

APPENDIX D

COMPUTER PROGRAM FOR CALCULATING THE DRAINAGE VOLUME -
WATER TABLE DEPTH RELATIONSHIP FOR LAYERED SOILS

The program reads in layer depths and soil water characteristics for up to five-layers. The drainage volumes for a wide range of water table depths are calculated by assuming a hydrostatic pressure head distribution above the water table.

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C           DRAINAGE VOLUME—WATER TABLE DEPTH PROGRAM
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C
C   THIS PROGRAM READS IN SOIL WATER CHARACTERISTIC DATA FOR AS MANY
C   AS 5 LAYERS AND COMPUTES THE 'DRAINED TO EQUILIBRIUM' RELATIONSHI
C   BETWEEN DRAINAGE VOLUME AND WATER TABLE DEPTH.
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C   DIMENSION H(5,100),THETA(5,100),ATHT(5,500),X(500),W(500),IC(5),
C   *D(5),AH(5,500),AV(5,500)
C   READ(1,205)N,(D(I),I=1,N),AINC,M
205  FORMAT(I2,4F8.1,I4)
C   READ DATA FOR ALL THE LAYERS .
C   DO 10 I=1,N
C     IC(I)=1
C   1   READ(1,206)THETA(I,IC(I)),H(I,IC(I))
C     IF(H(I,IC(I)))10,5,5
206  FORMAT(F10.3,8X,F10.3)
C   5   IC(I)=IC(I)+1
C     GO TO 1
C  10  IC(I)=IC(I)-1
C*****
C           DEFINITION OF SOME TERMS
C
C   THETA IS THE VOLUMETRIC WATER CONTENT CORRESPONDING TO THE PRESSU
C   HEAD H.
C   H IS THE PRESSURE HEAD WRITTEN AS A POSITIVE QUANTITY; I.E. TENSI
C   X(L) IS WATER TABLE DEPTH IN METERS
C   W(L) IS DRAINAGE VOLUME IN MILLIMETERS.
C   P IS THE PROFILE VOLUME
C   X IS THE PROFILE DEPTH
C   AINC IS THE INCREMENT IN WATER TABLE
C   N IS THE NUMBER OF LAYERS
C   D(1),D(2),D(3),... ARE THE CUMULATIVE DEPTHS OF EACH LAYER.
C   M IS NUMBER OF SECTIONS IN THE PROFILE
C   IC IS THE COUNTER OF DATA CARDS FOR EACH LAYER
C   FIRST DATA CARD SHOULD CONTAIN N,D1,D2.....,DN,AINC,M
C   THIS SHOULD BE FOLLOWED BY THE DATA CARDS FOR LAYER1,LAYER2..ETC.
C   THE LAST CARD OF EACH LAYER SHOULD BE A DUMMY CARD CONTAINING A
C   NEGATIVE NUMBER FOR 'H'.
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C   PRINT DATA
    WRITE(6,15)N,(D(I),I=1,N)
    WRITE(6,16)AINC,M
15  FORMAT('0'/////10X,'N=',I2,'D=',5F10.1)
16  FORMAT('0',10X,'INCREMENT=',F6.2,10X,'SECTIONS=',I5)
    DO 30 I=1,N
    WRITE(6,35)I
    N1=IC(I)
    DO 20 J=1,N1

20  WRITE(6,40)H(I,J),THETA(I,J)
30  CONTINUE
35  FORMAT('0'/////35X,'LAYER=',I2//20X,'PRESSURE HEAD',10X,'THETA')
40  FORMAT(' ',F29.1,F19.3)
    X(1)=0.0
    DO 25 I=2,M
25  X(I)=X(I-1)+AINC
C   INTERPOLATE
    DO 80 I=1,N
    J=2
    ATHT(I,1)=THETA(I,1)
    N1=IC(I)
    DELTA=(THETA(I,J)-THETA(I,J-1))/(H(I,J)-H(I,J-1))
    DO 75 L=2,M
    IF(X(L)-H(I,J))72,65,65
65  J=J+1
    IF(J-N1)71,71,80
71  DELTA=(THETA(I,J)-THETA(I,J-1))/(H(I,J)-H(I,J-1))
    ATHT(I,L)=THETA(I,J-1)
    GO TO 75
72  ATHT(I,L)=ATHT(I,L-1)+DELTA
75  CONTINUE
80  CONTINUE
C   CALCULATE AND PRINT VOLUMES FOR EACH LAYER
    DO 70 I=1,N
    S=ATHT(I,1)
    AV(I,1)=0.0
    DO 60 J=2,M
    DV=0.5*(X(J)-X(J-1))*(S-ATHT(I,J)+S-ATHT(I,J-1))
    AV(I,J)=AV(I,J-1)+DV
60  CONTINUE
70  CONTINUE
C   CALCULATE PROFILE
C   CALCULATE WATER TABLE AT PROFILE
    WRITE(6,160)
    W(1)=0.0
    DO 151 L=2,M
    IF(X(L)-D(1))85,85,90
C   FIRST LAYER
85  N1=X(L)/AINC+1
    W(L)=AV(1,N1)
    GO TO 150
90  IF(X(L)-D(2))95,95,100
95  N1=X(L)/AINC+1
    N2=(X(L)-D(1))/AINC+1
    V1=AV(1,N1)-AV(1,N2)

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W(L)=AV(2,N2)+V1
GO TO 150
100 IF(X(L)-D(3))105,105,110
105 N1=X(L)/AINC+1
N2=(X(L)-D(1))/AINC+1
V1=AV(1,N1)-AV(1,N2)
N1=(X(L)-D(2))/AINC+1
V2=AV(2,N2)-AV(2,N1)
V3=AV(3,N1)
W(L)=V1+V2+V3
GO TO 150
110 IF(X(L)-D(4))170,170,180
170 N1=X(L)/AINC+1
N2=(X(L)-D(1))/AINC+1
N3=(X(L)-D(2))/AINC+1
N4=(X(L)-D(3))/AINC+1
V1=AV(1,N1)-AV(1,N2)
V2=AV(2,N2)-AV(2,N3)
V3=AV(3,N3)-AV(3,N4)
V4=AV(4,N4)
W(L)=V1+V2+V3+V4
GO TO 150
180 IF(X(L)-D(5))190,190,200
190 N1=X(L)/AINC+1
N2=(X(L)-D(1))/AINC+1
N3=(X(L)-D(2))/AINC+1
N4=(X(L)-D(3))/AINC+1
N5=(X(L)-D(4))/AINC+1
V1=AV(1,N1)-AV(1,N2)
V2=AV(2,N2)-AV(2,N3)
V3=AV(3,N3)-AV(3,N4)
V4=AV(4,N4)-AV(4,N5)
V5=AV(5,N5)
W(L)=V1+V2+V3+V4+V5
200 CONTINUE
150 X(L)=X(L)/100.0
W(L)=W(L)*10.0
WRITE(6,165)X(L),W(L)
151 CONTINUE
160 FORMAT('1'/////25X,'WATER TABLE',10X,'VOLUME')
165 FORMAT(' ',F29.2,F20.3)
END

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CC

C

C SAMPLE INPUT DATA FOR WT VS VOL DRAINED

C

CC

| | | | | | |
|-------|------|-------|-------|-----|-----|
| 3 | 40.0 | 115.0 | 300.0 | 2.0 | 150 |
| 0.630 | | | 0.0 | | |
| 0.615 | | | 10. | | |
| 0.596 | | | 20. | | |
| 0.582 | | | 30. | | |
| 0.572 | | | 40. | | |
| 0.556 | | | 60. | | |

| | |
|-------|--------|
| 0.545 | 80. |
| 0.536 | 100. |
| 0.514 | 150. |
| 0.498 | 200. |
| 0.470 | 400. |
| 0.22 | 15000. |
| 0.22 | -500. |
| 0.530 | 0. |
| 0.525 | 10. |
| 0.510 | 20. |
| 0.475 | 30. |
| 0.450 | 40. |
| 0.415 | 60. |
| 0.392 | 80. |
| 0.376 | 100. |
| 0.355 | 150. |
| 0.340 | 200. |
| 0.312 | 400. |
| 0.18 | 15000. |
| 0.18 | -500. |
| 0.375 | 0. |
| 0.371 | 10. |
| 0.365 | 20. |
| 0.355 | 30. |
| 0.345 | 40. |
| 0.322 | 60. |
| 0.306 | 80. |
| 0.296 | 100. |
| 0.283 | 150. |
| 0.277 | 200. |
| 0.268 | 400. |
| 0.12 | 15000. |
| 0.12 | -500. |

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C  
C          SAMPLE OUTPUT FOR WT VS VOL DRAINED  
C  
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0          N= 3D=      40.0      115.0      300.0  
0          INCREMENT= 2.00          SECTIONS= 150
```

LAYER= 1

| PRESSURE HEAD | THETA |
|---------------|-------|
| 0.0 | 0.630 |
| 10.0 | 0.615 |
| 20.0 | 0.596 |
| 30.0 | 0.582 |
| 40.0 | 0.572 |
| 60.0 | 0.556 |
| 80.0 | 0.545 |
| 100.0 | 0.536 |
| 150.0 | 0.514 |
| 200.0 | 0.498 |
| 400.0 | 0.470 |
| 15000.0 | 0.220 |

0

LAYER= 2

| PRESSURE HEAD | THETA |
|---------------|-------|
| 0.0 | 0.530 |
| 10.0 | 0.525 |
| 20.0 | 0.510 |
| 30.0 | 0.475 |
| 40.0 | 0.450 |
| 60.0 | 0.415 |
| 80.0 | 0.392 |
| 100.0 | 0.376 |
| 150.0 | 0.355 |
| 200.0 | 0.340 |
| 400.0 | 0.312 |
| 15000.0 | 0.180 |

0

LAYER= 3

| PRESSURE HEAD | THETA |
|---------------|-------|
| 0.0 | 0.375 |
| 10.0 | 0.371 |
| 20.0 | 0.365 |
| 30.0 | 0.355 |
| 40.0 | 0.345 |
| 60.0 | 0.322 |
| 80.0 | 0.306 |

| | |
|---------|-------|
| 100.0 | 0.296 |
| 150.0 | 0.283 |
| 200.0 | 0.277 |
| 400.0 | 0.268 |
| 15000.0 | 0.120 |

1

| WATER TABLE (m) | VOLUME (mm) |
|-----------------|-------------|
| 0.02 | 0.015 |
| 0.04 | 0.060 |
| 0.06 | 0.135 |
| 0.08 | 0.240 |
| 0.10 | 0.450 |
| 0.12 | 0.769 |
| 0.14 | 1.126 |
| 0.16 | 1.521 |
| 0.18 | 1.954 |
| 0.20 | 2.520 |
| 0.22 | 3.214 |
| 0.24 | 3.936 |
| 0.26 | 4.686 |
| 0.28 | 5.464 |
| 0.30 | 6.340 |
| 0.32 | 7.310 |
| 0.34 | 8.300 |
| 0.36 | 9.310 |
| 0.38 | 10.340 |
| 0.40 | 11.440 |
| 0.42 | 12.598 |
| 0.44 | 13.752 |
| 0.46 | 14.902 |
| 0.48 | 16.048 |
| 0.50 | 17.140 |
| 0.52 | 18.184 |
| 0.54 | 19.236 |
| 0.56 | 20.296 |
| 0.58 | 21.364 |
| 0.60 | 22.500 |
| 0.62 | 23.726 |
| 0.64 | 25.006 |
| 0.66 | 26.338 |
| 0.68 | 27.724 |
| 0.70 | 29.267 |
| 0.72 | 30.963 |
| 0.74 | 32.699 |
| 0.76 | 34.477 |
| 0.78 | 36.295 |
| 0.80 | 38.285 |
| 0.82 | 40.439 |
| 0.84 | 42.621 |
| 0.86 | 44.831 |

| | |
|------|---------|
| 0.88 | 47.069 |
| 0.90 | 49.335 |
| 0.92 | 51.629 |
| 0.94 | 53.951 |
| 0.96 | 56.301 |
| 0.98 | 58.679 |
| 1.00 | 61.225 |
| 1.02 | 63.935 |
| 1.04 | 66.667 |
| 1.06 | 69.419 |
| 1.08 | 72.191 |
| 1.10 | 74.985 |
| 1.12 | 77.799 |
| 1.14 | 80.635 |
| 1.16 | 83.491 |
| 1.18 | 86.366 |
| 1.20 | 89.321 |
| 1.22 | 92.352 |
| 1.24 | 95.396 |
| 1.26 | 98.450 |
| 1.28 | 101.504 |
| 1.30 | 104.556 |
| 1.32 | 107.606 |
| 1.34 | 110.654 |
| 1.36 | 113.654 |
| 1.38 | 116.592 |
| 1.40 | 119.530 |
| 1.42 | 122.465 |
| 1.44 | 125.359 |
| 1.46 | 128.086 |
| 1.48 | 130.656 |
| 1.50 | 133.315 |
| 1.52 | 136.061 |
| 1.54 | 138.783 |
| 1.56 | 141.406 |
| 1.58 | 143.939 |
| 1.60 | 146.466 |
| 1.62 | 148.987 |
| 1.64 | 151.502 |
| 1.66 | 154.011 |
| 1.68 | 156.514 |
| 1.70 | 159.011 |
| 1.72 | 161.502 |
| 1.74 | 163.987 |
| 1.76 | 166.406 |
| 1.78 | 168.761 |
| 1.80 | 171.116 |
| 1.82 | 173.469 |
| 1.84 | 175.822 |
| 1.86 | 178.173 |
| 1.88 | 180.524 |
| 1.90 | 182.868 |
| 1.92 | 185.207 |
| 1.94 | 187.544 |
| 1.96 | 189.845 |

| | |
|------|---------|
| 1.98 | 192.112 |
| 2.00 | 194.457 |
| 2.02 | 196.881 |
| 2.04 | 199.302 |
| 2.06 | 201.719 |
| 2.08 | 204.132 |
| 2.10 | 206.542 |
| 2.12 | 208.948 |
| 2.14 | 211.350 |
| 2.16 | 213.719 |
| 2.18 | 216.056 |
| 2.20 | 218.392 |
| 2.22 | 220.727 |
| 2.24 | 223.061 |
| 2.26 | 225.394 |
| 2.28 | 227.727 |
| 2.30 | 230.059 |
| 2.32 | 232.390 |
| 2.34 | 234.720 |
| 2.36 | 237.050 |
| 2.38 | 239.379 |
| 2.40 | 241.701 |
| 2.42 | 244.019 |
| 2.44 | 246.336 |
| 2.46 | 248.652 |
| 2.48 | 250.968 |
| 2.50 | 253.284 |
| 2.52 | 255.599 |
| 2.54 | 257.914 |
| 2.56 | 260.229 |
| 2.58 | 262.543 |
| 2.60 | 264.856 |
| 2.62 | 267.170 |
| 2.64 | 269.483 |
| 2.66 | 271.755 |
| 2.68 | 273.988 |
| 2.70 | 276.219 |
| 2.72 | 278.449 |
| 2.74 | 280.679 |
| 2.76 | 282.907 |
| 2.78 | 285.135 |
| 2.80 | 287.363 |
| 2.82 | 289.589 |
| 2.84 | 291.815 |
| 2.86 | 294.040 |
| 2.88 | 296.263 |
| 2.90 | 298.487 |
| 2.92 | 300.709 |
| 2.94 | 302.931 |
| 2.96 | 305.151 |
| 2.98 | 307.371 |