SECTION B: CRITERIA FOR THE PLANNING AND DESIGNING OF DRY HYDRANTS

A. General

In 1984, Insurance Service Organization (ISO) first acknowledged the use of a shuttle water supply in providing grades for insurance premium rates. This allowed the use of dry hydrants. The installation of a system of dry hydrants may result in a reduced ISO grading which may result in reduced insurance premiums for the area served by the dry hydrants. Other individuals or communities may be interested in installing dry hydrants for their own convenience or protection even though it would not affect their insurance rates, unless their insurance company gives a discount independently.

The planning and design of dry hydrants requires the close cooperation of the local fire department and the landowner. For each dry hydrant, the local fire department should concur in the following:

1. Location
2. Specifics within the site location
3. Access roads are durable and sufficient to support a fire truck
4. Safety of road and line-of site is adequate
5. Type of pipe and fittings
6. Fittings are compatible with the fire truck system
7. Design and construction plans

B. Water Supply

The reliability of an impounded water supply, cistern, tank, or storage facility as defined by National Fire Protection Association (NFPA) 1231 Specification is the minimum quantity available (at not over 15-ft static lift) during a drought with an average 50-year frequency. The maximum rate of flow is determined by testing using the pumper(s), hose arrangement, and dry hydrant normally used at this site. A minimum water supply of 30,000 gallons (1.1 acre – inches) of pumpable impoundment of water or a minimum pump flow rate of 250 gpm without interruption for 2 hours is considered a dependable supply.

Further, the reliability of a supply from a flowing stream is the minimum rate of flow during a drought with an average 50-year frequency. The maximum rate of flow is determined by testing using the pumper(s), hose arrangement, and dry hydrant normally used at this site. The minimum rate is 250 gpm flow without interruption for 2 hours.

Dry hydrants shall conform to Florida NRCS conservation practice standard Dry Hydrant, Code 432 and Construction Specification, Code CS432. NRCS will use the procedure in this guide for design.

The adequacy of the water supply from impoundments shall be determined by one of the following methods:

C. Uplands

A detailed site specific analysis using SPAW or Technical Release (TR) 19 (RESOP) shall be made to determine the minimum water available during a drought with an average 50-year frequency.

Input data sets for RESOP can be developed with an ASCII text editor (e.g. EDLIN, QEDIT, COED, AHED) or by using the computer program RIP (RESOP Input Program).

All inputs to RESOP are explained in TR-19, Appendix A, November 1987, with the exception of the following:

The upper storage limit for input to RESOP will be based on storage available when the pond is at bank full.

The lower storage limit for input to RESOP will be based on the storage required to provide a 2-foot depth of water over the top of the intake strainer.

Evaporation data is found in the NOAA Technical Report NWS 34, Mean Monthly,

Seasonal and Annual Pan Evaporation for the United States. Appendix 1 contains the appropriate Data for Florida.

Rainfall data for use in RESOP is available from the State Climate Data Liaison.

The "*.txt" climatic files must be in a specific format for access by the SPAW model and its CLIMATE DATA editor. The first line must be of the exact format and wording as follows: "XXXXXX-date ^ tmax ^ tmin ^ prcp ^ evap", where the XX is a six digit station identification, "^" symbol denotes a single tab either side, and the designators must be spelled exactly as shown, although the order can be varied if the data are in another column arrangement. Additional data can be included, tab delimited, and will be ignored by the read routine. The date is in the format "mo-da-yr", e.g. 021598 for Feb. 15, 1998. Data after year 2000 are designated by the last two digits. Two other measurements of potential ET are possible to enter, measured Penman (mpen) and estimated Penman (epen), and show in the Climatic Data editor. However, these have not been activated in the model calculations. If available, these can be used by copying into the "evap" data column with an edit program, then adjusting any appropriate default values and coefficients in the "Default" file.

After the input data set is assembled, run SPAW or RESOP to determine the 50-year drought storage value. Compute the 50-year drought elevation by interpolating between the known elevation and storage values used to develop the stage - storage - surface area table. To be acceptable the volume of storage of the 50-year drought level shall provide 30,000 gals of pumpable volume while maintaining a 2-foot depth of water over the intake strainer. See Appendix 2 for sample RESOP Input and Output.

For sites that do not have 50 years of rainfall data available, the following procedure will be used:

1. Import the FILE.SRT file into LOTUS or similar spreadsheet program as a "number" file.
2. Sort the data in ascending order based on the storage volume.
3. Rank the values from 1 through the end of the data set with 1 being the smallest storage volume as shown in Appendix C.
4. Use the Gumbel method to calculate a return period for the event. The equation for this is: $T = (N+1) / m$

   T is the return period in years.

   m is the rank of events.

   N is the total number of events.
5. Plot storage versus T on probability graph paper and extend the curve to the 2 percent line. The storage value at this point is the value for the 50-year drought level.

See Appendix C for sample problem for uplands with less than 50 years of rainfall data.

D. High Water Table Soils

A detailed site specific analysis using DRAINMOD ver. 4.6 (or later) shall be made to determine the minimum depth to water table during a drought of 50-year frequency.

Select the vertical seepage option on the drainage design parameters screen 1 of 5 and enter the following information on the drainage parameters screen 4 of 5: piezometric head (hydraulic head of the groundwater aquifer), depth of restrictive layer and the vertical conductivity of the restrictive layer.

Save the file and run the DRAINMOD program. After running the DRAINMOD program, the following procedure will be used to determine the 50-year drought level.

1. Run the DMSORT program using the daily output file from DRAINMOD, DMSORT creates the file SORT.OUT, which is a table of year and depth to water table values. Before running DMSORT, rename the DRAINMOD daily output file (xxx.DAY) DAY.OUT, then type the command DMSORT DAY.

2. Import the SORT.OUT file into LOTUS or similar spreadsheet program as a "number" file.
3. Sort the data in ascending order based on the depth to the water table.
4. Rank the values from 1 through the end of the data set with 1 being the smallest storage volume as shown in Appendix D.
5. Use the Gumbel method to calculate a return period for the event. The equation for this is: $T = (N+1) / m$

   T is the return period in years.

   m is the rank of events.

   N is the total number of events.
6. Plot storage versus T on probability graph paper and extend the curve to the 2 percent line. The depth to the water table at this point is the value for the 50-year drought level.

This depth will be the maximum water table elevation used to compute the minimum depth of the pond required to provide 30,000 gallons of pumpable water and maintain a 2 foot depth of water over the intake strainer.

See Appendix D for sample problem for high water table soils.

E. All Methods

Figure 1 provides an over view for water supply needs and terms in accordance with Florida NRCS conservation practice Dry Hydrant, Code 432 and Specification, FL 205. Water usage for irrigation, livestock water, crop spraying, and other related uses, as well as known or estimated seepage losses, should be subtracted from the normal pool level. Sites known to have periodically gone dry shall not be used.

F. Hydrant Site Location

Generally, the hydrant will be located near the embankment to take advantage of deeper water and be less likely to have problems due to siltation and algae growth.

Location of the dry hydrant down a land ridge (slope) will (a) provide surface drainage for the road and hydrant, (b) allow the fire truck to get underway faster under load, and (c) keep the inlet away from a swale (drain) which could be a siltation and maintenance problem and cause pump failure.

Locations within a drainage area with an expected high silt load, such as cultivated fields without terraces or adequate soil cover, shall be avoided. Dry hydrants shall be installed at locations assuring 20 or more years of service life.

G. Intake Strainer Details

To avoid a vortex or whirlpool during pumping, the top of the inlet pipe shall be at least 2 feet below the 50-year drought elevation plus 30,000 gallons storage (see Figure 1) unless a special design is prepared to eliminate the vortex. A vortex allows air to enter the pump which decreases pump capacity and may cause the pump to loose prime. Special designs may include a baffle or anti-swirl plates or the top of the pipe may be left solid (without holes). See Table No. 1 to determine the top width in inches to leave solid.

Table No. 1 also shows the number of holes by diameter (1/4", 3/16", and 3/8") needed to give four times the open area for the pipe size diameter being used. Also, it shows the minimum perforated pipe length needed, (i.e., for 6" diameter pipe - 1024 holes @ 3/8" diameter are needed for 3.4' length of pipe with the top 4" left solid).

Shop built strainers shall have the holes deburred and smoothed so that flow through the hole (orifice) is not impeded and that chips do not come loose to clog the openings of the strainer in the hydrant head or get into the fire truck pump.

Holes larger than 3/8" diameter are not recommended as minnows can enter, grow, and cannot get back out. Where silt or other minute particles are a concern, commercial well screens should be recommended. Also, manufactured

strainers meeting NFPA 1231 specifications are available.

It is recommended that the intake strainer and end cap also be perforated to improve intake flow characteristics. Also, a pinned or snap-in cap is preferred to a hinged cap. Their performance on the back-flushing is superior to the hinged cap and again, the perforations assist in flushing silt away from the intake, if necessary.

Table 1. Intake Strainer Details

Pipe Dia.	Hole Size, Inches			Min. Length [1/]	Top Width Solid Inches [2]
	1/4	3/16	3/8		
Number of Holes needed for 4 x Area of Pipe					
6	2303	1475	1024	3.4	4
8	4096	2621	1820	4.6	6
10	6400	4096	2844	5.6	7
12	9216	5898	4096	6.6	8
[1/]Based on hole spacing = 2 hole diameter minimum					
[2/]No holes in top portion of pipe for distance shown to counter anti-vortex forces.					

H. Pumping Lift

To prevent an air-lock, which will not allow the fire truck pump to prime, the centerline of the pump intake on the truck shall be no lower than the centerline of the dry hydrant outlet.

The dry hydrant outlet should be approximately 24 inches above ground level and near enough to the access road so that one 10-foot length of flexible hard rubber suction hose can be used to connect the fire truck.

Since it is the gpm delivered which controls fires, or the lack of it that allows fire to burn uncontrolled, pump flow should not be restricted by having too much head loss from the suction line and connectors. It is recommended regardless of the capacity of the (truck) pump that it be equipped with 6" (hard) suction hose and inlets. Even if a 6-inch suction hose is not available, 6" x 5" and 5" x 4-1/2" reducers should be installed on the hydrant inlets, with 4-1/2 inch blind caps. By doing this, any diameter of suction (fitting) can be connected at any time. And the adapters are carried where they will be needed. Also, suction losses can be significantly reduced when using dual lines.

By adhering to the following guidelines, there will be a minimum of 2 psi atmospheric at the pumps. The total lift (pumping head) shall not exceed 20 feet when line, elbow, fitting losses, and elevation head are added. Pumping head shall be figured for each site to include head loss from screen, elbows, line friction, elevation (static head) and hard rubber suction hose to the fire truck. Head loss for fittings (intake screen if applicable, elbows, and hydrant connection) are computed by using equivalent pipe length from Table 2 and adding the total length of pipe required.

Total head loss = head loss x (line length + equivalent length of pipe) + elevation change or static head + length of hard rubber hose x headloss of rubber hose. (See Example Problem and Exhibit 1)

Table 2. Equivalent Pipe Length for Various Fittings

Pipe Fitting	Pipe Diameter, Inches			
	6	8	10	12
	Equivalent Pipe Length			
Intake Screen	5	7	8	9
90 degree elbow (standard)	16	22	27	32
90 degree elbow	11	14	18	20
45 degree elbow	7.5	10	13	15
Hydrant Connection (6” x 4-1/2”)	2.5	2.5	2.5	2.5

Table 3. Head loss in Feet per 100 Feet of Pipe Length (PVC, PIP, SDR-26)

Pumping Rate, GPM	Pipe Diameter, Inches			
	6	8	10	12
	Head Loss			
250	0.58	0.15	0.05	0.02
500	2.08	0.52	0.17	0.07
750	4.42	1.11	.37	0.15
1000	7.54	1.88	.64	0.26
1250	11.4	2.85	0.97	0.39

Table 4. Head loss in Feet per 100 Feet of Hard Rubber Suction Hose

Pumping Rate, GPM	Inside Diameter of Hose, Inches				
	2.5	4.0	4.5	5.0	6.0
	Head Loss				
250	38.2	3.9	2.2	1.3	0.5
500	138.0	14.0	7.79	4.7	1.9
750		29.8	16.8	10.0	4.2
1000		50.6	28.5	17.1	7.0
1250		76.7	43.2	25.9	10.7

I. Example Problem

Given: The local fire department trucks pump 500 gpm. Pump inlet will be installed 24" above ground line at hydrant. Ground line at the hydrant is Elevation 106.0.

Surface Area = 55.0 Acres.

Pond depth = 9.0 feet total.

Drainage Area = 100.0 Acres.

Lateral run pipe length = 35 feet.

Riser height = 14.5 feet

Screen length from Table 1 = 3.4 feet.

Will use 2 - 90·degree standard elbows and 6" x 6" hydrant connection. 10 feet of hard suction hose will be used.

Determine: Diameter of pipe to use and total suction lift. (Maximum total suction lift = 20.0')

From RESOP analysis the elevation of the bottom of the 30,000 gal storage below the 50-year drought level of elevation is 98.4.

Try 6" I.D. PVC pipe.

Static lift = Elevation at center of hydrant connection (108.0') - (50-year drought elevation (98.4) - 30,000 gal (0.002) = 9.60' (Maximum allowable = 15 feet)

Installed pipe length = horizontal + vertical + intake screen = 52.9 feet

Compute equivalent pipe length from Table 2.

Intake Screen = 5.0’

90 Deg. Elbow (std.) = 32.0’

Hydrant Connection (6” x 6”) = 2.5’

Total equivalent pipe length = 39.5’

Total head loss for pipe and fittings = (52.9 ft. + 39.5 ft.) x (2.08'/100') = 1.85' (See Table 3).

Hard suction pipe head loss = 10' x (1.9'x 100') = 0.19' (see Table 4).

Total suction lift = 9.60' static lift + 1.85' pipe & fitting head loss + 0.19' suction hose loss = 11.64' total suction lift (Maximum allowable = 20.0'). See example design sheet, Exhibit 1.

J. Underwater Support

A pipe support shall be provided for the intake screen to assure that it has 2.0 feet of clearance from the pond bottom. The intake shall be firmly held in place at locations where persons boating or fishing may not inadvertently disturb it. Anchorage may be at either end of the pipe with strap or clamp or other adequate means as approved by the local fire department.

K. Dry Hydrant

Dry barrel (conventional) hydrants shall not be used for dry hydrants due to excess suction loss and the necessity that they be absolutely air tight.

If a dry hydrant is properly installed, inspected, and maintained, it should provide trouble-free service for a minimum life of 20 years. Care should be taken in the planning and design phase of the installation to insure that the maximum benefit is derived from the hydrant installation in the years to come. Rural fire departments should anticipate their future needs 5 to 10 years from now. Providing the best possible delivery rate usually only requires increasing the diameter of pipe being used. The costs associated with increasing the diameter of pipe and fittings are a small percentage of the total cost of the installation.

Also, the following recommendations should be considered by those installing dry hydrants:

Dry hydrants should be manufactured by a company with adequate financial resources to assure long-term supply.

Dry hydrant manufacturer should be able and ready to support product in field with on-site personnel.

Dry hydrant manufacturer should maintain a reasonable on-hand supply of all component parts.

L. Access Road

The following guidance for access road is from NFPA 1231 Specifications, Table B-6-2:

Width:

Roadbed - 12 ft. (3.7 m)

Tread: 8 ft. (2.4 m)

Shoulders - 2 ft. (0.6 m)

Alignment:

Radius centerline curvature - 50 ft. (15.2 m)

Gradient:

Maximum sustained grade - 8 percent

Side Slopes:

All cut and fill slopes to be stable for the soil involved.

Drainage:

Bridges, culverts, or grade dips at all drainageway crossings. Roadside ditches deep enough to provide drainage. Special drainage facilities (tile, etc.) at all seep areas and high-water table areas.

Surface:

Treatment as required for year-round travel.

Erosion Control:

Measures as needed to protect road ditches, cross drains, and cut and fill slopes.

Load Carrying Capacity:

Adequate to carry maximum vehicle load expected.

Condition:

Suitable for all weather use.

Additional guidance may be found in the following material for reference:

National Fire Protection Specification No. 1231

Appendix B, page 1231-17 through 1231-27

Appendix D, page 1231-40 through 1231-44

Other portions as desired dealing with rural areas

Firefighting Operations Book Two - The first encyclopedia of water supplies and water delivery techniques by Larry Davis.

Figure 1. Schematic of Dry Hydrant

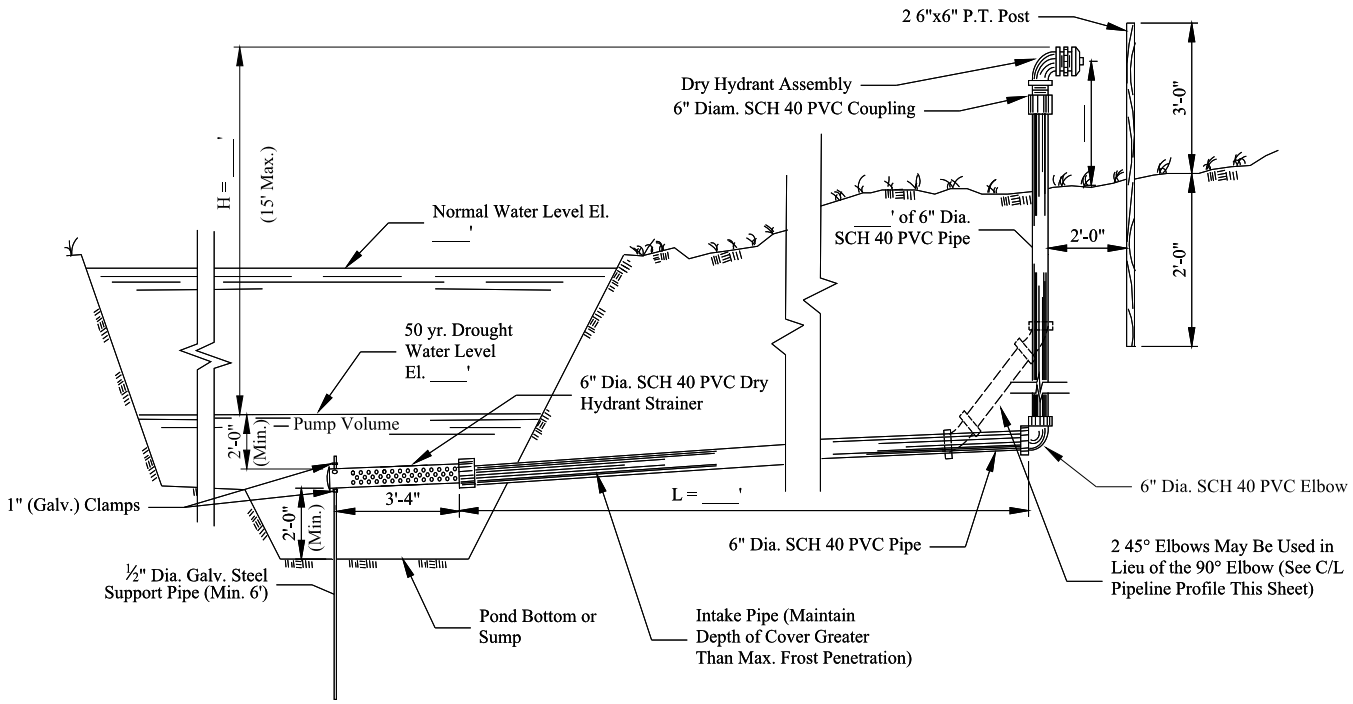


Exhibit FL12-5. Sample Dry Hydrant Hydraulic Design Documentation

Cooperator R. Doe **Location** Anywhere, Florida

Hydrant No. A-100 **Fire Department** Anywhere Vol. Fire Dept.

Surface Area 55 Ac. **Depth** 10.0 Ft. **Drainage Area** 100 Ac.

Step 1 - Compute straight pipe

Pipe Size	6	inch I.D.
Screen Length	3.4	L.F.
Lateral Run Length	35.00	L.F.
Riser Height	14.50	L.F.
Total Straight Pipe	**52.9**	**L.F.**

Step 2 - Compute straight pipe equivalent

Use Table No.1 for following pipe length equivalents for fittings:

Hydrant Adapter	2.5'	Elbow	90 degrees = 16.0'
Intake Screen	5.0'	Elbow	90 degrees = 16.0'
Elbow	_____	Elbow	_____
Other	_____	Other	_____

Straight Pipe Equivalent for Fittings = 39.5'

Step 3

Total Straight Pipe Equivalent = **52.9'** + **39.5'** = **92.4 Ft**.
(step 1) (step 2)

Step 4

Design flow = 500 GPM.

Step 5

Compute Pipe and Fitting Head Loss by using answers from Steps 3 and 4 and Table No. 2.

Head Loss for Pipe and Fittings = (2.08 Ft/100') x (92.4 Ft) = 1.92 Ft.

Step 6

Using Table No. 3, determine Suction Hose Head Loss for length of suction hose used to connect the pump to the hydrant.

Suction Hose Head Loss = (1.9 Ft/100') x (10Ft) = 0.19 Ft.

Step 7

Static Lift = Elev. 108 – Elev. 98.3 = 9.7 Ft.

Step 8

Add the answers from #5, 6, and 7 to get Total Suction Lift.
#5 1.92' + #6 0.19' + #7 9.7' = Total Suction Lift 11.8 Ft.
Total suction lift shall not be greater than 20 feet.

J.Q. Citizen	3/14/11
Designed By (name)	(Date)
J.Q. Citizen	3/14/11
Designed By (name)	(Date)

APPENDIX A
MEAN MONTHLY AND ANNUAL PAN EVAPORATION FOR FLORIDA

MONTHLY PAN EVAPORATION DATA FOR FLORIDA

NO.	LOCATION	COUNTY	EVAPORATION COEFFICIENT	MONTHLY-EVAPORATION JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL EVAPORATION
1	ZONE 1	*	76	2.61	3.26	5.11	6.40	7.17	7.55	7.04	6.61	6.04	5.14	3.33	2.48	62.74
2	ZONE 2	*	76	2.96	3.72	5.65	7.07	7.79	7.53	7.30	6.62	5.81	4.94	3.56	2.90	65.85
3	ZONE 3	*	75	2.94	3.58	5.34	6.74	7.50	6.98	6.72	6.18	5.31	4.70	3.47	2.84	62.30
4	ZONE 4	*	74	3.30	3.89	5.93	7.26	7.93	7.15	7.18	6.80	5.94	5.27	3.83	3.05	67.53
5	ZONE 5	*	72	3.75	4.15	6.02	7.18	7.73	6.95	7.10	6.80	5.90	5.55	4.09	3.44	68.66
6	ZONE 6	*	73	3.50	4.10	5.76	6.87	7.40	6.64	6.69	6.55	5.56	5.15	4.01	3.33	65.56
7	ZONE 7	*	74	5.00	5.00	7.00	9.00	9.00	8.00	8.15	7.43	6.00	6.00	4.00	4.38	78.96
8	VERO BEACH	INDIAN RIVER	74	2.80	3.60	5.44	6.64	7.07	6.66	6.64	6.32	5.03	4.81	3.31	2.64	60.96
9	BELLE GLADE	PALM BEACH	72	3.35	3.99	5.70	6.45	7.07	6.29	6.33	6.15	5.30	4.73	3.66	3.14	62.16
10	FLAMINGO	MONROE	72	5.00	5.00	7.00	9.00	9.00	8.00	8.15	7.43	6.00	6.00	4.00	4.38	78.96
11	FT LAUDERDALE	BROWARD	74	3.83	4.33	6.24	7.54	7.83	6.92	7.15	6.97	5.94	5.52	4.31	3.81	70.39
12	GAINESVILLE	ALACHUA	76	2.95	3.71	5.65	7.14	7.97	7.59	7.14	6.71	5.74	4.97	3.60	2.82	65.99
13	LAKE ALFRED	POLK	74	3.33	3.91	6.01	7.37	8.16	7.23	7.33	6.92	6.17	5.30	3.90	3.09	68.72
14	LAKE CITY	COLUMBIA	76	2.99	3.76	5.70	7.06	7.70	7.55	7.49	6.59	5.92	4.94	3.56	2.98	66.24
15	LISBON	LAKE	76	2.75	3.30	5.01	6.59	7.15	6.61	6.55	6.02	5.09	4.44	3.21	2.69	59.41
16	MILTON	SANTA ROSA	76	2.58	3.26	4.99	6.25	7.02	7.08	6.56	6.05	5.27	4.70	3.18	2.32	59.26
17	MOORE HAVEN	GLADES	72	4.05	4.30	6.47	7.87	8.50	7.68	7.50	7.17	6.56	5.91	4.46	3.60	74.07
18	TAMIAMI TRL	DADE	73	3.36	3.85	5.41	6.31	6.83	6.15	6.87	6.57	5.36	5.53	3.81	3.20	63.25

(From NOAA Technical Report NWS 34 – Mean Monthly, Seasonal and Annual Pan Evaporation Data for the United States)
* For zones, see Florida Irrigation Guide, Chapter 4

APPENDIX B

SAMPLE RESOP AND RIP COMPUTER PROGRAM IN PUT AND OUTPUT

STAGE - STORAGE - AREA WORKSHEET
FOR SAMPLE RESOP INPUT

STAGE (FEET)	AREA (ACRES)	STORAGE (AC-FT)
101.50	55.00	550.00
100.50	55.00	495.00
98.50	55.00	385.00
97.50	55.00	330.00
96.50	55.00	275.00
95.50	55.00	220.00
94.50	55.00	165.00
91.50	55.00	0.00

Minimum storage from RESOP INPUT PROGRAM output 377.83 AC.FT.

(See page B-6)

STAGE	STORAGE
98.50	385.00
98.37	377.83
97.50	330.00

(385.00-378.51)/(385-330) = (98.50 - X)/(98.50 - 97.50)

X = 98.50 -((98.50 - 97.50)*((385.00 - 377.83)/(385.00 - 330.00)))
X = 98.37 FEET

Use elevation 98.4 for the 50 year drought elevation.

```
RESOP   XEQ  04/06/93   10:34:22   ECHO LISTING OF INPUT DATA     PAGE   1
        REV  11/30/87

TITLE     SAMPLE RESOP DATA SET FOR DOGWOOD LAKE
TITLE     USING DEFUNIAK SPRINGS RAINFALL DATA
STO-AREA      550.00     55.00    400.00     55.00    300.00     55.00    0.00
STO-AREA      200.00     55.00    100.00     55.00      0.00     55.00    0.00
LIMITS        400.00    300.00    200.00    100.00      0.00      0.00    0.00
GENERAL        76.00   1931.00      0.00      0.00      1.00      1.00    0.00
SEEPAGE        55.00      0.00      0.00      0.00      0.00      0.00    0.00
RAINFALL        3.21      4.63      4.83      2.72      2.30      3.37 1931.00
RAINFALL        8.03      8.23      4.33      2.39      0.11      6.71 1931.00
RUNOFF          0.83      1.77      1.91      0.56      0.36      0.93 1931.00
RUNOFF          4.49      4.66      1.55      0.40      0.16      3.38 1931.00
EVAP            2.61      3.26      5.11      6.40      7.17      7.55 1931.00
EVAP            7.04      6.61      6.04      5.14      3.33      2.48 1931.00
DEMAND          0.00      0.00      0.00      0.00      0.00      0.00 1931.00
DEMAND          0.00      0.00      0.00      0.00      0.00      0.00 1931.00
OTHER           0.00      0.00      0.00      0.00      0.00      0.00 1931.00
OTHER           0.00      0.00      0.00      0.00      0.00      0.00 1931.00

                        < DATA OMITTED FOR BREVITY>

RAINFALL        6.24      1.47     12.68      7.39      6.18      4.46 1980.00
RAINFALL        5.50      3.73      4.86      4.62      1.57      0.68 1980.00
RUNOFF          3.00      0.08      8.68      3.94      2.95      1.65 1980.00

RESOP   XEQ  04/06/93   10:34:22   ECHO LISTING OF INPUT DATA     PAGE  11
        REV  11/30/87

RUNOFF          2.41      1.15      1.93      1.76      0.10      0.01 1980.00
EVAP            2.61      3.26      5.11      6.40      7.17      7.55 1980.00
EVAP            7.04      6.61      6.04      5.14      3.33      2.48 1980.00
DEMAND          0.00      0.00      0.00      0.00      0.00      0.00 1980.00
DEMAND          0.00      0.00      0.00      0.00      0.00      0.00 1980.00
OTHER           0.00      0.00      0.00      0.00      0.00      0.00 1980.00
OTHER           0.00      0.00      0.00      0.00      0.00      0.00 1980.00
END DATA
```

YEAR 1931

MONTH	RAINFALL IN.	RUNOFF IN.	EVAP IN.	OTHER AF	DEMAND AF	UP. SITE AF	TOTAL INFLOW AF
JAN	3.21	.83	2.61	.00	.00	.00	4437.57
FEB	4.63	1.77	3.26	.00	.00	.00	9453.11
MAR	4.83	1.91	5.11	.00	.00	.00	10200.05
APR	2.72	.56	6.40	.00	.00	.00	2996.57
MAY	2.30	.36	7.17	.00	.00	.00	1928.89
JUN	3.37	.93	7.55	.00	.00	.00	4971.18
JUL	8.03	4.49	7.04	.00	.00	.00	23962.89
AUG	8.23	4.66	6.61	.00	.00	.00	24869.69
SEP	4.33	1.55	6.04	.00	.00	.00	8279.41
OCT	2.39	.40	5.14	.00	.00	.00	2142.45
NOV	.11	.16	3.33	.00	.00	.00	853.10
DEC	6.71	3.38	2.48	.00	.00	.00	18041.93
YR TOTAL	50.86	21.00	62.74	.00	.00	.00	112136.80

MONTH	SEEPAGE AF	SURF AREA ACRES	EVAP AF	STORAGE AF	DEFICIT AF	SPILL AF
JAN	.00	55.00	9.09	400.00	.00	4328.48
FEB	.00	55.00	11.36	400.00	.00	9441.75
MAR	.00	55.00	17.80	400.00	.00	10182.25
APR	.00	55.00	22.29	400.00	.00	2974.27
MAY	.00	55.00	24.98	400.00	.00	1903.92
JUN	.00	55.00	26.30	400.00	.00	4944.88
JUL	.00	55.00	24.52	400.00	.00	23938.37
AUG	.00	55.00	23.02	400.00	.00	24846.67
SEP	.00	55.00	21.04	400.00	.00	8258.37
OCT	.00	55.00	17.90	400.00	.00	2124.55
NOV	.00	55.00	11.60	400.00	.00	841.50
DEC	.00	55.00	8.64	400.00	.00	18033.29
YR TOTAL	.00		218.54		.00	111818.30

<DATA OMITTED FOR BREVITY>

YEAR 1980

MONTH	RAINFALL IN.	RUNOFF IN.	EVAP IN.	OTHER AF	DEMAND AF	UP. SITE AF	TOTAL INFLOW AF
JAN	6.24	3.00	2.61	.00	.00	.00	16014.85
FEB	1.47	.08	3.26	.00	.00	.00	433.04
MAR	12.68	8.68	5.11	.00	.00	.00	46311.66
APR	7.39	3.94	6.40	.00	.00	.00	21029.14
MAY	6.18	2.95	7.17	.00	.00	.00	15748.14
JUN	4.46	1.65	7.55	.00	.00	.00	8812.88
JUL	5.50	2.41	7.04	.00	.00	.00	12867.50
AUG	3.73	1.15	6.61	.00	.00	.00	6145.16
SEP	4.86	1.93	6.04	.00	.00	.00	10306.76
OCT	4.62	1.76	5.14	.00	.00	.00	9399.77
NOV	1.57	.10	3.33	.00	.00	.00	540.07
DEC	.68	.01	2.48	.00	.00	.00	56.40
YR TOTAL	59.38	27.66	62.74	.00	.00	.00	147665.40

MONTH	SEEPAGE AF	SURF AREA ACRES	EVAP AF	STORAGE AF	DEFICIT AF	SPILL AF
JAN	.00	55.00	9.09	400.00	.00	16005.76
FEB	.00	55.00	11.36	400.00	.00	421.68
MAR	.00	55.00	17.80	400.00	.00	46293.86
APR	.00	55.00	22.29	400.00	.00	21006.85
MAY	.00	55.00	24.98	400.00	.00	15723.16
JUN	.00	55.00	26.30	400.00	.00	8786.58
JUL	.00	55.00	24.52	400.00	.00	12842.97
AUG	.00	55.00	23.02	400.00	.00	6122.13
SEP	.00	55.00	21.04	400.00	.00	10285.72
OCT	.00	55.00	17.90	400.00	.00	9381.87
NOV	.00	55.00	11.60	400.00	.00	528.47
DEC	.00	55.00	8.64	400.00	.00	47.77
YR TOTAL	.00		218.54		.00	147446.80

RESOP XEQ 04/06/93 10:34:22 ECHO LISTING OF INPUT DATA PAGE 62
REV 11/30/87

END JOB
END RUN

SAMPLE OUTPUT FROM RIP PROGRAM

YEAR	MINIMUM STORAGE
1931	400.00
1932	400.00
1933	381.88
1934	400.00
1935	395.08
1936	400.00
1937	400.00
1938	392.02
1939	400.00
1940	400.00
1941	379.33
1942	385.90
1943	400.00
1944	377.83
1945	400.00
1946	394.71
1947	400.00
1948	400.00
1949	400.00
1950	392.25
1951	392.91
1952	400.00
1953	400.00
1954	400.00
1955	386.68
1956	400.00
1957	394.25
1958	400.00
1959	400.00
1960	400.00
1961	400.00
1962	400.00
1963	400.00
1964	400.00
1965	391.98
1966	400.00
1967	400.00
1968	400.00
1969	400.00
1970	400.00
1971	400.00
1972	400.00
1973	400.00
1974	400.00
1975	400.00
1976	400.00
1977	379.61
1978	400.00
1979	400.00
1980	400.00

END DATA

APPENDIX C

SAMPLE RIP OUTPUT FOR LESS THAN

50 YEARS OF DATA

SAMPLE OUTPUT FROM RIP PROGRAM
(For less than 50 years of data)

YEAR	MINIMUM STORAGE
1949	379.20
1950	391.88
1951	400.00
1952	400.00
1953	400.00
1954	395.22
1955	400.00
1956	400.00
1957	394.21
1958	400.00
1959	400.00
1960	400.00
1961	400.00
1962	400.00
1963	400.00
1964	400.00
1965	400.00
1966	400.00
1967	400.00
1968	400.00
1969	395.08
1970	400.00
1971	400.00
1972	400.00
1973	400.00
1974	400.00
1975	400.00
1976	392.63
1977	378.51
1978	400.00
1979	386.27
1980	400.00
1981	392.66
1982	400.00
1983	400.00
1984	400.00
1985	400.00
1986	400.00
1987	400.00
1988	386.50
1989	400.00
1990	383.50
1991	400.00

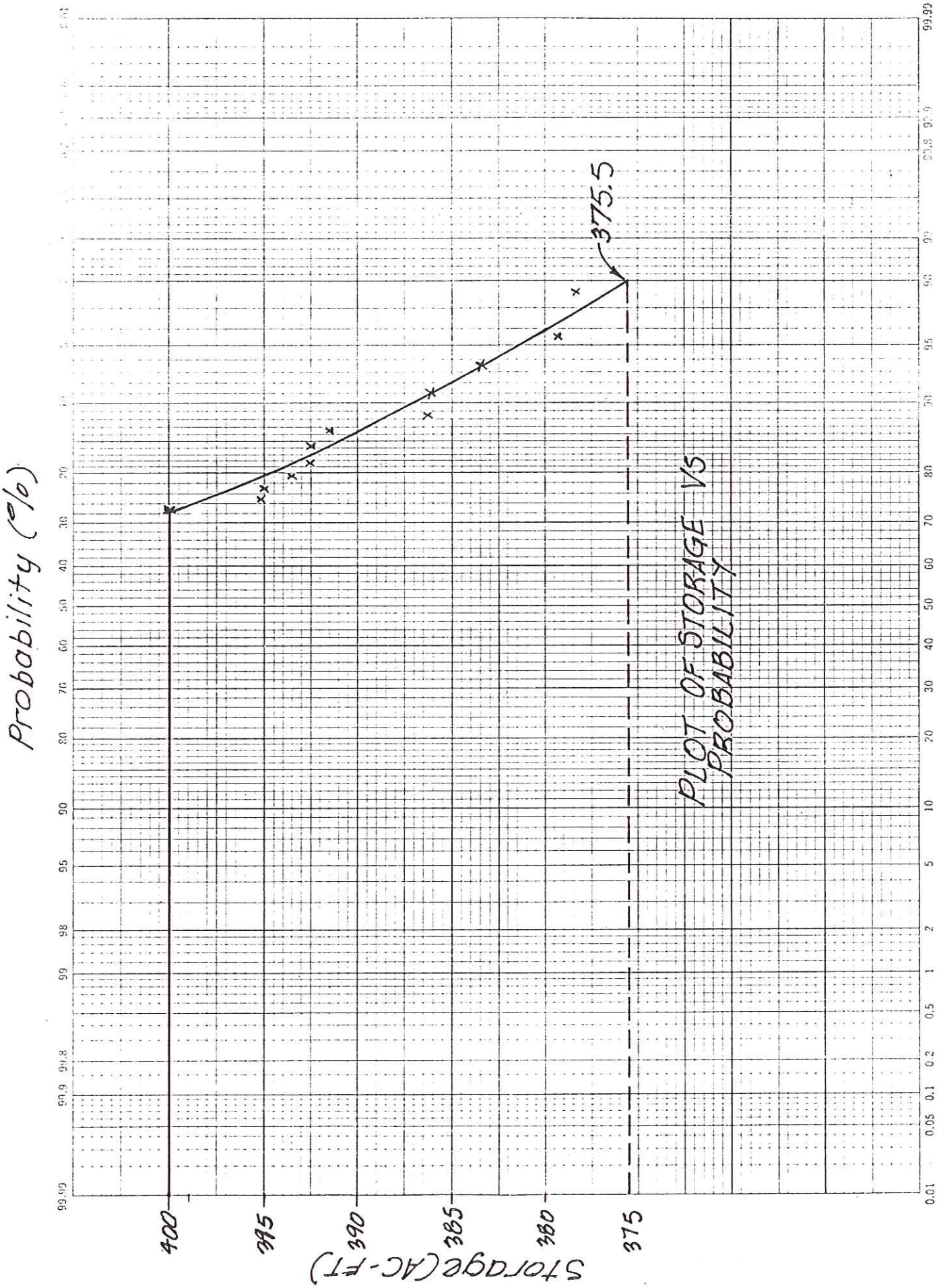
END DATA

MINIMUM STORAGE TABLE

YEAR	STORAGE (AC-FT)	RANK (m)	RETURN (T)	PROBABILITY
1977	378.5	1.0	44.0	2.3
1949	379.2	2.0	22.0	4.5
1990	383.5	3.0	14.7	6.8
1979	386.3	4.0	11.0	9.1
1988	386.5	5.0	8.8	11.4
1950	391.9	6.0	7.3	13.6
1976	392.6	7.0	6.3	15.9
1981	392.7	8.0	5.5	18.2
1957	394.2	9.0	4.9	20.5
1969	395.1	10.0	4.4	22.7
1954	395.2	11.0	4.0	25.0
1974	400.0	12.0	3.7	27.3
1970	400.0	13.0	3.4	29.5
1968	400.0	14.0	3.1	31.8
1986	400.0	15.0	2.9	34.1
1987	400.0	16.0	2.8	36.4
1975	400.0	17.0	2.6	38.6
1978	400.0	18.0	2.4	40.9
1985	400.0	19.0	2.3	43.2
1971	400.0	20.0	2.2	45.5
1973	400.0	21.0	2.1	47.7
1991	400.0	22.0	2.0	50.0
1951	400.0	23.0	1.9	52.3
1967	400.0	24.0	1.8	54.5
1958	400.0	25.0	1.8	56.8
1966	400.0	26.0	1.7	59.1
1965	400.0	27.0	1.6	61.4
1960	400.0	28.0	1.6	63.6
1959	400.0	29.0	1.5	65.9
1952	400.0	30.0	1.5	68.2
1972	400.0	31.0	1.4	70.5
1953	400.0	32.0	1.4	72.7
1961	400.0	33.0	1.3	75.0
1982	400.0	34.0	1.3	77.3
1984	400.0	35.0	1.3	79.5
1980	400.0	36.0	1.2	81.8
1989	400.0	37.0	1.2	84.1
1983	400.0	38.0	1.2	86.4
1955	400.0	39.0	1.1	88.6
1962	400.0	40.0	1.1	90.9
1956	400.0	41.0	1.1	93.2
1964	400.0	42.0	1.0	95.5
1963	400.0	43.0	1.0	97.7

RETURN PERIOD (T) = (N + 1)/RANK (m)
N = NUMBER OF DATA POINTS

PROBABILITY = 100/RETURN PERIOD


PLOT OF STORAGE V/S PROBABILITY
375.5
Probability (%)
Storage (AC-FT)
400
395
390
385
380
375
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01

APPENDIX D

SAMPLE DRAINMOD OUTPUT

```
*****************************************************************************

                    D R A I N M O D

          Copyright 1990-91 North Carolina State University
              VERSION: NORTH CAROLINA MICRO-UNIX 4.60a
                   LAST UPDATE: Sept. 1991
                 LANGUAGE: MS FORTRAN v 5.0 & UNIX f77

        DRAINMOD IS A FIELD-SCALE HYDROLOGIC MODEL DEVELOPED FOR
        THE DESIGN OF SUBSURFACE DRAINAGE SYSTEMS. THE MODEL WAS
        DEVELOPED BY RESEARCHERS AT THE DEPT. OF BIOLOGICAL AND
        AGRICULTURAL ENGINEERING, NORTH CAROLINA STATE UNIVERSITY
        UNDER THE DIRECTION OF R. W. SKAGGS.

*****************************************************************************

            ***************************
            * D R A I N M O D -- 4.60a *
            ***************************
   Copyright 1990-91 North Carolina State University


 DATA READ FROM INPUT FILE: c:\DM46\INPUT46\DRY165.LIS
 Cream selector (0=no, 1=yes) =  0

                 TITLE OF RUN
                 ************


DRY HYDRANT MODELING
MYAKKA SAND DRAINAGE ANALYSIS


                 CLIMATE INPUTS
                 ******* ******

   DESCRIPTION                          (VARIABLE)    VALUE   UNIT
-----------------------------------------------------------------------------
FILE FOR RAINDATA ............. c:\DM46\WEATHER\DAYTON.RAI
FILE FOR TEMPERATURE/PET DATA .. c:\DM46\WEATHER\DAYTON.TEM
RAINFALL STATION NUMBER.........................(RAINID)      82158
TEMPERATURE/PET STATION NUMBER..................(TEMPID)      82158
STARTING YEAR OF SIMULATION.................(START YEAR)      1955   YEAR
STARTING MONTH OF SIMULATION...............(START MONTH)         1   MONTH
ENDING YEAR OF SIMULATION.....................(END YEAR)      1989   YEAR
ENDING MONTH OF SIMULATION...................(END MONTH)         8   MONTH
TEMPERATURE STATION LATITUDE.................(TEMP LAT)      29.00  DEG.MIN
HEAT INDEX.......................................(HID)     127.00


ET MULTIPLICATION FACTOR FOR EACH MONTH
  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00  1.00
```

DRAINAGE SYSTEM DESIGN
****

*** CONVENTIONAL DRAINAGE ***

JOB TITLE:

DRY HYDRANT MODELING
MYAKKA SAND DRAINAGE ANALYSIS

```
        STMAX = 1.50 CM                SOIL SURFACE
+     __/)_____________________________________________________/)__
        :                                  :
        :                                  :
        :                                  :
        :                                  :
        :                                  :
      ADEPTH =140. CM                        DDRAIN =  1. CM
        :                                  :
        :                                  :
        :   O-------------SDRAIN =15240. CM -----------O  -
        :   *                              :
        : EFFRAD = .10 CM                        :
        :                              HDRAIN =122. CM
        :                                  :
        :                                  :
    - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
        :
        :
        :
        :                      IMPERMEABLE LAYER
+
    ////////////////////////////////////////////////////////////////////
```

DEPTH (CM)	SATURATED HYDRAULIC CONDUCTIVITY (CM/HR)
.0 - 20.0	22.130
20.0 - 58.0	13.250
58.0 - 135.0	.250
135.0 - 203.0	4.310

DEPTH TO DRAIN = 1.0 CM
EFFECTIVE DEPTH FROM DRAIN TO IMPERMEABLE LAYER = 122.4 CM
DISTANCE BETWEEN DRAINS = 15240.0 CM
MAXIMUM DEPTH OF SURFACE PONDING = 1.50 CM
EFFECTIVE DEPTH TO IMPERMEABLE LAYER = 123.4 CM
DRAINAGE COEFFICIENT(AS LIMITED BY SUBSURFACE OUTLET)= 1.00 CM/DAY
ACTUAL DEPTH FROM SURFACE TO IMPERMEABLE LAYER = 140.0 CM
SURFACE STORAGE THAT MUST BE FILLED BEFORE WATER CAN MOVE TO DRAIN = .50 CM
FACTOR -G- IN KIRKHAM EQ. 2-17 = 5.88

*** SEEPAGE LOSS INPUTS ***

No seepage due to field slope

Vertical Deep Seepage
hydraulic head in aquifer (cm)= 58.000000
thickness of impeading layer (cm)= 77.000000
vertical conductivity of impeading layer (cm/hr)= 2.500000E-01

No seepage due to lateral deep seepage

*** end of seepage inputs ***

WIDTH OF DITCH BOTTOM = 200.0 CM
SIDE SLOPE OF DITCH (HORIZ:VERT) = 2.00 : 1.00

INITIAL WATER TABLE DEPTH = 1.0 CM

DEPTH OF WEIR FROM THE SURFACE

DATE	1/ 1	2/ 1	3/ 1	4/ 1	5/ 1	6/ 1
WEIR DEPTH	1.0	1.0	1.0	1.0	1.0	1.0

DATE	7/ 1	8/ 1	9/ 1	10/ 1	11/ 1	12/ 1
WEIR DEPTH	1.0	1.0	1.0	1.0	1.0	1.0

SOIL INPUTS
****

TABLE 1

DRAINAGE TABLE

VOID VOLUME (CM)	WATER TABLE DEPTH (CM)
.0	.0
1.0	18.1
2.0	27.9
3.0	39.0
4.0	46.6
5.0	51.2
6.0	55.8
7.0	60.3
8.0	63.6
9.0	66.9
10.0	70.2
11.0	73.6
12.0	76.8
13.0	79.9
14.0	83.0
15.0	86.1
16.0	89.2

17.0	94.2
18.0	99.9
19.0	105.6
20.0	111.3
21.0	117.0
22.0	124.1
23.0	133.0
24.0	141.9
25.0	150.5
26.0	156.2
27.0	161.9
28.0	167.6
29.0	173.2
30.0	178.9
35.0	205.9
40.0	228.5
45.0	251.1
50.0	273.8
60.0	319.0
70.0	364.3
80.0	409.5
90.0	454.8

1 TABLE 2

SOIL WATER CHARACTERISTIC VS VOID VOLUME VS UPFLUX

HEAD (CM)	WATER CONTENT (CM/CM)	VOID VOLUME (CM)	UPFLUX (CM/HR)
.0	.5190	50.00	.5000
10.0	.4774	.32	.5000
20.0	.4330	1.19	.5000
30.0	.4040	2.20	.5000
40.0	.3060	3.09	.0415
50.0	.2310	4.75	.0166
60.0	.1790	6.92	.0065
70.0	.1645	9.93	.0041
80.0	.1500	13.04	.0024
90.0	.1460	16.26	.0013
100.0	.1420	18.02	.0010
110.0	.1380	19.78	.0007
120.0	.1340	21.53	.0004
130.0	.1300	22.66	.0003
140.0	.1260	23.79	.0002
150.0	.1220	24.92	.0001
160.0	.1202	26.67	.0001
170.0	.1184	28.43	.0001
180.0	.1166	30.19	.0000
190.0	.1148	31.94	.0000
200.0	.1130	33.70	.0000
210.0	.1122	35.91	.0000
220.0	.1115	38.12	.0000
230.0	.1107	40.33	.0000
240.0	.1100	42.54	.0000
250.0	.1092	44.75	.0000
260.0	.1085	46.96	.0000
270.0	.1077	49.17	.0000
280.0	.1070	51.38	.0000

290.0	.1062	53.59	.0000
300.0	.1055	55.80	.0000
350.0	.1029	66.85	.0000
400.0	.1027	77.90	.0000
450.0	.1024	88.95	.0000
500.0	.1022	100.00	.0000
600.0	.1017	100.00	.0000
700.0	.1011	100.00	.0000
800.0	.1006	100.00	.0000
900.0	.1001	100.00	.0000

GREEN AMPT INFILTRATION PARAMETERS

W.T.D. (CM)	A (CM)	B (CM)
.000	.000	39.350
10.000	9.880	39.350
20.000	15.310	30.740
40.000	17.410	22.970
60.000	22.490	22.970
80.000	25.260	22.970
100.000	26.770	22.970
150.000	47.220	22.970
200.000	47.220	22.970
1000.000	47.220	22.970

TRAFFICABILITY
****

REQUIREMENTS	FIRST PERIOD	SECOND PERIOD
-MINIMUM AIR VOLUME IN SOIL (CM):	2.30	2.30
-MAXIMUM ALLOWABLE DAILY RAINFALL(CM):	2.50	2.50
-MINIMUM TIME AFTER RAIN BEFORE TILLING CAN CONTINUE:	1.00	1.00

WORKING TIMES		
-DATE TO BEGIN COUNTING WORK DAYS:	3/ 1	10/ 1
-DATE TO STOP COUNTING WORK DAYS:	3/30	10/31
-FIRST WORK HOUR OF THE DAY:	7	78
-LAST WORK HOUR OF THE DAY:	20	20

CROP
****

SOIL MOISTURE AT CROP WILTING POINT = .04

HIGH WATER STRESS: BEGIN STRESS PERIOD ON 1/ 1
END STRESS PERIOD ON 12/30
CROP IS IN STRESS WHEN WATER TABLE IS ABOVE 30.0 CM

DROUGHT STRESS: BEGIN STRESS PERIOD ON 1/ 1
END STRESS PERIOD ON 12/30

MO	DAY	ROOTING DEPTH(CM)
1	1	15.0
12	31	15.0

WASTEWATER IRRIGATION
****

NO WASTEWATER IRRIGATION SCHEDULED:

***** No Wetlands Criteria ******

********** END OF INPUTS **********

SAMPLE OUTPUT FROM DMSORT PROGRAM

YEAR	MINIMUM WATER TABLE DEPTH (SURFACE TO WATER TABLE DEPTH) (cm)	(ft)
1955	204.74	6.72
1956	204.94	6.72
1957	205.55	6.74
1958	205.14	6.73
1959	205.23	6.73
1960	204.97	6.72
1961	205.28	6.73
1962	204.77	6.72
1963	205.46	6.74
1964	204.70	6.72
1965	204.92	6.72
1966	205.16	6.73
1967	205.05	6.73
1968	205.38	6.74
1969	205.13	6.73
1970	204.78	6.72
1971	205.13	6.73
1972	205.01	6.73
1973	204.88	6.72
1974	204.92	6.72
1975	204.77	6.72
1976	205.26	6.73
1977	205.42	6.74
1978	205.48	6.74
1979	204.55	6.71
1980	205.33	6.74
1981	204.68	6.72
1982	204.92	6.72
1983	205.02	6.73
1984	205.45	6.74
1985	205.17	6.73
1986	205.21	6.73
1987	205.08	6.73
1988	204.56	6.71
1989	204.68	6.72

END DATA

All data in the above table is extracted from the *FILE.DAY* output from DRAINMOD.

MINIMUM DESIGN WATER TABLE DEPTH

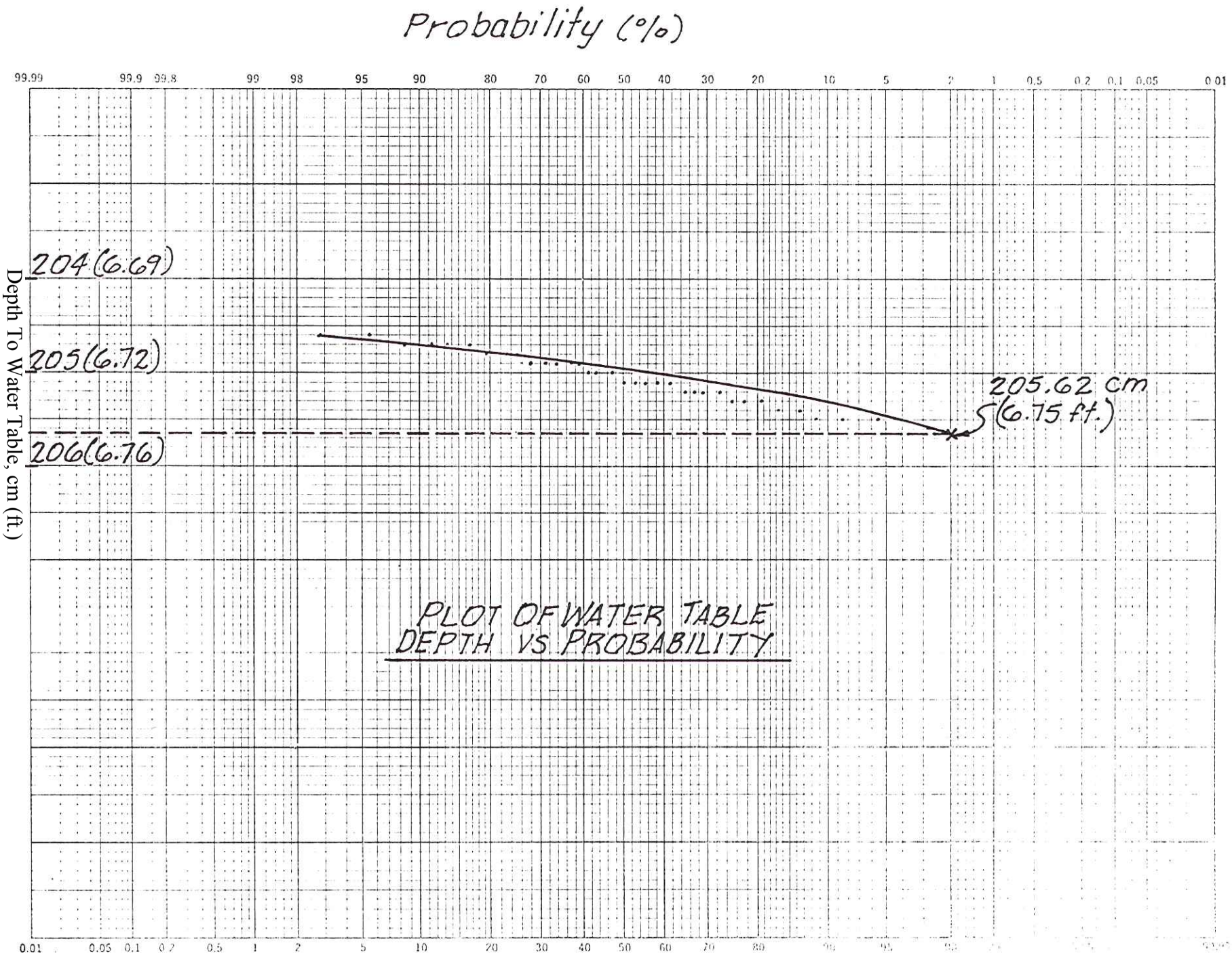
(SURFACE TO WATER TABLE)

YEAR	(cm)	(ft)	RANK	RETURN PERIOD	PROBABILITY
1957	205.55	6.74	1.00	36.00	2.8
1978	205.48	6.74	2.00	18.00	5.6
1963	205.46	6.74	3.00	12.00	8.3
1984	205.45	6.74	4.00	9.00	11.1
1977	205.42	6.74	5.00	7.20	13.9
1968	205.38	6.74	6.00	6.00	16.7
1980	205.33	6.74	7.00	5.14	19.4
1961	205.28	6.73	8.00	4.50	22.2
1976	205.26	6.73	9.00	4.00	25.0
1959	205.23	6.73	10.00	3.60	27.8
1986	205.21	6.73	11.00	3.27	30.6
1985	205.17	6.73	12.00	3.00	33.3
1966	205.16	6.73	13.00	2.77	36.1
1958	205.14	6.73	14.00	2.57	38.9
1971	205.13	6.73	15.00	2.40	41.7
1969	205.13	6.73	16.00	2.25	44.4
1987	205.08	6.73	17.00	2.12	47.2
1967	205.05	6.73	18.00	2.00	50.0
1983	205.02	6.73	19.00	1.89	52.8
1972	205.01	6.73	20.00	1.80	55.6
1960	204.97	6.72	21.00	1.71	58.3
1956	204.94	6.72	22.00	1.64	61.1
1974	204.92	6.72	23.00	1.57	63.9
1982	204.92	6.72	24.00	1.50	66.7
1965	204.92	6.72	25.00	1.44	69.4
1973	204.88	6.72	26.00	1.38	72.2
1970	204.78	6.72	27.00	1.33	75.0
1975	204.77	6.72	28.00	1.29	77.8
1962	204.77	6.72	29.00	1.24	80.6
1955	204.74	6.72	30.00	1.20	83.3
1964	204.70	6.72	31.00	1.16	86.1
1981	204.68	6.72	32.00	1.13	88.9
1989	204.68	6.72	33.00	1.09	91.7
1988	204.56	6.71	34.00	1.06	94.4
1979	204.55	6.71	35.00	1.03	97.2

RETURN PERIOD (T) = (N+1) / RANK (m)

N = Number of Data Entries

PROBABILITY = 100 / T


Probability (%)
99.99
99.9
99.8
99
98
95
90
80
70
60
50
40
30
20
10
5
2
1
0.5
0.2
0.1
0.05
0.01
204 (6.69)
205 (6.72)
206 (6.76)
205.62 cm
(6.75 ft.)
PLOT OF WATER TABLE
DEPTH VS PROBABILITY
Depth To Water Table, cm (ft.)

0-10

ANALYSIS OF DRAINMOD OUTPUT FOR DRY HYDRANT DESIGN

Based on the output from DRAINMOD using Myakka Fine Sand, the 50 year drought, depth to water table was determined to be 205.6 cm (6.75 feet). The procedure for calculating the minimum depth for the pond is as follows:

Given: 1.2 acre surface area (229 ft. X 229 ft.)
Natural ground elevation = 50.0 ft. (assumed)
Center line of Hydrant = 52.0 ft.
Intake pipe diameter = 0.5 ft.
Bottom of existing pond: EL. 35.0 ft.

STORAGE CURVE FOR RECTANGULAR SHAPED BASIN
SIDES OF RECTANGLE AT BOTTOM ARE.... 169 169
SIDE SLOPE IS..... 2

ELEV	GAL	CU.FT	AC.FT	
35	0	0	0	
36	218732	29242	.67	
37	447817	59868	1.37	
38	687493	91910	2.11	
39	938001	125401	2.88	
40	1199579	160371	3.68	
41	1472467	196853	4.52	
42	1756904	234880	5.39	
43	2053129	274482	6.3	
43.1	2114780	282725	6.75	(50 Year drought)
44	2361382	315692	7.25	
45	2681903	358543	8.23	
46	3014930	403065	9.25	
47	3360702	449291	10.31	
48	3719461	497254	11.42	
49	4091443	546984	12.56	
50	4476890	598514	13.74	

Elevation at bottom of pond = 50.0 ft (natural ground) - 6.75 (depth to water table) - 0.1 ft (depth required for 30,000 gallon storage) - 2.0 ft (depth of water over inlet) - 0.5′ (pipe diameter) - 2.0 ft (clearance between inlet invert and pond bottom)
= **38.65 feet** < 35.0 ft depth Pond depth is okay

Maximum static lift = 2.0′ (elev. @ center line of hydrant - natural ground elev.) + 6.75′ (depth to water table) + 0.1′ (storage depth)
= **8.85 feet** (maximum allowed static lift = 15 feet)

See Figure 2 for typical cross section.

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