

Tunneling Cost Example
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In December, 1984 a contract was awarded to Kenny Construction Co. of Wheeling, IL. for 18,260 feet of 12-foot diameter tunnel to be bored in the Silurian layer of dolomite (limestone) under the Village of LaGrange, Illinois as part of the Chicago Metropolitan Sanitary District Tunnel and Reservoir Project (TARP). A 12" reinforced concrete lining is included in the project. This is not a structural requirement but is required by the Village of LaGrange to give extra insurance against sewage exfiltration. The layer of dolomite in which TARP is sited is particularly uniform, a well-bedded dolomite with a strength of 20 kips requiring very little support. In one 9-mile stretch only 1% required lining.

Over 100 miles of tunnel have been bored for TARP in recent years so there are many experienced contractors in the area. The combination of uniform, well-understood rock and a pool of experienced contractors results in very competitive bidding. The spread in bids for this project was \$23.2M-\$31.0M.

Access to project data for inclusion in an SSC database has been facilitated by contact with Metropolitan Sanitary District engineering staff, the contractor, and one of the engineering firms doing the TARP design work. The resulting data provide a textbook example of honest variations in cited tunneling costs. The details of the project and of various cost reports are attached.

If the bid price were to be simply divided by the tunnel length without extracting elements not related to the main tunnel, the cost per linear foot would be \$1276. However, a more refined analysis is possible based on the

project engineer's detailed task breakdown by percentage of cost. The attached cost analyses illustrate the wide range of tunnel costs/1.f. that may be legitimately extracted from even a well-documented project. The first analysis distributes the costs using the engineer's estimated breakdown. The second analysis was made by the Metropolitan Sanitary District assigning appropriate fractions of the mobilization, construction shafts, and supports to the tunnel part of the project. They arrive at a cost of \$775/1.f. for the tunnel. The third analysis is by the contractor's consulting geologist, arriving at a cost of \$394/1.f. for the tunnel. By comparison with the bid breakdown it is apparent that in the last case mobilization and shaft costs have not been prorated to the tunnel. Both analyses provide legitimate responses to the question of cost/1.ft. of this tunnel; the \$775 number is what it costs the owner for the tunnel; the geologist's quote would be appropriate for an incremental length of tunnel.

This small case study illustrates some of the difficulty of arriving at definitive unit costs for even well-documented tunneling projects.

TARP Example Analysis

Project:	MSD Contract 75-130-24 TARP Extension 13A	
	TBM bored tunnel in dolomite (limestone).	Markgraf member of Silurian Joliet formation
	Rock tunnel - excavation	18,260 l.f.
	- diameter, bored	12'
	- rock strength	20 kips
	- lining	12" reinforced concrete*
	concrete strength	4 kips
	Shafts (7)	
	Construction shaft	26' dia. ID (lined)
	Access shaft	4' dia. " "
	Dropshaft	4' dia. " "
	3 x Dropshafts	5'8" dia. " "
	Dropshaft	9' dia. " "
	Contractor: Kenny Construction Co.	
	Bid Price	\$23,292,759.
	Construction start	16 Jan 1985
	Construction completion (proj.)	2 Feb 1988
	Calendar days	1113
	Current (14 April 86) status.	62% completion
	Equipment: TBM - Jarva Mark 12	
	- Motors	4 x 150 HP
	- Stroke	2'
	- Cutters - number	25
	- Cutters - diameter	15 1/2" - 16 1/4" 0
	- Thrust/cutter	45000 pounds
	Haulage - Trains	5 cars/trains
	- Muck cars	6.5 cu. yds./car:
	- Mucking rate	2 1/2 cars/stroke)
	- Track size	60#
	- Track gauge	24 in.

* Lining was not a structural requirement. The village of LaGrange insisted on a lining to give extra reassurance against sewage exfiltration.

Progress and Conditions:

Ave. advance: 72 ft/day (breakdowns)
Water infiltraton: 120 gpm (50 gpm/mile)

Cost analyses:

1. 12/28/84 analysis by T.E. Toohig with data from Harza Eng.
Bid breakdown: Engineers estimate

Excavation (incl. supports)	30%	-	\$381/1.f.
Lining	18.5%	-	235/1.f.
Mobilization & construction shafts	29%	-	6.7 M
Other shafts	14%	-	3.2 M
Misc, grouting, rockbolts and Sewer connections	8.5%	-	2.0 M

2. 1/29/85 MSD analysis

Tunnel excavation cost	\$ 775.17/1.f.
Reinforced concrete lining	244.07/1.f.
Shafts	\$2,887,370.00

3. 4/18/86 Analysis by P.H.M. Braam, Project Geologist

Tunnel excavation cost	\$ 394.18/1.f.
Lining	\$ 244.07/1.f.