

**Report of the Committee on  
Forest and Rural Fire Protection**

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**Committee Scope:** This Committee shall have primary responsibility for documents on fire protection for rural, suburban, forest, grass, brush, and tundra areas. This Committee shall also have primary responsibility for documents on Class A foam and its utilization for all wildland and structural fire fighting. This excludes fixed fire protection systems.

This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the front of this book.

The Report of the Technical Committee on **Forest and Rural Fire Protection** is presented for adoption.

This Report was prepared by the **Technical Committee on Forest and Rural Fire Protection**, and proposes for adoption, amendments to NFPA 1142, **Standard on Water Supplies for Suburban and Rural Fire Fighting**, 1999 edition. NFPA 1142-1999 is published in Volume 8 of the 2000 National Fire Codes and in separate pamphlet form.

This Report has been submitted to letter ballot of the **Technical Committee on Forest and Rural Fire Protection**, which consists of 28 voting members. The results of the balloting, after circulation of any negative votes, can be found in the report.

# NFPA 1142 — May 2001 ROP - Copyright 2000, NFPA

(Log #CP1)

1142- 1 - (Entire Document): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Restructure entire document to comply with the NFPA Manual of Style as follows:

1. Chapter 1 to contain administrative text only.
2. Chapter 2 to contain only referenced publications cited in the mandatory portions of the document.
3. Chapter 3 to contain only definitions.
4. All mandatory sections of the document must be evaluated for usability, adoptability, and enforceability language. Generate necessary committee proposals.
5. All units of measure in document are converted to SI units with inch/pound units in parentheses.
6. Appendices restructured and renamed as "Annexes."

**SUBSTANTIATION:** Editorial restructuring, to conform with the 2000 edition of the NFPA Manual of Style.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 28

(Log #CP3)

1142- 2 - (Entire Document): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Renumber the following chapters to comply with new NFPA Style Manual:

Move referenced publications to Chapter 2 to comply with new style manual.

Separate definitions into Chapter 3 and number according to the new style manual.

- Renumber existing Chapter 3 to Chapter 5.
- Renumber existing Chapter 4 to Chapter 6.
- Renumber existing Chapter 5 to Chapter 7.
- Renumber existing Chapter 6 to Chapter 8.
- Renumber existing Chapter 7 to Chapter 10.

**SUBSTANTIATION:** Editorial restructuring, to conform with the 2000 edition of the NFPA Manual of Style and to allow for the addition of a new chapter on dry hydrants

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 28

(Log #CP4)

1142- 3 - (1-3): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Replace 1-3 with the following text:

### 1.3 General.

1.3.1 The requirements of Chapters and 4 through 7 are to be used for determining the minimum amount of water required for fire suppression. Chapter 9 on dry hydrant construction is performance oriented and allows the authority having jurisdiction latitude in specifying the method by which water supplies are provided, considering local conditions and needs.

1.3.2 The water requirements developed by this standard are performance oriented and minimum in scope. The required water determined by the water supply officer must be delivered to the fire scene. [See Annexes A and B]

The authority having jurisdiction shall be permitted to determine that additional water supplies are warranted. Annex G contains water supply recommendations that may be useful where the authority having jurisdiction determines additional water supplies are necessary.

1.3.3 Fire apparatus and associated equipment are important components of the water transport process. [See Appendices B, C, D, and E, NFPA 901, and other applicable standards.]

**SUBSTANTIATION:** The language in these new paragraphs separates the determination portion of the document from the dry hydrant design section and establishes that 1142 is primarily a determination standard but allows for alternative methods of water supply.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 28

(Log #CP5)

1142- 4 - (1-4 Fire Department, Large Diameter Hose): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Revise the definition of Fire Department to read as shown:

3.3.7 Fire Department. ~~The fire department serving a designated geographic area as identified by the authority having jurisdiction. The authority having jurisdiction and the fire department having jurisdiction may be the same agency.~~ An organization providing rescue, fire suppression, and related activities. The term "fire department" shall include any public, governmental, private, industrial, or military organization engaging in this type of activity.

Revise the definition of Large Diameter Hose to read as follows:

Large Diameter Hose. A hose of 3.5 in. (8.9 cm) size or larger.

**SUBSTANTIATION:** The Committee reviewed the official NFPA definitions and felt that these were preferable for use in the document.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 28

(Log #CP6)

1142- 5 - (6-2): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Add the following paragraph:

6-2 In locations where municipal water systems are not provided but fire protection is determined needed or desired, minimum water supplies shall be established in, or transportable to, the designated area. Water sources provided or developed to supply dry hydrant systems shall continually meet all minimum capacity and delivery requirements, as determined by approved engineering practices.

Renumber existing 6-2 through 6-5 as 6-3 through 6-6.

**SUBSTANTIATION:** This addition allows for dry hydrants in a municipal setting, as necessary, to provide the minimum water supply necessary as determined by other parts of the document.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

AFFIRMATIVE: 28

(Log #CP7)

1142- 6 - (9-1 (New) ): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Add a new chapter on dry hydrant design and installation as follows:

### Chapter 9 Dry Hydrants

9.1\* General. The AHJ shall ensure that generally accepted design practices are employed during dry hydrant planning, the permit process, design criteria, and construction.

9.2\* Planning and Permits. The planning, permitting, and design processes shall be completed before the actual construction begins. Planning shall involve all affected agencies and private concerns so a coordinated effort is undertaken.

9.2.1\* Permits. Required permits to install a dry hydrant shall be obtained from the authorities having jurisdiction prior to installation.

### 9.3\* Dry Hydrant Design and Location.

9.3.1\* Design Criteria. To ensure safety of design, functionality, installation, maintenance, and proper appropriation of financial resources, the AHJ(s) shall approve all aspects of construction design, type of materials, pipe, and system fittings.

9.3.2\* The AHJ shall determine which materials are best suited to meet fire flow needs and installation conditions. In no case shall less than Schedule 40 pipe and component fittings be used.

9.3.3\* All dry hydrant systems shall be designed and constructed to provide a minimum flow of 1000 gpm (3780 L/min) at draft.

9.3.4\* Dry hydrant systems shall be designed and constructed so that slope and piping configuration does not impede drafting capability.

9.3.5\* All exposed surfaces and all underground metal surfaces shall be protected to prevent deterioration.

9.3.6\* A minimum number of 90-degree elbows, shall be used in the total system.

9.3.7 Dry hydrant design shall include a suitable protective cap. Steamer connection shall be compatible with the fire department's hard suction hose size and thread type.

9.3.8\* An acceptable system design formula shall be developed which reflects the various requirements outlined in this standard and the adequacy of the water source to be used to supply the DH.

9.3.8.1 Available site pressure shall be determined using the following formula: Available site pressure is equal to the atmospheric pressure above sea level minus the pressure changes associated with static lift, vapor pressure, and minimum pump pressure. Absent such a formula the following equation shall be used.

$$ASP = AAP.SL.VP.5.00$$

where:

- ASP= Available Site Pressure In psi
- AAP= Adjusted Atmospheric Pressure in psi
- SL= Static Lift in psi
- VP= Vapor Pressure in psi

9.3.9\* Dry hydrant system piping shall be supported and/or stabilized using approved engineering design practices. Thrust blocks, or equivalent protection, shall be employed at elbows and other system stress points.

9.3.10 In addition to strength of materials and structural support, criteria, design shall address appropriate aggregates and soil materials to be used to backfill/cover piping during installation.

9.3.11\* All connections shall be clean and the appropriate sealing materials used according to manufacturer's specifications so as to ensure all joints are airtight.

9.3.12\* System strainers shall be constructed to permit required fire flow, in accordance with approved engineering practices.

9.4\* Access to Water Sources and DH Locations

9.4.1 Locations for and the immediate area around DHs shall provide for firefighter safety.

9.4.2.1\* Dry hydrants shall be located to be accessible under all weather conditions.

9.4.2.2\* System and site accessibility criteria shall ensure that hydrant can be reached with one or two 10 ft lengths of hard suction.

9.4.3 DHs shall have a minimum clearance of 20 feet (6.6 m) on each side and be located a minimum of 100 ft (30 m) from any structure. Highway or road traffic shall not be impaired during the use of the DH.

9.4.4\* DHs shall be protected from damage by vehicular and other perils, including freezing and damage from ice and other objects.

9.4.5\* DH locations shall be made visible from the main roadway during emergencies by reflective marking and signage approved by the AHJ. All identification signs shall be approved by the highway authority prior to installation if they are to be located on the right-of-way or are subject to state laws.

9.4.6\* Vehicle access shall be designed and constructed to support the heaviest vehicle.

9.5\* Depth of Water Sources. Consideration shall be given to the measurement of water supply capacities when designing and installation of dry hydrant systems. There shall be not less than 2 ft (0.6 m) of water above the strainer and 1 ft (0.3 m) to 18 in. (\_\_\_ m) below the strainer depending on bottom condition of the body of water.

9.6\* Installation Procedure for Dry Hydrant System The AHJ(s) shall ensure the installation meets all design criteria and the process is conducted in a safe manner.

9.6.1 A safety officer shall be designated to monitor the installation of the DHs (s).

9.6.2\* The proximity of any underground and overhead utilities to the selected site(s) shall be identified and appropriate measures taken to ensure the safety of personnel shall be made prior to installation

9.6.3 During installation, no one shall be allowed into or close to the trench without adequate safety measures.

9.7\* Maintenance of Dry Hydrant. DHs require checking and maintenance at least quarterly. Thorough surveys shall be conducted, to reveal any deterioration in the water supply situation in ponds, streams, or cisterns.

9.7.1 Grass, brush and other vegetation shall be kept trimmed and neat. Vegetation shall be cleared for a minimum 3 ft (0.9 m) radius from around hydrants.

9.7.2 The hydrant shall be painted as needed, with reflective material to maintain visibility during emergencies, in accordance with 9.4.5 above.

9.7.3\* Maintenance Records for Dry Hydrants. The AHJ shall maintain in a safe location, maps and records of dry hydrant system installation, tests, inspections, maintenance and repairs.

9.7.4\* The hydrants shall be tested at least annually with a fire department pump.

9.8\* Maps and Location/Detail Drawings. An official record shall be kept of all pertinent information recommended for each dry hydrant area.

Add Appendix material as follows to support the Chapter 9:

A.9.1 Factors to consider in determining the need and locations for a dry hydrant system should include but not be limited to:

- (a) Current and future population and building trends.
- (b) Property values protected.
- (c) Potential for loss.
- (d) Proximity to structures (e.g., not closer than 100 ft. from a structure it is designed to protect)
- (e) Fire history of the area protected.
- (f) Current water supply systems.
- (g) Potential water supply sources and reliability (i.e., constructed or natural).
- (h) Cost of project.
- (i) Other factors of local concern.

A.9.2 Planning should involve all affected agencies and private concerns so a coordinated effort can be undertaken. Permits to install a dry hydrant should be obtained from the authorities having jurisdiction, which can include local, state, and federal agencies, such as zoning, water authority, environmental protection, resource departments, agriculture and conservation districts, among others.

In addition to permits, a water usage agreement is often required for using water sources on private lands. The WSO should make arrangements with the owner of water supplies before a fire develops. Such agreements should be made in writing in close cooperation with the municipal, town, or county attorney. Also, it is highly desirable that the agreement be reviewed by a representative of the highway or the county road department or other persons who will build, service, and maintain the access road to the supply, including such functions as snow plowing in certain areas of the country. The property owner also should have a copy of the agreement that has been used by several fire departments with the approval of their county or town attorney. (See sample water usage agreement, Figure A.9.2.)

**Water Usage Agreement**

I/We, the undersigned owner(s) of a lake or pond located at \_\_\_\_\_ do hereby grant the Anytown Fire Department permission to erect and maintain, at its expense, a dry hydrant and access roadway to said lake or pond to be utilized for emergency fire suppression purposes.

All other uses of said pond or lake shall be after notification and permission of the owners. The Anytown Fire Department shall be responsible for any and all damages to property resulting from fire department exercises.

This contract can be cancelled at any time by written notice thirty days in advance to the Anytown Fire Department located at Scott and College Road, Anytown, U.S.A.

Owner \_\_\_\_\_ Date \_\_\_\_\_

President \_\_\_\_\_ Date \_\_\_\_\_  
Anytown Fire Department

Secretary \_\_\_\_\_ Date \_\_\_\_\_  
Anytown Fire Department

Chief \_\_\_\_\_ Date \_\_\_\_\_  
Anytown Fire Department

**Figure A.9.2 Sample water usage agreement**

A.9.3 The design of dry hydrant installations should be carefully planned to incorporate the several desirable advantages that tend to bring the installation of dry hydrants within the resources of rural fire departments and property owners.

A.9.3.1 Local topography, climatic conditions, and access to materials will, among other factors, determine the design characteristics of each installation. Distance to the water combined with the difference in elevation between the hydrant head and the water source, and the desired gpm (L/min) flow, will affect the pipe size that needs to be used.

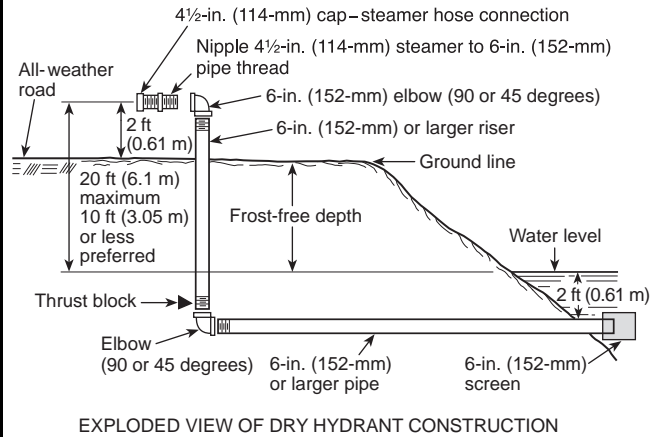
Local preferences and experience, along with access to materials, will determine the type of pipe and fittings best suited for the job. In some parts of the country, brass and bronze caps and steamer

connections, along with iron, steel, and bituminous cement pipe and fittings are being used for hydrant materials.

**A.9.3.2** However, in many parts of the country, schedule 40 or 80 PVC pipe, fittings, and connections are becoming more common.

Many fire service manufacturers are now offering pre-made and pre-assembled PVC suction screens, hydrant heads, and supports that come ready to attach to the pipe.

The following examples of DH design are provided here for guidance.



**Figure A.9.3.2(a) Dry hydrant construction using iron, steel, or PVC pipe.**

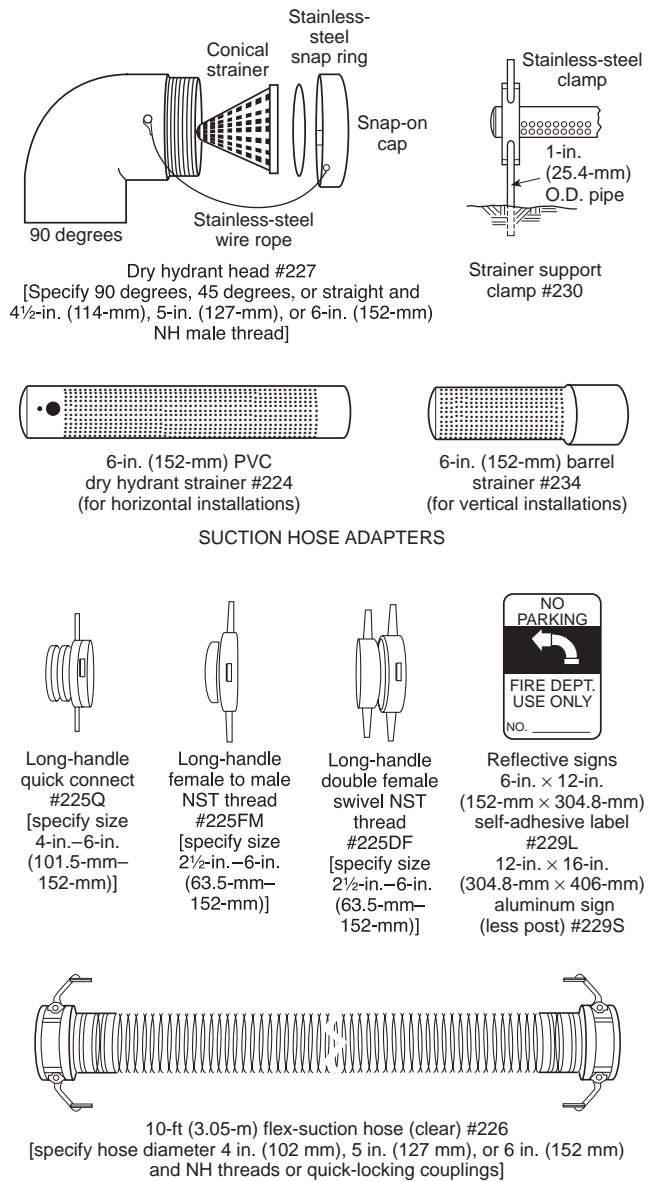
**A.9.3.3** System design requirements should consider required fire flow, atmospheric pressure, static lift, vapor pressure, length of required pipe run, coefficient of materials, piping configuration and other design factors approved engineering practices would necessitate.

Some factors to consider in designing the dry hydrant are:

(a) Static lift should not exceed 10 ft to 12 ft (3.1 m to 3.7 m), if possible. This is dead lift and cannot be overcome by enlarging the pipe size. Keep the static lift as low as possible.

(b) Total head loss should not exceed 20 ft (6.1 m), or the pump might not supply its rated gpm (L/min). If they fire department will be using portable pumps on the dry hydrant, keep total head loss as low as possible.

**A.9.3.4** The following worksheet (see Figure A.9.3.4) and charts [see Figures A.9.3.4(a), (b), (c), and (d)] can be used to assist in the design of a dry hydrant installation. These charts will help determine the size of pipe and fittings that will be needed to flow the capacity of the pumps being used at the hydrant site. The tables and charts provided below allow for flow calculations and conversions between various pipe material.



**Figure A.9.3.2(b) Commercially available dry hydrant components.** (Courtesy of Wisconsin Dept. Natural Resources)

**Design Worksheet**

FIRE DEPARTMENT \_\_\_\_\_

DRY HYDRANT LOCATION \_\_\_\_\_

**Step 1**

Screen length \_\_\_\_\_

Lateral run length \_\_\_\_\_

Riser height \_\_\_\_\_

Straight pipe = \_\_\_\_\_

**Step 2**

Use Table A.9.3.4(c) to fill in the following values:

Hydrant adapter \_\_\_\_\_ Reducer \_\_\_\_\_

Elbow \_\_\_\_\_ Elbow \_\_\_\_\_

Elbow \_\_\_\_\_ Elbow \_\_\_\_\_

Straight pipe equivalent for fittings = \_\_\_\_\_

**Step 3**

Straight pipe + Straight pipe equivalent for fittings =  
 \_\_\_\_\_ + \_\_\_\_\_ = \_\_\_\_\_ (Total straight pipe equivalent)

**Step 4**

Desired gpm flow = \_\_\_\_\_ (Rated pump capacity)

**Step 5**

Using answers from Steps 3 and 4, use Table A.9.3.4(a) to determine head loss for pipe and fittings.

Head loss for pipe and fittings = \_\_\_\_\_

**Step 6**

Using Table A.9.3.4(e), determine suction hose head loss for length of suction hose used to connect the pump to the hydrant.

Suction hose head loss = \_\_\_\_\_

**Step 7**

Static lift = \_\_\_\_\_

**Step 8**

Add the answers from Steps 5, 6, and 7 together to get total head loss.

#5 \_\_\_\_\_ + #6 \_\_\_\_\_ + #7 \_\_\_\_\_ = Total head loss

If total head loss is greater than 20 ft to 25 ft (6.1 m to 7.6 m), the pump might not be able to flow its rated gpm.

(c) Add the numbers from step 1 and step 2 together to obtain the TOTAL STRAIGHT PIPE EQUIVALENT of the hydrant. Write this figure down on the design worksheet at step 3.

(d) Determine the desired maximum gpm (L/min) hydrant flow. Usually this would be the pumping capacity of the pump or pumper used at this hydrant. Write this figure down on the design worksheet at step 4.

(e) Using Table A.9.3.4(a), determine the head loss due to friction per 100 ft (30.5 m) of pipe (number from step 3) based on the gpm (L/min) from step 4. If there is over or under 100 ft (30.5 m) of pipe equivalent (from step 3), adjust head loss from the chart. Example: TOTAL STRAIGHT PIPE EQUIVALENT is 75 ft (22.9 m) and the desired volume is 1950 gpm (7441 L/min) - head loss from the chart is 20 ft/100 ft (6.1 m/30.5 m) of pipe. For this run, there would be a head loss of 15 ft (4.6 m) [20 ft (6.1 m) - 75 ft/100 ft (22.9 m/30.5 m) = 15 ft (4.6 m)]. Write this figure down as HEAD LOSS FOR PIPE AND FITTINGS on the design worksheet at step 5.

(f) From Table A.9.3.4(e), figure the head loss due to friction in the suction hose to be used on the hydrant. Write this down on the design worksheet as SUCTION HOSE HEAD LOSS at step 6.

(g) Next, determine static lift. This is the vertical distance from the water's surface in the hydrant pipe (use the lowest water level as it will represent the maximum lift needed) and the pump or pumper intake. Write this figure down on the design worksheet as STATIC LIFT at step 7. Try not to exceed 8 ft to 10 ft (2.4 m to 3.1 m) if possible. Remember — this is a vertical measurement and represents dead lift.

(h) Add the answers from steps 5, 6, and 7 together on the design worksheet at step 8. This is the TOTAL HEAD LOSS. Do not exceed 20 ft to 25 ft (6.1 m to 7.6 m) of total head loss at the pump intake; otherwise, all the pump capacity will be used for suction (or lift), and the pump might not flow its rated capacity.

The charts are for PVC schedule 40 pipe. Other types of pipe material have similar charts that should be consulted when other pipe is used.

**A.9.3.5** Metal piping and surfaces should be primed and painted to prevent deterioration of the material.

**A.9.3.6** Preferably no more than two 90-degree elbows should be used. It might be desirable to have a wide-sweep elbow (using two 45-degree elbows and a 2 ft (0.6 m) length of pipe) installed at the bottom of the riser where the lateral run connects. In the event of a broken-off hydrant connection, this could permit sections of 2 1/2 in. (64 mm) suction hose to be inserted down the 6 in. (15.2 cm) pipe to the water and would permit drafting to continue, although at a much reduced rate of flow.

**A.9.3.8** For a supply flowing from a stream, the quantity to be considered available is the minimum rate of flow during a drought with an average 50-year frequency as determined by a registered/licensed professional engineer, hydrologist or other similarly qualified person. The maximum rate of flow is determined by testing using the pumper(s), hose arrangement, and dry hydrant normally used at this site.

**Figure A.9.3.4 Design worksheet.**

How to use the worksheet:

(a) Add the total length of straight pipe to be used at the site (screen + lateral run + riser = STRAIGHT PIPE). Write this down on the design worksheet at step 1.

(b) Using Figure A.9.3.4, add up the number of feet of straight pipe equivalent for all fittings used to make up the hydrant (elbows + hydrant adapter + any reducers = STRAIGHT PIPE EQUIVALENT FOR FITTINGS). Write this down on the design worksheet at step 2.

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**Table A.9.3.4(a) Friction Loss in Pipe**

		lb/in. <sup>2</sup> per 100 ft of Pipe Hazen-Williams C = 100*										
		Actual Diameter of Pipe 1/2 through 3 1/2 in.					Nominal Diameter of Pipe for 4 through 30 in.					
gpm		1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	gpm
5		17.9	4.55	1.40	0.369	0.174	0.052					5
10		64.5	16.4	5.06	1.33	0.629	0.186	0.078	0.030			10
15			34.7	10.7	2.82	1.33	0.394	0.166	0.064	0.028		15
20		5	59.1	18.2	4.89	2.27	0.671	0.282	0.109	0.048	0.027	20
30		0.019	<b>6</b>	38.6	10.2	4.80	1.42	0.598	0.231	0.102	0.057	30
40		0.033	—	65.8	17.3	8.17	2.42	1.02	0.393	0.174	0.097	40
50		0.050	.020	<b>8</b>	26.2	12.3	3.66	1.54	0.593	0.263	0.147	50
60		0.069	.029	—	36.6	17.3	5.12	2.16	0.831	0.369	0.206	60
70		0.092	.038	—	48.7	23.0	6.81	2.87	1.11	0.490	0.274	70
80		0.118	.049	—	62.4	29.4	8.72	3.67	1.41	0.628	0.350	80
90		0.147	.060	—	77.6	36.6	10.8	4.56	1.76	0.781	0.435	90
100		0.178	.074	—	<b>10</b>	44.5	13.1	5.55	2.14	0.949	0.529	100
120		0.250	.103	—	—	62.3	18.5	7.77	3.00	1.33	0.741	120
140		0.333	.137	0.034	—	82.9	24.6	10.3	3.98	1.77	0.986	140
160		0.426	.175	0.043	—	106.0	31.4	13.2	5.10	2.26	1.26	160
180		0.529	.218	0.054	0.018	<b>12</b>	39.1	16.5	6.34	2.81	1.57	180
200		0.643	.265	0.065	0.022	—	47.5	20.0	7.71	3.42	1.91	200
220		0.768	.316	0.078	0.026	—	56.7	23.9	9.19	4.08	2.28	220
240		0.902	.371	0.091	0.031	0.013	<b>14</b>	28.0	10.8	4.79	2.67	240
260		1.05	.430	0.106	0.036	0.015	—	32.5	12.5	5.56	3.10	260
280		1.20	.493	0.122	0.041	0.017	—	37.3	14.4	6.37	3.55	280
300		1.36	.562	0.138	0.047	0.019	—	42.3	16.3	7.24	4.04	300
350		1.81	.746	0.184	0.062	0.026	0.012	<b>16</b>	21.7	9.63	5.37	350
400		2.32	.955	0.235	0.079	0.033	0.015	—	27.8	12.3	6.88	400
450		2.88	1.19	0.292	0.099	0.041	0.019	—	34.6	15.3	8.55	450
500		3.51	1.44	0.353	0.120	0.049	0.023	0.012	42.0	18.6	10.4	500
550		4.18	1.72	0.424	0.143	0.059	0.028	0.015	50.1	22.2	12.4	550
600		4.91	2.02	0.498	0.168	0.069	0.033	0.017	58.8	26.1	14.6	600
650		5.70	2.34	0.577	0.195	0.080	0.038	0.020	68.2	30.3	16.9	650
700		6.53	2.69	0.662	0.223	0.092	0.043	0.023	<b>18</b>	34.7	19.4	700
750		7.42	3.05	0.752	0.254	0.104	0.049	0.026	—	39.4	22.0	750
800		8.36	3.44	0.848	0.286	0.118	0.056	0.029	—	44.5	24.8	800
850		9.35	3.85	0.948	0.320	0.132	0.062	0.032	—	49.7	27.7	850
900		10.4	4.28	1.05	0.356	0.146	0.069	0.036	—	<b>20</b>	30.8	900
950		11.5	4.73	1.17	0.393	0.162	0.076	0.040	—	—	34.1	950
1,000		12.6	5.20	1.28	0.432	0.178	0.084	0.044	—	—	37.5	1,000
1,250		19.1	7.85	1.94	0.653	0.269	0.127	0.066	—	—	<b>24</b>	1,250

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1,500	<b>30</b>	11.0	2.71 (18.7)	0.914	0.376	0.178	0.093	—	—	—	1,500
1,750	—	—	3.61	1.22	0.501	0.236	0.123	—	—	—	1,750
2,000	.007	—	4.62	1.56	0.641	0.303	0.158	0.089	0.053	0.022	2,000
2,250	.009	—	—	1.94	0.797	0.376	0.196	0.111	0.066	0.027	2,250
2,500	.011	—	—	2.35	0.969	0.457	0.239	0.134	0.081	0.033	2,500
2,750	.013	—	—	2.81	1.16	0.545	0.285	0.160	0.096	0.040	2,750
3,000	.016	—	—	3.30	1.36	0.641	0.334	0.188	0.113	0.046	3,000
4,000	.027	—	—	—	2.31	1.09	0.569	0.321	0.192	0.079	4,000
5,000	.040	—	—	—	3.49	1.65	0.860	0.485	0.290	0.119	5,000

\* To convert friction loss at C = 100 or other values of C, see Table 6-6E.

† Schedule 40 pipe sizes 1/2 through 31/2 in. steel pipe.

‡ SI units: 1 psi = 6.895 kPa; 1 gpm = 0.378 L/min; 1 in. = 25.4 mm.

Note: Actual inside diameter for sizes 1/2 in. through 31/2 in. is given for greater accuracy as these sizes include sprinkler branch lines and the smaller sizes of cross mains. For sizes 4 in. and greater, the nominal diameters were used as a fairly safe average for the diameters of various types of underground pipes as follows: cast-iron unlined and Enameline, greater than nominal; cast iron cement lines and Class 200 asbestos cement, less than nominal; Class 150 asbestos-cement sizes 6 and 8 in. less than nominal, and other sizes even nominal. (A 0.10 variation is true for Class 150 cement lined only—see ASHD FT-9 through 45 for actual IDs.)

This table will be useful in approximating friction loss in flow through existing underground piping where the type, inside diameter, and condition are frequently unknown. However, in such cases, a flow test is recommended.

When the type, inside diameter, and condition are known, and in designing new systems for all sizes and types of pipes, the friction loss tables should be used. Friction tables based on Hazen-Williams formula are published in Automatic Sprinkler Hydraulic Data by "Automatic" Sprinkler Corporation of America, and tables based on Darcy-Weisbach formula are published in Standards of the Hydraulic Institute.

**Table A.9.3.4(b) Conversion Factors for Friction Loss in Pipe**

C	Factor	C	Factor	C	Factor
150	0.472	110	0.838	70	1.93
145	0.503	105	0.914	65	2.22
140	0.537	100	1.00	60	2.57
135	0.574	95	1.10	55	3.02
130	0.615	90	1.22	50	3.61
125	0.662	85	1.35	45	4.38
120	0.714	80	1.51	40	5.48
115	0.772	75	1.70	35	6.97

**Table A.9.3.4(c) Equivalent Pipe Length Chart (Straight pipe equivalents for fittings in feet)**

	Fittings and Valves Expressed in Equivalent ft (m) of Pipe						
	3/4 in.	1 in.	1 1/4 in.	1 1/2 in.	2 in.	2 1/2 in.	3 in.
45-degree Elbow	1(0.3)	1(0.3)	1(0.3)	2(0.6)	2(0.6)	3(0.9)	3(0.9)
90-degree Standard Elbow	2(0.6)	2(0.6)	3(0.9)	4(1.2)	5(1.5)	6(1.8)	7(2.1)
90-degree Long-Turn Elbow	1(0.3)	2(0.6)	2(0.6)	2(0.6)	3(0.9)	4(1.2)	5(1.5)
Tee or Cross (Flow Turned 90°)	4(1.2)	5(1.5)	6(1.8)	8(2.4)	10(3.1)	12(3.7)	15(4.6)
Gate Valve					1(0.3)	1(0.3)	1(0.3)
Butterfly Valve					6(1.8)	7(2.1)	10(3.1)
Swing Check*	4(1.2)	5(1.5)	7(2.1)	9(2.7)	11(3.4)	14(4.3)	16(4.9)
	Fittings and Valves Expressed in Equivalent ft (m) of Pipe						
	3 1/2 in.	4 in.	5 in.	6 in.	8 in.	10 in.	12 in.
45-degree Elbow	3(0.9)	4(1.2)	5(1.5)	7(2.1)	9(2.7)	11(3.4)	13(4.0)
90-degree Standard Elbow	8(2.4)	10(3.1)	12(3.7)	14(4.3)	18(5.5)	22(6.7)	27(8.2)
90-degree Long-Turn Elbow	5(1.5)	6(1.8)	8(2.4)	9(2.7)	13(4.0)	16(4.9)	18(5.5)
Tee or Cross (Flow Turned 90°)	17(5.2)	20(6.1)	25(7.6)	30(9.2)	35(10.7)	50(15.3)	60(18.3)
Gate Valve	1(0.3)	2(0.6)	2(0.6)	3(0.9)	4(1.2)	5(1.5)	6(1.8)
Butterfly Valve		12(3.7)	9(2.7)	10(3.1)	12(3.7)	19(5.8)	21(6.4)
Swing Check*	19(5.8)	22(6.7)	27(8.2)	32(9.8)	45(13.7)	55(16.8)	65(19.8)

Use with Hazen-Williams C = 120 only. For other values of C, the figures in this table should be multiplied by the factors below:

Table A.9.3.4(d) Guide for Estimating Hazen-Williams C

Kind of Pipe	Value of C		
	1*	2	3
Cast iron, unlined:			
10 years old	110	90	75
15 years old	100	75	65
20 years old	90	65	55
30 years old	80	55	45
50 years old	70	50	40
Cast iron, unlined, new		120	
Cast iron, cement-lined		140	
Cast iron, bitumastic enamel-lined		140	
Average steel, new		140	
Riveted steel, new		110	
Asbestos-cement		140	
Reinforced concrete		140	
Plastic		150	

\* Water mildly corrosive. Use same values for fire-protection

Hose Size	1 1/2"	2 1/2"	4"	4 1/2"	5"	6"
GPM						
100	84.1	7.0	0.7	0.4	0.2	0.1
200	303.6	25.3	2.6	1.4	0.9	0.4
250	459.0	38.2	3.9	2.2	1.3	0.5
300	643.3	53.6	5.4	3.1	1.8	0.8
350	855.9	71.3	7.2	4.1	2.4	1.0
400	1096.0	91.3	9.3	5.2	3.1	1.3
500	1656.9	138.0	14.0	7.9	4.7	1.9
600	2322.4	193.4	19.7	11.1	6.6	2.7
700	3089.7	257.3	26.1	14.7	8.8	3.6
800	3956.6	329.5	33.5	18.9	11.3	4.7
900	4921.0	409.9	41.6	23.5	14.1	5.8
1000	5981.4	498.2	50.6	28.5	17.1	7.0
1100	7136.1	594.4	60.4	34.0	20.4	8.4
1200	8383.8	698.3	71.0	40.0	24.0	9.9
1300	9723.5	809.9	82.3	46.4	27.8	11.4
1400	11153.9	929.0	94.4	53.2	31.9	13.1
1500	12674.2	1055.6	107.2	60.5	36.2	14.9
1600	14283.3	1189.6	120.9	68.1	40.9	16.8
1700	15980.5	1331.0	135.2	76.2	45.7	18.8
1800	17765.0	1479.6	150.3	84.7	50.8	20.9
1900	19635.9	1635.5	166.2	93.7	56.1	23.1
2000	21592.7	1798.5	182.7	103.0	61.7	25.4
2100	23634.7	1968.5	200.0	112.8	67.5	27.8
2200	25761.2	2145.7	218.0	122.9	73.6	30.3
2300	27971.7	2329.8	236.7	133.4	80.0	32.9
2400	30265.7	2520.8	256.1	144.4	86.5	35.6
2500	32642.5	2718.8	276.2	155.7	93.3	38.4
2600	35101.9	2923.7	297.0	167.5	100.3	41.3
2700	37643.1	3135.3	318.5	179.6	107.6	44.3
2800	40265.8	3353.8	340.7	192.1	115.0	47.4
2900	42969.6	3579.0	363.6	205.0	122.8	50.6
3000	45753.9	3810.9	387.1	218.3	130.7	53.8

For SI units: 1 GPM = 0.0631 L/sec.

Figure A.9.3.4(e) Head loss (ft per 100 ft of hard rubber suction hose).

Historical Stream Flow data is available for most streams from the United States Geological Survey (USGS) Water Resources Information. This data can also be accessed from their Internet World Wide Web site: <http://www.usgs.gov>. The USGS does not establish flow rates but provides historical data to assist with assessment. Additional assistance is available from individual state and organization contacts at the National Drought Mitigation Center (NDMC). The National Drought Mitigation Center Directory of Drought Contacts can be accessed from their home page at:

Examples of two shallow stream installations are shown in Figures A.9.3.8.a and b.

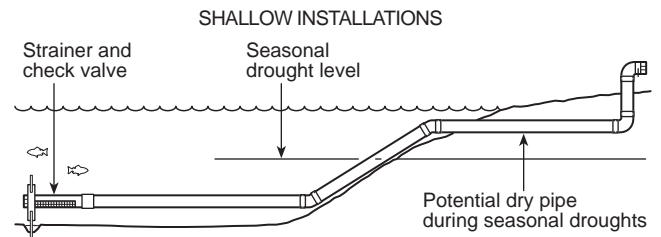
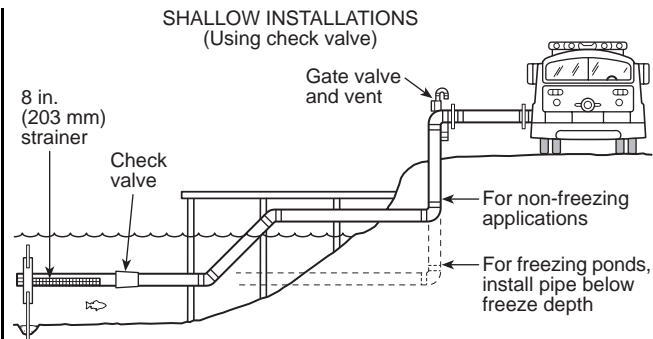


Figure A.9.3.8.a Shallow stream installation based on seasonal droughts



**Figure A.9.3.8.b Shallow stream installation based on seasonal drought and freezing conditions**

**A.9.3.9** Thrust blocks should be considered at the elbow joint both to resist hydraulic forces and to steady the installation in unstable soils.

**A.9.3.11** All connections should be clean and the appropriate sealing materials used according to manufacturer's specifications so as to ensure all joints are airtight.

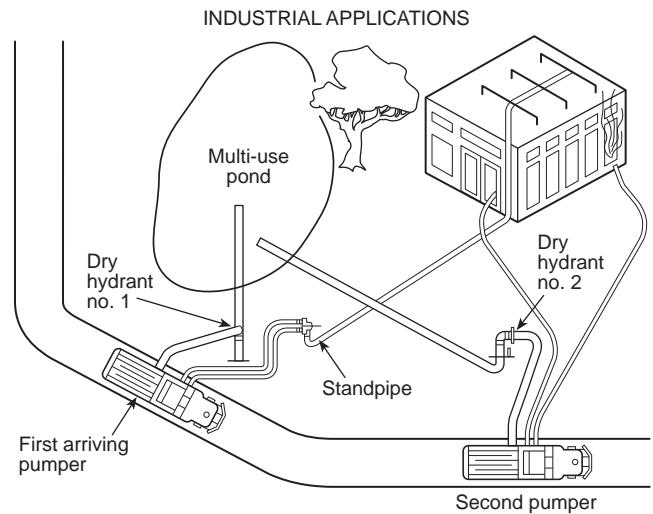
**A.9.3.12** Strainers or screens can be handmade by drilling 1000, 5/16 in. (8 mm) holes in length of pipe and capping the end with a removable or hinged cover. Remember to leave a solid strip of pipe approximately 4 in. to 5 in. (10.2 cm to 12.7 cm) wide along one side to act as a baffle to prevent whirlpooling during periods of low water.

**A.9.4** The fact that an adequate water supply is in sight of the main road does not ensure that the water can be used for fire fighting purposes. Many times, it is necessary that a suitable approach be provided to reach within 10 ft (3.1 m) of the water supply. This should be done and the department trained in the use and limitations of the water supply before a fire occurs. A suitable approach might call for a roadway. However, at some sites and in some areas of the country, it might not be necessary that a roadway be constructed, due to soil conditions. Other sites might already have roadways provided or pavement installed, with the construction of an entranceway or a gate necessary to provide access to the water supply. Other sites can be reached by foot only and can necessitate that a path be constructed and maintained so that portable pumps can be carried to the site.

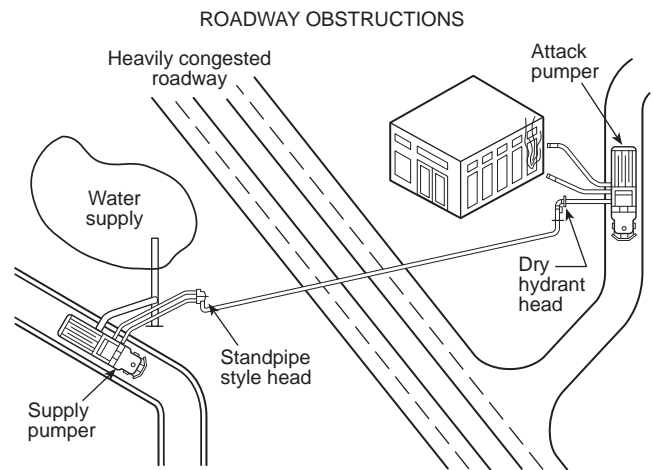
Dry hydrant installations can be adapted to as many situations as a fire department faces, including industrial fire protection (Figure A.9.4(a)), and can be designed to overcome various situations such as roadways that prevent the direct hauling of water (Figure A.9.4(b)), unusually heavy silt and mud in the water source (Figure A.9.4(c)) and underground obstructions like rocks (Figure A.9.4.6(d)).

Each site should be evaluated by the WSO to determine the best way, within the fire department's means, for using the water supply. Additional information on several optional water sources can be found in Annex B. Water Supply Operations.

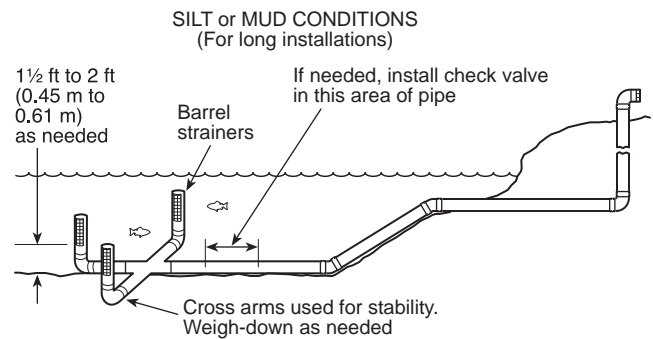
For an impounded supply, cistern, tank, or storage facility, the quantity of water to be considered available is the minimum available [at not over 15 ft (4.6 m) lift] during a drought with an average 50-year frequency (certified by a registered or licensed professional engineer). The maximum rate of flow is determined by testing, using the pumper(s), hose arrangement, and dry hydrant normally used at the site.



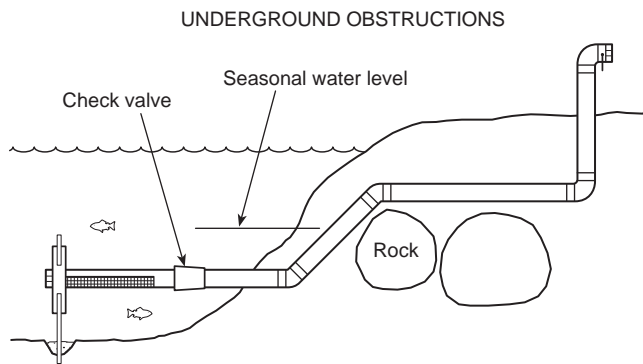
**Figure A.9.4(a) Locating Multiple Water Supply Points for Industrial Occupancies**



**Figure A.9.4(b) Locating Water Supplies to Overcome Roadway Obstructions**



**Figure A.9.4(c) Installation for Silt and Mud Conditions**



**Figure A.9.4.6(d) Overcoming underground obstructions for installing a dry hydrant**

**Natural Water Sources: Streams.** Streams, including rivers, bays, creeks, and irrigation canals, can represent a continuously flowing source of substantial capacity. Where considering water from flowing streams as potential water sources, the fire department should consider the following factors:

- (a) **Flowing Capacity.** The stream should deliver water in capacities compatible with those outlined in the water requirements of this standard. (See Chapter 5.)
- (b) **Climatic Characteristics.** Streams that deliver water throughout the year and are not susceptible to drought are desirable for fire protection. However, where such streams are not available, a combination of supplies might be necessary. In many sections of the country, streams cannot be relied on during drought seasons. If the stream is subject to flooding or freezing, special evolutions might be necessary to make the stream usable under such conditions. Similar circumstances might exist during wet periods or when the ground is covered with snow.
- (c) **Accessibility.** A river or other source of water might not be accessible to the fire department for use during a fire. Distance and terrain from the all-weather road to the source should be such as to make the water readily available. In some cases, special equipment should be used to obtain the water. (See Annexes B and E, Portable Pumps.) Where roadways are provided to the water supply, they should be constructed in accordance with A.9.4.6.
- (d) **Calculating Flow of a Stream.** A simple method for estimating the flow of water in a creek is to measure the width and depth of the creek. Drop a cork or any light floating object into the water, and determine the time it takes the cork to travel 10 ft (3.1 m). To obtain complete accuracy, the sides of the creek should be perpendicular, the bottom flat, and the floating object should not be affected by the wind. Where the sides and bottom of the stream are not uniform, the width and depth can be averaged.

Example: A creek that is 4 ft (1.2 m) wide and 6 in. (15.2 cm) deep. The flow of water is such that it takes 45 seconds for a cork to travel 10 ft (3 m). Therefore:

$$W \times D \times TD = \text{cubic feet ft}^3 \text{ (m}^3\text{) of water}$$

where:

$$W = \text{width} = 4 \text{ ft (1.2 m)}$$

$$D = \text{depth} = 6 \text{ in. (15.2 cm)} = 1/2 \text{ ft (0.15 m)}$$

$$TD = \text{travel distance} = 10 \text{ ft (3.1 m)}$$

$$T = \text{time in seconds} = 45 \text{ sec}$$

$$0.00223 \text{ ft}^3/\text{sec} = 1 \text{ gal}$$

$$4 (1.2 \text{ m}) \times 1/2 (0.15 \text{ m}) \times 10 (3.1 \text{ m}) = 20 \text{ ft}^3 (0.56 \text{ m}^3) \text{ of water}$$

The cork takes 45 seconds to flow the 10 ft (3.1 m) distance.

$$\text{ft}^3 \text{ of water/time} = \text{ft}^3/\text{sec} \text{ (m}^3 \text{ water/time} = \text{m}^3/\text{sec)}$$

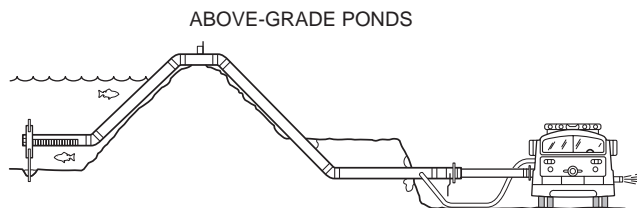
$$20/45 = 0.444 \text{ ft}^3 \text{ of water/sec (0.558/45} = 0.0124 \text{ m}^3 \text{ water/sec)}$$

$$0.444/0.00223 = 199 \text{ gpm flowing in the creek (0.0124/0.00223} = 5.56 \text{ L/min)}$$

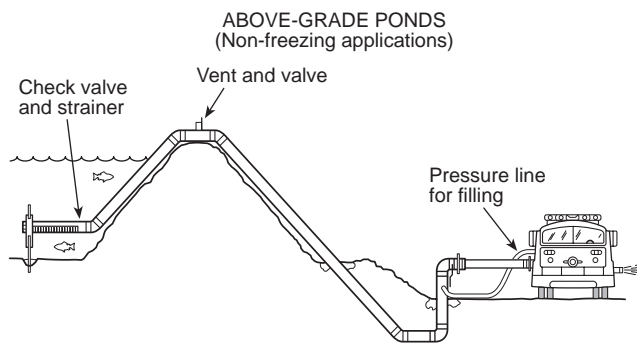
For assistance in more accurately determining stream flow, contact the state Department of Natural Resources, Soil Conservative Service, or county agent.

**Natural Water Sources: Ponds.** Ponds can include lakes or farm ponds used for watering livestock, irrigation, fish culture, recreation, or other purposes while serving a secondary function for fire protection. Valuable information concerning the design of ponds can be obtained from county agricultural agents, cooperative extension offices, county engineers, etc. Most of the factors relative to streams are pertinent to ponds, with the following items to be considered:

- (a) Minimum annual level should be adequate to meet water supply needs of the fire problem the pond serves.
  - (b) Freezing of a stationary water supply, contrasted with the flowing stream, presents a greater problem.
  - (c) Silt and debris can accumulate in a pond or lake, reducing its actual capacity, while its surface area and level remain constant. This can provide a deceptive impression of capacity and calls for at least seasonal inspections. See Figure A.9.4(c) for an example of protective measures for silt and mud conditions.
  - (d) Accessibility should always be considered. Many recreational lakes are provided with access by roads, driveways, and boat launching ramps and are available for fire department use. Some large lakes, formed by a dam on a river, might have been constructed for such purposes as to generate power, for flood control, or to regulate the flow of a river. During certain periods of the year (droughts, drawdowns, etc.), such bodies of water can have very low water levels. The water under such conditions might not be accessible to the fire department for drafting by the fire department pumping unit, even where a paved road, for boat launching, has been provided and extended into the water at normal water levels for several feet or meters. Under such conditions, other provisions should be made to make the water supply fully accessible to the fire department.
- Figures A.9.4(d) and (e) provide examples of access to ponds that are above grade in both freezing and non-freezing areas.



**Figures A.9.4(d) Example of access to a pond that is above grade in freezing areas.**



**Figures A.9.4(e) Example of access to a pond that is above grade in non-freezing areas.**

**Other Natural Sources** might include springs and artesian wells. Individual springs and occasional artesian water supplies exist in some areas and, again, while generally of more limited capacity, can be useful for water supply, subject to reasonable application of the factors listed for ponds and streams. In many cases, it might be necessary to form a temporary natural pool or form a pond with a salvage cover, for example, to collect water for the use of the fire department where using a spring or an artesian well.

**Developed Sources of Water** supplies adapted for fire fighting are limited only to the innovative nature of the fire department. They range from cisterns, swimming pools, quarries, mines, automatic sprinkler system supplies, stationary tanks, driven wells, and dry hydrants, to situations where fire fighters have drafted water out of the basement of a burning building into which it was pumped only minutes before to fight the fire. More information on using cisterns for water supplies can be found in Annex B.4.

Some fire departments are using reclaimed underground storage tanks that have purged and cleaned. These are fitted with piping

and places strategically around the community. See Figures A.9.4(f) and (g) are examples of construction of water cisterns using underground tanks.

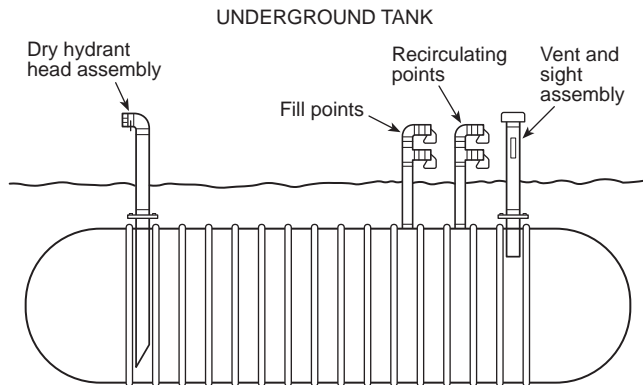


Figure A.9.4(f) Example of construction of water cisterns using an underground storage tank.

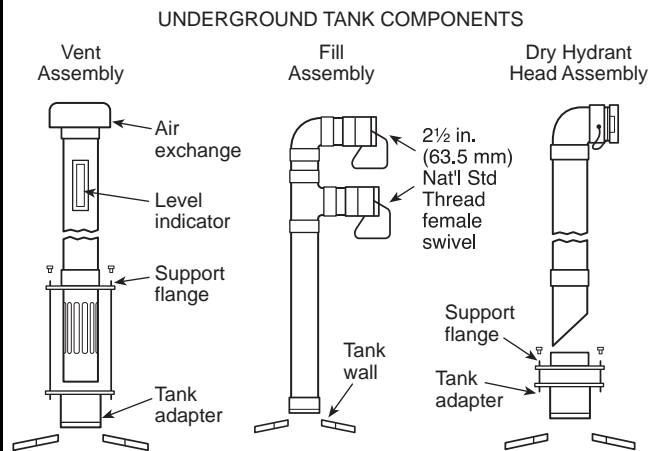


Figure A.9.4(g) Examples of fill and vent assemblies for of water cisterns using underground tanks.

Other types of existing water tanks can also be adapted for use with dry hydrants, as illustrated in Figure A.9.4(h).

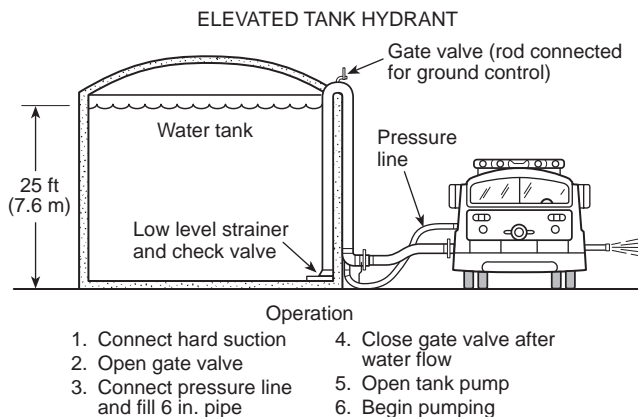


Figure A.9.4(h) Example of an elevated hydrant from a water tank.

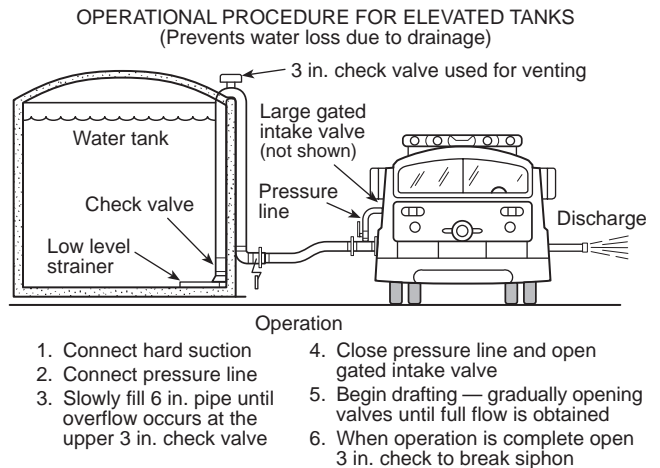


Figure A.9.4(i) Drafting Procedure for Elevated Tanks

A.9.4.2.1 It is the responsibility of the WSO to make inspections of all water sources available as often as conditions warrant and to note any changes in the facilities. This is particularly true during adverse weather conditions, such as droughts, very wet periods, heavy freezing, and following snowstorms.

A.9.4.4 In areas where frost is a problem, the design should ensure that no frost will reach the water in the pipe. There are two ways to accomplish this: (1) bury the pipe below the frost line and mound up the soil over the pipe and around the rise; or (2) place an insulating barrier, such as styrofoam, between the pipe and the surface to prevent the frost from reaching the water in the pipe. Placement of the suction screen in the body of water should be deep enough to ensure that ice will not reach the screen. In such cases, divers might be needed to assist in proper screen placement.

If a dry hydrant is not installed in a cistern, then, depending on local conditions, a heavy pipe or a pike pole can be adequate to break an ice formation. In fact, the weight of the suction hose itself can be sufficient, provided there is no danger of damaging the strainer, the hose, or hose threads.

There are several methods of providing an ice-free surface area in a cistern or other water source. These include floating a log or a bale of hay or straw on the surface of the water or placing a partly filled, floating barrel on the surface of the water.

Examples of freeze prevention methods are provided in Figures A.9.4.4(a), (b), and (c):

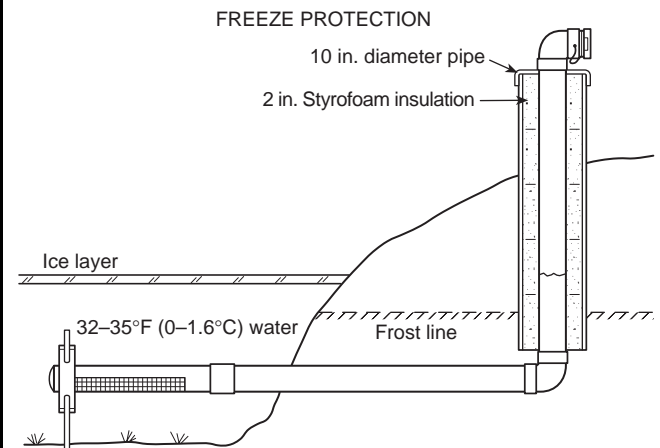


Figure A.9.4.4(a) Example of freeze protection for dry hydrant.

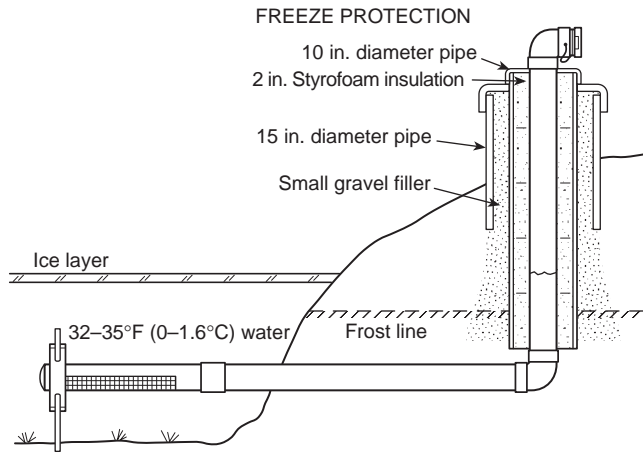


Figure A.9.4.4(b) Example of freeze protection for dry hydrant.

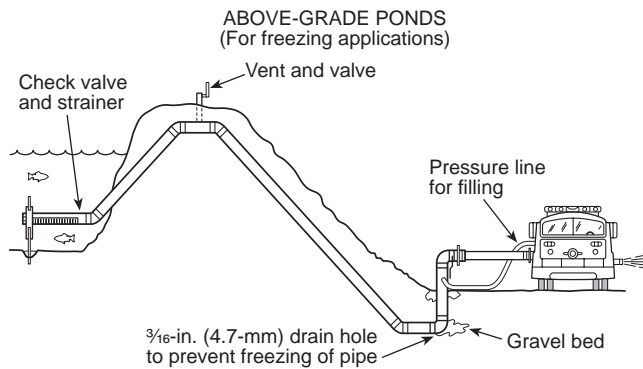


Figure A.9.4.4(c) Example of freeze protection for an above grade pond used as a water source.

**A.9.4.5** The WSO should ensure that an appropriate sign is erected at each water point identifying the site for fire department emergency use and including the name, or a number, for the water supply. Letters and numbers should be at least 3 in. (76 mm) high, with a 1/2 in. (13 mm) stroke and reflective, as allowed by state and local regulations.

**A.9.4.6** Most artificial lakes are constructed with heavy earth moving equipment. In order for the property owner to construct a roadway for fire department use, the WSO should make the property owner aware of the needs of the fire department while the heavy equipment is still on the job. Table A.9.4.6 details considerations that should be kept in mind when planning access.

While the roadway to the water supply is being developed, consideration should be given to providing a 90 ft (27.4 m) diameter turnaround for the mobile water supply apparatus. Where conditions at the supply do not make a turnaround feasible, a large underground pipe transmission line can be laid from the water supply to the highway and the mobile water supply apparatus filled on the highway right-of-way. However, a turnaround or looped facility will still need to be provided at the fill point on the right-of-way.

**Bridges Used as Water Points.** In some states, a fire department cannot use a bridge to park a mobile water supply while it is being filled, thereby blocking traffic on a road. However, the fire department might be able to use the water source by moving the fill point off of the bridge to the right-of-way. Therefore, the department needs to check with the state Department of Transportation and abide by the appropriate laws governing the situation. Two optional dry hydrant configurations for constructing dry hydrants using bridges are shown in Figures A.9.4.6 (a) and (b).

It is expected that the general condition of the bridges in most states is poor. A large number of these bridges are very old, and many that were built for farm-to market-type use are now in urban areas with greatly increased traffic loads. During the last few years, a number of states have set up bridge inspection programs and the current safe tonnage is being posted. Over the entire country, a large number of bridges have been restricted to below the legal weight limit for which the road and bridge were originally designed. One state with over 15,000 bridges reports that 50 percent of all its bridges are now posted below the original maximum load limits, and 25 percent of these bridges are unsafe for use by a fully loaded school bus or normal fire department equipment.

While highway departments are doing what is possible with the money available to improve bridge safety, priority is given to bridge upkeep only on primary roads. Many bridges cannot be brought up to standard without complete rebuilding, and most states do not have money available for such an overhaul program. Some state highway departments have consulted with fire officials to identify bridges in order of their importance to the fire service response needs. The highway departments then attempt to upgrade these bridges on the basis of fire department priority.

The load capacities of bridges are a serious consideration when planning purchases of fire apparatus. Mobile water supply apparatus must be restricted to volumes that will not cause overloading. Whether or not a fire department is held financially responsible for damage to a bridge depends on state law; however, a good policy for every rural fire department is to check the bridge load restrictions before purchasing a new piece of apparatus. The lighter the equipment, the more bridges the department can use. The fire department will need to make whatever special provision is indicated to protect an accessible area by an unsafe bridge.

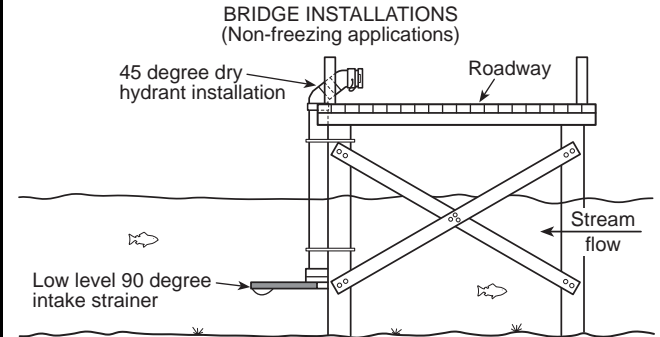
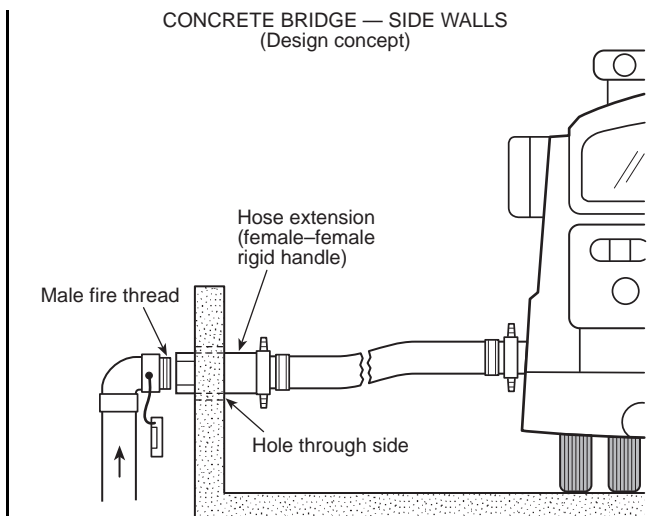


Figure A.9.4.6(a) Installation of a dry hydrant from a bridge

Table A.9.4.6 Recommendations for Roads to Water Supplies

Width:	Roadbed — 12 ft (3.7 m) Tread — 8 ft (2.4 m) Shoulders — 2 ft (0.6 m)
Alignment:	Radium 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.
Turnaround:	Turnaround should be designed to handle the equipment of the responding fire department with a minimum diameter of 90 ft (27.4 m).
Load Carrying Capacity:	Adequate to carry maximum vehicle load expected.
Condition:	Suitable for all-weather use.

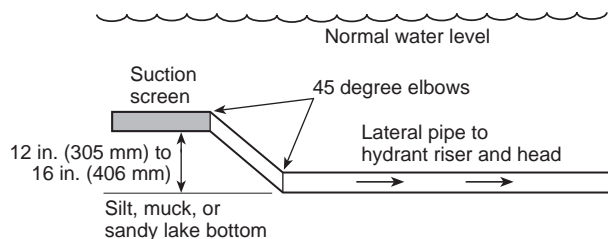


**Figure A.9.4.6(b) Installation of a dry hydrant through the sidewall of a concrete bridge.**

**A.9.5** The installation of dry hydrants calls for care in measuring water storage capacities. The useful depth of a lake with a dry hydrant installation, for instance, is from the minimum foreseeable low-water surface level to the top of the suction strainer, not to the bottom of the lake, and must be not less than 2 ft (0.6 m) of water. This becomes a very important point where hydrants are installed on a body of water affected by tide or on a lake that is lowered to maintain the flow of a river during drought conditions, to generate power, or that freezes over. Pump suction requires submergence below the water surface of 2 ft (0.6 m) or more, depending on the rate of pumping, to prevent the formation of a vortex or whirlpool. Baffle and anti-swirl plates should be added to minimize vortex problems and allow additional water use. The vortex allows air to enter the pump, which can cause the loss of the pump prime. Therefore, pumping rates should be adjusted as the water level is lowered. This factor should be considered by the WSO when estimating the effective rate at which water can be drawn from all suction supplies.

**A.9.6** A typical installation process includes these steps:

- (a) Check for any underground or overhead utilities before digging.
- (b) Using a backhoe or excavator, dig in the trench starting at the point where the suction screen will be placed in the water.
- (c) Maintain a uniform level trench cut all the way from the screen location to the point where the riser begins.
- (d) Assemble the horizontal run and vertical riser portion of the hydrant (screen, lateral run, and riser) and place into the trench and water source as one piece.
- (e) Sink the screen end and allow the assembly to sink into the bottom of the trench.
- (f) When certain the suction screen is placed correctly, start backfilling the trench at the riser (keeping the riser pipe vertical) and backfill out into the water, being careful not to cover the suction screen.
- (g) Mound and tamp the dirt slightly, as settling will occur over time. Mounding the dirt will also help to keep frost away from the water in the pipe.
- (h) Place a cement block or use a commercial or manufactured strainer support under the suction screen to support the screen off the bottom. If the installation is in a fast moving waterway, several blocks or supports might have to be attached to the screen to prevent the current from moving the screen. The pipe and screen will also have to have special protection from any debris washing down the stream and hitting the pipe or screen.



**Figure A.9.6 Offset screen installation (Courtesy of Weyerhaeuser Volunteer Fire Department, WI)**

- (i) Cut off the vertical riser and attach the hydrant connection, making sure that the top of the hydrant connection is below the bottom of the pump intake. It is important that the pump intake remain slightly above the hydrant connection to prevent an air lock in the suction line.
- (j) Set the guards and hose supports. Level, seed, and mulch the area to prevent erosion.
- (k) Test pump the hydrant

**A.9.6.2** Contact the appropriate authorities (for example, water, power, telephone, cable, and gas).

**A.9.7 Maintenance of Dry Hydrants.** These facilities require periodic checking, testing, and maintenance at least quarterly. 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.

Particular attention should be given to streams and ponds. They need frequent removal of debris, dredging or excavation of silt, and protection from erosion. The hydrants should be tested at least annually with a pumper. Back flushing, followed by a 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 the water supply available for any fire emergency.

The pond should be maintained as free of aquatic growth as possible. At times it might be necessary to drain the pond to control this growth. Helpful information is available from such sources as the county agricultural extension agent or the U.S. Department of Agriculture.

Inspections should verify safety procedures such as posted warning signs and the availability of life preservers, ropes, etc. Particular attention should be given to local authorities' regulations governing such water points.

It is important to consider appearance of this water point. Grass should be kept trimmed and neat. The hydrant should be freshly painted as needed. The cap can be painted a reflective material to improve visibility during emergencies. All identification signs should be approved by the Department of Transportation prior to installation if they are to be located on the right-of-way or are subject to state laws. Vegetation should be cleared for a minimum 3 ft (0.9 m) radius from around hydrants.

**A.9.7.3 Record keeping for Dry Hydrants.**

**Water Source Cards.** A recommended practice is to prepare individual water source cards for each water point. This is a job that lends itself ideally to computers. There may be one or more water source applicable to a given potential fireground. In addition to the computer, the water sources should be noted on a master grid map of the area. Thus, the grid map will show the index location of water source cards on which pertinent data will be noted. This data should include type of source (stream, cistern, domestic system, etc.), point of access [100 ft (30.5 m) north of barn, etc.], gallons available [flows minimum 250 gpm (946 L/min), 10,000 gal (37,850 L) storage, etc.], and any particular problem such as weather condition or seasonal fluctuations that can make a source unusable. It is good practice to attach a photograph of the water point to the card. It is advisable to designate an alternate source.

These water source cards should be used as the basis of regular inspections to make sure the source continues to be available and to note any improvement or deterioration of its usefulness. A program to develop additional sources as needed, including water sources for new construction as it evolves, should be an ongoing program in an alert organization.

It is suggested that a record of inspection be maintained with a separate card on each dry hydrant. (See Figure A.9.7.3.)

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Location and direction: \_\_\_\_\_

Depth of water above intake: \_\_\_\_\_

\_\_\_\_\_

Date: \_\_\_\_\_

Date of Insp.	By	Depth of Water <sup>1</sup>	Amount of Water Available <sup>2</sup>	Condition of Water <sup>3</sup>	Erosion <sup>4</sup>	Dry Hydrant		Weed Control <sup>7</sup>	Road Condition <sup>8</sup>	Sign <sup>9</sup>	Remarks <sup>10</sup>
						Test <sup>5</sup>	Flow <sup>6</sup>				

- <sup>1</sup> Record depth of water from the surface to the top of strainer.
- <sup>2</sup> Record amount of water available calculated from surface to at least 2 ft (0.61 m) above top of strainer.
- <sup>3</sup> Record a condition, the deterioration of which, over time, will reduce the water available. Special attention should be given to such items as silting, debris, and aquatic growth.
- <sup>4</sup> Record erosion of the areas around the hydrant, access road, and bank of the water supply.
- <sup>5</sup> Record by noting pumper used for the test, thereby indicating that the dry fire hydrant was back-flushed and that the end cap is in place, screen is clear of any stoppage, and supports or gravel, or both, is in place. Any problems corrected are recorded under "Remarks."
- <sup>6</sup> Record of the actual test of the hydrant in gpm (L/min) following the department's standard operating procedure for testing dry fire hydrants. Care should be taken to use the same test procedures during each test.
- <sup>7</sup> Record complete information on chemicals and process used, where applicable.
- <sup>8</sup> Record condition of roadway, drainage, and so forth.
- <sup>9</sup> Record information pertaining to accuracy and clarity of information on sign (e.g., repainted or replaced).
- <sup>10</sup> Record general information about the dry fire hydrant as found at the time of inspection.

**Figure A.9.7.3(a) Maintenance record for dry hydrant.**

An official record should be kept of all pertinent information recommended for each dry hydrant area. An example of one type is Figure A.9.7.3(b). The record will provide invaluable information whenever the need for such is required.

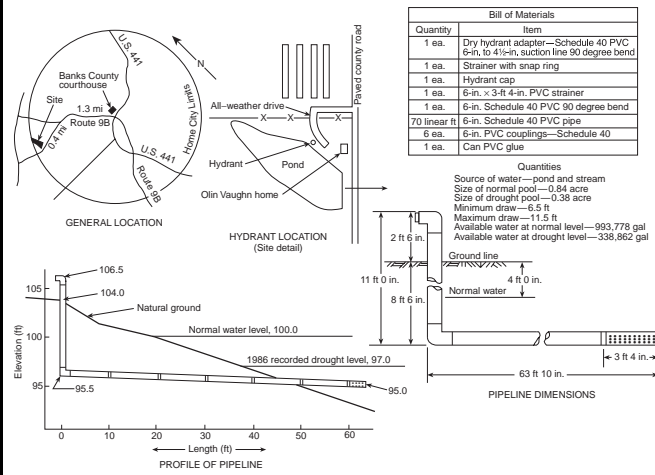


Figure A.9.7.3(b) Example map and location/detail drawing.

**A.9.7.4** Checking and testing by actual drafting shall be a part of fire department training and drills.

**A.9.8 Map and Location/Detail Drawing.**

**Water Map.** Each WSO should maintain a map showing the location and amount of water available at each water site. A copy of this map should be located in the fire alarm dispatcher's headquarters where such an alarm facility is available and should be carried on at least one pumper and the chief's car and by the WSO. Any problems that are encountered at the supply should be recorded.

**SUBSTANTIATION:** This new chapter is based on material extracted from Appendix A of the existing document and reworded to more performance-based language. The Committee realizes that the language is not totally performance-based, and supplies additional information in a revised Appendix A, now proposed as Annex A to comply with new NFPA style manual.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

**COMMENT ON AFFIRMATIVE:**

**MADRZYKOWSKI:** Review of correct section 9.3.8.1 and equation therein.

**RICHARDS:** Regarding 9.3.3\* Although dry hydrant systems can, under proper conditions, provide 1000 gpm at draft and should, when practical, be designed and installed to permit such a capacity; there will be situations where the 1000 gpm availability from draft, may not obtainable due to excessive life, elevation, and/or water temperature. In such cases multiple sites, that each provide less than 1000 gpm, may be needed to meet the required fire flow determined by the AHJ. A graduated standard permitting 500, 750 or 1000+ would seem more in concert with the intent of the NFPA 1142 standard and the given needs of the AHJ.

Modification of this part to obtain maximum available flow under existing conditions (in context with the previous minimums identified), would seem reasonable and will be submitted by this member as a comment. A recommendation to label the site with a dry hydrant symbol and the maximum flow expected availability during minimum conditions will also be submitted for considered.

(Log #CP8)

1142- 7 - (Appendix A): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Revise Appendix A (to be renamed Annex A) as follows:

**Annex A Explanatory Material**

Revise A-1-2 to read as follows:

**A.1.2** In some areas, water supply systems have been installed for domestic water purposes only. These systems can be equipped

with hydrants that might not be standard fire hydrants, with available volume, pressure, and duration of flow being less than needed for adequate fire fighting purposes. Where such conditions exist, this standard and annex should be applied in water supply matters.

Add Annex material for the definition of Water Supply Officer as follows:

Many progressive rural fire departments depend on a Water Supply Officer (WSO). The work of a properly trained and equipped WSO makes it possible for the officer supervising the actual fire attack to operate on the basis of reliable water supply information, to coordinate the attack with the available water supplies, and to help prevent the confusion inherent in fighting a major fire when the chief officer at the scene must divert too much personal attention from the attack to the logistics of backing it up.

**Duties of Water Supply Officer (WSO).** The WSO is the individual who implements the water supply pre-fire planning. The WSO's overall responsibilities are to determine water requirements of the targeted structures, to plan availability of and access to water sources, and to ensure sufficient water is provided at each fire site. The WSO should maintain and have available a complete set of files, including locations of water points and lists of automatic and mutual aid mobile water supply apparatus available. Modern technology in computers makes it feasible for even a relatively low-budget department to reduce this data to electronic files that can be maintained at the fire alarm communication center and provided at the scene of every fire.

The WSO participates in the pre-fire planning and in calculating the fire flow requirements for the various buildings in the area under the department's jurisdiction. To satisfy these water requirements, the WSO should survey the district and the surrounding areas for available water for fire fighting purposes. Water supplies might exist on the property to be protected or might need to be transported. The WSO should develop preplans and see that the fire department is kept aware of all the water supplies available to the entire area. The WSO maintains close coordination with the fire department training officer and provides assistance in joint water supply training sessions with neighboring fire departments. The WSO should make periodic inspections of all water supplies and structural changes in the department's jurisdiction.

A list of all apparatus, equipment, and personnel available to the officer's department should be developed. Arrangements should be developed for specific apparatus and personnel to respond under an automatic aid agreement (first alarm response) or a mutual aid agreement (called as needed). Needs will be dictated by the nature of the structure(s) involved and the quantity of water required.

At the fire scene, the WSO's duty is to maintain continuous fire streams by establishing several water hauling facilities, assembling water-carrying equipment of automatic and mutual aid departments, and calculating estimated arrival times of mobile water supply apparatus, through a thorough knowledge of available water supplies throughout a wide area of fire department jurisdiction.

To develop and sustain large fire flow requires the use of several water sources as well as several drop tanks where water may be dumped. Therefore, reliable and effective communication is necessary in directing mobile water supplies so that time is not lost at the fill and the dump points. To obtain water supply efficiency, a radio frequency separate from that used for the fire ground operations needs to be assigned to the WSO and the water supply site and the mobile water supply apparatus. The WSO will also require efficient communication with the incident commander.

The WSO (or designee) meets with property owners and others to secure their permission to use the water supply, to develop an all-weather road to the supply, and to install dry hydrants (see Chapter 9). The installation of roads to or dry hydrants in navigable water or wetlands might require a permit from appropriate local, state, or national agencies. The WSO should also consult with the owner in the design of a water source on a property to be protected.

Revise A-2-1.1 to read as follows:

Information needed to compute the minimum water supplies that should be collected during building surveys includes:

- (a) Area of all floors, including attics, basements, and crawl spaces.
- (b) Height between floors or crawl spaces and in the attics from floor to ridgepole.
- (c) Construction materials used in each building, including walls, floors, roofs, ceilings, interior partitions, stairs, etc.
- (d) Occupancy (occupancies) of buildings.
- (e) Occupancy (occupancies) of yard areas.

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(f) Exposures to buildings and yard storage and distances between them.

(g) Fire protection systems — automatic and manual protection systems, hydrants, yard mains, and other protection facilities.

(h) On-premises water supplies, including natural and constructed sources of water.

Revise A-2-1.2 to read as follows:

In determining suitable water quality, the authority having jurisdictions should consider potential environmental contaminants or particulate matter in the proposed source.

Revise A-3-2 to read as follows:

The occupancy hazard classification number is a mathematical factor to be used in calculating minimum water supplies. The lowest occupancy hazard classification number is 3 and is assigned to the highest hazard group. The highest occupancy hazard classification number is 7 and is assigned to the lowest hazard group.

Revise A-4-2 to read as follows:

The construction classification number is a mathematical factor to be used in calculating minimum water supplies. The slowest burning or lowest hazard type of construction, fire-resistive, is construction classification number 0.5. The fastest burning or highest hazard type of construction, wood frame, is construction classification number 1.5. All dwellings should be assigned a construction classification number of 1.0 or lower where construction is noncombustible or fire-resistive.

Revise A-4-2.4 to read as follows:

Due to cost savings, many Type III (ordinary) and Type V (wood frame) constructed buildings can have wood trusses as a lightweight pre-engineered framing system used in the roof and floors. As long as the integrity of all members of the unit is intact, the unit is a stable building item. However, this might not be the case if one of the outer members is destroyed or damaged. If this happens during a fire, the roof or floor supported by the unit can be weakened to the point where it will be unsafe to support fire fighters.

Another weak point found in the lightweight pre-engineered truss during a fire is the joint formed by metal gussets. The use of metal gussets has reduced the cost and increased production of wood trusses; however, the metal gussets might not retain their strength and integrity where exposed to heat or fire.

Therefore, during the survey of the buildings for water requirements, fire prevention, or pre-fire planning purposes, the fire department should be aware of such structural fire fighting hazards, take appropriate steps to make all fire fighters aware of the conditions, and plan alternate fire tactics.

Renumber A-5-2 as A-5-2.1 and revise the text to read as follows:

**A-5-2.1 Structures Without Exposure Hazards.** Examples of calculating minimum water supply:

Residential:

Dwelling: 50 ft by 24 ft; 2 stories, 8 ft each; pitched roof, 8 ft from attic floor to ridgepole; wood frame construction.

$$50 \times 24 = 1200 \text{ ft}^2$$

$$\text{Height} = 8 + 8 + 4^* = 20 \text{ ft}$$

$$1200 \times 20 = 24,000 \text{ ft}^3$$

Occupancy hazard classification number 7 (See 3.2.5.)

Construction classification number 1.0, frame dwelling (See 4.2.6.)

$$(24,000 / 7) \times 1.0 = 3429 \text{ gal}$$

Minimum water supply = 3429 gal

For SI Units: 1 ft = 0.305 m; 1 ft<sup>2</sup> = 0.092 m<sup>2</sup>; 1 ft<sup>3</sup> = 0.028 m<sup>3</sup>; 1 gal = 3.785 L.

\*For pitched roofs, calculate half the distance from attic floor to ridgepole.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size. (See 3.3.1.) For a dwelling, the construction classification number is no larger than 1.0.

Commercial:

Farm equipment shed: 125 ft × 100 ft; height 14 ft; 1 story; flat roof; noncombustible construction.

$$125 \times 100 = 12,500 \text{ ft}^2$$

$$\text{Height} = 14 \text{ ft}$$

$$12,500 \times 14 = 175,000 \text{ ft}^3$$

Occupancy hazard classification number 5 (See 3.2.3.)

Construction classification number 0.75 (See 4.2.3.)

$$(175,000 / 5) \times 0.75 = 26,250 \text{ gal}$$

Minimum water supply = 26,250 gal

For SI Units: 1 ft = 0.305 m; 1 ft<sup>2</sup> = 0.092 m<sup>2</sup>; 1 ft<sup>3</sup> = 0.028 m<sup>3</sup>; 1 gal = 3.785 L.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size.

Multiple Structure Calculations:

Church: 130 ft × 60 ft; height 25 ft to ridgepole (15 ft from ground to eaves, with pitched ridgepole 10 ft above the eaves); brick construction with fire-resistive constructed office building within 40 ft of church.

$$130 \times 60 = 7800 \text{ ft}^2$$

$$\text{Height} = 15 + \frac{10^*}{2} = 20 \text{ ft}$$

$$7800 \times 20 = 156,000 \text{ ft}^3$$

Occupancy hazard classification number 6 (See 3.2.6.)

Construction classification number 1.0 (See 4.2.6.)

$$(156,000 / 6) \times 1.0 = 26,000$$

The church has an exposure of a brick office building, so multiply by the exposure factor of 1.5.

$$26,000 \times 1.5 = 39,000 \text{ gal}$$

Minimum water supply = 39,000 gal

\*For pitched roofs, calculate half the distance from attic floor to ridgepole.

The fire-resistive office building:

Office building is 175 ft × 100 ft; 2 stories, each floor 10 ft; with a flat roof.

$$175 \times 100 = 17,500 \text{ ft}^2$$

$$\text{Height} = 10 + 10 = 20 \text{ ft}$$

$$17,500 \times 20 = 350,000 \text{ ft}^3$$

Occupancy hazard classification number 7 (See 3.2.7.)

Construction classification 0.5 (See 4.2.2.)

$$(350,000 / 7) \times 0.5 = 25,000 \text{ gal}$$

Minimum water supply = 25,000 gal

As this is a multiple structure location served from a single water point with the supply computed from the structure having the larger water supply requirement, the church will control the water supply requirement.

Water supply for church = 39,000 gal

Water supply for office = 25,000 gal

Therefore, the church has the larger water supply requirement.

Minimum water supply for these multiple structures = 39,000 gal

For SI Units: 1 ft = 0.305 m; 1 ft<sup>2</sup> = 0.092 m<sup>2</sup>; 1 ft<sup>3</sup> = 0.028 m<sup>3</sup>; 1 gal = 3.785 L.

**Precalculated Water Supply.** Table A-5-2.1 provides a quick method for determining the water requirements of this standard for structures without exposures.

To use the table, first determine the total volume in cubic feet of the structure. Then, locate the closest corresponding volume in the left-hand column and read across (to the right) to find the total gallons of water required for the occupancy hazard classification and the construction classification of the structure.

For structures with exposures, multiply the water requirements in Table A-5-2 by 1.5.

Example: A farm storage building housing a barn (occupancy hazard classification 4) of ordinary construction (construction classification number 1.0) with a cubic area of 160,000 ft<sup>3</sup> (4480 m<sup>3</sup>) will produce, using Table A-5-2.1, a water requirement of 40,000 gal (151,400 L).



Table A.5.2. Precalculated Minimum Water Supplies by Occupancy Hazard and Construction Classification (no exposures) (continues)

Occupancy Hazard Construction Classification	3			4			5			6			7							
	Gallons			Gallons			Gallons			Gallons			Gallons							
	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5	0.5	0.75	1.0	1.5				
400,000	66,667	100,000	133,333	200,000	50,000	75,000	100,000	150,000	40,000	60,000	80,000	120,000	33,333	50,000	66,667	100,000	28,571	42,857	57,143	85,714
425,000	70,833	106,250	141,667	212,500	53,125	79,688	106,250	159,375	42,500	63,750	85,000	127,500	35,417	53,125	70,833	106,250	30,357	45,536	60,714	91,071
450,000	75,000	112,500	150,000	225,000	56,250	84,376	112,500	168,750	45,000	67,500	90,000	135,000	37,500	56,250	75,000	112,500	32,143	48,214	64,286	96,429
475,000	79,167	118,750	158,333	237,500	59,375	89,063	118,750	178,125	47,500	71,250	95,000	142,500	39,583	59,375	79,167	118,750	33,929	50,893	67,857	101,786
500,000	83,333	125,000	166,667	250,000	62,500	93,751	125,000	187,500	50,000	75,000	100,000	150,000	41,667	62,500	83,333	125,000	35,714	53,571	71,429	107,143
525,000	87,500	131,250	175,000	262,500	65,625	98,438	131,250	196,875	52,500	78,750	105,000	157,500	43,750	65,625	87,500	131,250	37,500	56,250	75,000	112,500
550,000	91,667	137,500	183,333	275,000	68,750	103,126	137,500	206,250	55,000	82,500	110,000	165,000	45,833	68,750	91,667	137,500	39,286	58,929	78,571	117,857
575,000	95,833	143,750	191,667	287,500	71,875	107,813	143,750	215,625	57,500	86,250	115,000	172,500	47,917	71,875	95,833	143,750	41,071	61,607	82,143	123,214
600,000	100,000	150,000	200,000	300,000	75,000	112,501	150,000	225,000	60,000	90,000	120,000	180,000	50,000	75,000	100,000	150,000	42,857	64,286	85,714	128,571
625,000	104,167	156,250	208,333	312,500	78,125	117,188	156,250	234,375	62,500	93,750	125,000	187,500	52,083	78,125	104,167	156,250	44,643	66,964	89,286	133,929
650,000	108,333	162,500	216,667	325,000	81,250	121,876	162,500	243,750	65,000	97,500	130,000	195,000	54,167	81,250	108,333	162,500	46,429	69,643	92,857	139,286
675,000	112,500	168,750	225,000	337,500	84,375	126,563	168,750	253,125	67,500	101,250	135,000	202,500	56,250	84,375	112,500	168,750	48,214	72,321	96,429	144,643
700,000	116,667	175,000	233,333	350,000	87,500	131,251	175,000	262,500	70,000	105,000	140,000	210,000	58,333	87,500	116,667	175,000	50,000	75,000	100,000	150,000
725,000	120,833	181,250	241,667	362,500	90,625	135,938	181,250	271,875	72,500	108,750	145,000	217,500	60,417	90,625	120,833	181,250	51,786	77,679	103,571	155,357
750,000	125,000	187,500	250,000	375,000	93,750	140,626	187,500	281,250	75,000	112,500	150,000	225,000	62,500	93,750	125,000	187,500	53,571	80,357	107,143	160,714
775,000	129,167	193,750	258,333	387,500	96,875	145,313	193,750	290,625	77,500	116,250	155,000	232,500	64,583	96,875	129,167	193,750	55,357	83,036	110,714	166,071
800,000	133,333	200,000	266,667	400,000	100,000	150,001	200,000	300,000	80,000	120,000	160,000	240,000	66,667	100,000	133,333	200,000	57,143	85,714	114,286	171,429
825,000	137,500	206,250	275,000	412,500	103,125	154,688	206,250	309,375	82,500	123,750	165,000	247,500	68,750	103,125	137,500	206,250	58,929	88,393	117,857	176,786
850,000	141,667	212,500	283,333	425,000	106,250	159,376	212,500	318,750	85,000	127,500	170,000	255,000	70,833	106,250	141,667	212,500	60,714	91,071	121,429	182,143
875,000	145,833	218,750	291,667	437,500	109,375	164,064	218,750	328,125	87,500	131,250	175,000	262,500	72,917	109,375	145,833	218,750	62,500	93,750	125,000	187,500
900,000	150,000	225,000	300,000	450,000	112,500	168,751	225,000	337,500	90,000	135,000	180,000	270,000	75,000	112,500	150,000	225,000	64,286	96,429	128,571	192,857
925,000	154,167	231,250	308,333	462,500	115,265	173,439	231,250	346,875	92,500	138,750	185,000	277,500	77,083	115,625	154,167	231,250	66,071	99,107	132,143	198,214
950,000	158,333	237,500	316,667	475,000	118,750	178,126	237,500	356,250	95,000	142,500	190,000	285,000	79,167	118,750	158,333	237,500	67,857	101,786	135,714	203,571
975,000	162,500	243,750	325,000	487,500	121,875	182,814	243,750	365,625	97,500	146,250	195,000	292,500	81,250	121,875	162,500	243,750	69,643	104,464	139,286	208,929
1,000,000	166,667	250,000	333,333	500,000	125,000	187,501	250,000	375,000	100,000	150,000	200,000	300,000	83,333	125,000	166,667	250,000	71,429	107,143	142,857	214,286

Note: For structures with exposures, multiply results by 1.5 for water supply requirements.

L: 1 ft<sup>3</sup> = 0.0283 m<sup>3</sup>.

Revise A-5-3.1 to read as follows:

**A-5-3.1 Structures with Exposure Hazards.** Examples of calculating minimum water supply:  
Residential:

Dwelling 50 ft × 24 ft; 1 story, 8 ft high; pitched roof, 8 ft from attic floor to ridgepole; brick construction and exposed on one side by a frame dwelling with a separation of less than 50 ft and with areas greater than 100 ft<sup>2</sup>.

$$50 \times 24 = 1200 \text{ ft}^2$$

$$\text{Height} = 8 + 4^* = 12 \text{ ft}$$

$$1200 \times 12 = 14,400 \text{ ft}^3$$

Occupancy hazard classification number 7 (See 3.2.5.)

Construction classification number 1.0, brick dwelling, (See 4.2.6.)

$$(14,400 / 7) \times 1.0 = 2057$$

Since the dwelling exposure is a frame dwelling, multiply by the exposure factor of 1.5 [See Section 5.3.1]

$$2057 \times 1.5 = 3086 \text{ gal}$$

Minimum water supply = 3086 gal

For SI Units: 1 ft = 0.305 m; 1 ft<sup>2</sup> = 0.092 m<sup>2</sup>; 1 ft<sup>3</sup> = 0.028 m<sup>3</sup>; 1 gal = 3.785 L.

\*For pitched roofs, calculate half the distance from attic floor to ridgepole.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size. For a dwelling, the construction classification number is no larger than 1.0.

Multiple Structure Calculations:

A row of five dwellings, identical to the residential occupancy in A-5-2.1, except one has a brick barn measuring 80 ft by 40 ft located 35 ft from the dwelling. The barn is larger than 100 ft<sup>2</sup> in area and is closer than 50 ft to the dwelling. Therefore, the minimum water supply for this dwelling, 3429 gal, should be multiplied by 1.5 for the exposure.

$$3429 \times 1.5 = 5144 \text{ gal}$$

If the dwellings and barn are to be protected by the same water supply, as is likely, the water supply should be calculated on the structure that requires the largest minimum water supply, which is the barn in this case. Thus, if the barn has no hay storage and is 25 ft in height to the pitched ridgepole, and the ridgepole is 10 ft above the eaves, the calculations would be as follows:

$$80 \times 40 = 3200 \text{ ft}^2$$

$$\text{Height} = 15 + 5^* = 20 \text{ ft}$$

$$3200 \times 20 = 64,000 \text{ ft}^3$$

Occupancy hazard classification number 4, for the barn with no hay storage (See 3.2.2.)

Construction classification number is 1.0 (See 4.2.6.)

$$(64,000 / 4) \times 1.0 = 16,000$$

$$16,000 \times 1.5 \text{ (for exposure hazard the dwelling)} = 24,000 \text{ gal}$$

Minimum water supply = 24,000 gal

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size.

For SI Units: 1 ft = 0.305 m; 1 ft<sup>2</sup> = 0.092 m<sup>2</sup>; 1 ft<sup>3</sup> = 0.028 m<sup>3</sup>; 1 gal = 3.785 L.

\*For pitched roofs, calculate half the distance from attic floor to ridgepole.

Farm equipment shed, identical to commercial occupancy in A-5-2.1, except with a one-story, pitched-roof dwelling measuring 50 ft by 25 ft located 45 ft from the equipment shed. The dwelling is larger than 100 ft<sup>2</sup> in area and is closer than 50 ft to the equipment shed. Therefore, the minimum water supply for the equipment shed is 26,250 gal multiplied by 1.5.

$$26,250 \times 1.5 = 39,375 \text{ gal}$$

Minimum water supply = 39,375 gal

The total water supply for the dwelling is: 50 x 25 = 1250 ft<sup>2</sup>

$$\text{Height} = 8 + 4 = 12 \text{ ft}$$

$$1250 \times 12 = 15,000 \text{ ft}^3$$

Occupancy hazard classification number 7 (See 3.2.5.)

Construction classification number 1.0 (See 4.2.6.)

$$(15,000 / 7) \times 1.0 = 2143 \text{ gal}$$

For SI Units: 1 ft = 0.305 m; 1 ft<sup>2</sup> = 0.092 m<sup>2</sup>; 1 ft<sup>3</sup> = 0.028 m<sup>3</sup>; 1 gal = 3.785 L.

Since the equipment shed requires the larger minimum water supply, if these two buildings were to be protected by the same water supply, that minimum water supply would be 39,375 gal.

If a structure is of occupancy hazard classification number 3 or 4, it is considered an exposure hazard if within 50 ft, regardless of size. For a dwelling, the construction classification number is no larger than 1.0.

**SUBSTANTIATION:** In extracting the dry hydrant information from the existing Appendix B, much information was found to be redundant and irrelevant to new revisions that make the subject of dry hydrants a separate chapter. The Committee provides in the revision additional information in Appendix A (proposed to become Annex A) that will enable a variety of designs for dry hydrant systems and helps explain some of the performance-based requirements in Chapter 9.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28

**COMMENT ON AFFIRMATIVE:**

**FREYER:** 1. Regarding statements that are made for addition/correction in that Appendix.

2. Regarding the reason (not meant to include the above #1 listed items) for my not actually putting a vote for Appendix A in the pink sheet; if my reason could allow you to place a vote in a category, that is perfectly acceptable to me. I do not want to cast any negative perceptions on those who wrote up the Appendix, most especially as they thought well enough to include all the dry hydrant diagrams that I sent by Fred Richards. The entire problem is that I did totally forget to send this information with Fred Richards; however, as you will read when you arrive at the #2, I have a very strong (and a proven correct) feeling for what I have written. This "correctness" is due to my designing and installing better than 2500 dry hydrants, plus the utilization of being called on design these for engineering firms that plan the dry hydrants as part of developments that have no pressurized water system that can be used for fire protection. I have submitted one as an example, not prove what I do, but to prove that using the correct tabulation means, a person can exactly figure the gpm flow rate for any designed hydrant anywhere in the United States.

For ease of reference to my comments and their location in the Appendix, I numbered the pages starting with page 1 being the actual first page of the Appendix and not the cover sheet — I have 28 pages total. To be sure that we all follow each other, my first comment (under the category of my #1 above) will show the start (and first few words) of the first sentence at the top of that page!!

Within the following comments, I use the term "configuration"; this is intended to mean the over-all design of the particular dry hydrant. ALSO, every remark that sounds like a challenge or possibly an unknown is do so with deliberate attempt to "make" the users of the standard use the tables provided so that they better understand the need for, and understanding of, those tables.

Comment #1

A.9.3.2 Schedule 80 is not necessary for use in dry hydrants.

It costs more and slightly thicker. It's use in areas where there are freezing temperatures for goodly periods of the year, has been found not create an advantage over Schedule 40 "thickness" pipe. I mention the "freezing temperatures" since that was the reason for the thought to use Schedule 80 and it's additional thickness in the first place. Once it is used, all fittings have to remain Schedule 80, making the entire hydrant more expensive.

Comment #2 A.9.3.3.(a)

Would like to suggest that "If at all possible" be made the first two words of the sentence. At the end of the sentence, add this for further clarification. "The higher the elevation above sea level of the dry hydrant site and the longer the horizontal length of the dry hydrant, a life of 10 foot or higher will greatly decrease the gallon per minute flow capability of the dry hydrant."

Enlarging the horizontal pipe dimension can somewhat alleviate the loss that a higher lift does create, so that particular portion of the paragraph is not totally correct.

Comment #3 A.9.3.3.(b); the entire (b) wording. This has to be fully explained, in the written portion of this packet under the #2 category that is listed at the top of the first page (this will involve the tables and written parts on pages 5 - 7).

Comment #4 Table A.9.3.4.(b)

The psi loss for "hydrant Connection (6 in. x 4.5 in.) is called "sudden reduction" and is used for that loss created when the water flow goes from the 6 in. PVC 90 degree elbow into the connection for the suction hose that will go to the intake of fire

pump on the apparatus. This figure also need the (6 in. x 6 in. and 6 in. x 5 in.). See notes on my #2 section.

Comment #5 A.9.3.5

Add a comment to also include PVC (although it is not mandatory that PVC actually needs to be primed prior to painting - UNLESS reflective paint is to be applied).

The present wording invokes the thought that the only dry hydrant materials needing deterioration treatment is "metal piping and surfaces". The painting of PVC to retard "ultraviolet degradation" is in the PVC Pipe Manual. This is also one of the reasons that the check of this is one of the maintenance checks. ISO will look at all dry hydrants as part of their crediting them for use and will look for them to have "something on them".

Comment #6 A.9.3.6

The thought of using the 2 - 45 degree elbows and the section of PVC pipe to connect them, should only be suggested when there is found to be rock or some other obstacle in the way of the horizontal length of pipe under the water. This is always found AFTER THE EXCAVATION HAS BEGUN and is a unplanned for modification, and should be stated as such here in this paragraph. If the top of the dry hydrant is broken off, the ends are simply sawed as straight as possible, a collar is cemented to the lower section, the top cemented to the other end of the collar, silicon glue put around the circumference of both ends of the collar (double check to prevent any air leakage), and the hydrant is as good as new. ALSO, Figure B.5.3.3(a) shows that this above installation will create more of a total psi loss than one 90-degree elbow. Although the "thought" of sticking a 2 1/2 in. suction hose down the "broken dry hydrant" sounds real good on the surface, check around as see how few FD's have a mini-pumper (or any type smaller PTO pump type unit) that will actually have a 2 1/2 in. suction hose on it. Depending on the configuration of the dry hydrant, even more than one 10-foot section of hose may be needed.

Comment #7

A.9.3.8 second paragraph - this comment has appeared before; has anyone actually checked out these web addresses to see what really appears?

Comment #8

A.9.3.9 THIS COMMENT IS TOTALLY INCORRECT AND UNNECESSARY. This has come straight out of a book on the installation of pressurized fire hydrants. There will never be anywhere near the "hydraulic forces" on a dry hydrant since the pressure is draft (or negative pressure) and not pressure of the type within a pressurized water system. In 20 years of installation, I have never seen one and this is the first time I have ever even seen a mention of one being needed. WE DO NOT NEED THIS IN OUR STANDARD.

Comment #9

A.9.3.12 There is absolutely no need to even infer that the only size holes to be drilled in a dry hydrant strainer need be 5/16 in.

First, the holes drilled by commercial dry hydrant strainer "manufacturers" are either all 7/16 in. or their diameter sizes are staggered with larger holes toward the back of the strainer and smaller sizes toward the front of the strainer.

Second, the industry standard has always been that the total area of all the holes should equal 4 times the diameter of the strainer pipe size. Even if you drilled 5/16 in. holes, it would not give you enough area (3/8 in. holes = 1025). Suggest that you use Table #1 as an example. I think the title will be credit enough for the publisher (Mr. Jim Smalley is very familiar with this publication). As additional note, the 3/8 and 1/2 diameter holes can be on 1/2 ft apart centers and the number needed can be accomplished in 12 rows — little bit of actual construction info.

Comment #10 A.9.4 Natural Water Sources and 11 A.9.4 Natural Water Sources in the example

10. in (d), depth should always be stated as average depth. If the width of a stream is 12 feet, the measurement used for depth should be an average.

11. the 0.00223 cubic/feet/sec = 1 gal SHOULD SAY GAL/SEC OTHERWISE IT WILL HAVE NO RELEVANCE IN THE EQUATION.

Comment #12 A.9.4.6

The last sentence of the first paragraph also includes the "fully loaded school bus" portion. If you would like to remove this you can: There is not one school bus manufactured that has the GVW of a standard pumper mounted on a commercial chassis. The law (incorrect as all realize that it is) allows the weight of a school person riding on a bus as 66 pounds. Please check with Blue Bird in Fort Valley, GA if you choose (they are 16 miles from my house). I ran into this when I was specing chassis for the fire departments so that Forestry Commission could put out front-mount pump fire units. Very rarely will you find a school bus chassis over 23,000 GVW.

Even at 60 students in a bus, that is only a payload of 66 x 60 or 3960#.

Comment #13 and 14 A.9.6

13(h) - this is very infrequently done as the dry hydrant portion under the water is like a boat; it is actually buoyant. You may also have installations where the strainer is actually hanging into a deep void, as the bottom "drops off very abruptly". When there is "fast moving water", the dry hydrant is usually provided with a 45 degree elbow near the strainer, so that the strainer is not perpendicular to the water flow; this materially reduces the damage from "flotsam and jetsam" as well as from the force of fast flowing water after rainstorms.

14 after (j), make (k) read "back slush dry hydrant", then make an (l) for test pump the hydrant (actually "flow test" would really be better terminology since this needs to be done and right then would be the best time).

Comment #15 General to all Appendix A

There are many illustrations where we have shown a check valve strainer. I appreciate the use of these illustrations. I feel that this should be put in somewhere so that there is a better understanding of the use of this type strainer. They are actually immensely useful if the situation exists where they will fit and, as you can tell, they provide water from elevations that are totally impossible for "drafting". The write-up and photos can be used as is at the end of the present appendix.

Comment #16 A.9.3.3, there are excellent comments made covering the necessities that have to be calculated in the design of a dry hydrant; however, if you look closely at the design worksheet and the figures used in the calculations for the worksheet, you will see that many of those listed comments are not included. The fact that they are not make the entire "resulting calculation" on the worksheet incorrect from the standpoint that its will be made AT ANY ELEVATION IN THE UNITED STATES. The use of the comment at the end of the worksheet (page 8) "if Total Head Loss is greater than 20 to 25 ft, the pump might not be able to flow its rated GPM" is not correct when use of the information on pages 7 - 12 is to be considered for everywhere in the U.S. Using these pages with tables we have used throughout the U.S., the answers obtained in pages 7 - 12 (using exactly the same dry hydrant configuration for all examples) will not be correct in terms of gpm flow for dry hydrants installed at altitudes above 4,000 feet elevation. A dry hydrant configuration designed for the east coast of the U.S. will flow a grossly different gpm that same configuration at Leadville, CO with an elevation of 10,600 ft. I make this comment because Leadville, CO Fire District does have dry hydrants; in fact one provides the entire fire flow for a ski lodge.

The reason is very simple; although the worksheet and the figures used do contain correct information, the worksheet does not include many of the comments (as stated above) on page 5 (A.9.3.3); namely, tables showing psi and losses involved with atmospheric pressure, static lift, and vapor pressure (just to use those named). The entire concept of dry hydrant design is (1) to get water (a determined and calculated flow) (2) to determine what gpm flow is available using which size(s) of pipe (3) determining what you choose to do (or install)

The basic start is to determine how much atmospheric pressure is available based on the PSI available at that altitude, then subtracting (using tables of psi loss) that static lift height, the temperature of the water, the psi loss of the strainer (an industry figure of 5) and another 5 psi for the loss in the fire pump (this was determined long ago by the NFPA committee on centrifugal fire pumps). The resulting psi figure is the entire psi loss that the configuration of the dry hydrant (when calculated somewhat like the worksheet show) can have; this will be the sole criteria which you will use to calculate what FPM can available based on a configuration that you have to design given a definite lift and the needed longitudinal length. This is the reason that many personnel at disturbed when they flow a dry hydrant and it does not flow the rated capacity of their fire pump. They did not calculate the dry hydrant flow prior to it's installation. It is also very ridiculous to have this feeling about a dry hydrant for the following reasons:

1. it could have been calculated and the configuration changed prior to installation
2. you do have an uninterrupted flow of water where you had none before
3. anyone who flow fire hydrants for ISO testing in pressurized water systems knows that between 30 and 45 percent of pressurized fire hydrants in a water system will not flow the rated capacity of responding fire apparatus' fire pumps.

I realize that it is too late to do anything to discuss the above in regards to looking more closely at what I can prove, however, because of the fact that I do see the dissatisfaction that these pages could cause to some fire departments that use them, I did not

place a vote on the appendix even though I have a great interest in presenting the comments that I did make above.

Note: Supporting material is available for review at NFPA Headquarters.

PABICH: Clip tabled data to remove pipe sizes less than 2 1/2 inch.

(Log #CP9)

1142- 8 - (Appendix B): Accept

**SUBMITTER:** Technical Committee on Forest and Rural Fire Protection

**RECOMMENDATION:** Revise Appendix B and change Appendix to Annex to comply with new style:

**Annex B Water Supply**

*This annex is not a part of the requirements of this NFPA document, but is included for information purposes only.*

The following numbering system is not intended to correlate with the standard.

**B.1 Water Supply.**

**B.1.1 General.** The fire fighter operating without a water system with hydrants (or with a very limited number of hydrants) has two means of getting water: (1) from supplies on the fireground, which may be constructed or natural, or (2) from supplies transported to the scene. This annex discusses the variety and potential of these sources.

**B.1.2 Water Operations.** The WSO and the training officer, in conjunction with the fire chief, should develop standard operating procedures for hauling water to fires. The standard operating procedures should be put in motion for all structural fires; however, they can be discontinued after the officer in charge has evaluated the fire and determined that water hauling capabilities will not be needed.

**B.2 First-Aid Fire Protection Using On-Site Water Systems.**

**B.2.1 General.** The individual domestic water supply system provided in many rural homes and business establishments, if properly equipped and maintained, is an effective first aid fire extinguisher. For large establishments, an elevated water storage tank or reservoir connected to hydrants and standpipes could provide substantial fire streams as well.

**B.2.2 Domestic Water Systems.** In order for domestic (farm) water systems to provide some degree of reliability in case of fire, the pump or pumps should be placed in a fire-resistive location. The electric power supply should have the maximum protection from de-energization by fire or other cause. In some cases, standby power and pumps can be justified.

**B.2.3 Delivery of First-Aid Fire Protection.** For first-aid fire protection to be effective, every portion of the dwelling and outlying buildings should be within reach of a hose stream. This might require some additional pipelines beyond those needed for other purposes. A garden hose long enough to reach any point in a structure is often valuable for fire fighting use. Care should be taken so that water is drained from hose or pipes that could be subject to freezing weather.

**B.2.4 In-Depth Fire Protection.** To provide for in-depth fire protection, three types of water supplies might be needed: (1) first-aid via the domestic water system; (2) a bulk water supply at the property, which may be a stream, pond, elevated tank, ground level tanks, or cistern; or (3) an area system of static water supplies with drafting points and means for transporting the water to the fire site. Alternative power supplies should be considered.

**B.4.2 Cisterns.** Cisterns are one of the oldest sources of emergency water supply, both for fire fighting and drought storage. They are very important sources of water for fire fighting, domestic consumption, and drought storage in many rural and beach areas.

Cisterns should have a minimum usable volume as determined by the authority having jurisdiction, using the methods described in Chapter 5 of this standard, and there is no real limit to the maximum capacity. A cistern should be accessible to the fire apparatus or other pumping device but should be located far enough from the hazard that personnel and equipment are not endangered.

The water level of a cistern can be maintained by rainfall, water pumped from a well, water hauled by a mobile water supply, or by the seasonal high water of a stream or river. The cistern can present a freezing problem since its surface is often relatively inaccessible and the water is stagnant. One method for minimizing freezing is to use a dry hydrant protruding into the water at a point below the local frost line.

Cisterns should be capped for safety, but they should have openings to permit inspections and use of suction hose when needed. [See Figures B.4.6(e), B.4.6(f), and B.4.6(g).]

**B.4.4 Guide to Cistern Capacity.** A ready guide to the capacity of cisterns with vertical sides is provided in Table B.4.7.

**B.4.5 Construction of Cisterns.** Construction of cisterns is governed by local conditions of soil and material availability. Practical information can be obtained from local governmental departments or agricultural agencies.

Some engineering considerations to be used in designing cisterns include:

(a) Base, walls, and roof should be designed for the prevailing soil conditions and for the loads encountered where heavy vehicles are parked adjacent.

(b) If groundwater conditions are high, the cistern should not float when empty.

(c) Suction piping should be designed to minimize whirlpooling.

(d) Vent piping should be of sufficient size.

Maintenance factors to be considered by the fire department include the danger of silting, evaporation or other low water conditions, and the freezing problems previously discussed.

**B.4.6 Cistern Specifications.** Some governing bodies, where water systems are not available and water for water-hauling fire departments is inadequate, require developers to provide cisterns with all subdivisions that are constructed. As each cistern can provide fire protection for a number of buildings, the necessary capacity is rather large and represents a substantial investment. The following specifications for cistern design and construction are used by one governing body. [See Figures B.4.6(a) through (h).]

1. Cisterns should be located no more than 2200 feet (671 m) truck travel distance from the nearest lot line of the furthest lot.
2. The design of a cistern should be trouble-free and last a lifetime.
3. The cistern capacity should be 30,000 gallons (113 550 L) minimum, available through the suction piping system.
4. The suction piping system should be capable of delivering 1000 gpm (3800 L/min) for three quarters of the cistern capacity.
5. The design of the cistern should be submitted to the authority having jurisdiction for approval prior to construction. All plans should be signed by a licensed/registered professional engineer.
6. The entire cistern should be rated for highway loading, unless specifically exempted by the authority having jurisdiction.
7. All drawings are for estimating purposes only and are not intended for use as design.
8. Each cistern should be sited to the particular location by a registered engineer and approved by the authority having jurisdiction.
9. Cast in-place concrete should achieve a 28-day strength of 3000 psi (20 700 kPag). It should be placed with a minimum of 4 in. (10.2 cm) slump and vibrated in a professional manner.
10. The concrete should be mixed, placed, and cured without the use of calcium chloride. Winter placement and curing should follow the accepted American Concrete Institute (ACI) codes.
11. All suction and fill piping should be American Society for Testing and Materials (ASTM) Schedule 40 steel. All vent piping should be ASTM Schedule 40 PVC with glued joints.
12. All PVC piping should have glued joints.
13. The 8 in. × 5 in. (20.3 cm × 12.7 cm) eccentric reducer is available from suppliers.
14. The final suction connection should be a minimum of 4 1/2 in. (11.4 cm). It should be capped.
15. The filler pipe siamese should have 2 1/2 in. (64 mm) National Standard female threads with plastic caps.
16. The entire cistern should be completed and inspected before any backfilling is done.
17. All backfill material should be screened gravel with no stones larger than 1 1/2 in. (38 mm) and should be compacted to 95 percent ASTM 1557.
18. Bedding for the cistern should consist of a minimum of 12 in. of 3/4 in. to 1 1/2 in. crushed, washed stone, compacted. No fill should be used under stone.
19. Filler pipe siamese should be 36 in. (91.4 cm) above final backfill grade.
20. Suction pipe connection should be 20 in. to 24 in. (51 cm to 61 cm) above the level of the gravel where vehicle wheels will be located when cistern is in use.
21. Suction pipe should be supported either to top of tank or to a level below frost.
22. Base should be designed so that cistern will not float when empty.
23. Perimeter of tank at floor/wall joint should be sealed with 8 in. (20.3 cm) PVC waterstop.

24. After backfilling, tank should be protected by fencing or large stones.
25. Backfill over the tank should be:
  - (a) 4 ft (1.2 m) of fill; or
  - (b) The top and highest 2 ft (0.6 m) of sides of cistern should be insulated with vermin-resistant foam insulation, and 2 ft (0.6 m) of fill.
  - (c) All backfill should extend 10 ft (3.1 m) beyond the edge of the cistern, and then have a maximum 3:1 slope, loamed and seeded.
26. Bottom of suction pipe to pumper connection should not exceed 14 ft (4.25 m) vertical distance.
27. Pitch of shoulder and vehicle pad from edge of pavement to pumper suction connection should be 1 to 6 percent downgrade.
28. Shoulder and vehicle pad should be of sufficient length to permit convenient access to suction connection when pumper is set at 45 degrees to road.
29. All construction, backfill, and grading material should be in accordance with proper construction practices and acceptable to the authority having jurisdiction.
30. All horizontal suction piping should slope slightly uphill toward pumper connection.
31. Installer is responsible for completely filling cistern until accepted by the authority having jurisdiction.  
(Specifications furnished by the New Boston Fire Department, New Boston, NH.)

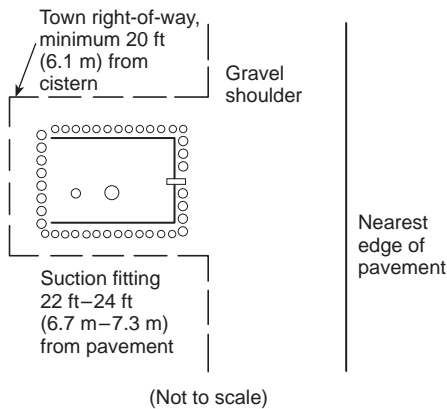
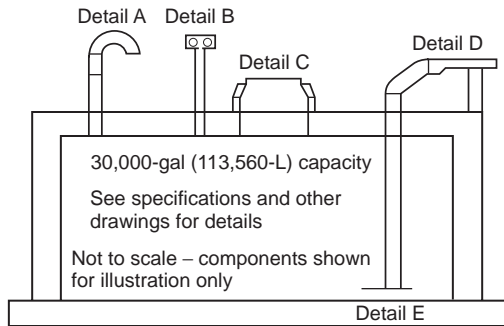


Figure B.4.6(a) Cistern site.



Minimum 12 in. (304 mm) of 3/4-in. (19-mm) to 1 1/2-in. (38-mm) crushed washed stone (compacted) as base under cistern

Notes:

1. For Detail A, see Figure B-4.6(c).
2. For Detail B, see Figure B-4.6(d).
3. For Detail C, see Figure B-4.6(e).
4. For Detail D, see Figure B-4.6(f).
5. For Detail E, see Figure B-4.6(g).

Figure B.4.6(b) Cistern.

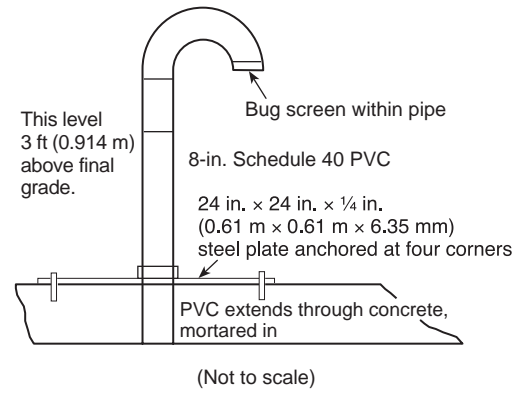


Figure B.4.6(c) Detail A — vent pipe.

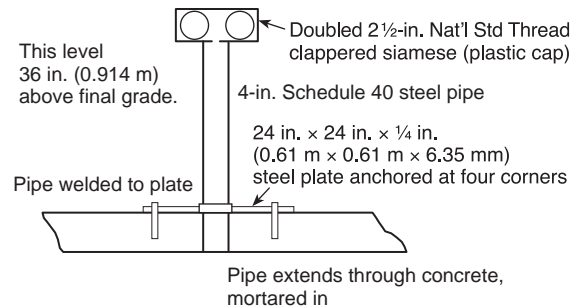


Figure B.4.6(d) Detail B — fill pipe.

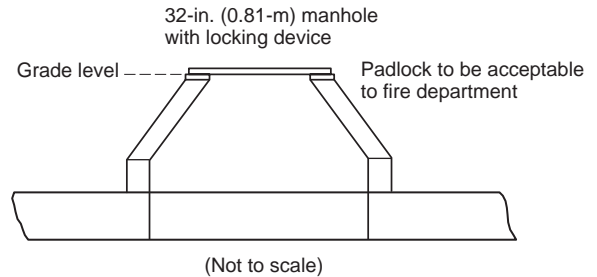


Figure B.4.6(e) Detail C — manhole.

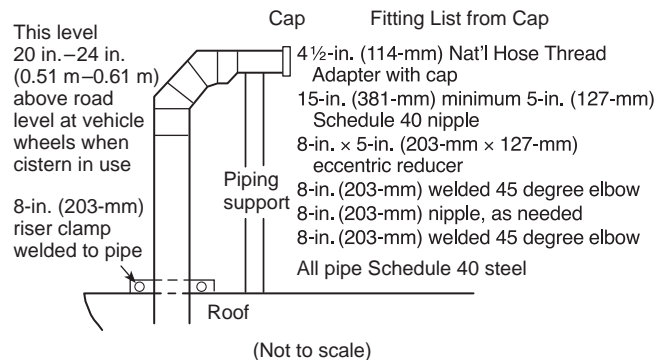


Figure B.4.6(f) Detail D — upper suction pipe.

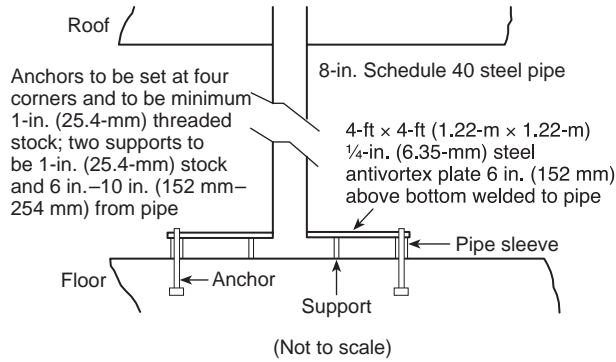


Figure B.4.6(g) Detail E — lower suction pipe.

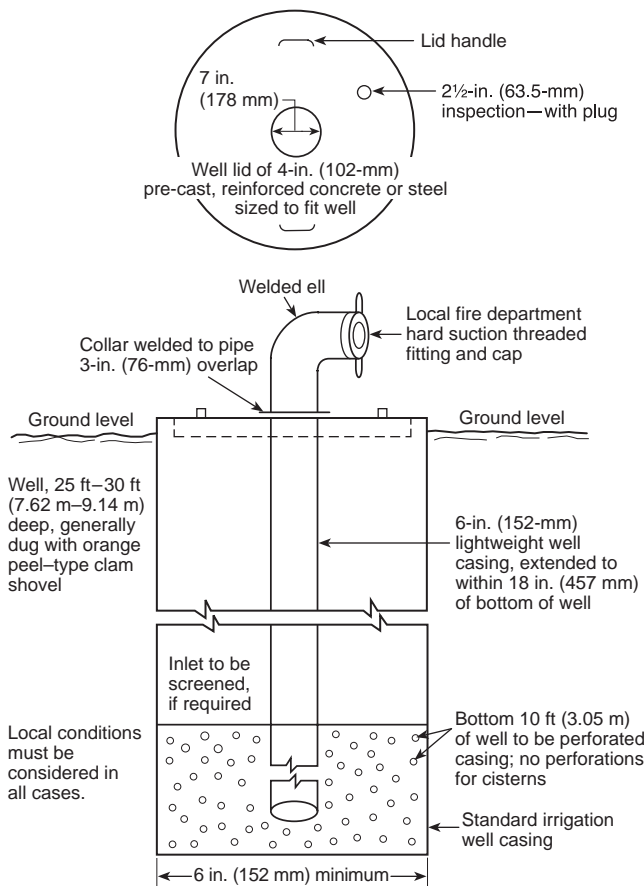


Figure B.4.6(h) Typical well (cistern) with dry hydrant installed. Same design suitable for cistern if bottom of casing is not perforated. For usable water depth, see B.4.7 warning.

**B.4.7 Guide to Circular Cistern Capacity.** A ready guide to the capacity of cisterns with vertical sides is provided in Table B.4.7.

Inside Diameter in Feet	Storage Capacity per Foot of Depth
6 (1.8 m)	212 gal (802 L)
7 (2.1 m)	288 gal (1090 L)
8 (2.4 m)	376 gal (1423 L)
9 (2.7 m)	476 gal (1801 L)
10 (3.0 m)	588 gal (2226 L)

For SI units: 1 ft<sup>3</sup> = 7.48 gal of water; 1 ft<sup>3</sup> = 0.02832 m<sup>3</sup>.  
A formula for calculating the storage capacity of a rectangular cistern is the same as the formula for pool capacity. (See B.4.8.2.)

**WARNING:** Reference is made to water depths in cisterns, swimming pools, streams, lakes, and other sources in a number of places in this annex. It should always be remembered that the depth with which the fire fighter is concerned is the usable depth. In a cistern, a bottom bed of gravel protecting a dry hydrant inlet, for instance, reduces the usable depth of the area above the gravel.

**B.4.8 Swimming Pools.** Swimming pools are an increasingly common source of water for fire protection. Even in some areas with normally adequate hydrant water supplies, they have been a factor in providing protection, such as in cases in which water demands have exceeded availability because of wildfire disasters, etc. They provide an advantage in that they are sources of clean water, but have major drawbacks due to the weight of fire department vehicles and poor accessibility for large apparatus. There are some areas of the country in which swimming pool distribution is better than hydrant distribution. If the WSO intends to use a swimming pool as a supply of water, it is a good practice to develop these water sources through working with property owners and preplanning.

**B.4.8.1 Pool Accessibility.** If fire department accessibility is considered with the design of the pool, a usable water supply should be available to the fire department for supplying direct hose lines or a source of water for mobile water supply filling. Most swimming pools are built in areas requiring security fencing or walls, and these can complicate accessibility. Fences and walls can be designed for fire department use or, depending on construction, can be entered forcibly. In most cases, a solution to the problems of accessibility can be achieved through preplanning and might call for long lengths of suction hose, portable pumps, dry hydrants, siphon ejectors, or properly spaced gates. Portable (or floating) pumps designed for large volume delivery at limited pressures deliver water to portable folding tanks or fire department pumpers and are frequently ideal where accessibility problems exist. (See E.1.2.6.)

A swimming pool located virtually under the eaves of a burning house can be a very poor location from which to pump if there are problems of fire exposure to the work area, etc. Pumping from a neighboring pool, if it is close enough, or setting the water-hauling program in motion is frequently preferable to pumping from the pool of the burning house. (See Figure B.4.8.1.)



Figure B.4.8.1 Pool accessibility. Where plans are made before a fire, it might not take elaborate preparation to use a swimming pool as a water supply.

**B.4.8.2 Pool Capacity.** A short-form method of estimating pool capacity is:

$$L \times W \times D \times 7.5 \text{ gal (1000 L)} = \text{estimated capacity in gallons (liters).}$$

where:

L = length in feet (m).

W = width in feet (m).

D = estimated average depth in feet, from water line in feet (m).

NOTE: These dimensions should be estimated or rounded off if pool is of stylized construction. 1 ft<sup>3</sup> water = 7.5 gal (1 m<sup>3</sup> = 1000 L)

Consideration should be given for providing more suction hose on fire apparatus responding in areas dependent on swimming pools. Fast rigging of such suction hose demands special training. Using long lengths of hose over walls and other obstacles typical of swimming pools demands techniques other than those used for drafting from ponds or streams. Adequate pre-fire planning requires knowledge of individual pools so that the method of obtaining water at the property is known. Lightweight or flexible-type suction hose can be advantageous for this purpose.

**B.4.8.3 Care in Use of Pools.** Care must be exercised to be sure structural damage will not be done to a pool and the surrounding area if the water is used for fire fighting. Lightly built cement, Gunite®, or poured concrete pools can present danger of structural damage, cracking, or collapse when drained. There is a further possibility that a pool in extremely wet soil will tend to float upwards when drained; therefore, it may be necessary to refill the pool as soon as the fire is under control and mobile water supply apparatus can be released from fire duties.

Some pools are compacted earth covered by a plastic surfacing or light-gauge metal panels placed against such earth or a special fill. Such pools can collapse internally if emptied. It might be possible to use a limited portion of such water sources but not possible to use the entire depth apparently available. It might be prudent not to use these pools at all.

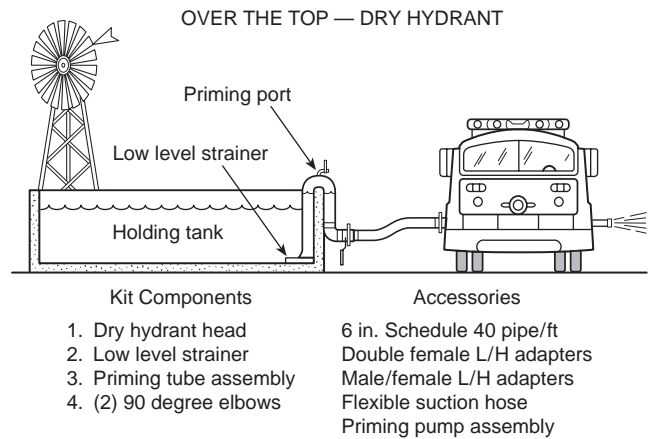
Another consideration is whether the ground surrounding a pool will support the weight of a fire department vehicle without collapsing. The WSO should study and know the various pool limitations within the area served by consulting with the builders and installers of these pools.

**B.4.9 Livestock Watering Ponds and Tanks.** Many farms have livestock water tanks and other similar facilities. If the owner is aware of the water needs for the farm's buildings for fire fighting purposes, such tanks and ponds should be so sized as to be adequate in volume for both farm and fire department use and so located as to be readily available to the fire department. Tanks should be placed on the edge of the barnyard and on a side accessible to the fire department, with the pumper or pump taking suction through a connection on the tank or by suction hose.

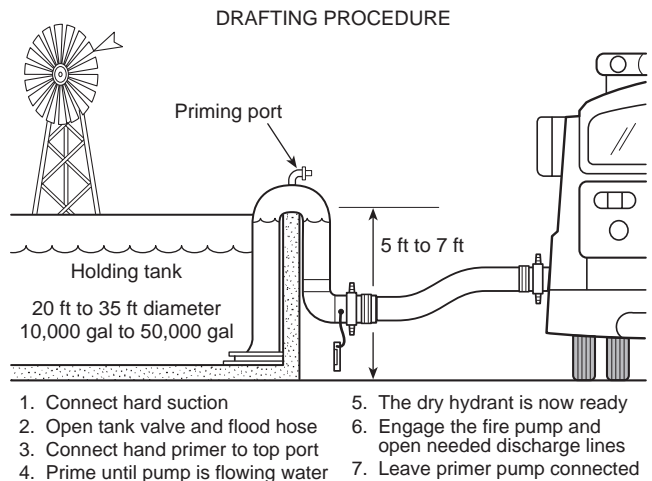
These watering tanks and ponds are often filled and maintained full by a pump operated by a windmill or by an electric pump. Figures B.9.4(a) and (b) illustrate the components of a dry hydrant system for holding tanks and procedures for successfully using them as water sources.

Where a well fitted with an electric pump is used for irrigation or industrial use, the fuses can be pulled for periods of time when the farmer or plant does not need the water supply. Therefore, the fire department should carry fuses for all of the pumps in the district, and provisions should be made for an electrician or a power company employee or individual knowledgeable of pumps to respond on all alarms of fire.

**B.4.10 Sprinkler Systems.** In some rural areas, the only large water supply might be storage provided for use of a sprinklered building. The supply might be from an underground water distribution system, a pond or suction tank with pumps, an elevated tank, or a combination of these. In many cases, pre-plan arrangements can be made to use the water. This is particularly true if the property owner is contacted before installation of sprinkler protection, as it might be necessary to increase the capacity of the storage or to install a hydrant that is accessible to the fire department and connected to the private yard distribution system.



**Figure B.4.9(a) Components of a dry hydrant system for farm holding tanks**



**Figure B.4.9(b) Drafting Procedure for farm holding tanks**

Extreme care should be exercised in the use of water supplies provided for sprinkler protection. A certain amount of water should be retained in these systems for minimum sprinkler protection. A careful study and pre-plan should be made to determine such use.

Some states and municipalities might have special ordinances requiring sprinkler protection for certain properties such as nursing homes. Frequently, the water supplies for these systems are minimal and are from pressure tanks of limited capacity. Where this is the case, it is suggested that the fire department not consider such supplies in their planning, as the rural fire department should take care that it does not disrupt the protection at such a property. (See Annex F for additional information on sprinkler systems.)

**B.4.11 Driven Wells.** Wells and well systems are becoming increasingly popular as water supplies for fire fighting purposes at industrial properties, shopping centers, subdivisions, and farm houses located in rural areas beyond the reach of a municipal water distribution system.

In areas with suitable soil conditions, for instance, those of a very sandy nature, it might be possible to use driven wells or water jetted wells to obtain water for fire fighting. These wells are, in essence, pipes, usually with perforations about the base to permit entry of water, driven into the ground. From the threaded pipe head (or a fitting attached to the body of the pipe) a pump connection can be made to draft water much as from a well hydrant. A high water table is a prerequisite to using this method. Fire fighting units in areas conducive to this technique should have the necessary equipment for such installations.

Some states and local governments have regulations or licensing requirements in order to construct a well. Such restriction will probably increase in the future.

**B.5 Dry hydrants.**

**B.5.1 General.** As the installation of rural dry hydrants using constructed or natural water sources increases, an understanding of the planning, permitting, design criteria, and construction processes becomes evident. A strategically placed rural dry hydrant system, with all-weather road access, significantly reduces water point set-up time and turnaround time to the fireground, improves the life safety of the fire fighter, and can reduce insurance costs. [See Figure B.5.1(a).]



**Figure B.5.1(a) Dry hydrant.**

**B.5.5 Pressurized Dry hydrant Sources.** There can be two types of pressurized dry hydrants—those flowing through a dam (or dike) and those coming from an uphill water source emptying at a point downhill from the source. Although the water source uphill can be of extreme advantage when flowed to a downhill source, a major disadvantage could lie in the burying of the pipe below the frost level. For a pressure hydrant, the pipe should be sloped downhill to the hydrant riser and be fitted with a gate valve. Where the supply line passes through the dike of a pond, anti-seep collars should be attached to the pipe to prevent water from seeping and channeling beside the pipe.

**B.5.6 Variations in Dry hydrant Design.** There are numerous adaptations to the basic design of a dry hydrant. These have been developed to overcome local or regional problems and can have applications over a large geographical area. [See Figures B.5.6(a) and (b).]

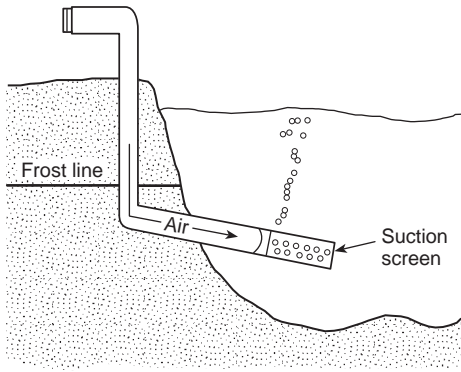


**Figure B.5.6(a) A dry hydrant innovation has eliminated the top 90-degree or 45-degree elbow on each hydrant. (Photo by Nahunta Volunteer Fire Department, NC)**



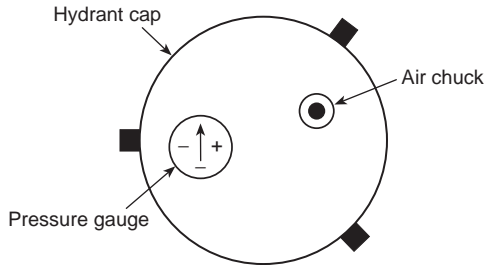
**Figure B.5.6(b) Hard suction hose is connected to the pumper. The driver maneuvers the truck as the fire fighter walks the suction end of the hose to the dry hydrant. An -O ring in the plastic -L provides a right fit and allows the operator to draft. This is a quick and simple method to connect the pumper to a dry hydrant. It is critical that a good seal be obtained with the -O ring to prevent any air leakage, or the pump will fail to prime.**

Dry hydrants can be installed in areas where the frost line would freeze the water in the hydrant pipe. This system was designed to inject air into the hydrant and displace the water to prevent freezing. With the water displaced below the frost line, the hydrant would be usable year-round for drafting purposes. Air is injected into the hydrant until it bubbles out of the suction screen, or the air pressure gauge no longer rises. This low-pressure air should not cause a safety problem, but all personnel should be advised to remove the hydrant cap slowly to prevent any possible injury. The air gauge should be checked periodically to be sure the water remains displaced in the hydrant. [See Figure B.5.6(c).]

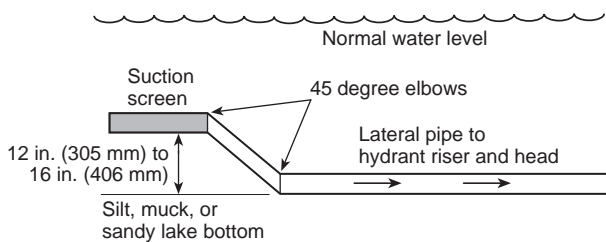


**Figure B.5.6(c) Air injection frost-proofing system (developed by Wascott Volunteer Fire Department, WI).**

Install an air pressure gauge and air chuck in the cap of the hydrant by drilling and tapping into the metal. The chain for the hydrant cap will have to be removed. Use Teflon® tape on the threads of the gauge and chuck. This method has the advantage that if the chuck or gauge is damaged, it will not effect the airtight integrity of the hydrant while drafting, because the cap is removed. [See Figure B.5.6(d).]



**Figure B.5.6(d) Cap design for air injection system.**



**Figure B.5.6(e) Offset screen installation (developed by Weyerhaeuser Volunteer Fire Department, WI).**

**B.6.3 Dry hydrant with Suction Line.** In some cases, it may be desirable to install a dry hydrant with a suction line in lieu of an access road. This can be true in marsh or swamp areas. In this case, the fire department will have access to the hydrant from the shoulder of the main road. So as not to block the road during pumper operations, a suitable parking area on the shoulder of the road should be provided. Basic recommendations in Table A.9.4.6 can be useful in the design of such an area so that pumpers can be used efficiently and safely.

**B.8 Preplanning Water Supply.**

**B.8.1 Preplanning.** Structures within the district of responsibility of the fire department should be surveyed in accordance with Chapter 2. The water requirement should be calculated, and the type and amount of equipment that should respond on first alarm should be designated. The response of fire apparatus, in conjunction with capacity of mobile water supply apparatus, travel distance to haul water, and the volume of water supply, can then be arranged so that a constant flow to equal the water flow requirements is obtained. The procedure should be verified under training conditions prior to a fire emergency. This training exercise should include the spotting of equipment to protect the fire property and the exposures, exploration of the water sources, designation of fire lanes or routes, and review and modification of the operations to meet unusual conditions.

Aircraft and aerial photographs can be very helpful in the survey of static water availability. Such photographs are usually available from the county agriculture department or the county office of planning and zoning. Topographical maps from the United States Geological Survey also can be of value in this survey. However, the value should be determined by the date that the map was made or revised, since an out-of-date map can prove to be of little value. Once sites are located, they need to be prepared for use according to the recommendations of this section.

**SUBSTANTIATION:** The committee, in taking out much of the dry hydrant information for placement into the main text, revised Appendix A and added a number of illustrations. The Committee also reviewed and modified several of the tables to more directly assist in the design of dry hydrant systems.

**COMMITTEE ACTION:** Accept.

**NUMBER OF COMMITTEE MEMBERS ELIGIBLE TO VOTE:** 28

**VOTE ON COMMITTEE ACTION:**

**AFFIRMATIVE:** 28