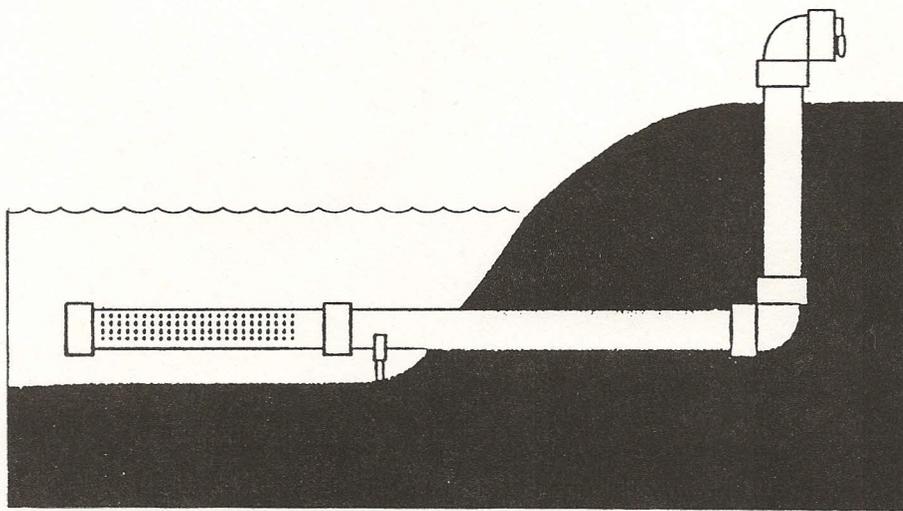


DRY HYDRANT MANUAL



**A Guide for Developing Alternative Water Sources and
Delivery Systems for Rural Fire Protection**

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A Guide for Developing Alternative Water Sources and
Delivery Systems for Rural Fire Protection

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Southern Region
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The second printing of the manual offers the reader the latest information on the planning, design, installation and water delivery system for rural fire fighting.

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- National Fire Protection Association

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Benefits of Dry Hydrant System

A properly installed dry hydrant allows natural, unprocessed water to be used for road maintenance and fire protection. This allows small towns to better use its limited water shortage for drinking water. A well planned and designed dry hydrant water delivery system can improve fire fighting capability of rural fire departments, save fuel and reduce the cost of operations.

An additional benefit to citizens where dry hydrants have been properly used is in the reduction of the fire classification for fire insurance. For example, when the Forsyth County, Georgia volunteer fire department, with proper training and equipment, used the dry hydrant water delivery system, county homeowners saw their insurance rates drop by 49 percent. For an \$85,000 home, this means \$200 savings per year on homeowner's insurance.

Water is a key ingredient for proper road maintenance. Research has shown that an automobile traveling on a well-compacted gravel road, as opposed to a loose road surface, will use 11 to 12 percent less fuel.

Improve Fire Protection

The recommended distance between dry hydrants is one every 3 square miles. This would ensure that fire tankers would travel no more than three miles to a fill-up point. And since the fill-up through the system usually takes about two minutes to complete, there could be an uninterrupted water supply and better fire control.

Lower Insurance Rates

Fire insurance premiums for each area are based on a classification by the Insurance Service Organization (ISO). The classification depends on each area's ability to fight fires.

Areas with no fire departments are given a class 10 rating. As the fire-fighting capability increases, the rating decreases. This can be accomplished through higher training levels, better equipment, etc. If a fire department can demonstrate the ability to keep 250 gallons of water per minute for two hours at a fire scene, the area's fire rating could potentially decrease to a six or seven. The ISO, however, makes the final determination regarding the rate.

With a dry hydrant system, this goal can be easily achieved. A fire rating decrease from a nine to a seven can often reduce insurance rates by 45 to 50 percent.

Conserve Treated Water Supply

Dry hydrants are installed in untreated water supplies, which means that fire departments do not have to use the treated water from towns in the country. As water becomes more scarce, the treated water would be available to the citizens for drinking.

Conserve Energy

Since tanker trucks have less travel time between fill-up points, they would save fuel. The overall operating costs of the fire department would be lessened by the use of dry hydrants.

Promote Economic Development

With lower insurance rates and higher fire-fighting capability, the area would be more attractive to developers and homeowners.

Improve Road Maintenance

A large amount of water is usually needed for the installation of the base on gravel roads. The water allows for better compacting of the road, which will often improve gas mileage for cars that travel on it.

Preplanning

A number of preplanning activities should take place by local government or community fire departments as a prerequisite to the consideration of dry hydrants.

A master fire plan should be developed stating goals and objectives for rural fire protection. The plan should serve as the guide for organization, equipment, training, and water supply needs to reach the level of fire protection desired. Assistance in developing such a plan is available from the State forestry commission RFD coordinator.

Plans should include, but are not limited to:

- a. Equipment (large-chassis, pumpers, tankers, ladder units, other rolling stock.)
- b. Equipment (support, accessory, and personnel)
- c. Manpower
- d. Training, equipment and facilities
- e. Building(s) - new, renovation, addition
- f. Inspections - commercial building, residential (all types), hospitals, schools, homes for the elderly, fire hydrants and water supply points.
- g. I and E - public education, fire prevention
- h. Water supply improvements for fire protection

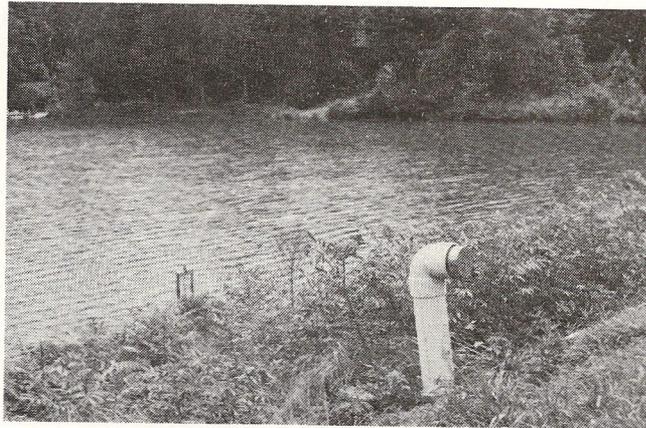
Local county or city governments are encouraged to set up an organizational structure to allow community volunteer fire departments to work together to promote dry hydrants for maximum benefit. Ideally, the county/city government should have a full time fire coordinator to work with volunteer fire districts implementing the goals and objectives of the master fire plan, including the implementation of the dry hydrant water delivery system.

CHAPTER II

SELECTING HYDRANT LOCATIONS



Dry hydrants should be easily accessible.



Natural, unprocessed water is used in fire fighting and road maintenance with dry hydrants

Mapping

Using a **county road map**, mark the good sites (Rating of "1" and "2") on the map. See example in figure 3. A study of the Master Fire Plan for the county and above discussed map showing possible dry hydrant sites will assist county planners in selecting strategic hydrant sites for water supply.

Past experience has shown that dry hydrants should be placed at an interval of one in every 3 square miles. This spacing would require tankers to travel approximately 3 miles round trip to any location. The following formula can be used to plan water availability at any point in an area. To be recognized as ISO Class 8 or better, you must be able to deliver at least 250 gallons per minute (gal/min) for a 2-hour period.

EXAMPLE:

$$Q = \frac{V}{A + (T_1 - T_2) + B} - 10\%$$

If tank capacity is 1,500 gal. (V) time to dump the tanker load into a portable tank is 3 minutes (A); round-trip time to the refill point is 6 minutes at a speed of 35 mph (T) and time to fill is 3 minutes (B). See table 1.

$$Q = \frac{1500}{3 + 6 + 3} - 10\% = 112 \text{ GPM}$$

Table 1 - Time distance table using an average safe constant speed of 35 mi/h.
(T = 0.65 + 1.70 D)

Distance Miles	Time Minutes	Distance Miles	Time Minutes	Distance Miles	Time Minutes
1.0	2.35	2.0	4.0	2.9	5.52
1.2	2.69	2.1	4.2	3.0	5.75
1.3	2.86	2.2	4.39	3.1	5.92
1.4	3.03	2.3	4.56	3.2	6.09
1.5	3.20	2.4	4.73	3.3	6.26
1.6	3.37	2.5	4.90	3.4	6.43
1.7	3.54	2.6	5.07	3.5	6.60
1.8	3.71	2.7	5.24	3.6	6.77
1.9	3.88	2.8	5.41	3.7	6.94
				4.0	7.45
				4.5	8.30

NOTE: The **distance** to fill-up points and the **number** and **capacity** of tankers available to a fire department is important for adequate water supply.

Field Checking

After the locations have been mapped, it is time to check them out in the field. During the field inspection, the following items should be evaluated.

- (1) access to water (fences, underground cables, etc.)
- (2) roadway access by fire equipment
- (3) drought water level (talk to people who know history of lake or stream)
- (4) flood frequency (talk to people who know history of area)
- (5) general configuration of lake (talk to people who know about depth construction)
- (6) presence of aquatic growth in ponds
- (7) property owners acceptance
- (8) using a stake or flag, mark the best location for the hydrant.

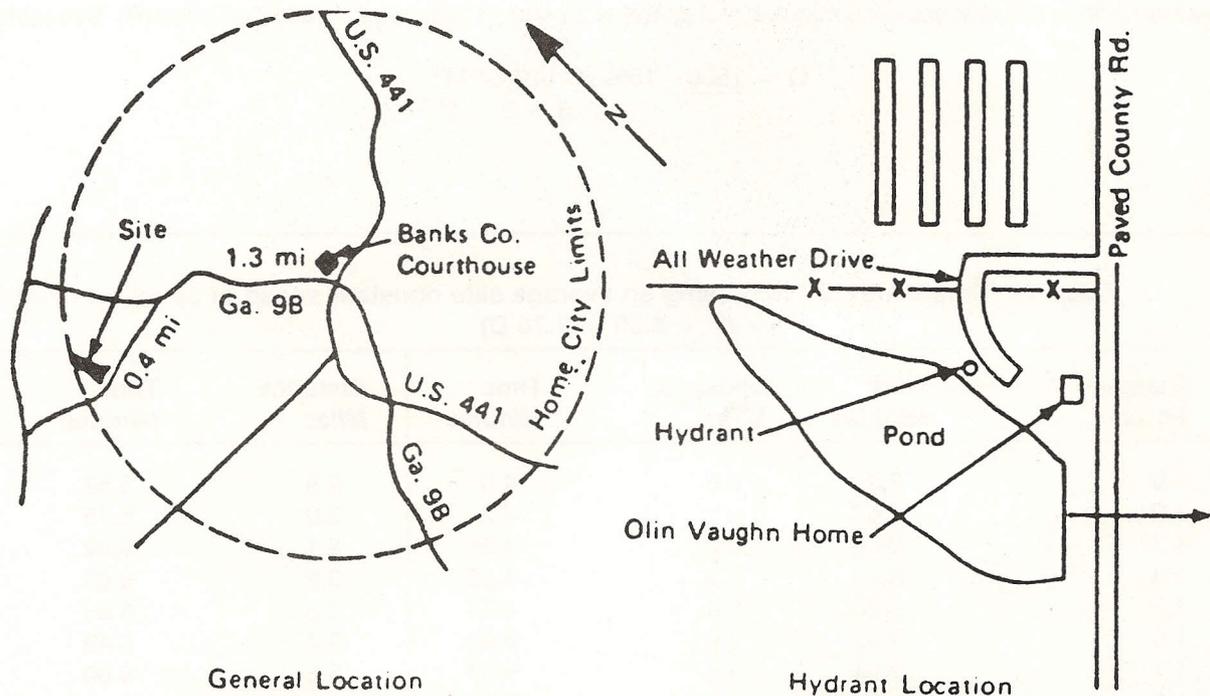


Figure 3.- Sample design and layout of dry hydrant.

Water Usage Easements

Should the proposed site retain a rating of "1" or "2" after a field inspection, the fire department water supply officer, fire chief or other county official should contact the legal property owner and secure permission to use the water source. Such permission should be given in writing in close cooperation with the municipal,

town or country attorney. It is recommended that the easement be reviewed by a representative of the highway or county road department or others who will be required to build, service and maintain access roads and areas adjacent to hydrants.

The property owner should have a copy of the agreement. It is highly recommended that a copy be on file in the official records of the county or city.

Figure 4 is an example of a water usage agreement that has been used by many fire departments with approval of county and city attorneys.

TO: _____
County

FROM: _____
Property Owner

SUBJECT: Letter of authorization to develop and utilize water source on my property

The _____ County is hereby authorized to develop a refill site at _____ for the purpose of providing water to extinguish fires in my community and for other uses with my permission.

I further give the _____ County permission to erect a dry hydrant stand at this location. I understand that _____ County will erect the stand and provide materials.

The _____ County will complete all excavation work so that the surrounding areas and the surface of the ground will be smooth, and present a pleasing appearance.

The _____ County may use, test, the dry hydrant at any time they deem necessary for continuity of hydrant operations.

The complete operation of the dry hydrant stand has been explained and all facets of the installation have been explained and I fully concur with all parts of the operation.

Permission is hereby granted to _____ County to come upon my land to refill its tankers until I revoke this permission in writing to _____ County.

SIGNATURE OF LANDOWNER

I have advised the landowner of the purpose, type of stand, method of operation with the above facts explained.

SIGNATURE OF COUNTY REPRESENTATIVE

Figure 4.- Water usage agreement.

CHAPTER III

SURVEY AND DESIGN

The survey notes and design of each hydrant site should be maintained and kept in an official record. An example of one type of record is shown in figure 5. Such a record provides valuable information needed for future certification.

Assistance may be available from the local Soil Conservation Service office and/or local State forestry agency to make the survey and design. The Soil Conservation Service will prepare the design as outlined in its Dry Hydrant Technical Guide and Engineer Manual. In most cases, SCS will have a certified engineer sign the design. This will facilitate the certification of the hydrant by ISO. Figures 6 and 7 show design forms for streams and ponds.

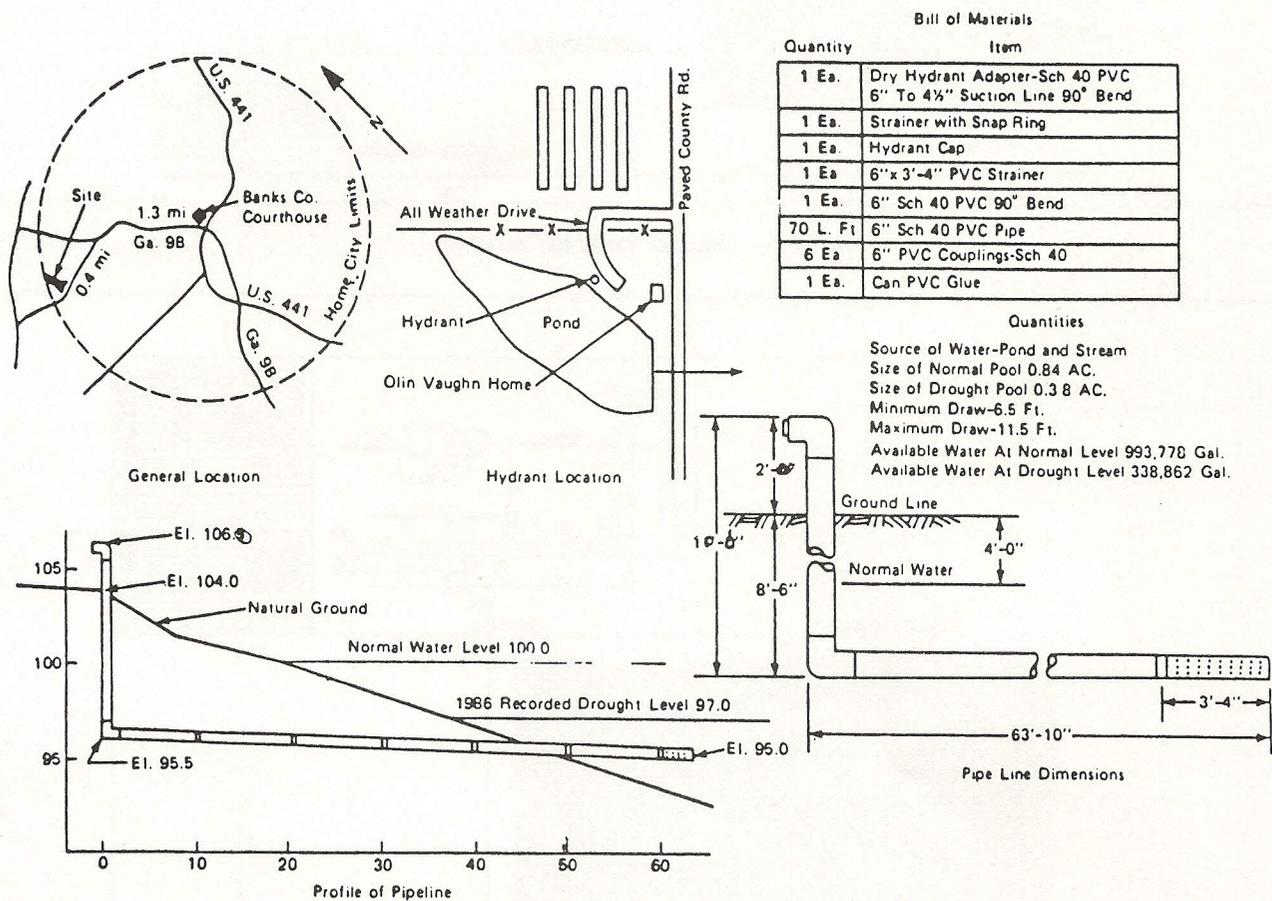


Figure 5.- Example of completed design form.

If qualified engineering assistance is not available from local agency or private engineers, carry out the following steps.

Field Survey

Determine the useful depth of the lake where the hydrant will be placed. The useful depth is from the minimum foreseeable low water surface level (drought level) to the top of the planned suction strainer, not to the bottom of the lake, and should be not less than 2 feet of water. A pump suction requires a submergence below the water surface of 2 feet or more to prevent the formation of a vortex or whirlpool.

Once the level of the suction strainer is determined, use a survey level to determine "A" – the difference between the top of suction strainer and the ground elevation at the riser. See figure 8. The difference should not be greater than 15 feet. Next determine "B" – the level of the top of the riser above the ground level. This should not be greater than 2 feet. The total of $A + B =$ suction lift or head "C" (20 foot maximum, 10 foot or less preferred). Next, determine the length of horizontal pipe line "D," measured from the end of the strainer to the vertical pipe. To obtain the total length of the pipe, add the vertical riser height and the horizontal pipeline length and subtract the elbows. Measurements of pipe needs should be liberal. If the pipe has few joints and turns, there is less chance of air leakage. The horizontal pipe should be laid level, unless the depth becomes too deep to dig, at which time another degree of elbow may be used.

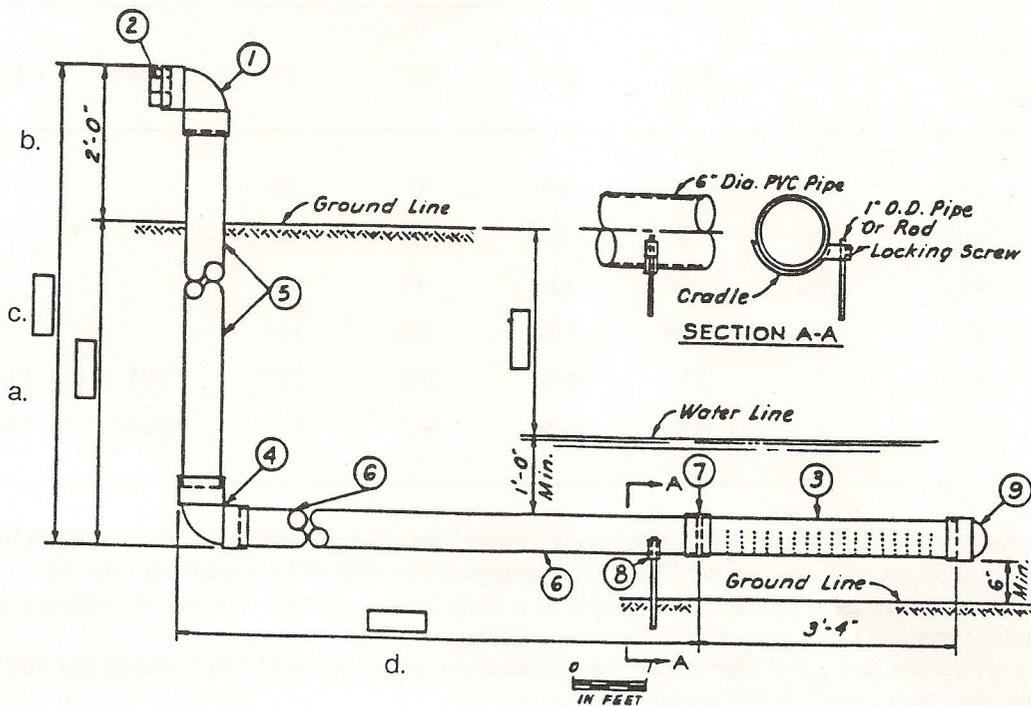


Figure 8.- Pipe details.

Design Features

Several factors should be considered when designing a dry hydrant: (A) desired flow from the hydrant in gallons per minute (gal/min). This will be affected by the distance to the water, difference in elevation between hydrant and water source and size of pipe; (B) suitability of the pipe materials. PVC (polyvinyl chloride) is commonly used because of its many advantages. Other types of materials such as iron, concrete and fiber may be used if a water-tight connection is made; (C) size and type of pumper that is available.

The following design features are suggested for dry hydrants using PVC pipes.

- A - Use a minimum of 6-inch pipes for dry hydrant construction.
- B - Schedule 40 pipe should be used.
- C - All exposed pipe should be primed and painted.
- D - Use a minimum number of elbows, preferably two. Elbows may be 90° or 45° bends.
- E - All connections should be properly jointed and cemented with few joints.
- F - Contact a supply firm to purchase the **dry hydrant assembly** (90° elbow, screen, coupling with cap above ground head) and strainer system (40-inch section of Sch. 40 PVC pipe with holes pre-drilled and removable cap or flap).

NOTE: A strainer (strainer section) may be constructed by boring 5/16, 3/8, or 1/2 inch holes through the pipe. The holes should be spaced on 1/2 inch centers with at least 12 rows drilled. Total area of strainer holes must exceed four times the area of the diameter of the pipe. See table 2.

Table 2.- Number of holes to provide four times area of pipe.

Diameter Pipe (inches)	1/2"	5/8"	3/4"	7/8"	1"	1 1/4"	1 1/2"
3	72	58	48	41	36		
4	128	102	85	73	64		
5	200	160	134	114	110		
6	288	230	192	165	144		
8		409	342	293	257	164	114
10		640	534	457	400	256	178

- G - The depth at which the pipe is installed below ground should be below the frost-free depth for the area. This depth may be obtained from SCS engineers or university Extension Service.
- H - Place the suction pipe in the pond or lake at a level below average 50-year drought as determined by engineer, soil conservationist, or hydrologist.
- I - The dry hydrant horizontal pipe should be laid level on minus grade of 1 to 2 inches per 100 feet, unless the depth of cut is too great.
- J - For streambed installation (with low flow depth less than 2 feet) the strainer section may be buried below bed of stream and covered with gravel. Obtain engineering assistance in the design to determine minimum rate of flow during drought with average 50-year frequency.
- K - Dry hydrants should be installed in close proximity to the water source. A flow of 600 to 1,000 gal/min from the hydrant is desirable. (See table 4.)
- L - Avoid designs with lifts in excess of 20 feet.
- M - Consider friction loss at these high lifts. Losses may be calculated using Mannings formula or Hazen-Williams equations.
- N - Place the pump at a higher elevation than the hydrant connection. This will eliminate air blockage and also prevent the operator from getting wet.

- O - In areas where rock is encountered, each hydrant must be tailored to fit the rock profiles as much as possible. This will create a detailed design and will normally involve more than the two conventional 90 degree bends. Carefully support the hydrant since quite often it has little support from the soils surrounding it.

Calculating Water Quantities

Two primary factors should be considered when developing a dry hydrant water delivery system for fire protection. One is the amount of water available from the water source at the hydrant site and the other is the amount that can be continuously delivered to the fire scene. See tables 3 and 4.

Table 3.- Flow with 6-inch diameter pipe and 25-foot suction head, no bends.

Length (feet)	Bituminous fiber or steel (C = 120)	Cast iron (C = 110)	PVC (C = 140)
	----- gal/min -----		
25	1,840	1,770	2,130
50	1,524	1,448	1,889
100	1,195	1,122	1,582
500	591	548	858
1,000	424	392	625

For SI Units: 1 ft = 0.305 m; 1 gpm = 3.785 L/min.

Table 4.- Formulas for calculation of water quantities from ponds and streams.

POND: 43,560 ft² = 1 acre
 STREAM: Width of flow X depth of flow X velocity = ft³/sec
 ft³/sec X 60 sec/min X 7.48 gal/ft³ = gal/min

A = Acres at normal pool
 B = Acres at drought pool
 C = Acres at strainer elevation
 D = Elevation normal pool-elevation of strainer
 E = Elevation drought pool-elevation of strainer

Available water at normal pool (gallons) $\frac{A+C}{2} \times D \times 43,560$
 Available water at drought pool (gallons) $\frac{B+C}{2} \times E \times 43,560$

Access to Water Supplies

Many times, it is necessary to provide an appropriate way to reach the water supply. Once this is accomplished, department personnel should be trained in the use and limitations of the water supply before the fire occurs. A suitable approach may call for a roadway. However, at some sites and in some areas of the country, it may not be necessary for a roadway to be constructed due to soil conditions. Other sites may already have roadways provided or pavement installed with an entrance way or a gate that allows access to the water supply. Each site must be evaluated by the water supply officer to determine the best way, within the fire department's means, for using the water supply. Table 5 details considerations that could help when planning access.

Table 5.- Recommendations for roads to water supplies.¹

Width:	Roadbed - 12 ft (3.7 m) Tread - 8 ft (2.4 m) Shoulder - 2 ft (0.6096 m)
Alignment:	Radius centerline curvature - 50 ft (15.2 m)
Gradient:	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 all high-water table areas.
Surface:	Treatment as required for year-round travel.
Erosion control:	Measures needed to protect road ditches, cross drains, and cut-and-fill slopes.
Load-carrying capacity:	Adequate to carry maximum vehicle load expected.
Condition:	Appropriate for all-weather use.

¹NFPA Standard 1231.

CHAPTER IV

INSTALLATION

Preplanning

Installation of the dry hydrant is easy if preplanning is completed before going into the field.

- (1) Study the installation design of the hydrant and check for materials.
- (2) Employ a backhoe or similar equipment to excavate ditch.
- (3) At least three people are needed to handle and place pipe in trench.
- (4) Select proper tools for cutting pipe (saw or pipe cutter); shovel; PVC cement and PVC primer; brush to apply cement and rags. A short board and hammer may also be needed.
- (5) Use a knife, plastic pipe deburring tool to remove burrs from the end of pipe after it has been cut.

Digging Trench

Step-by-step procedures for installing a dry hydrant.

- (1) Using a large backhoe, excavate ditch to the designed depth under water level (usually about 3 feet) or at least below the 50-year drought level.
 - (2) Using figure 9 as a guide, mark the backhoe arm with a ribbon to indicate desired depth.
 - (3) Excavate the ditch, beginning in the water, with the backhoe arm fully extended. Maintain a level bottom to the depth marked with ribbon. Excavate the entire horizontal section of the trench.
 - (4) The ditch should now be flooding the entire section of horizontal pipe.
-

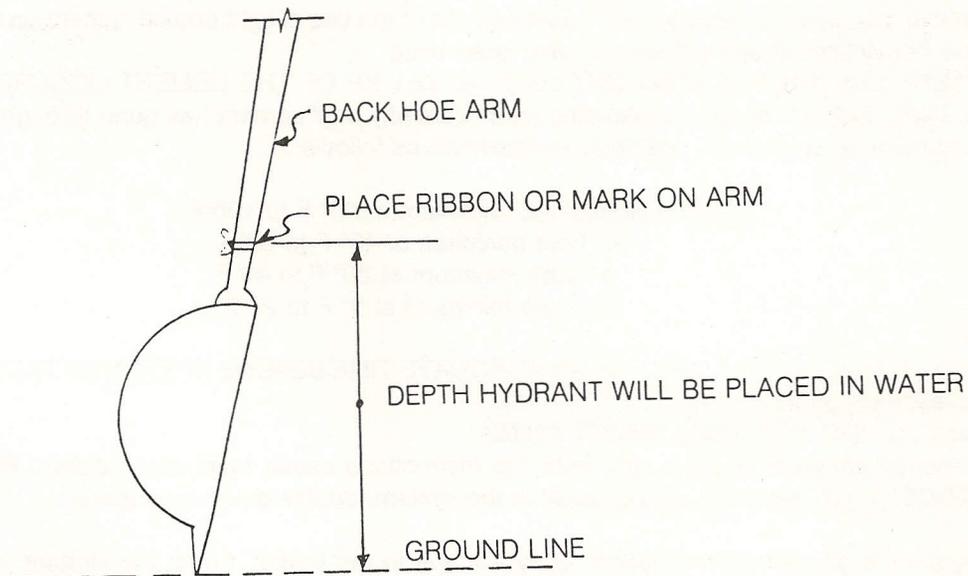


Figure 9.- Digging trench.

Pipe Connections and Laying

Experience indicates that it is very important to follow instructions on cutting, connecting and fitting of pipes to prevent field failures. Special attention should be given to set time and cure time of cement (steps 10 and 11).

1. Cut pipe square to desired length using hand saw and miter box or mechanical cut off saw. (Be sure cut is square and smooth).
A tube cutter designed for plastic may also be used for cutting the pipe. (It is essential to remove raised bead left on outside of pipe).
2. Bevel the end of pipe to approximately 10 to 15 degrees.
3. Clean and dry pipe and fitting socket of all dirt, moisture and grease. Use a clean, dry cloth.
4. Check dry fit of pipe in fitting. Pipe should enter fitting socket about 1/3 to 3/4 inches deep.
5. First dissolve inside socket surface by brushing with recommended primer. Be sure to use brush at least one-half the size of pipe diameter. Use a scrubbing motion to assure penetration. Repeated applications may be necessary. More time is necessary for belled pipe sockets.
6. Next, dissolve surface of male end of pipe, to be inserted into socket, to depth of fitting socket by brushing on **liberal coat of primer. Be sure entire surface is well dissolved.**
7. **Again** brush inside socket surface with **primer, then without delay, apply proper cement liberally** to male end of pipe. The amount should be sufficient to fill any gap.
Also apply cement inside of socket. Keep excess cement out of socket to prevent solvent damage to pipe. **Time is important at this stage. APPLY A SECOND COAT OF CEMENT TO THE PIPE END.**
NOTE: The cement should be applied deliberately but without delay. It may be necessary for two people to work together when cementing larger size pipe and fittings.
8. While both the inside socket surface and the outside surface of the male end of the pipe are SOFT and WET with cement, push bottom of male end of the pipe in the socket, giving the male end a one-quarter (1/4) turn, if possible. **THE PIPE MUST GO TO THE BOTTOM OF THE SOCKET. HOLD THE JOINT TOGETHER UNTIL BOTH SOFT SURFACES ARE FIRMLY GRIPPED (USUALLY LESS THAN 30 SECONDS).**
9. After assembly, wipe excess cement from the pipe at the end of the fitting socket. A properly made joint will normally show a bead around its entire perimeter. Any gaps at this point may indicate a defective assembly job, due to insufficient cement or the use of light bodied cement on large diameters where heavy bodied cement should have been used.
10. **DO NOT DISTURB THE JOINT UNTIL INITIAL SET-UP OF THE CEMENT OCCURS!**
SET TIME: Handle the new assembled joints carefully until cement has gone through the set period. Recommended set time is related to temperature as follows:

30 minutes minimum at 60° F to 100°F
1 hour minimum at 40° F to 60°F
2 hours minimum at 20° F to 40°F
4 hours minimum at 0° F to 20°F
11. **ALLOW THE JOINT TO CURE FOR AN ADEQUATE TIME BEFORE PRESSURE TESTING.** See table 6 on following page.
12. Short Cuts - **DO NOT TAKE SHORT CUTS!**
Experience shows that short cuts from the instructions cause most field failures. **DON'T TAKE A CHANCE!** If gap joints are encountered in the system, double these cure times.

After the hydrant is assembled and glued, carry the unit to the trench. Force the strainer under the water until it fills the pipe with water. If more than eight feet of pipe is out in the pond without support then a support bracket should be placed at the back of the strainer as shown on the design. When the pipe is submerged and lying in the bottom of the trench, backfilling can be completed.

Table 6.- Joint cure time.

Temperature range during cure period	Test pressures for pipe sizes 3 1/2" to 6"	
	Up to 180 lb/in ²	Above 180 to 315 lb/in ²
60° - 100°F	6 hr	24 hr
40° - 60°F	12 hr	48 hr
10° - 40°F	48 hr	8 days

Backfilling

After the pipe is firmly in place in the bottom of the ditch, place the backfill around the riser first and tamp so it is rigidly supported with earth fill. The ditch water is automatically forced back to the water source as backfilling is completed. Use caution to prevent large clumps or rocks from coming in contact with the pipe. Firmly pack the soil around pipe and continue until the original ground elevation is reached.

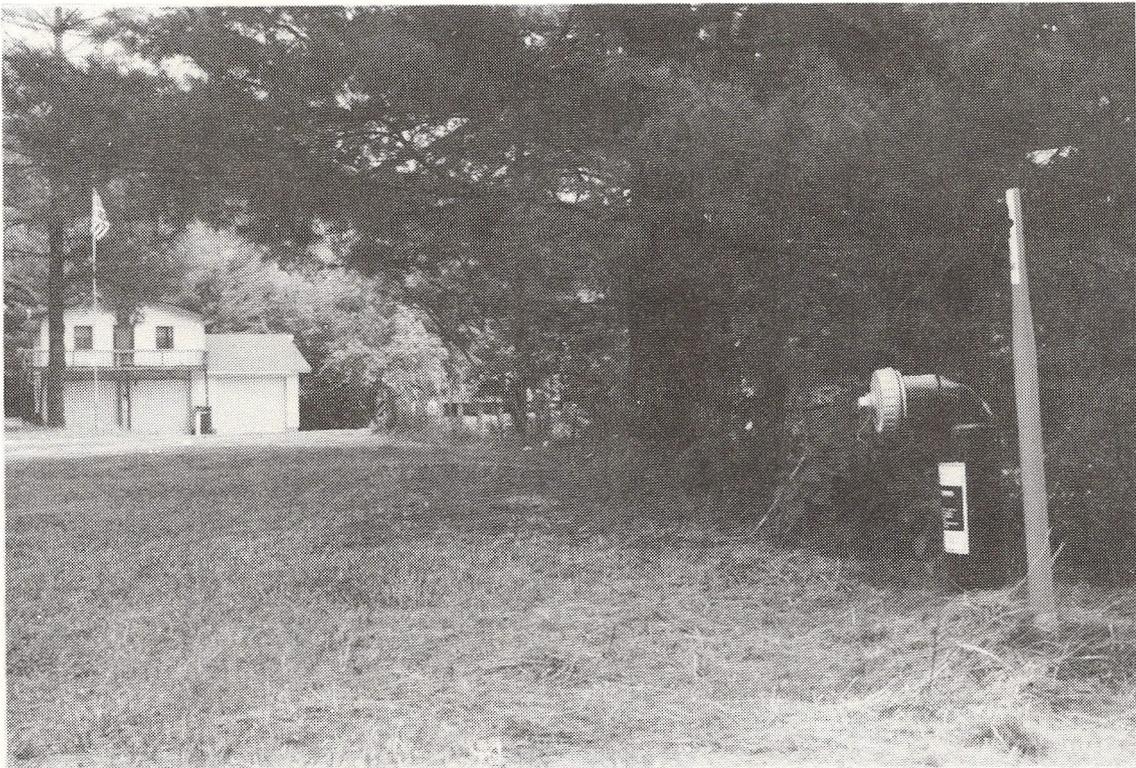
Smoothing and Revegetation

Smooth and rake all disturbed areas with a hand rake to prepare a seed bed. Apply grass seeds, fertilizer and mulch according to SCS specifications listed on table 7.

Table 7.- Seeding rates for ground covers.

Species	Rate per 100ft ²	Planting dates	Fertilizer rates per 1,000 ft ²
		M - Mountain P - Piedmont C - Coastal	
Fescue and Rye	1 lb	Aug-Oct - M Sept-Nov - P-C	25 lbs. 6-12-12
Common Bermuda	1/4 lb	Mar-Jun - M-P Feb-Jun - C	25 lbs. 6-12-12
Bahiagrass	1 lb	Mar-Jun - P Oct-Jun - C	25 lbs. 6-12-12
Daylilly tubers	111 tubers	Jan-Dec - M-P-C	25 lbs 12-24-21

AN INSTALLED DRY HYDRANT



CHAPTER V

TESTING AND MAINTENANCE OF DRY HYDRANTS

Dry hydrants require periodic checking, testing, and maintenance. This should be done semi-annually. Checking and testing by actual drafting should be a part of fire department training and drills. Thorough surveys should reveal any deterioration in the water supply in ponds, streams, or cisterns.

Particular attention should be given to streams and ponds. Frequent cleaning may be needed to remove debris, dredging or excavation of silt, and protection from erosion. The hydrants should be tested at least once a year with a pumper. Back flushing, followed by a pumper test at a maximum designed flow rate, with records kept of each test, is desired. Tests of this kind will not only verify proper condition but also keep the line and strainer clear of silt and the water supply available for any fire emergency.

The pond should be free of aquatic growth. It may be necessary to drain the pond to control this growth. Consult with Cooperative Extension Service or USDA office for assistance in weed control.

Inspections should include safety procedures such as posting warning signs and seeing that life preservers, ropes, etc., are available. Give particular attention to local authority regulations governing such water points.

It is important to consider appearance of this water point. Keep the grass trimmed and neat. Paint the hydrant periodically. The cap should be painted a reflective color to improve visibility during emergencies. All identification signs should be approved by the Department of Transportation prior to installation if they are to be on the right of way or come under State laws.

Maintenance Record

These facilities require periodic checking, testing and maintenance semi-annually. Checking and testing by actual drafting should be a part of fire department training and drills. Thorough surveys should reveal any deterioration in the water supply situation in ponds, streams or cisterns.

Give particular attention to streams and ponds. They may need frequent removal of debris, dredging or excavation of silt and protection from erosion. Test the hydrants at least annually with a pumper. Back flushing, followed by a pumper test at a maximum designed flow rate, with records kept of each test, is highly desirable. Tests of this kind will not only verify proper condition, but also keep the line and strainer clear of silt and water supply available for any fire emergency. Portions of the hydrant maintenance deal with on-site conditions such as:

1. Locally required signs warning of penalties for tampering, destruction, etc. of the hydrant*
2. Fire department hydrant identification sign*
3. Inspection of roadway and surface
4. Inspection of hydrant: condition, paint, riser, overall security, guard risers
5. Grass cut (ensure that PVC has not been damaged by cutting machine).

A record of inspection should be maintained for each hydrant. See following page for suggested format.

*Check local and State DOT specific requirements concerning signs on rights-of-way.

CHAPTER VI

USING THE DRY HYDRANT SYSTEM

In a water hauling operation, the time it takes to fill the tanker, the distance the tanker has to travel to the fire and the time it takes to discharge the water from the tanker become critical elements in rural fire protection. Time saved on any one of the above points will increase the amount of water that can be hauled to the fire. Dry hydrants, properly located, can substantially reduce travel time from water source to fire.

A number of rural fire departments are using gravity dump tanks with large discharge valves to reduce the time needed to empty tankers. See figure 11. The development of the portable drop-folding tank and the large dump valves help the tanker discharge water quickly. This has allowed many rural fire departments to use isolated water supplies and to obtain sufficient water for effective fire fighting. Following is a brief outline of how the system is being used by some departments.



Figure 11.- Example of gravity dump tank and use of portable drop-folding tank.

Water Shuttle

When a fire alarm is received, equipment is dispatched on a pre-planned basis determined by such things as fire flow needs, hazards involved, water supply available, etc. One tanker and one pumper respond to the fire. The pumper begins the fire attack with water from its booster tank. The first responding tanker may act as a nurse tanker, or may set up a portable drop tank and begin discharging its load of water into the drop tank. The water in the tanker can be transferred to the portable drop tank at a rate of approximately 1,000 gal/min. As soon as the tanker is empty, it immediately heads to the water supply. In the meantime, another fire department pumper has responded to the water supply, connected to the dry hydrant, and primed its pump. When the empty tanker arrives at the water supply, the pumper is ready to fill the tanker. The refilled tanker returns to the fire site, discharges its water, and the cycle is repeated. See figure 12.

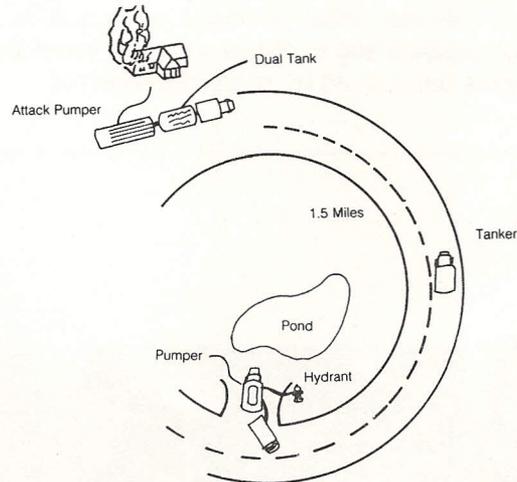


Figure 12.- Typical water shuttle system.

Training

For the dry hydrant water delivery system to work, it requires trained fire fighters and adequate equipment. The water supply office or fire chief in a rural area can plan the fire attack on the basis of reliable water supply information, coordinate the delivery of the available water supplies and help prevent the confusion inherent in fighting a major fire.

A training facility should be established so that personnel may practice the routine of drawing water from dry hydrants, shuttling the water to a location, dumping and refilling. Figure 13 displays a suggested layout of such a training facility.

The use of natural and constructed water sources requires an understanding of dry hydrant construction, drawing of water and water shuttle. For maximum benefits from this system, the volunteer fire department must maintain a training program that includes drills using dry hydrants and water shuttle.

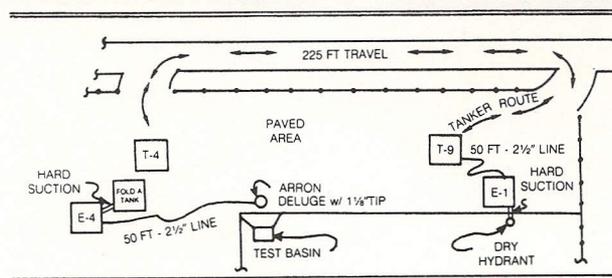


Figure 13.- Suggested layout for training facility.

CHAPTER VII

PROCEDURES FOR IMPROVING FIRE CLASSIFICATION

Basic Consideration and Calculations Used by Insurance Service Organizations

WATER SUPPLY

SUPPLY WORKS

Suction Supply

Where bays, rivers, canals, streams, ponds, wells, cisterns, or other similar sources are available as suction supply for fire department pumpers, the suction supply shall be considered with respect to its ability, including accessibility, availability during freezing weather, floods, droughts, or other adverse conditions to satisfy the Needed Fire Flow (NFF₁) at test locations.

Fire Department Supply (FDS)

Supply delivered by fire department vehicles carrying or relaying at least 250 gal/min to the fire shall be credited. This application rate shall be obtained within 5 minutes of arrival at the fire site, and shall continue for the fire duration of the NFF₁. If the rate of flow can be increased within 15 minutes of arrival at the fire site, and can be continued for the fire duration of the NFF₁, the higher rate will be credited.

The travel time of apparatus shall be calculated from the formula:

$$T = 0.65 + 1.7D$$

T = minutes

D = miles

Slower speeds will be used for underpowered apparatus, apparatus laying hose lines, adverse terrain, or poorer quality road surfaces.

The FDS shall be the capacity of the supply for the fire duration, the capacity of the source pumping equipment, the capacity of the delivery equipment, whichever is least, at the test location, expressed in gal/min.

Hydrant Distribution

A cistern or other suction point must be capable of supplying 250 gal/min for at least 2 hours to be recognized.

Hydrant Size, Type and Installation

Prorate points according to the number of hydrants of each type compared with the total number of hydrants.

Cistern or suction point

25

Inspection and Condition of Hydrants

A. Inspection

The frequency of inspection is the average time interval between the three most recent inspections.

<u>Frequency of Inspections</u>	<u>Points</u>
1/2 year	100
1 year	80
2 years	65
3 years	55
4 years	45
5 years or more	40

Note 1: The points for inspection frequency shall be reduced by 10 points if the inspections are incomplete.

If the inspection of cisterns or suction points does not include actual drafting with a pumper, deduct 40 points.

Note 2: If there are no records of claimed inspections, deduct an additional 20 points.

B. Condition (HF)

Prorate a factor (HF) from the following list of conditions according to the actual condition of hydrants examined compared with the total number examined during the survey:

<u>Condition</u>	<u>Factor</u>
Standard (no leaks, opens easily, conspicuous, well located for use by pumper)	1.0
Usable	0.5
Not Usable	0.0

CHAPTER VIII

MATERIALS

Materials for dry hydrants may be obtained by contacting your local RC&D Council. Be sure to install high quality material. The Southeastern Association of RC&D Councils can help you secure quality products. Schedule 40 PVC dry hydrant materials are being used in many areas.

Depending upon the desired flow, the distance to the water, and the difference in elevation between the hydrant and water source, a 6-inch or larger pipe is necessary. The pipe and material should be appropriate for use and installed to manufacturer's standard. In some areas of the country, PVC pipe is being used for the construction of dry hydrants. However, in other areas of the country, brass or bronze caps and strainer connections are being used with iron pipe elbows and risers. See figure 14. Pipes and other material should be based on local land condition usage. A strainer or well screen is needed for the suction end of the pipeline to keep foreign materials out of the pipe and the pumper. See figure 15.

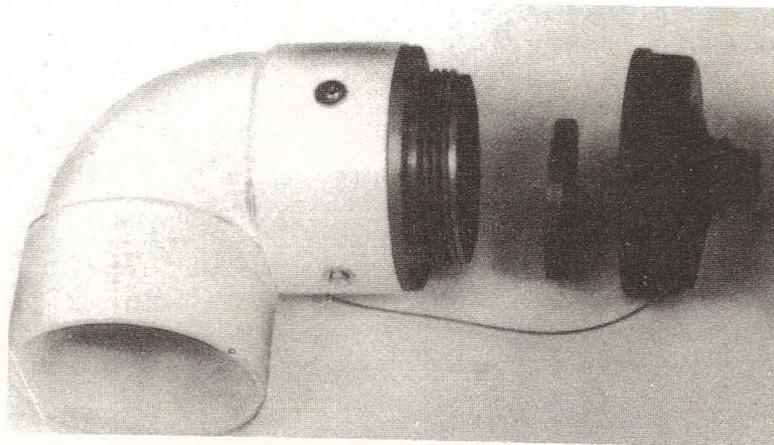


Figure 14.- Head and caps assembly.

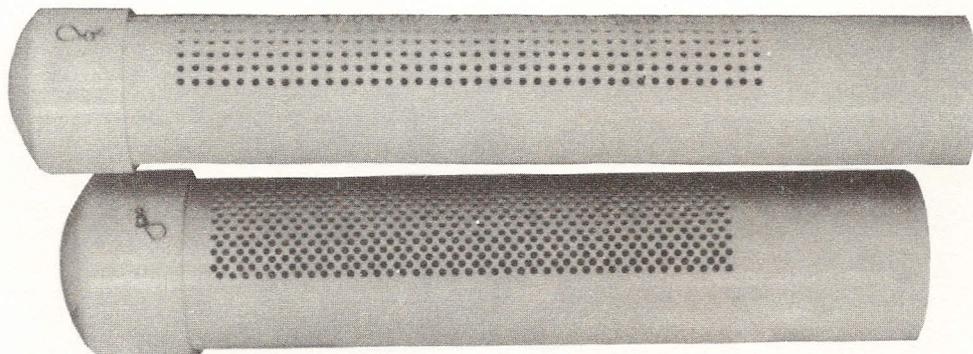


Figure 15.- Filtration system.

CHAPTER IX

SOURCES OF ASSISTANCE

Financial

Most rural fire departments are volunteer and funded by public monies. Lack of funding is a major reason for the limited number of dry hydrants. Many RC&D councils across the country have adopted dry hydrants as a project to assist with local communities. An RC&D council is a non-profit, incorporated council of community leaders working to assist in the conservation, development and improvement of natural resources.

In some States, funds are available to all counties. These funds are made possible through the RC&D councils, your State's Office of Energy, Soil and Water Conservation Commission, and forestry agency. For the nearest RC&D council, contact the USDA's SCS Office, Washington DC 20250, or telephone (202) 475-4575. Additional information is available from the Fire and Aviation Staff of the Forest Service's Southern Region; telephone (404) 347-4243. The district offices of the Farmers Home Administration offer a brochure, *Community Facility Loans*, Program Aid No. 1100.

Technical Assistance

Assistance with the **survey, design and 50-year drought** calculations may be available from your local SCS engineer, professional engineering association, or State forestry agency. For assistance with developing a **Master Fire Plan** to include dry hydrants, contact your state RFD coordinator or State forestry agency.

Fire Insurance Classification

Most States use ISO Commercial Risk Service, Inc. classification in the calculation of property insurance premiums. In order to be recognized as Class 8 or better, the fire department must be able to deliver at least 250 gallons of water per minute throughout the area within 5 minutes of the arrival of the first apparatus, and maintain at least that rate of flow without interruption for a 2-hour period. A local fire district/county/city interested in reclassification will be asked to provide the following information.

A. Criteria concerning water delivery by fire department apparatus:

1. When a tanker relay system is used, the volume of the tanker capacity is reduced by 10 percent for spillage, underfilling and incomplete unloading.
2. Travel time of apparatus is calculated from the formula:
$$T = 0.65 + 1.7D$$

T = minutes
D = miles.

Slower speeds will be used for low-powered apparatus, adverse terrain, nonpaved roads, or apparatus laying hose lines.

3. The delivery rate of a tanker relay system will be affected by the filling and dumping rate of the tankers and the usable volume of the fire-site holding tanks or other fire-site storage.
4. Credit may be given for apparatus responding from outside the community, depending upon communication facilities, handling of alarms, interdepartmental training, fire ground communications and arrival times at fires.

- B. A map showing: NFPA1231, Par. B.1.2.7:
1. Boundary of the community or area served by the local fire department.
 2. All roads usable by fire apparatus under all-weather conditions, certified by county engineer, or other registered professional engineer.
 3. Bridges that do not have a safe-weight capacity sufficient for fire fighting apparatus. Note: Weight information is available from your State Department of Transportation.
 4. The locations of fire stations.
 5. The locations and names of fire stations housing automatic-aid apparatus.
 6. The locations and identification of water supply points (hydrants or suction supplies).
 7. The total paved and unpaved road mileage (State, county, city and town) within the area served by the fire department.
- C. A description of each water supply point; and:
1. The maximum rate for a hydrant supplied from a water main, or a dry hydrant, using the pumper and hose arrangement scheduled to be used at this hydrant (supported by test results). Note: The maximum rate if tankers are supplied **directly** from a hydrant, using the hose arrangement scheduled to be used at this hydrant (supported by test results).
 2. For an impounded supply, cistern, tank or other storage facility show the minimum storage available (at not over 15-foot lift) during a drought with an average 50-year frequency (certified by a registered professional engineer). The maximum rate obtainable using the pumper(s) and hose arrangement scheduled to be used at this point (supported by test results).
 3. For a supply from a flowing stream, the minimum rate of flow available (not over 15-foot lift) during a drought with an average 50-year frequency (certified by a registered professional engineer, hydrologist, geologist, soil conservationist, or Federal surface water specialist.) The maximum rate obtainable using the pumper(s) and hose arrangement scheduled to be used at this point (supported by test results).
 4. For each location, the number of pumpers that can operate simultaneously.
 5. For each water supply point, the distance to the water supply point from each fire station with responding apparatus.
 6. A statement, signed by the owner of any private suction water supply point, authorizing its use by the fire department.
- D. A description of a recent fire or demonstration, more than 1,000 feet from a hydrant, where 250 gallons of water per minute or more were delivered for more than 1 hour, with the following information:
1. Location of fire or test
 2. Date
 3. Number of tankers (if used) dumping simultaneously
 4. Rate of flow delivered
 5. Distance delivered
 6. Time duration
 7. Number of personnel participating, with a description of each person's function such as fire fighter, pump operator, tanker operator, etc.
 8. The apparatus used with the following information for each:
 - a. Name
 - b. Pump capacity
 - c. Tank capacity
 - d. Functions
 9. The holding tanks used, if any, with the following information for each:
 - a. Total capacity
 - b. Usable capacity which is the total capacity less volume that cannot be pumped out when drawing from the tank.
 - c. Set-up time
 - d. Name of apparatus carrying each holding tank.
 10. Description of the overall operation.
- E. If different combinations of apparatus are used in various sections of the city, list the combinations with the data in numbers 7 and 8 above, and show the areas on the map.
- F. For each vehicle used to carry water, indicate the actual time to discharge the capacity of the tank and the actual time necessary to fill the tank using the pumpers that normally will be used for filling. If different capacity pumpers will be used for filling, the time shall be obtained for filling with each capacity pumper. (Note: The actual time to be recorded shall be the time necessary for the vehicle to travel 200 feet to the site, maneuver into position, fill or dump and travel 200 feet from the site.)

- G. When the water supply is delivered through a hose line, indicate the time for a pumper to travel 200 feet to a water supply point, connect suction and discharge hoses and commence pumping. If the water supply points are both hydrants and drafting sites, the time shall be obtained for both types of water supply points.
- H. When the water supply is delivered through a hose line, indicate the lengths and diameter of the hose line used for the time trial and the time when the pumper begins to fill the hose line until a solid stream of water is delivered at the other end.
- I. List the current equipment inventories for all apparatus in service and in reserve in the city. Copies of the form, **APPARATUS AND EQUIPMENT**, are located in the appendix.
- J. When the use of a water supply point at times depends on creating an opening in ice, the maximum known thickness of ice shall be given. Include a statement explaining the equipment used, apparatus carrying the equipment and the estimated time needed to provide a drawing site to draw water when the ice is at the maximum thickness.

Suggested Reading

- Davis, Larry. 1989. Rural Fire Fighting Operations; 370 pages. Available from International Society of Fire Service Instructors, 30 Main St., Ashland, MA 01721; telephone (508) 881-5800.
- National Fire Protection Association. 1989. NFPA Standard 1231, Water Supplies for Suburban and Rural Fire Fighting; 40 pages. A new edition will be published in September 1993. Available from NFPA, 1 Battery March Park, Quincy, MA 02269; telephone 1-800-344-3555.
- U.S. Department of Agriculture, Farmers Home Administration. Community Facility Loans. Program Aid No. 1100. Available from district offices of the FHA.

Your local library may offer more sources.

Technical Consultation

For more information on the Dry Hydrant Program and information on successful rural communities now using dry hydrants for improved fire protection, you may contact any of the following.

Jerry L. Boling
RC&D Coordinator
624 Green St., N.E.
Gainesville, GA 30501

Don Freyer
RFD Coordinator
GA Forestry Commission
P.O. Box 819
Macon, GA 31298-4599

Don Tomczak
Cooperative Forestry
Forest Service
1720 Peachtree Road N.W.
Atlanta, GA 30367-9102

Freddie Williams
Soil Conservation Service
P.O. Box 13
Athens, GA 30601

George Brooks
Fire & Aviation Management
Forest Service
1720 Peachtree Road N.W.
Atlanta, GA 30367-9102

CHAPTER X

APPENDIX

Reference Information

Design form for pond

Design form for stream

Information sheet for fire department capability

Dry hydrant location and initial test data sheet

Record of Inspection

Water source survey sheet

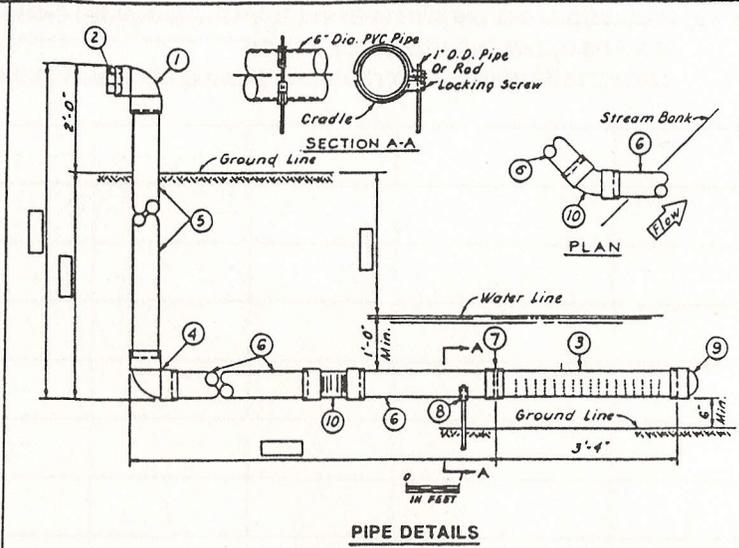
Design survey data sheet

ISO classification rate and estimated premiums

Dry hydrant maintenance record

Water usage agreement/authorization form

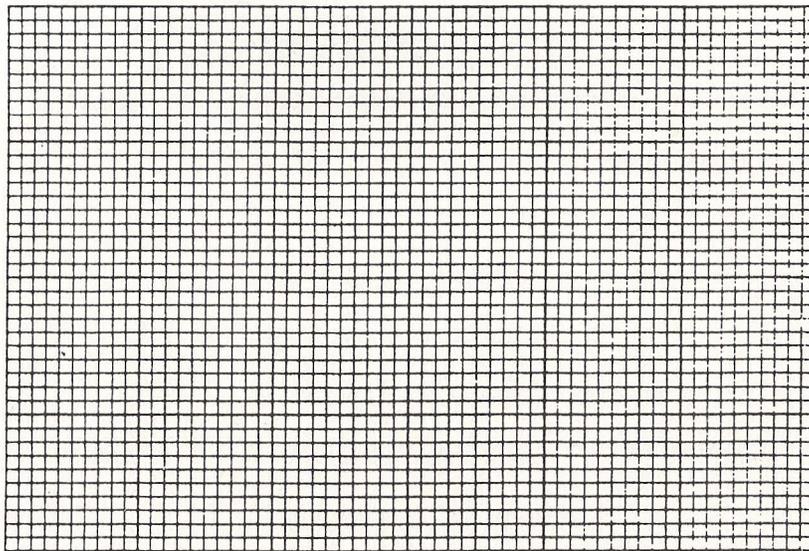
Fire department's water shuttle calculation and record



BILL OF MATERIALS			
ITEM	MARK	QUAN	UNIT
6" To 5" Hydrant Assembly - 90° Bend	1	1	Each
Hydrant Cap - 5"	2	1	Each
6" x 3'-4" PVC Strainer	3	1	Each
6" Sch. 40 PVC 90° Bend	4	1	Each
6" Sch. 40 PVC Pipe - Riser	5		Lin. Ft.
6" Sch. 40 PVC Pipe	6		Lin. Ft.
6" Sch. 40 PVC Couplings	7		Each
Underwater Support Cradle	8	1	Each
Strainer Cap	9	1	Each
6" Sch. 40 PVC 45° Bend	10	1	Each
Glue			Can
Cleaner			Can

QUANTITIES		
ITEM	QUAN	UNIT
Stream Bed Width		Feet
Stream Flow Depth		Feet
Average Flow		G.P.M.
Maximum Draw From W/L		Feet

PIPELINE PLAN



PIPELINE PROFILE

DETAILED HYDRANT LOCATION

GENERAL LOCATION MAP

STREAM - DRY HYDRANT NO. _____

_____ COUNTY, GEORGIA

PROFILES & LOCATION MAP

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed by _____	Checked by _____
Drawn by _____	Approved by _____
Title _____	Date _____
Sheet No. _____	Drawing No. _____
Checked by _____	Date _____

STANDARD DRAWING GA - N - 715

Note: This Design Is Applicable Only With Stream Of Adequate Depth And Flow

10-3

INFORMATION SHEET ON FIRE DEPARTMENT CAPABILITY

(NUMBER OF FIRE STATION LOCATIONS BEING SUBMITTED _____)

COUNTY _____

IS ITS LOCATION AND COVERAGE SHOWN ON ENCLOSED MAP? YES _____ NO _____

FIRE STATION LOCATION (OR NAME) _____

IS DEPARTMENT A HOUSE BILL 618 COMPLIANCE DEPARTMENT YES _____ NO _____

EQUIPMENT AT FIRE STATION		PUMPER	TANKER	FIRE KNOCKER	MINI PUMPER	BRUSH TRUCK
DRAFT	CAN IT DRAFT? YES OR NO					
	IF YES, SIZE OF DRAFT HOSE AND					
	LENGTH OF TOTAL HOSE					
	TYPE THREADS ON DRAFT HOSE - NST					
	_____ NPT					
	QUICK CONNECT					
PUMP	CAN IT PUMP? YES OR NO					
	SIZE HOSE USED					
	GAL/MIN					
DUMP	CAPABILITY TO DUMP YES OR NO					
	(4-INCH MINIMUM) GRAVITY					
	JET DUMP					
	SIZE / /					
	PUMP OUT WATER ONLY					
TANK SIZE	SIZE WATER TANK					
_____	IS IT BAFFLED? YES OR NO					
_____	IS IT BAFFLED? YES OR NO					
DUMP TANK	IS IT AVAILABLE? YES OR NO					
	SIZE					

ANY OTHER PUMP OR DRAFT CAPABILITY? WHERE/HOW CARRIED? IS THERE A PRESSURIZED WATER SYSTEM AND HYDRANT (S) IN DISTRICT COVERAGE Y _____ N _____. IF NO. DISTANCE TO NEAREST HYDRANT _____. DO YOU PRESENTLY USE WATER SOURCES FOR DRAFTING AND WATER HAULING? Y _____ N _____. DO NEIGHBORING DEPARTMENTS HAVE TANKERS HAULING THESE SOURCES? Y _____ N _____.

10-4

RECORD OF INSPECTION

Keep an up-to-date record of conditions associated with each dry hydrant:

1. Depth of water: approximate level (in feet) from surface to strainer.
2. Back flush: accomplished as per department standard operating procedure. (time of year, type of strainer end, steepness of bank, type of water source, etc.)
3. Gallons per minute flow: determined based on department standard operating procedure. (Fill-up of tanker, use of deluge gun, attach hose with pressure gage, etc.)
4. Weed control: same type cleanup as around pressurized hydrants. The standard operating procedure will determine who is responsible for cleanup.
5. Identification sign: Is the hydrant designation (number, name, etc.) sign readable and present?
6. Protection guards: If guard posts, rails, have been installed to protect dry hydrants, are they still present and in good condition? Are they painted, and is the paint in good condition?
7. Paint: Is the exposed portion of the dry hydrant painted: Is it painted in the particular designated color (if applicable by department standard operating procedure)?
8. Road access: Note any unusual access condition: road, surface, drainage, tree limbs, gates, locks.
9. Remarks: Comments listed below are general. Specify local conditions that department standard operating procedure may require.
 - a. Check end cap condition, locking procedure threads.
 - b. Identify pumping unit performing the inspection. Also identify any other equipment used.
 - c. Show the time required to prime and begin draft.
 - d. Identify the type and thread of section hose used or other type connection to connect with dry hydrant.
 - e. State the protection and other support condition for each dry hydrant such as head with end cap or strainer portion under water. (Can be accomplished later, if not initially planned.)
 - f. Identify any provisions for the protection for the underwater portion of each dry hydrant in streams where rapidly flowing water dictates the need for such operation. (Can be accomplished later, if not initially planned.)
 - g. Record the condition of the water: muddy, scum, debris, etc.
 - h. State whether erosion is occurring.

DESIGN SURVEY DATA

DRY HYDRANTS IN PONDS

Normal pool _____ Ac.

Hydrant No. _____

Drought level _____ Ft.

Location _____

Drought level pool _____ Ac.

County _____

Number hydrants in series

Show hydrants on country map

Sketch showing hydrant location on pond

Profile of proposed pipeline

O Station at hydrant

One shot at normal pool level

Extend survey into pool far enough to get 2 feet vertically below drought level.

DRY HYDRANTS IN STREAMS

Stream bed dimensions _____ wide x _____ deep

Normal water flow dimensions _____ wide x _____ deep

Show hydrants on county map

Number in series

Sketch showing location on stream

Profile of proposed pipeline

O Station at hydrant

One shot at normal water surface

Is there rock in stream bed within 2 feet of surface (YES, NO)

GEORGIA

ISO CLASSIFICATION		ESTIMATE DWELLING FIRE INSURANCE PREMIUMS PAID	
		FRAME	BRICK
HOME VALUE	\$40,000.00		
	7	319.14	265.00
	8	378.86	318.00
	9	562.33	472.83
	10	773.83	558.67
HOME VALUE	\$50,000.00		
	7	331.63	273.88
	8	390.50	325.88
	9	605.00	500.88
	10	833.14	589.86
HOME VALUE	\$60,000.00		
	7	373.25	308.25
	8	440.00	367.75
	9	690.71	572.14
	10	954.71	673.71
HOME VALUE	\$70,000.00		
	7	424.75	351.75
	8	502.88	476.25
	9	797.43	660.86
	10	1,105.71	778.29
HOME VALUE	\$80,000.00		
	7	479.88	397.88
	8	568.38	476.25
	9	909.86	752.29
	10	1,263.00	886.14

Classifications in other States may vary.

WATER USAGE AGREEMENT

TO: _____
County

FROM: _____
Property Owner

SUBJECT: Letter of authorization to develop and utilize water source on my property.

The _____ County is hereby authorized to develop a refill site at _____
_____ for the purpose of providing water to extinguish fires in my community
and for other uses with my permission.

I further give the _____ County permission to erect a dry hydrant stand at this location.
I understand that _____ County will erect the stand and provide
materials.

The _____ County will complete all excavation work so that the surrounding areas and
the surface of the ground will be smooth, and present a pleasing appearance.

The _____ County may use, test, the dry hydrant at any time they deem necessary
for continuity of hydrant operations.

The complete operation of the dry hydrant stand has been explained and all facets of the installation have
been explained and I fully concur with all parts of the operation.

Permission is hereby granted to _____ County to come upon my land to refill its
tankers until I revoke this permission in writing to _____ County.

SIGNATURE OF LAND OWNER

I have advised the land owner of the purpose, type of stand, method of operation with the above facts
explained.

SIGNATURE OF COUNTY REPRESENTATIVE

**CALCULATION OF WATER SUPPLY
(IN GAL/MIN) DELIVERED TO DUMP TANKS
FOR USE IN TALLY FOR ISO COMMERCIAL
RISK SERVICE "PUBLIC PROTECTION SURVEY
INFORMATION FOR AREAS WITHOUT WATER MAINS"
(SECTION A AND SECTION F)**

**FIRE DEPARTMENT TENDER/MOBILE WATER SUPPLY
(TRANSPORT/SHUTTLE) RECORD**

COUNTY _____ FIRE DEPT. _____

VEHICLE ID _____

CHASSIS (YR/MODEL/MAKE/RATED GVW [*] _____

EQUIPMENT: TANK SIZE _____ GAL.

PUMP: GAL/MIN _____ / PSI _____ CLASS "A" _____

PTO [+] _____

SUCTION HOSE: _____ INCHES / _____ FT.

DOUBLE JACKET HOSE: 1 1/2" _____ FT.

2 1/2" _____ FT.

3 " _____ FT.

[*] The total weight should include a full tank of water PLUS ALL equipment carried on the tender unit. Should there be consideration toward carrying certain equipment for Fire Suppression Rating Schedule points, it is strongly recommended that the ISO Office in Atlanta (404/923-9898) be contacted prior to the purchase/placement of any equipment of this nature. There are very strict requirements for any creditable fireground equipment on tender units.

[+] If a PTO unit is to be used, the following MUST BE considered and recognized:

1. The creditable gal/min will be the flow that results from the rated pump capacity multiplied by 0.7.
2. The gal/min supplied must be @ 150 lb/in².
3. Records must indicate that the pump was tested, from draft, at the flow rate indicated in 1 and 2 above for 50 minutes, and panel gage indications (pump pressure, vehicle engine pressure and temperature) were noted on the pump test sheet

I. Tender Locations

- A. Housed at fire station(s) in the fire district (fire zone, etc.) being surveyed for the ISO rating.
- B. Housed at fire station(s) in bordering fire districts (etc.) whose response to the district (etc.) being surveyed (A above) is an automatic aid response (Section B.5 of SURVEY INFORMATION sheet) with written agreements, SOP, etc. and test/actual fire records to substantiate such facts.
- C. For tenders being used in B. above, their station location cannot be any farther than a maximum of 5.0 road miles from the BOUNDARY OF THE DISTRICT TO WHICH AUTOMATIC AID IS BEING RENDERED. (see page 6.)
- D. Only tenders qualifying under A-C above will be creditable for use in the shuttle system that ISO will allow (ALSO SEE THE NOTE DESIGNATED BY THE # SYMBOL ON PAGE 5).
- E. For record use, the following may be used:

Distance from fire station to water source _____

(Water source ID _____)

Distance from water source to test/fire site _____

WATER SOURCE TYPE: pond, lake, stream, dry hydrant, cistern, irrigation system, pressurized water, storage tank (under/on/above ground)

- II. Formula (use is to determine the number of gallons per minute that each tanker is transporting to the fire based on the input figures): found in NFPA 1231 - Suburban and Rural Fire Fighting (Appendix C)

$$Q = \frac{V}{A + (T1 + T2) + B} - 10\%$$

Q: The resultant amount of water being credited to the tender being figured in gal/min, which it is carrying to the dump tank based on the figures used in the formula (see below- V, A, B, T). THE TOTAL OF ALL CREDITABLE TENDERS DELIVERY MUST BE AT LEAST 250 GAL/MIN.

V: The tender tank capacity in gallons: this should be calculated by measurement or be a placard by the tank manufacturer

A: Dump Time: total actual time required to accomplish the following four tasks

1. Drive 200 feet from a stopped position.
2. Position truck in such a manner to perform whatever actions are required for water to be off-loaded.
3. Off-load water
 - a. During the actual survey by ISO, all personnel used to perform these actions should be available.
 - b. Since only 90% of the water carried will be credited, it is extremely advisable to perform off-loading tests in terms of actual tank unloading to a level in the tank that is only 90% of the volume (stated in V above).
4. Return tender to original starting point 200 foot distance.
5. Calculated (recorded) time should be in minutes and tenths of minutes.

B: Fill Time: total actual time required to accomplish the following three tasks.

1. Drive 200 feet to fillup point.
2. Perform all tasks/actions required to fill the tank; a full tank is best indicated by water flow from the overflow pipe. A portion of this task could also have additional personnel from the pump crew.
3. Return tender to original starting point 200 foot distance.
4. Calculated (recorded) time should be in minutes and tenths of minutes.

These are the only two (2) factors that can be directly influenced and controlled by the fire department and its members in terms of testing, modification/corrections and further testing.

The dumping time (A) and the fill time (B) for the formula should be determined by drill/actual fire; they are needed by ISO as a part of the preclassification survey inspection records requirements.

T: Travel Time: to improve the safety factor by reducing congestion on the highways, some departments send tenders to the water source by one road and use another route for the tenders to return to the fire scene. Therefore, the time for the tender to travel from the fire to the water source (T1) may be a different time than the travel time back to the fire (T2). The reduction of congestion on the highway provides for a safer operation and may increase the actual amount of water hauled. Equipment does NOT have to be operated under emergency conditions to obtain travel time (T), since travel time is calculated at a maximum of 35 mph for level terrain (see below).

T1: Time in minutes and tenths of minutes to drive ONE WAY from the fire scene to the water source.

T2: Time in minutes and tenths of minutes to drive ONE WAY from the water source to the fire scene.

This time can be obtained by one of two methods:

1. Actual clocked time while driving the distance. HOWEVER, the elapsed time must be an "average safe constant speed" of 35 mph. This is the MAXIMUM SPEED that will be allowed by ISO in terms of "average safe constant speed" for T1 and T2 distances AND this is for level (or "reasonably level") terrain.

2. Calculate the time by measuring the distance, using a county road map or drive and clock using an odometer to the nearest tenth of a mile. Use the formula $0.65 + 1.7$ times the distance (tenths and miles) to obtain the 35 mph speed in minutes and tenths. When a tender is equipped with an adequate engine, chassis, brakes and is baffled correctly, a safe constant speed of 35 mph can generally be maintained on level terrain, in light traffic, and on an adequate roadway. Where conditions will not permit this speed, the average safe constant speed will be reduced by the ISO personnel. If there is any question as to the allowable "average safe constant speed" in your area, it will be to your best interests to check with ISO personnel before any planning or test runs for calculation purposes.

TIMES USED SHOULD BE AT LEAST THE AVERAGE OF NUMEROUS RUNS; actual filling time of tenders will vary as different water sources and distances of hose lay are tested.

To further assist in figures, calculations, and comparisons, the following figures will be useful. They are found in NFPA Standard 1231; the "T" calculations are also found in Section 611 F, ISO Fire Suppression Rating Schedule.

$T = 0.65 + 1.7D$ constant speed of 35 mph

$T = 0.65 + 2.0D$ constant speed of 30 mph

$T = 0.65 + 2.4D$ constant speed of 25 mph

$T = 0.65 + 3.0D$ constant speed of 20 mph

$T = 0.65 + 4.0D$ constant speed of 15 mph

T: time in minutes, tenths, and hundredths of ONE WAY travel.

D: distance in miles and tenths of ONE WAY travel.

Time Distance Table
Using an Average Safe Constant Speed of 35 MPH
 $T = 0.65 + 1.70 D$

Distance (miles)	Time (minutes)						
0	0						
0.1	0.82	2.6	5.07	5.1	9.32	7.6	13.57
0.2	0.99	2.7	5.24	5.2	9.49	7.7	13.74
0.3	1.16	2.8	5.41	5.3	9.66	7.8	13.91
0.4	1.33	2.9	5.58	5.4	9.83	7.9	14.08
0.5	1.50	3.0	5.75	5.5	10.00	8.0	14.25
0.6	1.67	3.1	5.92	5.6	10.17	8.1	14.42
0.7	1.84	3.2	6.09	5.7	10.34	8.2	14.59
0.8	2.01	3.3	6.26	5.8	10.51	8.3	14.76
0.9	2.18	3.4	6.43	5.9	10.68	8.4	14.93
1.0	2.35	3.5	6.60	6.0	10.85	8.5	15.10
1.1	2.52	3.6	6.77	6.1	11.02	8.6	15.27
1.2	2.69	3.7	6.94	6.2	11.19	8.7	15.44
1.3	2.86	3.8	7.11	6.3	11.36	8.8	15.61
1.4	3.03	3.9	7.28	6.4	11.53	8.9	15.78
1.5	3.20	4.0	7.45	6.5	11.70	9.0	15.95
1.6	3.37	4.1	7.62	6.6	11.87	9.1	16.12
1.7	3.54	4.2	7.79	6.7	12.04	9.2	16.29
1.8	3.71	4.3	7.96	6.8	12.21	9.3	16.46
1.9	3.88	4.4	8.13	6.9	12.38	9.4	16.63
2.0	4.05	4.5	8.30	7.0	12.55	9.5	16.80
2.1	4.22	4.6	8.47	7.1	12.72	9.6	16.97
2.2	4.39	4.7	8.64	7.2	12.89	9.7	17.14
2.3	4.56	4.8	8.81	7.3	13.06	9.8	17.31
2.4	4.73	4.9	8.98	7.4	13.23	9.9	17.48
2.5	4.90	5.0	9.15	7.5	13.40	10.0	17.65

10%:the 10% not credited is based on:

1. incorrect tank size (gallons actually carried are less than amount shown in V)
2. spillage enroute after fillup
3. tank not totally full at fillup
4. incomplete dumptage (water left in tank): an actual fact that in a timed dumping situation, you will lose time in dumping the last 10% of the water due to the minimal amount of water remaining in the tank on which the atmospheric pressure can act to force it out; the water is in reality draining out and is not being forced out by the atmospheric pressure, causing a greatly reduced dump time.

III. To increase the maximum continuous flow capability of a water shuttle system using tenders to off-load into dump tank(s), any of the following can be considered:

- A. Increase the capacity of the tender(s).
- B. Reduce the fill time of the tenders and/or any associated/necessary actions/tasks during filling operations.
- C. Develop and provide additional fill source points, thereby reducing travel time for tenders.
- D. Reduce dump time of the tenders and/or any associated/necessary actions/tasks during dumping operations.

During a comprehensive evaluation, many factors must be considered. Travel distances, operating site locations, and topography greatly affect water hauling turnaround time frames. USUALLY, THE MOST SIGNIFICANT TIME CAN BE SAVED DURING THE FILLING AND DISCHARGE SEGMENTS OF THE SHUTTLE OPERATION. Normally, greater quantities of water are made available

as filling/discharge rates increase. As rates increase, adequate logistics must support this increase. Additional water sources, tenders, and pumping units will ensure the adequacy of the overall increases.

IV. Additional calculations for automatic aid tenders:

- A. At this point, almost all water hauling tabulations have been calculated. However, if you are planning to lower an insurance classification through the hauling/shuttle of water, there is still one more, **VERY IMPORTANT, CONSIDERATION.**
1. The formula that was used showed a 10% water amount that was not considered usable. That 10% figure **WILL APPLY ONLY** to tenders housed/stationed in the district/zone that is being surveyed for the rating.
 2. The Fire Suppression Rating Schedule, Section 611 F, states that if the rate of flow by fire department supply (i.e., shuttle system) can be "increased within 15 minutes of the arrival at the fire site, and can be continued. . . ., this higher rate will be credited." The increase must be greater than the basic 250 gal/min. The automatic aid tenders will, in reality, provide the units that actually allow the initial 250 gal/min figure to be attained, and will also comprise the majority of the units used to initiate any higher delivery rates.
 3. A map study should be undertaken to determine what area(s) of the fire district/zone being surveyed may have their quantities increased based on the amount of automatic aid support available within the 15-minute time frame.
 4. There is a definite point credit for automatic aid in section 512 D of the Fire Suppression Rating Schedule. The calculated credit, based on definite, stated activities, training, and equipment, is a maximum of 0.9 and a minimum of 0.3. The "score" that you receive for the automatic aid section is extremely important in your water shuttling program and the calculations toward the amount of water delivered to the fire scene.
 - a. The decimal credit received for Section 512 D will be used by multiplying it to the Q (gal/min) figure that you found for every run calculated for automatic aid tenders.
 - b. Each automatic aid tender station could have a different credit for Section 512 D; therefore calculations should be checked carefully.
 - c. As can be seen from the above, the amount of water credited as being carried (and delivered) will be further reduced for those tenders that are automatic aid.
 - d. The delivered amounts that you calculate will apply for ALL runs made during any particular fire/training/test. This statement is made so that there is no differentiation made between initial responding run from the automatic aid stations to the supported district's fire and any/all shuttle runs within the supported district during the course of the fire suppression and related runs.