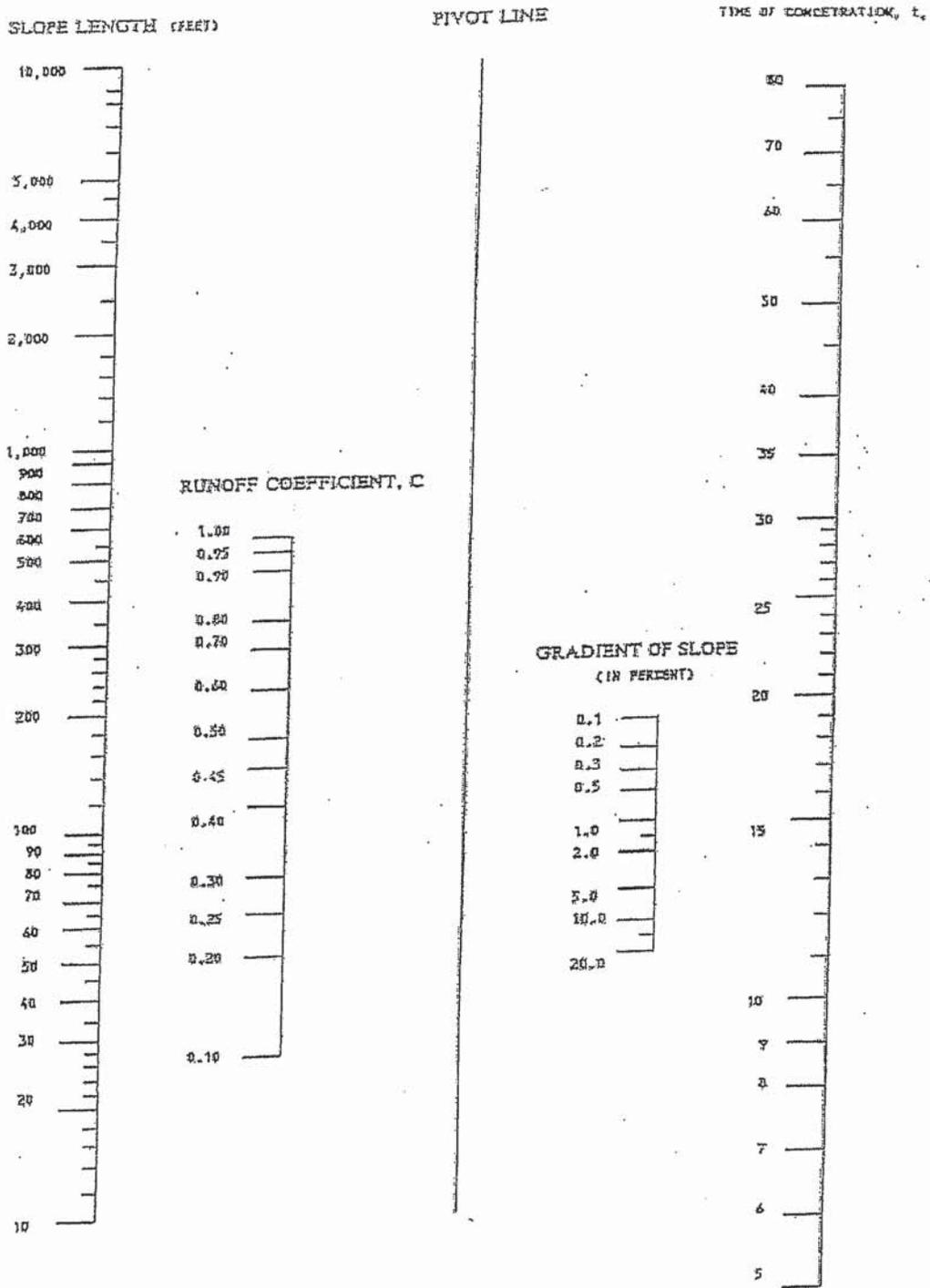


OVERLAND FLOW CHART



Worksheet 2: Runoff curve number and runoff

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____

1. Runoff curve number (CN)

Soil name and hydrologic group (Appendix A)	Cover description (cover type, treatment, and hydrologic condition; percent impervious; unconnected/connected impervious area ratio)	CN <u>1/</u>			Area <input type="checkbox"/> acres <input type="checkbox"/> mi ² <input type="checkbox"/> %	Product of CN % area
		Table 2-2	Fig. 2-3	Fig. 2-4		
<u>1/</u> Use only one CN source per line				Totals =		

CN (weighted) = total product/total area = _____ = _____; Use CN =

2. Runoff

Frequency.....yr

Rainfall, P (24-hour)in

Runoff, Qin
(Use P and CN with table 2-1, fig. 2-1, or eqs. 2-3 and 2-4.)

Storm #1	Storm #2	Storm #3

Worksheet 4: Graphical Peak Discharge method

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____

1. Data:

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

Runoff curve number $CN =$ _____ (From worksheet 2)

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

Rainfall distribution type = _____ (I, II, III)

Pond and swamp areas spread throughout watershed..... = _____ percent of A_m (_____ acres or mi^2 covered)

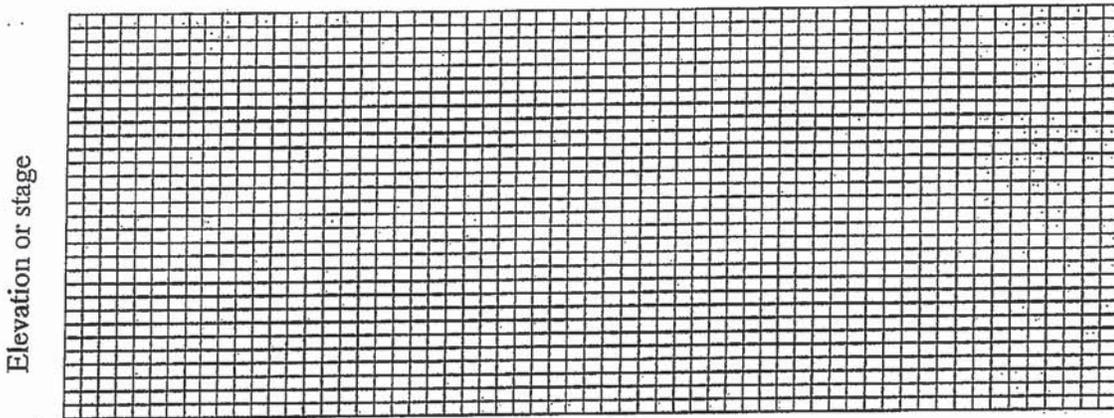
		Storm #1	Storm #2	Storm #3
2. Frequency	yr			
3. Rainfall, P (24-hour)	in			
4. Initial abstraction, I_a	in			
(Use CN with table 4-1.)				
5. Compute I_a/P				
6. Unit peak discharge, q_u	csn/in			
(Use T_c and I_a/P with exhibit 4 - _____)				
7. Runoff, Q	in			
(From worksheet 2).				
8. Pond and swamp adjustment factor, F_p				
(Use percent pond and swamp area with table 4-2. Factor is 1.0 for zero percent pond and swamp area.)				
9. Peak discharge, q_p	cfs			
(Where $q_p = q_u A_m Q F_p$)				

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

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____



Detention basin storage

1. Data:

Drainage area $A_m =$ _____ mi^2
 Rainfall distribution
 Type (I, IA, II, III) = _____

1 st stage	2 nd stage
--------------------------	--------------------------

2. Frequency.....yr

--	--

3. Peak inflow discharge

q_i cfs
 (from worksheet 4 or 5b)

--	--

4. Peak outflow discharge,
 q_o cfs

--	--

5. Compute q_o / q_i

--	--

6. V_s/V_r
 (Use q_o/q_i with figure 6-1)

--	--

7. Runoff, Q in
 (From worksheet 2)

--	--

8. Runoff volume,
 V_r ac-ft
 ($V_r = QA_m 53.33$)

--	--

9. Storage volume,
 V_s ac-ft
 ($V_s = V_r (V_s/V_r)$)

--	--

10. Maximum stage,
 (From plot)

E_{max}	
-----------	--

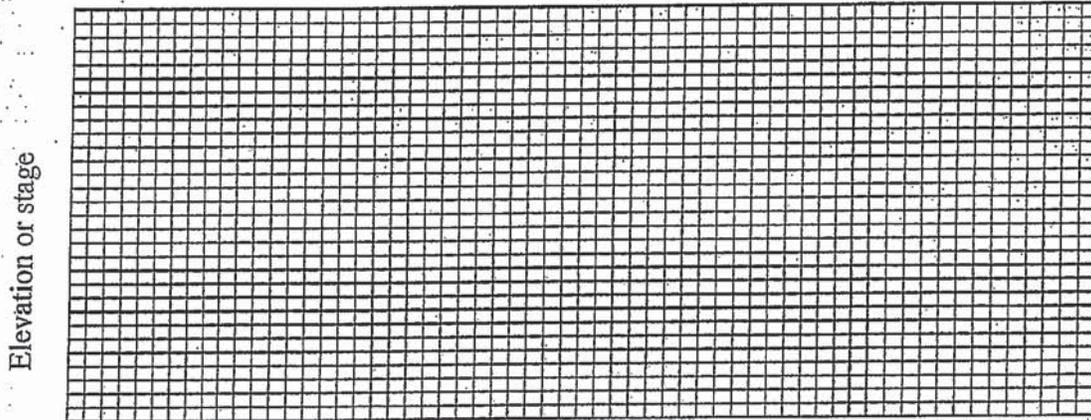
1/ 2nd stage q_o includes 1st stage q_o

Appendix A – Exhibit II (8 of 8)
 Worksheet 6b: Detention basin, peak outflow,
 storage volume (V_s) known

Project _____ By _____ Date _____

Location _____ Checked _____ Date _____

Circle one: Present Developed _____



Detention basin storage

1. Data:
 Drainage area
 Rainfall distribution
 type (I, IA, II, III)

$A_m =$ _____ mi^2
 = _____

1 st stage	2 nd stage
--------------------------	--------------------------

2. Frequency..... yr

--	--

3. Storage volume,
 V_s ac ft

--	--

4. Runoff, Q in
 (From worksheet 2)

--	--

5. Runoff volume,
 V_r ac ft
 ($V_r = QA_m 53.33$)

--	--

6. Compute V_s/V_r

--	--

7. q_o/q_i in
 (Use V_s/V_r and figure 6-1)

--	--

8. Peak inflow discharge,
 q_i cfs
 (From worksheet 4 or 5b)

--	--

9. Peak outflow discharge,
 q_o cfs
 ($q_o = q_i (q_o/q_i)$)

--	--

10. Maximum stage,
 E_{max}
 (From plot)

--	--

1/ 2nd stage q_o includes 1st stage q_o

DETENTION BASIN STORAGE DESIGN

I Calculate the peak flow in cfs due to the one (1) year frequency storm under predeveloped conditions.

$$q_1 = A * C * i \quad (\text{allowable detention basin outflow release rate – stage one})$$

Area, "A" = [_____] acres

Runoff Coefficient, "C" = [_____]

Intensity, "i" = $a / (t_c + b)$ = [_____] in/hr

Where: a = 80 (Table IV)

b = 14 (Table IV)

t_c = time of concentration (minutes) as determined from Appendix C – Exhibit 1

$$q_1 = A [\text{_____}] * C [\text{_____}] * i [\text{_____}] = [\text{_____}] \text{ cfs}$$

II Calculation for the one (1) year frequency storm under postdevelopment conditions.

$$Q_1 = A * C * i$$

Area, "A" = [_____] acres

Runoff Coefficient, "C" = [_____]

Intensity, "i" = $a / (t_c + b)$ = [_____] in/hr

Where: a = 80

b = 14

t_c = time of concentration (minutes)

$$Q_1 = A [\text{_____}] * C [\text{_____}] * i [\text{_____}] = [\text{_____}] \text{ cfs}$$

III Critical Storm Calculation.

$$[(Q_1/q_1) - 1.0] * 100 = PC \quad PC = [\text{_____}] \quad (\text{See Table II on Page 34 for Critical Storm Frequency})$$

Critical Storm Frequency = [_____]

IV Calculate maximum storm duration, T_{ccr} , for the critical storm frequency (in minutes).

$$T_{ccr} = \left[\frac{(A * C * a * b)}{(2 * q_1/3) - [(q_1^2 * t_c) / (6 * C * A * a)]} \right]^{1/2} - b$$

Appendix A – Exhibit III (2 of 4)

Where: a = determined from Table IV (for critical storm frequency)

b = determined from Table IV (for critical storm frequency)

C = the one year postdeveloped weighted runoff coefficient

A = area in acres

$$T_{ocr} = [\text{_____}] \text{ minutes}$$

V Calculate I_{cr} :

$$I_{cr} = [a / (T_{ocr} + b)] = [\text{_____}] \text{ in/hr}$$

VI Calculate Q_{cr} , flow at maximum duration for the critical storm frequency:

$$Q_{cr} = A [\text{_____}] * C [\text{_____}] * I_{cr} [\text{_____}] = [\text{_____}] \text{ cfs}$$

VII Calculate the required storage volume due to critical storm criteria, SV_{cr} :

$$SV_{cr} = [(60 * Q_{cr} * T_{ocr}) - \{ [2 * q_1 * (T_{ocr} + t_c) * 60] / 3 \} + [(q_1^2 * t_c * 60) / (6 * Q_{cr})]$$

$$SV_{cr} = [\text{_____}] \text{ ft}^3$$

VIII Calculate the peak flow in cfs due to the one-hundred (100) year frequency storm under predeveloped conditions.

$$q_{100} = A * C * i \quad (\text{allowable detention basin outflow release rate – stages one + two})$$

$$\text{Area, "A"} = [\text{_____}] \text{ acres}$$

$$\text{Runoff Coefficient, "C"} = [\text{_____}]$$

$$\text{Intensity, "i"} = a / (t_c + b) = [\text{_____}] \text{ in/hr}$$

Where: a = 290 (Table IV)

b = 31 (Table IV)

t_c = time of concentration (minutes) as determined from Appendix C – Exhibit 1, for predeveloped

$$q_{100} = A [\text{_____}] * C [\text{_____}] * i [\text{_____}] = [\text{_____}] \text{ cfs}$$

IX Calculate maximum storm duration T_{c100} , for the one-hundred year frequency (in minutes) storm under postdeveloped conditions.

Appendix A – Exhibit III (3 of 4)

$$T_{ocr} = \left[\frac{(A * C * a * b)}{(2 * q_{100}/3) - [(q_{100}^2 * t_c) / (6 * C * A * a)]} \right]^{1/2} - b$$

Where: a = 290

b = 31

C = the one-hundred year postdeveloped weighted runoff coefficient

A = area in acres

T_{C100} = [_____] minutes

X Calculate I₁₀₀:

$$I_{100} = [a / (T_{C100} + b)] = [_____] \text{ in/hr}$$

XI Calculate Q₁₀₀, flow at maximum duration for the critical storm frequency:

$$Q_{100} = A [_____] * C [_____] * I_{100} [_____] = [_____] \text{ cfs}$$

XII Calculate the required storage volume due to critical storm criteria, SV_{cr}:

$$SV_{100} = [(60 * Q_{100} * T_{C100})] - \{ [2 * q_1 * (T_{C100} + t_c) * 60] / 3 \} \\ + [(q_{100}^2 * t_c * 60) / (6 * Q_{100})]$$

$$SV_{100} = [_____] \text{ ft}^3$$

XIII Design Notes:

1. Design as a two stage outlet

a. An iterative process is required since the change in elevation head will cause an increase in the outflow of the stage one opening.

b. Two detention areas can be used to eliminate the iterative two stage outlet design process.

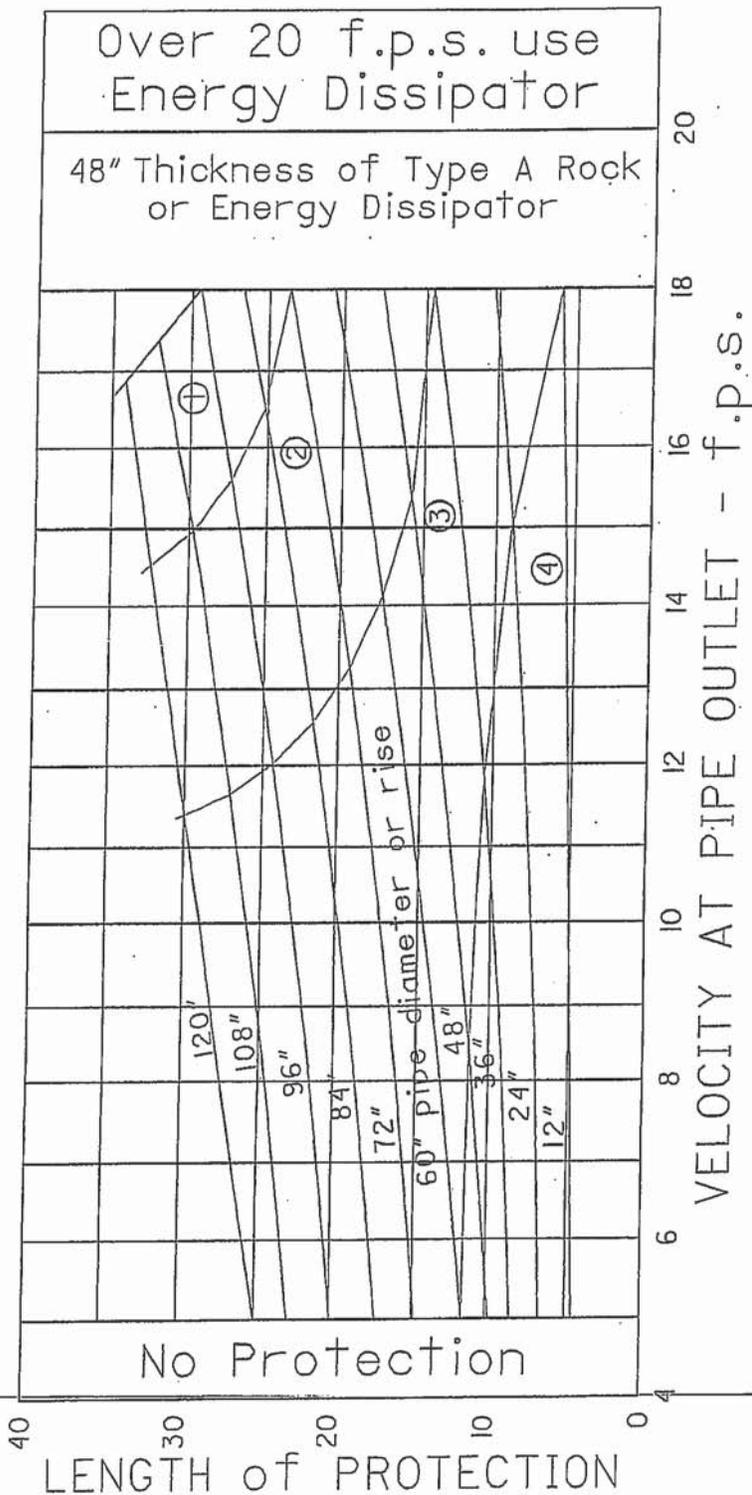
2. Emergency overflow must be accounted for via a spillway or other means.

General Notes:

1. The formulas used in calculations III through VII assume an orifice controlled outflow.

2. Reference pages 98 and 99, Water and Wastes Engineering, "Estimate Detention and Reservoir Storage". By A.S. Paital, P.E., Ph.D.

ROCK CHANNEL PROTECTION
AT CULVERT AND STORM
SEWER OUTLETS



NOTES

Rock size (6", 12", 18") indicates the square opening on which 85% of the material, by weight, will be retained.
The width of protection shall be the width of the headwall, with 4' being the minimum.
(Where a stream bed will withstand the calculated velocity without erosion, no rock channel protection will be required.)

- LEGEND
- ① 48" of 18" rock
 - ② 36" of 18" rock
 - ③ 30" of 12" rock
 - ④ 18" of 6" rock
- ROCK TYPE
- A
 - A
 - B
 - C

Appendix A – Exhibit IV

CRITICAL AREA PLANTING

1. TEMPORARY AND PERMANENT SEEDING

1.1 SEEDBED PREPARATION

A. **Lime** (in lieu of a soil test recommendation) on acid soil (ph = 5.5 or less) and subsoil at a rate of 100 pounds per 1000 sq. ft. or two (2) tons per acre of agricultural ground limestone.

B. **Fertilizer** (in lieu of soil test recommendation) shall be applied at a rate of 12-15 pounds (25 pounds for permanent seeding) per 1000 sq. ft. of 10-10-10 or 12-12-12 analysis or equivalent.

1.2 SEEDING

A. Species Selection

(1) Temporary Seeding Mixture

<u>Seeding Period</u>	<u>Type</u>	<u>Rate (1000 ft²)</u>
Spring and	1. Oats	3 lbs
Summer	2. Peren. Ryegrass	1 lbs
	3. Tall Fescue	1 lbs
Fall	1. Peren. Ryegrass	1 lbs
	2. Rye	3 lbs
	3. Wheat	3 lbs
	4. Tall Fescue	1 lbs

(2) Permanent Seeding Mixture

<u>Seeding Period</u>	<u>Type</u>	<u>Rate (1000 ft²)</u>
Spring,	1. Creeping Red Fescue	0.5 lbs
Summer, and	Domestic Ryegrass	0.25 lbs
Fall	Kentucky Bluegrass	0.25 lbs
	2. Tall Fescue	1 lbs
	3. Dwarf Fescue	1 lbs

(2-1) Seedings for Steep Banks or Cuts

Spring,	1. Tall Fescue	1 lbs
Summer, and		
Fall	2. Crownvetch	0.25 lbs
	Tall Fescue	0.50 lbs
	3. Flatpea	0.50 lbs
	Tall Fescue	0.50 lbs

(2-2) Seedings for Waterways and Road Ditches

Spring,	1. Tall Fescue	1 lbs
Summer, and		
Fall		

- B. Apply the seed uniformly with a cyclone seeder, drill, cultipacker seeder, or hydroseeder (slurry may include seed and fertilizer) preferably on a firm, moist seedbed. Seed wheat or rye no deeper than one (1) inch. Seed ryegrass no deeper than one quarter (1/4) of an inch.
- C. When feasible, except where a cultipacker type seeder is used, the seedbed should be firmed following seeding operations with a cultipacker, roller, or light drag. On sloping land seeding operations should be on the contour wherever possible.
- D. Other seed species may be substituted for these mixtures.
- E. These seeding rates need to be increased two to three times if they are to be used as a lawn.

2. DORMANT SEEDING

- A. Temporary Seeding - After November 1, use mulch only.
- B. Permanent Seeding - Seedings should not be planted from October 1 through November 20. The following methods may be used to make a "dormant seeding":
 - (1) From October 1 through November 20, prepare the seedbed, add the required amounts of lime and fertilizer, then mulch and anchor. After November 20, and before March 15, broadcast the selected seed mixture. Increase the seeding rates by 50 percent for this type of seeding.
 - (2) From November 20 through March 15, when soil conditions, permit, prepare the seedbed, lime and fertilize, apply the selected seed mixture, and
 - (3) mulch and anchor. Increase the seeding rates by 50 percent for this type of seeding.

3. MULCHING

- A. Mulch shall consist of small grain straw (preferably wheat or rye) and shall be applied at the rate of two tons per acre or 100 pounds per 1000 sq. ft.
- B. Spread the mulch uniformly by hand or mechanically so the soil surface is covered.
- C. **Mulch Anchoring Methods**
 - (1) Mechanical - Use a disk, crimper, or similar type tool set straight to punch or anchor the mulch material into the soil.
 - (2) Asphalt Emulsion - Apply at the rate of 160 gallons per acre into the mulch as it is being applied.
 - (3) Mulch Netting - Use according to the manufacturer's recommendations.

4. IRRIGATION

Supply new seedlings with adequate water for plant growth until they are firmly established.
