Attachment 2

Tunneling Evaluation

Subject: **San Onofre Nuclear Generating Station
Closed – Cycle Cooling Conversion**

The scope of this report is to investigate the San Onofre Nuclear Generating Station's geologic setting, evaluate the feasibility of excavating eight (8) tunnels approximately 2,700 long each capable of accommodating a 12-ft diameter water tight carrying pipe, supply a means and methods of accomplishing the above task, and finally provide a cost estimate to perform the work. I have not investigated the requirements of tunneling under the I-5 Freeway or the Union Pacific Railroad. Both of these requirements would require geotechnical investigation which at present, has not been performed. I toured the project site on May 21, 2009, where the cooling system is to be installed and generally the proposed alignment for the tunnels to the Pacific Ocean. I was unable to enter the actual Nuclear Generating area due to security reasons.

With the help of a hand held GPS, it was determined that the elevation of the proposed cooling station is about 110 feet above sea level. I assume that it would be desirable to obtain at least 40 feet of clearance between the proposed tunnels and existing plant utilities. Since the plant is located 10 feet above sea level, the top of tunnel would be 30 feet below sea level, or -30. With a desired tunnel diameter of 12-ft finished diameter, which equates to a 14-ft dia excavated tunnel, the tunnel invert would be located 44 feet below sea level, or -44. I have not considered anything concerning the work at the sea wall.

<u>Geologic Setting</u>

I was supplied seven (7) borings performed by Conestoga – Rovers & Associates. Unfortunately, none of the borings were deep enough to provide data at the proposed tunnel elevation of -30 to -44 (see above discussion). Therefore the data is useful for shaft sinking methodology only. The results are as follows:

- **GW-OCA-1**: This bore hole was 45 feet deep, with a tip elevation of Elev. 3 feet. This hole indicated the potential for alluvium, silt, sand, gravel, and cobbles.
- **GW-OCA-2:** This bore hole was 122 feet deep, with a tip elevation of Elev. -6 (ie. 6 feet below sea level). This hole indicated highly permeable sand in the lower half of the hole, at roughly Elev. 50 to Elev. -6. All sands were classified as fine coarse grained sands.
- **GW-OCA-2:** This bore hole was 108 feet deep, with a tip elevation of roughly Elev. -2. This hole indicated sands grading from fine sands to coarse grained. All sands indicated high permeability and no plasticity.
- **GW-PA-1:** This bore hole was 33 feet deep, with a tip elevation of roughly Elev. -4. This hole indicated yellow wet sands with no plasticity and high permeability fine to coarse grained.
- **GW-PA-2:** This bore hole was 33 feet deep, with a tip elevation of roughly Elev. -3. This hole indicated the same information as GW-PA-1.
- **GW-PA-3:** This bore hole was 33 feet deep, with a tip elevation of roughly Elev. -4. This hole also yielded the same information as GW-PA-1 and GW-PA-2.
- **GW-PA-4:** This bore hole was 33 feet deep, with a tip elevation of roughly Elev. -4. This hole also yielded the same information as GW-PA-1, GW-PA-2, and GW-PA-3.

In locating the holes OCA-1, OCA-2, and OCA-3, I determined that in all cases the bottom of the drilled hole did not intersect the proposed tunnel in horizon, and therefore the information could only be utilized in analyzing the proposed shaft sinking operation. The information supplied from the GW borings also did not penetrate the tunneling horizon.

Means and Methods

Based upon the geological information supplied and visual examination of the viable rock from the cooling station location and sea level, it looks to be sands plus layers of cobbles for the entire 110 feet. I envision sinking roughly two 80-ft diameter access shafts using liner plates and ring beams as the means of rock support. The shafts would be located such that one could begin tunneling all four tunnels from one central shaft located by each cooling station. Because the ground is highly permeable, I would recommend using rubber gasketed liner plates with the ring beams being placed inside the liner plate ring. Grouting the annular space between the liner plates and the excavated ground should also be performed to prevent any settlement and provide a friction coefficient. Periodic “key rings” should also be installed to provide a stable environment. American Commercial, Inc. (ACI) is a liner plate manufacturer with corporate offices in Louisville, Kentucky. They would supply the calculations for the design of the liner plate also. ACI also manufactures the ring beams, as well as the ¾” hanging rods used between beams.

The excavation is envisioned to be accomplished with a large track mounted crane on surface in the 200 Ton class. Mucking the shaft spoil would be performed using a small track loader in the Cat 939 class mucking into 6 CY muck buckets. Based on the physical data supplied plus visual inspection, I see no need for any hoe rams or other mechanical methods to break up the shaft spoil.

The shaft support system will be installed from the top down. I recommend the use of an excavator excavating the first 12 feet of shaft depth while the remaining shaft crew is assembling the liner plate circle complete with interior ring beam steel. After completion of the assembly, the large crane would lower the can assembly into the excavated hole which has leveling sand on the bottom. The approximately 12-ft high x 80-ft diameter liner plate plus ring beam can be leveled and plumbed using the crane, and the tracked loader. Upon completion of this operation, we would concrete the outside annulus with 4,000 psi concrete. This operation would give a sound foundation upon which to begin sinking the shaft. Liner plates are built to a Pie radius with each piece being 3.14 feet long circumferentially and depending upon design, either 16-inches or 2-feet high. Normally we would propose using 16-inch high liner plates. A 5/16-inch thick liner plate x 16-inch high weighs 68.6 lbs. per plate and the 3/8-inch thick plate weighs 82.3 lbs. Liner plates are bolted to the bottom of the last ring installed. As the excavator excavates 16-inches deeper, each liner plate is installed and bolted together by laborers on the shaft bottom until an entire ring has been erected.

Ring beams will probably consist of either 8WF31 or 10WF49 steel. ¾ inch hanging rods are used to suspend the ring steel from the previously erected ring, as the ring is being assembled. Upon completion of the ring, the ring is plumbed and blocked tightly against the liner plate ring. The rings would typically be on 4-ft centers. About every 10 vertical feet, the contractor would be expected to grout the annulus behind the liner plates to prevent surrounding ground movements and by preventing water inflows which can potentially wash in fine sands. This will require you to sand the shaft bottom tight to stop grout leaks from the last ring of liner plates. Upon completion of the shaft sinking and installation of the support system, you will have to pour a concrete slab to prevent upheaval plus stabilize the shaft. Should groundwater be encountered, the slab would need to be engineered for to include steel reinforcing with a thickness dependent upon the actual physical conditions. We only know that the sands are highly permeable which lends itself to be a drained environment. Therefore I have not allowed for encountering any ground water inflows during shaft sinking. Based on the elevation of the proposed cooling station to the shaft bottom, the shaft would be excavated to a depth of approximately 150 vertical feet.

I have also assumed that the shaft will bottom out in the San Mateo formation which is defined as massive thick bedded sandstone. During my site investigation, this formation was visible. After touring the site, I drove over to where the formation outcropped and examined the sandstone. The surface weathered sandstone is massive and thick. The grains range from fine to coarse and the color is reddish. I was told by the plant's field personnel that if the tunnel crown is 30 feet below sea level, the entire tunnel would be in the San Mateo formation. I relied on this information in my recommended means and methods, as the boring data was not deep enough. Again, the sandstone appeared permeable but the rock is cemented so groundwater will most likely be a factor during tunneling.

The shafts required at the front of the plant would also be about 60-ft to 80-ft in diameter. Looking at surface and the boring information closest to the site, I could not tell if a secant wall shaft lining or a slurry wall would be most appropriate. For purposes of this study, I would assume a subcontracted slurry wall shaft socketed into the San Mateo sandstone by the use of a rotary tooth cutter. Shaft sinking would be accomplished same as the upper shafts without the ring beams and liner plates. A tracked loader loading 6 CY muck buckets on the shaft bottom would be used for excavation. Again a shaft slab would be poured upon completion of the actual sinking, with a design consistent with the physical conditions encountered. Tunnel breakthroughs would be allowed for within the slurry wall design.

Should the shafts require a concrete lining, the concrete would be poured from the bottom up using a circular steel form designed and built. In these large diameter shafts, I would plan on a 10-ft high pour using a 12-ft high steel concrete form. After the first concrete pour, through inserts in the previous pour, shelves are installed which you reset the concrete form on. These shelves are about 2-ft below the previous pour. One sets the steel form on these shelves, aligns the concrete form, and pours the 10-ft concrete lining using a concrete bucket lowered with the crane. The larger diameter shafts may require interior bracing of the steel concrete form which the form designer would account for in design and fabrication.

Tunneling

I envision using a 13'-8" diameter shielded Earth Pressure Balance (EPB) Tunnel Boring Machine (TBM) as the primary mining method. The TBM will be shielded and equipped with a segment erector for installing the concrete ring support system as the tunnel advances. The concrete segments will be manufactured using special molds or forms. The precast segments will be equipped with gaskets and bolted to each ring installed. This concrete lining will be water tight. If required, the concrete segments can be lined to protect the concrete from the salt water. The concrete segments would probably be 9-inches thick and 5-ft long. They would be designed to withstand the anticipated hydrostatic pressures. For estimating purposes, I assumed a maximum of 4 bars.

The TBM uses disc cutters to excavate the rock. The spoil enters a pressure chamber and is extracted using a screw conveyor. From the screw the material is loaded onto a conveyor which feeds muck cars. The pressure chamber is designed to keep any ground water out of the excavated tunnel until the concrete segments are installed within the shield thus always having a water tight tunnel during construction. IT is believed that the San Mateo sandstones are permeable and this type of tunneling machine would be required especially as you approach the Pacific Ocean. By installing the lining as you advance the tunnel, you will always have a safe somewhat dry environment and should eliminate any ground movement which during tunneling underneath the freeway and railroad is absolutely essential. As you install the concrete ring within the shield of the TBM and the tunnel advances, each ring is pushed out of the shield and expanded out against the soil. At this point you must fill any voids between the outside of the concrete ring and the excavated rock/soil with a high strength grout. This operation is performed immediately after the concrete ring leaves the tunnel shield thus eliminating any chance of ground settlement.

The tunnel muck will be removed using muck cars designed to be lifted off the shaft bottom and dumped on surface. Locomotives will transport muck cars plus concrete segments to the mining machine and haul full muck cars to the shaft for muck removal. Additionally, when locomotives are utilized, it is highly recommended that the tunnel slope does not exceed 2%. 3% is possible in short sections only. The estimate for construction has allowed for the aforementioned means and methods with a maximum tunnel slope of 2%. The estimate also assumes using two TBM's: one TBM per shaft at each cooling station.

This concludes the narrative which is the basis of the attached cost estimate.

Very truly yours,

Robert A. Reseigh
Underground Consultant

Bid-Item	Description	Quantity	UM	Unit Cost	Total Cost
?326	Labor Check	1.00	HR	2,539.4100	2,539.41

Prod. per Hr: 1.00 Day Lgth: 8.00 Hrs Req: 1.00 Lbr Typ: Standard Man. Hrs.: 43.00
Work. Comp. 00001 0.00% Days Req: 0.13 Prod./Man Hr: 0.023256

	Material	Labor	Equipment	Other	Subcontractor	Plug	Truck
ᴊnit Cost:		2,539.41					
Total Cost:		2,539.41					

Take-off Quantity:

	Description	Area	Quantity/Hours		UM	Unit Cost	Total Cost
L	Crew Foreman	CALD	1.00 /	1.00	HR	81.2700	81.27
L	Flagger	CALD	1.00 /	1.00	HR	48.3500	48.35
L	General Laborer	CALD	1.00 /	1.00	HR	48.4700	48.47
L	Pipelayer / Asphalt Raker	CALD	1.00 /	1.00	HR	48.6600	48.66
L	Skilled Laborer	CALD	1.00 /	1.00	HR	49.5000	49.50
L	BCCI Traveling Laborer	CALD	1.00 /	1.00	HR	49.5000	49.50
L	Roller Operator	CALD	1.00 /	1.00	HR	68.6600	68.66
L	Loader / Dozer Operator	CALD	1.00 /	1.00	HR	73.1900	73.19
L	Excavator Operator	CALD	1.00 /	1.00	HR	74.8700	74.87
L	Crane Operator	CALD	1.00 /	1.00	HR	77.8000	77.80
L	BCCI Traveling Operator	CALD	1.00 /	1.00	HR	76.6700	76.67
L	Carpenter Foreman	CALD	1.00 /	1.00	HR	71.2800	71.28
L	Journeyman Carpenter	CALD	1.00 /	1.00	HR	67.0400	67.04
L	BCCI Traveling Carpenter	CALD	1.00 /	1.00	HR	67.0400	67.04
L	Cement Mason	CALD	1.00 /	1.00	HR	65.6700	65.67
L	Ironworker	CALD	1.00 /	1.00	HR	65.6700	65.67
L	Journeyman Boilermaker	CALD	1.00 /	1.00	HR	37.5800	37.58
L	Security Guard	CALD	1.00 /	1.00	HR	31.5700	31.57
'	Grade Checker	CALD	1.00 /	1.00	HR	73.1900	73.19
	Oiler	CALD	1.00 /	1.00	HR	73.1900	73.19
L	Chainman/Rodman	CALD	1.00 /	1.00	HR	36.0800	36.08
L	Surveyor	CALD	1.00 /	1.00	HR	37.5800	37.58
L	Electrician	CALD	1.00 /	1.00	HR	63.4100	63.41
L	Ironworker Foreman	CALD	1.00 /	1.00	HR	69.5400	69.54
L	Water / Flatbed / Single Belly	CALD	1.00 /	1.00	HR	34.5800	34.58
L	Lowboy / Double Belly	CALD	1.00 /	1.00	HR	34.5800	34.58
L	Pipefitter	CALD	1.00 /	1.00	HR	79.6000	79.60
L	Mechanic W/Truck	CALD	1.00 /	1.00	HR	81.6900	81.69
L	Mechanic Helper	CALD	1.00 /	1.00	HR	67.2700	67.27
L	Welder	CALD	1.00 /	1.00	HR	73.1900	73.19
L	Welder With A Truck	CALD	1.00 /	1.00	HR	79.6900	79.69
L	Surveyor	CALD	1.00 /	1.00	HR	37.5800	37.58
L	Chainman/Rodman	CALD	1.00 /	1.00	HR	36.0800	36.08
L	Tunnnel Bore Machine Operator	CALD	1.00 /	1.00	HR	59.8900	59.89
L	Tunnel Mechanic/Welder	CALD	1.00 /	1.00	HR	59.8200	59.82
L	General Tunnel Operator	CALD	1.00 /	1.00	HR	59.1000	59.10
L	Lead Miner	CALD	1.00 /	1.00	HR	52.6000	52.60
L	Tunnel Laborer	CALD	1.00 /	1.00	HR	39.9800	39.98
L	Shaft Walker/ Foreman	CALD	1.00 /	1.00	HR	56.8500	56.85
L	Shaft Blaster	CALD	1.00 /	1.00	HR	66.4100	66.41
L	TOPMAN	CALD	1.00 /	1.00	HR	38.1100	38.11
L	Tunnel Walker/Foreman	CALD	1.00 /	1.00	HR	80.5100	80.51

California Union Wage Rates

TOTAL COST SUMMARY ALL WORK

1.)	EQUIPMENT BUY	22,226.000
2.)	ALL TUNNELING	54,184.000
	EXIT SHAFTS	7009000
	ENTRANCE SHAFTS	11,478.000
	ALL INDIRECTS	24.891.000
	ENGR COSTS (DESIGN) 3%	4.000.000
	CONTRACTOR MARGIN	18.000,000
	TOTAL PROJECT	$119,810,000

INDIRECT SUMMARY

OH-1	FREIGHT + MOVEIN	520.000
2	JOB SUPERVISION	12,742,000
3	BUILDINGS	497,000
4	UTILITIES	329,000
5	JOB TEMP CONST	45,000
6	TRANSPORTATION + MECH.	4,018,000
7	JOB OFFICE	530,000
8	INS + TAXES	2 340,000
9	EMPLOYEE MOVE IN	360.000
10	BONDS	2.
11	QA-QC	20000
12	ESCALATION	3 000 000
13	DEMOBILIZATION	500,000
	TOTAL	$24.891,000

INDIRECT COSTS

OH-1 FREIGHT & MOVE-IN OF EQUIPMENT

2 EA 200T CRANES @ 20,000 EA	40,000
2 EA TBM (GERMANY)	300,000
LOCOMOTIVES 4 EA	30000
MUCK CARS, FLAT CARS, SEGMENT CARS	30000
CAT 938 + 966	20000
MISC	50,000
OFFLOAD DUNNAGE + LABOR	50,000
TOTAL OH-1	$520,000

OH-2 JOB SUPERVISION, ENGINEERING, OFFICE, PURCHASING

	SUPERVISION	DURATION	SALARY	PROJ COST
1	PROJ MGR	48	22,545	1,082,000
1	GENERAL SUPT	44	19,000	836,000
2	TUNNEL SUPT	44	17,000	1,496,000
1	PROJ ENGR	48	17000	816,000
1	DESIGN MGR	9	15000	135,000
6	SITE ENGR	44	11,000	2,904,000
1	MECH SUPT	44	17000	748000
1	ELECT SUPT	44	17000	748 000
1	SEGMENT, QA-QC	46	15000	690,000
1	OFF MGR	48	15000	720,000
3	ACCOUNTING	44	9000	1,188,000
2	SECRETARY	44	5600	492,800
2	DRY HOUSE ATTEND	44	5600	492800
1	SAFETY MGR	46	12000	552,000
3	ASSIST SAFETY	44	9000	1,188,000
		TOTAL INDIRECTS		12,742,200

PAY ROLL BURDENS, 401K ETC AT 35% OF BASE WAGE

OH-3 TEMPORARY BUILDINGS (INSTALL ONLY)

1.) OFFICE SITE 72,000

2.) SHOP FACILITY 100x50 175,000

3) GAS + Fuel Stn 20,000

4) FIRST AID + SAFETY 20,000

5) WAREHOUSE 50,000
(ATTENDANT NOT REQUIRED)

6) DRY HOUSE CHANGE HOUSE 150,000

TOTAL BUILDINGS 487,000 ←

OH-4 TEMP UTILITIES

1) DRINKING H_2O + ICE 3000/MO 132,000

2) CONST H_2O (OWNER SUPPLIED)

3 LIGHT + POWER (OWNER SUPPLIED

4) SANITARY FACILITIES 10EA PORTAS 96,800

5) TELEPHONE - COMPUTERS, COPIERS ETC 100,000

TOTAL = 328,800

OH-5 TEMP JOB CONSTRUCTION

1.) TEMP YARD, LAYDOWN 40,000

2) SIGNS 5000

TOTAL 45,000

OH-6

JOB TRANSPORTATION, MATERIAL HANDLING, SITE MECHANICS

4 MECHANICS		2,230,000
3 ELECTRICIANS		1,673,300
10 PICKUPS	O-M ONLY	115,000
	TOTAL	4,018,300

OH-7 JOB OFFICE EXPENSE

ENGR SUPPLIES	1000/MO	48000
PHOTOS		10,000
TRAVELING EXPENSE	3,000/MO	144,000
OFFICE EQUIP + FURNITURE		50,000
SAFETY SUPPLIES AWARDS		144000
STATIONARY + SUPPLIES		44000
OUTSIDE CONSULTANTS		60000
FIRE PROTECTION		30000
	530,000	

OH-8 INSURANCE + TAXES

BUILDERS RISK	USE 150,000,000	1,500,000
EQUIPMENT FLOATER		600,000
AUTO + TRUCK INS		240 000
PERSONAL PROPERTY	(UNKNOWN)	
		2,340,000

OH-9 EMPLOYEE MOVE-IN

18 MOVE-INS AT 20,000 EA 360,000

OH-10 CONTRACT BONDS ?

OH-11 QUALITY CONTROL

OUTSIDE TESTING 20,000

OH-12 ESCALATION

USE 3% AFTER YEAR 1

OH-13 DEMOBILIZATION

500,000

ENERCON COST ESTIMATE

1 EA 80' DIAMETER SHAFT CONCRETE LINED

A.) PERMANENT MATERIALS

LINER PLATE USE 5/16" 16" PLATES

150 VF / 1.33 = 113 RINGS

(80 PLATES)(113 RINGS)(68.6#)(1.05) = 651,000 #

RING BEAMS USE 10WF49 ON 4'-CTRS

(49#)(251')(1.05)(38 RINGS) = 482,000 #

TIE RODS + BOLTS 22,000 #

TOTAL WEIGHT = 1,155,000 #

SUPPLIER AMERICAN COMMERCIAL

TOM CLEMMONS

PRICE ± $1.50/LB = $1,732,500

GROUT BEHIND LINER PLATES

251 FT X 150' = 38,000 FT^2

ALLOW 1" OF GROUT BEHIND LINERS

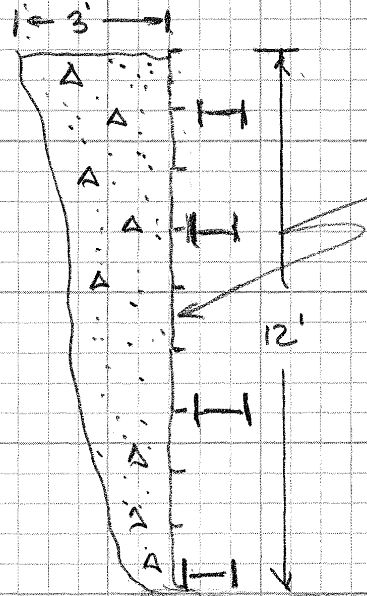
= 3167 FT^3 OF GROUT

1½ CF OF GROUT = 1 SACK OF CEMENT

3167/1.5 = 2100 SACKS OF CEMENT

80' DIA SHAFT CONT.

CONCRETE AT TOP OF SHAFT



TOP OF SHAFT

LINER PLATES (SECTION)

$V_1 = (40^2)(\pi) = 5024\ ft^3$

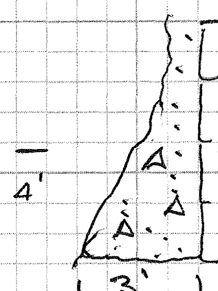
$V_2 = (42)^2(\pi) = 5539\ ft^3$

$\Delta = 515/27 = 19\ cy/ft$

$19\ cy \times 12 = \underline{230\ cy}$

SHAFT BOTTOM

ON 16'-CTRS PLACE KEY AROUND CONC



TYPICAL KEY = ±75 CY CONC

USE 9 EA = <u>675 CY</u> ←

SHAFT BOTTOM SLAB USE 2' THICK

$(5024/27)(2) = \underline{372\ cy}$ ←

80' DIA SHAFT CONT

TOTAL CONCRETE BEHIND LINER PLATES.

TOP OF SHAFT	=	230 CY
KEYS	=	675 CY
BOTTOM SLAB	=	372 CY
REI-BAR (BS ONLY)	=	37,000 #

SHAFT CONCRETE USE $1\frac{1}{2}$' THICK (NO-REBAR)

$V_1 = 5024\ FT^3$

$V_2 = (38.5)^2(\pi) = 4654$

$\Delta = 370/27 = 14\ CY/FT$

$(14)(150)(1.05)$ 2205 CONC CY

80' DIA SHAFT ACTUAL COST

EQUIPMENT		OPERATING COST
1	200 TON CRANE	$25.00/HR
1	CAT 345 EXC	$78.00/HR
1	CAT 966 FEL	$38.00/HR
	MUCK DISPOSAL	$15.00/TON
1	CAT 939 TRACK LOADER	34.00/HR

LABOR (DIRECT ONLY)

1 - CRANE OPERATOR
1 OILER
1 CAT 345 OPER
1 CAT 966 OPER
1 CAT 939 OPER
6 MINERS
1 TOP MAN
1 MECHANIC

DURATION EXCAVATION ONLY

ALLOWED 40 HOURS FOR 1ST 12-0"
REST OF SHAFT AT 1 RING / SHIFT = 103 SHIFTS = 824 HRS
ALLOW 40 HRS FOR BOTTOM SLAB

COST

EQUIPMENT	DURATION	COST/HR	TOTAL
200 T CRANE	904	25	22,600
CAT 966	600	38	22 800
CAT 939	864	34	29.400
MISC EQUIP	904	20	18080
			92,880

LABOR	NUMBER	COST/HR	
FOREMAN	1 EA	81.27	ALL ARE
CRANE OPER	1 EA	71.80	
OILER	1 EA	73.19	
345 OPER	1 EA	73.19	
966 OPER	1 EA	73.19	
939 OPER	2 EA	146.38	748 512
MINER	5 EA	263.00	<63.236>
TOP MAN	1 EA	39.98	
		$823/hr	

TOTAL LABOR
DIRECT
$ 685.276

ADD MISC OTF OF 5% = $719.540

CONSUMABLES EXCAVATION ONLY

6 CY MUCK BUCKETS	2 EA	36,000
SLINGS		10,000
MISC SMALL TOOLS + SUPPLIES	10% LABOR	72,000
MUCK DUMP SITE		20,000
CONCRETE BUCKETS	2 EA	28,000
		$166,000

PERMANENT MATERIALS

LINER PLATES		1,732,500
RING BEAMS		723,000
TIES + BOLTS		44,000
GROUT	2100 SACKS	14,700
CONCRETE	1277 CY	159,250
RE-BAR	37,090 #	18,500
	TOTAL PMs	2,851,575

MUCK DISPOSAL

SUBCONTRACT AT $5.00/TON

$(5024)(150)/27\ (2) = 55,820$ TONS

MUCK DISPOSAL = $837,300

SHAFT EXCAVATION SUMMARY DIRECT COST ONLY

EQUIPMENT OPERATING COSTS	92,880
LABOR	719,540
CONSUMABLES	166,000
PERMANENT MATERIALS	2,851,575
MUCK DISPOSAL	837,300
TOTAL DIRECT	\$ 4,667,295

NOTE: ALL EQUIPMENT BUY IS IN INDIRECTS
ALL SUPERVISION + PLANT SET-UP IN INDIRECTS

SHAFT CONCRETE LINING

THIS OPERATION WILL BE PERFORMED AT COMPLETION OF ALL TUNNEL WORK

POUR 10'-0" POURS USING A 12'-0" HIGH CIRCULAR STEEL CONC FORM

15 POURS AT 1 POUR EVERY 24 HOURS

TOTAL DURATION = 360 HOURS

ALLOW 40 HRS TO PUT CONC FORM INTO SHAFT AND ALIGN SAME

say = 400 HOURS

CONTACT GROUT = 120 HOURS

SHAFT CONCRETE CONT.

PURCHASE CONC FORM	2900 FT² @ 75/		$217,500
8 SHELVES	FAB OUT SIDE		8,000
500 CONC INSERTS	8/EA		4,000
MISC TOOLS + SUPPLIES	10% LABOR (VIBRATORS ETC)		41200
SLINGS			10000
SPIDER (PLATFORM TO WORK OFF)			50,000
POUR LIP			6000
GROUT	1010 SACKS		8,080

SHAFT LABOR CONC

USE SAME CREW

(754.81 / HOUR)(520 HRS) = 392.501

MISC OTF = 5% 19.625

PERMANENT MATERIALS

CONCRETE	2205 CY @ 125	275,625
RE-BAR (TOP POUR ONLY)	37.000#	18 500
EQUIPMENT OPERATION ONLY		20,800

TOTAL CONCRETE ITEM $1,071,831

TOTAL EXC 4.667 295

TOTAL SHAFT = $ 5.739.126

TOTAL DURATION

NOTE: MOBILIZATION + PLANT SET-UP IN INDIRECTS

SHAFT EXCAVATION = 113 SHIFTS

SHAFT CONCRETE = 65 SHIFTS

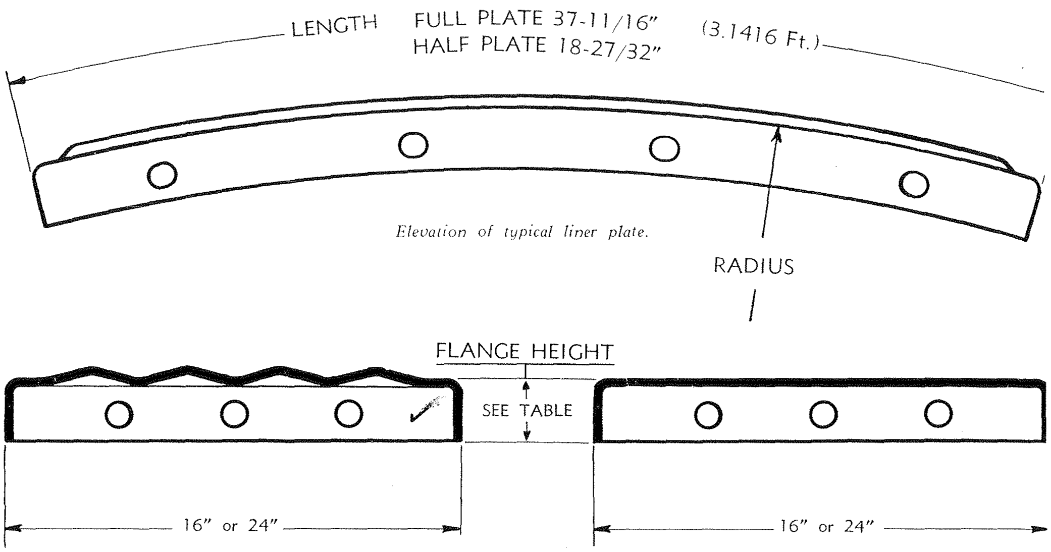
TOTAL = 178 SHIFTS

IF YOU WORK SINGLE SHIFT = 36 WEEKS

DOUBLE SHIFT = 18 WEEKS

I SAW NO REASON NOT TO WORK NIGHTS AS NOISE RESTRICTIONS SHOULD NOT EXIST AND LIGHT RESTRICTIONS SHOULD BE NEGLIGIBLE

LAGGING DETAILS



Elevation of typical liner plate.

Cross Section of liner plates. May be furnished corrugated or plain as shown.

37-11/16″ FULL SIZE AND HALF SIZE PLATES AVAILABLE										
Thickness	Min. Flange Height		Weight 16″ Wide Plates		Weight 24″ Wide Plates		Bolt Size & Weight Pls. Above Ribs		Pls. Between Ribs	
	Side	End	Full Plate	Half Plate	Full Plate	Half Plate	Size	Weight Each	Size	Weight Each
1/8″	2″	2⅛″	27.7	14.7	39.3	21.4	½″ x 1″	.17	½″ x 1½″	.20
3/16″	2⅛″	2″	40.9	21.7	56.9	30.7	½″ x 1½″	.20	½″ x 1½″	.20
1/4″	2¼″	2⅛″	54.9	28.9	80.2	43.2	⅝″ x 1½″	.36	⅝″ x 2″	.36
5/16″	2⅜″	2⅛″	68.6	36.1	101.6	54.0	⅝″ x 1½″	.36	⅝″ x 2″	.36
3/8″	2½″	2¼″	82.3	43.3	121.9	65.8	⅝″ x 1½″	.36	⅝″ x 2″	.36

Bolts furnished per plate 7 5 7 5

Quick acting thread. Head and nut same size.

Grout holes Plain for 1½″ or 2″ pipe (1½″ pipe standard)
Tapped for 1½″ or 2″ pipe (in 3/16″ and heavier plates)

Pipe plugs for tapped grout holes supplied if requested.

262

technique of hole-through procedure

The customary procedure is to work from shafts that are rather closely spaced, i.e., 150 to 500 feet apart. Because the tunnel is small, the work shafts are also quite small and relatively inexpensive. They may be (and often are) enlargements of manholes required at intervals in sewer lines.

Mining proceeds both ways from each shaft to the halfway point between shafts. Then the concrete crew takes over. Normally, a concrete cradle is located in the invert, starting the pour at the halfway point and progressing backward to the shaft. The pipe sections are then placed, starting at one end and proceeding from shaft to shaft. Concrete backfill is poured as the pipe is placed. In good ground, tunnels with a rough bore up to 7 feet or even 8 feet may be holed through.

compressed air leakage reduced by mudding and grouting

The same disadvantages and risks are present when holing through small or large tunnels, except they cannot be avoided in small tunnels. These are ordinarily driven with a full circle of liner plates of proper strength to take maximum earth pressures that can develop in several months. Most hazards stemming from loads are eliminated. But in porous ground, leakage of compressed air may develop to be quite serious due to the large area of ground exposed to the air. If the ground is known to be porous over long stretches, an adequate air plant with generous cooling capacity is usually installed. If, however, this porosity prevails over short stretches only, air leakage can be minimized. In the early days of tunneling, leakage was minimized by *mudding* the joints of liner plates to make them hold air. Wet, sticky clay was smeared over the flange and around the bolts of the plates. This effectively held the air only as long as the clay was kept wet and plastic.

Such tunnels were sometimes grouted as the liner plates were installed, though this was not completely effective since compressed air forced the grout away from the tunnel before it could harden. It was believed by some builders that a soupy mixture of clay and oats as grout was more effective than the usual mixture of sand and cement. The clay sealed and the oats swelled, thus blocking small passages. Because the only function of the grout was to fill outside voids and seal the ground, no strength was required, therefore conventional grout had no advantage over a clay slurry.

Today, air leakage through steel linings is prevented by rubber gasketing material applied over the flanges, as shown in Figure 13-1. This eliminates leakage between the flanges and through the bolt holes.

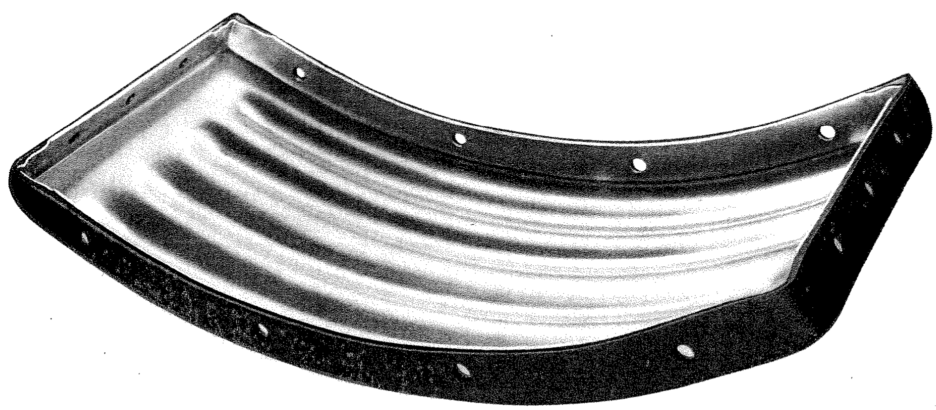


Figure 13-1

These are the prevailing conditions in raveling ground with stand-up time that permits excavation, plus another 30 minutes, perhaps, to install supports. The same applies to squeezing ground, provided the tunnel can be mined open-face. This means the ground must be moving slowly.

The backs of liner plates coincide with the outer design line of the concrete. The outer flange of the rib is located at least one-half inch beyond the liner plate, making the outer flange at least one-half inch beyond the design concrete line.

Excavation proceeds ahead for a distance equal to the width of one course of support after which the course of lining is erected. First, the nuts from the liner plate bolts projecting through the last rib are removed (they were left finger-tight when the last course was installed). The new course of plates is then erected on the face of the rib, and the nuts replaced, finger-tight. Next, a rib is erected on the leading edge of this new course. Bolts are entered through the flanges of the liner plates and the web of the new rib, and the nuts are finger tightened. The rib is then wedged to line and grade, and the rib-joint bolts of the previous course tightened. Bolts both sides of the last course are finger tight. Then the rib is

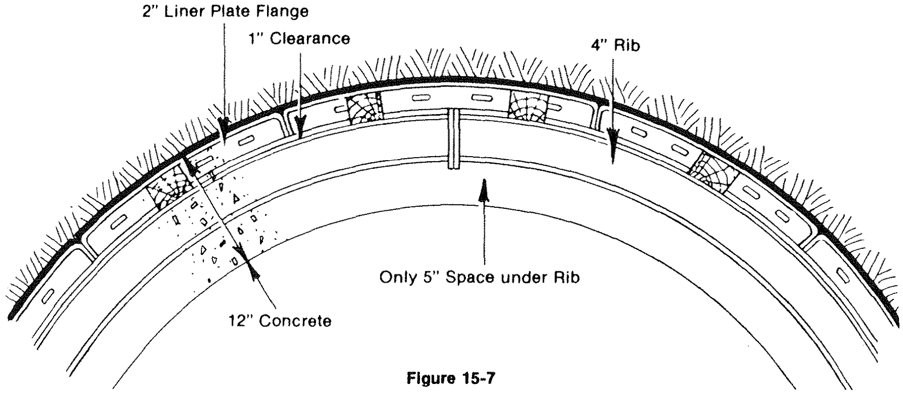


Figure 15-7

If ribs are placed under the liner plates, there may not be room enough between the form and the bottom of the rib for the concrete delivery pipe, which requires at least 7 inches. Such conditions frequently exist in small tunnels where the concrete lining is relatively thin. Thus, in a 10-foot tunnel with a 12-inch lining, 4-inch ribs under plates do not allow the necessary 7 inches of space for the concrete delivery pipe.

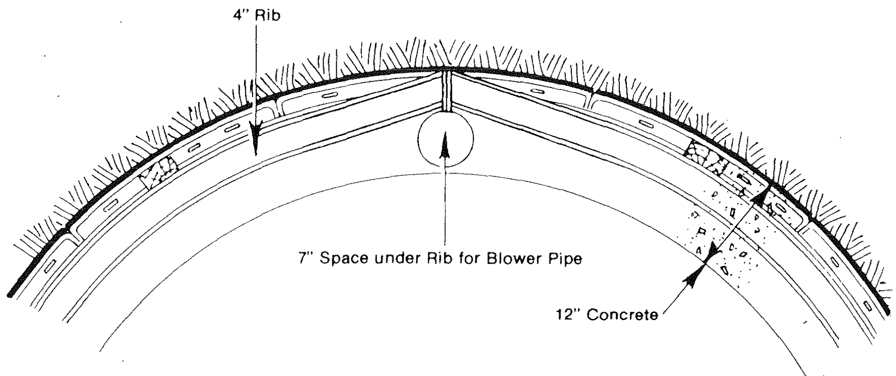


Figure 15-8 Ribs Kicked Up for Concrete Delivery Pipe

About 2 or 3 inches of room for the pipe can be gained by a *kick up* in the rib. The rib terminates in a short tangent at the crown. The crown joint is thus raised to meet the back of the liner plates.

punched is attached to each end. It is this end plate which is bolted to the web of the rib member, except in the case of pipe spacers which are installed with tie rods inside them.

Tie rods are 5/8-inch or 3/4-inch rods threaded on both ends. They are inserted through holes in the webs of two adjacent ribs and held by nuts.

Wall plates are longitudinal members of the steel support system placed flat on the bench at or near the spring line. They can be single wide-flange beams laid flat with the flanges vertical; or double wide-flange beams, or I-beams with the webs vertical and the flanges horizontal. They are mined-in ahead of the face, so they form sills to receive the rib segments of the arch and caps for the posts or lower rib segments later erected. Wall plates are made to various lengths that are multiples of the rib spacing.

rib and liner plate combinations

Ribs can be placed either under the liner plates (Figure 15-4 and 15-5), or between them (Figure 15-4 and 15-6). Each position has certain advantages as well as disadvantages. How the tunnel is to be mined bears on which position the builder will choose.

When ribs are to be positioned *under* the liner plates, or when steel lagging plates or wood lagging are used, these ribs in most instances are fabricated from H-beams or WF-beams. These particular sections have wider flanges than I-beams, which gives them more bearing for the lagging and, because blocking is necessary between the outer flanges and the

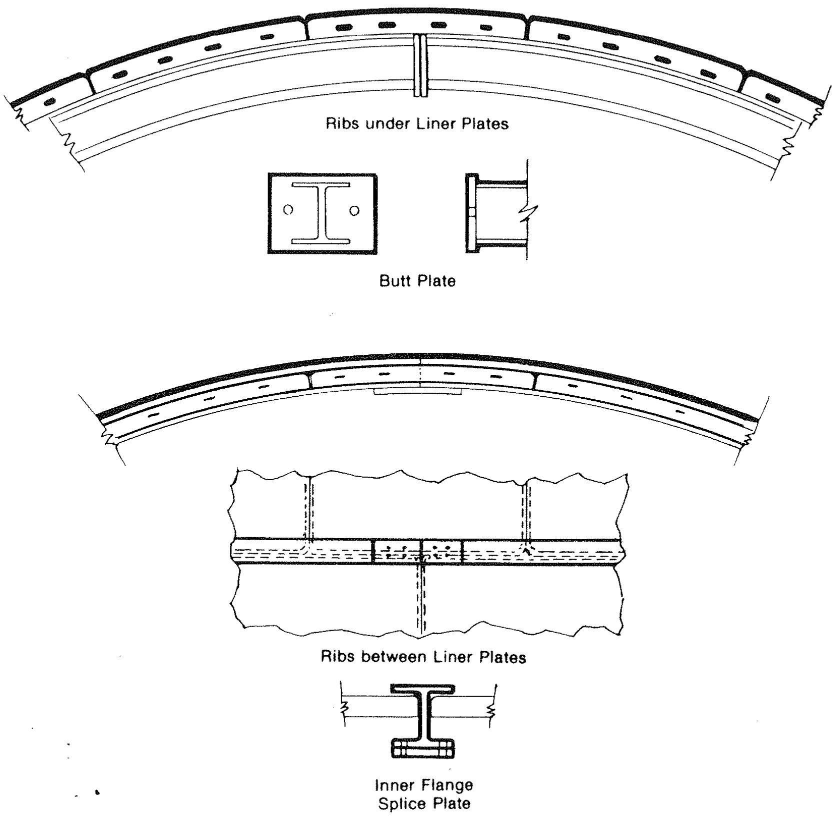


Figure 15-4

158

punched is attached to each end. It is this end plate which is bolted to the web of the rib member, except in the case of pipe spacers which are installed with tie rods inside them.

Tie rods are 5/8-inch or 3/4-inch rods threaded on both ends. They are inserted through holes in the webs of two adjacent ribs and held by nuts.

Wall plates are longitudinal members of the steel support system placed flat on the bench at or near the spring line. They can be single wide-flange beams laid flat with the flanges vertical; or double wide-flange beams, or I-beams with the webs vertical and the flanges horizontal. They are mined-in ahead of the face, so they form sills to receive the rib segments of the arch and caps for the posts or lower rib segments later erected. Wall plates are made to various lengths that are multiples of the rib spacing.

rib and liner plate combinations

Ribs can be placed either under the liner plates (Figure 15-4 and 15-5), or between them (Figure 15-4 and 15-6). Each position has certain advantages as well as disadvantages. How the tunnel is to be mined bears on which position the builder will choose.

When ribs are to be positioned *under* the liner plates, or when steel lagging plates or wood lagging are used, these ribs in most instances are fabricated from H-beams or WF-beams. These particular sections have wider flanges than I-beams, which gives them more bearing for the lagging and, because blocking is necessary between the outer flanges and the

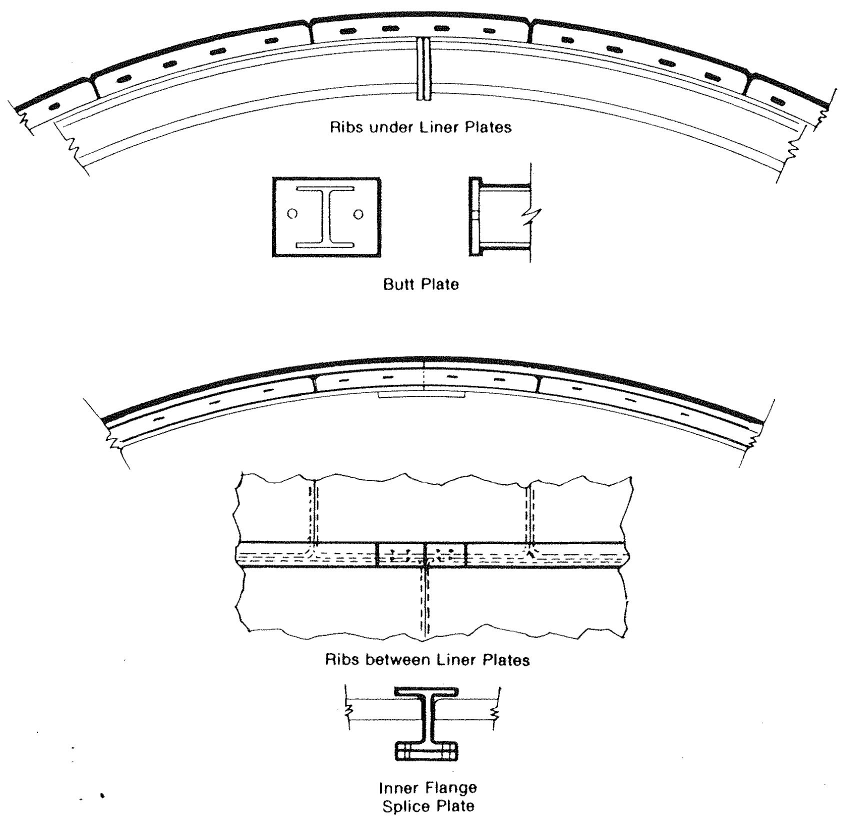


Figure 15-4

158

EQUIPMENT REQUIRED			QTY
TUNNEL BORING MACHINE + BACK-UP QUOTE HERRENKNECHT 7,000,000		14,000,000	2EA
10 TON LOCOMOTIVES	270,000	1,350,000	5EA
8 CY MUCK CARS LIFTOFF	18000	144,000	8EA
MANTRIP CARS	14000	42,000	3EA
SEGMENT CARS	14000	112,000	8EA
4CY GROUT CARS	30000	120,000	4EA
FLAT CARS	12000	72000	6EA
CALIFORNIA SWITCH	150,000	300 000	2EA
GROUT PLANT	500,000	1000,000	2EA
200T CRANE (TRACK)	1,200,000	2,400,000	2EA
CAT 939 TRACKED FEL	90,000	360,000	4EA
CAT 966 FEL	320,000	640,000	2EA
18T RT CRANE	250,000	500000	2EA
RT FORK LIFT	250,000	500 000	2EA
WELDERS	20000	80000	4EA
AIR COMPRESSORS	108000	216000	2EA
PICKUPS	30000	300,000	10EA
FLAT TRUCKS	45000	90 000	2EA
TOTAL EQUIPMENT BUY		$ 22,226,000	

BUY LINEAL PLANT FOR TUNNEL BUY 2SETS

	QTY	
VENT FANS 60 HP	2EA	50.000
60# RAIL =224,000 #	5600 LF 112 TONS	112,000
RAIL TIES + GAUGE TIES	2800 EA	22400
30" VENT LINE	6000 LF	84000
VENT ELBOWS SILENCERS	4 EA	4000
4" H_2O	6000 LF	42000
6" AIRLINE	6000 LF	48000
4-0 13.2 KW	6000 LF	150.000
13.2 - 480 MINE POWER CTRS	2EA	60.000
PHONE SYSTEM	6000 LF	10.000
TUNNEL LIGHTS	6000 LF	30.000
JACKING FRAMES	8EA	24.000
LAUNCHING FRAMES	2EA	40.000
SURFACE LIGHTS 480V	8EA	16.000
TOTAL LINEAR PLANT		692.400

PURCHASE & DELIVER ALL CONCRETE SEGMENTS TO JOB SITE

22,000 LF @ 1200 LF + $100 LF FREIGHT

= 28.600.000

TUNNEL CONSTRUCTION

STEP #1 INSTALL TRACK SWITCH IN SHAFT BOTTOM
#2 INSTALL JACKING FRAME
#3 LOWER TBM
#4 BEGIN BURYING TBM + TRAILING GEAR
#5 DURING ABOVE CONSTRUCT TAIL TUNNEL ± 80'

ERECT TBM ON SURFACE

ALLOW 6 WEEKS WITH 240 HR

1	45T CRANE	40/hr	9600
1	CAT 966	38/hr	3800
3	MECH	179.46	
3	ELECT	190.23	
2	LABORERS	79.96	
	ROPER	155.60	
		605.25	145,260
	MISC STFS 10%		14 260
	TOTAL PRE ERECT		172,920

PREPARE SHAFT + BOTTOM TAIL TUNNEL

INSTALL VENT SYSTEM AVG TUNNEL IS 2520 LF

USE 30" VENT LINE

USE 24" TRACK 60# RAIL

USE 4" H_2O LINE

USE 6" AIR LINE

USE 4-0 13,200 VOLT POWER CABLE

USE 1500 KVA 13.2 - 480 VOLT TRANSFORMER ON TBM (IN PRICE OF TBM)

USE TUNNEL CREW TO INSTALL TBM SERVICES

1	CRANE OPER	77.80
1	OILER	73.19
1	FOREMAN	81.27
1	LEAD MINER	52.60
1	TBM OPER	59.89
1½	LOCOMOTIVE OPER	88.65
3	MINERS	294.00
1	TOP MAN	39.98
1	BOTTOM MAN	39.98
		807.36/hr
	LABOR	48,442.00

INSTALL LAUNCHING FRAME + JACKING FRAMES

USE SAME CREW 40 HOURS

(807.36)(40) = #32,294

LOWER AND COMPLETE TBM

(807.36)(80 HRS) = 64,589

COMPLETE TAIL TUNNEL

USE STEEL SETS ON 4'-0 CTRS 6WF25

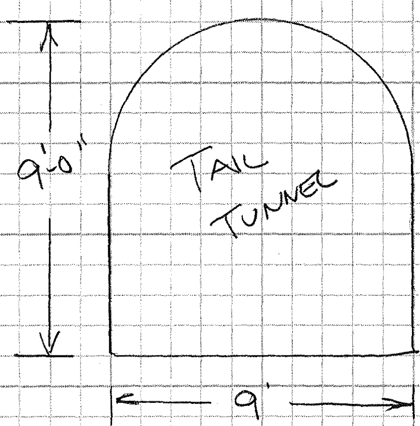
20 SETS HORSESHOE

USE CREW 160 HRS

(807.36)(160) = 129,178

ADD STEEL SETS 12,000

LAGGING 600



EACH SET WEIGHS 800#

(20)(800) = 16,000#

WOOD LAG SAME = 640 BF

SUMMARY OF TUNNEL SET-UP

ERECT TBM (SURFACE)	172,920
PREPARE SHAFT	48,442
LAUNCHING + JACKING FRAME	32,294
LOWER + COMPLETE TBM	64,589
TAIL TUNNEL	141,778
EQUIP OPER EXPENSE	24,920
MISC SMALL TOOLS + SUPPLIES	31,700
MISC OTF @ 3%	13,770
TOTAL TUNNEL SET-UP	530,413

NOTES: YOU WILL USE TAIL TUNNEL FOR ALL 4 DRIVES OUT OF EACH SHAFT ∴ DIVIDE # BY 4 FOR EQUIV TUNNEL START-UP

USE 36,000 TOTAL THUS – <105,800>

EACH TUNNEL START-UP IS 530,400 - 105,800 = 424,600

ALL SITE POWER ON OWNER AT -0-
(POWER PLANT RIGHT THERE

ACTUAL TUNNEL DRIVE

FROM 0 - 500 LF AT 20 LF/DAY = 75 SHIFTS

500 - 2885 AT 40' DAY. 180 SHIFTS

TOTAL OPERATING EXPENSE

TBM	2040 HRS	40/HR	\$ 81,600
200T CRANE	2040 HRS	25/HR	51,000
10T LOCO	3060 HRS	35/HR	107 100
CAT 966	2040 HRS	38/hr	77.520
FORK LIFT	2040 HRS	\$15/hr	30600
FLAT RACK	2040 HRS	13/hr	26 520
		TOTAL	374,340

TUNNEL LABOR

(807.36)(2040)(1.03) OTF = 1,696,425

CONSUMABLES

CUTTER WEAR 16 440 CY (NEAT)

USE 3 - /CY 49.320

MISC ST&S 10% 170.000

GROUT 15,750 SACKS [illegible]

124,000 FT² @ 0.167 = 21,000 FT³ 126,000

21,000 FT³ = 158,000 gallons / 10 gallon/SACK

CONSUMABLES CONT

GROUT PLANT MAINT

780 cy grout 11/cy = 9000

FAN REPAIR 3000

ROLLING STOCK 12000

TOTAL CONSUMABLES $ 369,320

TUNNEL CLEAN-UP REMOVAL OF TBM + TRAILING GEAR

TRACK & ALL UTILITIES

USE 100LF/DAY = 672 HRS

LABOR (672)(808)(1.03) 559,300

OPER EQUIP EXPENSE 61,152

CONSUMABLES

MISC STCS 55,930

GROUT POCKETS 5-STAR
NON SHRINK
(9300 POCKETS)(30)/3 93000

TOTAL CLEAN-UP 713,452

MUCK REMOVAL

33,000 TONS $ 495,000

TUNNEL DRIVE SUMMARY 2885 LF

LINEAR PLANT	86,550
SEGMENTS 2950'	3,835,000
TUNNEL SET-UP	424,600
TUNNEL	3,275550
	7,621,700
THERE ARE 4EA =	$30,486,800 ←

DIRECT COST ONLY

USE SAME PRODUCTION RATES FOR OTHER 4 TUNNELS

LINEAR PLANT	86,550
SEGMENTS	2,989,000
SET-UP	424,600
	2,424,120
4 TUNNELS	5,924,170
4EA TUNNELS =	23,696,680 ←

Technopref Industries

Dear Sir,

We are pleased to quote for the supply and delivery to job site of **3,872 precast concrete tunnel liner rings** for the above mentioned project, for a price of **$21,470,240.00 (twenty one million four hundred and seventy thousand two hundred and forty dollars), (approx. $1,109.00 per linear foot)**, all applicable taxes excluded (if any).

The quotation provided herein is based on the following documents available to us:

- Drawings S9 to S12 ; all dated April 11, 2007;
- Specifications Section 02425, 03200, 03300 and 09962;
- Addenda no.1 to no.4 for elements concerning the previously mentioned related drawings and specs.

FOR SAN ONOFRE USE $1200/LF

TECHNOPREF INDUSTRIES INC.
P.O. Box 37
Blairsville, PA, 15717
Tel: (724) 459-6811
Fax : (724) 459-6779

TECHNOPREF INDUSTRIES INC.
170, Roland-Godard Boulevard
St-Jerome (Quebec) J7Y 4P7, Canada
Tel : (450 569-8043
Fax : (450) 431-4235

Terms and Conditions:

- Geometry of segment ring :
  - Tunnel interior diameter : 144 inches;
  - Tunnel ring thickness : 10 inches;
  - Ring width : 5'-0", Universal ring
  - Number of segments per ring : 6

- The segment-rings are based on a design made with concrete using calcareous aggregate with an Ameron T-Lock lining (1,75mm thick). The spec request to use calcareous stone is based on reasoning that we do not understand and please consider that if we can supply concrete with a normal top quality aggregate found in the Sacramento area, we would offer a credit of $700,000.

- Prices of segments include all the accessories embedded in concrete, EPDM gaskets, compression packing material, grout lift inserts including one-way valve and screw caps, radial assembly bolts including steel and plastic washers and circumferential plastic connector dowels. Hydrophilic gaskets are not included in pricing.

- Prices are FOB your job site, 2 rings per load. Unloading and coordination is the responsibility of the GC. We have assumed a maximum of 30 minutes at job site for unloading. Any additional time will be charged at $95.00/hour.

- Payment schedule to be such that Technopref keeps a positive cash-flow which means that payments will be required during the preparation and set up stages to cover all expenses. Once production is started, segments to be paid on hand for product stored in our yard or shipped to your site.

- Prices are based on segment steel reinforcement cages of cold drawn welded wire fabric to be fabricated similar to other like projects utilizing circumferential curved bars and curved and straight ladders as principal reinforcement with a Fy = 80,000 psi manufactured in accordance with ASTM A-496 and ASTM A-497. The steel factor proposed if 128.50 lbs / cubic yard. Assembly of the cages will be achieved with a minimum amount of spot welds (of non-structural nature) to ensure that the cages maintain their rigid geometrical integrity.

- Production of segments will start 35 weeks after issuance of a signed/agreed upon Segment Purchase Order (SPO) by General Contractor and Approved Shop Drawings of Segments by the General Contractor and the Owner. The production is scheduled to last for a period of 42 weeks with a maximum of 20 rings/day; 5

TECHNOPREF INDUSTRIES INC.
P.O. Box 37
Blairsville, PA. 15717
Tel: (724) 459-6811
Fax : (724) 459-6779

TECHNOPREF INDUSTRIES INC.
170, Roland-Godard Boulevard
St-Jerome (Quebec) J7Y 4P7, Canada
Telephone : (450) – 569-8043
Fax : (450) – 431-4235

days/week. Shipment of segments will occur as soon as product reaches shipping strength.

- Precast plant storage area for segments is provided for a maximum of 1,500 segment/rings for three (3) months. With our scheme, if needed, there is a possibility to store the whole job – but a negotiated arrangement will need to take place when real needs are defined. It is the GC's responsibility to provide for base dunnage when receiving rings at jobsite storage yard.

- Prices do not include any means that would be required to protect the EPDM gaskets from sunlight or rain/snow when stored out-of-doors.

- The specification is not clear regarding the test pressure for the water tightness test, therefore we have provided for a gasket type that has an excellent performance rating, however - the exact test pressure should be provided.

- Assembly system is composed of black steel bolts (including black steel washer) on the radial joints and SOF FIX dowels on the circumferential joints.

- Technopref will not assume any responsibility towards the structural engineering of the segments; hence, no money is carried in our price for any required structural engineering checks and verifications.

- Bonding (if required) is not included in this price.

- No hold back or retainage for the supply of segment-rings.

- All taxes (if any) are extra (taxes are excluded in our price).

- This proposal price is valid for a period of 30 days.

We hope that this quotation is in line with your expectations. Should you need any clarifications, please contact me.

Yours truly,

Technopref Industries Inc.

CCattelan

Carlo Cattelan, P.Eng.
Project Manager
450.569.8043 x 201
514.581.4854 mobile
450.431.4235 fax

TECHNOPREF INDUSTRIES INC.
P.O. Box 37
Blairsville, PA, 15717
Tel: (724) 459-6811
Fax : (724) 459-6779

TECHNOPREF INDUSTRIES INC.
170, Roland-Godard Boulevard
St-Jerome (Quebec) J7Y 4P7, Canada
Telephone : (450) – 569-8043
Fax : (450) – 431-4235

EXIT SHAFTS

USE SLURRY WALL FOR SUPPORT
SOCKET INTO ROCK
SUBCONTRACT SAME
NICHOLSON
TREVI ICOS
BENCOR
MALCOLM DRILLING

USE $300/FT²

MAKE SHAFT RECTANGULAR 50' ± DEEP
60' X 40' INSIDE
= 10000 FT²

SUB COST 3,000,000

EXCAVATE SAME
= 4000 CY
USE CRANE 6CY BUCKET
CAT 939 MUCKER
MUCK AT RATE OF 25CY/HR
4000/25 = 160 HOURS

EXIT SHAFTS

200 T CRANE	160	4000
CAT 966	160	6080
CAT 939	160	5440
EQUIPMENT OPERATING		$ 15,520

LABOR

1 CRANE OPER	160 HRS	
1 OILER		
1 CAT 966 OPER		
1 CAT 939 OPER		
2 MINERS	320 HRS	
1 TOPMAN		83,890
1 MECH		
OTF OF 1.03		= $ 86,400

CONSUMABLES

MISC STL'S 10% $ 8,700

FLOOR SLAB

ASSUME 3' THICK = 270 CY

RE-BAR 26000 #

EXIT SHAFTS

POUR FLOOR SLAB 40 HRS

CRANE OPER

OILER

966 OPER

4 MINERS

TOPMAN

434.58 (40) (1.03) = 17,905

MISC STÉS = 2000

CONC 270 CY @ 125 33750

REBAR 26,000 13000

℄ CHEMICAL GROUT 4EA TUNNEL EYES FOR TBM EXIT - GO BACK 12'-0"

VOLUME = USE 20 EFFECTIVE AREA 3' AROUND TUNNEL

VOID VOLUME MAX = 17% = 641 CF

= 4800 gallons

4 SHAFT EYES = 19200 gallons

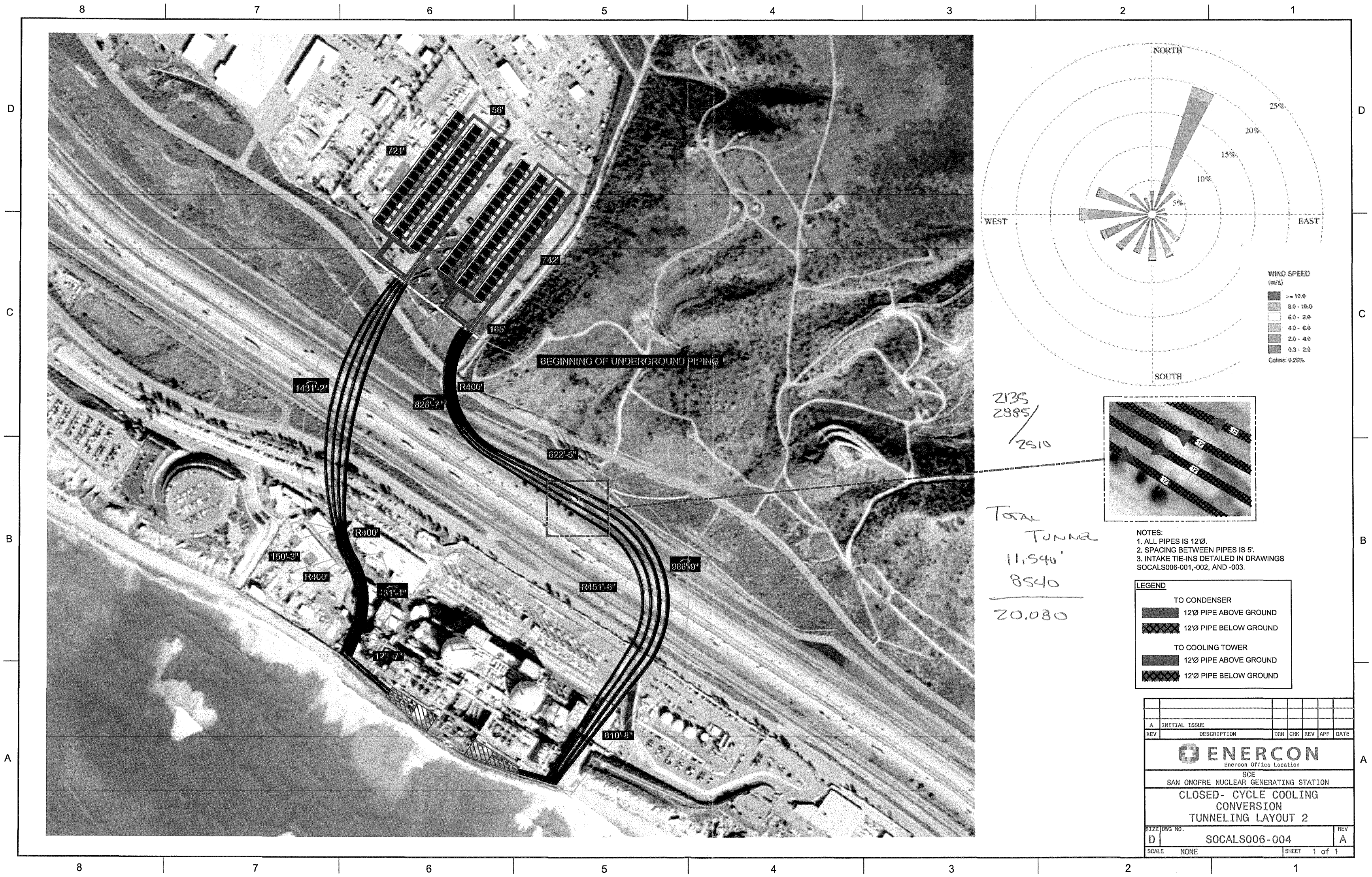
SILICATE GROUTS

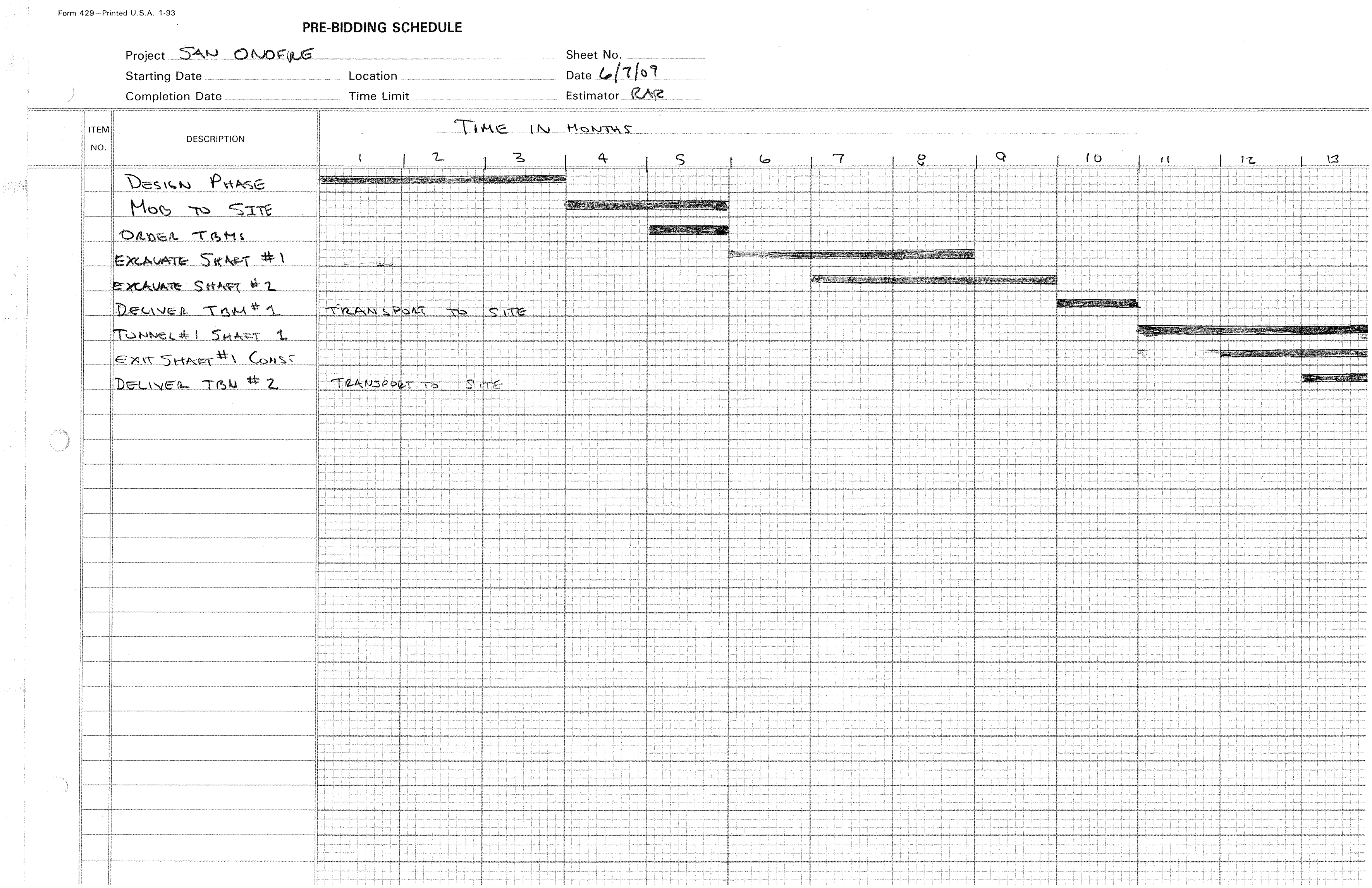
AGAIN SUBCONTRACT (19.200)(10) = $192,000

EXIT SHAFT SUMMARY EACH

SLURRY WALL	SUB	3,000,000
EXCAVATION		126,140
FLOOR SLAB		66,655
GROUT		192,000
MUCK REMOVAL	8000T	120,000
	TOTAL/SHAFT =	3,504,795

2 SHAFTS = 7,009,590


NORTH
SOUTH
WEST
EAST
5%
10%
15%
20%
25%
WIND SPEED (m/s)
Calms: 0.29%
56'
721'
742'
165'
BEGINNING OF UNDERGROUND PIPING
R400'
1431'-2"
826'-7"
622'-5"
R400'
150'-3"
R400'
R451'-6"
810'-6"
2135
2885
2510
TOTAL TUNNEL
11,540'
8540
20.080
NOTES:
1. ALL PIPES IS 12'Ø.
2. SPACING BETWEEN PIPES IS 5'.
3. INTAKE TIE-INS DETAILED IN DRAWINGS SOCALS006-001,-002, AND -003.
LEGEND
TO CONDENSER
12'Ø PIPE ABOVE GROUND
12'Ø PIPE BELOW GROUND
TO COOLING TOWER
12'Ø PIPE ABOVE GROUND
12'Ø PIPE BELOW GROUND
A INITIAL ISSUE
REV DESCRIPTION DRN CHK REV APP DATE
ENERCON
Enercon Office Location
SCE
SAN ONOFRE NUCLEAR GENERATING STATION
CLOSED- CYCLE COOLING CONVERSION
TUNNELING LAYOUT 2
SIZE D
DWG NO. SOCALS006-004
REV A
SCALE NONE
SHEET 1 of 1


Form 429—Printed U.S.A. 1-93
PRE-BIDDING SCHEDULE
Project SAN ONOFRE
Sheet No.
Starting Date
Location
Date 6/7/09
Completion Date
Time Limit
Estimator RAR
ITEM NO.
DESCRIPTION
TIME IN MONTHS
1 2 3 4 5 6 7 8 9 10 11 12 13
DESIGN PHASE
MOB TO SITE
ORDER TBMS
EXCAVATE SHAFT #1
EXCAVATE SHAFT #2
DELIVER TBM #1
TRANSPORT TO SITE
TUNNEL #1 SHAFT 1
EXIT SHAFT #1 CONST
DELIVER TBM #2
TRANSPORT TO SITE

Form 429—Printed U.S.A. 1-93

PRE-BIDDING SCHEDULE

Project SAN ONOFRE   Sheet No. 2
Starting Date   Location   Date
Completion Date   Time Limit   Estimator RAK

ITEM NO.	DESCRIPTION	14	15	16	17	18	19	20	?·41	42	43	44	45	46
	TUNNEL #1 (CONT													
	CONST EXIT SHAFT #1													
	TUNNEL #1 SHAFT #2													
	CONST EXIT SHAFT # 2													
	SS													
	TUNNEL# 2.3.4 SHAFT #1													
	CONCRETE SHAFT # 1													
	TUNNELS 2.3.4 SHAFT 2													
	DEMOBILIZE PROJECT	2 MONTHS TAKES YOU TO MONTH 48												

RESUME OF ROBERT A. RESEIGH
Underground Construction
Consultant – Tunnels, Shafts, Mine Development

376 Summer Ridge Road **(406) 599-3696**
Bozeman, Montana 59715 **rar@theglobal.net**

EDUCATION

Colorado School of Mines
Master of Science, Engineer of Mines, 1968

AREAS OF EXPERTISE

Bob Reseigh's expertise in construction developed from a career that spans more than 40 years and includes specializing in underground construction, both domestically and overseas. He is one of the most experienced and knowledgeable individuals in the country in deep shaft and drill and blast tunnel work, having been responsible for in excess of 6 miles of shaft sinking and 55 miles of tunnel/horizontal mine development during his career.

WORK EXPERIENCE

2005-Present **Consultant.** Bozeman, Montana
Tunnels, Shafts, Mine Development Projects

1990-2005 **Atkinson Construction Company.** Lakewood, Colorado
Executive Vice President. Complete responsibility for all construction projects performed by Atkinson, a subsidiary of Clark Construction, Bethesda, MD.

2005-2007 McCormick Place West Hall Expansion Storm Water Tunnel. Chicago, Illinois. This design/build project for the expansion of the downtown convention center provides a storm water drainage system for the new complex. The tunnel was constructed via a TBM and consists of 3,450 LF x 12.5-FT diameter. The project also included 300-FT of drop and outlet shafts.

2005-2007 West APM Tunnel. Washington, D.C. Automated People Mover Tunnel constructed on the west side of Dulles Airport to provide rapid passenger transport from the main terminal to Concourse B. Required the construction of 2,250 LF of cut and cover tunnel (3 sections) and 1,860 LF by NATM techniques (2 sections).

2005-2007 East APM Tunnels and Stations. Washington, D.C. Automated People Mover Tunnel constructed on the east side of Dulles Airport to provide rapid passenger transport from the main terminal to Concourse B and future tiers 2 and 3. Required 5,900 LF of cut and cover tunnel (2 sections), 825 LF by NATM techniques (2 sections) and 4,400 LF by Earth Pressure Balanced TBMs.

2004-2007 Claremont Tunnel Seismic Upgrade. Berkeley/Oakland, California. Construction of a 2,000 LF x 16 FT horseshoe bypass tunnel to insure the integrity of the existing 18,065 LF water tunnel. Excavation was performed primarily by an AM-75 Roadheader along with drill-blast and the use of a mini-excavator across the fault zone. The finished tunnel incorporated a steel liner through the Hayward Fault for stabilization in the event of an earthquake.

2003-2005 Leeville Shafts Project. Carlin, Nevada. Project included the excavation of a 22-FT-diameter x 1,900-FT concrete-lined production shaft for a new gold mine, a 20-FT-diameter x 1,650-FT ventilation/exhaust shaft, and sinking plant set-ups for both shafts, as well as equipment for both shafts. Included drill-blast excavation of a 1,500 FT x 15-FT horseshoe drift to connect two levels of the new mine.

2002-2003 Capitol Peak Tunnel Complex. White Sands, New Mexico. Excavation of a tunnel complex that included two inter-connected tunnels and two stub portal tunnels ranging from 13 FT wide x 13 FT high to 20 FT wide x 16 FT high and a 40-FT-wide x 20-FT-high connecting alcove, incidental underground facilities, and an access road at White Sands Missile Range. A total of 1,850 FT of tunnel was excavated by drill-blast.

2002-2004 Blue Ridge Low Level Outlet Project. Blue Ridge Dam, Georgia. Construction of a low-level inlet/outlet structure in the dam involving design-build of a 975-FT x 12-FT-diameter drillblast tunnel, cofferdam, flow control devices, hydraulic energy dissipation systems, and wet lake tap.

2001 Mission Valley East Extension Light Rail Project. San Diego, California. 1,085-FT underground tunnel (37 FT wide x 29 FT high) via the New Austrian Tunneling Method (NATM) at San Diego University. Included cast-in-place cut and cover tunnel (2,915 FT), underground station, and installation of mechanical, electrical, communications, and utilities.

2001 Carolina Power & Light Surge Shaft Repair Project. North Carolina. Fast-track concrete lining and grouting project incorporating innovative shaft set-up inside a surface surge tank.

2000-2005 Independent Salt No. 2 Shaft Repair. Kanopolis, Kansas. Provided custom work decks and set-up to repair 600 FT of one compartment of an 80-year-old timbered shaft. Removed old timber and caved clay followed by installation of new timbers with concrete backing. Work scheduled for two years.

1999-2001 U1h Shaft Project. Nevada Test Site, Nevada. Design-build of a 113-FT-deep shaft collar, installation of sinking set-up, and excavation of a 1,045-FT-deep, 20-FT-diameter combination ventilation/access shaft.

2000	No. 2 Shaft Rehabilitation Project. Carlsbad, New Mexico. Conversion and update of a 900-FT-deep, three compartment man/service shaft to a production skip shaft. Consolidation grouting included, along with underground excavation and installation of load-out pockets.
1996-1998	Minorco Lisheen. Tipperary, Ireland. Designed an underground lead and zinc mine. Major features were a 1,800-meter, 15 percent decline, underground crushing, and conveyance to a surface secondary crushing and milling plant, plus four shafts used for ventilation and secondary means of egress.
1996-1998	American Rock Salt. Rochester, New York. Designed a new mine 2.5 million tons/year of salt. Major features were two-each 1,600-FT-deep shafts plus related underground development, and load-out facilities.
1996-1999	P-1 Pressure Tunnel. Hemet, California. 2,500 FT of drill blast tunnel with a 16-FT ID steel liner encased in concrete, plus two-each drainage and grouting tunnels each 1,600 LF x 16-FT-diameter excavated by drill blast techniques.
1995-1996	Parsa Project. Dead Sea, Israel. 1,200 LF of tunnel, 4m x 4m. Extensive ground constraint grouting program and extensive core drilling to determine geophysical formations that exist to aid in the design for future pump storage.
1995-1996	Sapir Pumping Plant Mekoroth Water Company. Tiberias, Israel. Extensive grouting and repair program on the underground pumping plant. The pits and underground structure were leaking over 2,500 gpm of potable water. Program reduced leaks to less than 20 gpm.
1994-1996	Conrail Project. Altoona, Pennsylvania. Enlargement of two existing tunnels totaling 4,300-FT for double-stacked rail cars on double-track railroad. Used drill blast techniques plus robotic shotcrete equipment.
1992-1993	SSC Project Medium Energy Booster. Waco, Texas. 18,000 LF of 15-FT-diameter tunnel. Tunnel excavated utilizing TBM and road headers.
1989-1993	Kemano Power Tunnel. British Columbia, Canada. Ten-mile, 19-FT-diameter tunnel for Alcan, located at a remote camp site in upper British Columbia. Excavated using a Robbins TBM.
1989-1991	E-8a Greenbelt Route Metro Subway Project. Greenbelt, Maryland. Twin subway soft ground tunnels for WMATA, 6,000 FT long each. Precast segments were installed in conjunction with a digger shield.
1990-1991	Staten Island Sewer Tunnel. New York City, New York. 1,270 LF of Earth Pressure Balance sewer tunnel for the City of New York.

1990-2000 Boston Outfall Tunnel. Boston, Massachusetts. Ten-mile-long outfall tunnel, 26-FT finished diameter plus 55 diffusers to be utilized in conjunction with the new sewage treatment plant.

1991-1993 Grizzly Powerhouse. Quincy, California. 12,100 LF, 11-FT-diameter power tunnel for Pacific Gas and Electric Company. Tunnel was excavated using NATM tunneling in conjunction with conventional tunnel boring.

1991-1993 Ortiz Project. Taos, New Mexico. Construction management of open-pit gold mine, including some pit planning, ore and waste control.

1989 Dynatec Mining Corporation

V**ice President-Operations**.
Responsible for operating projects in the United States, including mine development, raise drilling, construction, and shaft sinking. Key projects included Montanore Project consisting of 6 miles of NATM decline near Libby, Montana, and McCoy Mine, Battle Mountain, Nevada, Contract Mining.

1971-1989 Peter Kiewit Sons, Inc.

Area Manager. (1985–1989). Precious Metals Mine Projects. Reno, Nevada.
Responsibilities included managing the design and engineering of precious metals mines and evaluating properties for acquisition. Projects included Rawhide Mine, Contract Mining, and acquisition in Nevada, and numerous outside contract open-pit mining and engineering projects in Nevada and Montana.

District Manager and Vice President. **(1983–1985).** District Office, Gilbert Underground in Omaha, Nebraska.

1984-1985 Asamera Gold Corp. Wenatchee, Washington. Excavation of 15,000 LF of decline and horizontal work including complete construction of an 18-FT-diameter x 900-FT production shaft and installation of an underground crushing and conveying plant.

1984 Dept. of Interior, Grand Coulee Dam. Washington. Instrumentation and monitoring shaft. Complete dewatering and sinking of two observation and instrumentation shafts x 300-LF at Grand Coulee Dame for the Bureau of Reclamation.

1984-1987 Bad Creek Pump Storage - Duke Power. Clemson, South Carolina. Complete construction of the Bad Creek pump storage underground power plant. Work included two-each 30-FTdiameter x 1,000 FT deep intake shafts, four-each intake tunnels complete with manifold, plus four-each tailrace tunnels, ventilation shafts, and complete underground powerhouse and access tunnels.

More than 1 million CY of underground excavation and placing of 150,000 CY of structural concrete.

1982-1983 **Project Manager.** Parachute Slope Project. Parachute, Colorado.
Conveyor tunnel, access tunnels and related work for Colony Shale Oil Project. This included installation of the world's largest primary crushing facility.

1978-1983 **Project Manager.** Cathedral Bluff's Oil Shale Venture. Rio Blanco, Colorado.
Four concrete-lined shafts: two 34-FT-diameter, one 29-FT-diameter, and one 15-FT-diameter. The shafts were 2,000 FT deep with five levels of underground development. Five miles of horizontal development work, plus installation of over 6,000 tons of structural shaft steel, loading pockets, and numerous pumping plants capable of handling in excess of 6,000 gpm.

1977-1978 **Senior Engineer Estimator**. Shafts and Caverns District Office in Omaha, Nebraska. Responsibilities included estimating and bidding new work.

1974-1977 **Project Manager.** Carr Fork Project. Tooele, Utah. Two 19-FT-diameter x 4,000 FT deep concrete-lined shafts to include installation of two loading pockets, three main pump stations, plus main mining level development on three levels; enlargement of 6,500-FT tunnel from 7 FT x 7 FT to 18 FT x 18 FT; and installation of a complete underground facility to sink an internal shaft to include related stations, head frame, rope raise, ore and waste raises, and hoist room.

1973-1974 **Job Superintendent.** Section 19 Mine. Grants, New Mexico. Construction of station facilities on two levels to include slusher trench, pump station, sumps, ore passes and waste passes, 9,100 FT of 9-FT x 9-FT main haulage drifting, manway and ore raises.

1971-1974 **Project Engineer, Assistant Superintendent.** Section 35 Mine. Church Rock, New Mexico. One 1,850-FT-deep concrete-lined shaft, including pump stations, slusher trench, sumps, ore and waste passes, and 3,000-FT of haulage drifting. The mine required handling of 2,000 gpm during shaft and station construction. Various extensive grouting techniques were utilized.

1969-1971 **United States Army**

1968-1969 **Dixilyn Corporation Mine.** Silverton, Colorado
Engineer. 7,000-foot haulage drift and surface facility.

1962-1968 **Colorado Department of Highways**
Survey Party Chief. Various state highway projects.

Excellence—Every project. Every day.

RECORD OF TELECON

BETWEEN: Ashlie Brown of Enercon Services, Inc.

AND: Vicki Norman of Jones Lang LaSalle # (817) 230-2628

SUBJECT: Permits for Tunneling under BNSF Railway Lines

DATE: 04/27/2009

DISCUSSION: Ms. Brown began the discussion by describing the tunneling project under consideration; eight circulating water pipes of 12' diameter would cross under the railway near San Onofre Nuclear Generating Station (SONGS). As the Burlington Northern Santa Fe (BNSF) Railway is the sole carrier of freight on that line, the tunneling project would need to meet the BNSF guidelines for pipeline crossings. Ms. Norman stated that each pipe would require a separate tunneling permit, due to the large diameter. As a rough guideline for pricing, Ms. Norman estimated that a permit for each pipe crossing no greater than 200 feet long would cost $2500. For pipe crossings longer than 200 feet, the permit price would be determined on a $/ft basis. In addition, the BSNF railroad would require Railroad Protective Liability Insurance (RPLI), which could cost ~$1000 for each bore. The permit application processing fee would be $600. Ms. Norman will send the permit application and BNSF Utility Accommodation Policy to Ms. Brown through email.

Excellence—Every project. Every day.

RECORD OF TELECON

BETWEEN: Ashlie Brown of Enercon Services, Inc.

AND: John Markey of CalTrans Encroachment Permits Branch # (619) 688-6158

SUBJECT: Permits for Tunneling under Interstate 5

DATE: 05/11/2009

DISCUSSION: Ms. Brown began the discussion by describing the tunneling project under consideration; eight circulating water pipes of 12' diameter would cross under Interstate 5 near San Onofre Nuclear Generating Station (SONGS). The tunneling project would need to meet the CalTrans guidelines for pipeline crossings. Mr. Markey stated the magnitude of the tunneling project is larger than anything discussed in the general pipeline crossing guidelines and would require a site-specific engineering study. In addition, a minimum spacing of twice the casing diameter would be required between each pipe. Mr. Markey estimated the casing diameter to be 13' for a 12' diameter pipe, requiring a spacing of 26' between each of the eight pipes to be installed.