing a vegetative swale.

[a] Swale has a bottom width of 1.0 foot, a top width of 10 feet with 1:3 side slopes, and a 1,000-foot length.

[b] Area cleared = (top width + 10 feet) x swale length.

[c] Area grubbed = (top width x swale length).

[d] Volume excavated = (0.67 x top width x swale depth) x swale length (parabolic cross-section).

[e] Area tilled = $(\text{top width} + \frac{8(\text{swale depth}^2)}{3(\text{top width})}) \times \text{swale length}$ (parabolic cross-section).

[f] Area seeded = area cleared x 0.5.

[g] Area sodded = area cleared x 0.5.

**Table 3 Estimated Maintenance Costs (SEWRPC, 1991)**

| Component | Unit Cost | Swale Size (Depth and Top Width) | | Comment |
|---|---|---|---|---|
| | | 1.5 Foot Depth, One-Foot Bottom Width, 10-Foot Top Width | 3-Foot Depth, 3-Foot Bottom Width, 21-Foot Top Width | |
| Lawn Mowing | $0.85 / 1,000 ft² / mowing | $0.14 / linear foot | $0.21 / linear foot | Lawn maintenance area=(top width + 10 feet) x length. Mow eight times per year |
| General Lawn Care | $8.00 / 1,000 ft² / year | $0.18 / linear foot | $0.28 / linear foot | Lawn maintenance area = (top width + 10 feet) x length |
| Swale Debris and Litter Removal | $0.10 / linear foot / year | $0.10 / linear foot | $0.10 / linear foot | – |
| Grass Reseeding with Mulch and Fertilizer | $0.30 / yd² | $0.01 / linear foot | $0.01 / linear foot | Area revegetated equals 1% of lawn maintenance area per year |
| Program Administration and Swale Inspection | $0.15 / linear foot / year, plus $25 / inspection | $0.15 / linear foot | $0.15 / linear foot | Inspect four times per year |
| Total | -- | $0.58 / linear foot | $ 0.75 / linear foot | -- |

***Maintenance Cost***

Caltrans (2002) estimated the expected annual maintenance cost for a swale with a tributary area of approximately 2 ha at approximately $2,700. Since almost all maintenance consists of mowing, the cost is fundamentally a function of the mowing frequency. Unit costs developed by SEWRPC are shown in Table 3. In many cases vegetated channels would be used to convey runoff and would require periodic mowing as well, so there may be little additional cost for the water quality component. Since essentially all the activities are related to vegetation management, no special training is required for maintenance personnel.

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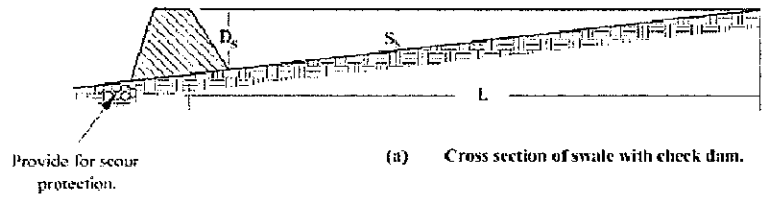
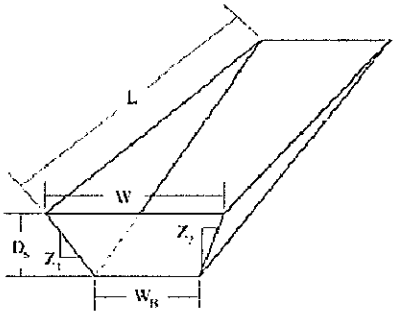



(a) Cross section of swale with check dam.




(b) Dimensional view of swale impoundment area.

Notation:

L = Length of swale impoundment area per check dam (ft)
$D_S$ = Depth of check dam (ft)
$S_S$ = Bottom slpe of swale (ft/ft)
W = Top width of check dam (ft)
$W_B$ = Bottom width of check dam (ft)
$Z_{1&2}$ = Ratio of horizontal to vertical change in swale side slope (ft:ft)

# Vegetated Buffer Strip TC-31

## Design Considerations

- Tributary Area
- Slope
- Water Availability
- Aesthetics

## Description

Grassed buffer strips (vegetated filter strips, filter strips, and grassed filters) are vegetated surfaces that are designed to treat sheet flow from adjacent surfaces. Filter strips function by slowing runoff velocities and allowing sediment and other pollutants to settle and by providing some infiltration into underlying soils. Filter strips were originally used as an agricultural treatment practice and have more recently evolved into an urban practice. With proper design and maintenance, filter strips can provide relatively high pollutant removal. In addition, the public views them as landscaped amenities and not as stormwater infrastructure. Consequently, there is little resistance to their use.

## Targeted Constituents

| | | |
|---|---|---|
| ☑ | Sediment | ■ |
| ☑ | Nutrients | ● |
| ☑ | Trash | ▲ |
| ☑ | Metals | ■ |
| ☑ | Bacteria | ● |
| ☑ | Oil and Grease | ■ |
| ☑ | Organics | ▲ |

**Legend** ***(Removal Effectiveness)***

● Low ■ High

▲ Medium

## California Experience

Caltrans constructed and monitored three vegetated buffer strips in southern California and is currently evaluating their performance at eight additional sites statewide. These strips were generally effective in reducing the volume and mass of pollutants in runoff. Even in the areas where the annual rainfall was only about 10 inches/yr, the vegetation did not require additional irrigation. One factor that strongly affected performance was the presence of large numbers of gophers at most of the southern California sites. The gophers created earthen mounds, destroyed vegetation, and generally reduced the effectiveness of the controls for TSS reduction.

## Advantages

- Buffers require minimal maintenance activity (generally just erosion prevention and mowing).
- If properly designed, vegetated, and operated, buffer strips can provide reliable water quality benefits in conjunction with high aesthetic appeal.

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- Flow characteristics and vegetation type and density can be closely controlled to maximize BMP effectiveness.
- Roadside shoulders act as effective buffer strips when slope and length meet criteria described below.

### Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- Buffer strips cannot treat a very large drainage area.
- A thick vegetative cover is needed for these practices to function properly.
- Buffer or vegetative filter length must be adequate and flow characteristics acceptable or water quality performance can be severely limited.
- Vegetative buffers may not provide treatment for dissolved constituents except to the extent that flows across the vegetated surface are infiltrated into the soil profile.
- This technology does not provide significant attenuation of the increased volume and flow rate of runoff during intense rain events.

### Design and Sizing Guidelines

- Maximum length (in the direction of flow towards the buffer) of the tributary area should be 60 feet.
- Slopes should not exceed 15%.
- Minimum length (in direction of flow) is 15 feet.
- Width should be the same as the tributary area.
- Either grass or a diverse selection of other low growing, drought tolerant, native vegetation should be specified. Vegetation whose growing season corresponds to the wet season is preferred.

### *Construction/Inspection Considerations*

- Include directions in the specifications for use of appropriate fertilizer and soil amendments based on soil properties determined through testing and compared to the needs of the vegetation requirements.
- Install strips at the time of the year when there is a reasonable chance of successful establishment without irrigation; however, it is recognized that rainfall in a given year may not be sufficient and temporary irrigation may be required.
- If sod tiles must be used, they should be placed so that there are no gaps between the tiles; stagger the ends of the tiles to prevent the formation of channels along the strip.
- Use a roller on the sod to ensure that no air pockets form between the sod and the soil.

- Where seeds are used, erosion controls will be necessary to protect seeds for at least 75 days after the first rainfall of the season.

## Performance

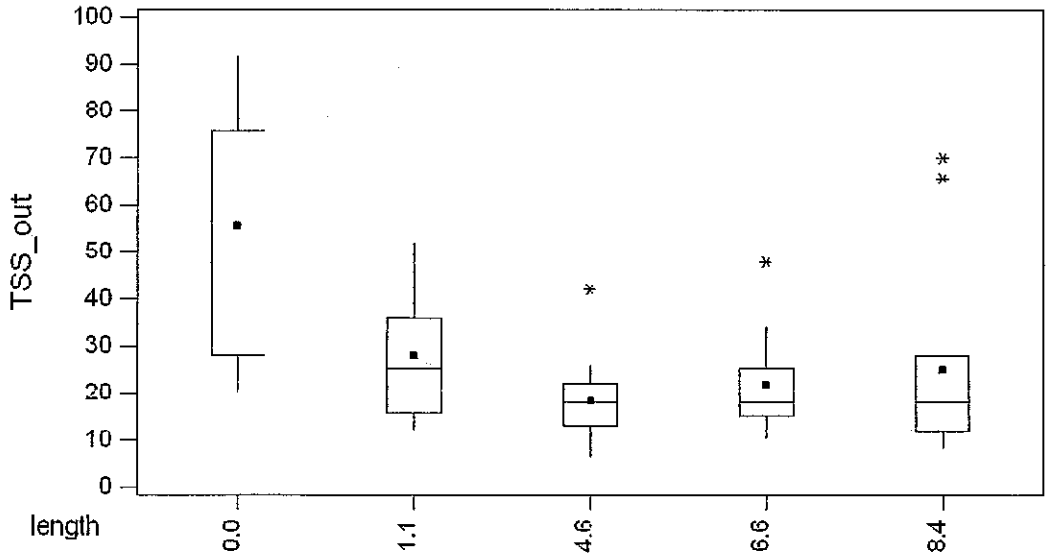
Vegetated buffer strips tend to provide somewhat better treatment of stormwater runoff than swales and have fewer tendencies for channelization or erosion. Table 1 documents the pollutant removal observed in a recent study by Caltrans (2002) based on three sites in southern California. The column labeled "Significance" is the probability that the mean influent and effluent EMCs are not significantly different based on an analysis of variance.

The removal of sediment and dissolved metals was comparable to that observed in much more complex controls. Reduction in nitrogen was not significant and all of the sites exported phosphorus for the entire study period. This may have been the result of using salt grass, a warm weather species that is dormant during the wet season, and which leaches phosphorus when dormant.

Another Caltrans study (unpublished) of vegetated highway shoulders as buffer strips also found substantial reductions often within a very short distance of the edge of pavement. Figure 1 presents a box and whisker plot of the concentrations of TSS in highway runoff after traveling various distances (shown in meters) through a vegetated filter strip with a slope of about 10%. One can see that the TSS median concentration reaches an irreducible minimum concentration of about 20 mg/L within 5 meters of the pavement edge.

**Table 1 Pollutant Reduction in a Vegetated Buffer Strip**

| Constituent | Mean EMC | | Removal % | Significance |
|---|---|---|---|---|
| | Influent (mg/L) | Effluent (mg/L) | | P |
| TSS | 119 | 31 | 74 | <0.000 |
| $NO_3$-N | 0.67 | 0.58 | 13 | 0.367 |
| TKN-N | 2.50 | 2.10 | 16 | 0.542 |
| Total N[a] | 3.17 | 2.68 | 15 | - |
| Dissolved P | 0.15 | 0.46 | -206 | 0.047 |
| Total P | 0.42 | 0.62 | -52 | 0.035 |
| Total Cu | 0.058 | 0.009 | 84 | <0.000 |
| Total Pb | 0.046 | 0.006 | 88 | <0.000 |
| Total Zn | 0.245 | 0.055 | 78 | <0.000 |
| Dissolved Cu | 0.029 | 0.007 | 77 | 0.004 |
| Dissolved Pb | 0.004 | 0.002 | 66 | 0.006 |
| Dissolved Zn | 0.099 | 0.035 | 65 | <0.000 |




Filter strips also exhibit good removal of litter and other floatables because the water depth in these systems is well below the vegetation height and consequently these materials are not easily transported through them. Unfortunately little attenuation of peak runoff rates and volumes (particularly for larger events) is normally observed, depending on the soil properties. Therefore it may be prudent to follow the strips with another practice than can reduce flooding and channel erosion downstream.

### Siting Criteria

The use of buffer strips is limited to gently sloping areas where the vegetative cover is robust and diffuse, and where shallow flow characteristics are possible. The practical water quality benefits can be effectively eliminated with the occurrence of significant erosion or when flow concentration occurs across the vegetated surface. Slopes should not exceed 15 percent or be less than 1 percent. The vegetative surface should extend across the full width of the area being drained. The upstream boundary of the filter should be located contiguous to the developed area. Use of a level spreading device (vegetated berm, sawtooth concrete border, rock trench, etc) to facilitate overland sheet flow is not normally recommended because of maintenance considerations and the potential for standing water.

Filter strips are applicable in most regions, but are restricted in some situations because they consume a large amount of space relative to other practices. Filter strips are best suited to treating runoff from roads and highways, roof downspouts, small parking lots, and pervious surfaces. They are also ideal components of the "outer zone" of a stream buffer or as pretreatment to a structural practice. In arid areas, however, the cost of irrigating the grass on the practice will most likely outweigh its water quality benefits, although aesthetic considerations may be sufficient to overcome this constraint. Filter strips are generally impractical in ultra-urban areas where little pervious surface exists.

Some cold water species, such as trout, are sensitive to changes in temperature. While some treatment practices, such as wet ponds, can warm stormwater substantially, filter strips do not

are not expected to increase stormwater temperatures. Thus, these practices are good for protection of cold-water streams.

Filter strips should be separated from the ground water by between 2 and 4 ft to prevent contamination and to ensure that the filter strip does not remain wet between storms.

### Additional Design Guidelines

Filter strips appear to be a minimal design practice because they are basically no more than a grassed slope. In general the slope of the strip should not exceed 15fc% and the strip should be at least 15 feet long to provide water quality treatment. Both the top and toe of the slope should be as flat as possible to encourage sheet flow and prevent erosion. The top of the strip should be installed 2-5 inches below the adjacent pavement, so that vegetation and sediment accumulation at the edge of the strip does not prevent runoff from entering.

A major question that remains unresolved is how large the drainage area to a strip can be. Research has conclusively demonstrated that these are effective on roadside shoulders, where the contributing area is about twice the buffer area. They have also been installed on the perimeter of large parking lots where they performed fairly effectively; however much lower slopes may be needed to provide adequate water quality treatment.

The filter area should be densely vegetated with a mix of erosion-resistant plant species that effectively bind the soil. Native or adapted grasses, shrubs, and trees are preferred because they generally require less fertilizer and are more drought resistant than exotic plants. Runoff flow velocities should not exceed about 1 fps across the vegetated surface.

For engineered vegetative strips, the facility surface should be graded flat prior to placement of vegetation. Initial establishment of vegetation requires attentive care including appropriate watering, fertilization, and prevention of excessive flow across the facility until vegetation completely covers the area and is well established. Use of a permanent irrigation system may help provide maximal water quality performance.

In cold climates, filter strips provide a convenient area for snow storage and treatment. If used for this purpose, vegetation in the filter strip should be salt-tolerant (e.g., creeping bentgrass), and a maintenance schedule should include the removal of sand built up at the bottom of the slope. In arid or semi-arid climates, designers should specify drought-tolerant grasses to minimize irrigation requirements.

### Maintenance

Filter strips require mainly vegetation management; therefore little special training is needed for maintenance crews. Typical maintenance activities and frequencies include:

- Inspect strips at least twice annually for erosion or damage to vegetation, preferably at the end of the wet season to schedule summer maintenance and before major fall run-off to be sure the strip is ready for winter. However, additional inspection after periods of heavy run-off is most desirable. The strip should be checked for debris and litter and areas of sediment accumulation.

- Recent research on biofiltration swales, but likely applicable to strips (Colwell et al., 2000), indicates that grass height and mowing frequency have little impact on pollutant removal;

consequently, mowing may only be necessary once or twice a year for safety and aesthetics or to suppress weeds and woody vegetation.

- Trash tends to accumulate in strip areas, particularly along highways. The need for litter removal should be determined through periodic inspection but litter should always be removed prior to mowing.

- Regularly inspect vegetated buffer strips for pools of standing water. Vegetated buffer strips can become a nuisance due to mosquito breeding in level spreaders (unless designed to dewater completely in 48-72 hours), in pools of standing water if obstructions develop (e.g. debris accumulation, invasive vegetation), and/or if proper drainage slopes are not implemented and maintained.

## Cost

### *Construction Cost*

Little data is available on the actual construction costs of filter strips. One rough estimate can be the cost of seed or sod, which is approximately 30¢ per $ft^2$ for seed or 70¢ per $ft^2$ for sod. This amounts to between $13,000 and $30,000 per acre of filter strip. This cost is relatively high compared with other treatment practices. However, the grassed area used as a filter strip may have been seeded or sodded even if it were not used for treatment. In these cases, the only additional cost is the design. Typical maintenance costs are about $350/acre/year (adapted from SWRPC, 1991). This cost is relatively inexpensive and, again, might overlap with regular landscape maintenance costs.

The true cost of filter strips is the land they consume. In some situations this land is available as wasted space beyond back yards or adjacent to roadsides, but this practice is cost-prohibitive when land prices are high and land could be used for other purposes.

### *Maintenance Cost*

Maintenance of vegetated buffer strips consists mainly of vegetation management (mowing, irrigation if needed, weeding) and litter removal. Consequently the costs are quite variable depending on the frequency of these activities and the local labor rate.

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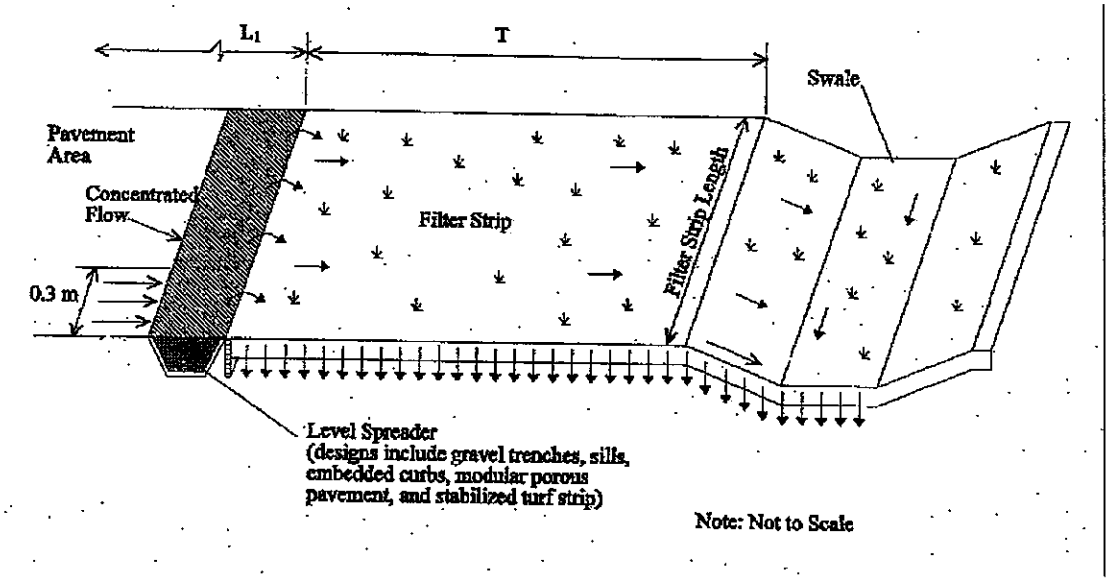
L1
T
Swale
Pavement Area
Concentrated Flow
Filter Strip
Filter Strip Length
0.3 m
Level Spreader
(designs include gravel trenches, sills, embedded curbs, modular porous pavement, and stabilized turf strip)
Note: Not to Scale