

002543
HARZA-EBASCO

Susitna Joint Venture
Document Number

2543

Please Return To
DOCUMENT CONTROL

SUSITNA PROJECT

WATANA DAM UNDERGROUND EXCAVATION

FEASIBILITY LEVEL ESTIMATE

VOLUME III

HARZA-EBASCO SUSITNA JOINT VENTURE

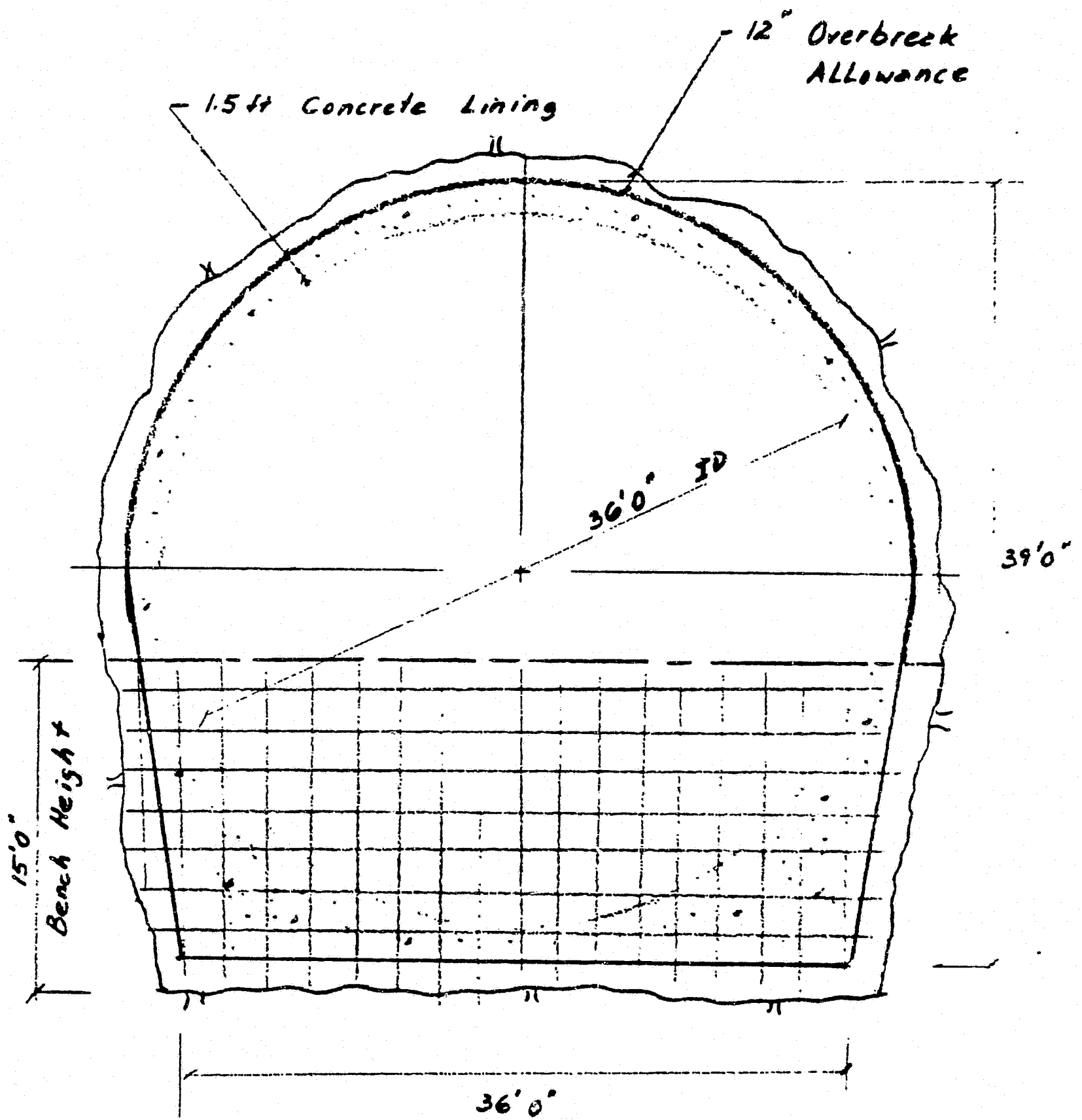
MARCH 1984

TUNNELS - WATANA

EXCAVATION

DIRECT UNIT COSTS

<u>Item #</u>	<u>Description</u>	<u>\$/LF</u>	<u>\$/CY</u>
332.211	Diversion Tunnel 39' Diameter	2254	46.85
332.212	Diversion Tunnel 48' Diameter	2996	42.29
331.120	Access Tunnel 35 X 28' (benched)	2017	62.20
331.121	Access Tunnel 25 X 20	1853	110.09
331.123	Access Tunnel 10 X 10'	707	207.51
331.126	Access Tunnel 12 X 14'	850	150.55
331.151	Bus Tunnel Horizontal 22 X 22	1846	110.41
331.152	Bus Tunnel Inclined 16 X 16	1532	166.47
332.210	Access Tunnel to Gate Chamber 15X20	1081	105.24
332.321	Grouting Gallery 10 X 10'	539	158.16
332.322	Grouting Gallery Inclined 10 X 10'	826	242.30
332.512	Outlet Tunnel 31' Diameter	2075	69.06
332.51A	Outlet Tunnel 31' Diameter- Inclined	2316	77.06
332.51B	Manifold Tunnel 11' Dia	766	191.47
332.810A	Penstock 27' Dia	1816	75.34
332.812	Penstock 21' Dia	1342	92.04
332.812B	Penstock 18' Dia	1128	105.36
332.911	Tailrace Tunnel-Modified Horseshoe	2140	52.70
332.811	Penstock Shafts 27' Dia	2918	137.59
332.323	Grout Gallery Shafts 10 X 10'	1497	403.02
332.712	Vent Shaft 8.5' Dia	1289	613.65
332.131	Access Shaft 23' Dia	2359	153.28
331.171	Bus Shaft 10.5' Dia	1266	394.87
- Transformer Gallery Cavern		\$54.72/BCY	
- Powerhouse Cavern		\$51.00/BCY	
- Surge Chamber		\$63.14/BCY	



TOP HEADING & BENCH EXCAVATION SCALE 0 2 ft

SUSITNA - NATANA

DIVERSION TUNNEL

HARZA ENGINEERING CO., CHICAGO
APPROVED.....

DATE

DWG. NO.

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HARZA ENGINEERING COMPANY	
DIRECT COST ESTIMATE	
ITEM: DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER	QUANTITY: 7220.FT
PROJECT: SUSITNA	DATE: FEB 15, 1984 -
FILE NO: 1563	EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 39.0 X 36.0 FT

ANGLE OF ARCH = $2 \times (\arccos 19.5 - 19.5 / 19.5) = 3.14$ RADIANS

ARCH AREA = $0.5 \times (19.5) \times 2 (3.14 - \sin 3.14) = 597.3$ FT-2

BCY/LF = $(597.3 + 4.5 \times 36.0) / 27 = 28.1$ BCY/LF

PERIMETER = $3.14 \times 19.5 + 2.0 \times 4.5 + 36.0 = 106.3$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $106.3 / 24. / 12 = 54.$

AREA OF PATTERN = $759.30 \text{ FT}^2 - 24.0 / 12.0 \times 106.3 = 546.8$ FT-2

PATTERN HOLES @ 3.0 X 3.0 = $546.8 / 9.00 = 61.$

TOTAL HOLES = $54. + 61. = 115.$

NUMBER OF DRILLS = 1 - 6 — DRILLS = 6.

NUMBER OF HOLES/DRILL = $115. / 6. = 19.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $115. \times 12. / 11. \times 7220. = 904861. \text{ LF}$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER  QUANTITY: 7220.FT
PROJECT:  SUSITNA  DATE: FEB 15, 1984 -
FILE NO:  1563  EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	0.50 HRS
DRILL 19. HOLES/DRILL X 12.0 @ 60. FT/HR	3.83 HRS
LOAD 19. HOLES/MINER @ 3.0 MIN/EA	1.15 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 2. \times 0.83 \times 50.00 = 296.31 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 28.12 \text{ BCY/LF} \times 11.0 \text{ LF} = 309.34$$

$$\text{MUCK TIME} = 309.34 \text{ BCY} \times 1.14 \text{ (OB)} / 296.31 = 1.19 \text{ HRS}$$

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.19- 3.83- 1.15- 0.50	0.00 HRS
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TOTAL CYCLE TIME

5.98 HRS

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 5.98 = 37. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY	
DIRECT COST ESTIMATE	
ITEM: DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER	QUANTITY: 7220.FT
PROJECT: SUSITNA	DATE: FEB 15, 1984 -
FILE NO: 1563	EST. BY RAM D/OEB

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BENCH EXCAVATION

BENCH DIMENSIONS : 36.0 X 15.0 FT

BCY/LF = $36.0 \times 15.0 / 27 = 20.0$ BCY/LF

PERIMETER = $36.0 + 2 \times 30.0 = 96.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $96.0 / 24. / 12 = 48.$

PATTERN HOLES = $36.0 \times 30.0 / 25.00 \text{ FT-2/HOLE} = 43.$

TOTAL HOLES = $48. + 43. = 91.$

NUMBER OF DRILLS = 6.

NUMBER OF HOLES/DRILL = $91. / 6. = 15.2$

TOTAL LF OF HOLE = $91. \times (15.0 + 1) \times 7220.0/30.0 = 351181. \text{ LF}$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER  QUANTITY: 7220.FT
PROJECT:  SUSITNA  DATE: FEB 15, 1984 -
FILE NO: 1563  EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	0.50 HRS
DRILL 91. HOLES X 16.0 DEPTH/ 60. FT/HR X 6.	4.05 HRS
LOAD 91. HOLES X 3.0 MIN/EA /50 MIN/HR X 6.	0.91 HRS
SHOOT AND SMOKE	0.50 HRS
MUCKING OPERATION:	
MUCK TIME = 600.00 BCY X 1.14 (OB)/ 296.31 = 2.31 HRS	
(ACTUAL CYCLE) MUCK TIME = 2.31- 4.05- 0.91 = 0.00 HRS	
TOTAL CYCLE TIME	5.97 HRS

USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 30.0 LF/ROUND X 2. X 10. / 5.97 = 101. LF/DAY

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER

PROJECT: SUSITNA

FILE NO: 1563

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QUANTITY: 7220.FT

DATE: FEB 15, 1984 -

EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 200.0 FT @ 18. LF/DAY (50.0 %)	10.9 DAYS
REMAINING 7020. FT @ 37. FT/DAY	190.8 DAYS
BENCH EXCAVATION 7220. FT @ 101. FT/DAY	71.8 DAYS
TURN UNDER AT TUNNEL PORTALS	4.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	4.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	2.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	6.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	1.0 DAYS

TOTAL EXCAVATION TIME	290.4 DAYS

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER QUANTITY: 7220.FT
PROJECT: SUSITNA DATE: FEB 15, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

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CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	6.0	6.0	0.0	12.0	35.64	4276.80
CHUCK TENDER	6.0	6.0	0.0	12.0	34.91	4189.20
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	5.0	5.0	0.0	10.0	39.37	3937.00
SUBTOTAL	23.5	23.5	0.0	47.0		17485.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 17485.40

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER QUANTITY: 7220.FT
PROJECT: SUSITNA DATE: FEB 15, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

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EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0	DRILLS	42.01 X 20. HRS	5041.20
6.0	AIR COMPRESSORS 600	40.36 X 20. HRS	4843.20
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
2.0	FEL 988	115.74 X 20. HRS	4629.60
5.0	R 355	62.64 X 20. HRS	6264.00
SUBTOTAL			21803.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 21803.00 X 75.0/100.0 = \$ 16352.25 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
347441.19	BCY	POWDER & CAPS	6.80	2362600.00
*****	LF	BITS & STEEL	0.40	502416.76
150.00	EA	STEEL SUPPORTS (40 LB/FT)	4250.00	637500.00
7500.00	EA	ROCKBOLTS (15FT)	127.00	952500.00
410.00	CY	SHOTCRETE (3")	450.00	184500.00
7220.00	LF	AIR AND WATER DISCHARGE	30.00	216600.00
7220.00	LF	FAN LINES	25.00	180500.00
7220.00	LF	ELECTRIC SUPPLIES	100.00	722000.00

TOTAL COST FOR MATERIAL AND SUPPLIES \$ 5758616.85

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                HARZA ENGINEERING COMPANY.
                DIRECT COST ESTIMATE
ITEM:  DIVERSION TUNNEL 39 FT EXCAVATED DIAMETER  QUANTITY: 7220.FT
PROJECT:  SUSITNA  DATE: FEB 15, 1964 -
FILE NO:  1563  EST. BY RAM D/OEB
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SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 290. DAYS

LABOR COSTS:
 290. X \$ 17485.40 / DAY \$ 5,077,996 703.32

EQUIPMENT COSTS:
 290. X \$ 16352.25 / DAY \$ 4,748,914 657.74

MATERIALS & SUPPLIES: \$ 5,758,616 797.59

S T & S +/-15% OF LABOR \$ 692,130 95.86

 TOTAL DIRECT COST \$ 16,277,658 2254.52

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 16,277,658 X 1.00 = \$ 16,277,658

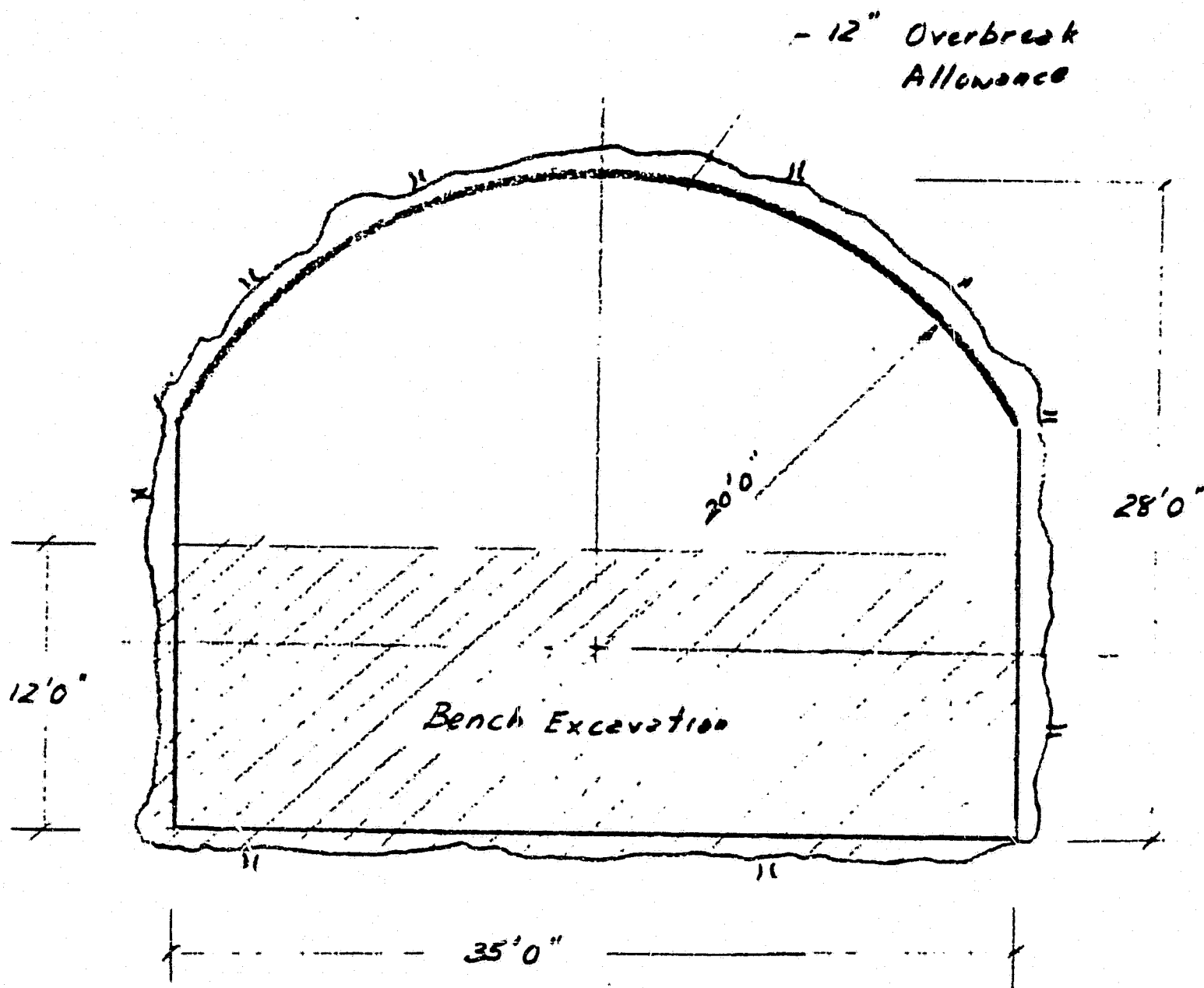
UNIT PRICE PER LF = 16,277,658 / 7220. = \$ 2254.52 / LF

UNIT PRICE PER CY = 16,277,658 / 7220. X 48.1 = \$ 46.85 /

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 290. DAYS X 47. MEN / 7220. LF = 1.09 MD/LF
- MAN-DAYS/CY = 290. DAYS X 47. MEN / 7220. LF/48.12 = 0.04 MD/C

ACCESS TUNNEL
35 x 20



TOP HEADING & BENCH EXCAVATION

Scale 0 2"

SUSITNA - WATANA

ACCESS TUNNELS

HARZA ENGINEERING CO., CHICAGO

APPROVED.....

DATE

DWG. NO.

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HARZA ENGINEERING COMPANY		
DIRECT COST ESTIMATE		
ITEM:	ACCESS TUNNEL 35 X 28 FT HEIGHT	QUANTITY: 2970.FT
PROJECT:	SUSITNA - 331.120	DATE: FEB 16, 1984 -
FILE NO:	1563	EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 28.0 X 35.0 FT

ANGLE OF ARCH = $2 \times (\arccos 20.0 - 10.4 / 20.0) = 2.14$ RADIANS

ARCH AREA = $0.5 \times (20.0) \times 2 (2.14 - \sin 2.14) = 259.6$ FT-2

BCY/LF = $(259.6 + 5.6 \times 35.0) / 27 = 16.9$ BCY/LF

PERIMETER = $2.14 \times 20.0 + 2.0 \times 5.6 + 35.0 = 89.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $89.0 / 24. / 12 = 45.$

AREA OF PATTERN = $455.62 \text{ FT}^2 - 24.0 / 12.0 \times 89.0 = 277.6$ FT-2

PATTERN HOLES @ 3.0 X 3.0 = $277.6 / 9.00 = 31.$

TOTAL HOLES = $45. + 31. = 76.$

NUMBER OF DRILLS = $3 - 2 =$ DRILLS = 6.

NUMBER OF HOLES/DRILL = $76. / 6. = 13.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $76. \times 12. / 11. \times 2970. = 247369. \text{ LF}$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 35 X 28 FT HEIGHT
PROJECT: SUSITNA - 331.120
FILE NO: 1563

QUANTITY: 2970.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 13. HOLES/DRILL X 12.0 @ 60. FT/HR	2.54 HRS
LOAD 13. HOLES/MINER @ 3.0 MIN/EA	0.76 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 12.50 \times 0.85 \times 0.60 = 6.37$$

$$\text{BCY/HR} = 6.37 \times 1. \times 0.83 \times 50.00 = 264.56 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 16.87 \text{ BCY/LF} \times 11.0 \text{ LF} = 185.62$$

$$\text{MUCK TIME} = 185.62 \text{ BCY} \times 1.20 \text{ (OB)} / 264.56 = 0.84 \text{ HRS}$$

TOTAL CYCLE TIME	5.65 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 5.65 = 39. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 35 X 28 FT HEIGHT
PROJECT: SUSITNA - 331.120
FILE NO: 1563

QUANTITY: 2970.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

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BENCH EXCAVATION

BENCH DIMENSIONS : 35.0 X 12.0 FT

BCY/LF = $35.0 \times 12.0 / 27 = 15.6$ BCY/LF

PERIMETER = $35.0 + 2 \times 30.0 = 95.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $95.0 / 24. / 12 = 48.$

PATTERN HOLES = $35.0 \times 30.0 / 25.00 \text{ FT-2/HOLE} = 42.$

TOTAL HOLES = $48. + 42. = 90.$

NUMBER OF DRILLS = 6.

NUMBER OF HOLES/DRILL = $90. / 6. = 14.9$

TOTAL LF OF HOLE = $90. \times (12.0 + 1) \times 2970.0 / 30.0 = 115187. \text{ LF}$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  ACCESS TUNNEL 35 X 28 FT HEIGHT      QUANTITY: 2970.FT
PROJECT:  SUSITNA - 331.120                DATE: FEB 16, 1984 -
FILE NO:  1563                             EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 90. HOLES X 13.0 DEPTH/ 60. FT/HR X 6.	3.23 HRS
LOAD 90. HOLES X 3.0 MIN/EA /50 MIN/HR X 6.	0.90 HRS
SHOOT AND SMOKE	0.50 HRS
MUCKING OPERATION:	
MUCK TIME = 466.67 BCY X 1.20 (OB)/ 264.56	= 2.11 HRS
(ACTUAL CYCLE) MUCK TIME = 2.11- 3.23- 0.90	= 0.00 HRS
TOTAL CYCLE TIME	5.63 HRS

USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 30.0 LF/ROUND X 2. X 10. / 5.63 = 107. LF/DAY

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 35 X 28 FT HEIGHT

PROJECT: SUSITHA - 331.120

FILE NO: 1563

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QUANTITY: 2970.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/O:B

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BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 200.0 FT @ 19. LF/DAY (50.0 %)	10.3 DAYS
REMAINING 2770. FT @ 39. FT/DAY	71.1 DAYS
BENCH EXCAVATION 2970. FT @ 107. FT/DAY	27.9 DAYS
TURN UNDER AT TUNNEL PORTALS	4.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	6.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	2.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	1.5 DAYS

TOTAL EXCAVATION TIME	126.7 DAYS

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 35 X 28 FT HEIGHT
PROJECT: SUSITNA - 331.120
FILE NO: 1563

QUANTITY: 2970.FT
DATE: FEB 16, 1964 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	6.0	6.0	0.0	12.0	35.64	4276.80
CHUCK TENDER	6.0	6.0	0.0	12.0	34.91	4189.20
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	20.5	20.5	0.0	41.0		15128.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 15128.80

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 35 X 28 FT HEIGHT
PROJECT: SUSITNA - 331.120
FILE NO: 1563

QUANTITY: 2970.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

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EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0	DRILLS	42.01 X 20. HRS	5041.20
6.0	AIR COMPRESSORS 600	40.36 X 20. HRS	4843.20
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	FEL 992	201.13 X 20. HRS	4022.60
3.0	R 50S	84.19 X 20. HRS	5051.40
SUBTOTAL			19983.40
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 19983.40 X 75.0/100.0 = \$ 14987.55 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
96318.33	BCY	POWDER & CAPS	6.80	654964.63
362555.22	LF	BITS & STEEL	0.40	145022.09
60.00	EA	STEEL SUPPORTS (40 LB/FT)	3120.00	187200.00
3000.00	EA	ROCKBOLTS (15FT)	127.00	381000.00
110.00	CY	SHOTCRETE (3")	450.00	49500.00
2970.00	LF	AIR AND WATER DISCHARGE	30.00	89100.00
2970.00	LF	FAN LINES	25.00	74250.00
2970.00	LF	ELECTRIC SUPPLIES	100.00	297000.00

TOTAL COST FOR MATERIAL AND SUPPLIES \$ 1878036.72

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 35 X 28 FT HEIGHT

PROJECT: SUSITNA - 331.120

FILE NO: 1563

QUANTITY: 2970.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

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SUMMARY OF COSTS

NUMBER OF DAYS

FOR EXCAVATION = 127. DAYS

LABOR COSTS:

127. X \$ 15128.80 / DAY \$ 1,917,169 645.51

EQUIPMENT COSTS:

127. X \$ 14987.55 / DAY \$ 1,899,270 639.48

MATERIALS & SUPPLIES: \$ 1,878,036 632.34

S T & S @ 15.% OF LABOR \$ 296,490 99.83

TOTAL DIRECT COST \$ 5,990,966 2017.16

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 5,990,966 X 1.00 = \$ 5,990,966

UNIT PRICE PER LF = 5,990,966 / 2970. = \$ 2017.16 / LF

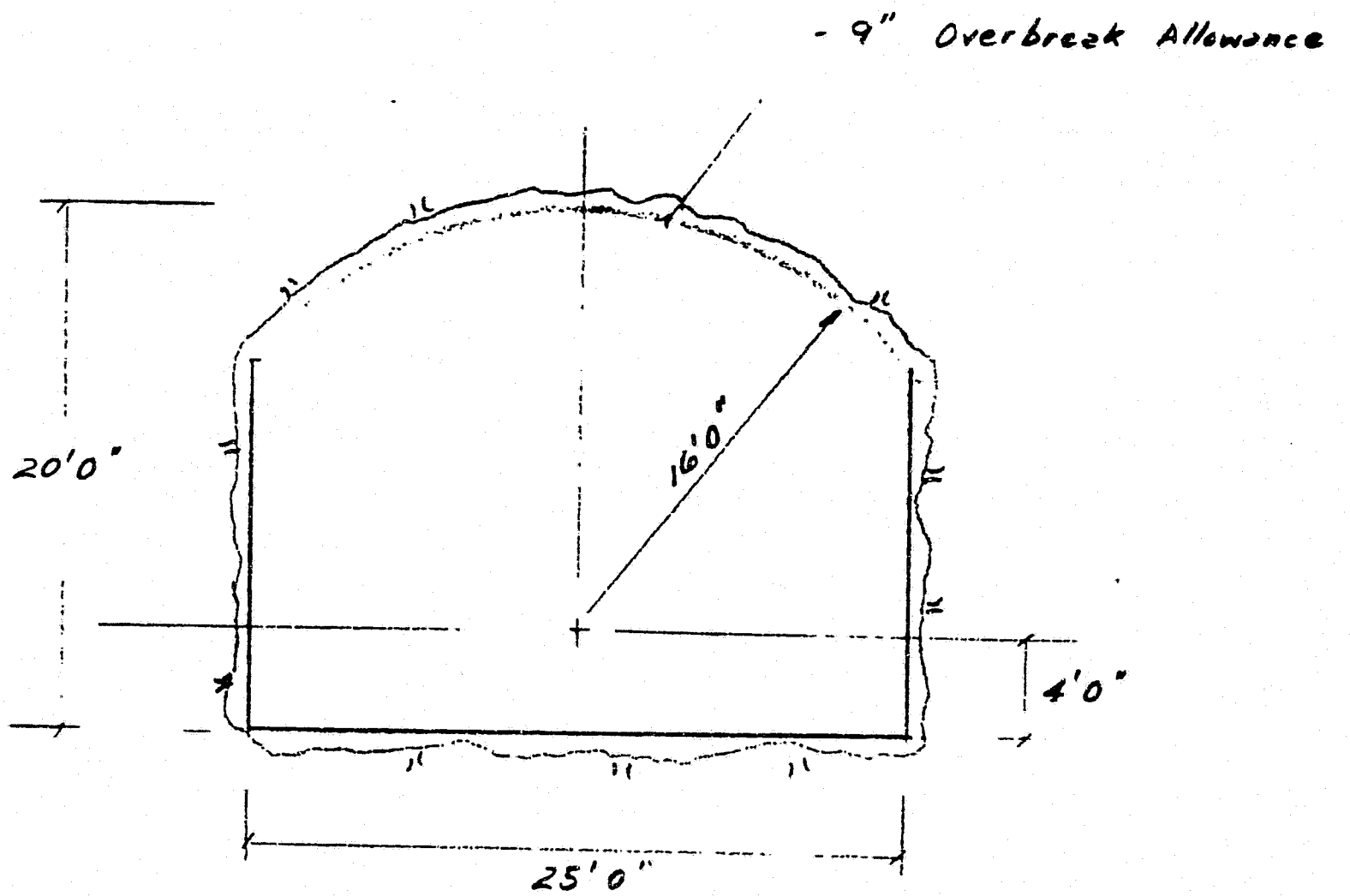
UNIT PRICE PER CY = 5,990,966 / 2970. X 32.4 = \$ 62.20 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 127. DAYS X 41. MEN / 2970. LF = 1.75 MD/LF

- MAN-DAYS/CY = 127. DAYS X 41. MEN / 2970. LF/32.43 = 0.05 MD/CY

ACCESS TUNNEL
25 x 20



Full Face Method of Excavation

Scale. 0 2'

SUSITNA - NATANA

ACCESS TUNNEL

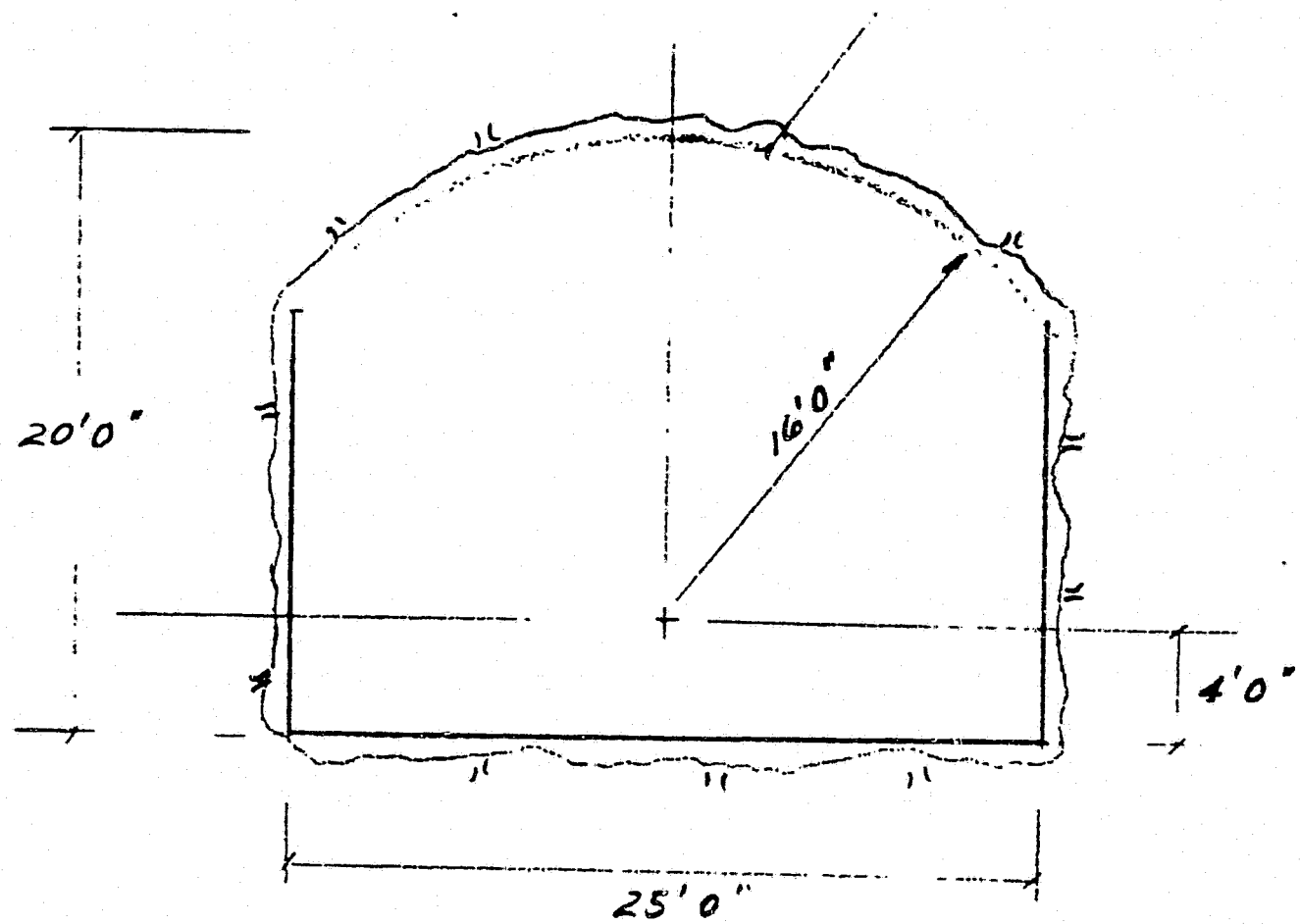
HARZA ENGINEERING CO., CHICAGO

APPROVED.....

DATE

DWG. NO.

- 9" Overbreak Allowance



Full Face Method of Excavation

Scale 0 2'

SUSITNA - NATANA	
ACCESS TUNNEL	
HARZA ENGINEERING CO., CHICAGO	
APPROVED.....	
DATE	DWG. NO.

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 25 X 20 FT HEIGHT

PROJECT: SUSITNA - 331.121

FILE NO: 1563

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QUANTITY: 180.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 20.0 X 25.0 FT

ANGLE OF ARCH = $2 \times (\arccos 16.0 - 6.3 / 16.0) = 1.83 \text{ RADIANS}$

ARCH AREA = $0.5 \times (16.0)^2 (1.83 - \sin 1.83) = 110.7 \text{ FT}^2$

BCY/LF = $(110.7 + 13.8 \times 25.0) / 27 = 16.8 \text{ BCY/LF}$

PERIMETER = $1.83 \times 16.0 + 2.0 \times 13.8 + 25.0 = 81.8 \text{ FT}$

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $81.8 / 24. / 12 = 41.$

AREA OF PATTERN = $454.43 \text{ FT}^2 - 24.0 / 12.0 \times 81.8 = 290.8 \text{ FT}^2$

PATTERN HOLES @ 3.0 X 3.0 = $290.8 / 9.00 = 33.$

TOTAL HOLES = $41. + 33. = 74.$

NUMBER OF DRILLS = $2 - 2 = \text{DRILLS} = 4.$

NUMBER OF HOLES/DRILL = $74. / 4. = 19.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $74. \times 12. / 11. \times 180. = 14573. \text{ LF}$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 25 X 20 FT HEIGHT
PROJECT: SUSITNA - 331.121
FILE NO: 1563

=====

QUANTITY: 180.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 19. HOLES/DRILL X 12.0 @ 60. FT/HR	3.71 HRS
LOAD 19. HOLES/MINER @ 3.0 MIN/EA	1.11 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 1. \times 0.93 \times 50.00 = 148.15 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 16.83 \text{ BCY/LF} \times 11.0 \text{ LF} = 185.14$$

$$\text{MUCK TIME} = 185.14 \text{ BCY} \times 1.18 \text{ (OB)} / 148.15 = 1.47 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 1.47 - 3.71 - 1.11 - 0.50 \quad 0.00 \text{ HRS}$$

TOTAL CYCLE TIME	-----
	6.32 HRS

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 6.32 = 35. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 25 X 20 FT HEIGHT
PROJECT: SUSITNA - 331.121
FILE NO: 1563

QUANTITY: 180.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 40.0 FT @ 17. LF/DAY (50.0 %)	2.3 DAYS
REMAINING 140. FT @ 35. FT/DAY	4.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	1.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	0.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	1.5 DAYS

TOTAL EXCAVATION TIME	9.3 DAYS

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 25 X 20 FT HEIGHT

PROJECT: SUSITNA - 331.121

FILE NO: 1563

QUANTITY: 100.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.10	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.00
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.00

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 25 X 20 FT HEIGHT
PROJECT: SUSITNA - 331.121
FILE NO: 1563

QUANTITY: 100.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
4.0	AIR TRACK DRILLS	42.01 X 20. HRS	3360.80
4.0	AIR COMPRESSORS 600	40.36 X 20. HRS	3228.80
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	FEL 988 (7 CY)	115.74 X 20. HRS	2314.80
3.0	R 355	62.64 X 20. HRS	3750.40
SUBTOTAL			13687.80
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 13687.80 X 75.0/100.0 = \$ 10265.85 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
3029.56	BCY	POWDER & CAPS	6.80	20601.04
14572.94	LF	BITS & STEEL	0.40	5829.18
12.00	EA	STEEL SUPPORTS (40 LB/FT)	2272.00	27264.00
180.00	EA	ROCKBOLTS (15FT)	127.00	22860.00
5.00	CY	SHOTCRETE (3")	450.00	2250.00
180.00	LF	AIR AND WATER DISCHARGE	30.00	5400.00
180.00	LF	FAN LINES	25.00	4500.00
180.00	LF	ELECTRIC SUPPLIES	100.00	18000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				106704.22

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 25 X 20 FT HEIGHT
PROJECT: SUSITNA - 331.121
FILE NO: 1563

QUANTITY: 180.11
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 9. DAYS

LABOR COSTS:

9. X \$ 12306.80 / DAY \$ 114,747 637.49

EQUIPMENT COSTS:

9. X \$ 10265.85 / DAY \$ 95,717 531.77

MATERIALS & SUPPLIES: \$ 106,704 592.80

S T & S +/-15% OF LABOR \$ 16,358 90.88

TOTAL DIRECT COST \$ 333,528 1852.93

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 333,528 X 1.00 = \$ 333,528

UNIT PRICE PER LF = 333,528 / 180. = \$ 1852.93 / LF

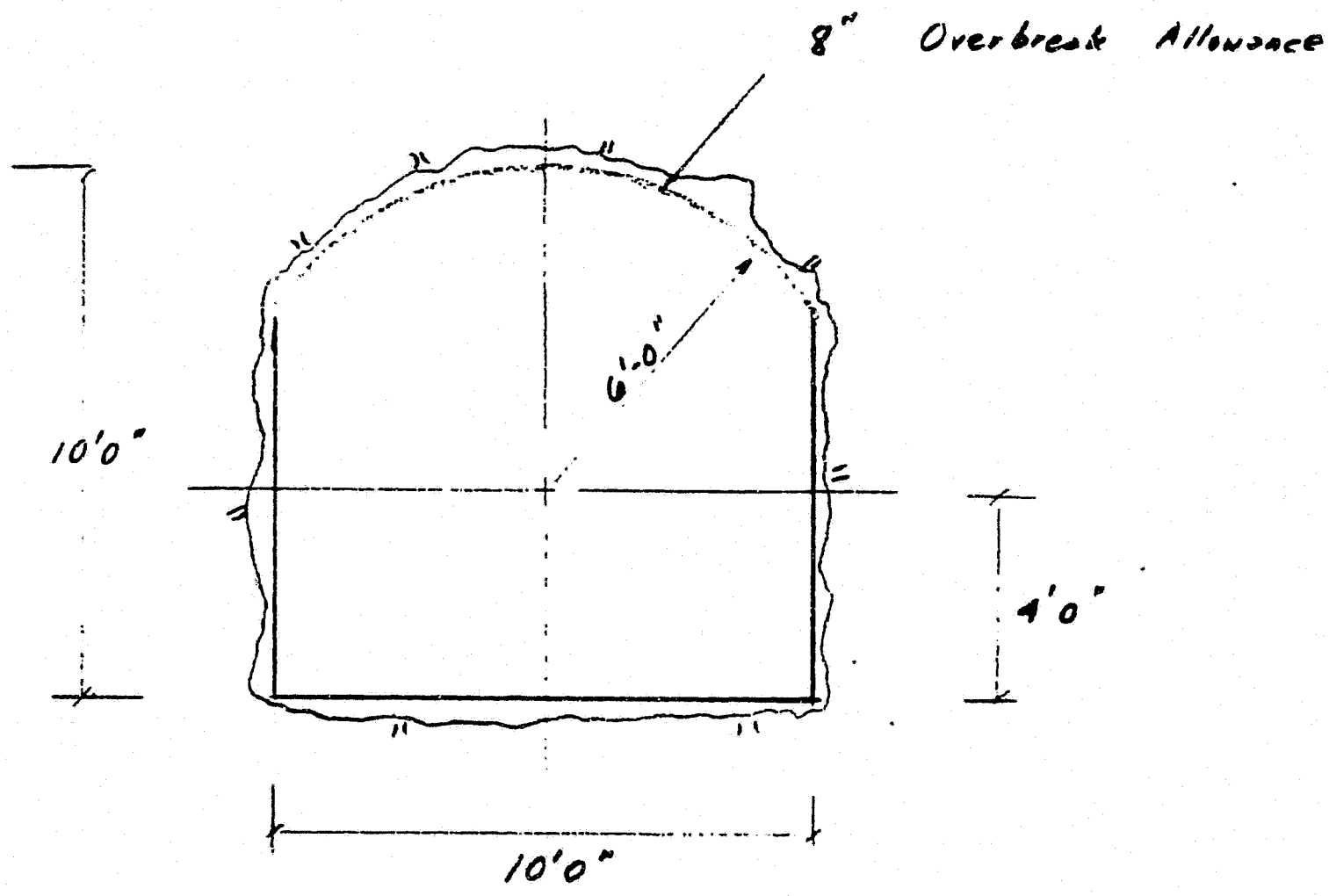
UNIT PRICE PER CY = 333,528 / 180. X 16.8 = \$ 110 09 /

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 9. DAYS X 33. MEN / 180. LF = 1.71 MD/LF

- MAN-DAYS/CY = 9. DAYS X 33. MEN / 180. LF/16.83 = 0.10 MD/C

ACCESS TUNNEL
10 x 10



Scale 0 1'

SUSITNA - NATANA	
GROUTING GALLERY	
WARZA ENGINEERING CO., CHICAGO	
APPROVED.....	
DATE	DWG. NO.

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=====
                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  ACCESS TUNNEL 10 X 10 FT HEIGHT      QUANTITY:  570.FT
PROJECT:  SUSITNA - 331.123                DATE:  FEB 16, 1984 -
FILE NO:  1563                             EST. BY RAM D/OEB
=====
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BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 10.0 X 10.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos(6.0 - 2.8 / 6.0)) = 2.00 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (6.0)^2 (2.00 - \sin 2.00) = 19.6 \text{ FT}^2$$

$$\text{BCY/LF} = (19.6 + 7.3 \times 10.0) / 27 = 3.4 \text{ BCY/LF}$$

$$\text{PERIMETER} = 2.00 \times 6.0 + 2.0 \times 7.3 + 10.0 = 36.5 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 18. IN CENTERS} = 36.5 / 18. / 12 = 25.$$

$$\text{AREA OF PATTERN} = 92.05 \text{ FT}^2 - 18.0 / 12.0 \times 36.5 = 37.3 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 37.3 / 9.00 = 5.$$

$$\text{TOTAL HOLES} = 25. + 5. = 29.$$

$$\text{NUMBER OF DRILLS} = 1 - 2 - \text{DRILLS} = 2.$$

$$\text{NUMBER OF HOLES/DRILL} = 29. / 2. = 15.$$

DRILL 9.0 FT - PULL 8.0 FT

$$\text{TOTAL LF OF HOLE} = 29. \times 9. / 8. \times 570. = 18096. \text{ LF}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 10 X 10 FT HEIGHT
PROJECT: SUSITNA - 331.123
FILE NO: 1563

=====

QUANTITY: 570.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	0.50 HRS
DRILL 15. HOLES/DRILL X 9.0 @ 60. FT/HR	2.21 HRS
LOAD 15. HOLES/MINER @ 3.0 MIN/EA	0.88 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 2.00 \times 0.85 \times 0.60 = 1.02$$

$$\text{BCY/HR} = 1.02 \times 1. \times 0.83 \times 40.00 = 33.86 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 3.41 \text{ BCY/LF} \times 8.0 \text{ LF} = 27.27$$

$$\text{MUCK TIME} = 27.27 \text{ BCY} \times 1.30 \text{ (OB)} / 33.86 = 1.04 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 1.04 - 2.21 - 0.88 - 0.50 \quad 0.00 \text{ HRS}$$

$$\text{TOTAL CYCLE TIME} \quad 4.09 \text{ HRS}$$

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 8.0 \text{ LF/ROUND} \times 2. \times 10. / 4.09 = 39. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 10 X 10 FT HEIGHT
PROJECT: SUSITNA - 331.123
FILE NO: 1563

QUANTITY: 570.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 30.0 FT @ 20. LF/DAY (50.0 %)	1.5 DAYS
REMAINING 540. FT @ 39. FT/DAY	13.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	0.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	1.5 DAYS
ADDITIONAL TIME FOR SHOTCRETE (3")	0.5 DAYS

TOTAL EXCAVATION TIME	19.9 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 10 X 10 FT HEIGHT
PROJECT: SUSITNA - 331.123
FILE NO: 1563

QUANTITY: 570.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.80
SUBTOTAL	11.5	11.5	0.0	23.0		8697.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 8697.40

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 10 X 10 FT HEIGHT
PROJECT: SUSITNA - 331.123
FILE NO: 1563

QUANTITY: 570.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

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EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
2.0	DRILLS	42.01 X 20. HRS	1680.40
2.0	AIR COMPRESSORS 600	40.36 X 20. HRS	1614.40
1.0	FANS	10.07 X 20. HRS	201.40
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	EIMCO (2 CY)	21.05 X 20. HRS	421.00
2.0	CARS W/ PRIME MOVERS	31.08 X 20. HRS	1243.20
SUBTOTAL			5370.80
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 5370.80 X 75.0/100.0 = \$ 4028.10 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
1943.28	BCY	POWDER & CAPS	6.80	13214.29
18896.38	LF	BITS & STEEL	0.40	7558.55
6.00	EA	STEEL SUPPORTS (20 LB/FT)	530.00	3180.00
456.00	EA	ROCKBOLTS (10FT)	84.67	38609.52
42.00	CY	SHOTCRETE (3")	450.00	18900.00
570.00	LF	AIR AND WATER DISCHARGE	15.00	8550.00
570.00	LF	FAN LINES	12.50	7125.00
570.00	LF	ELECTRIC SUPPLIES	50.00	28500.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				125637.36

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=====
                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  ACCESS TUNNEL 10 X 10 FT HEIGHT      QUANTITY:  570.FT
PROJECT:  SUSITNA - 331.123                DATE:  FEB 16, 1984 -
FILE NO:  1563                            EST. BY RAM D/OEB
=====
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SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 20. DAYS

LABOR COSTS:
20. X \$ 8697.40 / DAY \$ 172,669 302.93

EQUIPMENT COSTS:
20. X \$ 4028.10 / DAY \$ 79,970 140.30

MATERIALS & SUPPLIES: \$ 125,637 220.42

S T & S +/-15% OF LABOR \$ 24,971 43.81

TOTAL DIRECT COST \$ 403,248 707.45

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 403,248 X 1.00 = \$ 403,248

UNIT PRICE PER LF = 403,248 / 570. = \$ 707.45 / LF

UNIT PRICE PER CY = 403,248 / 570. X 3.4 = \$ 207.51 /

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 20. DAYS X 23. MEN / 570. LF = 0.80 MD/LF

- MAN-DAYS/CY = 20. DAYS X 23. MEN / 570. LF / 3.41 = 0.23 MD/C

ACCESS TUNNEL
12 x 14

=====

HARZA ENGINEERING COMPANY		
DIRECT COST ESTIMATE		
ITEM: ACCESS TUNNEL 12 X 14 FT HEIGHT		QUANTITY: 560.FT
PROJECT: SUSITNA - 331.12C		DATE: FEB 16, 1984 -
FILE NO: 1563		EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 14.0 X 12.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 6.0 - 6.0 / 6.0) = 3.14 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (6.0) \times (3.14 - \sin 3.14) = 56.5 \text{ FT}^2$$

$$\text{BCY/LF} = (56.5 + 8.0 \times 12.0) / 27 = 5.6 \text{ BCY/LF}$$

$$\text{PERIMETER} = 3.14 \times 6.0 + 2.0 \times 8.0 + 12.0 = 46.8 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 46.8 / 24. / 12 = 24.$$

$$\text{AREA OF PATTERN} = 152.55 \text{ FT}^2 - 24.0 / 12.0 \times 46.8 = 58.8 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 58.8 / 9.00 = 7.$$

$$\text{TOTAL HOLES} = 24. + 7. = 31.$$

$$\text{NUMBER OF DRILLS} = 1 - 2 - \text{DRILLS} = 2.$$

$$\text{NUMBER OF HOLES/DRILL} = 31. / 2. = 15.$$

DRILL 9.0 FT - PULL 8.0 FT

$$\text{TOTAL LF OF HOLE} = 31. \times 9. / 8. \times 560. = 19507. \text{ LF}$$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  ACCESS TUNNEL 12 X 14 FT HEIGHT      QUANTITY:  560.FT
PROJECT:  SUSITNA - 331.12C                DATE:  FEB 16, 1984 -
FILE NO:  1563                             EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	0.50 HRS
DRILL 15. HOLES/DRILL X 9.0 @ 60: FT/HR	2.32 HRS
LOAD 15. HOLES/MINER @ 3.0 MIN/EA	0.93 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 2.00 \times 0.85 \times 0.60 = 1.02$$

$$\text{BCY/HR} = 1.02 \times 1. \times 0.83 \times 40.00 = 33.86 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 5.65 \text{ BCY/LF} \times 8.0 \text{ LF} = 45.20$$

$$\text{MUCK TIME} = 45.20 \text{ BCY} \times 1.20 \text{ (OB)} / 33.86 = 1.61 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 1.61 - 2.32 - 0.93 - 0.50 \quad 0.00 \text{ HRS}$$

TOTAL CYCLE TIME	-----	4.25 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 8.0 \text{ LF/ROUND} \times 2. \times 10. / 4.25 = 38. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 12 X 14 FT HEIGHT
PROJECT: SUSITHA - 331.12C
FILE NO: 1563

=====

QUANTITY: 560.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OED

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 60.0 FT @ 19. LF/DAY (50.0 %)	3.2 DAYS
REMAINING 500. FT @ 38. FT/DAY	13.3 DAYS
ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	2.5 DAYS
ADDITIONAL TIME FOR SHOTCRETE (3")	2.0 DAYS

TOTAL EXCAVATION TIME	24.5 DAYS

=====

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 12 X 14 FT HEIGHT

PROJECT: SUSITHA - 331.12C

FILE NO: 1563

QUANTITY: 560.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

=====

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.80
SUBTOTAL	11.5	11.5	0.0	23.0		8697.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 8697.40

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 12 X 14 FT HEIGHT
PROJECT: SUSITHA - 331.12C
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
2.0	DRILLS	42.01 X 20. HRS	1680.40
2.0	AIR COMPRESSORS 600	40.36 X 20. HRS	1614.40
1.0	FANS	10.07 X 20. HRS	201.40
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	EIMCO (2 CY)	21.05 X 20. HRS	421.00
2.0	CARS W/ PRIME MOVERS	31.08 X 20. HRS	1243.20
SUBTOTAL			5370.80
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 5370.80 X 75.0/100.0 = \$ 4028.10 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
3163.97	BCY	POWDER & CAPS	6.00	21515.01
19507.08	LF	BITS & STEEL	0.40	7802.83
6.00	EA	STEEL SUPPORTS (20 LB/FT)	696.00	4176.00
456.00	EA	ROCKBOLTS (10FT)	84.67	38609.52
42.00	CY	SHOTCRETE (3")	450.00	18900.00
560.00	LF	AIR AND WATER DISCHARGE	15.00	8400.00
560.00	LF	FAN LINES	12.50	7000.00
560.00	LF	ELECTRIC SUPPLIES	50.00	28000.00

TOTAL COST FOR MATERIAL AND SUPPLIES \$ 134403.36

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 12 X 14 FT HEIGHT
PROJECT: SUSITNA - 331.12C
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 24. DAYS

LABOR COSTS:

24. X \$ 8697.40 / DAY \$ 212,854 380.10

EQUIPMENT COSTS:

24. X \$ 4028.10 / DAY \$ 98,580 176.04

MATERIALS & SUPPLIES: \$ 134,403 240.01

S T & S +/-15% OF LABOR \$ 30,508 54.48

TOTAL DIRECT COST \$ 476,347 850.62

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 476,347 X 1.00 = \$ 476,347

UNIT PRICE PER LF = 476,347 / 560. = \$ 850.62 / LF

UNIT PRICE PER CY = 476,347 / 560. X 5.6 = \$ 150.55 /

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 24. DAYS X 23. MEN / 560. LF = 1.01 MD/LF

- MAN-DAYS/CY = 24. DAYS X 23. MEN / 560. LF / 5.65 = 0.18 MD/C

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL 12 X 14 FT HEIGHT
PROJECT: SUSITNA - 331.12C
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OE

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 24. DAYS

LABOR COSTS:

24. X \$ 8697.40 / DAY \$ 212,854 380.10

EQUIPMENT COSTS:

24. X \$ 4028.10 / DAY \$ 98,580 176.04

MATERIALS & SUPPLIES: \$ 134,403 240.01

S T & S +/-15% OF LABOR \$ 30,508 54.48

TOTAL DIRECT COST \$ 476,347 850.62

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 476,347 X 1.00 = \$ 476,347

UNIT PRICE PER LF = 476,347 / 560. = \$ 850.62 / LF

UNIT PRICE PER CY = 476,347 / 560. X 5.6 = \$ 150.55 /

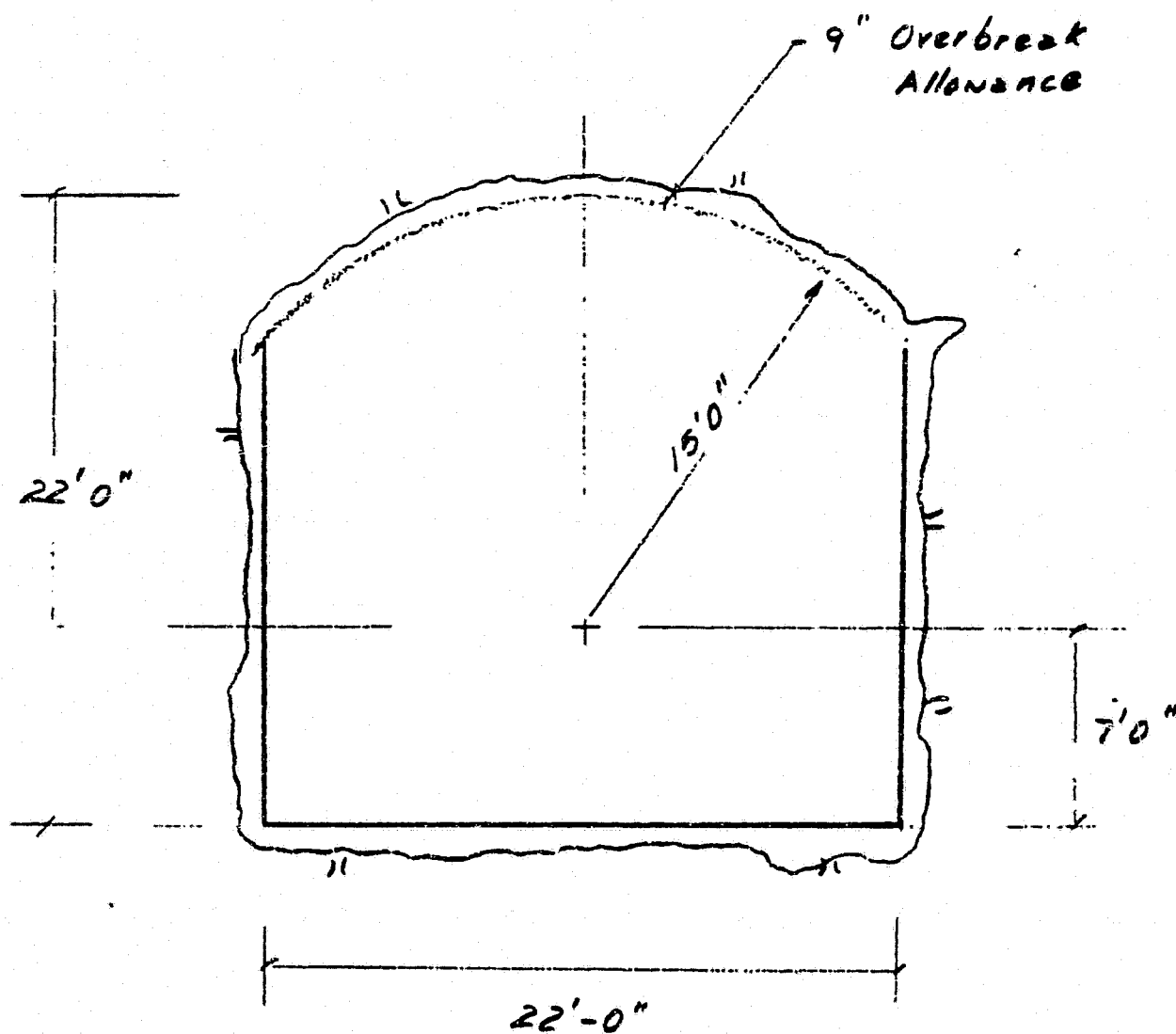
SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 24. DAYS X 23. MEN / 560. LF = 1.01 MD/LF

- MAN-DAYS/CY = 24. DAYS X 23. MEN / 560. LF / 5.65 = 0.18 MD/C

#C700

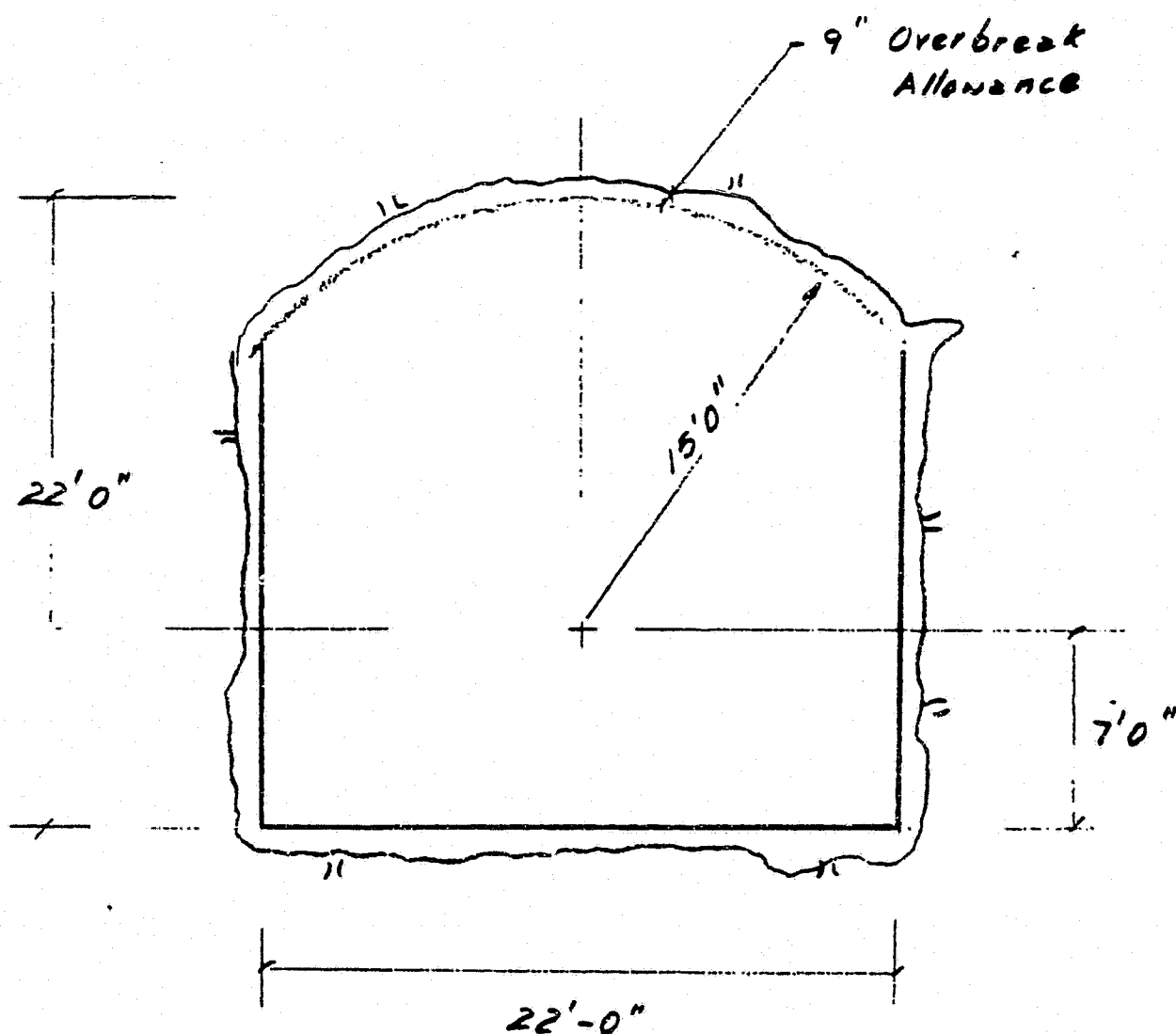
BUS TUNNEL
22 x 22



FULL FACE METHOD OF EXCAVATION

Scale 0 2

SUSITNA - WATANA	
BUS TUNNEL	
HARZA ENGINEERING CO., CHICAGO	
APPROVED.....	
DATE	DWG. NO.



FULL FACE METHOD OF EXCAVATION

Scale 0 2

SUSITNA - WATANA

BUS TUNNEL

HARZA ENGINEERING CO., CHICAGO
APPROVED.....

DATE

DWG. NO.

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL HORIZONTAL 22 X 22 FT
PROJECT: SUSITNA - 331.151
FILE NO: 1563

QUANTITY: 156.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 22.0 X 22.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 15.0 - 5.0 / 15.0) = 1.68 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (15.0)^2 (1.68 - \sin 1.68) = 77.4 \text{ FT}^2$$

$$\text{BCY/LF} = (77.4 + 17.0 \times 22.0) / 27 = 16.7 \text{ BCY/LF}$$

$$\text{PERIMETER} = 1.68 \times 15.0 + 2.0 \times 17.0 + 22.0 = 81.2 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 81.2 / 24. / 12 = 41.$$

$$\text{AREA OF PATTERN} = 451.44 \text{ FT}^2 - 24.0 / 12.0 \times 81.2 = 289.0 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 289.0 / 9.00 = 33.$$

$$\text{TOTAL HOLES} = 41. + 33. = 74.$$

$$\text{NUMBER OF DRILLS} = 1 - 4. - \text{DRILLS} = 4.$$

$$\text{NUMBER OF HOLES/DRILL} = 74. / 4. = 18.$$

DRILL 12.0 FT - PULL 11.0 FT

$$\text{TOTAL LF OF HOLE} = 74. \times 12. / 11. \times 156. = 12547. \text{ LF}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL HORIZONTAL 22 X 22 FT
PROJECT: SUSITNA - 331.151
FILE NO: 1563

=====

QUANTITY: 156.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 18. HOLES/DRILL X 12.0 @ 60. FT/HR	3.69 HRS
LOAD 18. HOLES/MINER @ 3.0 MIN/EA	1.11 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 1. \times 0.83 \times 50.00 = 148.15 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 16.72 \text{ BCY/LF} \times 11.0 \text{ LF} = 183.92$$

$$\text{MUCK TIME} = 183.92 \text{ BCY} \times 1.18 \text{ (OB)} / 148.15 = 1.46 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 1.46 + 3.69 + 1.11 + 0.50 \quad 0.00 \text{ HRS}$$

$$\text{TOTAL CYCLE TIME} \quad \text{-----} \quad 6.29 \text{ HRS}$$

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 6.29 = 35. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL HORIZONTAL 22 X 22 FT
PROJECT: SUSITNA - 331.151
FILE NO: 1563

=====

QUANTITY: 156.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 18.0 FT @ 17. LF/DAY (50.0 %)	1.0 DAYS
REMAINING 138. FT @ 35. FT/DAY	3.9 DAYS
ALLOWANCE FOR DELAYS & FAULTS	1.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	0.7 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	2.0 DAYS

TOTAL EXCAVATION TIME	8.7 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL HORIZONTAL 22 X 22 FT
PROJECT: SUSITHA - 331.151
FILE NO: 1563

QUANTITY: 156.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.00

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL HORIZONTAL 22 X 22 FT
PROJECT: SUSITNA - 331.151
FILE NO: 1563

QUANTITY: 156.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
4.0	DRILLS	42.01 X 20. HRS	3360.00
4.0	AIR COMPRESSORS 600	40.36 X 20. HRS	3228.00
2.0	FANS	10.07 X 20. HRS	402.00
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	FEL 988 (7 CY)	115.74 X 20. HRS	2314.00
3.0	R 355	62.64 X 20. HRS	3750.40
SUBTOTAL			13276.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 13276.00 X 75.0/100.0 = \$ 9957.00 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
2608.30	BCY	POWDER & CAPS	6.00	17736.46
12546.51	LF	BITS & STEEL	0.40	5018.60
6.00	EA	STEEL SUPPORTS (40 LB/FT)	2368.00	14208.00
125.00	EA	ROCKBOLTS (15FT)	127.00	15875.00
5.00	CY	SHOTCRETE (3")	450.00	2250.00
156.00	LF	AIR AND WATER DISCHARGE	30.00	4680.00
156.00	LF	FAN LINES	25.00	3900.00
156.00	LF	ELECTRIC SUPPLIES	100.00	15600.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				79268.06

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL HORIZONTAL 22 X 22 FT
PROJECT: SUSITNA - 331.151
FILE NO: 1563

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QUANTITY: 156.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

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SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 9. DAYS

LABOR COSTS:

9. X \$ 12306.80 / DAY \$ 106,779 684.48

EQUIPMENT COSTS:

9. X \$ 9957.00 / DAY \$ 86,391 553.79

MATERIALS & SUPPLIES: \$ 79,268 508.13

S T & S @ 15.% OF LABOR \$ 15,548 99.67

TOTAL DIRECT COST \$ 287,987 1846.07

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 287,987 X 1.00 = \$ 287,987

UNIT PRICE PER LF = 287,987 / 156. = \$ 1846.07 / LF

UNIT PRICE PER CY = 287,987 / 156. X 16.7 = \$ 110.41 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 9. DAYS X 33. MEN / 156. LF = 1.84 MD/LF

- MAN-DAYS/CY = 9. DAYS X 33. MEN / 156. LF/16.72 = 0.11 MD/CY

BUS TUNNEL
16 x 16

=====

HARZA ENGINEERING COMPANY		
DIRECT COST ESTIMATE		
ITEM: BUS TUNNEL INCLINE	16 X 16 FT	QUANTITY: 282.FT
PROJECT: SUSITNA - 331.152		DATE: FEB 16, 1984 -
FILE NO: 1563		EST. BY RAM D/C/B

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 16.0 X 16.0 FT

ANGLE OF ARCH = $2 \times (\arccos 12.0 - 6.0 / 12.0) = 2.09$ RADIANS

ARCH AREA = $0.5 \times (12.0) \times 2 (2.09 - \sin 2.09) = 88.4$ FT-2

BCY/LF = $(88.4 + 10.0 \times 16.0) / 27 = 9.2$ BCY/LF

PERIMETER = $2.09 \times 12.0 + 2.0 \times 10.0 + 16.0 = 61.1$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $61.1 / 24. / 12 = 31.$

AREA OF PATTERN = $248.44 \text{ FT}^2 - 24.0 / 12.0 \times 61.1 = 126.2$ FT-2

PATTERN HOLES @ 3.0 X 3.0 = $126.2 / 9.00 = 15.$

TOTAL HOLES = $31. + 15. = 46.$

NUMBER OF DRILLS = 1 - 2. — DRILLS = 2.

NUMBER OF HOLES/DRILL = $46. / 2. = 23.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $46. \times 6. / 5. \times 282. = 15426.$ LF


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  BUS TUNNEL INCLINE   16 X 16 FT      QUANTITY:  282.7T
PROJECT:  SUSITNA - 331.152                DATE:  FEB 16, 1984 -
FILE NO:  1563                             EST. BY RAM D/OEB
=====

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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 23. HOLES/DRILL X 6.0 @ 60. FT/HR	2.28 HRS
LOAD 23. HOLES/MINER @ 3.0 MIN/EA	1.37 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 4.00 \times 0.85 \times 0.60 = 2.04$$

$$\text{BCY/HR} = 2.04 \times 1. \times 0.83 \times 40.00 = 67.73 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 9.20 \text{ BCY/LF} \times 5.0 \text{ LF} = 46.01$$

$$\text{MUCK TIME} = 46.01 \text{ BCY} \times 1.18 \text{ (OB) / } 67.73 = 0.80 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 0.80 - 2.28 - 1.37 - 0.50 \quad 0.00 \text{ HRS}$$

TOTAL CYCLE TIME	5.15 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 5.15 = 19. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL INCLINE 16 X 16 FT
PROJECT: SUSITNA - 331.152
FILE NO: 1563

=====

QUANTITY: 282.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OE9

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 20.0 FT @ 10. LF/DAY (50.0 %)	2.1 DAYS
REMAINING 262. FT @ 19. FT/DAY	13.5 DAYS
ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS
ADDITIONAL TIME FOR ROCKBUSTING	0.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	1.0 DAYS
ADDITIONAL TIME FOR INCLINE	8.0 DAYS

TOTAL EXCAVATION TIME	27.0 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL INCLINE 16 X 16 FT
PROJECT: SUSITNA - 331.152
FILE NO: 1563

QUANTITY: 202.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.80
SUBTOTAL	10.5	10.5	0.0	21.0		7934.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7934.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL INCLINE 16 X 16 FT
PROJECT: SUSITNA - 331.152
FILE NO: 1563

QUANTITY: 282.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	ALIMAC DRILLS	42.01 X 20. HRS	840.20
2.0	FANS	10.07 X 20. HRS	402.00
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	FEL 966 (4 CY)	50.68 X 20. HRS	1013.60
2.0	R 25S	42.45 X 20. HRS	1698.00
SUBTOTAL			4165.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 4165.00 X 75.0/100.0 = \$ 3123.75 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
2594.85	BCY	POWDER & CAPS	6.00	17644.95
15426.32	LF	BITS & STEEL	0.40	6170.53
6.00	EA	STEEL SUPPORTS (20 LB/FT)	1120.00	6720.00
225.00	EA	ROCKBOLTS (10FT)	84.67	19050.75
15.00	CY	SHOTCRETE (3")	450.00	6750.00
282.00	LF	AIR AND WATER DISCHARGE	30.00	8460.00
282.00	LF	FAN LINES	25.00	7050.00
282.00	LF	ELECTRIC SUPPLIES	100.00	28200.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				100046.22

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS TUNNEL INCLINE 16 X 16 FT
PROJECT: SUSITNA - 331.152
FILE NO: 1563

=====

QUANTITY: 282.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 27. DAYS

LABOR COSTS:

27. X \$ 7934.80 / DAY \$ 214,585 760.94

EQUIPMENT COSTS:

27. X \$ 3123.75 / DAY \$ 84,477 299.57

MATERIALS & SUPPLIES: \$ 100,046 354.77

S T & S @ 15.% OF LABOR \$ 32,844 116.47

TOTAL DIRECT COST \$ 431,953 1531.75

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 431,953 X 1.00 = \$ 431,953

UNIT PRICE PER LF = 431,953 / 282. = \$ 1531.75 / LF

UNIT PRICE PER CY = 431,953 / 282. X 9.2 = \$ 166.47 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 27. DAYS X 21. MEN / 282. LF = 2.01 MD/LF

- MAN-DAYS/CY = 27. DAYS X 21. MEN / 282. LF / 9.20 = 0.22 MD/CY

ACCESS TUNNEL
15 x 20

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT QUANTITY: 2100.FT
PROJECT: SUSITNA - 332.210 DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 15.0 X 20.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 15.0 - 5.0 / 15.0) = 1.68 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (15.0) \times 2 (1.68 - \sin 1.68) = 77.4 \text{ FT}^2$$

$$\text{BCY/LF} = (77.4 + 10.0 \times 20.0) / 27 = 10.3 \text{ DCY/LF}$$

$$\text{PERIMETER} = 1.68 \times 15.0 + 2.0 \times 10.0 + 20.0 = 65.2 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 65.2 / 24. / 12 = 33.$$

$$\text{AREA OF PATTERN} = 277.44 \text{ FT}^2 - 24.0 / 12.0 \times 65.2 = 147.0 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 147.0 / 9.00 = 17.$$

$$\text{TOTAL HOLES} = 33. + 17. = 50.$$

$$\text{NUMBER OF DRILLS} = 1 - 4. - \text{DRILLS} = 4.$$

$$\text{NUMBER OF HOLES/DRILL} = 50. / 4. = 12.$$

DRILL 12.0 FT - PULL 11.0 FT

$$\text{TOTAL LF OF HOLE} = 50. \times 12. / 11. \times 2100. = 114423. \text{ LF}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT
PROJECT: SUSITNA - 332.210
FILE NO: 1563

=====

QUANTITY: 2100.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 15.0 X 20.0 FT

ANGLE OF ARCH = $2 \times (\arccos 15.0 - 5.0 / 15.0) = 1.68$ RADIANS

ARCH AREA = $0.5 \times (15.0) \times 2 (1.68 - \sin 1.68) = 77.4$ FT-2

BCY/LF = $(77.4 + 10.0 \times 20.0) / 27 = 10.3$ DCY/LF

PERIMETER = $1.68 \times 15.0 + 2.0 \times 10.0 + 20.0 = 65.2$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $65.2 / 24. / 12 = 33.$

AREA OF PATTERN = $277.44 \text{ FT}^2 - 24.0 / 12.0 \times 65.2 = 147.0 \text{ FT}^2$

PATTERN HOLES @ $3.0 \times 3.0 = 147.0 / 9.00 = 17.$

TOTAL HOLES = $33. + 17. = 50.$

NUMBER OF DRILLS = 1 - 4. — DRILLS = 4.

NUMBER OF HOLES/DRILL = $50. / 4. = 12.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $50. \times 12. / 11. \times 2100. = 114423. \text{ LF}$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT
PROJECT: SUSITNA - 332.210
FILE NO: 1563

QUANTITY: 2100.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS 1.00 HRS

DRILL 12. HOLES/DRILL X 12.0 @ 60. FT/HR 2.50 HRS

LOAD 12. HOLES/MINER @ 3.0 MIN/EN 0.75 HRS

SHOOT AND SMOKE 0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 1. \times 0.83 \times 50.00 = 148.15 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 10.28 \text{ BCY/LF} \times 11.0 \text{ LF} = 113.03$$

$$\text{MUCK TIME} = 113.03 \text{ BCY} \times 1.24 \text{ (OB)} / 148.15 = 0.94 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 0.94 - 2.50 - 0.75 - 0.50 \quad 0.00 \text{ HRS}$$

$$\text{TOTAL CYCLE TIME} \quad 4.75 \text{ HRS}$$

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 4.75 = 46. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT
PROJECT: SUSITNA - 332.210
FILE NO: 1563

=====

QUANTITY: 2100.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 100.0 FT @ 23. LF/DAY (50.0 %)	4.3 DAYS
REMAINING 2000. FT @ 46. FT/DAY	43.2 DAYS
TURN UNDER AT PORTALS	2.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	7.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	2.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	5.0 DAYS
ADDITIONAL TIME FOR SHOTCRETE (3")	1.0 DAYS

TOTAL EXCAVATION TIME	65.0 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT
PROJECT: SUSITNA - 332.210
FILE NO: 1563

QUANTITY: 2100.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PEP DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.80

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT

PROJECT: SUSITNA - 332.210

FILE NO: 1563

QUANTITY: 2100.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
4.0	DRILLS	42.01 X 20. HRS	3360.80
4.0	AIR COMPRESSORS 600	40.36 X 20. HRS	3228.80
2.0	FANS	10.07 X 20. HRS	402.80
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	FEL 988 (7 CY)	115.74 X 20. HRS	2314.80
3.0	R 355	62.64 X 20. HRS	3758.40
SUBTOTAL			13276.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 13276.00 X 75.0/100.0 = \$ 9957.00 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
21578.43	BCY	POWDER & CAPS	6.80	146733.35
114422.54	LF	BITS & STEEL	0.40	45769.02
21.00	EA	STEEL SUPPORTS (20 LB/FT)	1120.00	23520.00
1680.00	EA	ROCKBOLTS (10FT)	84.67	142245.60
50.00	CY	SHOTCRETE (3")	450.00	22500.00
2100.00	LF	AIR AND WATER DISCHARGE	30.00	63000.00
2100.00	LF	FAN LINES	25.00	52500.00
2100.00	LF	ELECTRIC SUPPLIES	100.00	210000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				706267.96

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  ACCESS TUNNEL TO GATE CHAMBER 15 X 20 FT    QUANTITY: 2100.FT
PROJECT:  SUSITNA - 332.210                      DATE: FEB 16, 1984 -
FILE NO:  1563                                    EST. BY RAM D/OEB
=====

```

SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 65. DAYS

LABOR COSTS:

65. X \$ 12306.80 / DAY \$ 799,512 380.72

EQUIPMENT COSTS:

65. X \$ 9957.00 / DAY \$ 646,057 300.03

MATERIALS & SUPPLIES: \$ 706,267 336.32

S T & S @ 15.% OF LABOR \$ 118,399 56.38

 TOTAL DIRECT COST \$ 2,271,038 1081.45

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 2,271,038 X 1.00 = \$ 2,271,038

UNIT PRICE PER LF = 2,271,038 / 2100. = \$ 1081.45 / LF

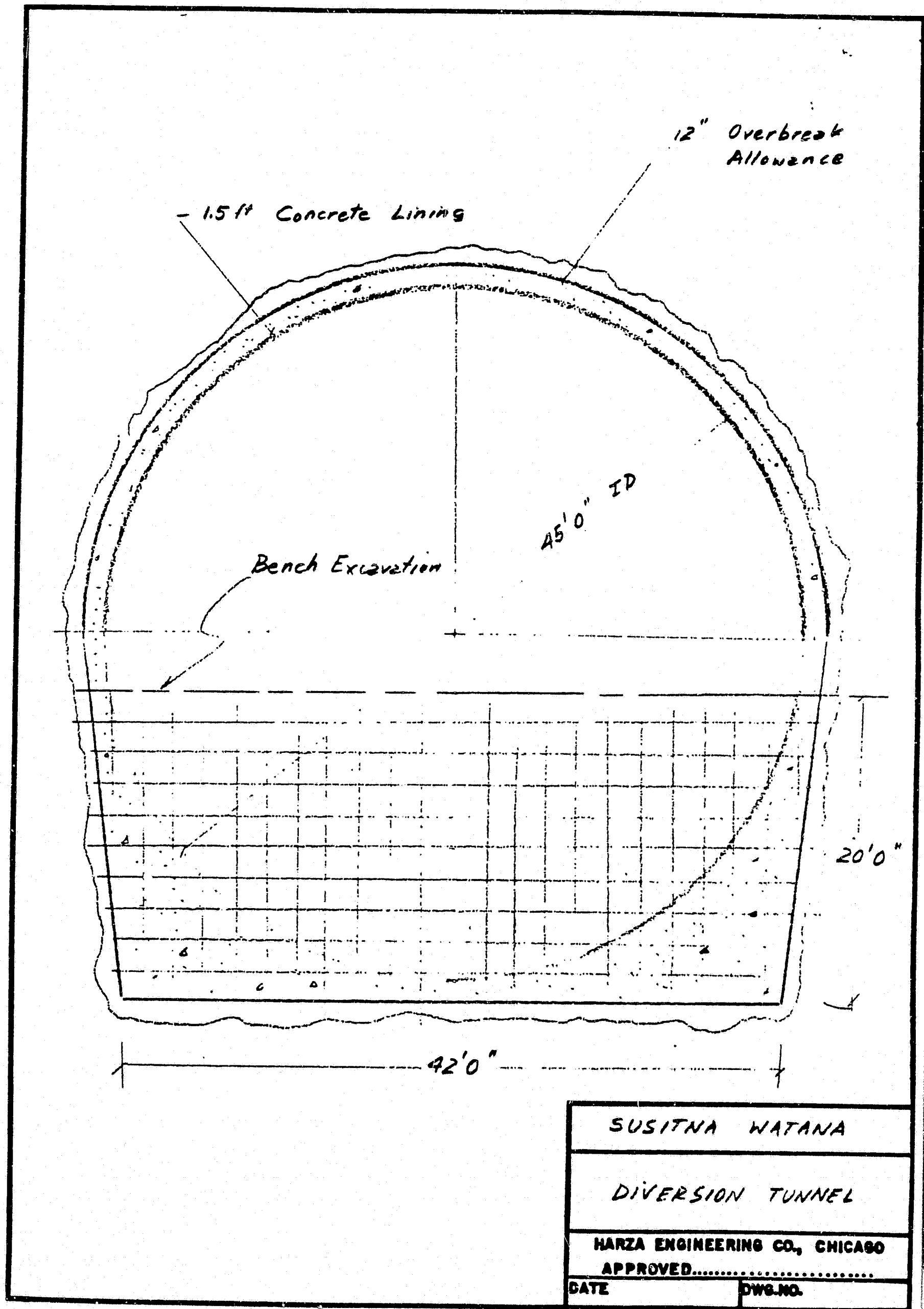
UNIT PRICE PER CY = 2,271,038 / 2100. X 10.3 = \$ 105.25 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 65. DAYS X 33. MEN / 2100. LF = 1.02 MD/LF

- MAN-DAYS/CY = 65. DAYS X 33. MEN / 2100. LF/10.28 = 0.10 MD/CY

DIVERSION TUNNEL
48 P



=====

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER

QUANTITY: 760.FT

PROJECT: SUSITNA 332.212

DATE: FEB 16, 1984 -

FILE NO: 1563

EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 48.0 X 42.0 FT

ANGLE OF ARCH = $2 \times (\arccos 24.0 - 24.0 / 24.0) = 3.14$ RADIANS

ARCH AREA = $0.5 \times (24.0) \times 2 (3.14 - \sin 3.14) = 904.8$ FT-2

BCY/LF = $(904.8 + 4.0 \times 42.0) / 27 = 39.7$ BCY/LF

PERIMETER = $3.14 \times 24.0 + 2.0 \times 4.0 + 42.0 = 125.4$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $125.4 / 24. / 12 = 63.$

AREA OF PATTERN = $*****FT-2 - 24.0 / 12.0 \times 125.4 = 822.0$ FT-2

PATTERN HOLES @ $3.0 \times 3.0 = 822.0 / 9.00 = 92.$

TOTAL HOLES = $63. + 92. = 155.$

NUMBER OF DRILLS = $1 - 6. - DRILLS = 6.$

NUMBER OF HOLES/DRILL = $155. / 6. = 26.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $155. \times 12. / 11. \times 760. = 128534. LF$


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=====
                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  DIVERSION TUNNEL  48 FT EXCAVATED DIAMETER  QUANTITY:  760.FT
PROJECT:  SUSITNA  332.212  DATE:  FEB 16, 1984 -
FILE NO:  1563  EST. BY RAM D/OEB
=====

```

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 26. HOLES/DRILL X 12.0 @ 60. FT/HR	5.17 HRS
LOAD 26. HOLES/MINER @ 3.0 MIN/EA	1.55 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 2. \times 0.83 \times 50.00 = 296.31 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 39.73 \text{ BCY/LF} \times 11.0 \text{ LF} = 437.06$$

$$\text{MUCK TIME} = 437.06 \text{ BCY} \times 1.12 \text{ (OB)} / 296.31 = 1.65 \text{ HRS}$$

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.65- 5.17- 1.55- 0.50	0.00 HRS
---	----------

TOTAL CYCLE TIME

	8.22 HRS
--	----------

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 8.22 = 27. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER
PROJECT: SUSITHA 332.212
FILE NO: 1563

QUANTITY: 760.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BENCH EXCAVATION

BENCH DIMENSIONS : 42.0 X 20.0 FT

BCY/LF = $42.0 \times 20.0 / 27 = 31.1$ BCY/LF

PERIMETER = $42.0 + 2 \times 30.0 = 102.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $102.0 / 24. / 12 = 51.$

PATTERN HOLES = $42.0 \times 30.0 / 25.00 \text{ FT-2/HOLE} = 50.$

TOTAL HOLES = $51. + 50. = 101.$

NUMBER OF DRILLS = 6.

NUMBER OF HOLES/DRILL = $101. / 6. = 16.9$

TOTAL LF OF HOLE = $101. \times (20.0 + 1) \times 760.0/30.0 = 53945. \text{ LF}$

=====

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER
PROJECT: SUSITNA 332.212
FILE NO: 1563

QUANTITY: 760.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS 1.00 HRS

DRILL 101. HOLES X 21.0 DEPTH/ 60. FT/HR X 6. 5.91 HRS

LOAD 101. HOLES X 3.0 MIN/EA /50 MIN/HR X 6. 1.01 HRS

SHOOT AND SMOKE 0.50 HRS

MUCKING OPERATION:

MUCK TIME = $933.33 \text{ BCY} \times 1.12 \text{ (OB)} / 296.31 = 3.52 \text{ HRS}$

(ACTUAL CYCLE) MUCK TIME = $3.52 - 5.91 - 1.01 = 0.00 \text{ HRS}$

TOTAL CYCLE TIME 8.43 HRS

USE 2. - 10. HR SHIFTS

DAILY ADVANCE = $30.0 \text{ LF/ROUND} \times 2. \times 10. / 8.43 = 71. \text{ LF/DAY}$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER QUANTITY: 760.FT
PROJECT: SUSITNA 332.212 DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB
=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST	0.0 FT @ 13. LF/DAY (50.0 %)	0.0 DAYS
REMAINING	760. FT @ 27. FT/DAY	28.4 DAYS
BENCH EXCAVATION	760. FT @ 71. FT/DAY	10.7 DAYS
ALLOWANCE FOR DELAYS & FAULTS		2.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING		1.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS		1.5 DAYS

TOTAL EXCAVATION TIME		43.6 DAYS

=====

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER

QUANTITY: 760.FT

PROJECT: SUSITNA 332.212

DATE: FEB 16, 1984 -

FILE NO: 1563

EST. BY RAM D/OEB

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CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	6.0	6.0	0.0	12.0	35.64	4276.80
CHUCK TENDER	6.0	6.0	0.0	12.0	34.91	4189.20
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	5.0	5.0	0.0	10.0	39.37	3937.00
SUBTOTAL	23.5	23.5	0.0	47.0		17485.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 17485.40

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER QUANTITY: 760.FT
PROJECT: SUSITHA 332.212 DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0	DRILLS	42.01 X 20. HRS	5041.20
6.0	AIR COMPRESSORS 600	40.36 X 20. HRS	4843.20
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
2.0	FEL 980	115.74 X 20. HRS	4629.60
5.0	R 355	62.64 X 20. HRS	6264.00
SUBTOTAL			21803.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 21803.00 X 75.0/100.0 = \$ 16352.25 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
53841.18	BCY	POWDER & CAPS	6.00	366120.01
182479.15	LF	BITS & STEEL	0.40	72991.66
6.00	EA	STEEL SUPPORTS (40 LB/FT)	5840.00	35040.00
608.00	EA	ROCKBOLTS (15FT)	127.00	77216.00
51.00	CY	SHOTCRETE (3")	450.00	22950.00
760.00	LF	AIR AND WATER DISCHARGE	30.00	22800.00
760.00	LF	FAN LINES	25.00	19000.00
760.00	LF	ELECTRIC SUPPLIES	100.00	76000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				692117.67

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: DIVERSION TUNNEL 48 FT EXCAVATED DIAMETER QUANTITY: 760. FT
PROJECT: SUSITHA 332.212 DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB
=====

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 44. DAYS

LABOR COSTS:

44. X \$ 17485.40 / DAY \$ 761,771 1002.33

EQUIPMENT COSTS:

44. X \$ 16352.25 / DAY \$ 712,404 937.37

MATERIALS & SUPPLIES: \$ 692,117 910.68

S T & S +/-15% OF LABOR \$ 110,411 145.28

TOTAL DIRECT COST \$ 2,276,704 2995.66

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 2,276,704 X 1.00 = \$ 2,276,704

UNIT PRICE PER LF = 2,276,704 / 760. = \$ 2995.66 / LF

UNIT PRICE PER CY = 2,276,704 / 760. X 70.8 = \$ 42.29 /

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 44. DAYS X 47. MEN / 760. LF = 2.60 MD/LF

- MAN-DAYS/CY = 44. DAYS X 47. MEN / 760. LF/70.84 = 0.04 MD/C

GROUTING GALLERY
10 x 10

=====

HARZA ENGINEERING COMPANY		
DIRECT COST ESTIMATE		
ITEM: GROUTING GALLERY 10 X 10 FT		QUANTITY: 6650.FT
PROJECT: SUSITNA - 332.321		DATE: FEB 16, 1984 -
FILE NO: 1563		EST. BY RAM D/OFB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 10.0 X 10.0 FT

ANGLE OF ARCH = $2 \times (\arccos \frac{6.0 - 2.0}{6.0}) = 2.00 \text{ RADIANS}$

ARCH AREA = $0.5 \times (6.0)^2 (2.00 - \sin 2.00) = 19.6 \text{ FT}^2$

BCY/LF = $(19.6 + 7.3 \times 10.0) / 27 = 3.4 \text{ BCY/LF}$

PERIMETER = $2.00 \times 6.0 + 2.0 \times 7.3 + 10.0 = 36.5 \text{ FT}$

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $36.5 / 24. / 12 = 19.$

AREA OF PATTERN = $92.05 \text{ FT}^2 - 24.0 / 12.0 \times 36.5 = 19.1 \text{ FT}^2$

PATTERN HOLES @ $3.0 \times 3.0 = 19.1 / 9.00 = 3.$

TOTAL HOLES = $19. + 3. = 21.$

NUMBER OF DRILLS = $1 - 2. = \text{DRILLS} = 2.$

NUMBER OF HOLES/DRILL = $21. / 2. = 11.$

DRILL 9.0 FT - PULL 8.0 FT

TOTAL LF OF HOLE = $21. \times 9. / 8. \times 6650. = 159809. \text{ LF}$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY 10 X 10 FT
PROJECT: SUSITHA - 332.321
FILE NO: 1563

=====

QUANTITY: 6650.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 11. HOLES/DRILL X 9.0 @ 60. FT/HR	1.60 HRS
LOAD 11. HOLES/MINER @ 3.0 MIN/EA	0.64 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 2.00 \times 0.85 \times 0.60 = 1.02$$

$$\text{BCY/HR} = 1.02 \times 1. \times 0.83 \times 40.00 = 33.86 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 3.41 \text{ BCY/LF} \times 8.0 \text{ LF} = 27.27$$

$$\text{MUCK TIME} = 27.27 \text{ BCY} \times 1.26 \text{ (OD)} / 33.86 = 1.02 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 1.02 - 1.60 - 0.64 - 0.50 \quad 0.00 \text{ HRS}$$

$$\text{TOTAL CYCLE TIME} \quad 3.74 \text{ HRS}$$

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 8.0 \text{ LF/ROUND} \times 2. \times 10. / 3.74 = 43. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY 10 X 10 FT
PROJECT: SUSITHA - 332.321
FILE NO: 1563

=====

QUANTITY: 6650.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST ***** FT @ 21. LF/DAY (50.0 %)	56.1 DAYS
REMAINING 5450. FT @ 43. FT/DAY	127.5 DAYS
TURN UNDER AT PORTALS	4.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	9.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	8.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	12.0 DAYS
ADDITIONAL TIME FOR SHOTCRETE (3")	8.0 DAYS

TOTAL EXCAVATION TIME	224.6 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY 10 X 10 FT
PROJECT: SUSITNA - 332.321
FILE NO: 1563

QUANTITY: 6650.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/ULB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.80
SUBTOTAL	10.5	10.5	0.0	21.0		7933.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7933.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY 10 X 10 FT
PROJECT: SUSITNA - 332.321
FILE NO: 1563

QUANTITY: 6650.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	DRILLS	42.01 X 20. HRS	840.20
1.0	FANS	10.07 X 20. HRS	201.40
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	EIMCO (2 CY)	21.05 X 20. HRS	421.00
2.0	CARS W/ PRIME MOVERS	31.08 X 20. HRS	1243.20
SUBTOTAL			2916.20
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 2916.20 X 75.0/100.0 = \$ 2107.15 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
22671.58	BCY	POWDER & CAPS	6.80	154166.73
159808.93	LF	BITS & STEEL	0.40	63923.57
75.00	EA	STEEL SUPPORTS (20 LB/FT)	530.00	39750.00
2700.00	EA	ROCKBOLTS (10FT)	84.67	228609.00
82.00	CY	SHOTCRETE (3")	450.00	36900.00
6650.00	LF	AIR AND WATER DISCHARGE	15.00	99750.00
6650.00	LF	FAN LINES	12.50	83125.00
6650.00	LF	ELECTRIC SUPPLIES	50.00	332500.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$ 1038724.30				

=====

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY 10 X 10 FT

PROJECT: SUSITHA - 332.321

FILE NO: 1563

QUANTITY: 6650.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

=====

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	DRILLS	42.01 X 20. HRS	840.20
1.0	FANS	10.07 X 20. HRS	201.40
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	EIMCO (2 CY)	21.05 X 20. HRS	421.00
2.0	CARS W/ PRIME MOVERS	31.08 X 20. HRS	1243.20
SUBTOTAL			2916.20
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 2916.20 X 75.0/100.0 = \$ 2107.15 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
22671.58	BCY	POWDER & CAPS	6.80	154166.73
159808.93	LF	BITS & STEEL	0.40	63923.57
75.00	EA	STEEL SUPPORTS (20 LB/FT)	530.00	39750.00
2700.00	EA	ROCKBOLTS (10FT)	84.67	228609.00
82.00	CY	SHOTCRETE (3")	450.00	36900.00
6650.00	LF	AIR AND WATER DISCHARGE	15.00	99750.00
6650.00	LF	FAN LINES	12.50	83125.00
6650.00	LF	ELECTRIC SUPPLIES	50.00	332500.00

TOTAL COST FOR MATERIAL AND SUPPLIES \$ 1038724.30

ITEM: GROUTING GALLERY 10 X 10 FT
PROJECT: SUSITNA - 332.321
FILE NO: 1563

QUANTITY: 6650.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

NUMBER OF DAYS
FOR EXCAVATION = 225. DAYS

225. X \$ 7933.80 / DAY \$ 1,782,229 268.00

225. X \$ 2187.15 / DAY \$ 491,316 73.88

MATERIALS & SUPPLIES:	\$	1,038,724	156.20
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S T & S @ 15.% OF LABOR	\$	273,394	41.11
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TOTAL DIRECT COST	\$	3,585,664	539.20
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$$\text{MARK UP FACTOR} = (1 + 0./100.) = 1.00$$

TOTAL PRICE = 3,585,664 X 1.00 = \$ 3,585,664

UNIT PRICE PER LF = 3,585,664 / 6650. = \$ 539.20 / LF

UNIT PRICE PER CY = 3,585,664 / 6650. X 3.4 = \$ 158.16 / CY

$$- \text{MAN-DAYS/LF} = 225. \text{ DAYS} \times 21. \text{ MEN} / 6650. \text{ LF} = 0.71 \text{ MD/LF}$$
$$- \text{MAN-DAYS/CY} = 225. \text{ DAYS} \times 21. \text{ MEN} / 6650. \text{ LF} / 3.41 = 0.21 \text{ MD/CY}$$

GROUTING GALLERY
INCLINED

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY INCLINED 10 X 10 FT
PROJECT: SUSITNA - 332.322
FILE NO: 1563

QUANTITY: 2580.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 10.0 X 10.0 FT

ANGLE OF ARCH = $2 \times (\arccos 6.0 - 2.8 / 6.0) = 2.00$ RADIANS

ARCH AREA = $0.5 \times (6.0)^2 (2.00 - \sin 2.00) = 19.6$ FT-2

BCY/LF = $(19.6 + 7.3 \times 10.0) / 27 = 3.4$ BCY/LF

PERIMETER = $2.00 \times 6.0 + 2.0 \times 7.3 + 10.0 = 36.5$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $36.5 / 24. / 12 = 19.$

AREA OF PATTERN = $92.05 \text{ FT}^2 - 24.0 / 12.0 \times 36.5 = 19.1$ FT-2

PATTERN HOLES @ 3.0 X 3.0 = $19.1 / 9.00 = 3.$

TOTAL HOLES = $19. + 3. = 21.$

NUMBER OF DRILLS = 1 - 2. - DRILLS = 2.

NUMBER OF HOLES/DRILL = $21. / 2. = 11.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $21. \times 6. / 5. \times 2580. = 66134. \text{ LF}$


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  GROUTING GALLERY INCLINED 10 X 10 FT      QUANTITY: 2500.FT
PROJECT:  SUSITNA - 332.322                      DATE: FEB 16, 1984 -
FILE NO:  1563                                    EST. BY RAM D/OED
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 11. HOLES/DRILL X 6.0 @ 30. FT/HR	2.14 HRS
LOAD 11. HOLES/MINER @ 3.0 MIN/EA	0.64 HRS
SHOOT AND SMOKE	0.75 HRS

MUCKING OPERATION:

BCY/LOAD = $2.00 \times 0.85 \times 0.60 = 1.02$

BCY/HR = $1.02 \times 1. \times 0.83 \times 40.00 = 33.86$ BCY/HR

BCY/CYCLE = 3.41 BCY/LF $\times 5.0$ LF = 17.05

MUCK TIME = 17.05 BCY $\times 1.26$ (OB) / $33.86 = 0.64$ HRS

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = $0.64 - 2.14 - 0.64 - 0.75$ 0.00 HRS

TOTAL CYCLE TIME	4.53 HRS
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USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 5.0 LF/ROUND $\times 2. \times 10. / 4.53 = 22. \text{ LF/DAY}$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY INCLINED 10 X 10 FT
PROJECT: SUSITNA - 332.322
FILE NO: 1563

=====

QUANTITY: 2580.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 60.0 FT @ 11. LF/DAY (50.0 %)	5.4 DAYS
REMAINING 2520. FT @ 22. FT/DAY	114.1 DAYS
TURN UNDER AT PORTALS	2.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	1.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETE (3")	0.5 DAYS
ADDITIONAL TIME DUE TO INCLINE	6.0 DAYS

TOTAL EXCAVATION TIME	134.5 DAYS

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                        HARZA ENGINEERING COMPANY
                        DIRECT COST ESTIMATE
ITEM:  GROUTING GALLERY INCLINED 10 X 10 FT      QUANTITY: 2580.FT
PROJECT:  SUSITNA - 332.322                      DATE: FEB 16, 1984 -
FILE NO:  1563                                   EST. BY RAM D/OEB
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CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.00
SUBTOTAL	10.5	10.5	0.0	21.0		7933.00
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7933.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUTING GALLERY INCLINED 10 X 10 FT
PROJECT: SUSITNA - 332.322
FILE NO: 1563

QUANTITY: 2580.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	ALIMAC DRILLS	42.01 X 20. HRS	840.20
1.0	FANS	10.07 X 20. HRS	201.40
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	EIMCO (2 CY)	21.05 X 20. HRS	421.00
2.0	CARS W/ PRIME MOVERS	31.08 X 20. HRS	1243.20
SUBTOTAL			2916.20
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 2916.20 X 75.0/100.0 = \$			2187.15 / DAY

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
8795.89	BCY	POWDER & CAPS	6.80	59812.05
66134.46	LF	BITS & STEEL	0.40	26453.78
30.00	EA	STEEL SUPPORTS (20 LB/FT)	530.00	15900.00
450.00	EA	ROCKBOLTS (10FT)	84.67	38101.50
32.00	CY	SHOTCRETE (3")	450.00	14400.00
2580.00	LF	AIR AND WATER DISCHARGE	15.00	38700.00
6650.00	LF	FAN LINES	12.50	83125.00
6650.00	LF	ELECTRIC SUPPLIES	50.00	332500.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				608992.34

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  GROUTING GALLERY INCLINED 10 X 10 FT      QUANTITY: 2580.FT
PROJECT:  SUSITNA - 332.322                      DATE: FEB 16, 1984 -
FILE NO:  1563                                    EST. BY RAM D/OEB
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SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 135. DAYS

LABOR COSTS:

135. X \$ 7933.80 / DAY \$ 1,067,190 413.64

EQUIPMENT COSTS:

135. X \$ 2187.15 / DAY \$ 294,197 114.03

MATERIALS & SUPPLIES: \$ 608,992 236.04

S T & S @ 15.% OF LABOR \$ 160,857 62.35

 TOTAL DIRECT COST \$ 2,131,237 826.06

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 2,131,237 X 1.00 = \$ 2,131,237

UNIT PRICE PER LF = 2,131,237 / 2580. = \$ 826.06 / LF

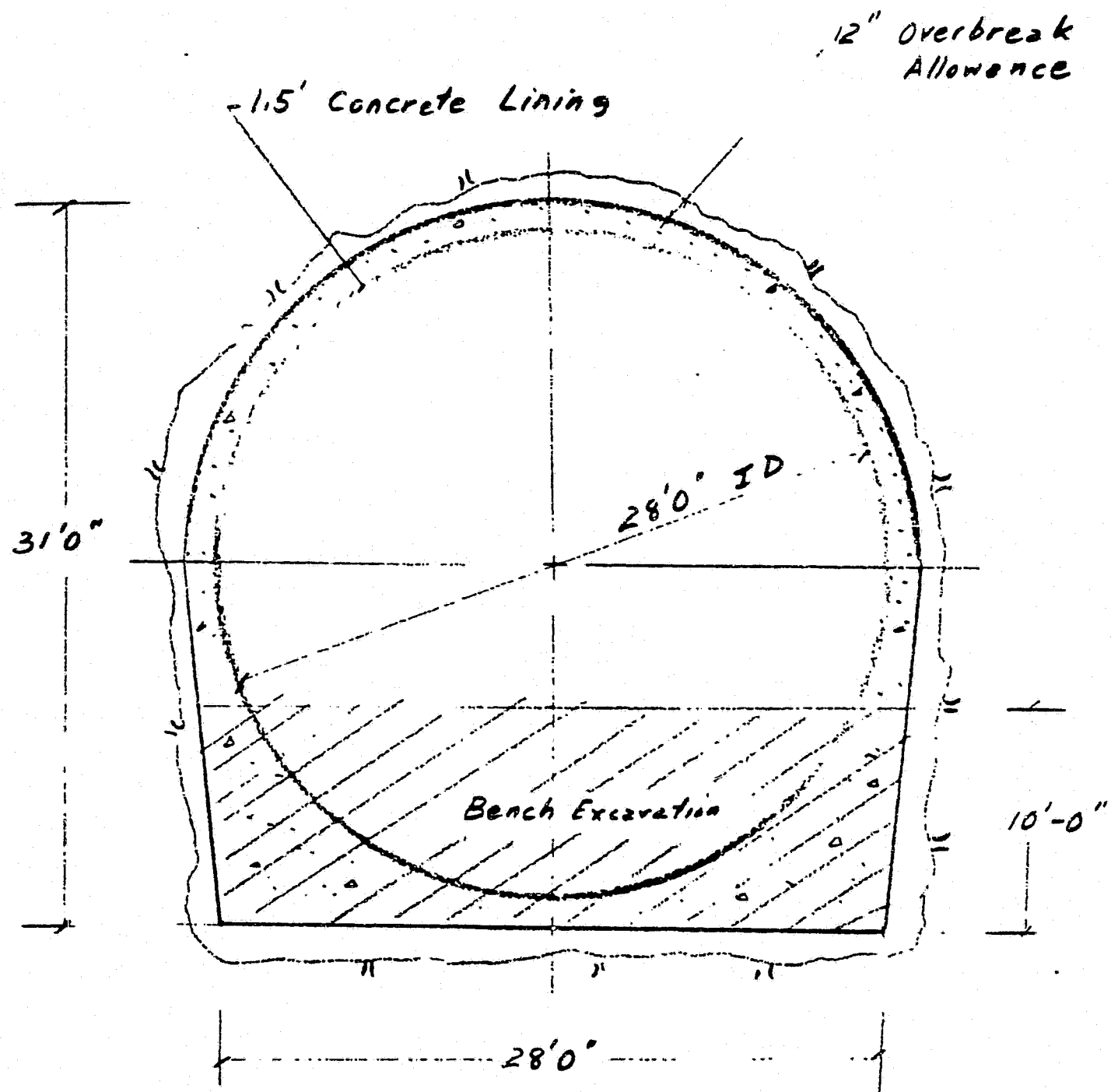
UNIT PRICE PER CY = 2,131,237 / 2580. X 3.4 = \$ 242.30 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 135. DAYS X 21. MEN / 2580. LF = 1.09 MD/LF

- MAN-DAYS/CY = 135. DAYS X 21. MEN / 2580. LF / 3.41 = 0.32 MD/CY

OUTLET TUNNEL
31' Ø



TOP HEADING & BENCH EXCAVATION

Scale 0 2'

SUSITNA - WATANA

OUTLET TUNNEL

HARZA ENGINEERING CO., CHICAGO

APPROVED.

DATE

DWG. NO.

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER
PROJECT: SUSITNA 332.512
FILE NO: 1563

QUANTITY: 2050.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 31.0 X 28.0 FT

ANGLE OF ARCH = $2 \times (\arccos 15.5 - 15.5 / 15.5) = 3.14$ RADIANS

ARCH AREA = $0.5 \times (15.5) \times 2 (3.14 - \sin 3.14) = 377.4$ FT-2

BCY/LF = $(377.4 + 5.5 \times 28.0) / 27 = 19.7$ BCY/LF

PERIMETER = $3.14 \times 15.5 + 2.0 \times 5.5 + 28.0 = 87.7$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $87.7 / 24. / 12 = 44.$

AREA OF PATTERN = $531.38 \text{ FT}^2 - 24.0 / 12.0 \times 87.7 = 356.0$ FT-2

PATTERN HOLES @ $3.0 \times 3.0 = 356.0 / 9.00 = 40.$

TOTAL HOLES = $44. + 40. = 84.$

NUMBER OF DRILLS = $1 - 4. =$ DRILLS = 4.

NUMBER OF HOLES/DRILL = $84. / 4. = 21.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $84. \times 12. / 11. \times 2050. = 188754. \text{ LF}$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER
PROJECT: SUSITNA 332.512
FILE NO: 1563

QUANTITY: 2050.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 21. HOLES/DRILL X 12.0 @ 60. FT/HR	4.22 HRS
LOAD 21. HOLES/MINER @ 3.0 MIN/EA	1.27 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 12.50 \times 0.85 \times 0.60 = 6.37$$

$$\text{BCY/HR} = 6.37 \times 1. \times 0.83 \times 40.00 = 211.65 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 19.68 \text{ BCY/LF} \times 11.0 \text{ LF} = 216.49$$

$$\text{MUCK TIME} = 216.49 \text{ BCY} \times 1.17 \text{ (OB)} / 211.65 = 1.19 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 1.19 - 4.22 - 1.27 - 0.50 \quad 0.00 \text{ HRS}$$

$$\text{TOTAL CYCLE TIME} \quad 6.99 \text{ HRS}$$

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 6.99 = 31. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER
PROJECT: SUSITNA 332.512
FILE NO: 1563

QUANTITY: 2050.FT
DATE: FEB 16, 1964 -
EST. BY RAM D/OEB

=====

BENCH EXCAVATION

BENCH DIMENSIONS : 28.0 X 10.0 FT

BCY/LF = $28.0 \times 10.0 / 27 = 10.4$ BCY/LF

PERIMETER = $28.0 + 2 \times 30.0 = 88.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $88.0 / 24. / 12 = 44.$

PATTERN HOLES = $28.0 \times 30.0 / 25.00 \text{ FT}^2/\text{HOLE} = 34.$

TOTAL HOLES = $44. + 34. = 78.$

NUMBER OF DRILLS = 4.

NUMBER OF HOLES/DRILL = $78. / 4. = 19.4$

TOTAL LF OF HOLE = $78. \times (10.0 + 1) \times 2050.0/30.0 = 58329. \text{ LF}$

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER

PROJECT: SUSITHA 332.512

FILE NO: 1563

QUANTITY: 2050.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS 1.00 HRS

DRILL 78. HOLES X 11.0 DEPTH/ 60. FT/HR X 4. 3.56 HRS

LOAD 78. HOLES X 3.0 MIN/EA /50 MIN/HR X 4. 1.16 HRS

SHOOT AND SMOKE 0.50 HRS

MUCKING OPERATION:

MUCK TIME = $311.11 \text{ BCY} \times 1.17 \text{ (OB) / } 211.65 = 1.71 \text{ HRS}$

(ACTUAL CYCLE) MUCK TIME = $1.71 - 3.56 - 1.16 = 0.00 \text{ HRS}$

TOTAL CYCLE TIME -----
6.22 HRS

USE 2. - 10. HR SHIFTS

DAILY ADVANCE = $30.0 \text{ LF/ROUND} \times 2. \times 10. / 6.22 = 96. \text{ LF/DAY}$

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HARZA ENGINEERING COMPANY		
DIRECT COST ESTIMATE		
ITEM:	OUTLET TUNNEL 31 FT EXCAVATED DIAMETER	QUANTITY: 2050.FT
PROJECT:	SUSITNA 332.512	DATE: FEB 16, 1984 -
FILE NO:	1563	EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 380.0 FT @ 16. LF/DAY (50.0 %)	24.1 DAYS
REMAINING 1670. FT @ 31. FT/DAY	53.0 DAYS
BENCH EXCAVATION 2050. FT @ 96. FT/DAY	21.3 DAYS
TURN UNDER AT TUNNEL PORTALS	2.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	6.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	2.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	6.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	1.0 DAYS

TOTAL EXCAVATION TIME	115.4 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER
PROJECT: SUSITNA 332.512
FILE NO: 1563

QUANTITY: 2050.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER
PROJECT: SUSITNA 332.512
FILE NO: 1563

QUANTITY: 2050.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT EXCAVATED DIAMETER QUANTITY: 2050.FT
PROJECT: SUSITNA 332.512 DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
4.0	DRILLS	42.01 X 20. HRS	3360.80
4.0	AIR COMPRESSORS 600	40.36 X 20. HRS	3228.80
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	EXPLOSIVE CARRIER	25.00 X 20. HRS	500.00
1.0	FEL 992	201.13 X 20. HRS	4022.60
3.0	R 50S	84.19 X 20. HRS	5051.40
SUBTOTAL			17188.60
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 17188.60 X 75.0/100.0 = \$ 12891.45 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
61605.07	BCY	POWDER & CAPS	6.80	418914.46
247083.53	LF	BITS & STEEL	0.40	98833.41
44.00	EA	STEEL SUPPORTS (40 LB/FT)	3896.00	171424.00
656.00	EA	ROCKBOLTS (15FT)	127.00	83312.00
92.00	CY	SHOTCRETE (3")	450.00	41400.00
2050.00	LF	AIR AND WATER DISCHARGE	30.00	61500.00
2050.00	LF	FAN LINES	25.00	51250.00
2050.00	LF	ELECTRIC SUPPLIES	100.00	205000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$ 1131633.87				

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  OUTLET TUNNEL  31 FT EXCAVATED DIAMETER    QUANTITY: 2050.FT
PROJECT:  SUSITNA 332.512                        DATE: FEB 16, 1984 -
FILE NO:  1563                                    EST. BY RAM D/OEB
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SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 115. DAYS

LABOR COSTS:
 115. X \$ 12306.80 / DAY \$ 1,420,440 692.90

EQUIPMENT COSTS:
 115. X \$ 12891.45 / DAY \$ 1,487,919 725.81

MATERIALS & SUPPLIES: \$ 1,131,633 552.02

S T & S @ 15.% OF LABOR \$ 214,514 104.64

 TOTAL DIRECT COST \$ 4,254,508 2075.37

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 4,254,508 X 1.00 = \$ 4,254,508

UNIT PRICE PER LF = 4,254,508 / 2050. = \$ 2075.37 / LF

UNIT PRICE PER CY = 4,254,508 / 2050. X 30.1 = \$ 69.06 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 115. DAYS X 33. MEN / 2050. LF = 1.86 MD/LF

- MAN-DAYS/CY = 115. DAYS X 33. MEN / 2050. LF/30.05 = 0.06 MD/CY

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT INCLINE
PROJECT: SUSITNA 332.51A
FILE NO: 1563

=====

QUANTITY: 460.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 31.0 X 28.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 15.5 - 15.5 / 15.5) = 3.14 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (15.5) \times 2 (3.14 - \sin 3.14) = 377.4 \text{ FT}^2$$

$$\text{BCY/LF} = (377.4 + 15.5 \times 28.0) / 27 = 30.1 \text{ BCY/LF}$$

$$\text{PERIMETER} = 3.14 \times 15.5 + 2.0 \times 15.5 + 28.0 = 107.7 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 107.7 / 24. / 12 = 54.$$

$$\text{AREA OF PATTERN} = 811.38 \text{ FT}^2 - 24.0 / 12.0 \times 107.7 = 596.0 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 596.0 / 9.00 = 67.$$

$$\text{TOTAL HOLES} = 54. + 67. = 121.$$

$$\text{NUMBER OF DRILLS} = 1 - 2. = \text{DRILLS} = 2.$$

$$\text{NUMBER OF HOLES/DRILL} = 121. / 2. = 61.$$

DRILL 9.0 FT - PULL 8.0 FT

$$\text{TOTAL LF OF HOLE} = 121. \times 9. / 8. \times 460. = 62653. \text{ LF}$$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT INCLINE
PROJECT: SUSITNA 332.51A
FILE NO: 1563

QUANTITY: 460.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 61. HOLES/DRILL X 9.0 @ 50. FT/HR	10.90 HRS
LOAD 61. HOLES/MINER @ 3.0 MIN/EA	3.63 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 4.00 \times 0.85 \times 0.60 = 2.04$$

$$\text{BCY/HR} = 2.04 \times 1. \times 0.83 \times 30.00 = 50.80 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 30.05 \text{ BCY/LF} \times 8.0 \text{ LF} = 240.41$$

$$\text{MUCK TIME} = 240.41 \text{ BCY} \times 1.13 \text{ (OB)}/ 50.80 = 5.36 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 5.36 - 10.90 - 3.63 - 0.50 \quad 0.00 \text{ HRS}$$

$$\text{TOTAL CYCLE TIME} \quad 16.03 \text{ HRS}$$

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 8.0 \text{ LF/ROUND} \times 2. \times 10. / 16.03 = 10. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT INCLINE
PROJECT: SUSITNA 332.51A
FILE NO: 1563

=====

QUANTITY: 460.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 16.0 FT @ 5. LF/DAY (50.0 %)	3.2 DAYS
REMAINING 444. FT @ 10. FT/DAY	44.5 DAYS
ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	1.0 DAYS
ADDITIONAL TIME FOR INCLINE	6.0 DAYS

TOTAL EXCAVATION TIME	61.7 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT INCLINE
PROJECT: SUSITNA 332.51A
FILE NO: 1563

QUANTITY: 460.FT
DATE: FEB 16, 1964 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
EIMCO OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.80
SUBTOTAL	10.5	10.5	0.0	21.0		7933.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7933.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT INCLINE
PROJECT: SUSITNA 332.51A
FILE NO: 1563

QUANTITY: 460.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
2.0	ALIMAC DRILLS	42.01 X 20. HRS	1680.40
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	EIMCO MUCKER	35.02 X 20. HRS	700.40
2.0	R 255	42.45 X 20. HRS	1698.00
SUBTOTAL			5103.80
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 5103.80 X 75.0/100.0 = \$ 3827.85 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
13823.58	BCY	POWDER & CAPS	6.80	94000.32
62653.18	LF	BITS & STEEL	0.40	25061.27
12.00	EA	STEEL SUPPORTS (40 LB/FT)	3896.00	46752.00
150.00	EA	ROCKBOLTS (15FT)	127.00	19050.00
20.00	CY	SHOTCRETE (3")	450.00	9000.00
460.00	LF	AIR AND WATER DISCHARGE	30.00	13800.00
460.00	LF	FAN LINES	25.00	11500.00
460.00	LF	ELECTRIC SUPPLIES	100.00	46000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				265163.59

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: OUTLET TUNNEL 31 FT INCLINE
PROJECT: SUSITNA 332.51A
FILE NO: 1563

QUANTITY: 460.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 62. DAYS

LABOR COSTS:

62. X \$ 7933.80 / DAY \$ 489,389 1063.89

EQUIPMENT COSTS:

62. X \$ 3827.85 / DAY \$ 236,117 513.30

MATERIALS & SUPPLIES: \$ 265,163 576.44

S T & S @ 15.% OF LABOR \$ 74,504 161.97

TOTAL DIRECT COST \$ 1,065,175 2315.60

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 1,065,175 X 1.00 = \$ 1,065,175

UNIT PRICE PER LF = 1,065,175 / 460. = \$ 2315.60 / LF

UNIT PRICE PER CY = 1,065,175 / 460. X 30.1 = \$ 77.05 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 62. DAYS X 21. MEN / 460. LF = 2.82 MD/LF

- MAN-DAYS/CY = 62. DAYS X 21. MEN / 460. LF/30.05 = 0.09 MD/CY

00234

MANIFOLD TUNNELS

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TUNNEL EXCAVATION MANIFOLD 11 FT DIA
PROJECT: SUSITNA - 332.51B
FILE NO: 1563

QUANTITY: 900.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 11.0 X 11.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 5.5 - 5.5 / 5.5) = 3.14 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (5.5) \times 2 \times (3.14 - \sin 3.14) = 47.5 \text{ FT}^2$$

$$\text{BCY/LF} = (47.5 + 5.5 \times 11.0) / 27 = 4.0 \text{ BCY/LF}$$

$$\text{PERIMETER} = 3.14 \times 5.5 + 2.0 \times 5.5 + 11.0 = 39.3 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 39.3 / 24. / 12 = 20.$$

$$\text{AREA OF PATTERN} = 108.02 \text{ FT}^2 - 24.0 / 12.0 \times 39.3 = 29.5 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 29.5 / 9.00 = 4.$$

$$\text{TOTAL HOLES} = 20. + 4. = 24.$$

$$\text{NUMBER OF DRILLS} = 1 - 2 = \text{DRILLS} = 2.$$

$$\text{NUMBER OF HOLES/DRILL} = 24. / 2. = 12.$$

DRILL 9.0 FT - PULL 8.0 FT

$$\text{TOTAL LF OF HOLE} = 24. \times 9. / 8. \times 900. = 24212. \text{ LF}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TUNNEL EXCAVATION MANIFOLD 11 FT DIA
PROJECT: SUSITNA - 332.51B
FILE NO: 1563

QUANTITY: 900.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 12. HOLES/DRILL X 9.0 @ 60. FT/HR	1.79 HRS
LOAD 12. HOLES/MINER @ 3.0 MIN/EA	0.72 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 2.00 \times 0.85 \times 0.60 = 1.02$$

$$\text{BCY/HR} = 1.02 \times 1. \times 0.83 \times 40.00 = 33.86 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 4.00 \text{ BCY/LF} \times 8.0 \text{ LF} = 32.00$$

$$\text{MUCK TIME} = 32.00 \text{ BCY} \times 1.24 \text{ (OB)} / 33.86 = 1.17 \text{ HRS}$$

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.17- 1.79- 0.72- 0.50	0.00 HRS
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TOTAL CYCLE TIME	----- 4.01 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 8.0 \text{ LF/ROUND} \times 2. \times 10. / 4.01 = 40. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TUNNEL EXCAVATION MANIFOLD 11 FT DIA
PROJECT: SUSITNA - 332.51B
FILE NO: 1563

=====

QUANTITY: 900.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 480.0 FT @ 20. LF/DAY (50.0 %)	24.1 DAYS
REMAINING 420. FT @ 40. FT/DAY	10.5 DAYS
ALLOWANCE FOR DELAYS & FAULTS	4.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETE (3")	1.0 DAYS

TOTAL EXCAVATION TIME	45.1 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TUNNEL EXCAVATION MANIFOLD 11 FT DIA
PROJECT: SUSITNA - 332.51B
FILE NO: 1563

QUANTITY: 900.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
TRUCK DRIVERS	2.0	2.0	0.0	4.0	39.37	1574.80
SUBTOTAL	10.5	10.5	0.0	21.0		7934.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7934.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TUNNEL EXCAVATION MANIFOLD 11 FT DIA
PROJECT: SUSITNA - 332.51B
FILE NO: 1563

QUANTITY: 900.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	JUMBO WITH DRILLS	42.01 X 20. HRS	840.20
1.0	AIR COMPRESSORS 600	40.36 X 20. HRS	807.20
1.0	FANS	10.07 X 20. HRS	201.40
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	EIMCO (2 CY)	21.05 X 20. HRS	421.00
2.0	CARS W/ PRIME MOVERS	31.08 X 20. HRS	1243.20
SUBTOTAL			3723.40
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 3723.40 X 75.0/100.0 = \$ 2792.55 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
3600.55	BCY	POWDER & CAPS	6.80	24483.76
24211.52	LF	BITS & STEEL	0.40	9684.61
24.00	EA	STEEL SUPPORTS (20 LB/FT)	692.00	16608.00
288.00	EA	ROCKBOLTS (10FT)	84.67	24384.96
15.00	CY	SHOTCRETE (3")	450.00	6750.00
900.00	LF	AIR AND WATER DISCHARGE	15.00	13500.00
900.00	LF	FAN LINES	12.50	11250.00
900.00	LF	ELECTRIC SUPPLIES	50.00	45000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$ 151661.33				

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TUNNEL EXCAVATION MANIFOLD 11 FT DIA
PROJECT: SUSITNA - 332.51B
FILE NO: 1563

QUANTITY: 900.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

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SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 45. DAYS

LABOR COSTS:

45. X \$ 7934.80 / DAY \$ 357,806 397.56

EQUIPMENT COSTS:

45. X \$ 2792.55 / DAY \$ 125,925 139.92

MATERIALS & SUPPLIES: \$ 151,661 168.51

S T & S @ 15.% OF LABOR \$ 53,671 59.63

TOTAL DIRECT COST \$ 689,064 765.63

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 689,064 X 1.00 = \$ 689,064

UNIT PRICE PER LF = 689,064 / 900. = \$ 765.63 / LF

UNIT PRICE PER CY = 689,064 / 900. X 4.0 = \$ 191.38 / CY

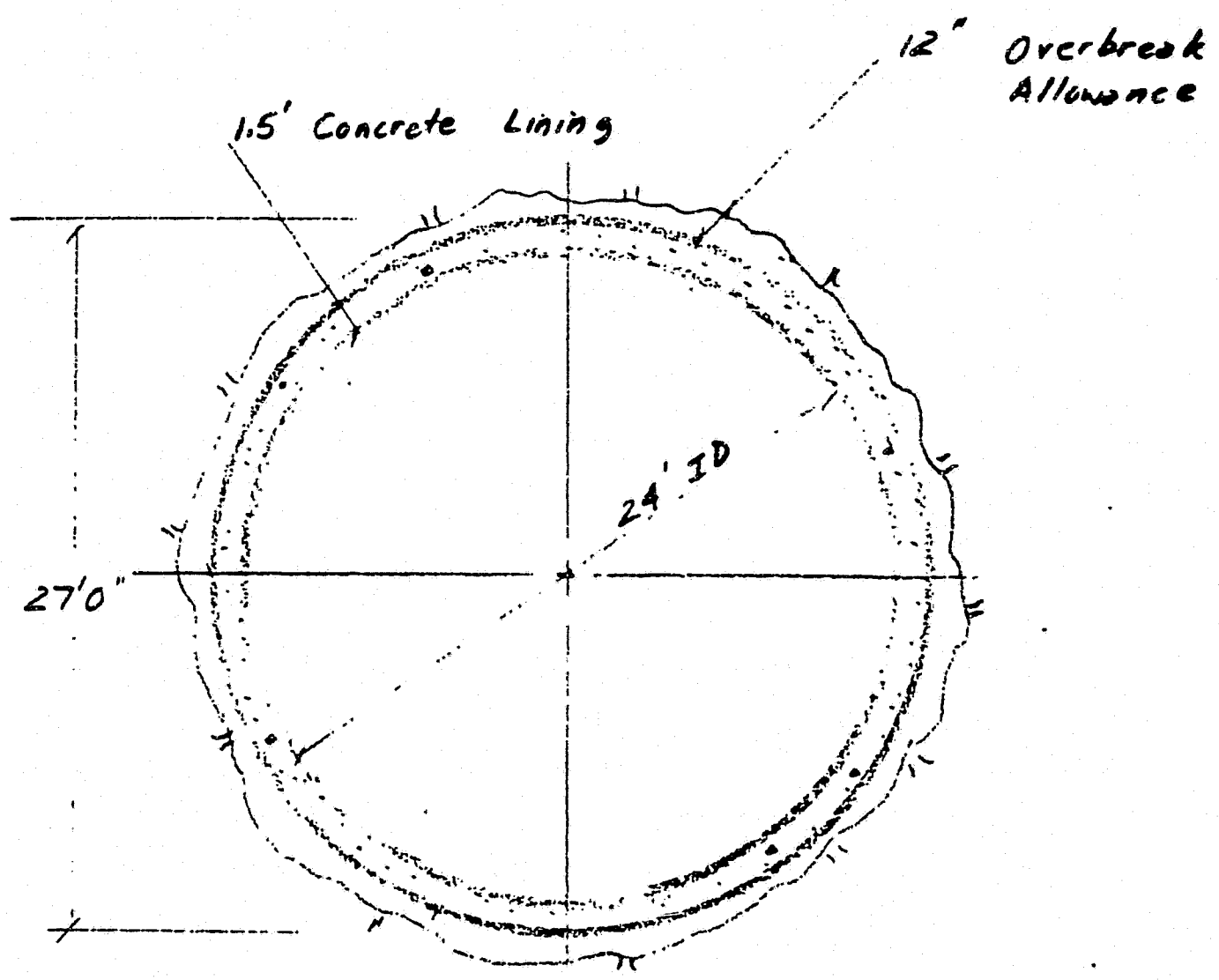
SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 45. DAYS X 21. MEN / 900. LF = 1.05 MD/LF

- MAN-DAYS/CY = 45. DAYS X 21. MEN / 900. LF / 4.00 = 0.26 MD/CY

00254

00234



FULL FACE METHOD OF EXCAVATION

Scale 0 2'

SUSITNA - NATANA	
PENSTOCK	
HARZA ENGINEERING CO., CHICAGO	
APPROVED.....	
DATE	DWG. NO.


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS      27 FT EXCAVATED DIAMETER      QUANTITY: 1245.FT
PROJECT:  SUSITNA 332.810A      DATE: FEB 16, 1984 -
FILE NO:  1563      EST. BY RAM D/OEB
=====
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BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 27.0 X 27.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 13.5 - 13.5 / 13.5) = 3.14 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (13.5)^2 \times (3.14 - \sin 3.14) = 286.3 \text{ FT}^2$$

$$\text{BCY/LF} = (286.3 + 13.5 \times 27.0) / 27 = 24.1 \text{ BCY/LF}$$

$$\text{PERIMETER} = 3.14 \times 13.5 + 2.0 \times 13.5 + 27.0 = 96.4 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 96.4 / 24. / 12 = 49.$$

$$\text{AREA OF PATTERN} = 650.78 \text{ FT}^2 - 24.0 / 12.0 \times 96.4 = 458.0 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 458.0 / 9.00 = 51.$$

$$\text{TOTAL HOLES} = 49. + 51. = 100.$$

$$\text{NUMBER OF DRILLS} = 1 - 6 - \text{DRILLS} = 6.$$

$$\text{NUMBER OF HOLES/DRILL} = 100. / 6. = 17.$$

DRILL 12.0 FT - PULL 11.0 FT

$$\text{TOTAL LF OF HOLE} = 100. \times 12. / 11. \times 1245. = 135940. \text{ LF}$$


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS      27 FT EXCAVATED DIAMETER    QUANTITY: 1245.FT
PROJECT:  SUSITHA 332.810A                      DATE: FEB 16, 1984 -
FILE NO:  1563                                   EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 17. HOLES/DRILL X 12.0 @ 60. FT/HR	3.34 HRS
LOAD 17. HOLES/MINER @ 3.0 MIN/EA	1.00 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

BCY/LOAD = $12.50 \times 0.85 \times 0.60 = 6.37$

BCY/HR = $6.37 \times 1. \times 0.83 \times 40.00 = 211.65$ BCY/HR

BCY/CYCLE = 24.10 BCY/LF $\times 11.0$ LF = 265.13

MUCK TIME = 265.13 BCY $\times 1.15$ (OB) / $211.65 = 1.44$ HRS

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.44- 3.34- 1.00- 0.50	0.00 HRS
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TOTAL CYCLE TIME	5.84 HRS
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USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 11.0 LF/ROUND $\times 2. \times 10. / 5.84 = 38. \text{ LF/DAY}$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS      27 FT EXCAVATED DIAMETER      QUANTITY: 1245.FT
PROJECT:  SUSITNA 332.810A      DATE: FEB 16, 1984 -
FILE NO:  1563      EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 130.0 FT @ 19. LF/DAY (50.0 %)	6.9 DAYS
REMAINING 1115. FT @ 38. FT/DAY	29.6 DAYS
TURN UNDER AT TUNNEL PORTALS	3.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	3.5 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.5 DAYS
ADDITIONAL TIME FOR SHOTCRETING	1.0 DAYS

TOTAL EXCAVATION TIME	49.5 DAYS

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS      27 FT EXCAVATED DIAMETER    QUANTITY: 1245.FT
PROJECT:  SUSITNA 332.810A                      DATE: FEB 16, 1984 -
FILE NO:  1563                                   EST. BY RAM D/OEB
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CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	6.0	6.0	0.0	12.0	35.64	4276.80
CHUCK TENDER	6.0	6.0	0.0	12.0	34.91	4189.20
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	20.5	20.5	0.0	41.0		15128.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 15128.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 27 FT EXCAVATED DIAMETER QUANTITY: 1245.FT
PROJECT: SUSITNA 332.810A DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0	DRILLS	42.01 X 20. HRS	5041.20
6.0	AIR COMPRESSORS 600	40.36 X 20. HRS	4843.20
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	FEL 992	201.13 X 20. HRS	4022.60
3.0	R 50S	84.19 X 20. HRS	5051.40
SUBTOTAL			19983.40
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 19983.40 X 75.0/100.0 = \$ 14987.55 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
30008.08	BCY	POWDER & CAPS	6.80	204054.94
135939.87	LF	BITS & STEEL	0.40	54375.95
34.00	EA	STEEL SUPPORTS (40 LB/FT)	3896.00	132464.00
398.00	EA	ROCKBOLTS (15FT)	127.00	50546.00
50.00	CY	SHOTCRETE (3")	450.00	22500.00
1245.00	LF	AIR AND WATER DISCHARGE	30.00	37350.00
1245.00	LF	FAN LINES	25.00	31125.00
1245.00	LF	ELECTRIC SUPPLIES	100.00	124500.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				656915.89

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 27 FT EXCAVATED DIAMETER QUANTITY: 1245.FT
PROJECT: SUSITNA 332.810A DATE: FEB 16, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0	DRILLS	42.01 X 20. HRS	5041.20
6.0	AIR COMPRESSORS 600	40.36 X 20. HRS	4843.20
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	FEL 992	201.13 X 20. HRS	4022.60
3.0	R 50S	84.19 X 20. HRS	5051.40
SUBTOTAL			19983.40
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 19983.40 X 75.0/100.0 = \$ 14987.55 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
30008.00	BCY	POWDER & CAPS	6.80	204054.94
135939.87	LF	BITS & STEEL	0.40	54375.95
34.00	EA	STEEL SUPPORTS (40 LB/FT)	3896.00	132464.00
398.00	EA	ROCKBOLTS (15FT)	127.00	50546.00
50.00	CY	SHOTCRETE (3")	450.00	22500.00
1245.00	LF	AIR AND WATER DISCHARGE	30.00	37350.00
1245.00	LF	FAN LINES	25.00	31125.00
1245.00	LF	ELECTRIC SUPPLIES	100.00	124500.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				656915.09

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS      27 FT EXCAVATED DIAMETER    QUANTITY: 1245.FT
PROJECT:  SUSITNA 332.810A                      DATE: FEB 16, 1984 -
FILE NO:  1563                                   EST. BY RAM D/OEB
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SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 49. DAYS

LABOR COSTS:
 49. X \$ 15128.80 / DAY \$ 748,612 601.30

EQUIPMENT COSTS:
 49. X \$ 14987.55 / DAY \$ 741,622 595.68

MATERIALS & SUPPLIES: \$ 656,915 527.64

S T & S @ 15.% OF LABOR \$ 113,557 91.21

 TOTAL DIRECT COST \$ 2,260,708 1815.83

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 2,260,708 X 1.00 = \$ 2,260,708

UNIT PRICE PER LF = 2,260,708 / 1245. = \$ 1815.83 / LF

UNIT PRICE PER CY = 2,260,708 / 1245. X 24.1 = \$ 75.34 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 49. DAYS X 41. MEN / 1245. LF = 1.63 MD/LF

- MAN-DAYS/CY = 49. DAYS X 41. MEN / 1245. LF/24.10 = 0.07 MD/CY

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PENSTOCKS 21' Ø

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 21 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.812
FILE NO: 1563

QUANTITY: 690.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 21.0 X 21.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 10.5 - 10.5 / 10.5) = 3.14 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (10.5) \times 2 (3.14 - \sin 3.14) = 173.2 \text{ FT}^2$$

$$\text{BCY/LF} = (173.2 + 10.5 \times 21.0) / 27 = 14.6 \text{ BCY/LF}$$

$$\text{PERIMETER} = 3.14 \times 10.5 + 2.0 \times 10.5 + 21.0 = 75.0 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 75.0 / 24. / 12 = 38.$$

$$\text{AREA OF PATTERN} = 393.68 \text{ FT}^2 - 24.0 / 12.0 \times 75.0 = 243.7 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 243.7 / 9.00 = 28.$$

$$\text{TOTAL HOLES} = 38. + 28. = 66.$$

$$\text{NUMBER OF DRILLS} = 1 - 4. - \text{DRILLS} = 4.$$

$$\text{NUMBER OF HOLES/DRILL} = 66. / 4. = 16.$$

DRILL 12.0 FT - PULL 11.0 FT

$$\text{TOTAL LF OF HOLE} = 66. \times 12. / 11. \times 690. = 49358. \text{ LF}$$


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS 21 FT DIAMETER - HORIZONTAL    QUANTITY:  690.FT
PROJECT:  SUSITNA 332.812                      DATE:  FEB 16, 1984 -
FILE NO:  1563                                EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 16. HOLES/DRILL X 12.0 @ 60. FT/HR	3.28 HRS
LOAD 16. HOLES/MINER @ 3.0 MIN/EA	0.98 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 1. \times 0.83 \times 40.00 = 118.52 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 14.58 \text{ BCY/LF} \times 11.0 \text{ LF} = 160.39$$

$$\text{MUCK TIME} = 160.39 \text{ BCY} \times 1.19 \text{ (OB)} / 118.52 = 1.61 \text{ HRS}$$

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.61- 3.28- 0.98- 0.50	0.00 HRS
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TOTAL CYCLE TIME	5.76 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 5.76 = 38. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 21 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.812
FILE NO: 1563

QUANTITY: 690.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 84.0 FT @ 19. LF/DAY (50.0 %)	4.4 DAYS
REMAINING 606. FT @ 38. FT/DAY	15.9 DAYS
ALLOWANCE FOR DELAYS & FAULTS	3.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	0.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	0.5 DAYS

TOTAL EXCAVATION TIME	28.3 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 21 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.812
FILE NO: 1563

QUANTITY: 690.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	EVENING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.00

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 21 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.012
FILE NO: 1563

QUANTITY: 690.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
4.0	DRILLS	42.01 X 20. HRS	3360.00
4.0	AIR COMPRESSORS 600	40.36 X 20. HRS	3220.00
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.00
1.0	FEL 988	115.74 X 20. HRS	2314.00
3.0	R 355	62.64 X 20. HRS	3750.40
SUBTOTAL			13687.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 13687.00 X 75.0/100.0 = \$ 10265.05 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
10060.72	BCY	POWDER & CAPS	6.00	60412.09
49357.76	LF	BITS & STEEL	0.40	19743.10
26.00	EA	STEEL SUPPORTS (20 LB/FT)	691.00	17966.00
221.00	EA	ROCKBOLTS (10FT)	84.64	18705.44
11.00	CY	SHOTCRETE (3")	450.00	4950.00
690.00	LF	AIR AND WATER DISCHARGE	30.00	20700.00
690.00	LF	FAN LINES	25.00	17250.00
690.00	LF	ELECTRIC SUPPLIES	100.00	69000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				236727.43

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS 21 FT DIAMETER - HORIZONTAL      QUANTITY:  690.FT
PROJECT:  SUSITHA 332.012                        DATE:  FEB 16, 1984 -
FILE NO:  1563                                    EST. BY RAM D/OEB
=====

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SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 28. DAYS

LABOR COSTS:
 28. X \$ 12306.80 / DAY \$ 347,942 504.26

EQUIPMENT COSTS:
 28. X \$ 10265.85 / DAY \$ 290,239 420.64

MATERIALS & SUPPLIES: \$ 236,727 343.08

S T & S @ 15.% OF LABOR \$ 51,102 74.06

 TOTAL DIRECT COST \$ 926,012 1342.05

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 926,012 X 1.00 = \$ 926,012

UNIT PRICE PER LF = 926,012 / 690. = \$ 1342.05 / LF

UNIT PRICE PER CY = 926,012 / 690. X 14.6 = \$ 92.04 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 28. DAYS X 33. MEN / 690. LF = 1.35 MD/LF

- MAN-DAYS/CY = 28. DAYS X 33. MEN / 690. LF/14.58 = 0.09 MD/CY

=====

HARZA ENGINEERING COMPANY		
DIRECT COST ESTIMATE		
ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL		QUANTITY: 1200.FT
PROJECT: SUSITNA 332.812B		DATE: FEB 16, 1984 -
FILE NO: 1563		EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 18.0 X 18.0 FT

ANGLE OF ARCH = $2 \times (\arccos 9.0 - 9.0 / 9.0) = 3.14$ RADIANS

ARCH AREA = $0.5 \times (9.0)^2 (3.14 - \sin 3.14) = 127.2$ FT-2

BCY/LF = $(127.2 + 9.0 \times 18.0) / 27 = 10.7$ BCY/LF

PERIMETER = $3.14 \times 9.0 + 2.0 \times 9.0 + 18.0 = 64.3$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $64.3 / 24. / 12 = 33.$

AREA OF PATTERN = $289.23 \text{ FT}^2 - 24.0 / 12.0 \times 64.3 = 160.7$ FT-2

PATTERN HOLES @ $3.0 \times 3.0 = 160.7 / 9.00 = 18.$

TOTAL HOLES = $33. + 18. = 51.$

NUMBER OF DRILLS = $1 - 4. - \text{DRILLS} = 4.$

NUMBER OF HOLES/DRILL = $51. / 4. = 13.$

DRILL 12.0 FT - PULL 11.0 FT

TOTAL LF OF HOLE = $51. \times 12. / 11. \times 1200. = 66752. \text{ LF}$


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCKS 18 FT DIAMETER - HORIZONTAL      QUANTITY: 1200.FT
PROJECT:  SUSITHA 332.0120                      DATE:  FEB 16, 1984 -
FILE NO:  1563                                  EST. BY RAM D/OED
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 13. HOLES/DRILL X 12.0 @ 60. FT/HR	2.55 HRS
LOAD 13. HOLES/MINER @ 3.0 MIN/EA	0.76 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 1. \times 0.83 \times 40.00 = 118.52 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 10.71 \text{ BCY/LF} \times 11.0 \text{ LF} = 117.84$$

$$\text{MUCK TIME} = 117.84 \text{ BCY} \times 1.17 \text{ (OB)}/118.52 = 1.16 \text{ HRS}$$

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.16- 2.55- 0.76- 0.50	0.00 HRS
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TOTAL CYCLE TIME

4.81 HRS

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 4.81 = 46. \text{ LF/DAY}$$

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.8128
FILE NO: 1563

QUANTITY: 1200.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 170.0 FT @ 23. LF/DAY (50.0 %)	7.4 DAYS
REMAINING 1030. FT @ 46. FT/DAY	22.5 DAYS
ALLOWANCE FOR DELAYS & FAULTS	4.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	0.5 DAYS

TOTAL EXCAVATION TIME	40.0 DAYS

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL

PROJECT: SUSITNA 332.812B

FILE NO: 1563

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QUANTITY: 1200.FT

DATE: FEB 16, 1984 -

EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 170.0 FT @ 23. LF/DAY (50.0 %)	7.4 DAYS
REMAINING 1030. FT @ 46. FT/DAY	22.5 DAYS
ALLOWANCE FOR DELAYS & FAULTS	4.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	0.5 DAYS

TOTAL EXCAVATION TIME	40.0 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.812B
FILE NO: 1563

QUANTITY: 1200.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	3.0	3.0	0.0	6.0	39.37	2362.20
SUBTOTAL	16.5	16.5	0.0	33.0		12306.80
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 12306.80

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.812B
FILE NO: 1563

QUANTITY: 1200.FT
DATE: FEB 16, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
4.0	DRILLS	42.01 X 20. HRS	3360.00
4.0	AIR COMPRESSORS 600	40.36 X 20. HRS	3220.00
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.00
1.0	FEL 988	115.74 X 20. HRS	2314.00
3.0	R 355	62.64 X 20. HRS	3758.40
SUBTOTAL			13687.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 13687.00 X 75.0/100.0 = \$ 10265.85 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
12854.87	BCY	POWDER & CAPS	6.80	87413.09
66752.05	LF	BITS & STEEL	0.40	26700.82
30.00	EA	STEEL SUPPORTS (20 LB/FT)	1130.00	33900.00
384.00	EA	ROCKBOLTS (10FT)	84.64	32501.76
31.00	CY	SHOTCRETE (3")	450.00	13950.00
1200.00	LF	AIR AND WATER DISCHARGE	30.00	36000.00
1200.00	LF	FAN LINES	25.00	30000.00
1200.00	LF	ELECTRIC SUPPLIES	100.00	120000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				380465.67

ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL
PROJECT: SUSITNA 332.812B
FILE NO: 1563

QUANTITY: 1200.FT
DATE: FEB 16, 1934 -
EST. BY RAM D/OEB

NUMBER OF DAYS
FOR EXCAVATION = 40. DAYS

40. X \$ 12306.80 / DAY	\$	492,034	410.03
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40. X \$ 10265.85 / DAY	\$	410,436	342.03
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MATERIALS & SUPPLIES:	\$	380,465	317.05
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S T & S +/-15% OF LABOR	\$	71,413	59.51
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TOTAL DIRECT COST	\$	1,354,350	1128.63
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$$\text{MARK UP FACTOR} = (1 + 0.7/100.) = 1.007$$

TOTAL PRICE = 1,354,350 X 1.00 = \$ 1,354,350

UNIT PRICE PER LF = 1,354,350 / 1200. = \$ 1128.63 / LF

UNIT PRICE PER CY = $1,354,350 / 1200. \times 10.7 = \$ 105.36 /$

$$\text{MAN-DAYS/LF} = 40. \text{ DAYS} \times 33. \text{ MEN} / 1200. \text{ LF} = 1.10 \text{ MD/LF}$$
$$- \text{MAN-DAYS/CY} = 40. \text{ DAYS} \times 33. \text{ MEN} / 1200. \text{ LF} / 10.71 = 0.10 \text{ MD/C}$$

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: PENSTOCKS 18 FT DIAMETER - HORIZONTAL
 PROJECT: SUSITNA 332.812B
 FILE NO: 1563

QUANTITY: 1200.FT
 DATE: FEB 16, 1984 -
 EST. BY RAM D/OEB

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SUMMARY OF COSTS

XXXXXXXXXXXXXXXXXXXX

NUMBER OF DAYS
 FOR EXCAVATION = 40. DAYS

LABOR COSTS:

40. X \$ 12306.80 / DAY \$ 492,034 410.03

EQUIPMENT COSTS:

40. X \$ 10265.85 / DAY \$ 410,436 342.03

MATERIALS & SUPPLIES: \$ 380,465 317.05

S T & S +/-15% OF LABOR \$ 71,413 59.51

 TOTAL DIRECT COST \$ 1,354,350 1128.63

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 1,354,350 X 1.00 = \$ 1,354,350

UNIT PRICE PER LF = 1,354,350 / 1200. = \$ 1128.63 / LF

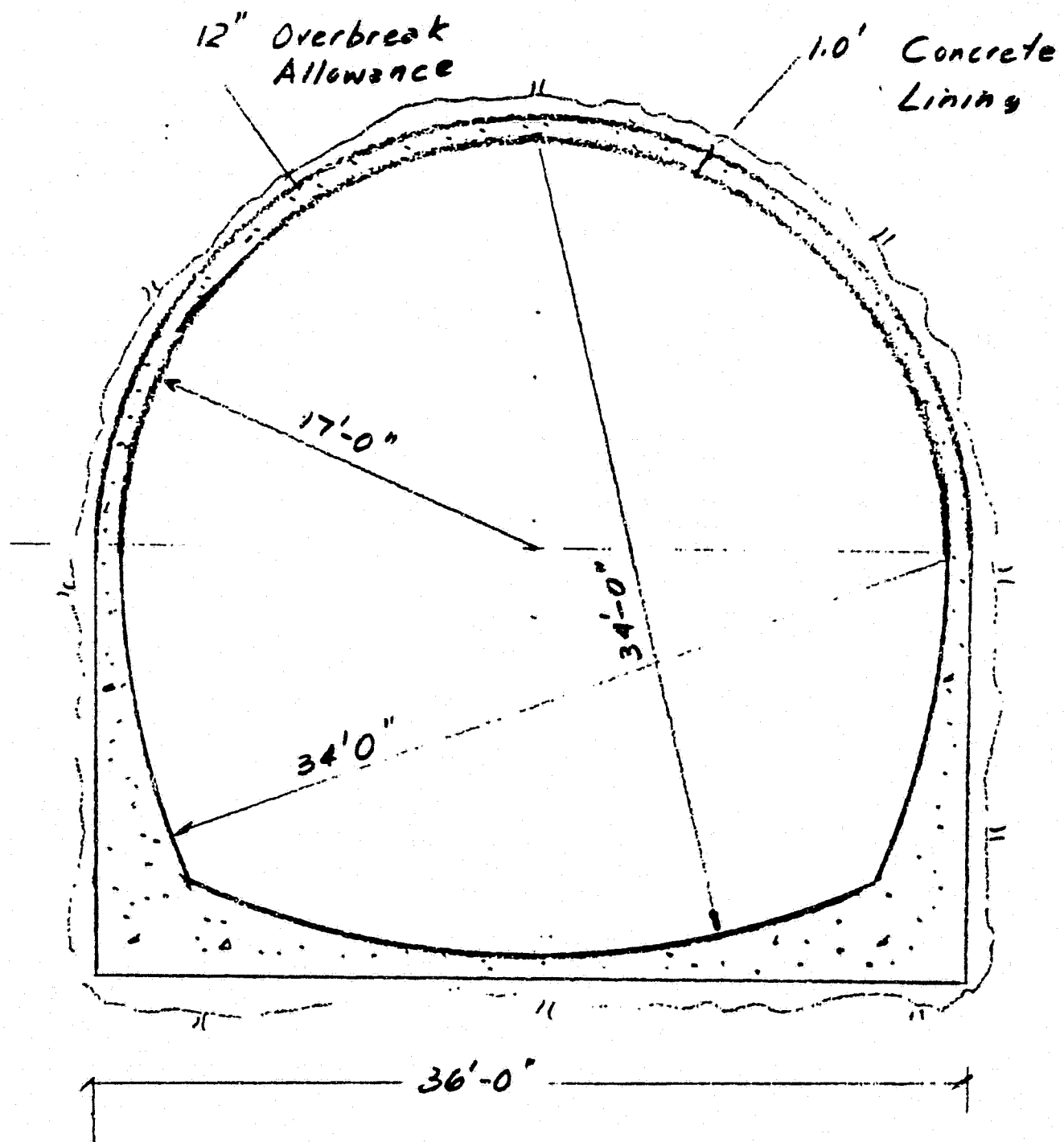
UNIT PRICE PER CY = 1,354,350 / 1200. X 10.7 = \$ 105.36 /

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 40. DAYS X 33. MEN / 1200. LF = 1.10 MD/LF

- MAN-DAYS/CY = 40. DAYS X 33. MEN / 1200. LF/10.71 = 0.10 MD/C

TAILRACE TUNNEL



TOP HEADING & BENCH METHOD OF EXCAVATION

SUSITNA WATANA

TAILRACE TUNNEL

HARZA ENGINEERING CO., CHICAGO

APPROVED.....

DATE

DWG. NO.

=====

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: TAILRACE TUNNEL 37 FT EXCAVATED DIAMETER

PROJECT: SUSITNA - 332.911

FILE NO: 1563

QUANTITY: 2080.FT

DATE: FEB 15, 1984 -

EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

EXCAVATED DIAMETER = 37.0 FT

BCY/LF = $3.1416/4 \times (37.0)^2 \times 1.020 / 27 = 40.6$ BCY/LF

PERIMETER = $3.1416 \times 37.0 \times 1.020 = 118.5$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $118.5 / 24. / 12 = 60.$

AREA OF PATTERN = $3.1416 \times (18.5 - 2.0)^2 \times 1.020 = 872.1$ FT-2

PATTERN HOLES @ 3.0 X 3.0 = $0.0 / 9.00 = 1.$

TOTAL HOLES = $60. + 1. = 60.$

NUMBER OF DRILLS = 1 - 6 - DRILLS = 6.

NUMBER OF HOLES/DRILL = $60. / 6. = 10.$

DRILL 12.0 FT - PULL 11.0.FT

TOTAL LF OF HOLE = $60. \times 12./11. \times 2080. = 136733.$ LF

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TAILRACE TUNNEL 37 FT EXCAVATED DIAMETER
PROJECT: SUSITNA - 332.911
FILE NO: 1563

QUANTITY: 2000.FT
DATE: FEB 15, 1984 -
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 10. HOLES/DRILL X 12.0 @ 60. FT/HR	2.01 HRS
LOAD 10. HOLES/MINER @ 3.0 MIN/EA	0.60 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 2. \times 0.83 \times 50.00 = 296.31 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 40.60 \text{ BCY/LF} \times 11.0 \text{ LF} = 446.64$$

$$\text{MUCK TIME} = 446.64 \text{ BCY} \times 1.35 \text{ (OB)} / 296.31 = 2.03 \text{ HRS}$$

ALTERNATING CREWS :

$$\text{(ACTUAL) MUCK TIME} = 2.03 - 2.01 - 0.60 - 0.50 \quad 0.00 \text{ HRS}$$

TOTAL CYCLE TIME	4.11 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 4.11 = 54. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TAILRACE TUNNEL 37 FT EXCAVATED DIAMETER QUANTITY: 2080.FT
PROJECT: SUSITNA - 332.911 DATE: FEB 15, 1984 -
FILE NO: 1563 EST. BY RAM D/OEB
=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 13. HOLES/DRILL X 12.0 @ 60. FT/HR	2.01 HRS
LOAD 10. HOLES/MINER @ 3.0 MIN/EA	0.60 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

BCY/LOAD = $7.00 \times 0.85 \times 0.60 = 3.57$

BCY/HR = $3.57 \times 2. \times 0.83 \times 50.00 = 296.31$ BCY/HR

BCY/CYCLE = 40.60 BCY/LF $\times 11.0$ LF = 446.64

MUCK TIME = 446.64 BCY $\times 1.35$ (OB) / $296.31 = 2.03$ HRS

ALTERNATING CREWS :
(ACTUAL) MUCK TIME = $2.03 - 2.01 - 0.60 - 0.50$ 0.00 HRS

TOTAL CYCLE TIME 4.11 HRS

USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 11.0 LF/ROUND $\times 2. \times 10. / 4.11 = 54.$ LF/DAY

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=====
                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TAILRACE TUNNEL 37 FT EXCAVATED DIAMETER    QUANTITY: 2080.FT
PROJECT:  SUSITHA - 332.911                        DATE: FEB 15, 1964 -
FILE NO:  1563                                     EST. BY RAM D/OEB
=====
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BENCH EXCAVATION

BENCH DIMENSIONS : 0.0 X 15.0 FT

BCY/LF = $0.0 \times 15.0 / 27 = 0.0$ BCY/LF

PERIMETER = $0.0 + 2 \times 30.0 = 60.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $60.0 / 24. / 12 = 30.$

PATTERN HOLES = $0.0 \times 30.0 / 25.00 \text{ FT-2/HOLE} = 0.$

TOTAL HOLES = $30. + 0. = 30.$

NUMBER OF DRILLS = 6.

NUMBER OF HOLES/DRILL = $30. / 6. = 5.0$

TOTAL LF OF HOLE = $30. \times (15.0 + 1) \times 2080.0/30.0 = 33280. \text{ LF}$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TAILRACE TUNNEL  37 FT EXCAVATED DIAMETER    QUANTITY: 2000.FT
PROJECT:  SUSITNA - 332.911                        DATE: FEB 15, 1984 -
FILE NO:  1563                                     EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

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CYCLE TIME: MOVE IN DRILLS                                1.00 HRS

DRILL  30. HOLES X 16.0 DEPTH/ 60. FT/HR X 6.           1.33 HRS
LOAD   30. HOLES X  3.0 MIN/EA /50 MIN/HR X 6.           0.30 HRS
SHOOT AND SMOKE                                           0.50 HRS

MUCKING OPERATION:

MUCK TIME =  0.00 BCY X 1.35 (OB)/ 296.31 = 0.00 HRS

(ACTUAL CYCLE) MUCK TIME =  0.00- 1.33- 0.30  =  0.00 HRS

TOTAL CYCLE TIME                                           -----
                                                                3.13 HRS

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USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 30.0 LF/ROUND X 2. X 10. / 3.13 = 191. LF/DAY

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=====
                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TAILRACE TUNNEL  37 FT EXCAVATED DIAMETER  QUANTITY: 2080.FT
PROJECT:  SUSITNA - 332.911  DATE: FEB 15, 1984 -
FILE NO:  1563  EST. BY RAM D/OEB
=====
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BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 750.0 FT @ 27. LF/DAY (50.0 %)	28.0 DAYS
REMAINING 1330. FT @ 54. FT/DAY	24.9 DAYS
BENCH EXCAVATION 2080. FT @ 191. FT/DAY	10.9 DAYS
TURN UNDER AT TUNNEL PORTALS	4.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS	8.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	3.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	8.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING	1.0 DAYS

TOTAL EXCAVATION TIME	87.7 DAYS

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: TAILRACE TUNNEL 37 FT EXCAVATED DIAMETER
 PROJECT: SUSITNA - 332.911
 FILE NO: 1563

QUANTITY: 2000.FT
 DATE: FEB 15, 1984 -
 EST. BY RAM D/OEB

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CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	6.0	6.0	0.0	12.0	35.64	4276.80
CHUCK TENDER	6.0	6.0	0.0	12.0	34.91	4189.20
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
FEL OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	5.0	5.0	0.0	10.0	39.37	3937.00
SUBTOTAL	23.5	23.5	0.0	47.0		17485.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 17485.40

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: TAILRACE TUNNEL 37 FT EXCAVATED DIAMETER
PROJECT: SUSITHA - 332.911
FILE NO: 1563

QUANTITY: 2080.FT
DATE: FEB 15, 1984 -
EST. BY RAN D/OED

EQUIPMENT REQUIREMENTS

EQUIPMENT # TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0 AIR TRACK DRILLS	42.01 X 20. HRS	5041.20
6.0 AIR COMPRESSORS 600	40.36 X 20. HRS	4043.20
3.0 FANS	10.07 X 20. HRS	604.20
4.0 DEWATERING PUMPS	5.26 X 20. HRS	420.80
2.0 FEL 988	115.74 X 20. HRS	4529.60
5.0 R 35S	62.64 X 20. HRS	6264.00
SUBTOTAL		21803.00
DUTY FACTOR 75.0 %		
TOTAL COST PER DAY = 21803.00 X 75.0/100.0 = \$ 16352.25 / DAY		

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
84454.68	BCY	POWDER & CAPS	6.80	574291.85
170012.57	LF	BITS & STEEL	0.40	68005.03
48.00	EA	STEEL SUPPORTS (40 LB/FT)	3250.00	156000.00
666.00	EA	ROCKBOLTS (15FT)	127.00	84582.00
111.00	CY	SHOTCRETE (3")	450.00	49950.00
2080.00	LF	AIR AND WATER DISCHARGE	30.00	62400.00
2080.00	LF	FAN LINES	25.00	52000.00
2080.00	LF	ELECTRIC SUPPLIES	100.00	208000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$ 1255228.80				


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TAILRACE TUNNEL  37 FT EXCAVATED DIAMETER    QUANTITY: 2060.FT
PROJECT:  SUSITNA - 332.911                        DATE: FEB 15, 1984 -
FILE NO:  1563                                       EST. BY RAM D/OEB
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SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 88. DAYS.

LABOR COSTS:

88. X \$ 17485.40 / DAY \$ 1,534,297 737.64

EQUIPMENT COSTS:

88. X \$ 16352.25 / DAY \$ 1,434,866 689.84

MATERIALS & SUPPLIES: \$ 1,255,228 603.48

S T & S @ 15.% OF LABOR \$ 226,477 108.88

TOTAL DIRECT COST \$ 4,450,871 2139.84

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 4,450,871 X 1.00 = \$ 4,450,871

UNIT PRICE PER LF = 4,450,871 / 2080. = \$ 2139.84 / LF

UNIT PRICE PER CY = 4,450,871 / 2080. X 40.6 = \$ 52.70 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 88. DAYS X 47. MEN / 2080. LF = 1.98 MD/LF

- MAN-DAYS/CY = 88. DAYS X 47. MEN / 2080. LF/40.60 = 0.05 MD/CY

00294

ACCESS SHAFT
23' 0"

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
PROJECT: SUSITNA - 331.131
FILE NO: 1563

=====

QUANTITY: 740.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

EXCAVATED DIAMETER = 23.0 FT

BCY/LF = $3.1416/4 \times (23.0)^2 \times 1.000 / 27 = 15.4 \text{ BCY/LF}$

PERIMETER = $3.1416 \times 23.0 \times 1.000 = 72.3 \text{ FT}$

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $72.3 / 24. / 12 = 37.$

AREA OF PATTERN = $3.1416 \times (11.5 - 2.0)^2 \times 1.000 = 283.5 \text{ FT}^2$

PATTERN HOLES @ 2.0 X 2.0 = $283.5 / 4.00 = 71.$

TOTAL HOLES = $37. + 71. = 108.$

NUMBER OF DRILLS = 1 - 4 — DRILLS = 4.

NUMBER OF HOLES/DRILL = $108. / 4. = 27.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $108. \times 6. / 5. \times 740. = 95914. \text{ LF}$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
PROJECT: SUSITNA - 331.131
FILE NO: 1563

QUANTITY: 740.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 27. HOLES/DRILL X 6.0 @ 60. FT/HR	2.70 HRS
LOAD 27. HOLES/MINER @ 3.0 MIN/EA	1.62 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 3.00 \times 0.85 \times 0.60 = 1.53$$

$$\text{BCY/HR} = 1.53 \times 1. \times 0.83 \times 15.00 = 19.05 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 15.39 \text{ BCY/LF} \times 5.0 \text{ LF} = 76.94$$

$$\text{MUCK TIME} = 76.94 \text{ BCY} \times 1.13 \text{ (OB)}/19.05 = 4.57 \text{ HRS}$$

TOTAL CYCLE TIME	10.39 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 10.39 = 10. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
PROJECT: SUSITNA - 331.131
FILE NO: 1563

QUANTITY: 740.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 60.0 FT @ 5. LF/DAY (50.0 %)	12.5 DAYS
REMAINING 680. FT @ 10. FT/DAY	70.6 DAYS
ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	0.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	1.5 DAYS

TOTAL EXCAVATION TIME	87.1 DAYS

AVERAGE ADVANCE, LF/DAY = $740. / 87.1 = 8.50$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
PROJECT: SUSITNA - 331.131
FILE NO: 1563

QUANTITY: 740.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

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CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
HOIST/CRANE OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
SUBTOTAL	13.5	13.5	0.0	27.0		9982.00
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 9982.00

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
PROJECT: SUSITNA - 331.131
FILE NO: 1563

QUANTITY: 740.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
HOIST/Crane OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
SUBTOTAL	13.5	13.5	0.0	27.0		9982.00
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 9982.00

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
 PROJECT: SUSITNA - 331.131
 FILE NO: 1563

QUANTITY: 740.FT
 DATE: FEB 17, 1984
 EST. BY RAM D/OEB

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EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
2.0	ALIMAC DRILLS	42.01 X 20. HRS	1680.40
2.0	FANS	10.07 X 20. HRS	402.80
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	ALIMAC MUCKER	50.68 X 20. HRS	1013.60
1.0	HOIST&FRAME SYSTEM	60.00 X 20. HRS	1200.00
SUBTOTAL			4507.20
DUTY FACTOR 80.0 %			
TOTAL COST PER DAY = 4507.20 X 80.0/100.0 = \$			3605.76 / DAY

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
11387.14	BCY	POWDER & CAPS	10.20	116148.79
95913.55	LF	BITS & STEEL	0.40	38365.42
6.85	MO	HOIST & FRAME RENTAL	12000.00	82196.12
20.00	EA	STEEL SUPPORTS (20 LB/FT)	1445.00	28900.00
535.00	EA	ROCKBOLTS (10FT)	84.67	45298.45
25.00	CY	SHOTCRETE (3")	450.00	11250.00
740.00	LF	AIR AND WATER DISCHARGE	30.00	22200.00
740.00	LF	FAN LINES	25.00	18500.00
740.00	LF	ELECTRIC SUPPLIES	100.00	74000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				436858.78

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: ACCESS SHAFT 23 FT DIA
PROJECT: SUSITNA - 331.131
FILE NO: 1563

QUANTITY: 740.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

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SUMMARY OF COSTS

NUMBER OF DAYS FOR EXCAVATION = 87. DAYS
AVERAGE PRODUCTION, LF/DAY = 8.5

LABOR COSTS:

87. X \$ 9982.00 / DAY \$ 869,348 1174.79

EQUIPMENT COSTS:

87. X \$ 3605.76 / DAY \$ 314,031 424.37

MATERIALS & SUPPLIES: \$ 436,858 590.35

S T & S +/-15% OF LABOR \$ 125,160 169.14

TOTAL DIRECT COST \$ 1,745,398 2358.65

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 1,745,398 X 1.00 = \$ 1,745,398

UNIT PRICE PER LF = 1,745,398 / 740. = \$ 2358.65 / LF

UNIT PRICE PER CY = 1,745,398 / 740.X15.4 = \$ 153.20 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 87. DAYS X 27. MEN / 740. LF = 3.18 MD/LF

- MAN-DAYS/CY = 87. DAYS X 27. MEN / 740. LF/15.39 = 0.21 MD/C

CONSTRUCTION METHODS : ALL SHAFTS WILL BE EXCAVATED USING ALIMAC DRILLS
WITH HOIST & FRAME SYSTEM AT SURFACE LEVEL. A POWDER FACTOR OF 6 LBS/CY IS
ESTIMATED FOR ALL SHAFTS. THE MUCKING OPERATION WILL BE PERFORMED USING
AN ALIMAC MUCKER-PLATFORM ARRANGEMENT.

ALL SHAFTS HAVE A WORKING SCHEDULE OF 2-10 HR SHIFTS.

00254

BUS SHAFT
10.5" Ø

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
PROJECT: SUSITHA - 331.171
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

EXCAVATED DIAMETER = 10.5 FT

BCY/LF = $3.1416/4 \times (10.5)^2 \times 1.000 / 27 = 3.2 \text{ BCY/LF}$

PERIMETER = $3.1416 \times 10.5 \times 1.000 = 33.0 \text{ FT}$

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $33.0 / 24. / 12 = 17.$

AREA OF PATTERN = $3.1416 \times (5.3 - 2.0)^2 \times 1.000 = 33.2 \text{ FT-2}$

PATTERN HOLES @ 1.8 X 1.8 = $33.2 / 3.06 = 11.$

TOTAL HOLES = $17. + 11. = 28.$

NUMBER OF DRILLS = 1 - 2 — DRILLS = 2.

NUMBER OF HOLES/DRILL = $28. / 2. = 14.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $28. \times 6. / 5. \times 560. = 19037. \text{ LF}$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
PROJECT: SUSITNA - 331.171
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 14. HOLES/DRILL X 6.0 @ 60. FT/HR	1.42 HRS
LOAD 14. HOLES/MINER @ 3.0 MIN/EA	0.85 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 1.50 \times 0.85 \times 0.60 = 0.76$$

$$\text{BCY/HR} = 0.76 \times 1. \times 0.83 \times 12.00 = 7.62 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 3.21 \text{ BCY/LF} \times 5.0 \text{ LF} = 16.04$$

$$\text{MUCK TIME} = 16.04 \text{ BCY} \times 1.29 \text{ (OB)/} \quad 7.62 = 2.71 \text{ HRS}$$

TOTAL CYCLE TIME	6.47 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 6.47 = 15. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
 PROJECT: SUSITNA - 331.171
 FILE NO: 1563

QUANTITY: 560.FT
 DATE: FEB 17, 1984
 EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 14. HOLES/DRILL X 6.0 @ 60. FT/HR	1.42 HRS
LOAD 14. HOLES/MINER @ 3.0 MIN/EA	0.85 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 1.50 \times 0.85 \times 0.60 = 0.76$$

$$\text{BCY/HR} = 0.76 \times 1. \times 0.83 \times 12.00 = 7.62 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 3.21 \text{ BCY/LF} \times 5.0 \text{ LF} = 16.04$$

$$\text{MUCK TIME} = 16.04 \text{ BCY} \times 1.29 \text{ (OB)/} \underline{7.62} = 2.71 \text{ HRS}$$

TOTAL CYCLE TIME	6.47 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 6.47 = 15. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
PROJECT: SUSITNA - 331.171
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 80.0 FT @ 8. LF/DAY (50.0 %)	10.4 DAYS
REMAINING 480. FT @ 15. FT/DAY	31.1 DAYS
ALLOWANCE FOR DELAYS & FAULTS	4.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	2.0 DAYS

TOTAL EXCAVATION TIME	48.4 DAYS

AVERAGE ADVANCE, LF/DAY = $560. / 48.4 = 11.57$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
PROJECT: SUSITNA - 331.171
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
HOIST/CRANE OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
SUBTOTAL	9.5	9.5	0.0	19.0		7160.00
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7160.00

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
PROJECT: SUSITNA - 331.171
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	ALIMAC DRILLS	42.01 X 20. HRS	840.20
2.0	FANS	10.07 X 20. HRS	402.80
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	ALIMAC MUCKER	50.68 X 20. HRS	1013.60
1.0	HOIST&FRAME SYSTEM	60.00 X 20. HRS	1200.00
SUBTOTAL			3667.00
DUTY FACTOR 80.0 %			
TOTAL COST PER DAY = 3667.00 X 80.0/100.0 = \$ 2933.60 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
1795.95	BCY	POWDER & CAPS	10.20	18318.67
19036.90	LF	BITS & STEEL	0.40	7614.76
5.36	MO	HOIST & FRAME RENTAL	12000.00	64348.42
17.00	EA	STEEL SUPPORTS (20 LB/FT)	670.00	11390.00
224.00	EA	ROCKBOLTS (10FT)	84.67	18966.00
9.00	CY	SHOTCRETE (3")	450.00	4050.00
560.00	LF	AIR AND WATER DISCHARGE	15.00	8400.00
560.00	LF	FAN LINES	12.00	6720.00
560.00	LF	ELECTRIC SUPPLIES	50.00	28000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				167807.93

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: BUS SHAFT 10.5 FT DIA
PROJECT: SUSITNA - 331.171
FILE NO: 1563

QUANTITY: 560.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

SUMMARY OF COSTS

NUMBER OF DAYS FOR EXCAVATION = 48. DAYS
AVERAGE PRODUCTION, LF/DAY = 11.6

LABOR COSTS:

48. X \$ 7160.00 / DAY \$ 346,698 619.10

EQUIPMENT COSTS:

48. X \$ 2933.60 / DAY \$ 142,049 253.66

MATERIALS & SUPPLIES: \$ 167,807 299.66

S T & S @ 15.% OF LABOR \$ 52,611 93.95

TOTAL DIRECT COST \$ 709,167 1266.37

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 709,167 X 1.00 = \$ 709,167

UNIT PRICE PER LF = 709,167 / 560. = \$ 1266.37 / LF

UNIT PRICE PER CY = 709,167 / 560.X 3.2 = \$ 394.87 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 48. DAYS X 19. MEN / 560. LF = 1.64 MD/LF

- MAN-DAYS/CY = 48. DAYS X 19. MEN / 560. LF / 3.21 = 0.51 MD/CY

CONSTRUCTION METHODS : ALL SHAFTS WILL BE EXCAVATED USING ALIMAC DRILLS
WITH HOIST & FRAME SYSTEM AT SURFACE LEVEL. A POWDER FACTOR OF 6 LBS/CY IS
ESTIMATED FOR ALL SHAFTS. THE MUCKING OPERATION WILL BE PERFORMED USING
AN ALIMAC MUCKER-PLATFORM ARRANGEMENT.

ALL SHAFTS HAVE A WORKING SCHEDULE OF 2-10 HR SHIFTS.

GROUT GALLERY
SHAFT

=====

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUT GALLERY SHAFT 10 X 10 FT
PROJECT: SUSITNA - 331.323
FILE NO: 1563

QUANTITY: 500.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

EXCAVATED DIAMETER = 11.3 FT

BCY/LF = $3.1416/4 \times (11.3)^2 \times 1.000 / 27 = 3.7 \text{ BCY/LF}$

PERIMETER = $3.1416 \times 11.3 \times 1.000 = 35.5 \text{ FT}$

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $35.5 / 24. / 12 = 18.$

AREA OF PATTERN = $3.1416 \times (5.7 - 2.0)^2 \times 1.000 = 41.9 \text{ FT}^2$

PATTERN HOLES @ 1.8 X 1.8 = $41.9 / 3.06 = 14.$

TOTAL HOLES = 18. + 14. = 32.

NUMBER OF DRILLS = 1 - 2 - DRILLS = 2.

NUMBER OF HOLES/DRILL = $32. / 2. = 16.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $32. \times 6. / 5. \times 500. = 19450. \text{ LF}$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUT GALLERY SHAFT 10 X 10 FT
PROJECT: SUSITNA - 331.323
FILE NO: 1563

QUANTITY: 500.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 16. HOLES/DRILL X 6.0 @ 60. FT/HR	1.62 HRS
LOAD 16. HOLES/MINER @ 3.0 MIN/EA	0.97 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 1.50 \times 0.85 \times 0.60 = 0.76$$

$$\text{BCY/HR} = 0.76 \times 1. \times 0.83 \times 12.00 = 7.62 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 3.71 \text{ BCY/LF} \times 5.0 \text{ LF} = 18.57$$

$$\text{MUCK TIME} = 18.57 \text{ BCY} \times 1.24 \text{ (OB)}/7.62 = 3.01 \text{ HRS}$$

TOTAL CYCLE TIME	7.11 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 7.11 = 14. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUT GALLERY SHAFT 10 X 10 FT
PROJECT: SUSITNA - 331.323
FILE NO: 1563

QUANTITY: 500.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 75.0 FT @ 7. LF/DAY (50.0 %)	10.7 DAYS
REMAINING 425. FT @ 14. FT/DAY	30.2 DAYS
ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	2.0 DAYS

TOTAL EXCAVATION TIME	45.9 DAYS

AVERAGE ADVANCE, LF/DAY = $500. / 45.9 = 10.90$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUT GALLERY SHAFT 10 X 10 FT
PROJECT: SUSITNA - 331.323
FILE NO: 1563

QUANTITY: 500.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
HOIST/CRANE OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
SUBTOTAL	10.5	10.5	0.0	21.0		7923.60
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7923.60

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUT GALLERY SHAFT 10 X 10 FT
PROJECT: SUSITNA - 331.323
FILE NO: 1563

QUANTITY: 500.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	ALIMAC DRILLS	42.01 X 20. HRS	840.20
2.0	FANS	10.07 X 20. HRS	402.80
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	ALIMAC MUCKER	50.68 X 20. HRS	1013.60
1.0	HOIST&FRAME SYSTEM	60.00 X 20. HRS	1200.00
1.0	MISCELLANEOUS	40.00 X 20. HRS	800.00
SUBTOTAL			4467.00
DUTY FACTOR 80.0 %			
TOTAL COST PER DAY = 4467.00 X 80.0/100.0 = \$ 3573.60 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
1857.18	DCY	POWDER & CAPS	10.20	18943.24
19449.98	LF	BITS & STEEL	0.40	7779.99
5.26	MO	HOIST & FRAME RENTAL	12000.00	63165.86
17.00	EA	STEEL SUPPORTS (20 LB/FT)	800.00	13600.00
224.00	EA	ROCKBOLTS (10FT)	84.67	18966.08
10.00	CY	SHOTCRETE (3")	450.00	4500.00
500.00	LF	AIR AND WATER DISCHARGE	15.00	7500.00
500.00	LF	FAN LINES	12.00	6000.00
500.00	LF	ELECTRIC SUPPLIES	50.00	25000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				165455.17

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: GROUT GALLERY SHAFT 10 X 10 FT
PROJECT: SUSITNA - 331.323
FILE NO: 1563

QUANTITY: 500.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

=====

SUMMARY OF COSTS

NUMBER OF DAYS FOR EXCAVATION = 46. DAYS
AVERAGE PRODUCTION, LF/DAY = 10.9

LABOR COSTS:

46. X \$ 7923.60 / DAY \$ 363,371 726.74

EQUIPMENT COSTS:

46. X \$ 3573.60 / DAY \$ 163,882 327.77

MATERIALS & SUPPLIES: \$ 165,455 330.91

S T & S @ 15.% OF LABOR \$ 55,773 111.55

TOTAL DIRECT COST \$ 748,483 1496.97

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 748,483 X 1.00 = \$ 748,483

UNIT PRICE PER LF = 748,483 / 500. = \$ 1496.97 / LF

UNIT PRICE PER CY = 748,483 / 500.X 3.7 = \$ 403.02 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 46. DAYS X 21. MEN / 500. LF = 1.93 MD/LF

- MAN-DAYS/CY = 46. DAYS X 21. MEN / 500. LF/ 3.71 = 0.52 MD/CY

CONSTRUCTION METHODS : ALL SHAFTS WILL BE EXCAVATED USING ALIMAC DRILLS
WITH HOIST & FRAME SYSTEM AT SURFACE LEVEL. A POWDER FACTOR OF 6 LBS/CY IS
ESTIMATED FOR ALL SHAFTS. THE MUCKING OPERATION WILL BE PERFORMED USING
AN ALIMAC MUCKER-PLATFORM ARRANGEMENT.

ALL SHAFTS HAVE A WORKING SCHEDULE OF 2-10 HR SHIFTS.

VENT SHAFT
8 5 0

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: VENT SHAFT 8.5 FT DIA
PROJECT: SUSITHA - 332.712
FILE NO: 1563

QUANTITY: 575.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

EXCAVATED DIAMETER = 8.5 FT

BCY/LF = $3.1416/4 \times (8.5)^2 \times 1.000 / 27 = 2.1 \text{ BCY/LF}$

PERIMETER = $3.1416 \times 8.5 \times 1.000 = 26.7 \text{ FT}$

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $26.7 / 24. / 12 = 14.$

AREA OF PATTERN = $3.1416 \times (4.3 - 2.0)^2 \times 1.000 = 15.9 \text{ FT}^2$

PATTERN HOLES @ 1.5 X 1.5 = $15.9 / 2.25 = 8.$

TOTAL HOLES = $14. + 8. = 21.$

NUMBER OF DRILLS = 1 - 2 - DRILLS = 2.

NUMBER OF HOLES/DRILL = $21. / 2 = 11.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $21. \times 6. / 5. \times 575. = 14700. \text{ LF}$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: VENT SHAFT 8.5 FT DIA
PROJECT: SUSITNA - 332.712
FILE NO: 1563

QUANTITY: 575.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 11. HOLES/DRILL X 6.0 @ 60. FT/HR	1.07 HRS
LOAD 11. HOLES/MINER @ 3.0 MIN/EA	0.64 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 1.00 \times 0.85 \times 0.60 = 0.51$$

$$\text{BCY/HR} = 0.51 \times 1. \times 0.83 \times 10.00 = 4.23 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 2.10 \text{ BCY/LF} \times 5.0 \text{ LF} = 10.51$$

$$\text{MUCK TIME} = 10.51 \text{ BCY} \times 1.31 \text{ (OB)/} 4.23 = 3.26 \text{ HRS}$$

TOTAL CYCLE TIME	6.47 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 6.47 = 15. \text{ LF/DAY}$$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: VENT SHAFT 8.5 FT DIA
PROJECT: SUSITNA - 332.712
FILE NO: 1563

QUANTITY: 575.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 64.0 FT @ 8. LF/DAY (50.0 %)	8.3 DAYS
REMAINING 511. FT @ 15. FT/DAY	33.1 DAYS
ALLOWANCE FOR DELAYS & FAULTS	3.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	1.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	3.0 DAYS

TOTAL EXCAVATION TIME	48.4 DAYS

AVERAGE ADVANCE, LF/DAY = $575. / 48.4 = 11.89$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: VENT SHAFT 8.5 FT DIA
PROJECT: SUSITNA - 332.712
FILE NO: 1563

QUANTITY: 575.FT
DATE: FEB 17, 1984
EST. BY RAM D/O-B

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	2.0	2.0	0.0	4.0	35.64	1425.60
CHUCK TENDER	2.0	2.0	0.0	4.0	34.91	1396.40
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
HOIST/CRANE OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
SUBTOTAL	10.5	10.5	0.0	21.0		7923.60
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 7923.60

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: VENT SHAFT 8.5 FT DIA
PROJECT: SUSITNA - 332.712
FILE NO: 1563

QUANTITY: 575.FT
DATE: FEB 17, 1984
EST. BY RAM D/DEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
1.0	ALIMAC DRILLS	42.01 X 20. HRS	840.20
2.0	FANS	10.07 X 20. HRS	402.80
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	ALIMAC MUCKER	50.68 X 20. HRS	1013.60
1.0	HOIST&FRAME SYSTEM	60.00 X 20. HRS	1200.00
SUBTOTAL			3667.00
DUTY FACTOR 80.0 %			
TOTAL COST PER DAY = 3667.00 X 80.0/100.0 = \$ 2933.60 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
1208.46	BCY	POWDER & CAPS	10.20	12326.31
14780.08	LF	BITS & STEEL	0.40	5912.03
5.36	MO	HOIST & FRAME RENTAL	12000.00	64326.86
17.00	EA	STEEL SUPPORTS (20 LB/FT)	534.00	9078.00
230.00	EA	ROCKBOLTS (10FT)	84.67	19474.10
7.00	CY	SHOTCRETE (3")	450.00	3150.00
575.00	LF	AIR AND WATER DISCHARGE	15.00	8625.00
575.00	LF	FAN LINES	12.00	6900.00
575.00	LF	ELECTRIC SUPPLIES	50.00	28750.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				150542.29

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: VENT SHAFT 8.5 FT DIA
PROJECT: SUSITNA - 332.712
FILE NO: 1563

QUANTITY: 575.FT
DATE: FEB 17, 1984
EST. BY RAM D/OEB

SUMMARY OF COSTS

NUMBER OF DAYS FOR EXCAVATION = 48. DAYS
AVERAGE PRODUCTION, LF/DAY = 11.9

LABOR COSTS:

48. X \$ 7923.60 / DAY \$ 383,303 666.61

EQUIPMENT COSTS:

48. X \$ 2933.60 / DAY \$ 141,912 246.80

MATERIALS & SUPPLIES: \$ 158,542 275.73

S T & S @ 15.% OF LABOR \$ 57,495 99.99

TOTAL DIRECT COST \$ 741,253 1289.14

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 741,253 X 1.00 = \$ 741,253

UNIT PRICE PER LF = 741,253 / 575. = \$ 1289.14 / LF

UNIT PRICE PER CY = 741,253 / 575.X 2.1 = \$ 613.39 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 48. DAYS X 21. MEN / 575. LF = 1.77 MD/LF

- MAN-DAYS/CY = 48. DAYS X 21. MEN / 575. LF / 2.10 = 0.84 MD/CY

CONSTRUCTION METHODS : ALL SHAFTS WILL BE EXCAVATED USING ALIMAC DRILLS WITH HOIST & FRAME SYSTEM AT SURFACE LEVEL. A POWDER FACTOR OF 6 LBS/CY IS ESTIMATED FOR ALL SHAFTS. THE MUCKING OPERATION WILL BE PERFORMED USING AN ALIMAC MUCKER-PLATFORM ARRANGEMENT.

ALL SHAFTS HAVE A WORKING SCHEDULE OF 2-10 HR SHIFTS.

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PENSTOCK SHAFTS
27' Ø


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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCK SHAFTS 27 FT DIA  3 # (600 FT/EA)  QUANTITY: 1800.FT
PROJECT:  SUSITNA - 332.811  DATE: FEB 17, 1984
FILE NO:  1563  EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

EXCAVATED DIAMETER = 27.0 FT

BCY/LF = $3.1416/4 \times (27.0)^2 \times 1.000 / 27 = 21.2$ BCY/LF

PERIMETER = $3.1416 \times 27.0 \times 1.000 = 84.8$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $84.8 / 24. / 12 = 43.$

AREA OF PATTERN = $3.1416 \times (13.5 - 2.0)^2 \times 1.000 = 415.5$ FT-2

PATTERN HOLES @ 2.0 X 2.0 = $415.5 / 4.00 = 104.$

TOTAL HOLES = $43. + 104. = 147.$

NUMBER OF DRILLS = 1 - 4 — DRILLS = 4.

NUMBER OF HOLES/DRILL = $147. / 4. = 37.$

DRILL 6.0 FT - PULL 5.0 FT

TOTAL LF OF HOLE = $147. \times 6. / 5. \times 1800. = 318126.$ LF

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: PENSTOCK SHAFTS 27 FT DIA 3 # (600 FT/EA)
 PROJECT: SUSITNA - 332.811
 FILE NO: 1563

QUANTITY: 1800.FT
 DATE: FEB 17, 1984
 EST. BY RAM D/OEB

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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 37. HOLES/DRILL X 6.0 @ 60. FT/HR	3.68 HRS
LOAD 37. HOLES/MINER @ 3.0 MIN/EA	2.21 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 3.00 \times 0.85 \times 0.60 = 1.53$$

$$\text{BCY/HR} = 1.53 \times 1. \times 0.83 \times 15.00 = 19.05 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 21.21 \text{ BCY/LF} \times 5.0 \text{ LF} = 106.03$$

$$\text{MUCK TIME} = 106.03 \text{ BCY} \times 1.15 \text{ (O\%)} / 19.05 = 6.39 \text{ HRS}$$

TOTAL CYCLE TIME	13.70 HRS
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USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 5.0 \text{ LF/ROUND} \times 2. \times 10. / 13.78 = 7. \text{ LF/24}$$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  PENSTOCK SHAFTS 27 FT DIA  3 # (600 FT/EA)  QUANTITY: 1800.FT
PROJECT:  SUSITNA - 332.811  DATE: FEB 17, 1984
FILE NO:  1563  EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST 100.0 FT @ 4. LF/DAY (50.0 %)	27.6 DAYS
REMAINING 1700. FT @ 7. FT/DAY	234.3 DAYS
ALLOWANCE FOR DELAYS & FAULTS	4.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING	2.0 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS	4.0 DAYS

TOTAL EXCAVATION TIME	271.9 DAYS

AVERAGE ADVANCE, LF/DAY = $1800. / 271.9 = 6.62$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: PENSTOCK SHAFTS 27 FT DIA 3 # (600 FT/EA) QUANTITY: 1800.FT
PROJECT: SUSITNA - 332.811 DATE: FEB 17, 1984
FILE NO: 1563 EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	4.0	4.0	0.0	8.0	35.64	2851.20
CHUCK TENDER	4.0	4.0	0.0	8.0	34.91	2792.80
MUCKER OPERATOR	1.0	1.0	0.0	2.0	39.09	781.80
HOIST/Crane OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
SUBTOTAL	13.5	13.5	0.0	27.0		9982.00
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 9982.00

HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: PENSTOCK SHAFTS 27 FT DIA 3 # (600 FT/EA) QUANTITY: 1800.FT
 PROJECT: SUSITNA - 332.811 DATE: FEB 17, 1984
 FILE NO: 1563 EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
2.0	ALIMAC DRILLS	42.01 X 20. HRS	1680.40
2.0	FANS	10.07 X 20. HRS	402.80
2.0	DEWATERING PUMPS	5.26 X 20. HRS	210.40
1.0	ALIMAC MUCKER	50.68 X 20. HRS	1013.60
1.0	HOIST&FRAME SYSTEM	60.00 X 20. HRS	1200.00
SUBTOTAL			4507.20
DUTY FACTOR 80.0 %			
TOTAL COST PER DAY = 4507.20 X 80.0/100.0 = \$			3605.76 / DAY

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
38170.44	BCY	POWDER & CAPS	10.20	389338.49
318126.42	LF	BITS & STEEL	0.40	127250.57
13.96	MD	HOIST & FRAME RENTAL	12000.00	167474.05
45.00	EA	STEEL SUPPORTS (20 LB/FT)	1696.00	76320.00
900.00	EA	ROCKBOLTS (10FT)	84.67	76203.00
71.00	CY	SHOTCRETE (3")	450.00	31950.00
1800.00	LF	AIR AND WATER DISCHARGE	30.00	54000.00
1800.00	LF	FAN LINES	25.00	45000.00
1800.00	LF	ELECTRIC SUPPLIES	100.00	180000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				1147536.11

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HARZA ENGINEERING COMPANY

DIRECT COST ESTIMATE

ITEM: PENSTOCK SHAFTS 27 FT DIA 3 # (600 FT/EA) QUANTITY: 1800.FT
 PROJECT: SUSITNA - 332.811 DATE: FEB 17, 1984
 FILE NO: 1563 EST. BY RAM D/OEB

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SUMMARY OF COSTS

NUMBER OF DAYS FOR EXCAVATION = 272. DAYS
 AVERAGE PRODUCTION, LF/DAY = 6.6

LABOR COSTS:

272. X \$ 9982.00 / DAY \$ 2,713,710 1507.62

EQUIPMENT COSTS:

272. X \$ 3605.76 / DAY \$ 980,263 544.59

MATERIALS & SUPPLIES: \$ 1,147,536 637.52

S T & S @ 15.% OF LABOR \$ 410,557 228.09

 TOTAL DIRECT COST \$ 5,252,067 2917.82

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 5,252,067 X 1.00 = \$ 5,252,067

UNIT PRICE PER LF = 5,252,067 / 1800. = \$ 2917.82 / LF

UNIT PRICE PER CY = 5,252,067 / 1800.X21.2 = \$ 137.60 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 272. DAYS X 27. MEN / 1800. LF = 4.08 MD/LF

- MAN-DAYS/CY = 272. DAYS X 27. MEN / 1800. LF/21.21 = 0.19 MD/CY

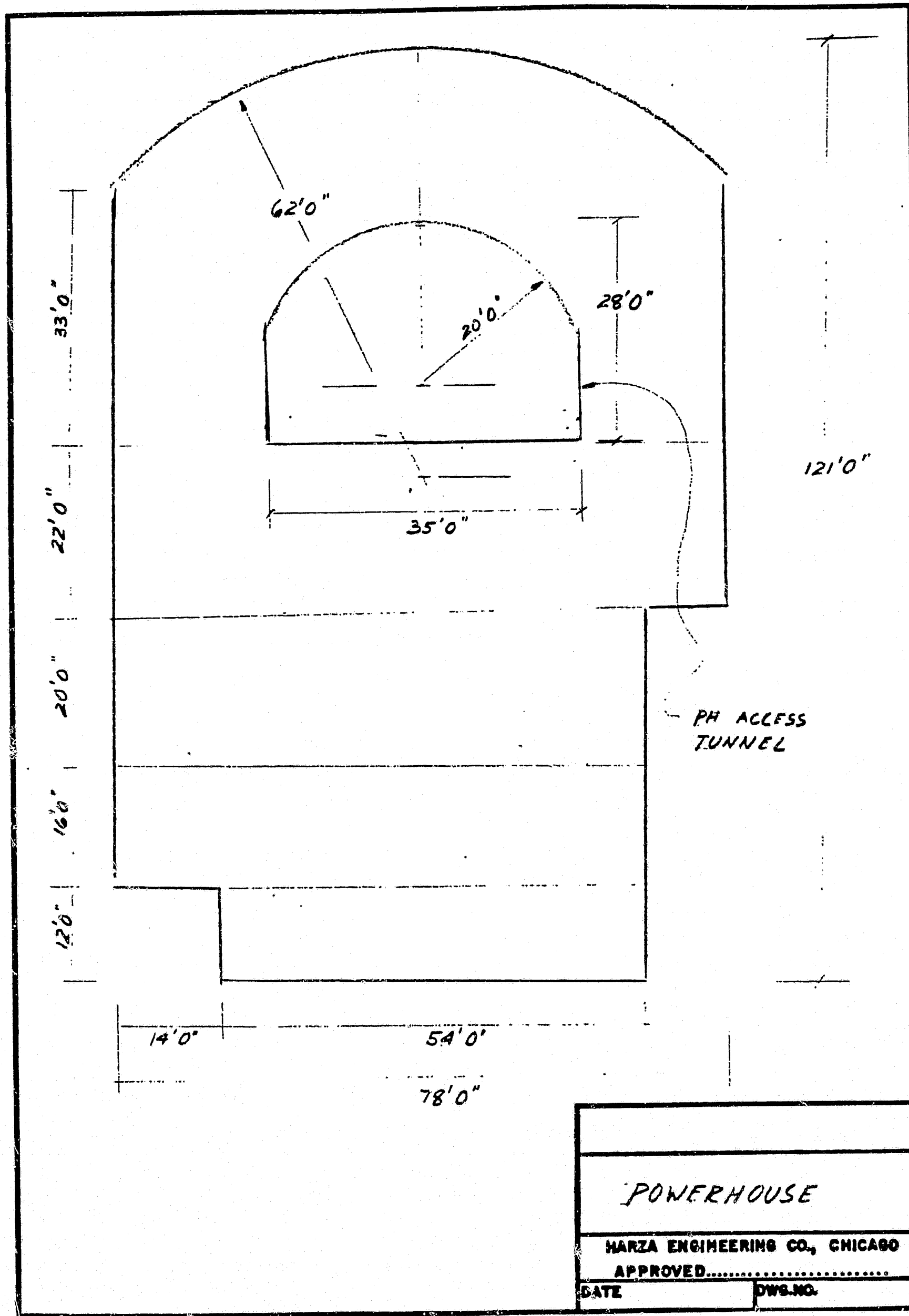
CONSTRUCTION METHODS : ALL SHAFTS WILL BE EXCAVATED USING ALIMAC DRILLS
 WITH HOIST & FRAME SYSTEM AT SURFACE LEVEL. A POWDER FACTOR OF 6 LBS/CY IS
 ESTIMATED FOR ALL SHAFTS. THE MUCKING OPERATION WILL BE PERFORMED USING
 AN ALIMAC MUCKER-PLATFORM ARRANGEMENT.

ALL SHAFTS HAVE A WORKING SCHEDULE OF 2-10 HR SHIFTS.

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POWERHOUSE

000543



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT <u>Powerhouse</u>	PROJECT <u>SUSITNA - WATANA</u>
	<u>Rock Excavation</u>	FILE NO. <u>1563 X 103</u>
	COMPUTED <u>O. Ballate</u> CHECKED _____	DATE <u>2/27/84</u> PAGE _____ OF _____ PAGES

Item: Powerhouse Excavation

QTY: 150,442

(1) Exploratory Tunnel 35x28

$$480 \text{ lf} @ 2017 = 968,160$$

(2) Top & Side Excavation

$$480 \text{ lf} (2574 + 1076 - 876) / 27 @ 62^{\text{cc}} = 3,067,428$$

(3) Bench Excavation

$$480 \text{ lf} (1716 + 1360 + 1088 + 648) / 27 @ 39^{\text{cc}} = 3,337,175$$

(4) Construction Adit

$$(876 / 27) \times 300 \text{ lf} @ 30^{\text{cc}} / \text{Bcy} = 299,787$$

(16% grade)

Total Direct Costs \$ 7,672,550

$$\text{Unit Cost} = \frac{7,672,550}{150,442}$$

$$= \$ 51^{\text{cc}} / \text{Bcy}$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT <u>Powerhouse</u>	PROJECT <u>SUSITNA - WATANA</u>
	<u>Rock Excavation</u>	FILE NO. <u>1563X103</u>
	COMPUTED <u>O. Ballate</u> CHECKED _____	DATE <u>2/27/84</u> PAGE _____ OF _____ PAGES

Item: Powerhouse Excavation

QTY: 150,442

(1) Exploratory Tunnel 35x28

$$480 \text{ lf} @ 2017 = 968,160$$

(2) Top & Side Excavation

$$480 \text{ lf} (2574 + 1076 - 876) / 27 @ 62^{\text{cc}} = 3,067,428$$

(3) Bench Excavation

$$480 \text{ lf} (1716 + 1360 + 1088 + 648) / 27 @ 39^{\text{cc}} = 3,337,175$$

(4) Construction Adit

$$(876 / 27) \times 300 \text{ lf} @ 30^{\text{cc}} / \text{bcy} = 299,787$$

(16% grade)

$$\text{Total Direct Costs} \quad \$ 7,672,550$$

$$\text{Unit Cost} = \frac{7,672,550}{150,442}$$

$$= \$ 51^{\text{cc}} / \text{bcy}$$

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: POWERHOUSE CAVERN
PROJECT: SUSITNA 331.111
FILE NO: 1563

QUANTITY: 41600. CY
DATE: 2/23/84 -
EST. BY RAM D/OLB

SECTION/LIFT	AREA	PERI	DEPTH	PATTERN	HOLES	CAPS	FT	BCY
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POWERHOUSE LIFT#1

(1)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(2)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(3)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(4)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(5)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(6)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(7)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(8)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(9)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(10)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(11)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467
(12)	3120.0	171.0	30.00	6.0 X	9.0	171	0	5130 3467

TOTALS					2052	0	61560	41604
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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: POWERHOUSE CAVERN
PROJECT: SUSITNA 331.111
FILE NO: 1553

QUANTITY: 41600. CY
DATE: 2/23/84 -
EST. BY RAM D/OEB

SECTION/ LIFT	DRILLING MIN/ RATE FT/MIN HOLE		DURATION (HRS)			
			DRILL	SHOOT	SMOKE	TOTAL
POWERHOUSE LIFT#1						
(1)	1.00	34.00	19.38	2.28	0.50	22.16
(2)	1.00	34.00	19.38	2.28	0.50	22.16
(3)	1.00	34.00	19.38	2.28	0.50	22.16
(4)	1.00	34.00	19.38	2.28	0.50	22.16
(5)	1.00	34.00	19.38	2.28	0.50	22.16
(6)	1.00	34.00	19.38	2.28	0.50	22.16
(7)	1.00	34.00	19.38	2.28	0.50	22.16
(8)	1.00	34.00	19.38	2.28	0.50	22.16
(9)	1.00	34.00	19.38	2.28	0.50	22.16
(10)	1.00	34.00	19.38	2.28	0.50	22.16
(11)	1.00	34.00	19.38	2.28	0.50	22.16
(12)	1.00	34.00	19.38	2.28	0.50	22.16
TOTALS			232.56	27.36	6.00	265.92

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: POWERHOUSE CAVERN
PROJECT: SUSITNA 331.111
FILE NO: 1563

QUANTITY: 41600. CY
DATE: 2/23/64 -
EST. BY RAM D/OEB

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CONSTRUCTION SCHEDULE

1) DRILL & BLAST	13.3 DAYS
2) ALLOWANCE FOR ACCESSIBILITY	2.0 DAYS
3) ALLOWANCE FOR MUCKING DELAYS	3.5 DAYS
4) ALLOWANCE FOR SUPPORT SYSTEM	3.5 DAYS
5) ALLOWANCE FOR DELAYS & FAULTS	2.0 DAYS

EXCAVATION TIME	24.3 DAYS
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TOTAL EXCAVATION TIME = 24.3 X 1.33 = 32.3 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: POWERHOUSE CAVERN
PROJECT: SUSITNA 331.111
FILE NO: 1563

QUANTITY: 41600. CY
DATE: 2/23/84 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR	2. - 10. HR SHIFTS				HOURLY	TOTAL
DESCRIPTION	DAY	SWING	GWY	TOTAL	RATE	COST PER DAY
CHUCK TENDERS	6.0	6.0	0.0	12.0	34.91	4189.20
CRANE/HOIST OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
BULLGANG FOREMAN	1.0	0.0	0.0	1.0	34.07	340.70
BULLGANG LABORERS	3.0	0.0	0.0	3.0	31.29	938.70
COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	22.50	450.00
FEL OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
TRUCK DRIVERS	4.0	4.0	0.0	8.0	39.37	3149.60
ELECTRICIAN	1.0	1.0	0.0	2.0	44.74	894.80
MINERS	4.0	4.0	0.0	8.0	35.64	2851.20
SUBTOTAL	24.0	20.0	0.0	44.0		15941.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 15941.40

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: POWERHOUSE CAVERN
PROJECT: SUSITHA 331.111
FILE NO: 1563

QUANTITY: 41600. CY
DATE: 2/23/84 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
2.0	FEL 988	115.70 X 20. HRS	4620.00
4.0	R 35S	62.64 X 20. HRS	5011.20
4.0	VENTILATORS	10.07 X 20. HRS	805.60
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	EXPLOSIVE CARRIER	25.00 X 20. HRS	500.00
1.0	MISCELLANEOUS	40.00 X 20. HRS	800.00
1.0	HOIST & FRAME	60.00 X 20. HRS	1200.00
SUBTOTAL			13365.60
DUTY FACTOR 80.0 %			
TOTAL COST PER DAY = ***** X 80.0/100.0 = \$ 10692.48 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
61560.00	LF	BITS & STEEL	0.40	24624.00
83208.00	LBS	POWDER	1.70	141453.60
0.00	EA	CAPS	1.00	0.00
36.00	SETS	STEEL SUPPORTS (80 LBS/LF)	5600.00	201600.00
288.00	EA	ROCKBOLTS (20 LF)	170.00	48960.00
250.00	CY	SHOTCRETE (3)	450.00	112500.00
3.00	MOS	HOIST & FRAME RENTAL	12000.00	36000.00
480.00	LF	AIR AND WATER	60.00	28800.00
480.00	LF	FANS	50.00	24000.00
480.00	LF	ELECTRIC SUPPLIES	200.00	96000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				713937.60

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HARZA ENGINEERING COMPANY		QUANTITY: 41600. CY
DIRECT COST ESTIMATE		DATE: 2/23/84 -
ITEM: POWERHOUSE CAVERN		EST. BY RAM D/OEB
PROJECT: SUSITNA 331.111		
FILE NO: 1563		

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SUMMARY OF COSTS

NUMBER OF DAYS
 FOR EXCAVATION = 32. DAYS

	TOTAL COST	UNIT COST
LABOR COSTS:		
32. X \$ 15941.40 / DAY	\$ 515,125	12.38
EQUIPMENT COSTS:		
32. X \$ 10692.48 / DAY	\$ 345,513	8.31
MATERIALS & SUPPLIES:	\$ 713,937	17.16
S T & S @ 10.% OF LABOR	\$ 51,512	1.24

DIRECT COST FOR ROCK EXCAVATION	\$ 1,626,088	39.09
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MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 1,626,088 X 1.00 = \$ 1,626,088

UNIT PRICE PER LF = 1,626,088 / 61560 = \$ 26.41 / LF

UNIT PRICE PER CY = 1,626,088 / 41600. = \$ 39.09 / CY

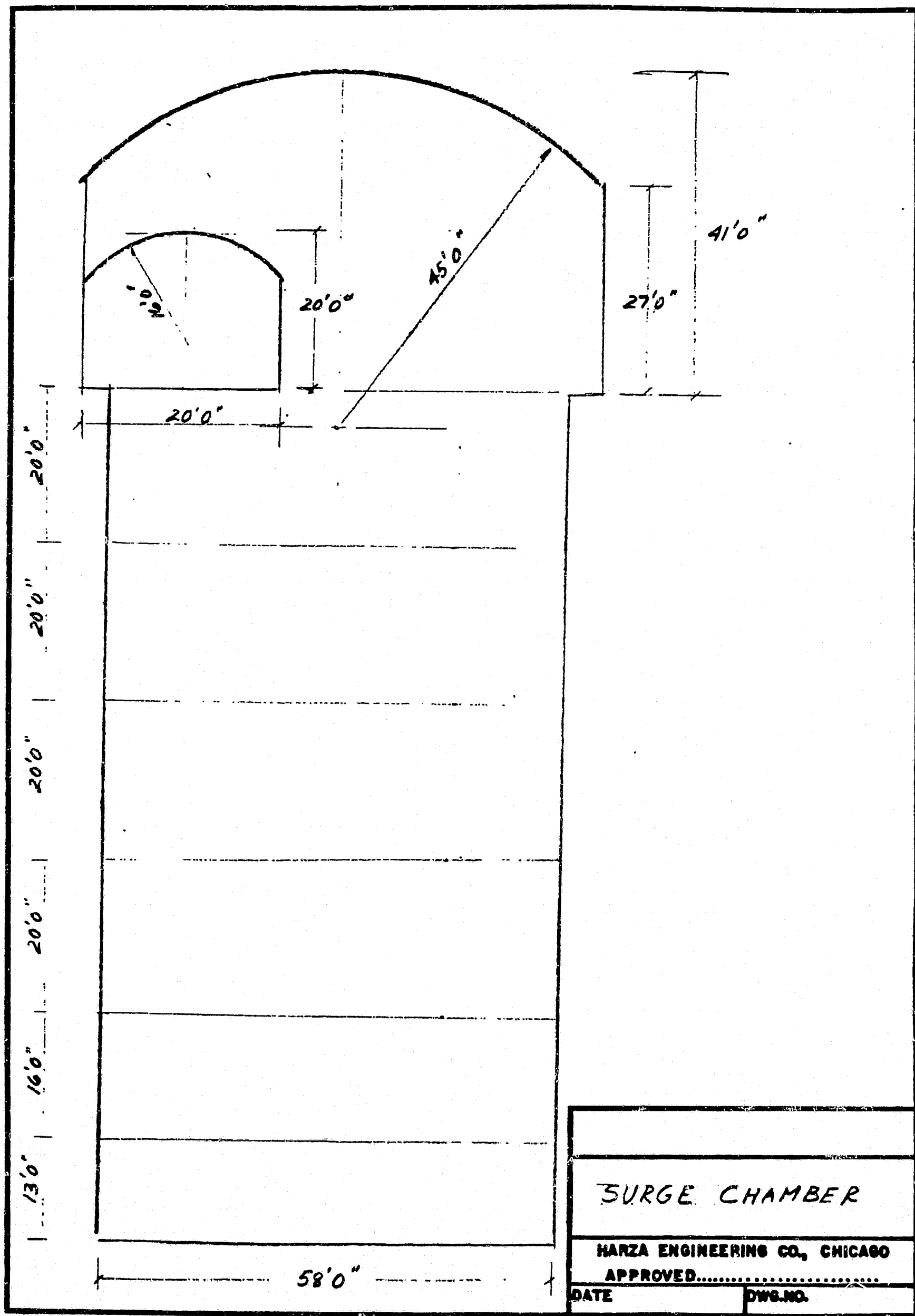
SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 32. DAYS X 44. MEN / 61560 LF = 0.02 MD/LF

- MAN-DAYS/CY = 32. DAYS X 44. MEN / 41600. CY = 0.03 MD/CY

4020

00254



HARZA
ENGINEERING
COMPANY
CHICAGO

SUBJECT Surge Chamber
Rock Excavation
COMPUTED O. Ballate CHECKED _____

PROJECT SUSITNA - WATANA
FILE NO. 1563X103
DATE 2/27/84 PAGE _____ OF _____ PAGES

Item: Surge Chamber Excavation QTY: 119,768 cu yd

(1) Exploratory Tunnel 25x20'

415 LF @ \$ 2044/LF = \$ 848,260

(2) Top & Side Excavation

415 cu (629 + 1755 - 454) / 27 @ \$ 75⁰⁰/cu yd = 2,246,220

(3) Bench Excavation

83,122 cu yd @ \$ 39⁰⁰/cu yd = 3,242,589

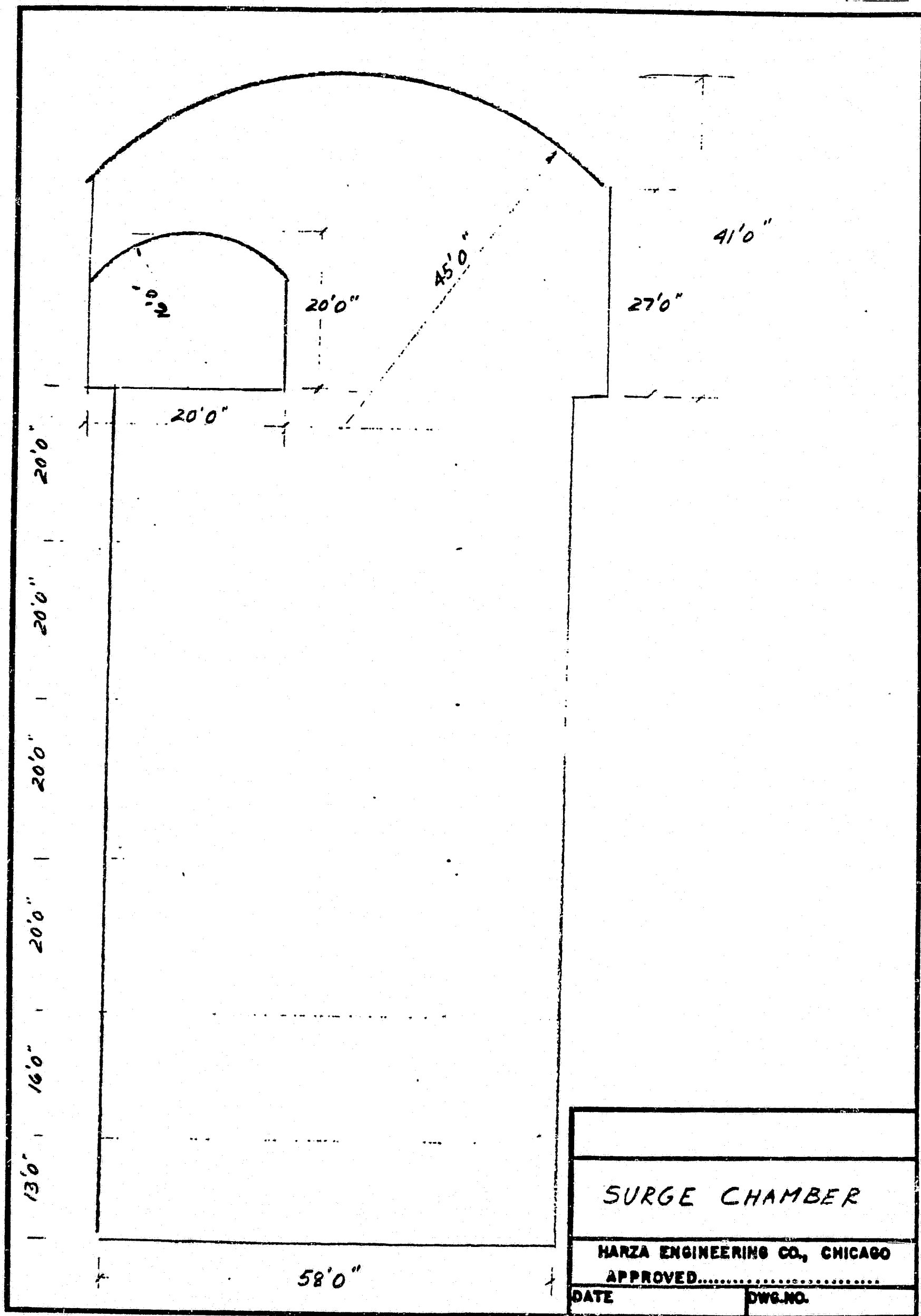
(4) Construction Adits - (2 each 300 LF)

(454⁰⁰ / 27) (600 LF) @ 121⁰⁰ = 1,225,195

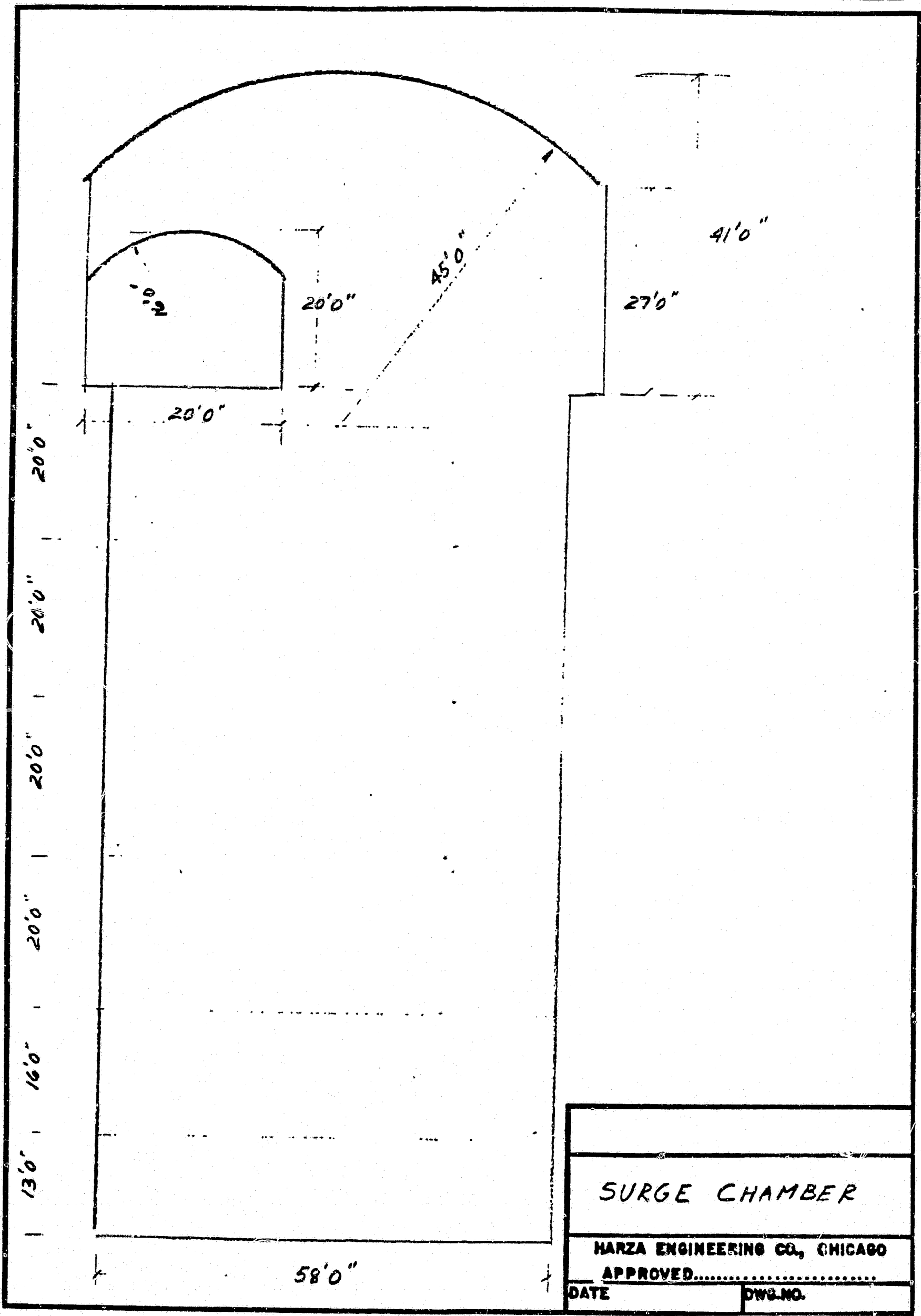
Total Direct Cost \$ 7,562,264

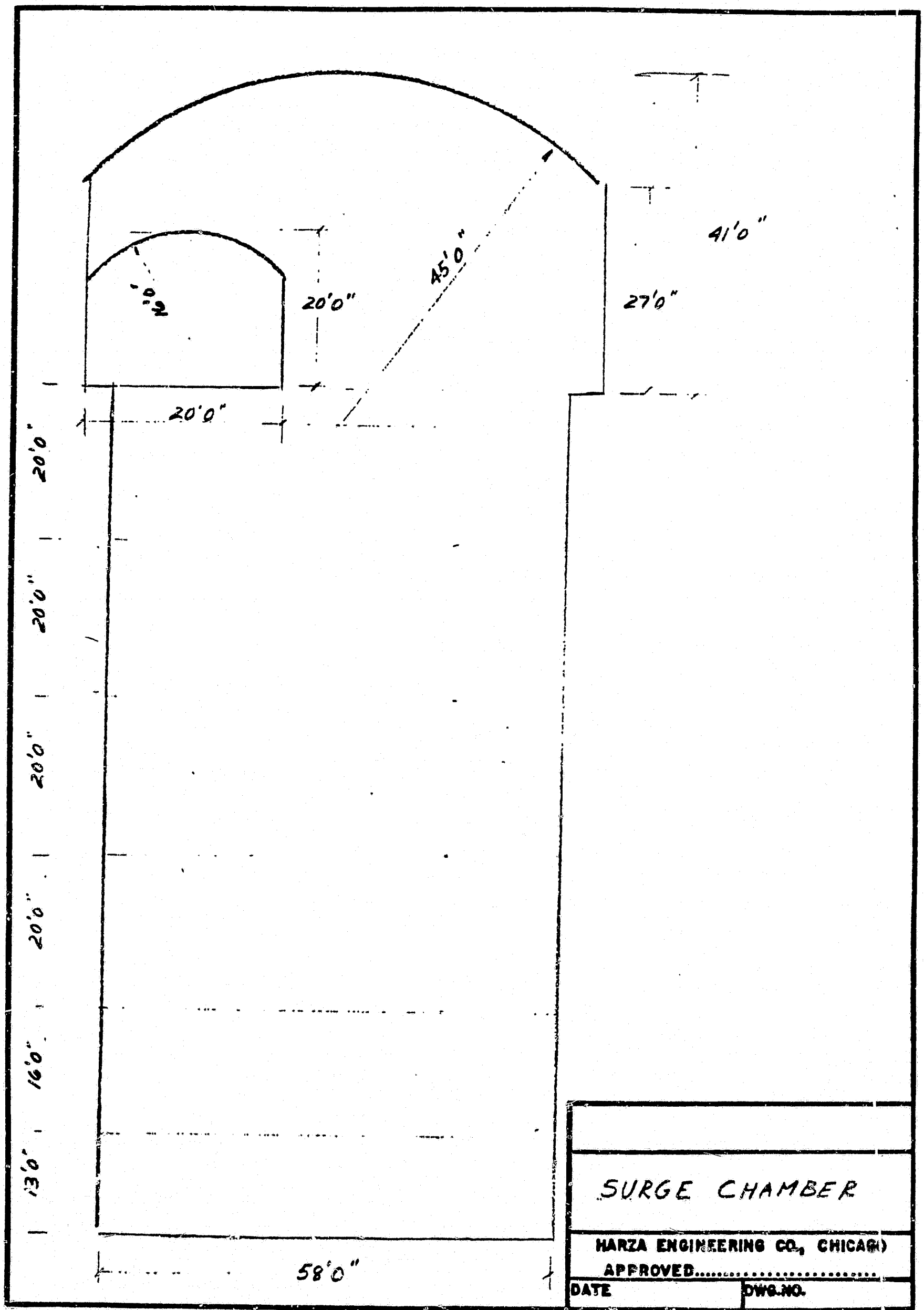
Unit Cost = \$ 63⁰⁰/cu yd

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT _____	PROJECT _____
	COMPUTED <u>O. Bellate</u> CHECKED _____	FILE NO. _____
	DATE _____ PAGE _____ OF _____ PAGES	

Suege Chamber

$$LF = 415 \text{ ft}$$

$$\theta = 2 \left(\arccos \frac{45 - 14}{45} \right) = 93^\circ \quad (1.62 \text{ rad})$$

$$A_c = \frac{1}{2} (45)^2 (1.62 - \sin 1.62) = 629 \text{ ft}^2$$

$$BCY/LF = (629 + 27 \times 65) / 27 = 88.3$$

$$BCY = 88.3 \times 415 = 36,645$$

$$A_{\text{across}} = 109 \times 58 = 6,322 \text{ ft}^2$$

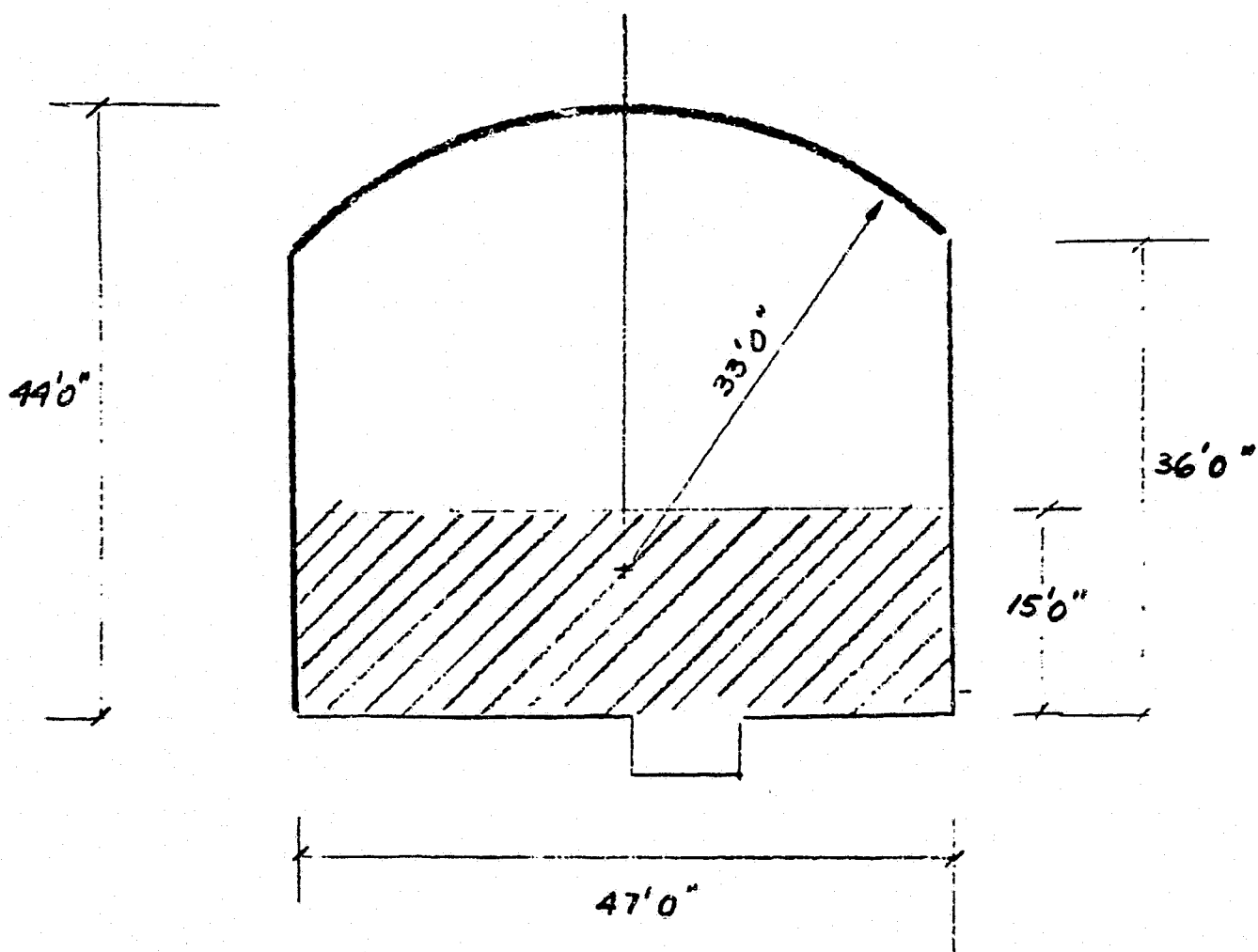
$$BCY = 6,322 \text{ ft}^2 \times 355 / 27 = 83,122$$

$$\underline{119,768 \text{ cu}}$$

TRANSFORMER
GALLERY

4
3
2
0
0

TOP HEADING & BENCH METHOD



TRANSFORMER GALLERY

HARZA ENGINEERING CO., CHICAGO

APPROVED.....

DATE 2/17/83 DWS:NO.

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TRANSFORMER GALLERY CAVERN          QUANTITY:  480.FT
PROJECT:  SUSITNA  331.161                DATE:  FEB 17, 1984 -
FILE NO:  1563                            EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

TUNNEL DIMENSIONS : 44.0 X 47.0 FT

$$\text{ANGLE OF ARCH} = 2 \times (\arccos 33.0 - 8.0 / 33.0) = 1.42 \text{ RADIANS}$$

$$\text{ARCH AREA} = 0.5 \times (33.0) \times 2 (1.42 - \sin 1.42) = 236.0 \text{ FT}^2$$

$$\text{BCY/LF} = (236.0 + 21.0 \times 47.0) / 27 = 45.3 \text{ BCY/LF}$$

$$\text{PERIMETER} = 1.42 \times 33.0 + 2.0 \times 21.0 + 47.0 = 135.9 \text{ FT}$$

NUMBER OF HOLES:

$$\text{LINE HOLES @ 24. IN CENTERS} = 135.9 / 24. / 12 = 68.$$

$$\text{AREA OF PATTERN} = \text{*****FT}^2 - 24.0 / 12.0 \times 135.9 = 951.1 \text{ FT}^2$$

$$\text{PATTERN HOLES @ 3.0 X 3.0} = 951.1 / 9.00 = 106.$$

$$\text{TOTAL HOLES} = 68. + 106. = 175.$$

$$\text{NUMBER OF DRILLS} = 1 - 6, - \text{DRILLS} = 6.$$

$$\text{NUMBER OF HOLES/DRILL} = 175. / 6. = 29.$$

DRILL 12.0 FT - PULL 11.0 FT

$$\text{TOTAL LF OF HOLE} = 175. \times 12. / 11. \times 480. = 91452. \text{ LF}$$

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TRANSFORMER GALLERY CAVERN          QUANTITY:  480.FT
PROJECT:  SUSITNA 331.161                 DATE:  FEB 17, 1984 -
FILE NO:  1563                           EST. BY RAM D/OEB
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BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 29. HOLES/DRILL X 12.0 @ 60. FT/HR	5.82 HRS
LOAD 29. HOLES/MINER @ 3.0 MIN/EA	1.75 HRS
SHOOT AND SMOKE	0.50 HRS

MUCKING OPERATION:

$$\text{BCY/LOAD} = 7.00 \times 0.85 \times 0.60 = 3.57$$

$$\text{BCY/HR} = 3.57 \times 2. \times 0.83 \times 50.00 = 296.31 \text{ BCY/HR}$$

$$\text{BCY/CYCLE} = 45.30 \text{ BCY/LF} \times 11.0 \text{ LF} = 498.25$$

$$\text{MUCK TIME} = 498.25 \text{ BCY} \times 1.11 \text{ (OB)} / 296.31 = 1.87 \text{ HRS}$$

ALTERNATING CREWS :

(ACTUAL) MUCK TIME = 1.87- 5.82- 1.75- 0.50	0.00 HRS
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TOTAL CYCLE TIME

9.07 HRS

USE 2. - 10. HR SHIFTS

$$\text{DAILY ADVANCE} = 11.0 \text{ LF/ROUND} \times 2. \times 10. / 9.07 = 24. \text{ LF/DAY}$$

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HARZA ENGINEERING COMPANY		QUANTITY: 480.FT
DIRECT COST ESTIMATE		DATE: FEB 17, 1984 -
ITEM: TRANSFORMER GALLERY CAVERN		EST. BY RAM D/OED
PROJECT: SUSITNA 331.161		
FILE NO: 1563		

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BENCH EXCAVATION

BENCH DIMENSIONS : 47.0 X 15.0 FT

BCY/LF = $47.0 \times 15.0 / 27 = 26.1$ BCY/LF

PERIMETER = $47.0 + 2 \times 30.0 = 107.0$ FT

NUMBER OF HOLES:

LINE HOLES @ 24. IN CENTERS = $107.0 / 24. / 12 = 54.$

PATTERN HOLES = $47.0 \times 30.0 / 25.00 \text{ FT-2/HOLE} = 56.$

TOTAL HOLES = $54. + 56. = 110.$

NUMBER OF DRILLS = 6.

NUMBER OF HOLES/DRILL = $110. / 6. = 18.3$

TOTAL LF OF HOLE = $110. \times (15.0 + 1) \times 480.0/30.0 = 28134. \text{ LF}$

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TRANSFORMER GALLERY CAVERN
PROJECT: SUSITNA 331.161
FILE NO: 1563

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QUANTITY: 400.FT
DATE: FEB 17, 1984 -
EST. BY RAM D/OEB

BACK-UP COMPUTATIONS

CYCLE TIME: MOVE IN DRILLS	1.00 HRS
DRILL 110. HOLES X 16.0 DEPTH/ 60. FT/HR X 6.	4.88 HRS
LOAD 110. HOLES X 3.0 MIN/EA /50 MIN/HR X 6.	1.10 HRS
SHOOT AND SMOKE	0.50 HRS
MUCKING OPERATION:	
MUCK TIME = 783.33 BCY X 1.11 (OB)/ 296.31 = 2.94 HRS	
(ACTUAL CYCLE) MUCK TIME = 2.94- 4.88- 1.10 = 0.00 HRS	
TOTAL CYCLE TIME	7.48 HRS

USE 2. - 10. HR SHIFTS

DAILY ADVANCE = 30.0 LF/ROUND X 2. X 10. / 7.48 = 80. LF/DAY

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                HARZA ENGINEERING COMPANY
                DIRECT COST ESTIMATE
ITEM:  TRANSFORMER GALLERY CAVERN          QUANTITY:  480.FT
PROJECT:  SUSITNA 331.161                  DATE:  FEB 17, 1984 -
FILE NO:  1563                             EST.  BY RAM D/OEB
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BACK-UP COMPUTATIONS

CONSTRUCTION SCHEDULE :

1ST	0.0 FT @ 12. LF/DAY (50.0 %)	0.0 DAYS
REMAINING	480. FT @ 24. FT/DAY	19.8 DAYS
BENCH EXCAVATION	480. FT @ 80. FT/DAY	6.0 DAYS
ALLOWANCE FOR DELAYS & FAULTS		1.0 DAYS
ADDITIONAL TIME FOR ROCKBOLTING		1.5 DAYS
ADDITIONAL TIME FOR STEEL SUPPORTS		2.0 DAYS
ADDITIONAL TIME FOR SHOTCRETING		1.0 DAYS

TOTAL EXCAVATION TIME		31.3 DAYS

HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TRANSFORMER GALLERY CAVERN
PROJECT: SUSITNA 331.161
FILE NO: 1563

QUANTITY: 480.FT
DATE: FEB 17, 1984 -
EST. BY RAM D/OEB

CREW REQUIREMENTS

LABOR DESCRIPTION	2. - 10. HR SHIFTS				HOURLY RATE	TOTAL COST PER DAY
	DAY	SWING	GWY	TOTAL		
WALKER	1.0	1.0	0.0	2.0	39.13	782.60
SHIFTER	1.0	1.0	0.0	2.0	38.13	762.60
MINER	6.0	6.0	0.0	12.0	35.64	4276.80
CHUCK TENDER	6.0	6.0	0.0	12.0	34.91	4189.20
BLASTING FOREMAN	1.0	1.0	0.0	2.0	38.13	762.60
BULLGANG FOREMAN	1.0	0.0	0.0	1.0	34.07	340.70
BULLGANG LABORERS	3.0	0.0	0.0	3.0	31.29	938.70
FEL OPERATOR	2.0	2.0	0.0	4.0	39.09	1563.60
ELECTRICIAN	0.5	0.5	0.0	1.0	44.74	447.40
BOOM TRUCK OPERATOR	1.0	1.0	0.0	2.0	36.98	739.60
AIR COMPRESSOR OPERATOR	1.0	1.0	0.0	2.0	38.18	763.60
TRUCK DRIVERS	5.0	5.0	0.0	10.0	39.37	3937.00
SUBTOTAL	28.5	24.5	0.0	53.0		19504.40
ALLOWANCE FOR UNSCHEDULED OVERTIME	0.0 %					0.00
TOTAL COST PER DAY						\$ 19504.40

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TRANSFORMER GALLERY CAVERN
PROJECT: SUSITNA 331.161
FILE NO: 1563

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QUANTITY: 480.FT
DATE: FEB 17, 1984 -
EST. BY RAM D/OEB

EQUIPMENT REQUIREMENTS

#	EQUIPMENT TYPE	HOURLY RATE	TOTAL COST PER DAY
6.0	DRILLS	42.01 X 20. HRS	5041.20
6.0	AIR COMPRESSORS 600	40.36 X 20. HRS	4843.20
3.0	FANS	10.07 X 20. HRS	604.20
4.0	DEWATERING PUMPS	5.26 X 20. HRS	420.80
1.0	EXPLOSIVE CARRIER	25.00 X 20. HRS	500.00
2.0	FEL 988	115.74 X 20. HRS	4629.60
1.0	MISCELLANEOUS	40.00 X 20. HRS	800.00
5.0	R 355	62.64 X 20. HRS	6264.00
SUBTOTAL			23103.00
DUTY FACTOR 75.0 %			
TOTAL COST PER DAY = 23103.00 X 75.0/100.0 = \$ 17327.25 / DAY			

MATERIALS AND SUPPLIES

QUANTITY	UNIT	DESCRIPTION	UNIT COST	TOTAL COSTS
34275.31	BCY	POWDER & CAPS	6.80	233072.08
119586.61	LF	BITS & STEEL	0.40	47834.64
48.00	EA	STEEL SUPPORTS (40 LB/FT)	4754.00	228192.00
240.00	EA	ROCKBOLTS (15FT)	127.00	30480.00
26.00	CY	SHOTCRETE (3")	450.00	11700.00
480.00	LF	MISCELLANEOUS	20.00	9600.00
480.00	LF	AIR AND WATER DISCHARGE	30.00	14400.00
480.00	LF	FAN LINES	25.00	12000.00
480.00	LF	ELECTRIC SUPPLIES	100.00	48000.00
TOTAL COST FOR MATERIAL AND SUPPLIES \$				635278.73

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HARZA ENGINEERING COMPANY
DIRECT COST ESTIMATE

ITEM: TRANSFORMER GALLERY CAVERN
PROJECT: SUSITNA 331.161
FILE NO: 1563

=====

QUANTITY: 480.FT
DATE: FEB 17, 1984 -
EST. BY RAM D/OEB

SUMMARY OF COSTS

NUMBER OF DAYS
FOR EXCAVATION = 31. DAYS

LABOR COSTS:

31. X \$ 19504.40 / DAY \$ 609,935 1270.70

EQUIPMENT COSTS:

31. X \$ 17327.25 / DAY \$ 541,852 1128.86

MATERIALS & SUPPLIES: \$ 635,278 1323.50

S T & S @ 15.% OF LABOR \$ 88,440 184.25

TOTAL DIRECT COST \$ 1,875,507 3907.31

MARK UP FACTOR = (1 + 0./100.) = 1.00

TOTAL PRICE = 1,875,507 X 1.00 = \$ 1,875,507

UNIT PRICE PER LF = 1,875,507 / 480. = \$ 3907.31 / LF

UNIT PRICE PER CY = 1,875,507 / 480. X 71.4 = \$ 54.72 / CY

SIGNIFICANT RATIOS:

- MAN-DAYS/LF = 31. DAYS X 53. MEN / 480. LF = 3.45 MD/LF

- MAN-DAYS/CY = 31. DAYS X 53. MEN / 480. LF/71.41 = 0.05 MD/CY