GRADE STABILIZATION STRUCTURE DESIGN METHOD

BASIC ASSUMPTIONS

1. The TR-55 Chapter 6 method (Storage Volume for Detention Basins) was used.

2. The peak discharge was maximized by minimizing the time of concentration to make this a conservative method.

   a. The drainage area was assumed to be circular in shape to minimize the ratio of travel length to drainage area.

   b. The sheet flow was assumed to be the first 100 feet of travel length.

   c. The shallow concentrated flow and channelized flow were assumed to each be one half of the remaining travel length (the travel lengths of each vary from 135 to 477 feet).

   d. Initially three different watercourse slopes were used to calculate travel time values for each of the three flow conditions (sheet, shallow concentrated and channel flow). For sheet flow, 1%, 3% and 5% slopes were used. For both shallow concentrated and channel flow, 5%, 10% and 15% slopes were used. However, for the small drainage areas used in this method, varying the slopes resulted in little variation in the resulting peak discharges. When there was any variation, the largest peak discharge was used.

3. A 10-year 24-hour storm was used. This assumes a principal spillway design without an emergency spillway.

4. This method applies to the State of Wisconsin (it assumes a Type II storm distribution).

LIMITATIONS OF THE GRADE STABILIZATION STRUCTURE DESIGN METHOD

1. The method uses a 10-yr 24-hr storm (and less than 10 ac-ft of runoff) to design the principal spillway without an emergency spillway. No emergency spillway is required since the principal spillway discharge and available storage will handle the design storm (standard 410 page 410-2 under "Pond size dams").

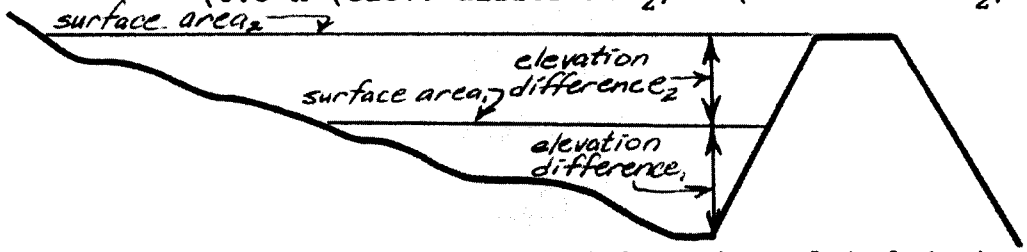
2. The method is for structural heights* of less than 15 feet.

3. The method is for drainage areas up to 20 acres.

4. The method is for curve numbers varying from 60 to 80.

5. A stage storage curve needs to be developed for the site to at least the planned top of the structure. The recommended method for determining storage is to survey the surface area for least at one elevation (at the planned top of structure or higher) and preferably at another, lower, elevation. Then estimate the storage to be:

$$S = (0.5 \times (\text{elev. difference}_1) \times (\text{surface area}_1)) + (0.5 \times (\text{elev. difference}_2) \times (\text{surface area}_2) + \ldots$$



6. The curves on the graphs must not be extrapolated (extended).

7. When a runoff curve number (CN) value falls between the values on a graph, the CN curves may be interpolated.

8. When a drainage area falls between the values for two figures, use the figure with the larger drainage area. For example, if the drainage area is 9 ac, use the figure for 10 ac.

9. When using the pipe flow graph and the pipe size falls between two sizes, use the larger pipe size.

10. The pipe flow graphs are for 70 foot long pvc pipe. Table 1 gives conversions for pvc pipe of different lengths (40 to 120 feet) and Table 2 gives conversions for cmp conduits of different lengths (40 to 120 feet). Additional graphs are available for several types of surface inlets.

*Structural Height - the difference in elevation in feet between the lowest point on the top of the dam and the lowest point in the natural streambed at the downstream toe of the dam.

HOW TO USE THE GRADE STABILIZATION STRUCTURE DESIGN METHOD

1. Determine the following:

   a. The drainage area to the proposed structure site.

   b. The runoff curve number for the drainage area.

   c. The stage storage curve for the proposed structure at least to the elevation of the proposed top of the structure. The storage volume to be used in the graphs is that volume to the design water surface. A minimum freeboard of 0.3 feet shall be provided from the design water surface to the top of settled fill.

   d. The head available for pipe flow. This is the difference between the elevation of the design water surface and the elevation of the center of the outlet of the pipe.

   e. The pipe material and the approximate pipe length needed.

2. For a 70 foot long PVC pipe:

   a. Select the figure (from Figures 1 through 6) for appropriate drainage area. If the drainage area falls between that for two different figures, select the figure with the larger drainage area.

   b. Determine the pipe diameter using one of two methods:

      i. Working from the left to the right in the figure:
      - Start with the graph on the left in the figure (the Peak Outflow Discharge versus Storage Volume graph). Determine the peak outflow discharge for the curve number and for the storage volume to the design water surface.
      - Use this peak outflow discharge in the graph on the right in the figure (the Peak Outflow Discharge versus Head graph). Determine the required pipe diameter for the available head.
      - If the pipe diameter falls between two different sizes, select the larger size.

      ii. Working from the right to the left in the figure:
      - Assume a pipe diameter and use the graph on the right to determine the peak outflow discharge for the available head.
      - Use this peak outflow discharge in the graph on the left and determine the minimum storage volume required for the given curve number.

- If the minimum storage volume required is slightly less than or equal to that available, then the pipe size is adequate. If it is significantly less than that available, try the next smaller pipe size. If the minimum storage volume required is greater than that available, select a larger pipe size and try again.

3. For a PVC pipe of length other than 70 feet (between 40 and 120 feet):

a. Select the figure (from Figures 1 through 6) for a 70 foot long pipe for the appropriate drainage area. If the drainage area falls between that for two different figures, select the figure with the larger drainage area.

b. Determine the pipe size using one of two methods:

i. Working from left to right in the figure:
- Start with the graph on the left. Determine the peak outflow discharge for the curve number and for the storage volume to the design water surface.
- Use this peak outflow discharge in the graph on the right and determine the required pipe diameter for the available head.
- If the pipe diameter falls between two different sizes, select the larger size. Determine the peak outflow discharge for this pipe diameter and for the available head.
- Select the conversion factor from Table 1 (Conversion Factors for Various PVC Pipe Lengths) for the selected pipe diameter and length.
- Multiply the peak outflow discharge by the conversion factor to obtain a new peak outflow discharge.
- Use this new peak outflow discharge with the curve number in the graph on the left to determine the minimum storage volume required.
- If the minimum storage volume required is slightly less than or equal to that available, then the pipe size is adequate. If it is significantly less than that available, try the next smaller pipe size. If the minimum storage volume required is greater than that available, select the next larger pipe size and try again.

ii. Working from right to left:
- Assume a pipe diameter and use the graph on the right to determine the peak outflow discharge for the available head.
- Select the conversion factor from Table 1 for the selected pipe diameter and length.

- Multiply the peak outflow discharge by this conversion factor to obtain a new peak outflow discharge.
- Use this new peak outflow discharge with the curve number in the graph on the left to determine the minimum storage volume required.
- If the minimum storage volume required is slightly less than or equal to that available, then the pipe size is adequate. If it is significantly less than that available, try the next smaller pipe size. If the minimum storage volume required is greater than that available, select a larger pipe size and try again.

4. For a CMP conduit of any length between 40 and 120 feet:

   a. Select the figure (from Figures 1 through 6) for a 70 foot long PVC pipe for the appropriate drainage area. If the drainage area falls between that for two different figures, use the figure with the larger drainage area.

   b. Determine the pipe size using one of two methods outlined in 3b. above, except use the conversion factors from Table 2 (Conversion Factors for CMP Conduits of Various Lengths).

5. For a 6" diameter PVC pipe surface inlet with 1-inch round holes or 1-inch x 4-inch slots:

   a. Select the appropriate figure (either Figure 7 or 8) and use this in place of the Peak Outflow Discharge versus Head graph on Figures 1 through 6, but other than this substitution, follow the procedure outlined in 2. above.

   b. The orifice diameter determines the appropriate curve to use on either Figure 7 or 8.

6. For a 6" diameter helical CMP surface inlet with 1-inch round holes or 1-inch x 4-inch slots:

   a. Select the appropriate figure (either Figure 9 or 10) and use this in place of the Peak Outflow Discharge versus Head graph on Figures 1 through 6, but other than this substitution, follow the procedure outlined in 2. above.

   b. The orifice diameter determines the appropriate curve to use on either Figure 9 or 10 for 1" to 4" orifice diameters. However, the pipe length and slope determines the appropriate curve to use for 5" orifice diameters.

TABLE 1

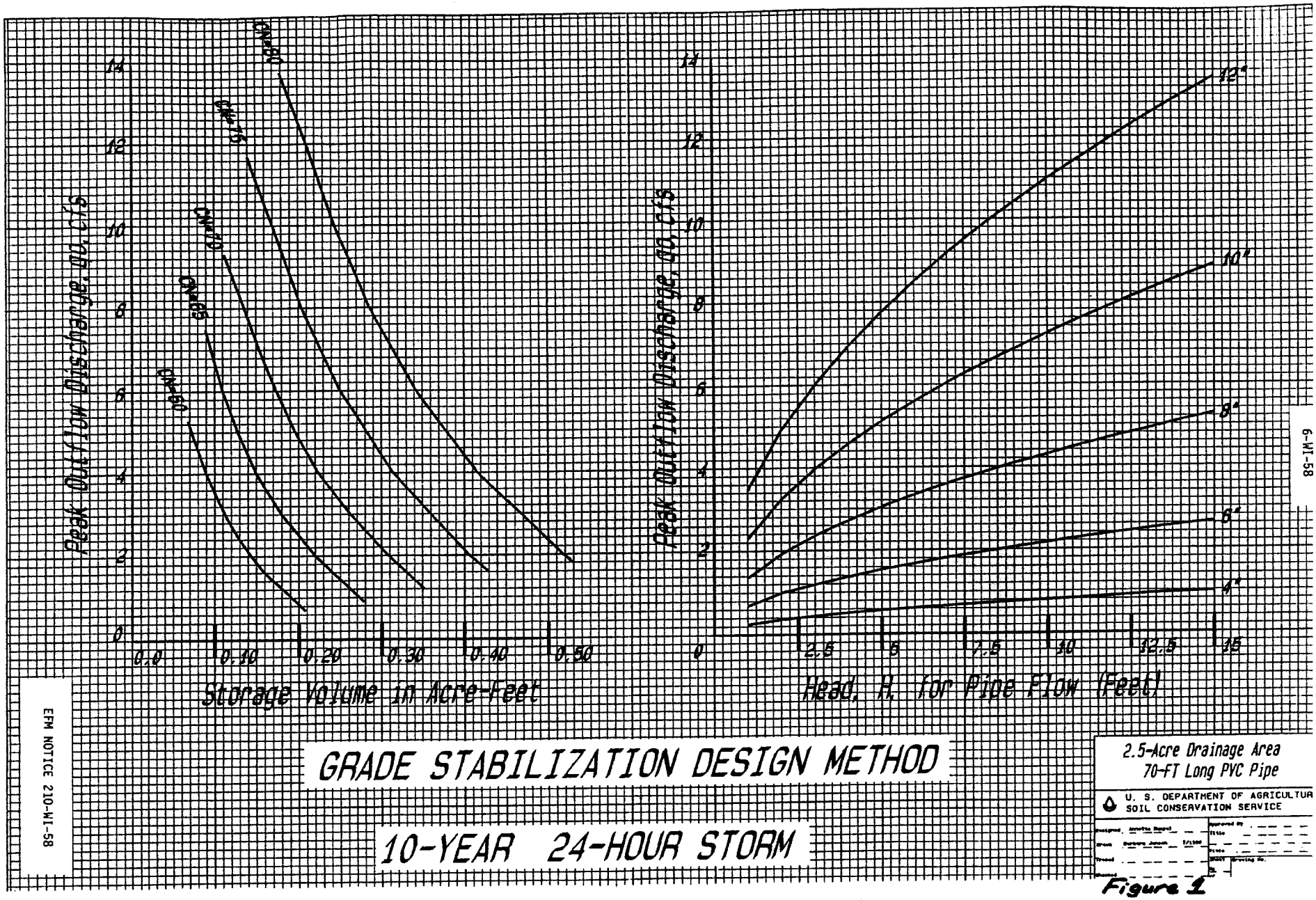
CONVERSION FACTORS FOR PVC PIPES OF VARIOUS LENGTHS

Pipe Length	Pipe Diameter 4"	6"	8"	10"	12"	15"	18"	21"	24"
40 ft	1.21	1.17	1.14	1.11	1.10	1.08	1.06	1.05	1.05
50	1.13	1.10	1.08	1.07	1.06	1.05	1.04	1.04	1.03
60	1.06	1.05	1.04	1.03	1.03	1.02	1.02	1.02	1.01
70	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
80	0.95	0.96	0.96	0.97	0.97	0.98	0.98	0.98	0.99
90	0.91	0.92	0.93	0.94	0.95	0.96	0.96	0.97	0.97
100	0.87	0.89	0.90	0.92	0.93	0.94	0.95	0.95	0.96
110	0.84	0.86	0.88	0.89	0.90	0.92	0.93	0.94	0.95
120	0.81	0.83	0.85	0.87	0.88	0.90	0.91	0.92	0.93

TABLE 2

CONVERSION FACTORS FOR CMP PIPES OF VARIOUS LENGTHS

Pipe Length	Pipe Diameter 4"	6"	8"	10"	12"	15"	18"	21"	24"
40 ft	0.59	0.62	0.65	0.68	0.71	0.74	0.77	0.79	0.81
50	0.53	0.56	0.59	0.62	0.65	0.69	0.72	0.74	0.77
60	0.49	0.52	0.55	0.58	0.61	0.64	0.68	0.70	0.73
70	0.45	0.48	0.51	0.54	0.57	0.61	0.64	0.67	0.70
80	0.43	0.46	0.49	0.51	0.54	0.58	0.61	0.64	0.67
90	0.40	0.43	0.46	0.49	0.52	0.55	0.58	0.61	0.64
100	0.38	0.41	0.44	0.47	0.49	0.53	0.56	0.59	0.62
110	0.36	0.39	0.42	0.45	0.47	0.51	0.54	0.57	0.60
120	0.35	0.38	0.40	0.43	0.46	0.49	0.52	0.55	0.58



GRADE STABILIZATION DESIGN METHOD

10-YEAR 24-HOUR STORM

2.5-Acre Drainage Area
70-FT Long PVC Pipe

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Figure 1

6-WI-58

EFM NOTICE 210-WI-58

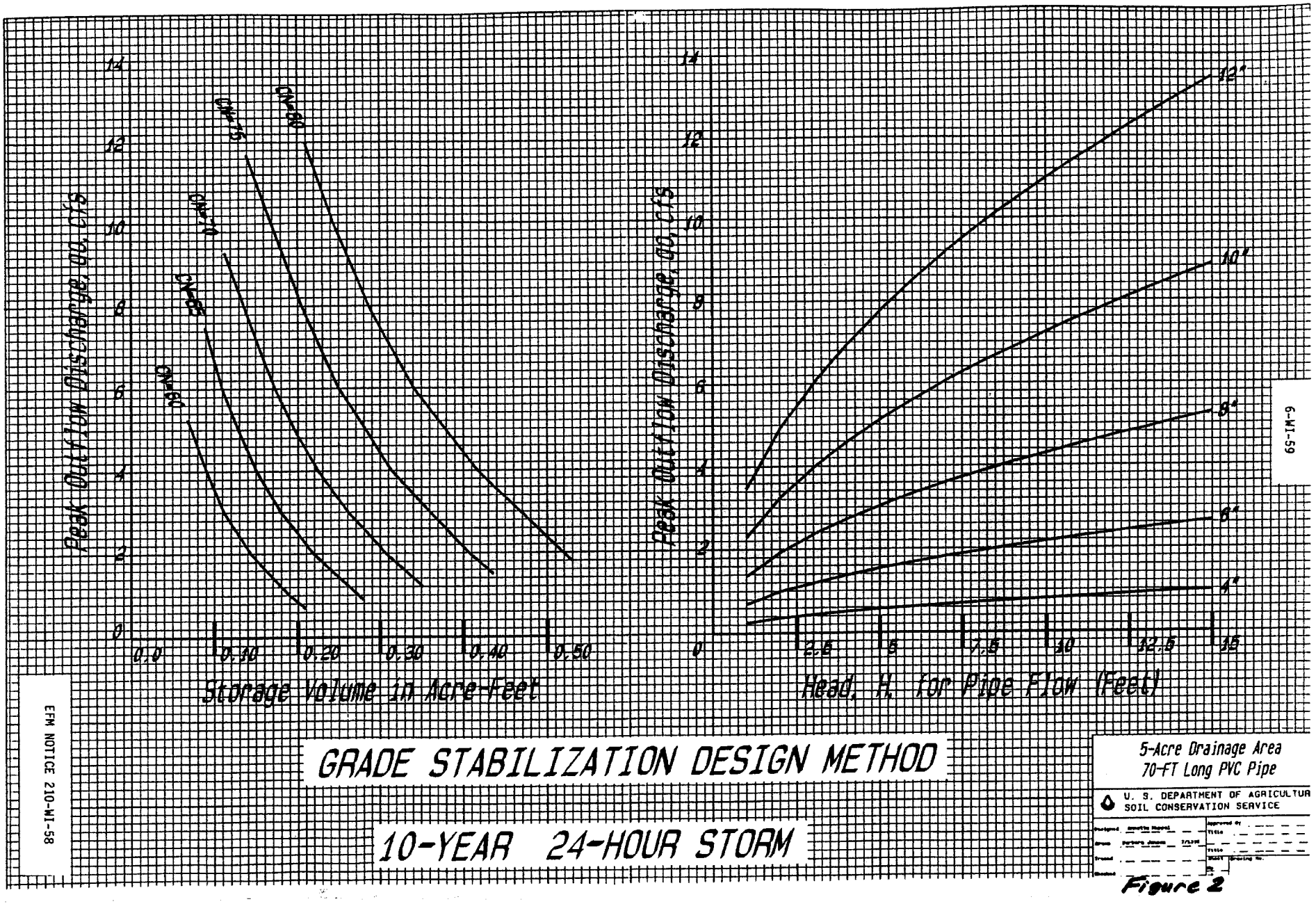
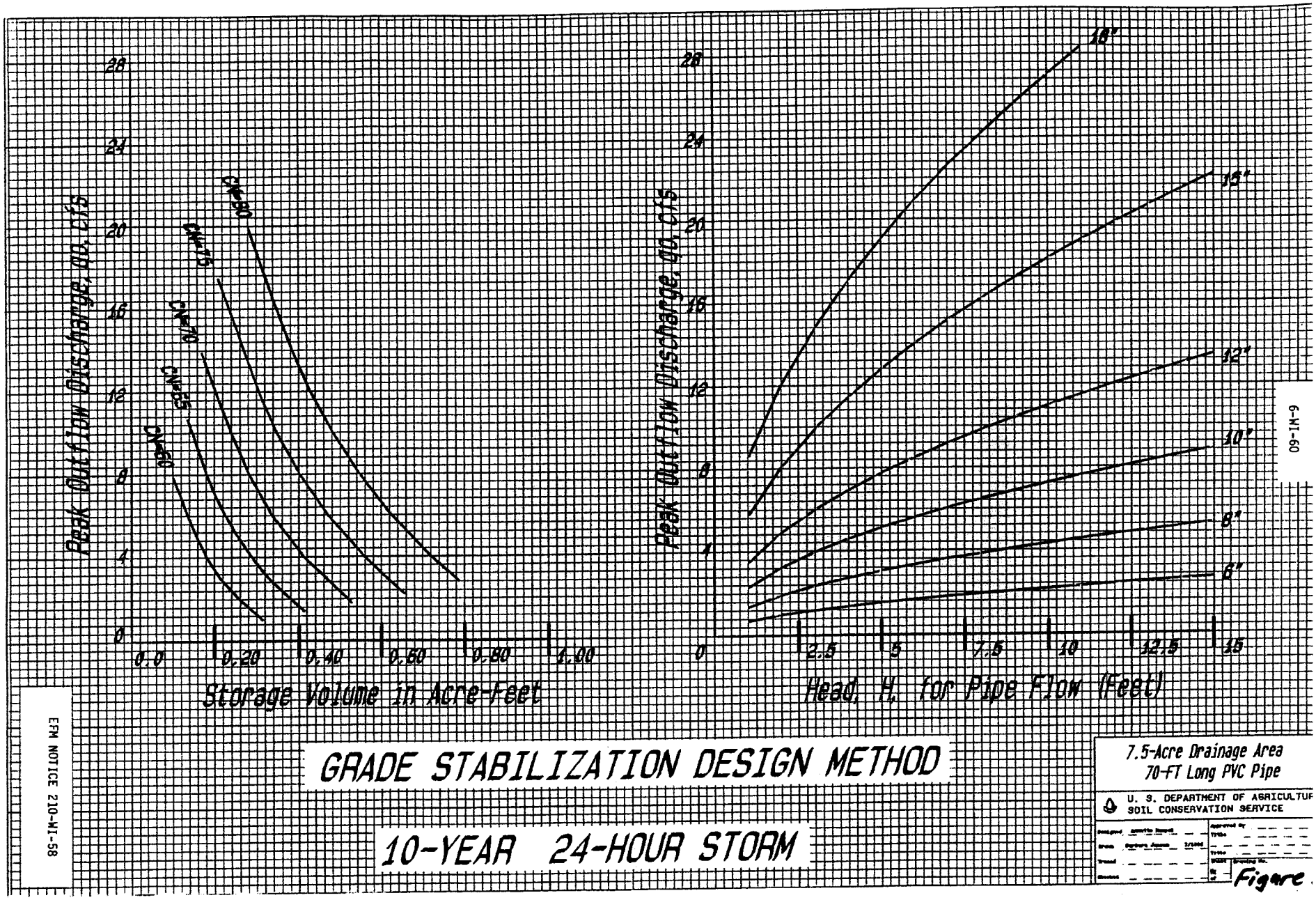

Peak Outflow Discharge, Qo, cfs
CN=95
CN=90
CN=80
CN=70
CN=60
0.0
0.10
0.20
0.30
0.40
0.50
Storage Volume in Acre-Feet
Peak Outflow Discharge, Qo, cfs
12"
10"
8"
6"
4"
2.5
5
7.5
10
12.5
15
Head, H, for Pipe Flow (Feet)
6-WI-59
GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
5-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
EFH NOTICE 210-WI-158

Figure 2



GRADE STABILIZATION DESIGN METHOD

10-YEAR 24-HOUR STORM

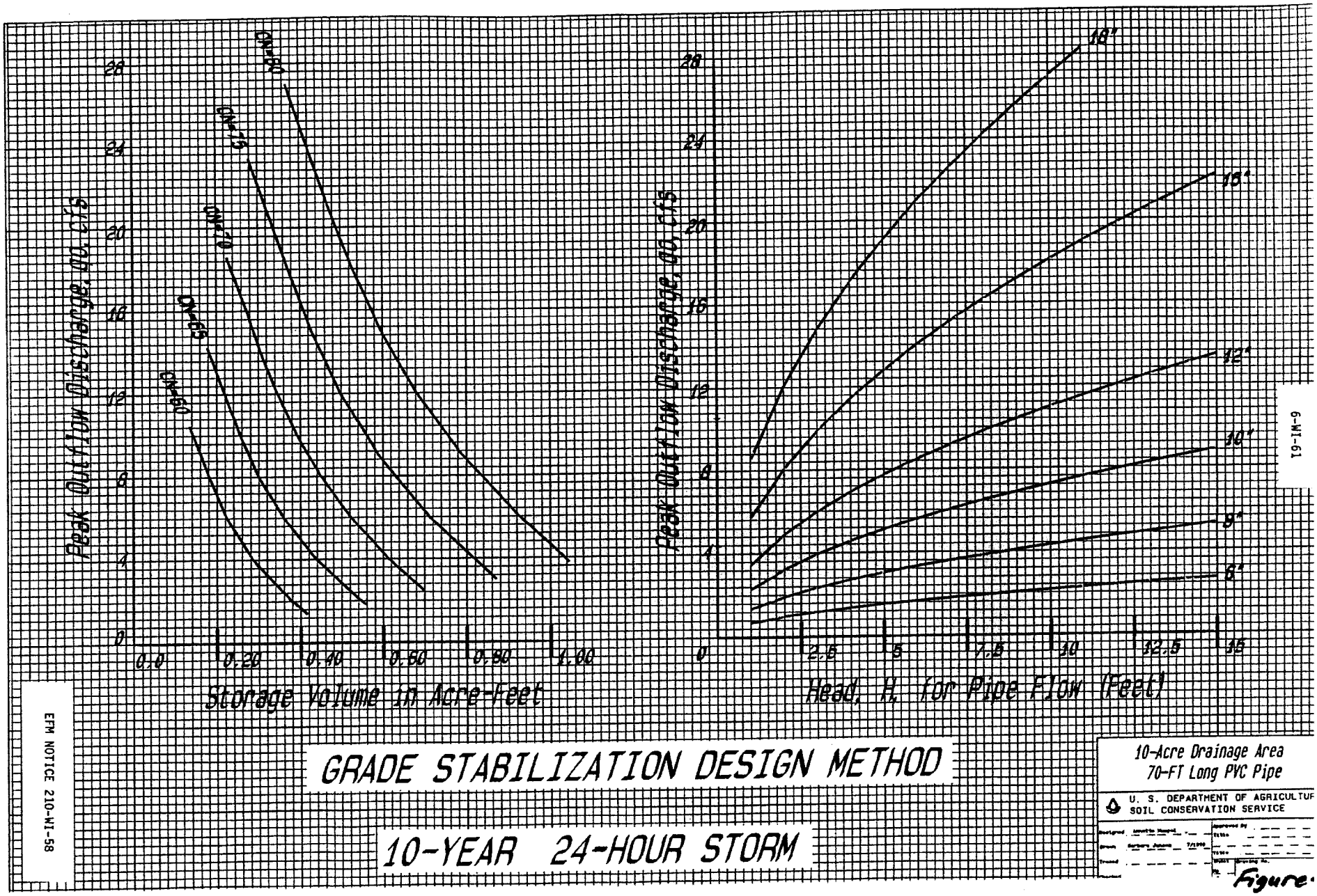
7.5-Acre Drainage Area
70-FT Long PVC Pipe

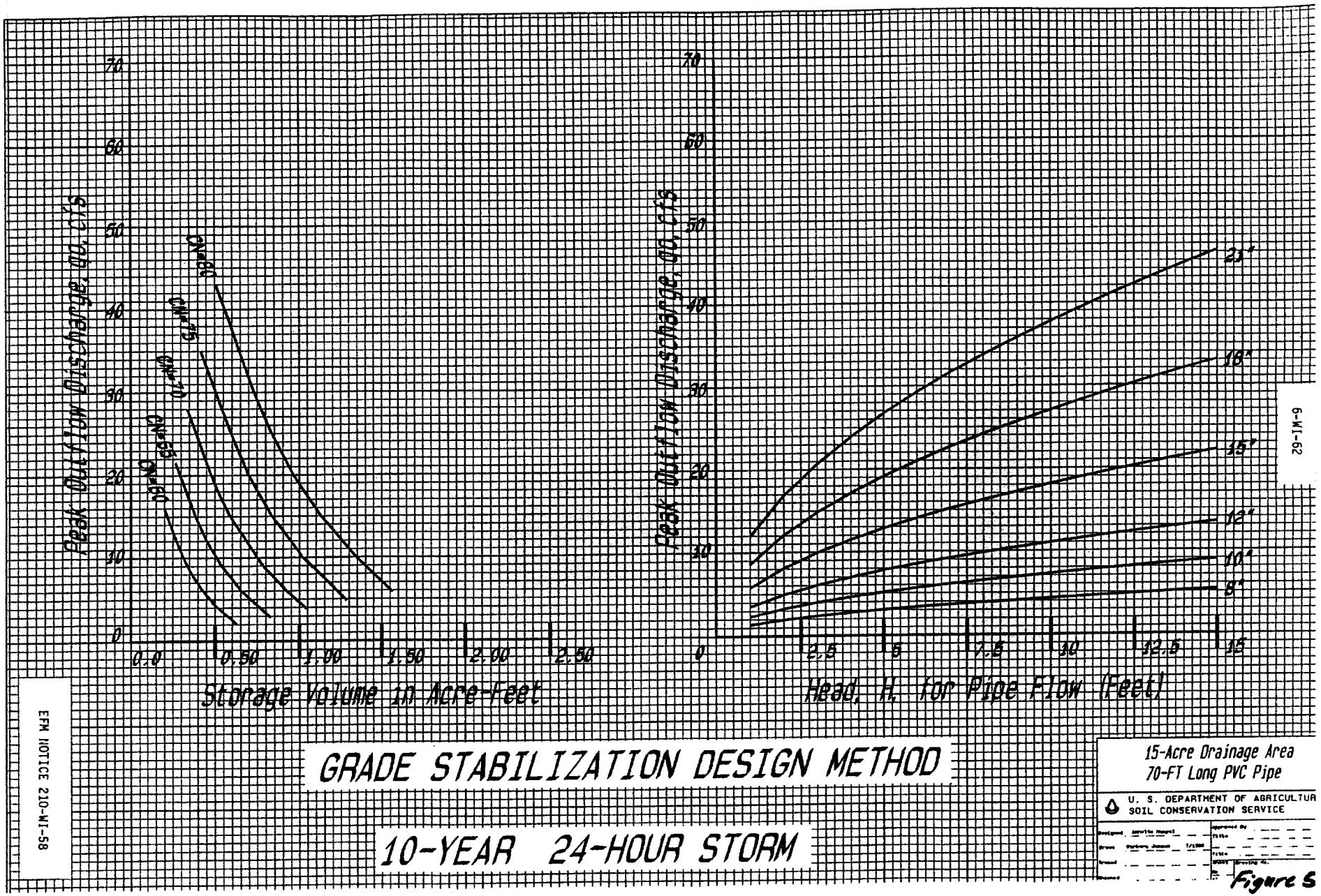
U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE

Figure

6-MI-60

EFM NOTICE 210-MI-58


GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
10-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Storage Volume in Acre-Feet
Head, H, for Pipe Flow (Feet)
Q=80
Q=75
Q=70
Q=65
Q=60
18"
15"
12"
10"
8"
6"
0.0
0.20
0.40
0.60
0.80
1.00
2.5
5
7.5
10
12.5
15
6-WI-61
EFH NOTICE 210-WI-58



EFH NOTICE 210-M1-58

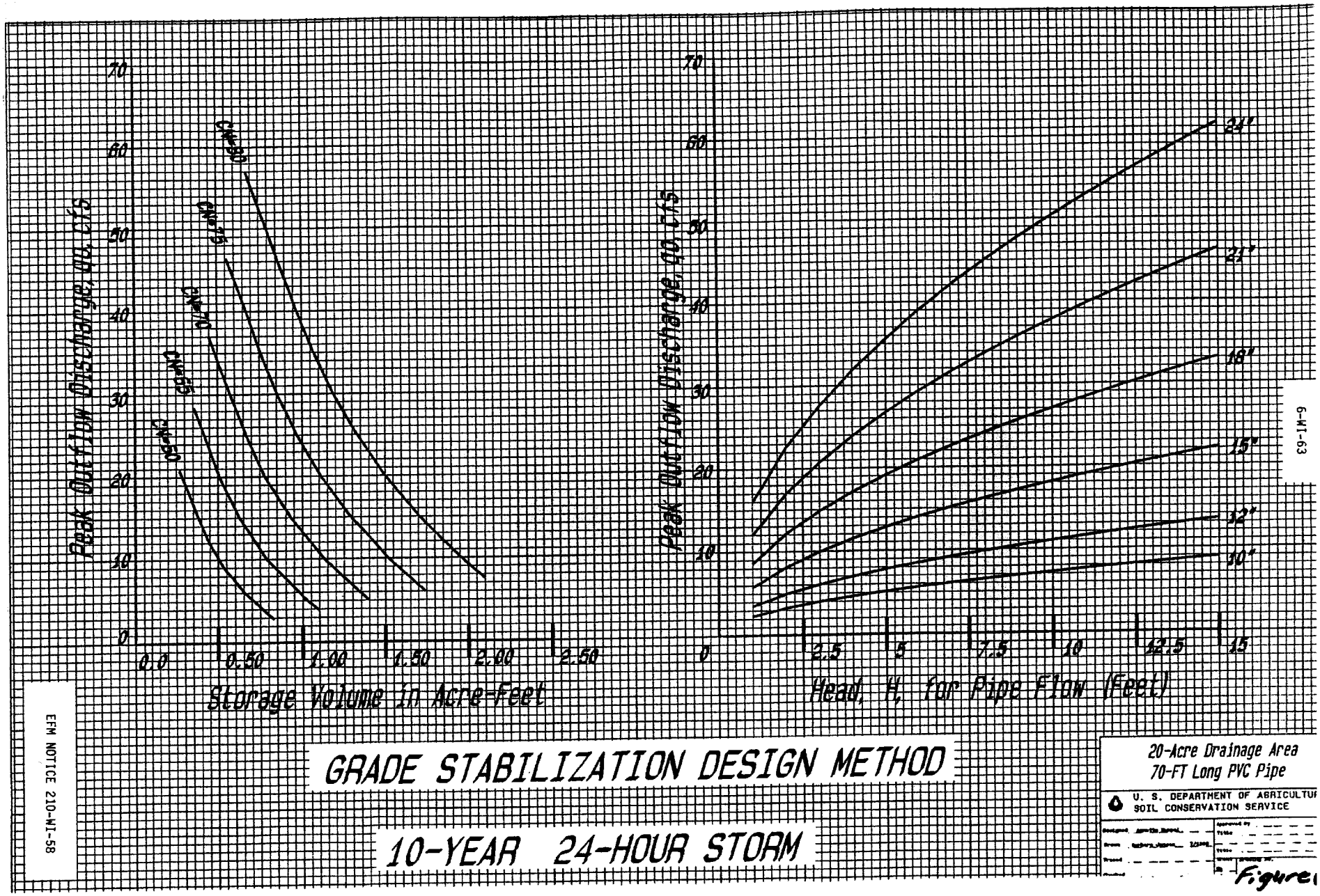
GRADE STABILIZATION DESIGN METHOD

10-YEAR 24-HOUR STORM

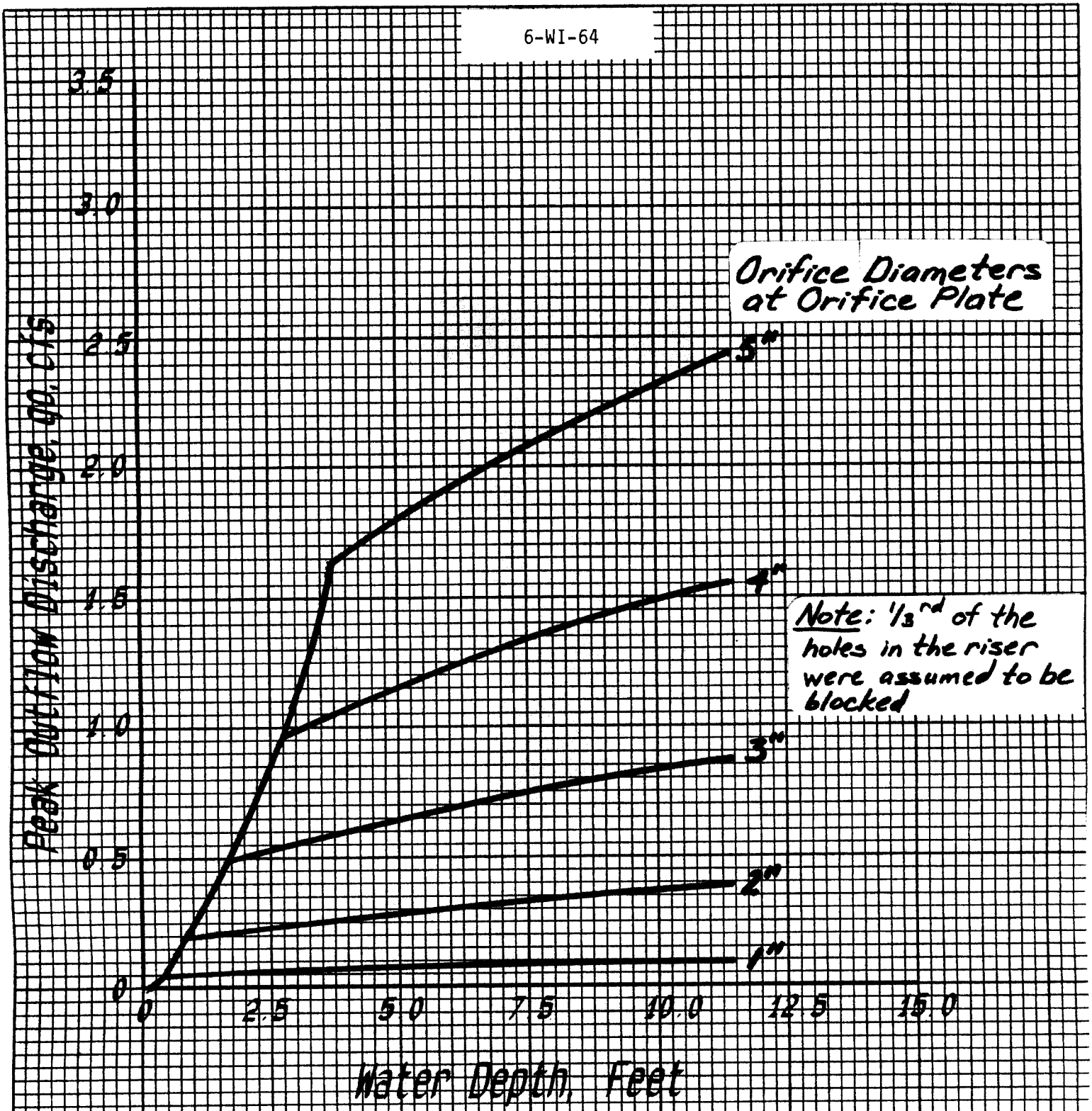
15-Acre Drainage Area
70-FT Long PVC Pipe

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Figure 5


Peak Outflow Discharge, Qo, cfs
70
60
50
40
30
20
10
0
CN=90
CN=75
CN=70
CN=65
CN=60
0.0
0.50
1.00
1.50
2.00
2.50
Storage Volume in Acre-Feet
Peak Outflow Discharge, Qo, cfs
24"
21"
18"
15"
12"
10"
0
2.5
5
7.5
10
12.5
15
Head, H, for Pipe Flow (Feet)
6-WI-63
EFW NOTICE 210-WI-58
GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
20-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
Figure

6-WI-64



Reference: Standard Drawing No. WI-400

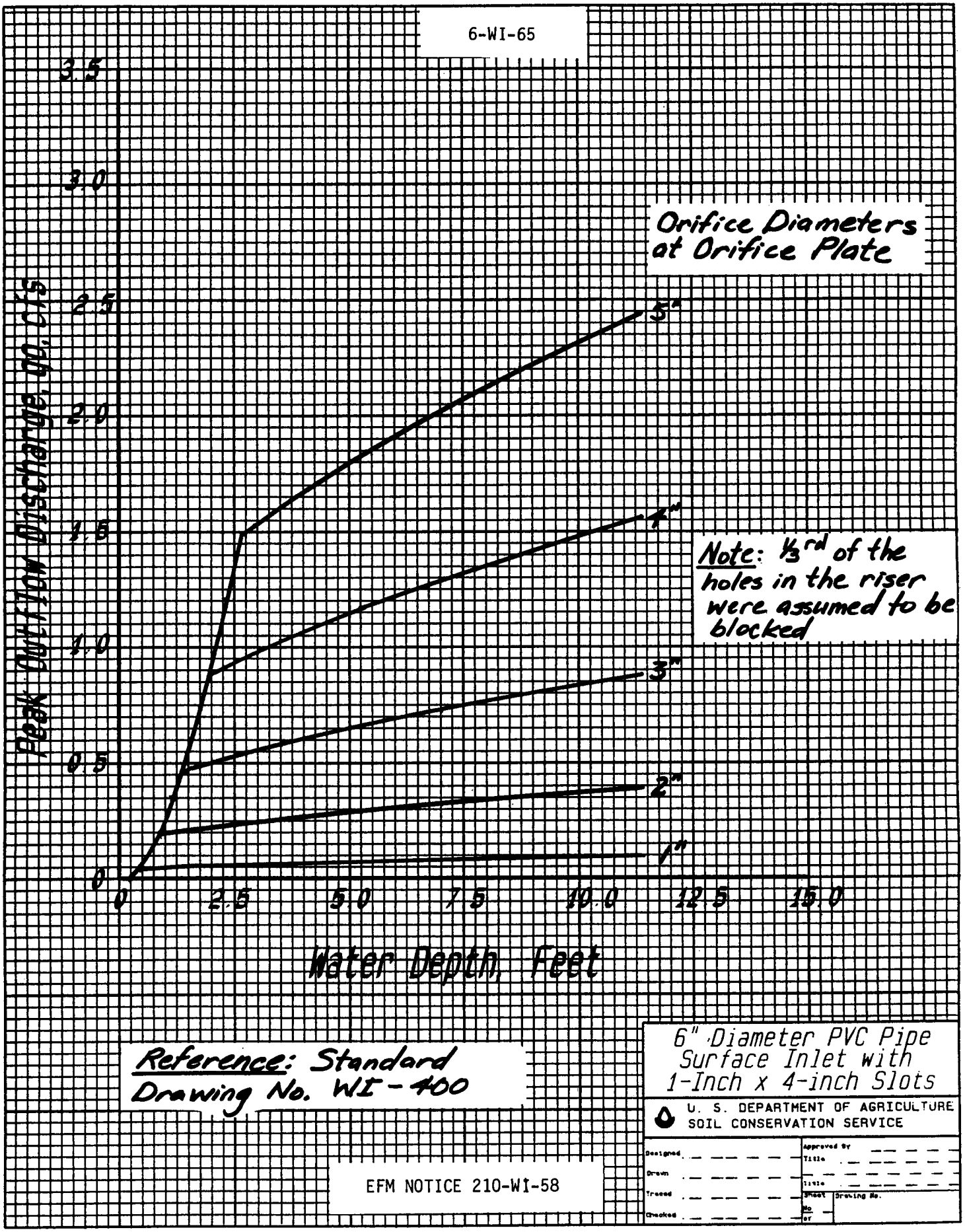
6" Diameter PVC Pipe Surface Inlet with 1-Inch Round Holes

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed	Approved By
Drawn	Title
Traced	Title
Checked	Sheet / Drawing No.
	No. / of

EFM NOTICE 210-WI-58

6-WI-65



Reference: Standard Drawing No. WI-400

6" Diameter PVC Pipe Surface Inlet with 1-Inch x 4-inch Slots

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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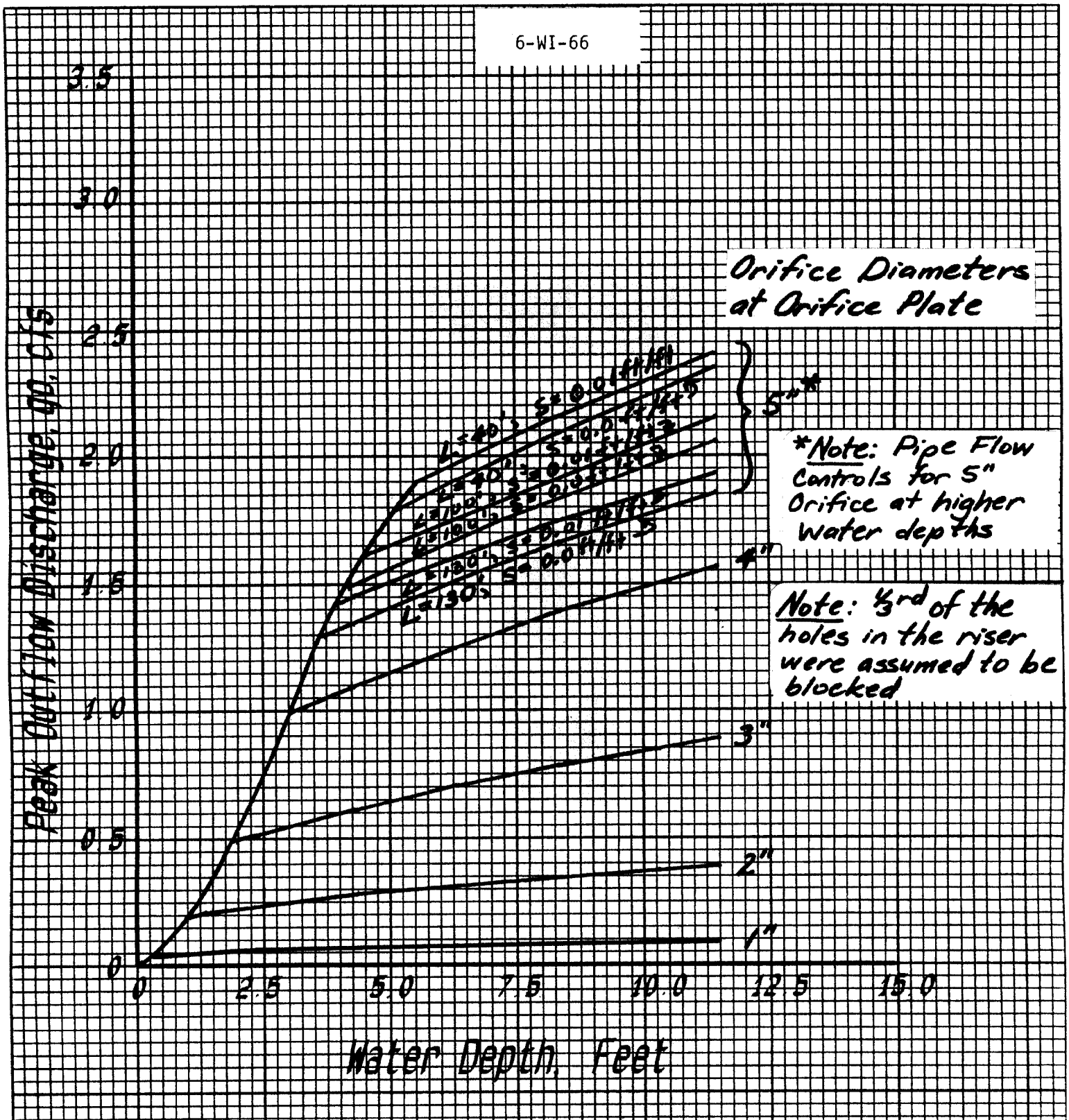
Sheet No. of
Drawing No.

EFM NOTICE 210-WI-58

6-WI-66



Reference: Standard Drawing No. WI-401

6" Diameter Helical CMP Surface Inlet with 1-Inch Round Holes

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

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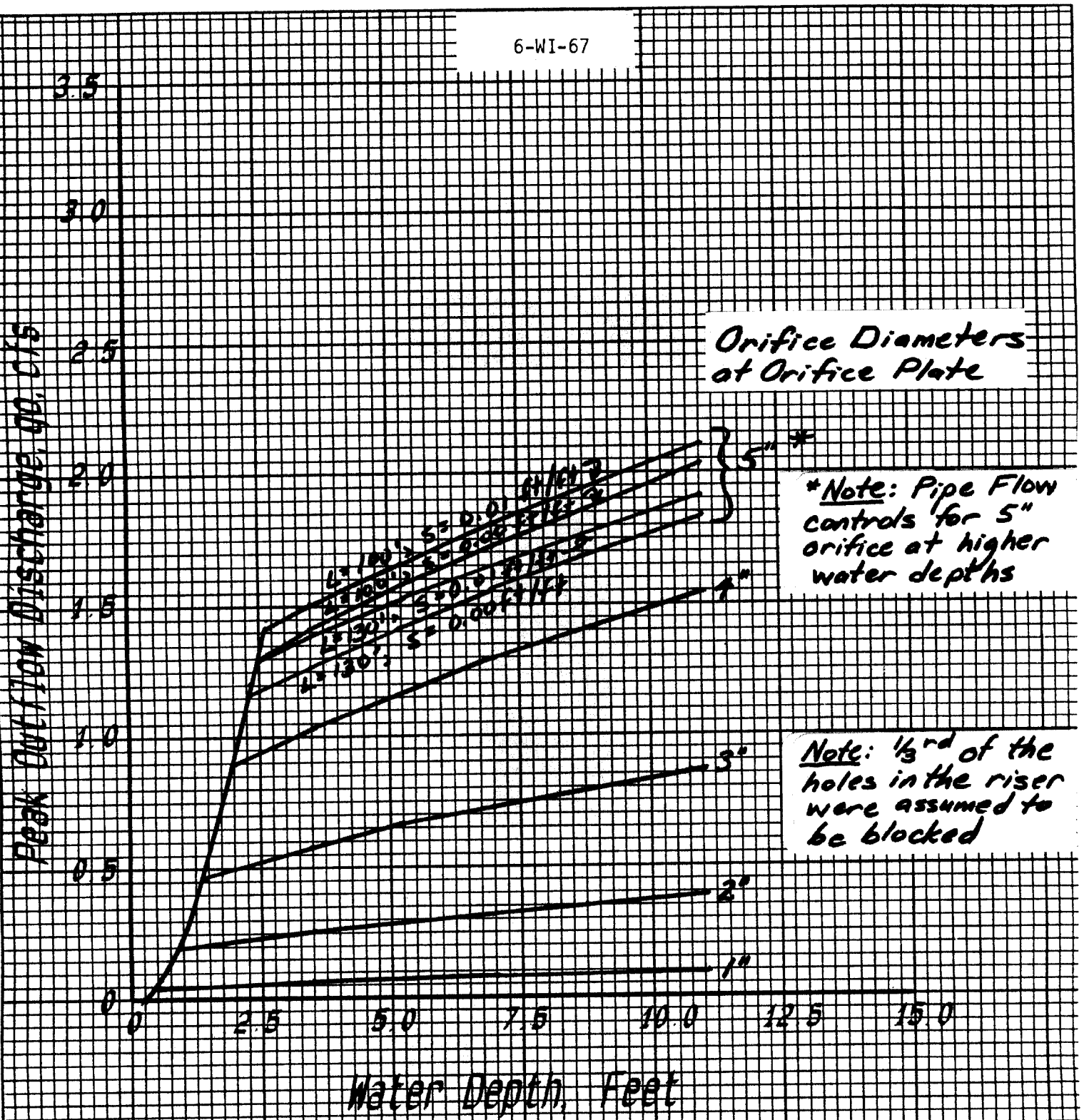
Drawing No.

EFM NOTICE 210-WI-58

6-WI-67



Reference: Standard Drawing No. WI-401

6" Diameter Helical CMP Surface Inlet with 1-Inch x 4-Inch Slots

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed | Approved By
Drawn | Title
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Checked | Sheet No. of | Drawing No.

EFM NOTICE 210-WI-58

GRADE STABILIZATION STRUCTURE DESIGN METHOD
EXAMPLE PROBLEMS

Example #1: Basic example for a 70 foot long PVC pipe (using the procedure outlined in 2b.i. of "How to Use the Grade Stabilization Structure Design Method")

Given:
- 15 acre drainage area
- CN of 70
- At the design water surface elevation, there is 7.5 feet of head and a storage volume of 0.48 acre-feet available.

Required: The pipe diameter

Solution: (See attached figure for a diagram of the solution).

From Figure 5, for a CN of 70 and a storage volume of 0.48 acre-feet, q_o = 20 cfs.

Then, going to the pipe flow graph (on the right side of the figure), for q_o = 20 cfs and H = 7.5 feet, the pipe size is between a 15 in. and 18 in. diameter.

Select an 18 in. diameter pipe.

As a check, from the pipe flow chart for a required q_o = 20 cfs and using an 18 in. diameter pipe, the minimum head required is 5.5 feet which is less than the 7.5 feet available - okay.

Looking at it in another way, for an 18 in. diameter pipe with 7.5 feet of head, q_o = 23.4 cfs. Then, for a CN of 70, the minimum storage volume required is 0.42 acre-feet, which is less than the 0.48 acre-feet available - okay.

Therefore, use an 18 in. diameter pipe.

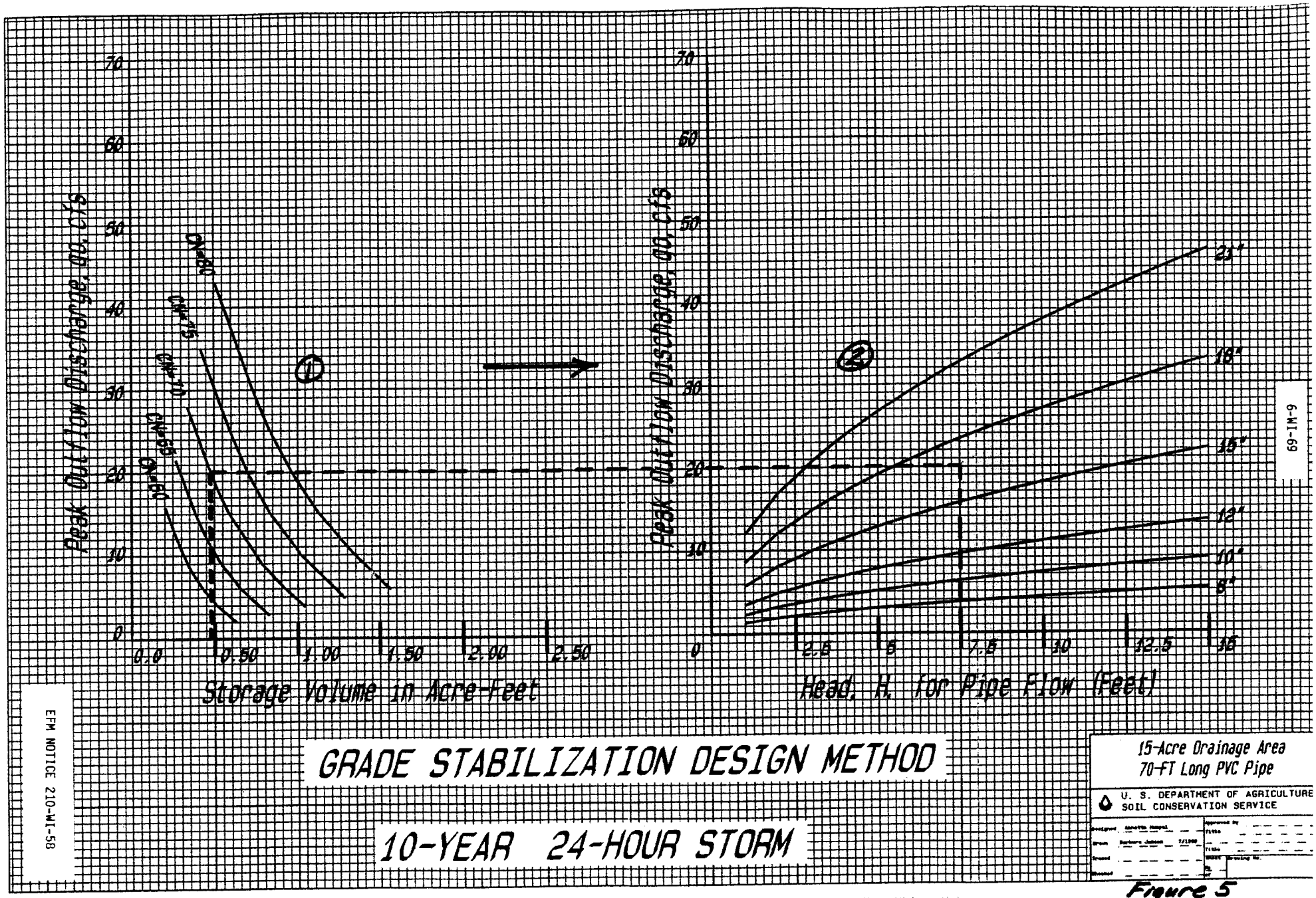

Peak Outflow Discharge, cfs
70
60
50
40
30
20
10
0
CN=80
CN=75
CN=70
CN=65
CN=60
①
0.0
0.50
1.00
1.50
2.00
2.50
Storage Volume in Acre-Feet
Peak Outflow Discharge, cfs
②
24"
18"
15"
12"
10"
8"
2.5
5
7.5
10
12.5
15
Head, H, for Pipe Flow (Feet)
69-IM-9
GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
15-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
EFM NOTICE 210-WI-58

Figure 5

Example #2: Another basic example for a 70 foot long PVC pipe (this time using the procedure outlined in 2b.ii.)

Given:
- 5 acre drainage area
- CN of 75
- At the design water surface elevation, there is 5 feet of head and a storage volume of 0.41 acre-feet available.

Required: The pipe diameter

Solution: (See attached figure for a diagram of the solution).

Assuming the pipe diameter and using the graphs in the opposite direction from in Example #1:

Trying a 6 in. diameter pipe in Figure 2, for 5 feet of head, q_o = 1.55 cfs.

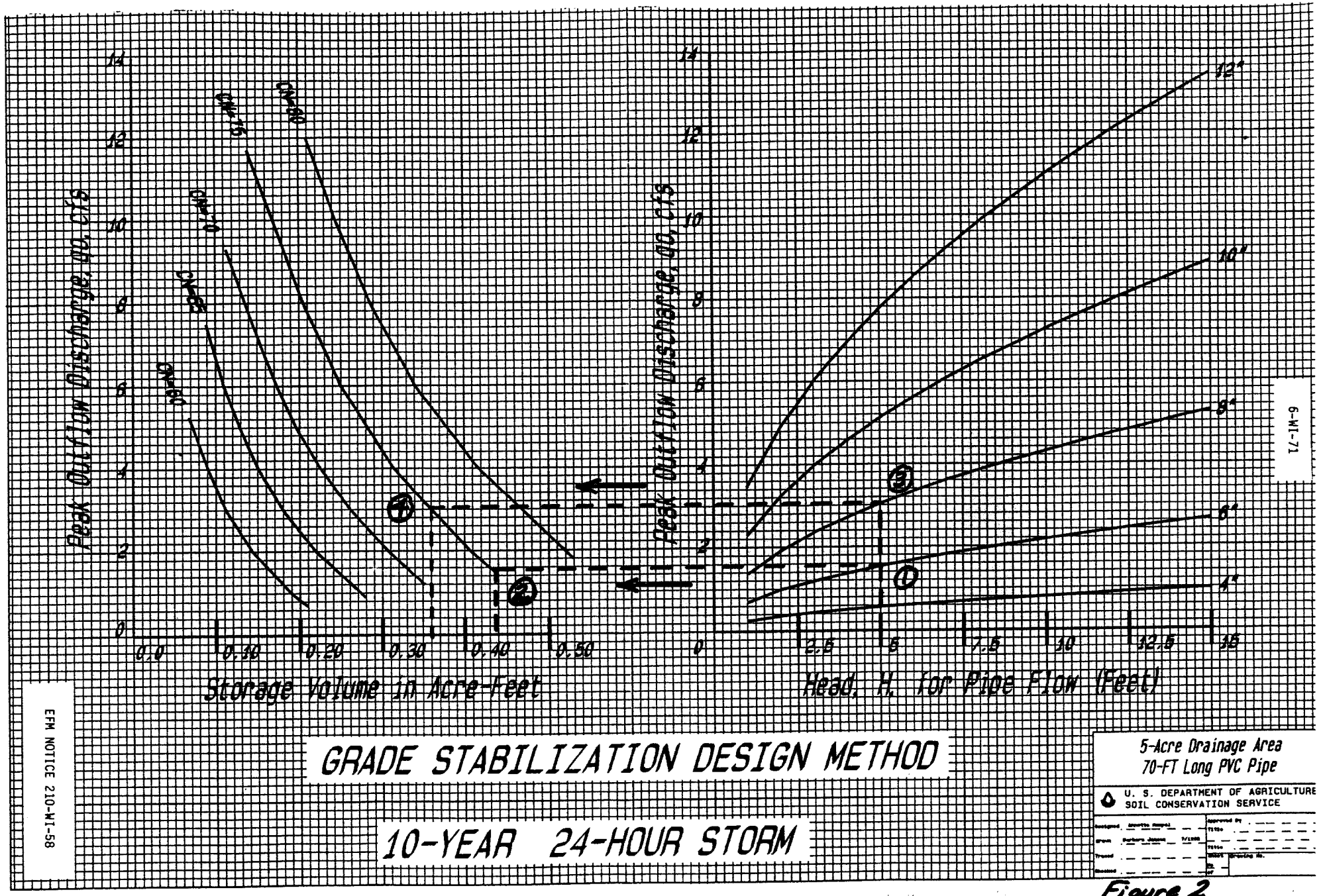
Then, for CN = 75, the minimum storage volume required (from the graph on the left) is 0.435 acre-feet, which is greater than the 0.41 acre-feet available at 5 feet of head; try a larger diameter.

Trying an 8 in. diameter, for 5 feet of head, q_o = 3.1 cfs.

Then, for a CN of 75, the minimum storage volume required is 0.36 acre-feet, which is less than the 0.41 acre-feet available at 5 feet of head, okay.

Use an 8 in. diameter pipe.

Note: it is also possible to adjust the head and storage volume values based on what is available at the site. For example, a 6 in. pipe would work in this case if 6 feet of head was available and the storage volume was 0.43 acre-feet or greater. The required storage volume for 6 in. pipe at 6 feet of head is 0.43 acre-feet.



6-M1-71

EFW NOTICE 210-M1-58

GRADE STABILIZATION DESIGN METHOD

10-YEAR 24-HOUR STORM

5-Acre Drainage Area
70-FT Long PVC Pipe

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Figure 2

Example #3: An example showing how to handle a variation in pipe length (using the procedure outlined in 3b.i.)

Given:
- 20 acre drainage area
- CN of 70
- At the design water surface elevation, there is 10 feet of head and a storage volume of 0.75 acre-feet available.
- pipe length of 100 feet

Required: The pipe diameter

Solution: (See attached figure for a diagram of the solution).

From the left side of Figure 6 using a CN of 70 and a storage volume of 0.75 acre-feet, q_o = 21.3 cfs (for a 70 foot long pipe).

From the pipe flow graph for 10 feet of head, the required pipe diameter is between 15 in. and 18 in. Assume the larger diameter. The peak outflow discharge for an 18 in. diameter 70 foot long pipe with 10 feet of head is q_o = 27 cfs.

From Table 1 (Conversion Factors for PVC Pipes of Various Lengths), the conversion factor is 0.95 for an 18 in. diameter 100 foot long pipe.

Therefore, the new q_o for an 100 foot long 18 in. diameter pipe is: $q_o = 27 \times 0.95 = 25.65$ cfs.

Using this new q_o, the minimum required storage volume is 0.66 acre-feet, which is less than the 0.75 acre-feet of storage available - okay.

Use an 18 in. diameter 100 foot long pipe.

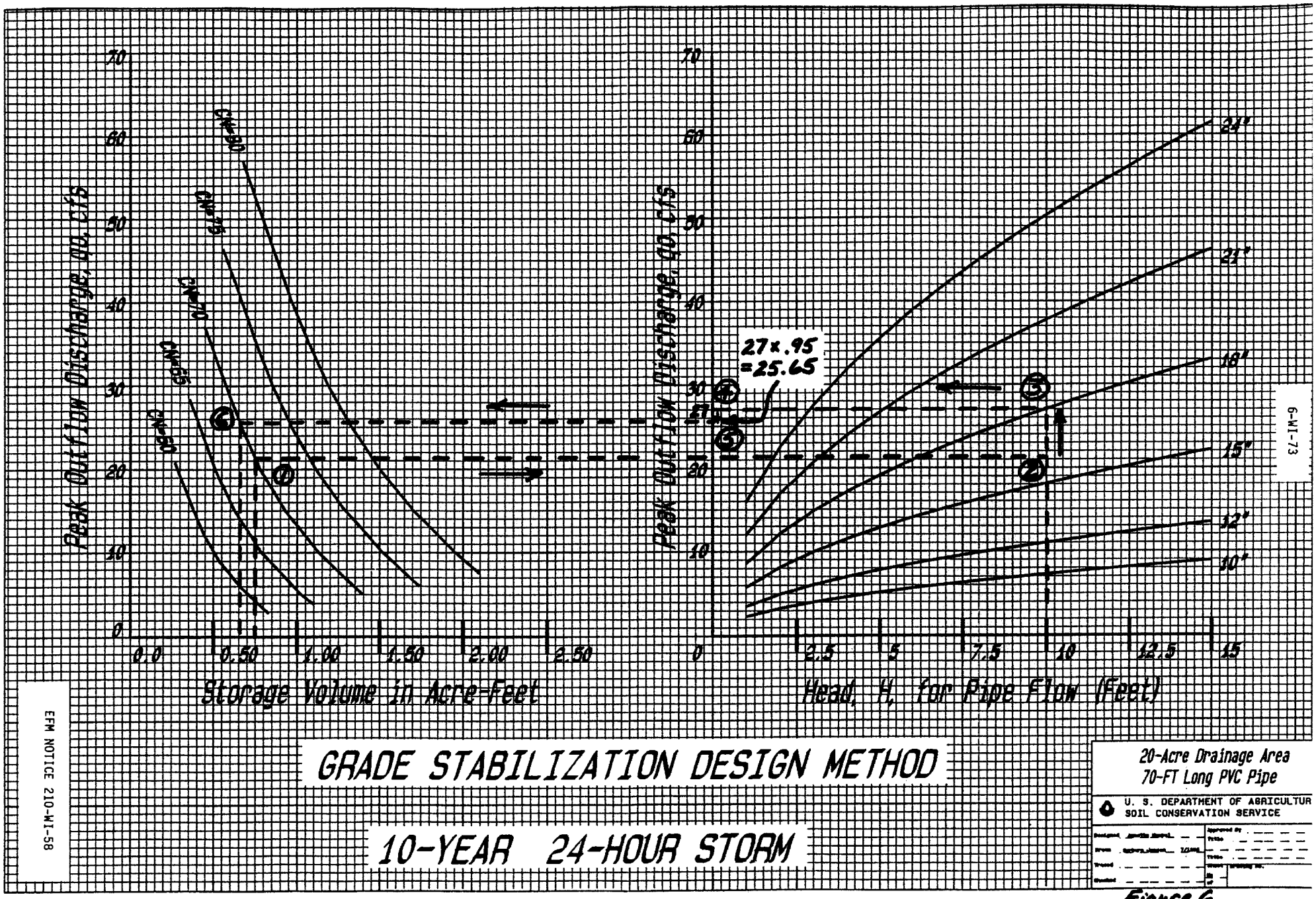
Peak Outflow Discharge, 100 cfs
CN=90
CN=75
CN=70
CN=65
CN=50
0.0
0.50
1.00
1.50
2.00
2.50
Storage Volume in Acre-Feet
Peak Outflow Discharge, 100 cfs
27 x .95
=25.65
24"
21"
18"
15"
12"
10"
2.5
5
7.5
10
12.5
15
Head, H, for Pipe Flow (Feet)
6-WI-73
GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
20-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTUR
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Figure 6

Example #4: Another example showing how to handle a variation in pipe length (using the procedure outlined in 3b.i.)

Given:
- 10 acre drainage area
- CN of 65
- At the design water surface elevation, there is 6 feet of head and a storage volume of 0.34 acre-feet available.
- pipe length of 50 feet

Required: The pipe diameter

Solution: (See attached figure for a diagram of the solution).

From the left side of Figure 4 using a CN of 65 and a storage volume of 0.34 acre-feet, q_o = 6.6 cfs for a 70 foot long pipe. From the pipe flow graph for 6 feet of head, the required pipe diameter is between 10 in. and 12 in.

Assume the larger diameter. The peak outflow discharge for a 12 in. diameter 70 foot long pipe with 6 feet of head is q_o = 8.5 cfs. From Table 1, the correction factor is 1.06 for a 12 in. diameter 50 foot long pipe.

The new q_o for a 50 foot long 12 in. diameter pipe is:
$q_o = 8.5 \times 1.06 = 9.0$ cfs.

Using this new q_o, the minimum required storage volume is 0.276 acre-feet, which is less than the 0.34 acre-feet available, okay.

As a check, try a 10 in. diameter 50 foot long pipe. For a 10 in. diameter 70 foot long pipe with 6 feet of head, q_o = 5.6 cfs. From Table 1, the correction factor is 1.07.

The new q_o for a 50 foot long 10 in. diameter pipe is:
$q_o = 5.6 \times 1.07 = 5.99$ cfs.

Using this new q_o, the minimum required storage volume is 0.36 acre-feet, which is greater than the 0.34 acre-feet available. Therefore a larger pipe is needed.

Use a 12 in. diameter 50 foot long pipe.

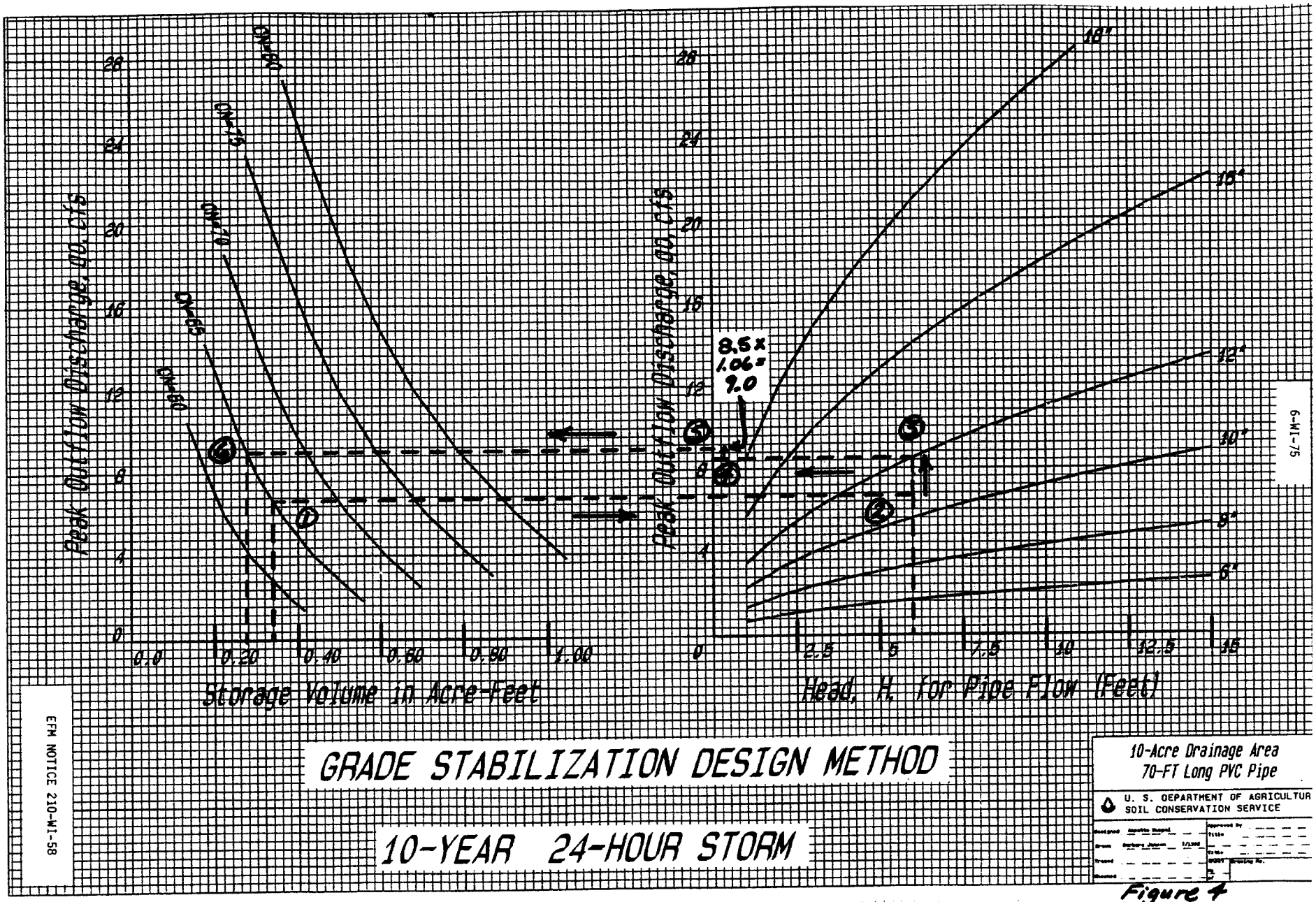

GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
10-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE
Storage Volume in Acre-Feet
Head, H, for Pipe Flow (Feet)
Peak Outflow Discharge, Qo, CFS
Peak Inflow Discharge, Qi, CFS
Qo=30
Qo=25
Qo=20
Qo=15
Qo=10
8.5 x 1.06 = 9.0
18"
15"
12"
10"
8"
6"
0.0
0.20
0.40
0.60
0.80
1.00
2.5
5
7.5
10
12.5
15
0
4
8
12
16
20
24
28
6-WI-75
EFH NOTICE 210-WI-58

Figure 4

Example #5: Another example showing how to handle a variation in pipe length (this time using the procedure outlined in 3b.ii.)

Given:
- 7.0 acre drainage area (use 7.5 acres)
- CN of 80
- At the design water surface elevation, there is 4 feet of head and a storage volume of 0.70 acre-feet available.
- pipe length of 40 feet

Required: The pipe diameter

Solution: (See attached figure for a diagram of the solution).

Assuming the pipe diameter and using the graphs in the opposite direction from in Examples 3 and 4:

Try a pipe diameter of 10 in. in Figure 3. From the pipe flow graph, for a 10 in. diameter 70 foot long pipe with 4.0 feet of head, q_o = 4.6 cfs.

From Table 1, the correction factor for a 10 in. diameter 40 foot long pipe is 1.11. The new q_o for a 40 foot long 10 in. diameter pipe is: q_o = 4.6 X 1.11 = 5.1 cfs.

Using this new q_o and using the graph on the left, the minimum required storage volume (for a CN of 80) is 0.67 acre-feet. This is less than the available storage volume of 0.70 acre-feet, okay.

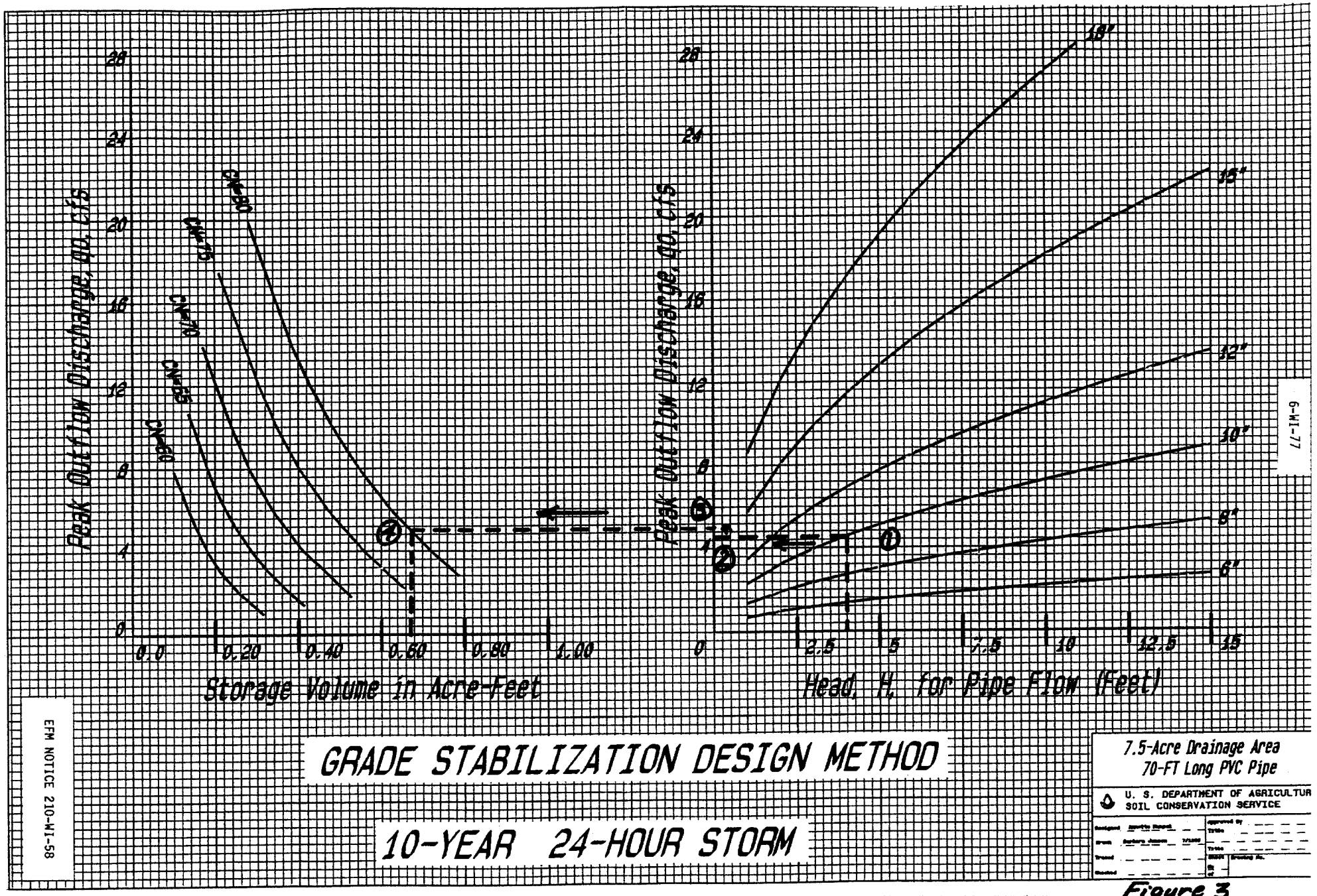
As a check, try an 8 in. diameter pipe. For an 8 in. diameter 70 foot long pipe with 4.0 feet of head, q_o = 2.7 cfs.

From Table 1, the correction factor for an 8 in. diameter 40 foot long pipe is 1.14. The new q_o is then:

q_o = 2.7 X 1.14 = 3.1 cfs.

Using this new q_o, the minimum required storage volume is 0.77 acre-feet, which is greater than the 0.70 acre-feet of available storage. Therefore a larger pipe is needed.

Use a 10 in. diameter 40 foot long pipe.



6-MI-77

EFM NOTICE 210-MI-58

GRADE STABILIZATION DESIGN METHOD

10-YEAR 24-HOUR STORM

7.5-Acre Drainage Area
70-FT Long PVC Pipe

U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE

Figure 3

Example #6: An example showing how to handle a design using a CMP conduit (using the procedure outlined in 4.)

Given:
- 14.0 acre drainage area (use 15 acres)
- CN of 60
- At the design water surface elevation, there is 7 feet of head and a storage volume of 0.45 acre-feet available.
- pipe length of 90 feet

Required: The pipe diameter for a CMP conduit.

Solution: (See attached figure for a diagram of the solution).

From the left side of Figure 5 using a CN of 60 and a storage volume of 0.45 acre-feet, q_o = 5.6 cfs for a 70 foot long PVC pipe. From the pipe flow graph for 7 feet of head, the pipe diameter is between 8 in. and 10 in.

Assume the larger diameter. The peak outflow discharge for a 10 in. diameter pipe with 7 feet of head is 6.1 cfs. From Table 2 (Conversion Factors for CMP Pipes of Various Lengths), the correction factor is 0.49 for a 10 in. diameter 90 foot long CMP pipe.

The new q_o for a 90 foot long 10 in. diameter CMP pipe is: $q_o = 6.1 \times .49 = 3.0$ cfs.

Note that an outflow discharge of at least 5.6 cfs is required in order to have a required storage volume of .45 acre-feet or less. To check this using the new q_o and a CN of 60, the minimum required storage volume is 0.57 acre-feet, which is greater than the 0.45 acre-feet available. Try a 12 in. CMP.

The peak outflow discharge is 9.2 cfs for a 12 in. diameter 70 foot long PVC pipe with 7 feet of head. From Table 2, the correction factor is 0.52 for a 12 in. diameter 90 foot long CMP pipe.

The new q_o for a 90 foot long 12 in. diameter CMP pipe is: $q_o = 9.2 \times .52 = 4.78$ cfs.

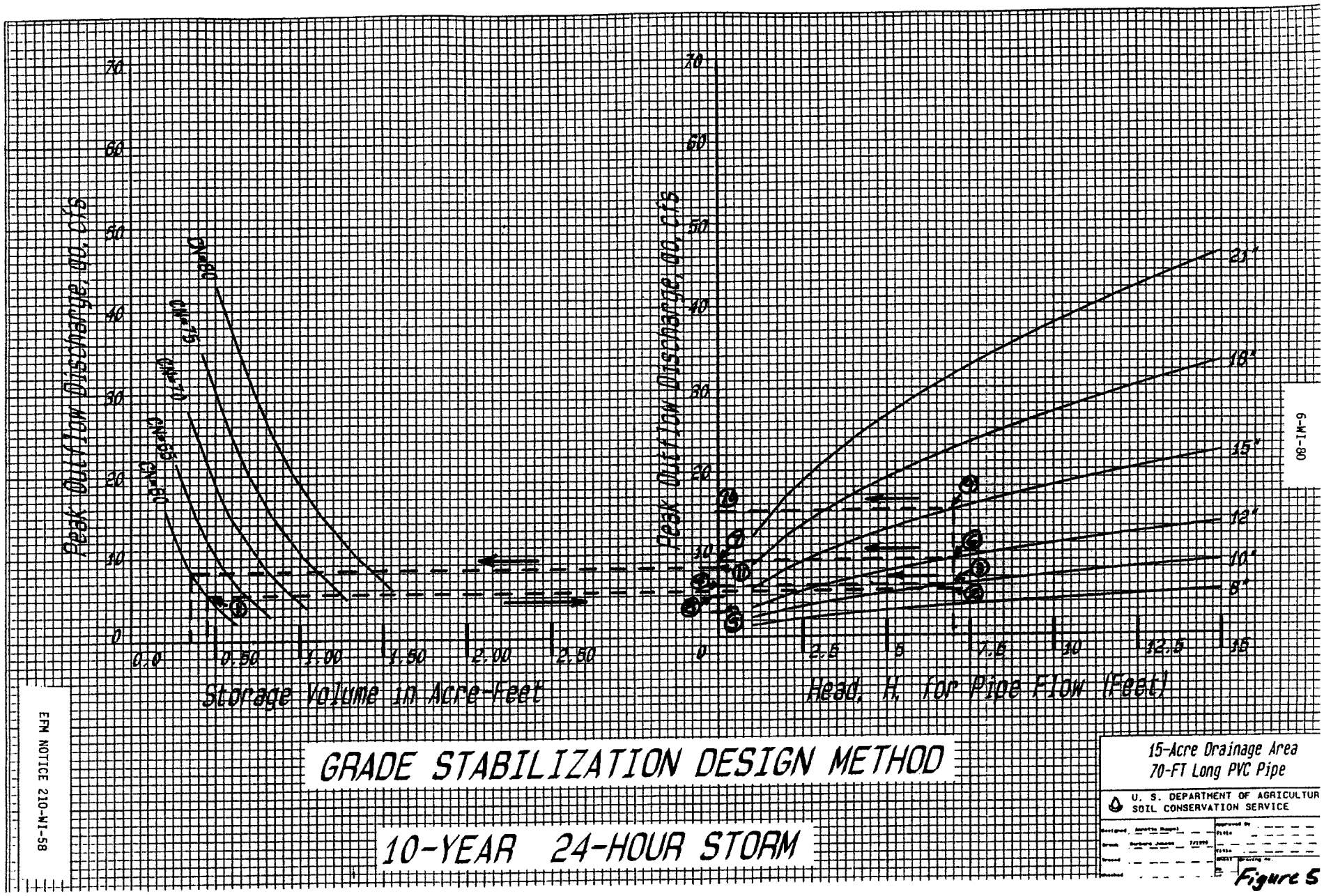
This is still less than 5.6 cfs, therefore a larger diameter is required. Try a 15 in. diameter CMP.

The peak outflow discharge is 15.2 cfs for a 15 in. diameter 70 foot long PVC pipe with 7 feet of head. From Table 2, the correction factor is 0.55 for a 15 in. diameter 90 foot long CMP conduit.

The new q_o for a 90 foot long 15 in. diameter CMP pipe is: $q_o = 15.2 \times .55 = 8.36$ cfs.

This is larger than 5.6 cfs, so the pipe size should be okay. To check this using the new q_o and a CN of 60, the minimum required storage volume is .355 acre-feet, which is less than the 0.45 acre-feet available; okay.

Use a 15 in. diameter 90 foot long CMP


GRADE STABILIZATION DESIGN METHOD
10-YEAR 24-HOUR STORM
Storage Volume in Acre-Feet
Head, H, for Pipe Flow (Feet)
Peak Outflow Discharge, Qo, cfs
15-Acre Drainage Area
70-FT Long PVC Pipe
U. S. DEPARTMENT OF AGRICULTUR
SOIL CONSERVATION SERVICE
EFM NOTICE 210-WI-58
6-WI-80
Figure 5