# STORM WATER CALCULATIONS

Bibb and associates
A KIEWIT COMPANY

# CALCULATIONS COVER SHEET

**PROJECT NAME:** PANOCHE ENERGY CENTER

**BIBB PROJECT NO.** 2006-027

**CALC NO.** N/A

**DISCIPLINE:** CIVIL

**TITLE:** DETENTION/INFILTRATION BASIN

**DRAWING:** N/A

**SCOPE:** Design of the Detention/Infiltration basin for the Panoche Energy Center in Fresno County, California in accordance with TC-11, California Stormwater BMP Handbook

**ASSUMPTIONS:** SEE ATTACHED

**REFERENCES:** SEE ATTACHED

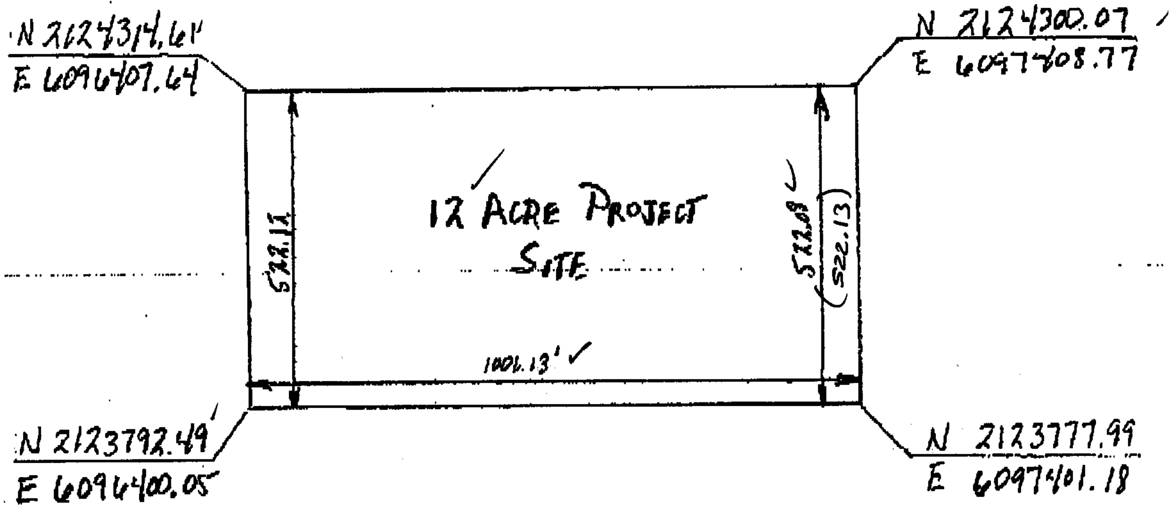
**RESULTS:** SEE ATTACHED

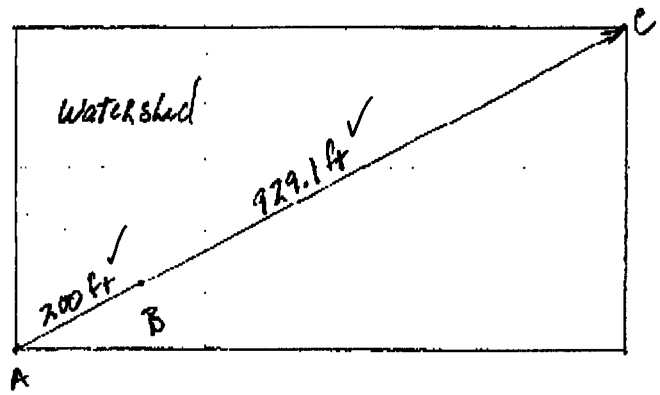
| Rev. | Prepared by | Date | Checked by | Date |
|---|---|---|---|---|
| 0 | Andy Noll | 7/12/2006 | Omar Olivares | 7/13/2006 |
| | | | | |
| | | | | |

| Bibb and associates | Made by: Rand M | Date: 5/23/06 | Job No. 2006027 |
|---|---|---|---|
| | Checked by: Andy N | Date: 6/16/06 | Sheet No. 1 |

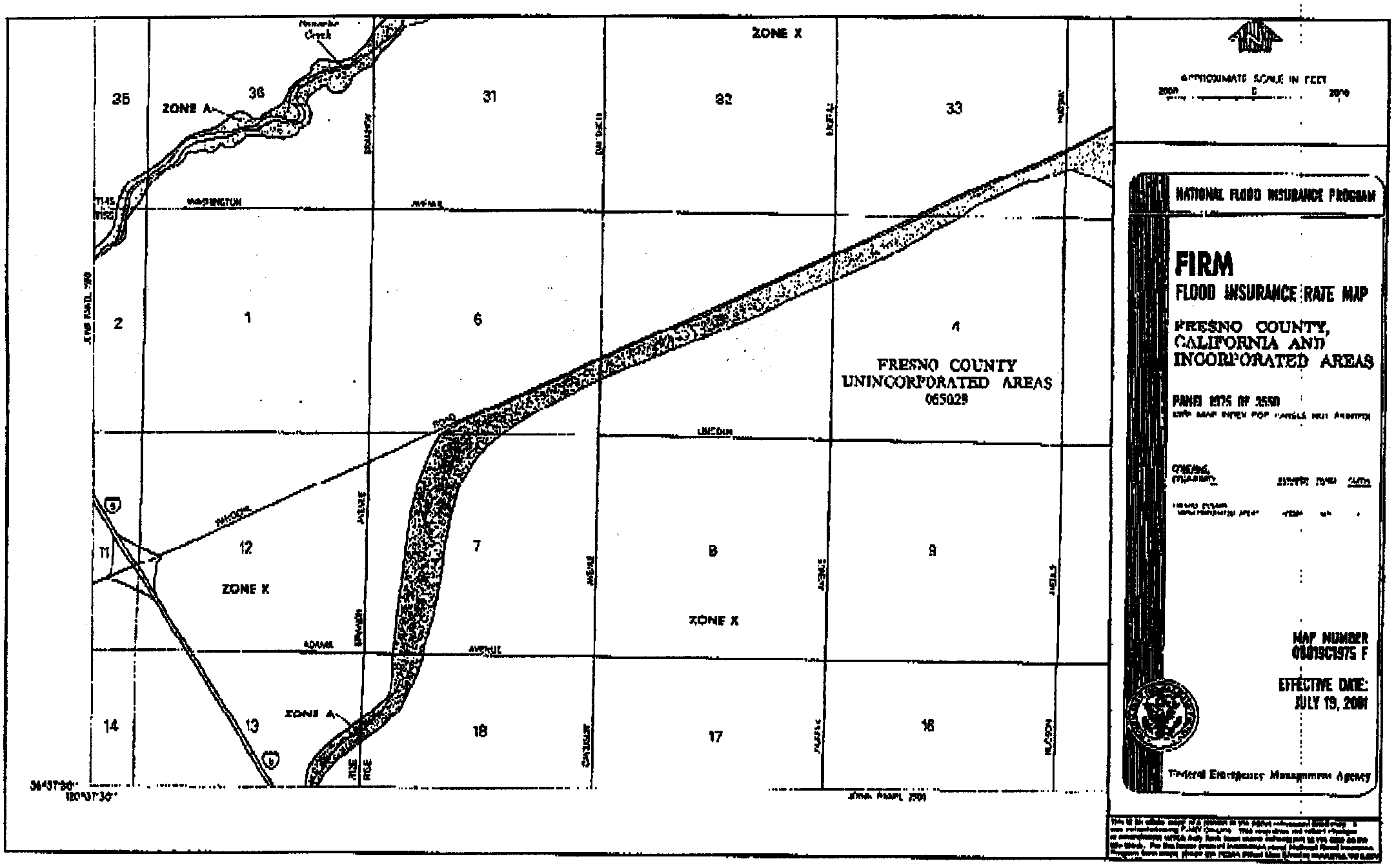
For: PANOCHE ENERGY CENTER: Detention / Infiltration Basin

Preliminary Storm Water



Sheet 2


ZONE X
ZONE A
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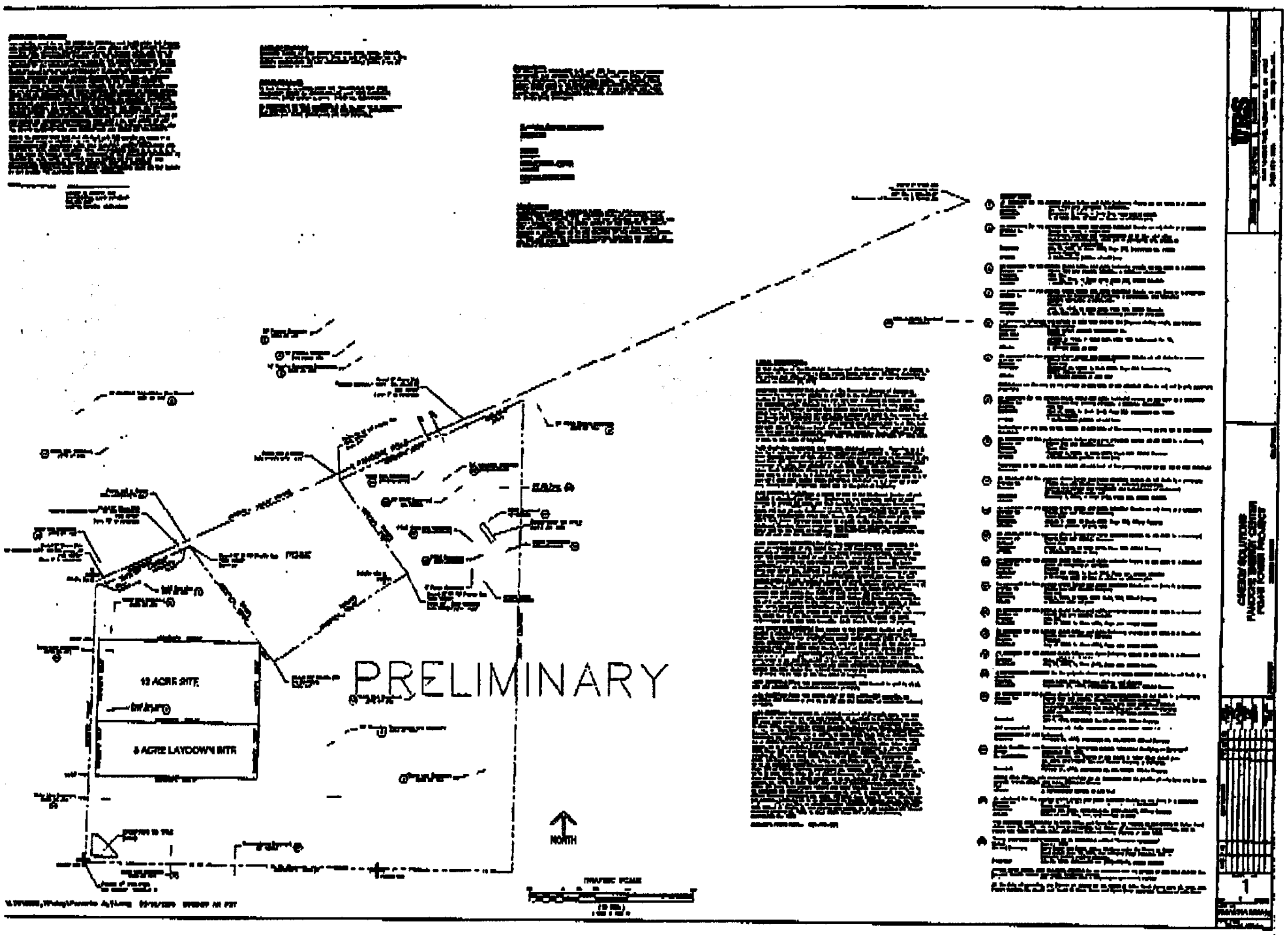
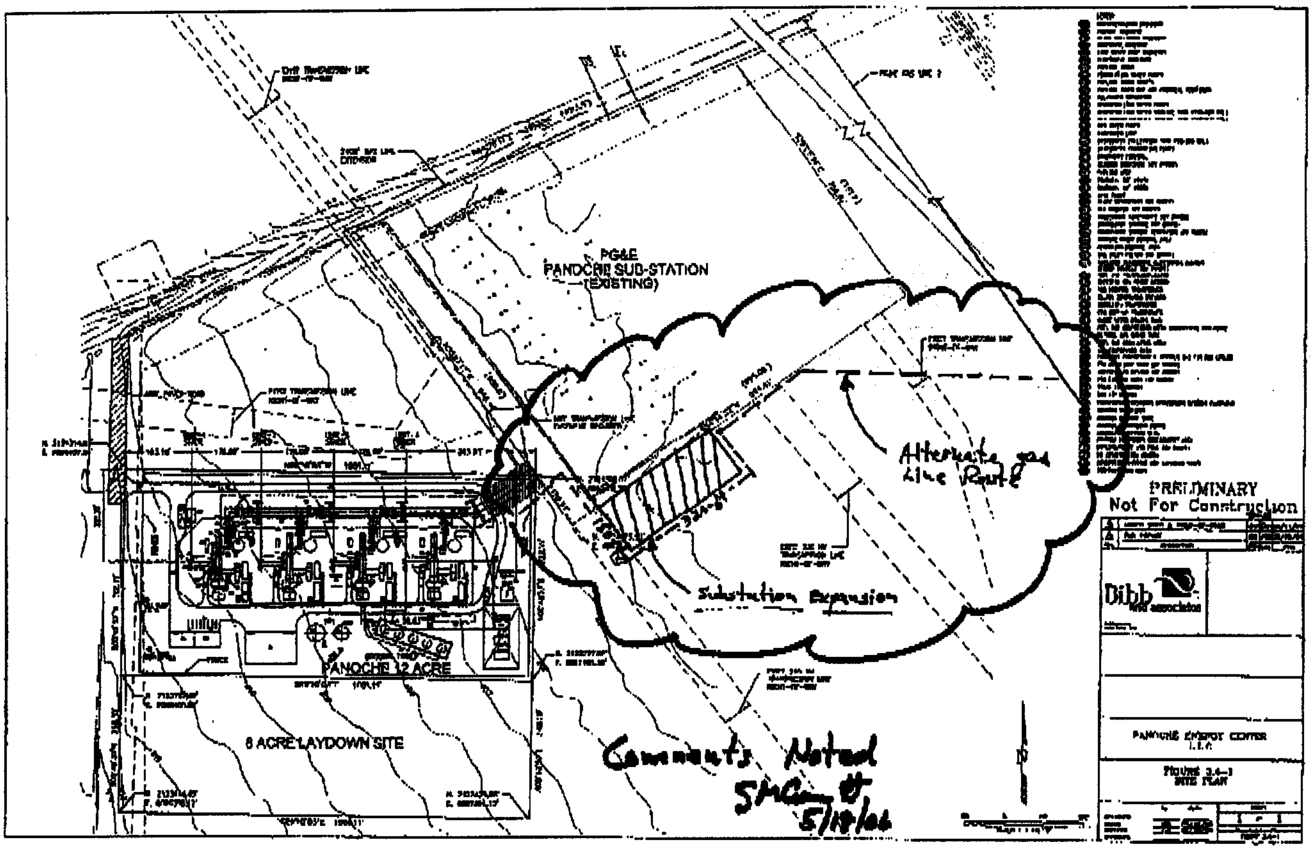
16
FRESNO COUNTY
UNINCORPORATED AREAS
065029
APPROXIMATE SCALE IN FEET
NATIONAL FLOOD INSURANCE PROGRAM
FIRM
FLOOD INSURANCE RATE MAP
FRESNO COUNTY, CALIFORNIA AND INCORPORATED AREAS
MAP NUMBER
06019C1975 F
EFFECTIVE DATE:
JULY 19, 2001
Federal Emergency Management Agency

sheet 3



sheet 4


PG&E
PANOCHE SUB-STATION
(EXISTING)
PANOCHE 12 ACRE
8 ACRE LAYDOWN SITE
Alternate gas line Route
Substation Expansion
PRELIMINARY
Not For Construction
Comments Noted
5/18/06

sheet 5

# Precipitation Frequency Data Output

**NOAA Atlas 2**
**California 36.625?N 120.625?W**
*Site-specific Estimates*

| Map | Precipitation (inches) | Precipitation Intensity (in/hr) |
|---|---|---|
| 2-year 6-hour | 0.78 | 0.13 |
| 2-year 24-hour | 1.18 | 0.05 |
| 100-year 6-hour | 1.50 | 0.25 |
| 100-year 24-hour | 2.50 | 0.10 |

Hydrometeorological Design Studies Center - NOAA/National Weather Service
1325 East-West Highway - Silver Spring, MD 20910 - (301) 713-1669
Tue May 23 12:47:08 2006

36° 39' 08" N 120° 35' 03" W

sheet 6

Fax to: Rand Matney
913-928-7647

Precipitation Information
**10-yr, 24 hr event**

| | |
|---|---|
| Firebaugh (Lat 36.851, Long –120.590) | 1.21 inches |
| Mendota (Lat 36.788, Long –120.372) | 1.27 Inches |
| Panoche (Lat 36.833, Long –120.733) (Six years data) | 1.38 inches |
| Fresno (Fresno Yosemite Airport) | 2.06 inches |

Source: California Department of Water Resources 5/31/06 by URS

sheet 7

# Worksheet 2: Runoff curve number and runoff

| Project PANOCHE ENERGY CENTER | By Rand M | Date 5/23/06 |
|---|---|---|
| Location | Checked ANDY N | Date 6/15/06 |

Check one: ☒ Present ☐ Developed

## 1. Runoff curve number

| Soil name and hydrologic group (appendix A) | Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio) | CN [1/] Table 2-2 | CN Figure 2-3 | CN Figure 2-4 | Area ☒ acres ☐ $mi^2$ ☐ % | Product of CN x area |
|---|---|---|---|---|---|---|
| Panoche Clay Lome Group B | Row Crops Straight Row (Poor) | 72 | | | 12 | 864 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | Totals ➡ | | 12 | 864 |

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}}$ = ________ = ______ ; Use CN ➡ 72

## 2. Runoff

| | | Storm #1 | Storm #2 | Storm #3 |
|---|---|---|---|---|
| Frequency | yr | 2 | 10 | 100 |
| Rainfall, P (24-hour) | in | 1.2 | 1.8 | 2.80 |
| Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4) | in | 0.05 | 0.23 | 0.56 |

Sheet 8

# Worksheet 3: Time of Concentration ($T_c$) or travel time ($T_t$)

| Project Panoche Energy Center | By Raud M | Date 5/23/06 |
|---|---|---|
| Location | Checked ANDY AL | Date 6/15/06 |

Check one: [X] Present [ ] Developed

Check one: [ ] $T_c$ [ ] $T_t$ through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

## Sheet flow (Applicable to Tc only)

| | | Segment 1 | Segment 2 | Total |
|---|---|---|---|---|
| | Segment ID | AB ✓ | | |
| 1. | Surface description (table 3-1) | Cultivated Soil ✓ | | |
| 2. | Manning's roughness coefficient, n (table 3-1) | 0.06 ✓ | | |
| 3. | Flow length, L (total L † 300 ft) ... ft | 50 ✓ | | |
| 4. | Two-year 24-hour rainfall, $P_2$ ... in | 1.7 ✓ | | |
| 5. | Land slope, s ... ft/ft | 0.02 ✓ | | |
| 6. | $T_t = \frac{0.007\ (nL)^{0.8}}{P_2^{0.5}\ s^{0.4}}$ Compute $T_t$ ... hr | 0.074 ✓ | + | = 0.074 ✓ |

## Shallow concentrated flow

| | | Segment 1 | Segment 2 | Total |
|---|---|---|---|---|
| | Segment ID | BC ✓ | | |
| 7. | Surface description (paved or unpaved) | UNPAVED ✓ | | |
| 8. | Flow length, L ... ft | 1079.1 ✓ | | |
| 9. | Watercourse slope, s ... ft/ft | 0.02 ✓ | | |
| 10. | Average velocity, V (figure 3-1) ... ft/s | 2.3 ✓ | | |
| 11 | $T_t = \frac{L}{3600\ V}$ Compute $T_t$ ... hr | 0.13 ✓ | + | = 0.13 ✓ |

## Channel flow

| | | Segment 1 | Segment 2 | Total |
|---|---|---|---|---|
| | Segment ID | | | |
| 12. | Cross sectional flow area, a ... $ft^2$ | | | |
| 13. | Wetted perimeter, $p_w$ ... ft | | | |
| 14. | Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft | | | |
| 15 | Channel slope, s ... ft/ft | | | |
| 16. | Manning's roughness coefficient, n ... | | | |
| 17. | $V = \frac{1.49\ r^{2/3}\ s^{1/2}}{n}$ Compute V ... ft/s | | | |
| 18. | ~~Flow length~~, L ... ft | | | |
| 19. | $T_t = \frac{L}{3600\ V}$ Compute $T_t$ ... hr | | + | = |
| 20. | Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, and 19) ... Hr | | | 0.204 ✓ |

# Worksheet 4: Graphical Peak Discharge method

| Project: PANOCHE ENERGY CENTER | By: Rand M | Date: 5/23/06 |
|---|---|---|
| Location: FRESNO COUNTY, CA | Checked: ANDY N | Date: 6/15/06 |

Check one: ☒ Present ☐ Developed

1. Data

Drainage area ........ $A_m$ = 0.01875 mi² (acres/640)

Runoff curve number ........ CN = 72 (From worksheet 2)

Time of concentration ........ $T_c$ = 0.204 hr (From worksheet 3)

Rainfall distribution ........ = I (I, IA, II III)

Pond and swamp areas sprea throughout watershed ........ = 0 percent of $A_m$ (____ acres or mi² covered)

| | | Storm #1 | Storm #2 | Storm #3 |
|---|---|---|---|---|
| 2. Frequency | yr | 2 | 10 | 100 |
| 3. Rainfall, P (24-hour) | in | 1.2 | 1.8 | 2.5 |
| 4. Initial abstraction, $I_a$ (Use CN with table 4-1) | in | 0.778 | 0.778 | 0.778 |
| 5. Compute $I_a/P$ | | 0.6483 | 0.4322 | 0.3112 |
| 6. Unit peak discharge, $q_u$ (Use $T_c$ and $I_a/P$ with exhibit 4– I ) | csm/in | 40 | 89 | 260 |
| 7. Runoff, Q (From worksheet 2) Figure 2-6 | in | 0.05 | 0.23 | 0.56 |
| 8. Pond and swamp adjustment factor, $F_p$ (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.) | | 1.0 | 1.0 | 1.0 |
| 9. Peak discharge, $q_p$ | ft³/s | 0.038 | 0.384 | 2.73 |

( Where $q_p = q_u A_m Q F_p$ )

Sheet 10

# Worksheet 2: Runoff curve number and runoff

| Project | By | Date |
|---|---|---|
| PANOCHE ENERGY CENTER | Rand M | 5/23/06 |
| Location | Checked | Date |
| FRESNO COUNTY, CA | ANDY N | 6/15/06 |

Check one: ☐ Present ☒ Developed

## 1. Runoff curve number

| Soil name and hydrologic group (appendix A) | Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio) | CN [1/] Table 2-2 | CN Figure 2-3 | CN Figure 2-4 | Area ☒ acres ☐ mi² ☐ % | Product of CN x area |
|---|---|---|---|---|---|---|
| PANOCHE CLAY LOME-GROUP B | PAVED AREAS | 98 | | | 6 | 588 |
| SAME | GRAVEL | 85 | | | 6 | 510 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | Totals ➡ | 12 | 1098 |

[1/] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1098}{12} = 91.5$ ; Use CN ➡ 92

## 2. Runoff

| | | Storm #1 | Storm #2 | Storm #3 |
|---|---|---|---|---|
| Frequency | yr | 2 | 10 | 100 |
| Rainfall, P (24-hour) | in | 1.2 | 1.8 | 2.50 |
| Runoff, Q | in | 0.57 | 1.07 | 1.70 |

(Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4)

sheet 11

# Worksheet 3: Time of Concentration ($T_c$) or travel time ($T_t$)

| | | |
|---|---|---|
| Project PANOCHE ENERGY CENTER / | By Raul M | Date 5/23/06 |
| Location FRESNO COUNTY CA | Checked ANDY N | Date 6/15/06 |

Check one: ☐ Present ☒ Developed ✓

Check one: ☐ $T_c$ ☐ $T_t$ through subarea

Notes: Space for as many as two segments per flow type can be used for each worksheet. Include a map, schematic, or description of flow segments.

## Sheet flow (Applicable to Tc only)

| | | | |
|---|---|---|---|
| Segment ID | AB ✓ | | |
| 1. Surface description (table 3-1) | Smooth Surfaces ✓ | | |
| 2. Manning's roughness coefficient, n (table 3-1) | 0.011 ✓ | | |
| 3. Flow length, L (total L † 300 ft) ... ft | 300 ✓ | | |
| 4. Two-year 24-hour rainfall, $P_2$ ... in | 1.2 ✓ | | |
| 5. Land slope, s ... ft/ft | 0.02 ✓ | | |
| 6. $T_t = \frac{0.007\,(nL)^{0.8}}{P_2^{0.5}\,s^{0.4}}$ $\frac{0.013153}{0.229086}$ Compute $T_t$ ... hr | 0.057 ✓ | + | = 0.057 ✓ |

## Shallow concentrated flow

| | | | |
|---|---|---|---|
| Segment ID | BC ✓ | | |
| 7. Surface description (paved or unpaved) | PAVED ✓ | | |
| 8. Flow length, L ... ft | 929.1 ✓ | | |
| 9. Watercourse slope, s ... ft/ft | 0.02 ✓ | | |
| 10. Average velocity, V (figure 3-1) ... ft/s | 2.85 ✓ | | |
| 11. $T_t = \frac{L}{3600\,V}$ Compute $T_t$ ... hr | 0.091 ✓ | + | = 0.091 ✓ |

## Channel flow

| | | | |
|---|---|---|---|
| Segment ID | | | |
| 12. Cross sectional flow area, a ... $ft^2$ | | | |
| 13. Wetted perimeter, $p_w$ ... ft | | | |
| 14. Hydraulic radius, $r = \frac{a}{p_w}$ Compute r ... ft | | | |
| 15 Channel slope, s ... ft/ft | | | |
| 16. Manning's roughness coefficient, n | | | |
| 17. $V = \frac{1.49\, r^{2/3}\, s^{1/2}}{n}$ Compute V ... ft/s | | | |
| 18. Flow length, L ... ft | | | |
| 19. $T_t = \frac{L}{3600\,V}$ Compute $T_t$ ... hr | | + | = |
| 20. Watershed or subarea $T_c$ or $T_t$ (add $T_t$ in steps 6, 11, and 19) ... Hr | | | 0.148 ✓ |

sheet 12

# Worksheet 4: Graphical Peak Discharge method

| Project PANOCHE ENERGY CENTER | By Rand M | Date 5/23/06 |
|---|---|---|
| Location FRESNO COUNTY CA | Checked ANDY N | Date 5/15/06 |

Check one: ☐ Present ☒ Developed

1. Data

Drainage area ............ $A_m$ = 0.01875 $mi^2$ (acres/640)

Runoff curve number ............ CN = 92 (From worksheet 2)

Time of concentration ............ $T_c$ = 0.148 hr (From worksheet 3)

Rainfall distribution ............ = I (I, IA, II III)

Pond and swamp areas sprea throughout watershed ............ = 0 percent of $A_m$ ( ______ acres or $mi^2$ covered)

| | | Storm #1 | Storm #2 | Storm #3 |
|---|---|---|---|---|
| 2. Frequency | yr | 2 | 10 | 100 |
| 3. Rainfall, P (24-hour) | in | 1.2 | 1.8 | 2.5 |
| 4. Initial abstraction, $I_a$ (Use CN with table 4-1) | in | 0.174 | 0.174 | 0.174 |
| 5. Compute $I_a/P$ | | 0.145 | 0.0967 | 0.070 |
| 6. Unit peak discharge, $q_u$ (Use $T_c$ and $I_a/P$ with exhibit 4– I ) | csm/in | 415 | 450 | 500 |
| 7. Runoff, Q (From worksheet 2) Figure 2-6 | in | 0.57 | 1.07 | 1.70 |
| 8. Pond and swamp adjustment factor, $F_p$ (Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond ans swamp area.) | | 1.0 | 1.0 | 1.0 |
| 9. Peak discharge, $q_p$ | $ft^3/s$ | 4.44 | 9.028 | 15.938 |

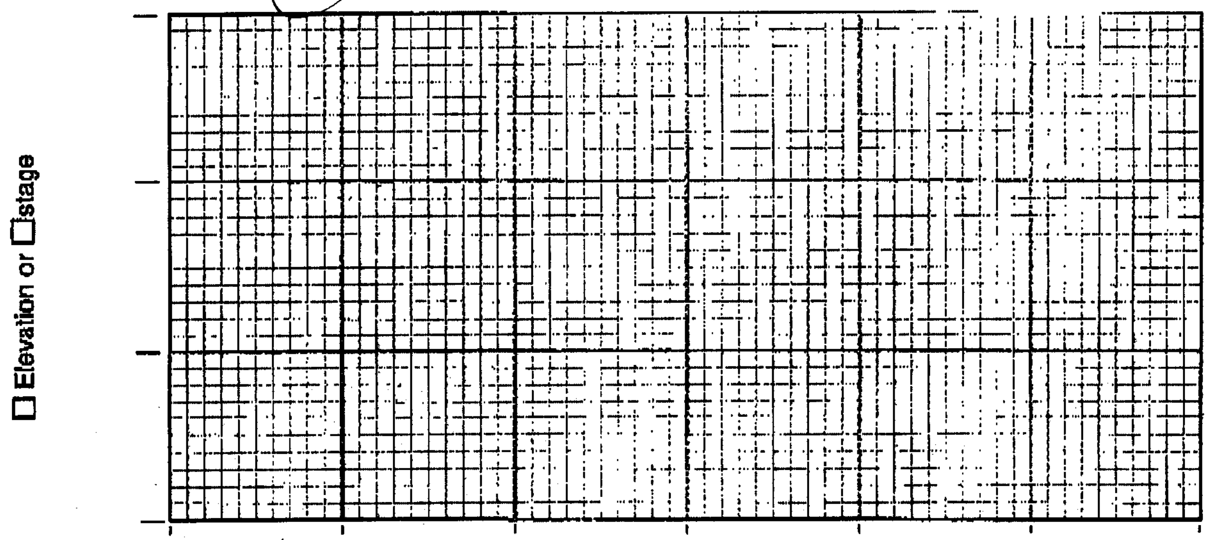
( Where $q_p = q_u A_m Q F_p$ )

Sheet 13

# Worksheet 6a: Detention basin storage, peak outflow discharge ($q_o$) known

| Project PANOCHE ENERGY CENTER | By Rand M | Date 5/23/06 |
|---|---|---|
| Location FRESNO COUNTY, CA | Checked ANDY M | Date 5/15/06 |

Check one: ☐ Present ☒ Developed

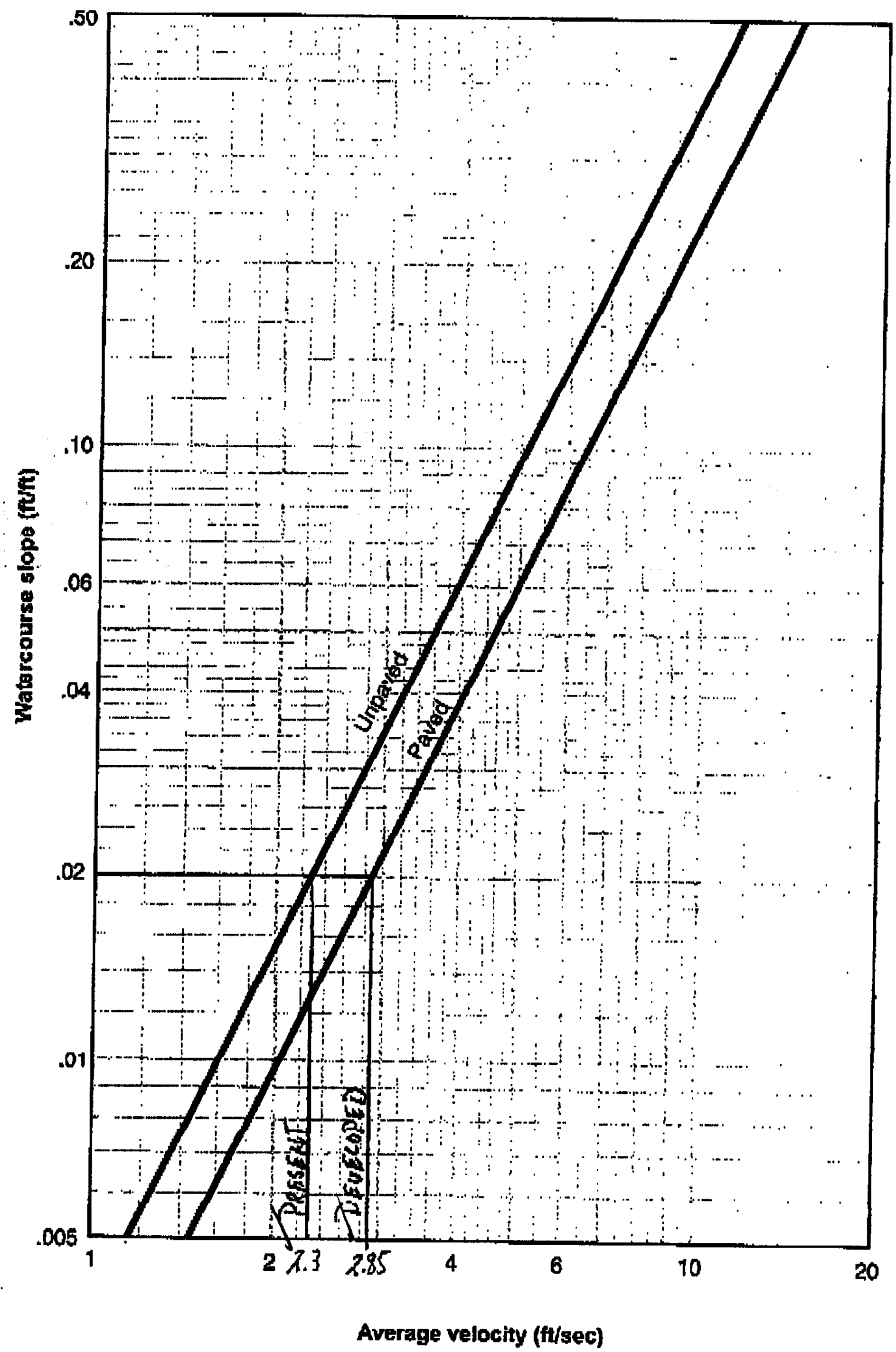



1. Data:
   Drainage area .............. $A_m$ = 0.01875 $mi^2$
   Rainfall distribution type ( I, IA, II, III) = I

| | 1st Stage | 2nd Stage |
|---|---|---|
| 2. Frequency .................. yr | 100 | |
| 3. Peak inflow discharge $q_i$ ............ ft³/s (from worksheet 4 or 5b) | 15.978 (100yr post-dev.) | |
| 4. Peak outflow discharge $q_o$ .......... ft³/s | 2.73 (100yr pre-dev.) | 1/ |
| 5. Compute $\frac{q_o}{q_i}$ ................ | 0.171 | |
| 6. $\frac{V_s}{V_r}$ ............................ ( Use $\frac{q_o}{q_i}$ with figure 6-1) | 0.42 | |
| 7. Runoff, Q ................ in ( From worksheet 2) | 1.70 | |
| 8. Runoff volume $V_r$.................. ac ft ($V_r = QA_m$ 53.33) | 1.70 | |
| 9. Storage volume, $V_s$ ......................... ac-ft ($V_s = V_r(\frac{V_s}{V_r})$) | 0.714 | |
| 10. Maximum storage $E_{max}$ (from plot) | | |

1/ 2nd stage $q_o$ includes 1st stage $q_o$.

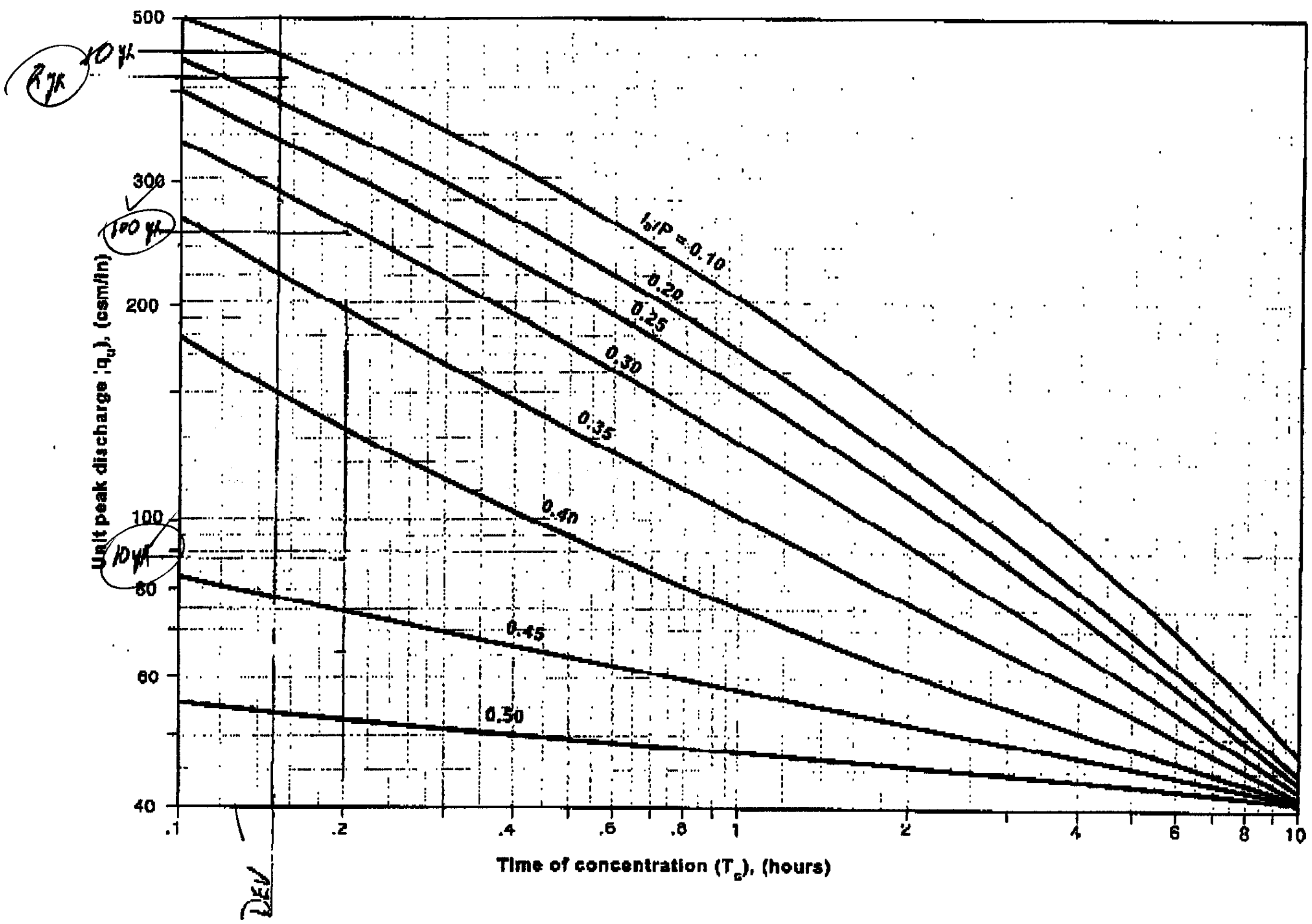
**Figure 3-1** Average velocities for estimating travel time for shallow concentrated flow



sheet 15



**Exhibit 4-I** Unit peak discharge ($q_u$) for NRCS (SCS) type I rainfall distribution



Determine invert area for the detention basin to function as an infiltration basin per TC-11 of the California Stromwater BMP Handbook.

per TC-11, use the following:

$$A := \frac{WQV}{Kt}$$

Where: A = Basin invert area ($m^2$)
WQV = water quality volume ($m^3$)
K = 0.5 times lowest field measured hydraulic conductivity (m/hr)
t = drawdown time (48 hr)

WQV = volume of runoff from the site such that 85% of the annual runoff is collected and infiltrated. Therefore, the runoff volume should be set from the runoff generated from a storm that has a 15% chance of being exceeded in any given year. Approximately equal to a 7 year storm event.

| | |
|---|---|
| from Sheet 17 & 5 | 2 yr-24 hr = 1.18" |
| from Sheet 18 | 5 yr - 24 hr = 1.5" |
| from Sheet 19 | 10 yr - 24 hr = 1.65" |

Use 1.5" as design rainfall event.

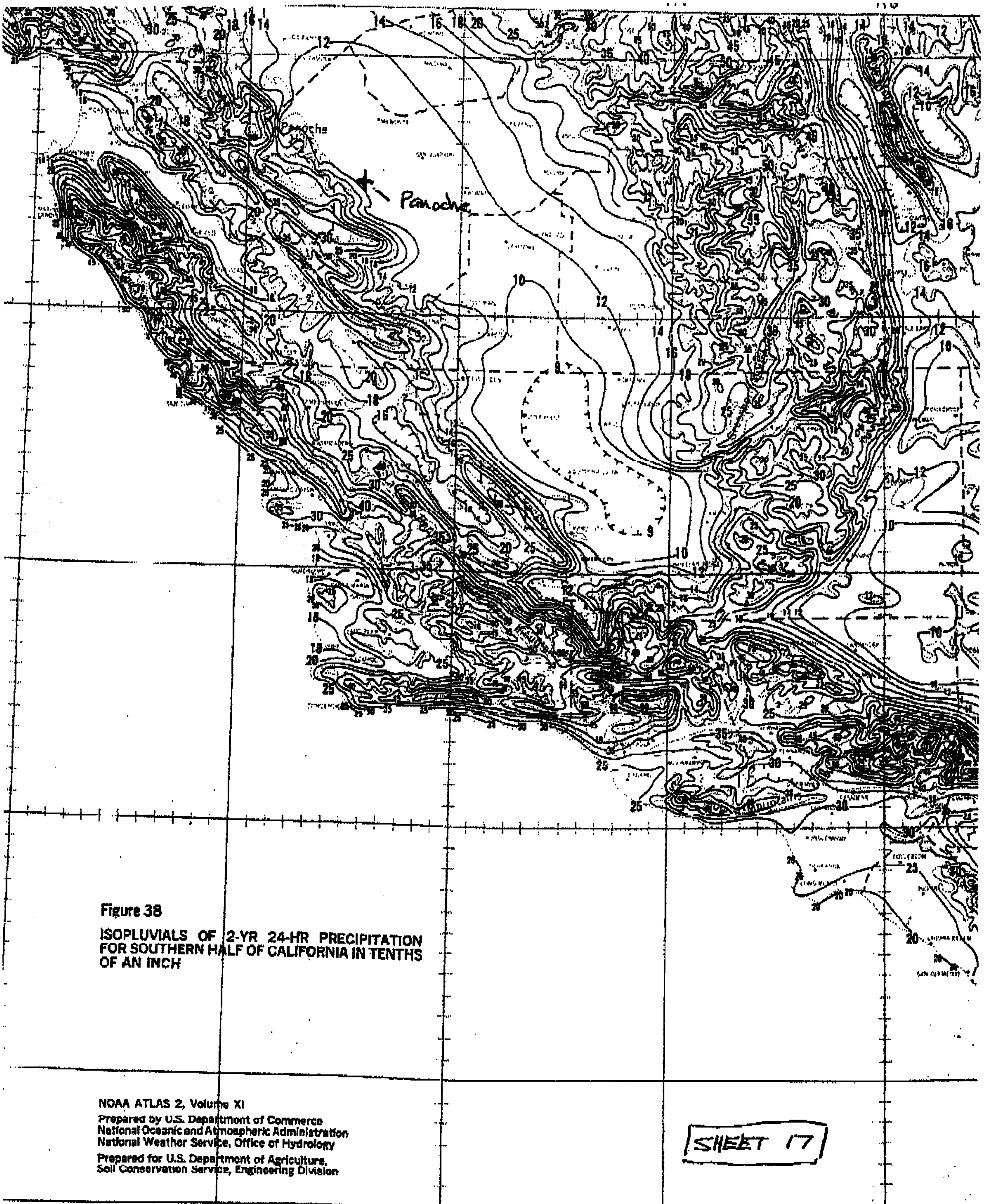



**Figure 38**

**ISOPLUVIALS OF 2-YR 24-HR PRECIPITATION FOR SOUTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH**

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

SHEET 17

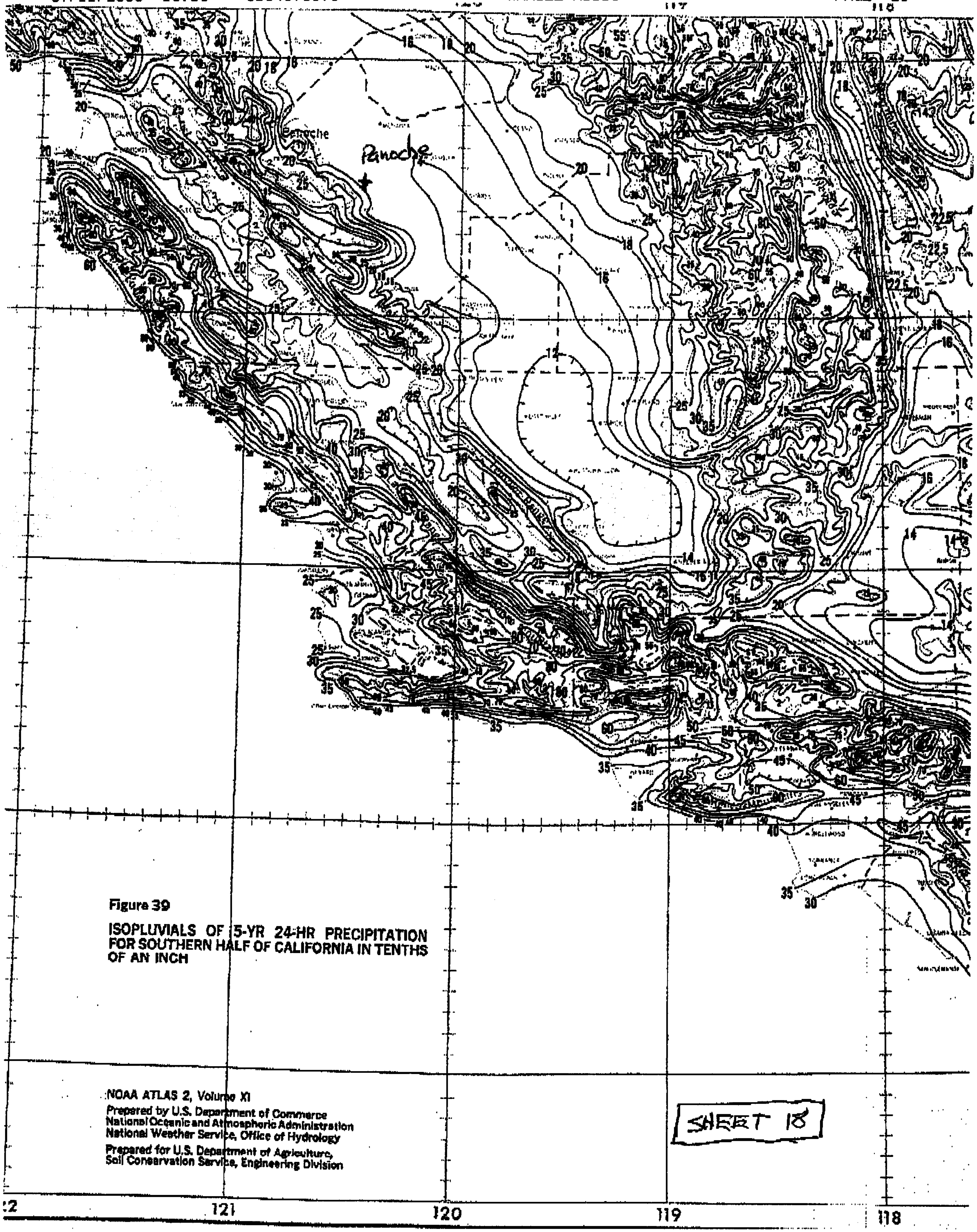



Figure 39

ISOPLUVIALS OF 5-YR 24-HR PRECIPITATION FOR SOUTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

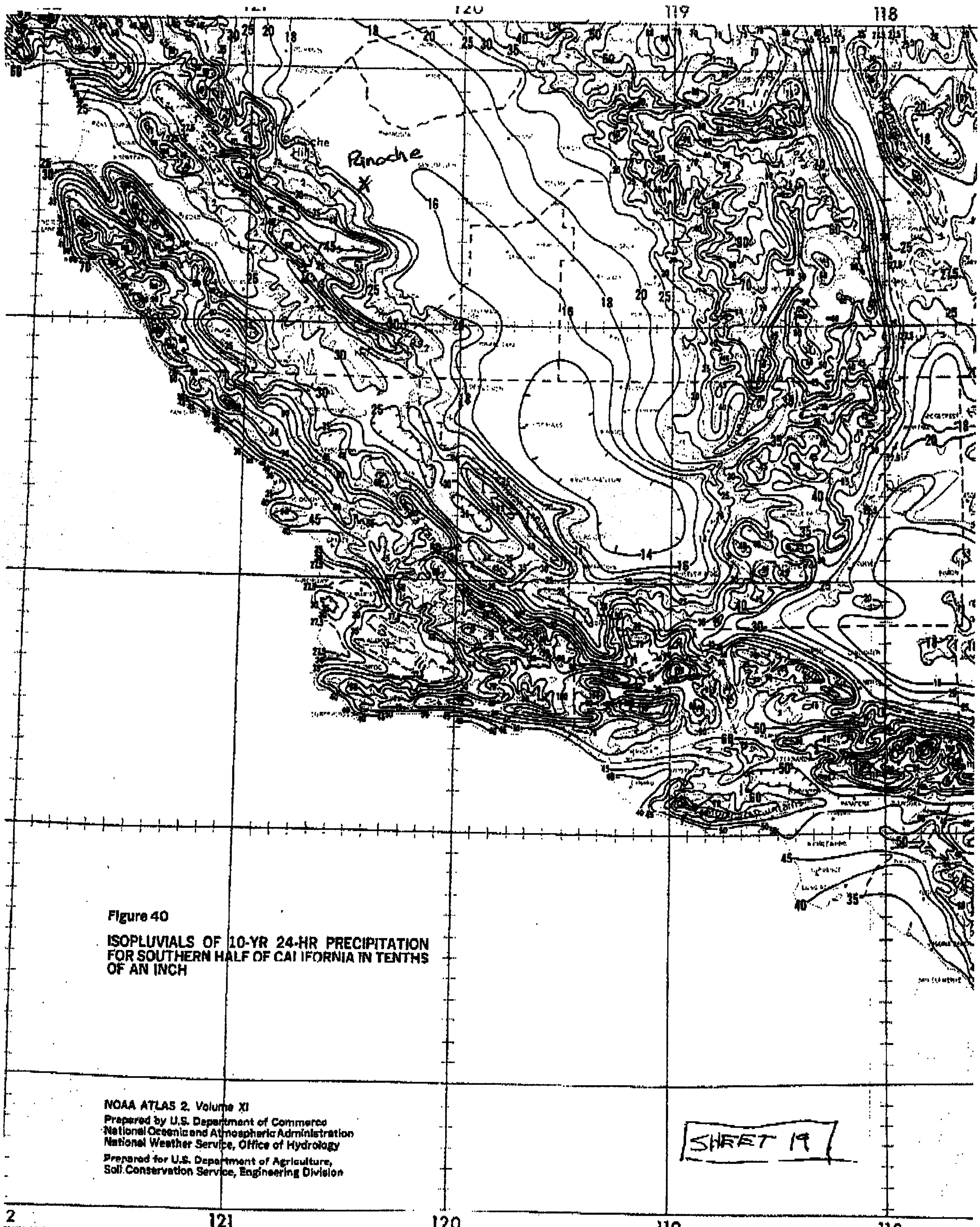



Figure 40

**ISOPLUVIALS OF 10-YR 24-HR PRECIPITATION FOR SOUTHERN HALF OF CALIFORNIA IN TENTHS OF AN INCH**

NOAA ATLAS 2, Volume XI
Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

Determine Runoff Depth to determine runoff volume

from Sheet 21

$Q := 0.75\ \text{in}$

from TR-55 Worksheet 6a:

Q= runoff depth (in)
$A_m$ = Drainage area ($mi^2$) See Sheet 9 $A_m := 0.01875\,mi^2$

$Volume := Q \cdot A_m \cdot 53.33$ $Volume = 0.75\ \text{acre ft}$

$Volume := 925 m^3$

$WQV := Volume$

$HydraulicConductivity := 4.00 \frac{\mu m}{s}$ From Sheet 22

$K := 0.5 \cdot (HydraulicConductivity)$ $K = 0.007 \frac{m}{hr}$

Determine Area of Basin: $t := 48hr$

$A := \frac{WQV}{K \cdot t}$ $A = 28810\,ft^2$

Depth of infiltration basin to provide volume necessary to mitigate 100 yr storm runoff, $V_{100}$, from Sheet 13:

$V_{100} := 0.714 acre \cdot ft$ $V_{100} = 31101.8\,ft^3$

$Depth_{min} := \frac{V_{100}}{A}$ $Depth_{min} = 1.08\,ft$

SHEET ~~20~~21

# Worksheet 2: Runoff curve number and runoff

| | | |
|---|---|---|
| Project: Panoche Energy Center | By: Andy Noll | Date: 7/12/06 |
| Location: | Checked: | Date: |

Check one: ☐ Present ☒ Developed

## 1. Runoff curve number

| Soil name and hydrologic group (appendix A) | Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio) | CN [1] Table 2-2 | CN [1] Figure 2-3 | CN [1] Figure 2-4 | Area ☒ acres ☐ mi² ☐ % | Product of CN x area |
|---|---|---|---|---|---|---|
| Panoche clay Loam – B | Paved Areas | 98 | | | 6 | 588 |
| | Gravel | 85 | | | 6 | 510 |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | Totals ➡ | 12 | 1098 |

[1] Use only one CN source per line

CN (weighted) = $\frac{\text{total product}}{\text{total area}} = \frac{1098}{12} = 91.5$ ; Use CN ➡ 92

## 2. Runoff

| | | Storm #1 | Storm #2 | Storm #3 |
|---|---|---|---|---|
| Frequency | yr | ≈ 7 ✓ | ← (14%) prob. | |
| Rainfall, P (24-hour) | in | 1.5 ✓ | | |
| Runoff, Q (Use P and CN with table 2-1, figure 2-1, or equations 2-3 and 2-4) | in | 0.75 ✓ | | |

# Physical Soil Properties

Fresno County, California, Western Part

[Entries under 'Erosion Factors--T' apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated. This report shows only the major soils in each map unit]

| Map symbol and soil name | Depth | Sand | Silt | Clay | Moist bulk density | Saturated hydraulic conductivity | Available water capacity | Linear extensibility | Organic matter | Erosion factors | | | Wind erodibility group | Wind erodibility index |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | Kw | Kf | T | | |
| | *In* | *Pct* | *Pct* | *Pct* | *g/cc* | *micro m/sec* | *In/In* | *Pct* | *Pct* | | | | | |
| 442: | | | | | | | | | | | | | | |
| PANOCHE, clay loam | 0-7 | 20-45 | 20-50 | 27-35 | 1.35-1.50 | 4.00-14.00 | 0.15-0.20 | 3.0-6.0 | 0.5-1.0 | .32 | .37 | 5 | 6 | 48 |
| | 7-16 | 20-52 | 20-50 | 18-35 | 1.35-1.55 | 4.00-14.00 | 0.13-0.20 | 3.0-6.0 | 0.4-1.0 | .37 | .43 | | | |
| | 16-27 | 20-52 | 20-50 | 18-35 | 1.35-1.50 | 4.00-14.00 | 0.13-0.20 | 3.0-6.0 | 0.3-0.5 | .43 | .43 | | | |
| | 27-43 | 20-52 | 20-50 | 18-35 | 1.35-1.55 | 4.00-14.00 | 0.13-0.20 | 3.0-6.0 | 0.2-0.5 | .43 | .43 | | | |
| | 43-57 | 20-52 | 20-50 | 18-35 | 1.35-1.55 | 4.00-14.00 | 0.13-0.20 | 3.0-6.0 | 0.2-0.5 | .43 | .43 | | | |
| | 57-72 | 20-80 | 10-50 | 10-30 | 1.40-1.60 | 4.00-14.00 | 0.09-0.18 | 3.0-6.0 | 0.1-0.4 | .37 | .37 | | | |

# PANOCHE ENERGY CENTER
## Detention/Infiltration Pond

Check previous calculations vs. Appendix D of the California Stormwater BMP Handbook.

from Sheet 24, conversely use runoff coefficient of 1.00, $\text{Depth} := 0.56\text{in}$

from Section 5.5.1 of BMP Handbook

$A := 12\text{acre}$

$WQV := \text{Depth} \cdot A$ $\quad WQV = 6.72\,\text{acre}\cdot\text{in}$ $\quad WQV = 690.75\,\text{m}^3$

from Sheet 20:

$K := 0.007\frac{\text{m}}{\text{hr}}$ $\quad t := 48\text{hr}$

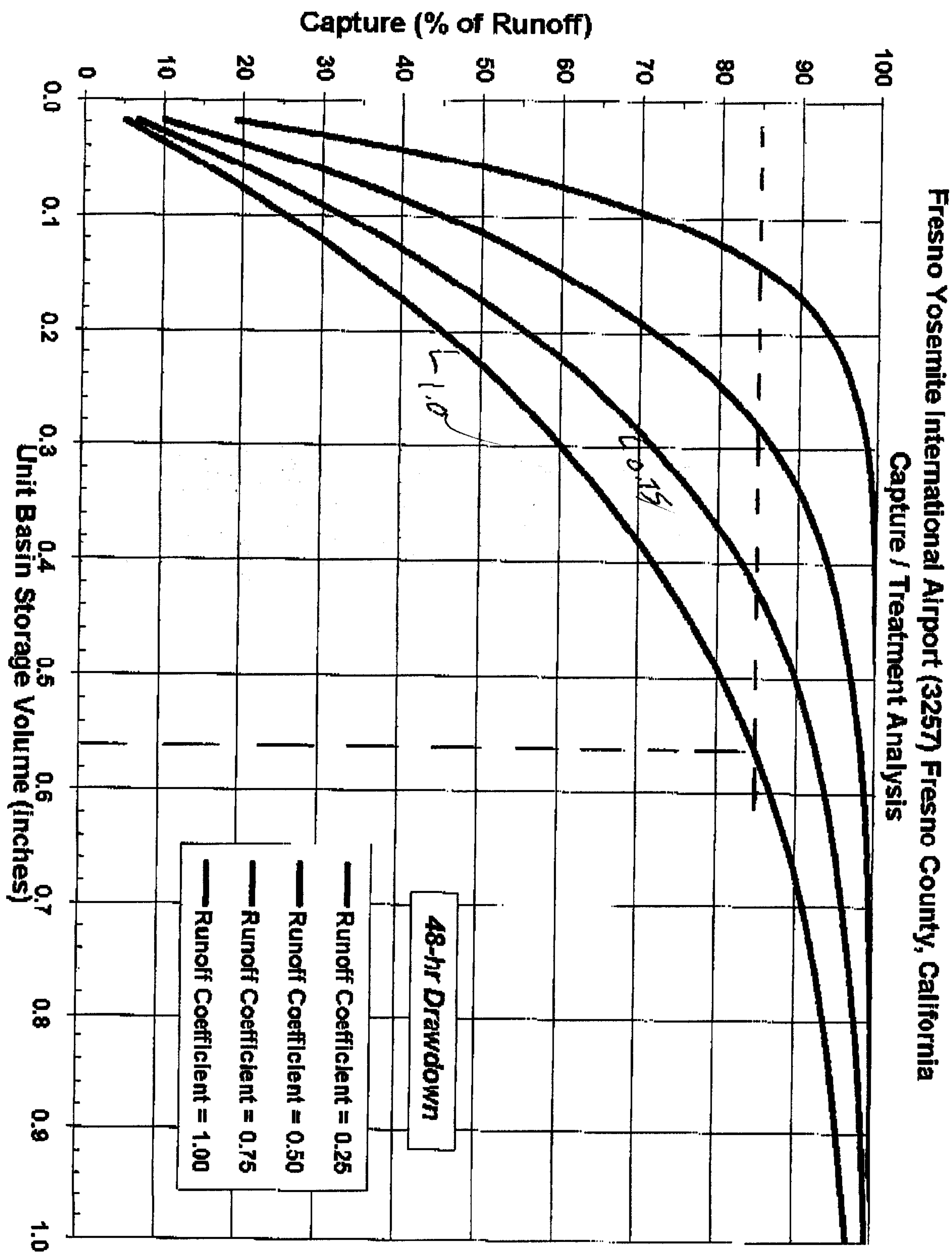
$V_{100} := 0.714\text{acre}\cdot\text{ft}$

Therefore :

$A := \frac{WQV}{K \cdot t}$ $\quad A = 22128\,\text{ft}^2$

$\text{Depth}_{min} := \frac{V_{100}}{A}$ $\quad \text{Depth}_{min} = 1.41\,\text{ft}$ $\quad$ TR-55 method is more conservative.

SHEET 24


Fresno Yosemite International Airport (3257) Fresno County, California
Capture / Treatment Analysis
Capture (% of Runoff)
0
10
20
30
40
50
60
70
80
90
100
Unit Basin Storage Volume (inches)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
48-hr Drawdown
Runoff Coefficient = 0.25
Runoff Coefficient = 0.50
Runoff Coefficient = 0.75
Runoff Coefficient = 1.00
1.0
0.75

# Infiltration Basin

# TC-11


### Design Considerations

- Soil for Infiltration
- Slope
- Aesthetics

### Targeted Constituents

| | | |
|---|---|---|
| ☑ | Sediment | ■ |
| ☑ | Nutrients | ■ |
| ☑ | Trash | ■ |
| ☑ | Metals | ■ |
| ☑ | Bacteria | ■ |
| ☑ | Oil and Grease | ■ |
| ☑ | Organics | ■ |

Legend *(Removal Effectiveness)*

● Low ■ High

▲ Medium

## Description

An infiltration basin is a shallow impoundment that is designed to infiltrate stormwater. Infiltration basins use the natural filtering ability of the soil to remove pollutants in stormwater runoff. Infiltration facilities store runoff until it gradually exfiltrates through the soil and eventually into the water table. This practice has high pollutant removal efficiency and can also help recharge groundwater, thus helping to maintain low flows in stream systems. Infiltration basins can be challenging to apply on many sites, however, because of soils requirements. In addition, some studies have shown relatively high failure rates compared with other management practices.

## California Experience

Infiltration basins have a long history of use in California, especially in the Central Valley. Basins located in Fresno were among those initially evaluated in the National Urban Runoff Program and were found to be effective at reducing the volume of runoff, while posing little long-term threat to groundwater quality (EPA, 1983; Schroeder, 1995). Proper siting of these devices is crucial as underscored by the experience of Caltrans in siting two basins in Southern California. The basin with marginal separation from groundwater and soil permeability failed immediately and could never be rehabilitated.

## Advantages

- Provides 100% reduction in the load discharged to surface waters.

- The principal benefit of infiltration basins is the approximation of pre-development hydrology during which a

CASQA

significant portion of the average annual rainfall runoff is infiltrated and evaporated rather than flushed directly to creeks.

- If the water quality volume is adequately sized, infiltration basins can be useful for providing control of channel forming (erosion) and high frequency (generally less than the 2-year) flood events.

## Limitations

- May not be appropriate for industrial sites or locations where spills may occur.
- 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 basins once clogged.

## Design and Sizing Guidelines

- Water quality volume determined by local requirements or sized so that 85% of the annual runoff volume is captured.
- Basin sized so that the entire water quality volume is infiltrated within 48 hours.
- Vegetation establishment on the basin floor may help reduce the clogging rate.

### *Construction/Inspection Considerations*

- Before construction begins, stabilize the entire area draining to the facility. If impossible, place a diversion berm around the perimeter of the infiltration site to prevent sediment entrance during construction or remove the top 2 inches of soil after the site is stabililized. Stabilize the entire contributing drainage area, including the side slopes, before allowing any runoff to enter once construction is complete.
- Place excavated material such that it can not be washed back into the basin if a storm occurs during construction of the facility.
- Build the basin without driving heavy equipment over the infiltration surface. Any equipment driven on the surface should have extra-wide ("low pressure") tires. Prior to any construction, rope off the infiltration area to stop entrance by unwanted equipment.
- After final grading, till the infiltration surface deeply.
- Use appropriate erosion control seed mix for the specific project and location.

### Performance

As water migrates through porous soil and rock, pollutant attenuation mechanisms include precipitation, sorption, physical filtration, and bacterial degradation. If functioning properly, this approach is presumed to have high removal efficiencies for particulate pollutants and moderate removal of soluble pollutants. Actual pollutant removal in the subsurface would be expected to vary depending upon site-specific soil types. This technology eliminates discharge to surface waters except for the very largest storms; consequently, complete removal of all stormwater constituents can be assumed.

There remain some concerns about the potential for groundwater contamination despite the findings of the NURP and Nightingale (1975, 1987a,b,c; 1989). For instance, a report by Pitt et al. (1994) highlighted the potential for groundwater contamination from intentional and unintentional stormwater infiltration. That report recommends that infiltration facilities not be sited in areas where high concentrations are present or where there is a potential for spills of toxic material. Conversely, Schroeder (1995) reported that there was no evidence of groundwater impacts from an infiltration basin serving a large industrial catchment in Fresno, CA.

### Siting Criteria

The key element in siting infiltration basins is identifying sites with appropriate soil and hydrogeologic properties, which is critical for long term performance. In one study conducted in Prince George's County, Maryland (Galli, 1992), all of the infiltration basins investigated clogged within 2 years. It is believed that these failures were for the most part due to allowing infiltration at sites with rates of less than 0.5 in/hr, basing siting on soil type rather than field infiltration tests, and poor construction practices that resulted in soil compaction of the basin invert.

A study of 23 infiltration basins in the Pacific Northwest showed better long-term performance in an area with highly permeable soils (Hilding, 1996). In this study, few of the infiltration basins had failed after 10 years. Consequently, the following guidelines for identifying appropriate soil and subsurface conditions should be rigorously adhered to.

- 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% clay or more than 40% 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% 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.

## Additional Design Guidelines

(1) Basin Sizing - The required water quality volume is determined by local regulations or sufficient to capture 85% of the annual runoff.

(2) Provide pretreatment if sediment loading is a maintenance concern for the basin.

(3) Include energy dissipation in the inlet design for the basins. Avoid designs that include a permanent pool to reduce opportunity for standing water and associated vector problems.

(4) Basin invert area should be determined by the equation:

$$A = \frac{WQV}{kt}$$

where A = Basin invert area ($m^2$)

WQV = water quality volume ($m^3$)

k = 0.5 times the lowest field-measured hydraulic conductivity (m/hr)

t = drawdown time ( 48 hr)

(5) 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).

# Infiltration Basin TC-11

### Maintenance

Regular maintenance is critical to the successful operation of infiltration basins. Recommended operation and maintenance guidelines include:

- Inspections and maintenance to ensure that water infiltrates into the subsurface completely (recommended infiltration rate of 72 hours or less) and that vegetation is carefully managed to prevent creating mosquito and other vector habitats.
- Observe drain time for the design storm after completion or modification of the facility to confirm that the desired drain time has been obtained.
- Schedule semiannual inspections for beginning and end of the wet season to identify potential problems such as erosion of the basin side slopes and invert, standing water, trash and debris, and sediment accumulation.
- Remove accumulated trash and debris in the basin at the start and end of the wet season.
- Inspect for standing water at the end of the wet season.
- Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons.
- Remove accumulated sediment and regrade when the accumulated sediment volume exceeds 10% of the basin.
- If erosion is occurring within the basin, revegetate immediately and stabilize with an erosion control mulch or mat until vegetation cover is established.
- To avoid reversing soil development, scarification or other disturbance should only be performed when there are actual signs of clogging, rather than on a routine basis. Always remove deposited sediments before scarification, and use a hand-guided rotary tiller, if possible, or a disc harrow pulled by a very light tractor.

### Cost

Infiltration basins are relatively cost-effective practices because little infrastructure is needed when constructing them. One study estimated the total construction cost at about $2 per ft (adjusted for inflation) of storage for a 0.25-acre basin (SWRPC, 1991). As with other BMPs, these published cost estimates may deviate greatly from what might be incurred at a specific site. For instance, Caltrans spent about $18/ft³ for the two infiltration basins constructed in southern California, each of which had a water quality volume of about 0.34 ac.-ft. Much of the higher cost can be attributed to changes in the storm drain system necessary to route the runoff to the basin locations.

Infiltration basins typically consume about 2 to 3% of the site draining to them, which is relatively small. Additional space may be required for buffer, landscaping, access road, and fencing. Maintenance costs are estimated at 5 to 10% of construction costs.

One cost concern associated with infiltration practices is the maintenance burden and longevity. If improperly maintained, infiltration basins have a high failure rate. Thus, it may be necessary to replace the basin with a different technology after a relatively short period of time.

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