

## Subpart P App D - Aluminum Hydraulic Shoring for Trenches

1. **Scope.** This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with § [1926.652\(c\)\(2\)](#).
2. **Soil Classification.** In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.
3. **Presentation of Information.** Information is presented in several forms as follows:
  1. Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and E-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D1.4 are for horizontal waler systems in Types B and C soil.
  2. Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.
  3. Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.
  4. Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.
  5. Miscellaneous notations (footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.
  6. Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring; Typical Installations."
4. **Basis and limitations of the data.**
  1. Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.
  2. Hydraulic cylinders specifications.

1. 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.
  2. 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.
3. Limitation of application.
1. It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in § [1926.652\(c\)](#).
  2. When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with § [1926.652](#).
    1. When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.
    2. When surcharge loads are present from equipment weighing in excess of 20,000 pounds.
    3. When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.
5. **Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.** The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in

accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

**6. Example to Illustrate the Use of the Tables:**

1. Example 1:

A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

2. Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

3. A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The trench is 16 feet deep and 9 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #B2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per footnote (g)(7) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

4. Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3 × 12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

5. Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0

section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3 × 12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

**7. Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4.**

1. For applications other than those listed in the tables, refer to § [1926.652\(c\)\(2\)](#) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to § [1926.652\(c\)\(2\)](#) and § [1926.652\(c\)\(3\)](#).
2. 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5 × 3.5 × 0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.
3. Hydraulic cylinders capacities.
  1. 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product
  2. 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.
4. All spacing indicated is measured center to center.
5. Vertical shoring rails shall have a minimum section modulus of 0.40 inch.
6. When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.
7. Plywood shall be 1.125 in. thick softwood or 0.75 inch. thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.
8. See appendix C for timber specifications.
9. Wales are calculated for simple span conditions.
10. See appendix D, item (d), for basis and limitations of the data.

**ALUMINUM HYDRAULIC SHORING  
TYPICAL INSTALLATIONS**

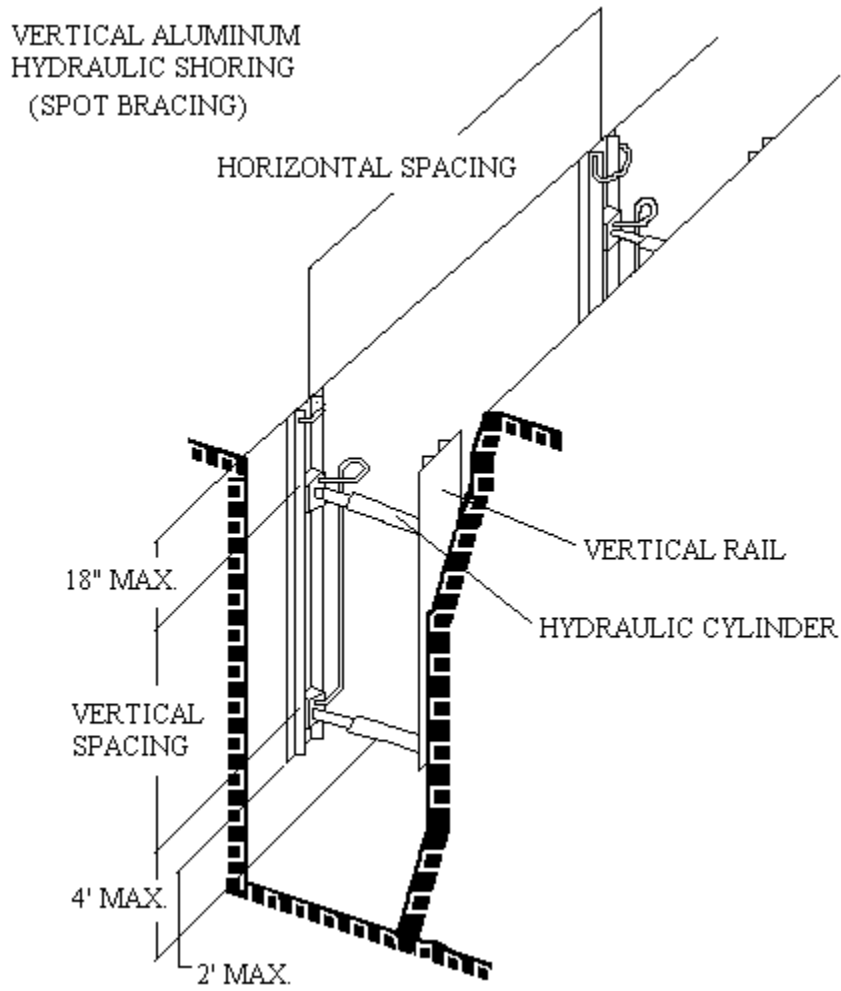


Figure No. 1 - Vertical aluminum hydraulic shoring (spot bracing)

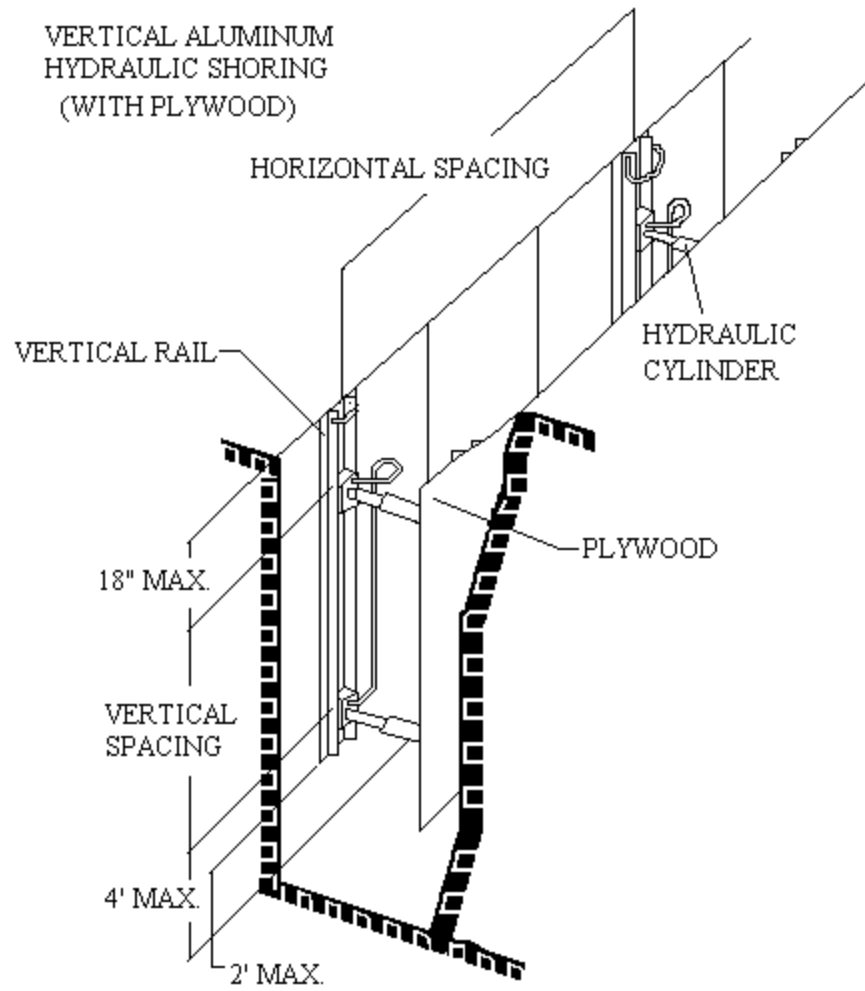


Figure No. 2 - Vertical aluminum hydraulic shoring (with plywood)

VERTICAL ALUMINUM  
HYDRAULIC SHORING  
(STACKED)

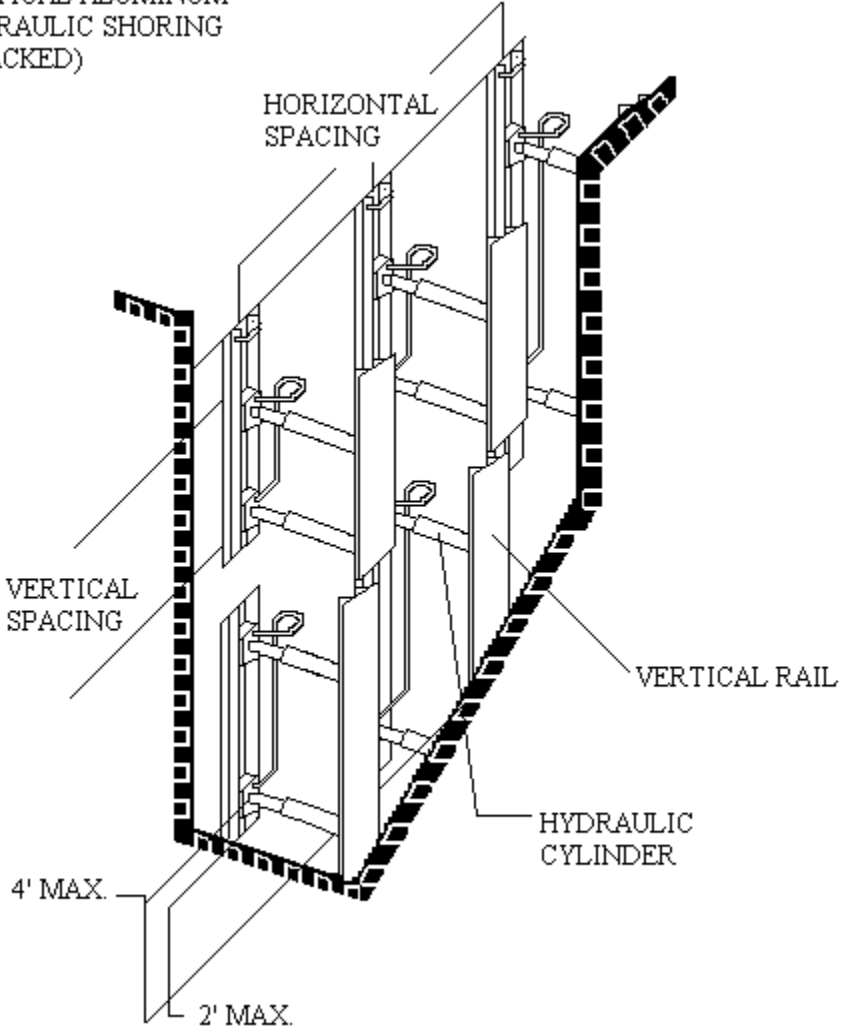


Figure No. 3 - Vertical aluminum hydraulic shoring (stacked)

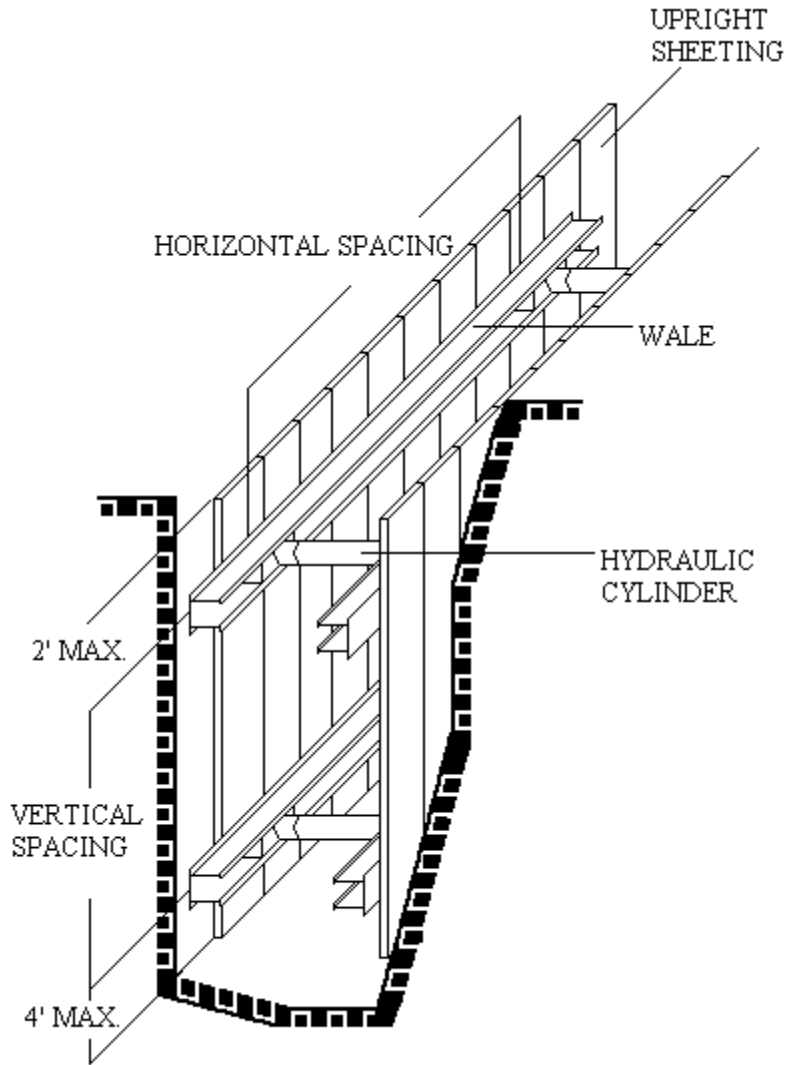


Figure No. 4 - Aluminum hydraulic shoring - Waler System (typical)

TABLE D - 1.1 ALUMINUM HYDRAULIC SHORING VERTICAL SHORES FOR SOIL TYPE A					
DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15



OVER 5 UPTO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE(2)	3 INCH DIAMETER
OVER 10 UPTO 15	8				
OVER 15 UPTO 20	7				
OVER 20	NOTE(1)				

**Footnotes** to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note(1): See Appendix D, Item (g)(1)

Note(2): See Appendix D, Item (g)(2)

<b>TABLE D - 1.2 ALUMINUM HYDRAULIC SHORING VERTICAL SHORES FOR SOIL TYPE B</b>					
<b>DEPTH OF TRENCH (FEET)</b>	<b>HYDRAULIC CYLINDERS</b>				
	<b>MAXIMUM HORIZONTAL SPACING (FEET)</b>	<b>MAXIMUM VERTICAL SPACING (FEET)</b>	<b>WIDTH OF TRENCH (FEET)</b>		
			<b>UP TO 8</b>	<b>OVER 8 UP TO 12</b>	<b>OVER 12 UP TO 15</b>
OVER 5 UPTO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE(2)	3 INCH DIAMETER
OVER 10 UPTO 15	6.5				
OVER 15	5.5				

UPTO 20					
OVER 20	NOTE(1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note(1): See Appendix D, Item (g)(1)

Note(2): See Appendix D, Item (g)(2)

<b>TABLE D - 1.3</b> <b>ALUMINUM HYDRAULIC SHORING</b> <b>WALER SYSTEMS</b> <b>FOR SOIL TYPE B</b>						
<b>DEPTH OF TRENCH</b> <b>(FEET)</b>	<b>WALES</b>		<b>HYDRAULIC CYLINDERS</b>			
	<b>VERTICAL</b> <b>SPACING</b> <b>(FEET)</b>	<b>*</b> <b>SECTION MODULUS</b> <b>(IN(3))</b>	<b>WIDTH OF TRENCH (FEET)</b>			
			<b>UP TO 8</b>		<b>OVER 8 UP TO 12</b>	
			<b>HORIZ</b> <b>SPACING</b>	<b>CYLINDER</b> <b>DIAMETER</b>	<b>HORIZ</b> <b>SPACING</b>	<b>CYLINDER</b> <b>DIAMETER</b>
OVER  5  UP TO  10	4	3.5	8.0	2 IN	8.0	2 IN NOTE (2)
		7.0	9.0	2 IN	9.0	2 IN NOTE (2)
		14.0	12.0	3 IN	12.0	3 IN
OVER  10  UP TO  15	4	3.5	6.0	2 IN	6.0	2 IN NOTE (2)
		7.0	8.0	3 IN	8.0	3 IN
		14.0	10.0	3 IN	10.0	3 IN
OVER  15  UP TO	4	3.5	5.5	2 IN	5.5	2 IN NOTE (2)
		7.0	6.0	3 IN	6.0	3 IN
		14.0	9.0	3 IN	9.0	3 IN

20						
OVER 20	NOTE (1)					

**TABLE D - 1.3  
ALUMINUM HYDRAULIC SHORING  
WALER SYSTEMS  
FOR SOIL TYPE B**

[Continued]

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS		TIMBER UPRIGHTS		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN(3))	WIDTH OF TRENCH (FEET)		MAX. HORIZ SPACING (ON CENTER)		
			OVER 12 UP TO 15		SOLID SHEET	2 FT	3 FT
			HORIZ SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	3 IN	3x12		
		7.0	9.0	3 IN			
		14.0	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	3 IN	3x12		
		7.0	8.0	3 IN			
		14.0	10.0	3 IN			
OVER 15	4	3.5	5.5	3 IN	3x12		
		7.0	6.0	3 IN			

UP TO 20		14.0	9.0	3 IN	
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)

Note(1): See Appendix D, Item (g)(1)

Note(2): See Appendix D, Item (g)(2)

\* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

<b>TABLE D - 1.4 ALUMINUM HYDRAULIC SHORING WALER SYSTEMS FOR SOIL TYPE C</b>						
<b>DEPTH OF TRENCH (FEET)</b>	<b>WALES</b>		<b>HYDRAULIC CYLINDERS</b>			
	<b>VERTICAL SPACING (FEET)</b>	<b>* SECTION MODULUS (IN(3))</b>	<b>WIDTH OF TRENCH (FEET)</b>			
			<b>UP TO 8</b>		<b>OVER 8 UP TO 12</b>	
			<b>HORIZ SPACING</b>	<b>CYLINDER DIAMETER</b>	<b>HORIZ SPACING</b>	<b>CYLINDER DIAMETER</b>
OVER 5 UP TO 10	4	3.5	6.0	2 IN	6.0	2 IN NOTE (2)
		7.0	6.5	2 IN	6.5	2 IN NOTE (2)
		14.0	10.0	3 IN	10.0	3 IN
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE (2)
		7.0	5.5	3 IN	5.5	3 IN
		14.0	8.0	3 IN	8.0	3 IN
OVER	4	3.5	3.5	2 IN	3.5	2 IN NOTE (2)

15		7.0	5.0	3 IN	5.0	3 IN
UP TO 20		14.0	6.0	3 IN	6.0	3 IN
OVER 20	NOTE (1)					

<b>TABLE D - 1.4</b> <b>ALUMINUM HYDRAULIC SHORING</b> <b>WALER SYSTEMS</b> <b>FOR SOIL TYPE C</b>  <b>[Continued]</b>							
DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS		TIMBER UPRIGHTS		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN <sup>3</sup> )	WIDTH OF TRENCH (FEET)		MAX. HORIZ SPACING (ON CENTER)		
			OVER 12 UP TO 15		SOLID SHEET	2 FT	3 FT
			HORIZ SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	6.0	3 IN	3x12		
		7.0	6.5	3 IN			
		14.0	10.0	3 IN			
OVER 10 UP TO 15	4	3.5	4.0	3 IN	3x12		
		7.0	5.5	3 IN			
		14.0	8.0	3 IN			
	4	3.5	3.5	3 IN	3x12		

OVER 15 UP TO 20		7.0	5.0	3 IN	
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g) Note(1):  
 See Appendix D, Item (g)(1) Note(2): See Appendix D, Item (g)(2) \* Consult product manufacturer and/or  
 qualified engineer for Section Modulus of available wales.