

WAC 296-155-66407 Appendix 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 WAC 296-155-657 (3) (b).

(2) **Soil Classification.** In order to use data presented in this appendix, you must first determine the soil type or types in which the excavation is made using the soil classification method set forth in appendix A of this Part.

(3) **Presentation of information.** Information is presented in several forms as follows:

(a) Information is presented in tabular form in Tables N-8 through N-11. 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 N-8 and N-9 are for vertical shores in Types A and B soil. Tables N-10 and N-11 are for horizontal waler systems in Types B and C soil.

(b) Information concerning the basis of the tabular data and the limitations of the data is presented in subsection (4) of this appendix.

(c) Information explaining the use of the tabular data is presented in subsection (5) of this appendix.

(d) Information illustrating the use of the tabular data is presented in subsection (6) of this appendix.

(e) Miscellaneous notations (footnotes) regarding Table N-8 through N-11 are presented in subsection (7) of this appendix.

(f) 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.**

(a) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in Tables N-8 through N-10. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(b) Hydraulic cylinders specifications.

(i) Two-inch cylinders must be a minimum two-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.

(ii) 3-inch cylinders must 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.

(c) Limitation of application.

(i) 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 WAC 296-155-657(3).

(ii) 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 WAC 296-155-657.

(A) 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.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The slope portion is sloped at an angle less steep than 3 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 N-8 through N-11.** 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 N-8 and N-9 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 N-10 and N-11. The soil type must first be determined in accordance with the soil classification system described in appendix A of this Part. 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 4 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:**

(a) Example 1: A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table N-8: Find vertical shores and two inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures N-23 & N-25 for typical installations.)

(b) Example 2: A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table N-9: Find vertical shores and two inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures N-23 & N-25 for typical installations.)

(c) 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 N-9: Find vertical shores and two inch diameter cylinder (with special oversleeves as designated by subdivision (7)(b)) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per subdivision (7)(g) to the N-8 through N-11 Tables) should be used behind the shores. (See Figures N-24 & N-25 for typical installations.)

(d) 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 N-10: 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, 3x12 timber sheeting is required at close spacing vertically. (See Figure N-26 for typical installation.)

(e) 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 N-11: Find horizontal wale with a section modulus of 7.0 and two 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. 3x12 timber sheeting is required at close spacing vertically. (See Figure N-26 for typical installation.)

(7) **Footnotes, and general notes, for Tables N-8 through N-11.**

(a) For applications other than those listed in the tables, refer to WAC 296-155-657 (3)(b) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to WAC 296-155-657 (3)(b) and (c).

(b) Two-inch diameter cylinders, at this width, must have structural steel tube (3.5x3.5x0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(c) Hydraulic cylinders capacities.

(i) Two-inch cylinders must be a minimum two-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 manufacturer.

(ii) 3-inch cylinders must 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.

(d) All spacing indicated is measured center to center.

(e) Vertical shoring rails must have a minimum section modulus of 0.40 inch.

(f) When vertical shores are used, there must be a minimum of 3 shores spaced equally, horizontally, in a group.

(g) Plywood must 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.

(h) See appendix C for timber specifications.

(i) Wales are calculated for simple span conditions.

(j) See subsection (4) of this appendix, for basis and limitations of the data.

**ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS**

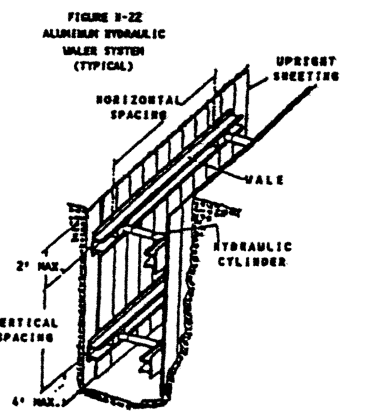
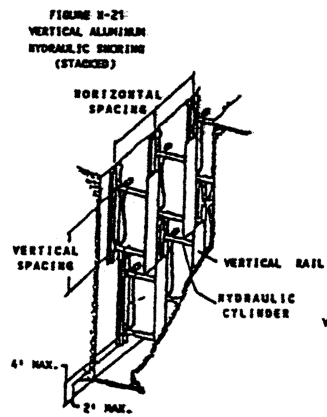
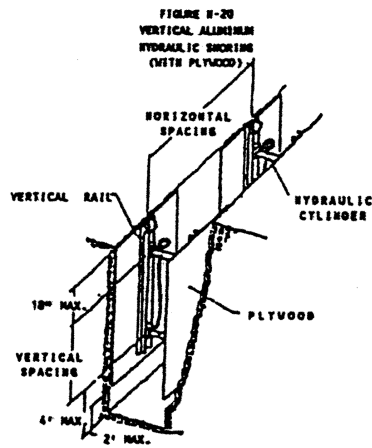
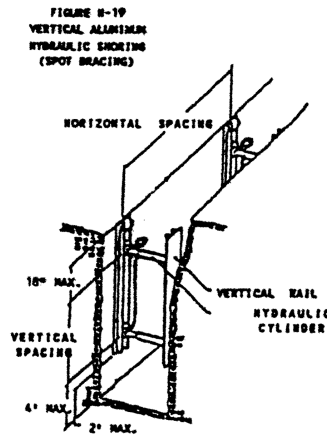


TABLE N-8
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

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 4 Up to 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
Over 10 Up to 15	8				
Over 15 Up to 20	7				
Over 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, WAC 296-155-66407(7)

Note (1): See Appendix D, WAC 296-155-66407 (7)(a)

Note (2): See Appendix D, WAC 296-155-66407 (7)(b)

TABLE N-9
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE B

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 4 Up to 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
Over 10 Up to 15	6.5				
Over 15 Up to 20	5.5				
Over 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, WAC 296-155-66407(7)

Note (1): See Appendix D, WAC 296-155-66407 (7)(a)

Note (2): See Appendix D, WAC 296-155-66407 (7)(b)

TABLE N-10
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE B

Depth of Trench (Feet)	Males		Hydraulic Cylinders						Timber Uprights		
	Vertical Spacing (Feet)	Section* Modulus (In ³)	Width of Trench (Feet)						Max. Horizontal Spacing (on Center)		
			Up to 8		Over 8 Up to 12		Over 12 Up to 15		Solid Sheet	2 Feet	3 Feet
			Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter			
Over 4 Up to 10	4	3.5	8.0	2 IN	8.0	2 IN Note (2)	8.0	3 IN	—	—	3 X 12
		7.0	9.0	2 IN	9.0	2 IN Note (2)	9.0	3 IN			
		14.0	12.0	3 IN	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)	6.0	3 IN	—	3 X 12	—
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
Over 15 Up to 20	4	3.5	5.5	2 IN	5.5	2 IN Note (2)	5.5	3 IN	3 X 12	—	—
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
Over 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, WAC 296-155-66407(7)

Note (1): See Appendix D, WAC 296-155-66407 (7)(a)

Note (2): See Appendix D, WAC 296-155-66407 (7)(b)

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

TABLE N-11
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

Depth of Trench (Feet)	Wales		Hydraulic Cylinders						Timber Uprights		
	Vertical Spacing (Feet)	Section ^a Modulus (In ⁴)	Width of Trench (Feet):						Max. Horizontal Spacing (on Center)		
			Up to 8		Over 8 Up to 12		Over 12 Up to 15		Solid Sheet	2 Feet	3 Feet
Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter	Horiz. Spacing	Cylinder Diameter				
Over 4 Up to 10	4	3.5	6.0	2 IN	6.0	2 IN <small>Note (2)</small>	6.0	3 IN	3 X 12	—	—
		7.0	6.5	2 IN	6.5	2 IN <small>Note (2)</small>	6.5	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
Over 10 Up to 15	4	3.5	4.0	2 IN	4.0	2 IN <small>Note (2)</small>	4.0	3 IN	3 X 12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN			
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
Over 15 Up to 20	4	3.5	3.5	2 IN	3.5	2 IN <small>Note (2)</small>	3.5	3 IN	3 X 12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN			
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
Over 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, WAC 296-155-66407(7)

Note (1): See Appendix D, WAC 296-155-66407 (7)(a)

Note (2): See Appendix D, WAC 296-155-66407 (7)(b)

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

[Statutory Authority: RCW 49.17.010, 49.17.040, 49.17.050, 49.17.060. WSR 16-09-085, § 296-155-66407, filed 4/19/16, effective 5/20/16. Statutory Authority: Chapter 49.17 RCW and RCW 49.17.040, [49.17].050 and [49.17].060. WSR 92-22-067 (Order 92-06), § 296-155-66407, filed 10/30/92, effective 12/8/92.]