Underground Construction and Rehabilitation: Faster, easier, CHEAPER with traditional trench shields

• Bruce Britt
• Regional Sales Specialist
• **Efficiency Production**

EFFICIENCY PRODUCTION
America's Trench Box Builder™

History of Trench Shoring and Shielding

Abb 105. Das Bild veranschaulicht, mit welchen Schwierigkeiten der Einbau der Betonrohre in den moorigen Boden

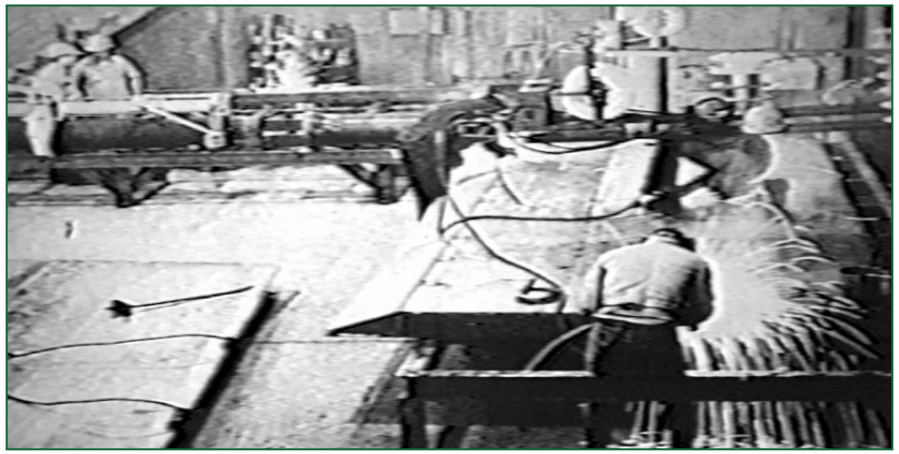
History of Trench Shoring and Shielding

- As industrial countries expanded their municipal systems the need for efficient methods of laying pipe and installing structures emerged.
- Contractors soon realized that the most cost effective method is limiting excavation & backfill.

History of Trench Shoring and Shielding

- The concept was simple – a vertical trench or excavation requires the least amount of excavation and backfill.
- The more of the trench wall that remained vertical the more efficient the method.
- **The last element was keeping the pipe layer alive…..**

Commercial Manufacture of Trench Shields



- Terry Forsberg, an underground contractor in Okemos, Michigan, decided that he should have a fleet of steel trench shields with a calculated safe depth and efficient way to change the width of the “trench box”
- The resulting design was so popular that Mr. Forsberg founded Efficiency Production, Inc. in 1971
- The modern trench shielding and shoring manufacturing industry was born

Commercial Manufacture of Trench Shields

- Availability of engineered production equipment capable of being used in a variety of soil conditions quickly transformed contractor's operations in US & Canada.
- Underground equipment dealers started stocking fleets of rental equipment making options cheap and readily available.

Trench Protective Systems

- **SLOPING** - Excavating the sides of the trench at an appropriate angle
- **SHORING** - Supporting the sides of the excavation
- **SHIELDING** - Placing a shield between the side of the excavation and the worker

OSHA requires that all excavations in which employees could potentially be exposed to cave-ins be protected by:

Sloping, **Shoring**, or **Shielding**

OPTION 1: SLOPING

Sloping involves removing overburden on an angle of repose that keeps banks stable.

OPTION 2: SHORING

- The function of trench shoring is to resist or replace the force of the soil on the excavation face
- The shoring of a trench can be accomplished with the use hydraulics, pneumatics, timber, and mechanical screw jacks

OPTION 3: SHIELDING

Trench Shield General Description

- A trench shield is a movable box strong enough to protect the employee inside, but light enough to handle easily in the trench
- Ideally, the width of a trench is approximately 4 in. wider than the width of the trench shield to reduce possible friction during movement. Thus, the trench shield cannot effectively prevent soil cave-ins outside the box
- The application depth in the trench or design pressure shall be clearly marked on the shield

Advantages of Shielding

- Narrows trench safely
- Cost of equipment off-set by lower excavation and restoration costs
- Manufactured system with proven safety record
- Provides on-site safety personnel with quick reference tabulated data

Disadvantages of Shielding

- Can be difficult to deal with crossing utilities
- Assembles into one complete item. This requires a large machine to handle if shield is long or ground is unstable
- Fixed width and length requiring several sizes for different applications

Manufacturer's Tabulated Data

- All manufactured shielding and shoring equipment shall be supplied with tabulated data indicating the proper use and limitations of the equipment
- This data shall be used for the design of the protected area and should be available on site if requested by OSHA
- Manufactured systems shall be used within the limits of this tabulated data

Manufacturer

Model # of Shield

Option & Lifting Information

Limitations

Certified by Engineer

Serial # of Shield

Soil Types

Max. Depths

Soil Descriptions

Placement Diagram

EFFICIENCY America's Trench Box Builder
605 HULL ROAD, MASON, MI 48854 PHONE (517) 676-0800

SERIAL NUMBER
SAMPLE

STEEL TRENCH SHIELD

MODEL: HT6-824	4-PIPE "I"	MAX SPREADER LENGTH	20 FEET
KNIFE-EDGE YES	FOAM FILLER YES	COLLAR TYPE	7" O.D. x 3/4" WALL with 2" PIN HOLES
DATE OF MANUFACTURE Sep-14	LIFT-LUG RATING 8,100 LBS	WEIGHT AS MANUFACTURED	12,185 LBS

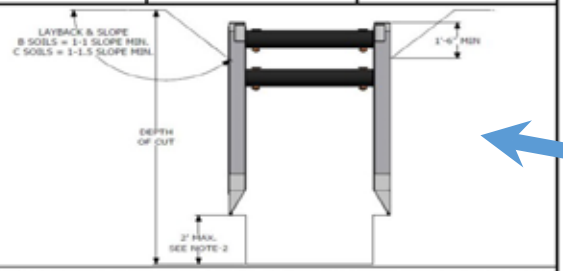
...OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION RULES AND REGULATIONS, 29 CFR, NO 209, PART 1926, SUBPART P

SHIELD SIZE		PSF RATING	EXAMPLES OF MAXIMUM ALLOWABLE DEPTH OF CUT (FEET) IN SOIL TYPE TO BE EXCAVATED		
HEIGHT (FEET)	LENGTH (FEET)	MAXIMUM LATERAL EARTH PRESSURE CAPACITY AT TRENCH BOTTOM IN POUNDS PER SQUARE FOOT	TYPE B-45 (II) MEDIUM COHESIVE TO GRANULAR SOIL 45 PSF PER FT OF DEPTH	TYPE C-60 (III) SOFT COHESIVE TO SATURATED SOIL. 60 PSF PER FT OF DEPTH	TYPE C-80 (IV) SOFT SUBMERGED AND FLOWING SOIL. 80 PSF PER FT OF DEPTH
8	24	1140	25	19	14
			DESCRIPTION	DESCRIPTION	DESCRIPTION
			CLAY, WITH UNCONFINED COMPRESSIVE STRENGTH GREATER THAN 0.5 TSF BUT LESS THAN 1.5 TSF COHESIONLESS GRAVEL, SILT, SILT LOAM OR SANDY LOAM	SOFT COHESIVE SOIL UNCONFINED COMPRESSIVE STRENGTH GREATER THAN 0.3 TSF, BUT LESS THAN 0.5 TSF CLAY, SAND AND LOAMY SAND; SATURATED SOIL THAT IS STABLE, DRY SAND, OR DEWATERED SOILS	SOFT COHESIVE SOIL UNCONFINED COMPRESSIVE STRENGTH LESS THAN 0.3 TSF, FRACTURED ROCK THAT IS NOT STABLE, OR SUBMERGED SAND AND LOAMY SAND THAT IS FLOWING. (SEE NOTE 5)

LIMITATIONS IN USE OF TABLE

1. TRENCH SHIELD TO BE ASSEMBLED AND INSTALLED IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS. (SEE PAGE-2)
2. EXCAVATION 2 FEET BELOW BOTTOM OF SHIELD IS PERMITTED WHEN NO LOSS OF SOIL FROM BEHIND OR BELOW THE BOTTOM OF SHIELD IS ENCOUNTERED. SEE PARAGRAPH 1926.652 (e)(2)(i). THE COMPETENT PERSON SHALL MAKE THE DETERMINATION FOR COMPLIANCE. SUDDEN SHIFTING OF THE SHIELD VERTICALLY SHALL BE AVOIDED.
3. DEPTH RATING IS BASED ON TEMPORARY LOADING. CONSULT MANUFACTURER IF SHIELD IS SUBJECT TO LONG TERM LOADING
4. ADDITIONAL SHIELDS MAY BE STACKED WITH NO PENALTY IN DEPTH OF CUT AS LONG AS THE RATING OF THE EACH SHIELD IS NOT EXCEEDED AT THE DEPTH IT IS USED. MANUFACTURER APPROVED STACKING METHOD MUST BE USED.
5. C-80 DOES NOT REPRESENT THE WORST POSSIBLE SOIL CONDITION. OBTAIN SITE-SPECIFIC ENGINEERING FOR EXTREMELY NON-STABLE CONDITIONS SUCH AS MARINE CLAY, PEAT, SOFT SUBMERGED AND FLOWING CLAYS, ETC.
6. ANY MODIFICATIONS OR ALTERATIONS NOT ALLOWED UNLESS APPROVED IN WRITING BY EFFICIENCY PRODUCTION, INC.
7. CONTRACTOR'S COMPETENT/QUALIFIED PERSON SHALL BE RESPONSIBLE FOR MONITORING SOIL CONDITIONS AND SHALL BE RESPONSIBLE FOR COMPLIANCE WITH ALL FEDERAL, STATE AND LOCAL LAWS, RULES, AND REGULATIONS.
8. SPREADER PINS SHALL BE 8620 COLD DRAWN 80-90 KSI MIN. YIELD AND NO MORE THAN 1/4" SMALLER THAN COLLAR AND SPREADER PIN HOLES AS MANUFACTURED BY EFFICIENCY PRODUCTION, INC.
9. LIFT LUG RATING IS (THE SAFE WORKING LOAD) FOR EACH INDIVIDUAL LIFT LUG.
10. WEIGHT LISTED IS FOR SHIELD ONLY. USE ASSEMBLED WEIGHT INCLUDING SPREADERS FOR RIGGING PURPOSES

CONTINUED ON REVERSE SIDE



MANUFACTURED UNDER ONE OR MORE OF THE FOLLOWING U.S. PATENT NUMBERS: 4,090,365-4,114,383-4,250,028 ONE OR MORE OF THE FOLLOWING CANADIAN PATENT NUMBERS: 1,062,683-1,062,684

CERTIFIED BY: EFFICIENCY PRODUCTION INC.

STATE OF MICHIGAN
ALEXANDRE NEDELTCHEV
ENGINEER
No. 6201062055
LICENSED PROFESSIONAL ENGINEER

9/16/2014

WARNING: Any use of this product not specifically described on this certificate could cause cave-in, collapse, or structural failure, and may result in injury, or death

Limitations Continued

Assembly Instructions

Use in Stable Soil

Use in Unstable Soil

Special Uses

EFFICIENCY PRODUCTION MASON, MI 48854 PH (800) 552-8800 PAGE 2 OF 2

- NOT TYPE A IF FISSURED, SUBJECT TO VIBRATION, PREVIOUSLY DISTURBED OR PART OF A SLOPED LAYERED SYSTEM WHERE LAYERS DIP INTO EXCAVATION ON A SLOPE OF FOUR HORIZONTAL TO ONE VERTICAL (4H:1V) OR GREATER.
- PREVIOUSLY DISTURBED SOILS MAY BE TYPE B UNLESS THEY WOULD BE CLASSIFIED AS TYPE C. SOIL THAT MEETS THE REQUIREMENTS OF TYPE A, BUT IT IS SUBJECT TO VIBRATION OR FISSURED MAY BE TYPE B. DRY ROCK THAT IS NOT STABLE OR SOIL THAT IS PART OF A SLOPED, LAYERED SYSTEM WHERE LAYERS DIP INTO THE EXCAVATION ON A SLOPE LESS STEEP THAN FOUR HORIZONTAL TO ONE VERTICAL (4H: 1V) ARE TYPE B BUT ONLY IF MATERIAL WOULD OTHERWISE BE CLASSIFIED AS TYPE B.
- SOIL IN A SLOPED LAYERED SYSTEM WHERE LAYERS DIP INTO THE EXCAVATION ON A SLOPE OF FOUR HORIZONTAL TO ONE VERTICAL (4H:1V) OR STEEPER MAY BE TYPE C. SUBMERGED SOIL IS MATERIAL WITH WATER FREELY SEEPING AND ENTERING THE TRENCH, BUT ONLY PART OF THE DEPTH OF THE RETAINED SOIL IS SUBMERGED. CONDITIONS MORE SEVERE WOULD REQUIRE DEWATERING OR SEALING FOUR SIDES OF THE EXCAVATION AND PUMPING THE TRENCH. SUCH SEVERE CONDITIONS WOULD REQUIRE THE SERVICES OF A SOILS ENGINEER TO ESTABLISH THE DESIGN PRESSURE. CONSULT THE MANUFACTURER FOR PRESSURES EXCEEDING TABULATED VALUES.
- ANY SOIL THAT WILL STAND UNSUPPORTED LONG ENOUGH TO INSTALL TRENCH SHIELD MAY BE CLASSIFIED AS C-60
- ANY USE OF A TRENCH SHIELD WITHOUT EFFICIENCY SPREADERS AND PINS OR EQUAL WILL VOID THE TABULATED DATA AND WARRANTY.
- SHIELD WAS DESIGNED TO BE USED WITHOUT PLATES EXTENDING BELOW, ABOVE, OR NEXT TO IT. ANY USE OF SUCH PLATES OR PANELS MAY VOID THE TABULATED DATA AND MAY REQUIRE SITE SPECIFIC ENGINEERING.
- TRENCH SHIELDS ARE DESIGNED TO BE PUSHED TO GRADE IF NECESSARY. AS NOTED BELOW, ANY UNNECESSARY ABUSE BY THE EXCAVATOR AND OR OPERATOR (SUCH AS POUNDING WITH THE BUCKET) WILL VOID THE TABULATED DATA AS WELL AS THE WARRANTY.
- CONDITION OF SHIELD, SPREADER PIPES, AND SPREADER PINS MUST BE CHECKED/ INSPECTED FOR SERVICEABILITY BY THE COMPETENT PERSON PRIOR TO EACH USE. PSF RATING IS NOT VALID IF THERE IS ANY VISIBLE DAMAGE TO, OR REPAIRS MADE TO THE SHIELD THAT HAS NOT BEEN DOCUMENTED AND CERTIFIED BY A REGISTERED PROFESSIONAL ENGINEER.
- A MINIMUM OF 2 SPREADERS, 1 ARCH, OR 1 SPREADER AND 1 MUDPLATE MUST BE INSTALLED ON EACH END OF TRENCH SHIELD PRIOR TO USE.
- DEPTH AND PSF RATING ARE FOR LATERAL EARTH PRESSURES ONLY AND DO NOT TAKE ANY SURCHARGES INTO ACCOUNT.

ASSEMBLY

MUDPLATE SPREADERS SYSTEM 5 PIPE SPREADER SYSTEM

LAY SIDE PANEL FLAT ON GROUND WITH COLLAR SOCKETS UP

PLACE SPREADER PIPE AND/OR PLATE ON TO COLLARS OR INTO BRACKETS AND PIN IN PLACE. SECURE PINS WITH KEEPERS

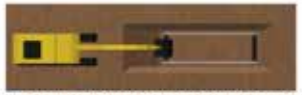
LOWER SECOND SIDEWALL ONTO SPREADERS AND PIN

STAND TRENCH SHIELD IN UPRIGHT POSITION AND PREPARE FOR INSTALLATION

USING A TRENCH SHIELD IN STABLE SOIL

EXCAVATE TO GRADE JUST SLIGHTLY WIDER THAN THE TRENCH SHIELD. DIG WALLS VERTICAL TO MINIMUM OF 18" BELOW THE TOP OF THE SHIELD. SLOPE SOILS ABOVE SHIELD ACCORDING TO MANUFACTURERS TABULATED DATA. INSTALL SHIELD IN TRENCH.

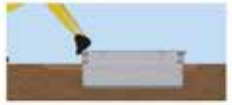
EXCAVATE IN FRONT OF THE TRENCH SHIELD



PULL SHIELD FORWARD BY FRONT TOP SPREADER PIPE OR WITH PULLING EYES. (PULLING EYES SHALL BE USED WITH SPREADERS WIDER THAN 72" OR WHEN SOIL PRESSURE IS SEVERE ENOUGH TO CAUSE SPREADER TO DEFLECT).

USING A TRENCH SHIELD IN UNSTABLE SOIL

EXCAVATE UNTIL SOIL BEGINS TO CRUMBLE BEYOND DESIRED TRENCH WIDTH. PLACE SHIELD IN LINE OF EXCAVATION



PRESS DOWN ON CORNERS TO PUSH SHIELD DOWN TO GRADE

PULL SHIELD FORWARD AND UP ON APPROPRIATE ANGLE

EXCAVATE SOIL WITHIN THE SHIELD AND REPEAT PREVIOUS PROCESS

USING TRENCH SHIELDS FOR PATCHWORK, REPAIRS OR TIE-INS

*CENTER SHIELD OVER WORK AREA
*LAY SOIL AT ENDS BACK ACCORDING TO MANUFACTURER'S TABULATED DATA OR USE MANUFACTURER'S DESIGNED PLATES TO PROTECT FROM CAVE-INS

MANHOLE BOX W/CORNER END PLATES

CORNER END PLATES HELP PREVENT LOOSE MATERIAL FROM RUNNING INTO THE END OF THE SHIELD. SOIL AT ENDS SHOULD BE SLOPED ACCORDING TO MANUFACTURER'S TABULATED DATA

USING 4-SIDED SHIELDS

WHEN USING SHIELDS AS PROTECTION DURING MANHOLE ASSEMBLY WORK, INSURE THAT PROPER END PANELS ARE USED, OR LAY SOIL AT THE ENDS BACK ACCORDING TO MANUFACTURER'S TABULATED DATA

*THIS MATERIAL IS INTENDED TO PROVIDE BASIC ASSEMBLY AND INSTALLATION INFORMATION ONLY.
*ALWAYS USE TRENCH SHIELD IN ACCORDANCE WITH APPLICABLE LOCAL, STATE, AND FEDERAL SAFETY LAWS AND REGULATIONS.
*FAILURE TO DO SO COULD CAUSE SEVERE INJURY OR DEATH.

Stacking Shields

- For pipe laying – shields can be stacked to provide maximum vertical wall with minimal cost

Shielding + Sloping

Trench Shields can be used in combination with Sloping, assuming the OSHA standards for sloping a trench is followed.

Specific Purpose Trench Shields

Steel Manhole Shield

Aluminum Octagon Manhole Box

Aluminum Trench Shields for smaller backhoes

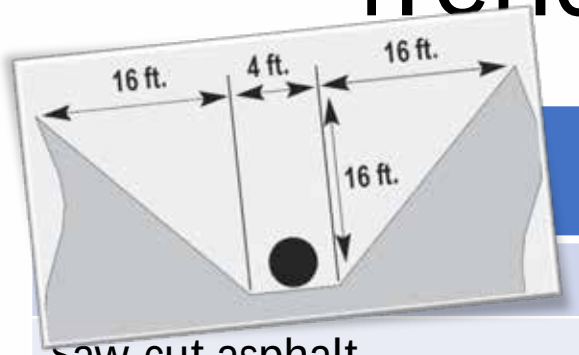
Alum-A-Shield™ w/ corrugated sidewalls

XLAP™ w/ 3” smooth panel sidewall

Modular Trench Shields for existing utilities

Build-A-Box™ Modular Trench Shielding System

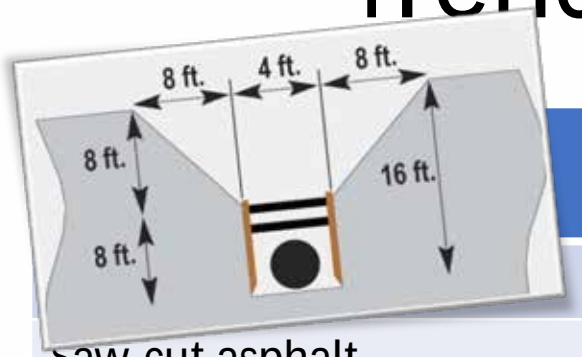
Trench Shields as a Production Tool



	SLOPING ONLY			
	QTY	UNITS	COST/UNIT	TOTAL COST
Saw-cut asphalt	800	LF	$2.22	$1,776
Remove 3” asphalt and 8” gravel base	1,666	Sq. Yd.	$5.29	$8,813
Excavate soil and haul away	5,096	Cu. Yd.	$3.55	$18,091
Backfill with sand	5,096	Cu. Yd.	$7.74	$39,443
Replace 8” gravel base	1,666	Sq. Yd.	$6.62	$11,023
Replace 3” asphalt	1,666	Sq. Yd.	$11.75	$19,575
Trench Shield Rental	0			$0
			TOTAL:	**$98,727**

Data Represents quantities for 400 LF of pipe laid at 16’ deep

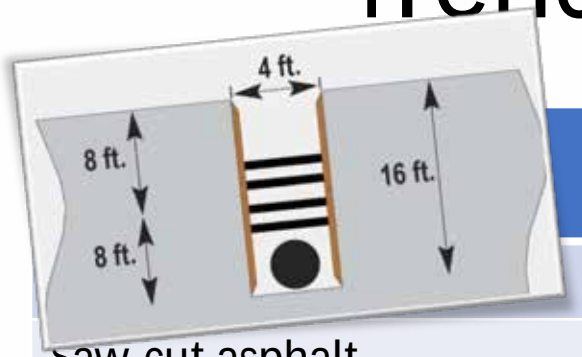
Trench Shields as a Production Tool



	ONE 8' TRENCH SHIELD			
	QTY	UNITS	COST/UNIT	TOTAL COST
Saw-cut asphalt	800	LF	$2.22	$1,776
Remove 3" asphalt and 8" gravel base	1,134	Sq. Yd.	$5.29	$5,999
Excavate soil and haul away	2,420	Cu. Yd.	$3.55	$8,591
Backfill with sand	2,420	Cu. Yd.	$7.74	$18,730
Replace 8" gravel base	1,134	Sq. Yd.	$6.62	$7,507
Replace 3" asphalt	1,134	Sq. Yd.	$11.75	$13,324
Trench Shield Rental	1	1 Wk. Rental	$290	$290
			TOTAL:	**$56,217**

Data Represents quantities for 400 LF of pipe laid at 16' deep

Trench Shields as a Production Tool

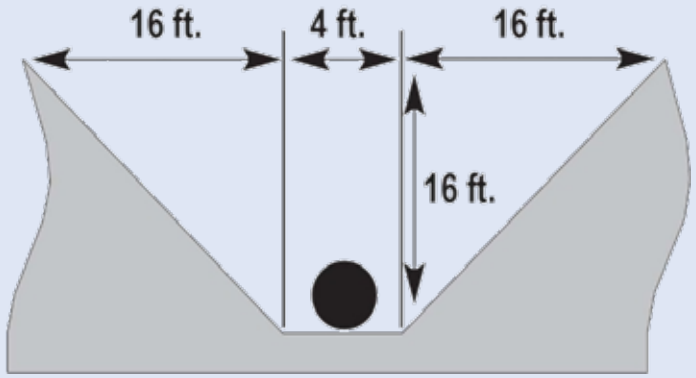


	TWO STACKED 8' TRENCH SHIELD			
	QTY	UNITS	COST/UNIT	TOTAL COST
Saw-cut asphalt	800	LF	$2.22	$1,776
Remove 3" asphalt and 8" gravel base	289	Sq. Yd.	$5.29	$1,529
Excavate soil and haul away	1,540	Cu. Yd.	$3.55	$5,467
Backfill with sand	1,540	Cu. Yd.	$7.74	$11,920
Replace 8" gravel base	289	Sq. Yd.	$6.62	$3,395
Replace 3" asphalt	289	Sq. Yd.	$11.75	$13,324
Trench Shield Rental	2	1 Wk. Rental	$290	$580
			TOTAL:	**$26,580**

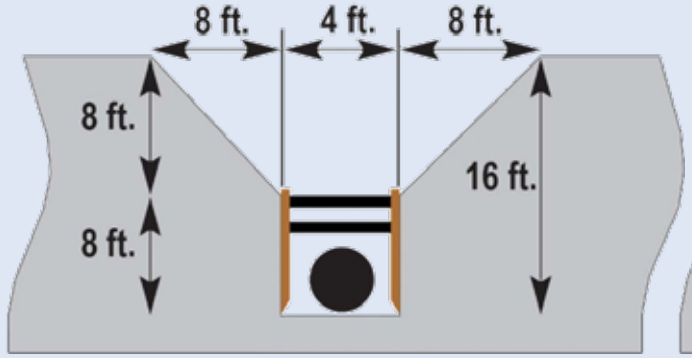
Data Represents quantities for 400 LF of pipe laid at 16' deep

Trench Shields as a Production Tool

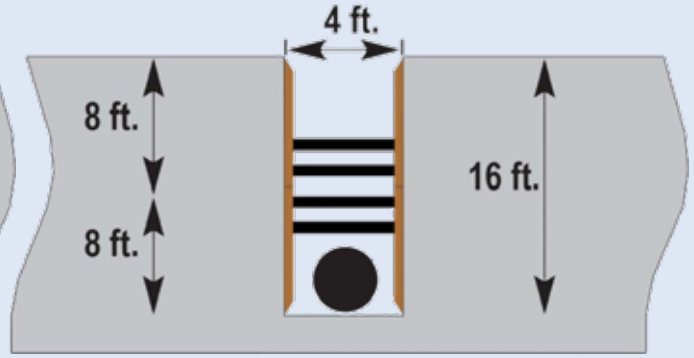
- Handle far less soil and greatly **reduce machine cycles**, even in most stable soil conditions
- Consider this example for a trench distance of 12 feet. The trench depth is 16 feet, the soil condition is stable, cohesive Type B soil (requiring minimum layback ratio 1 to 1) and a 2-cubic yard bucket is being used on the excavator



TOTAL SOIL REMOVED – 144 CYDS.
TOTAL MACHINE CYCLES - 72



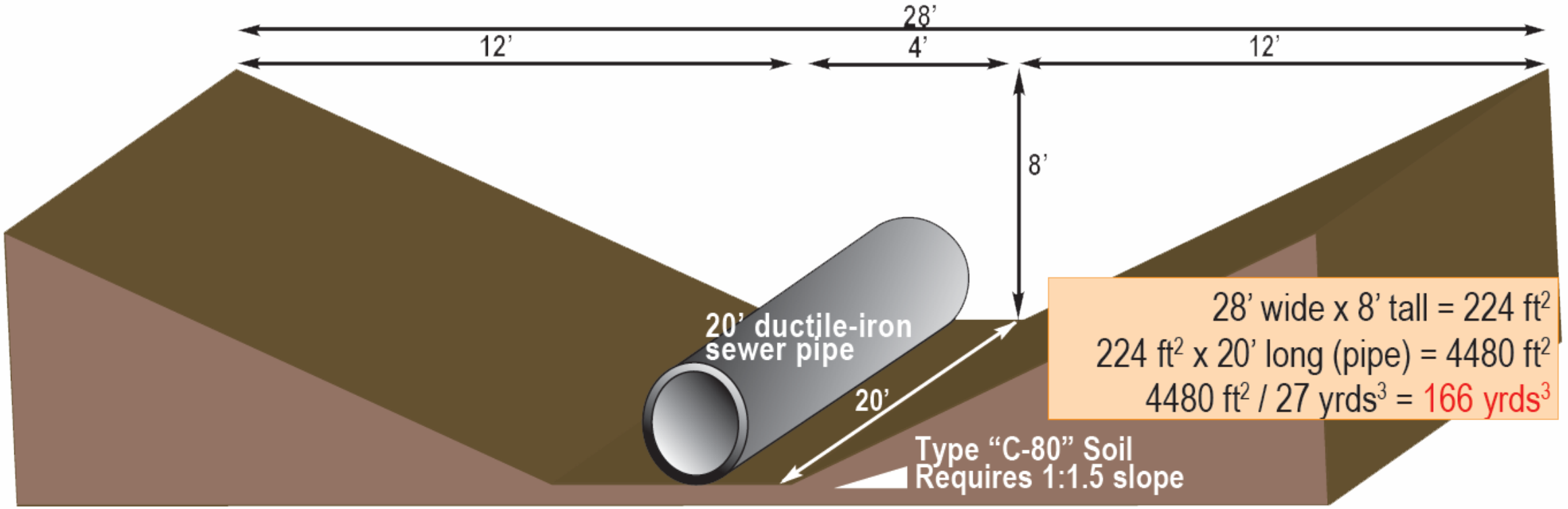
TOTAL SOIL REMOVED – 91 CYDS. **Save 37%**
Machine Cycles – Excavating: 46
Machine Cycles – Moving Shield: 3
TOTAL MACHINE CYCLES – 49 **Save 32%**



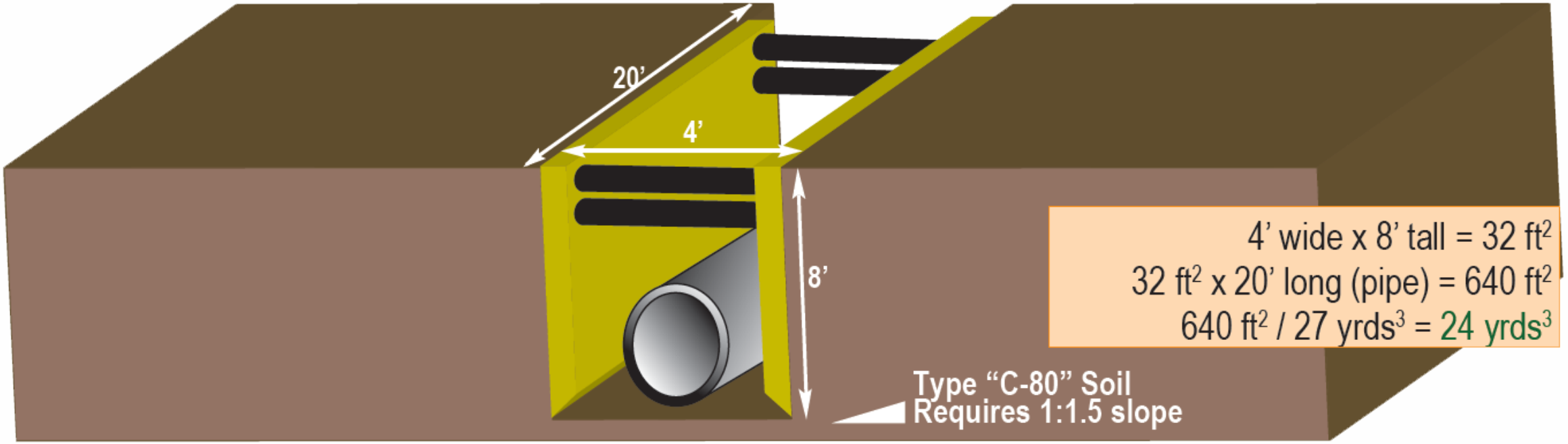
TOTAL SOIL REMOVED – 51 CYDS. **Save 65%**
Machine Cycles – Excavating: 26
Machine Cycles – Moving Shield: 3
TOTAL MACHINE CYCLES – 29 **Save 60%**

The savings are even more significant when thinner walled shields are used, or in Type C soil conditions.

Trench Shields vs. Sloping

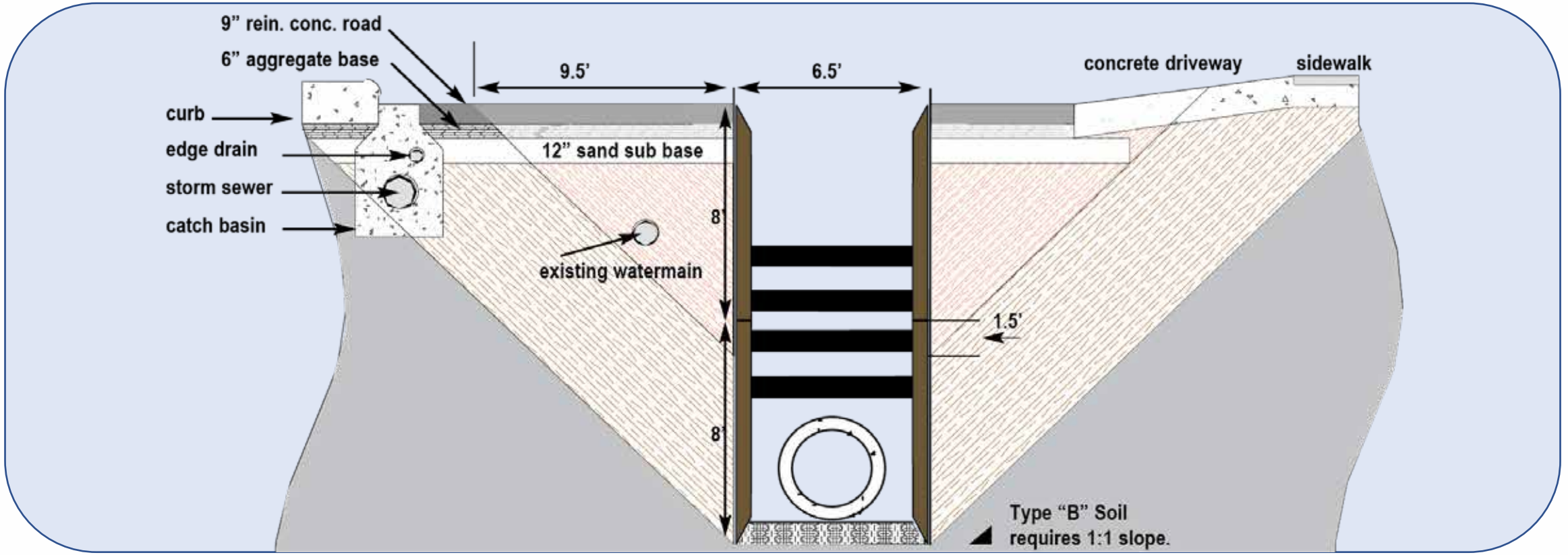


Trench Shields vs. Sloping



Trench Shielding Impact on Restoration Costs

- Street and lawn restoration costs can be higher than the cost of laying the pipe.
- Proper use of trench shields eliminate unnecessary excavating, reducing the damage to streets, sidewalks, and existing utilities.



QUESTIONS?

- Bruce Britt
- Regional Sales Specialist
- **Efficiency Production**

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