DISPOSAL OF MATERIAL TO BE EXCAVATED FROM THE ILLINOIS SSC

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April 1987

Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION

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EXECUTIVE SUMMARY

This report is based on the 52-mile circumference proton accelerator tunnel presented by the Central Design Group (CDG) prior to April 1987. A 12-foot excavated diameter for the main tunnel is assumed. Since this report was completed, the CDG has increased the circumference of the proton accelerator tunnel to 53 miles. In addition, Illinois has proposed a 10.5-foot instead of the 12-foot excavated diameter for the main tunnel. This results in a 23.4 percent decrease in the amount of rock material to be excavated from the tunnel. The Illinois State Geological Survey is revising its calculations on spoil volume and distribution, and adjusting cost estimates based on this revised information.

Ninety-four percent of the earth and rock material to be excavated for the Illinois Superconducting Super Collider (SSC) is expected to be dolomite and dolomitic limestone. The remaining six percent is comprised of shale, glacial till, and sand and gravel. The total amount of material to be excavated over the 30-month construction period is about 4.6×10^6 tons, of which about 59 percent will be produced by tunnel boring machines (TBM), and about 41 percent by drilling and blasting.

Four disposal alternatives are being studied. Alternatives 1, 2, and 3 use various combinations of the 46 sand and gravel pits and rock quarries within 10 miles of the proposed SSC ring as disposal sites. The total holding capacity of these 46 pits and quarries is estimated to be over 7.9×10^7 cubic yards (CY)--about 18 times that needed to contain the 4.4×10^6 CY of excavated material expected to be removed. Alternative 4 suggests using the excavated material for on-site landscaping.

The costs of Alternatives 1, 2, and 3 include transportation, construction of the access roads, road maintenance, and land acquisition costs or dumping fees. The costs of Alternative 4 are associated with spreading and landscaping the excavated material.

Alternative 3, disposing of the excavated material to the pits and quarries closest to each shaft, has the lowest estimated cost--$7.5 million. The two plans presented for Alternative 1, reconstructing the Kaneville Esker, have the highest estimated costs. They are $19.4 million for Plan 1, and $16.9 million for Plan 2. Alternative 2, disposing of the material in three selected quarries, is estimated to cost $10.1 million. Alternative 4, using the excavated material for landscaping around each access shaft, is estimated to cost $14.1 million.

1. DESCRIPTION OF MATERIAL TO BE EXCAVATED FROM THE SSC

1.1 VOLUME AND TONNAGE

About 4.4 x 10^6 cubic yards (CY) (4.6 x 10^6 tons) of excavated rock and earth material (EREM) is expected to be produced during the construction of the Illinois SSC. This is based on an estimated in situ volume of 2,009,110 CY with an average dry density of about 162 lb/ft^3 (Curran, 1986). The excavated volume assumes a muck swell factor of 2. The excavated tonnage provides for an increase in moisture (from the tunnel boring machine (TBM) and precipitation at the surface), which translates into a 5 percent weight increase.

1.2 TYPE OF MATERIAL TO BE EXCAVATED

Given the invert elevation for the Illinois SSC tunnel of 313 feet above mean sea level, the rock-type breakdown of the EREM is (Curran, 1986):

58.2%	Dolomite
18.9%	Dolomitic Limestone
17.0%	Cherty Dolomite
3.0%	Shale
2.6%	Glacial Till
0.3%	Sand and Gravel

1.3 CHARACTERIZATION OF EXCAVATED MATERIAL

An estimated 59 percent of the EREM will be produced by a TBM, and 41 percent will be produced by drill-and-blast excavation.

The character of the excavated rock from the Illinois SSC will be very similar to that of the Chicago Tunnel and Reservoir Plan (TARP) project, where more than 95 percent of the excavated rock from TARP was dolomitic limestone. More than 95 percent of the rock to be excavated from the Illinois SSC will be dolomite, cherty dolomite, and dolomitic limestone.

Sieve analysis has been conducted with the TARP TBM rock to determine the range of particle size. The results of a wet screen analysis following ASTM Standard Test Method C117 of the TARP TBM material are listed in Table 1 (IITRI, 1983). The TARP TBM rock has a distinctive appearance. It is flat and elongated with a general thickness:width:length ratio of about 1:4:8 (IITRI, 1983). This appearance is due to the spalling fracture that the TBM produces in cutting the rock.

No documentation on the characterization of the drill-and-blast material of TARP has been found. In most cases, the TARP drill-and-blast material was not separated from the TBM mate-

TABLE 1

WET SIEVE ANALYSIS OF TBM SPOIL FROM TARP

Particle Size	Weight %
+4 inches	0
-4+3	1.2
-3+2 1/2	.9
-2 1/2+2	3.1
-2+1 1/2	3.7
-1 1/2+1	5.6
-1+3/4	2.4
-3/4+1/2	4.2
-1/2+3/8	11.1
-3/8+1/4	14.8
-1/4+3/16	16.5
-3/16+1/8	6.8
-8+16 mesh	3.0
-16+30	2.8
-30+50	3.0
-50+100	2.4
-100+200	1.5
-200	17.0
Total	100.0

Source: IIT Research Institute, January 1983, Evaluation of TBM Produced Rock, prepared by R.F. Firestone, No. IITRI-M08206-5.

rial in the stockpiles (Cyrier, 1987). This indicates that a large size range is also prevalent in the TARP drill-and-blast material since generally no distinction was made between the two.

1.4 REMOVAL PLANS FOR EXCAVATED MATERIAL

The locations around the SSC from which the EREM would be removed were determined for two scenarios. Scenario 1 (Table 2) assumes that EREM from tunnels, chambers, passing areas, alcoves, and adits would be removed only from the 30-foot shafts and that the only EREM loaded out of a 20-foot shaft would be the material from that shaft. Scenario 2 (Table 3) assumes that EREM from tunnels, chambers, passing areas, alcoves, and adits would be removed from both 30-foot and 20-foot shafts. Scenario 2 assumes that removal from the 30-foot and the 20-foot shafts is equally efficient and cost effective; therefore, EREM is removed from the shaft nearest the excavation. Figure 1 shows the location of the 30-foot and 20-foot shafts around the SSC.

2. SSC EXCAVATED MATERIAL AND CURRENT MARKETS

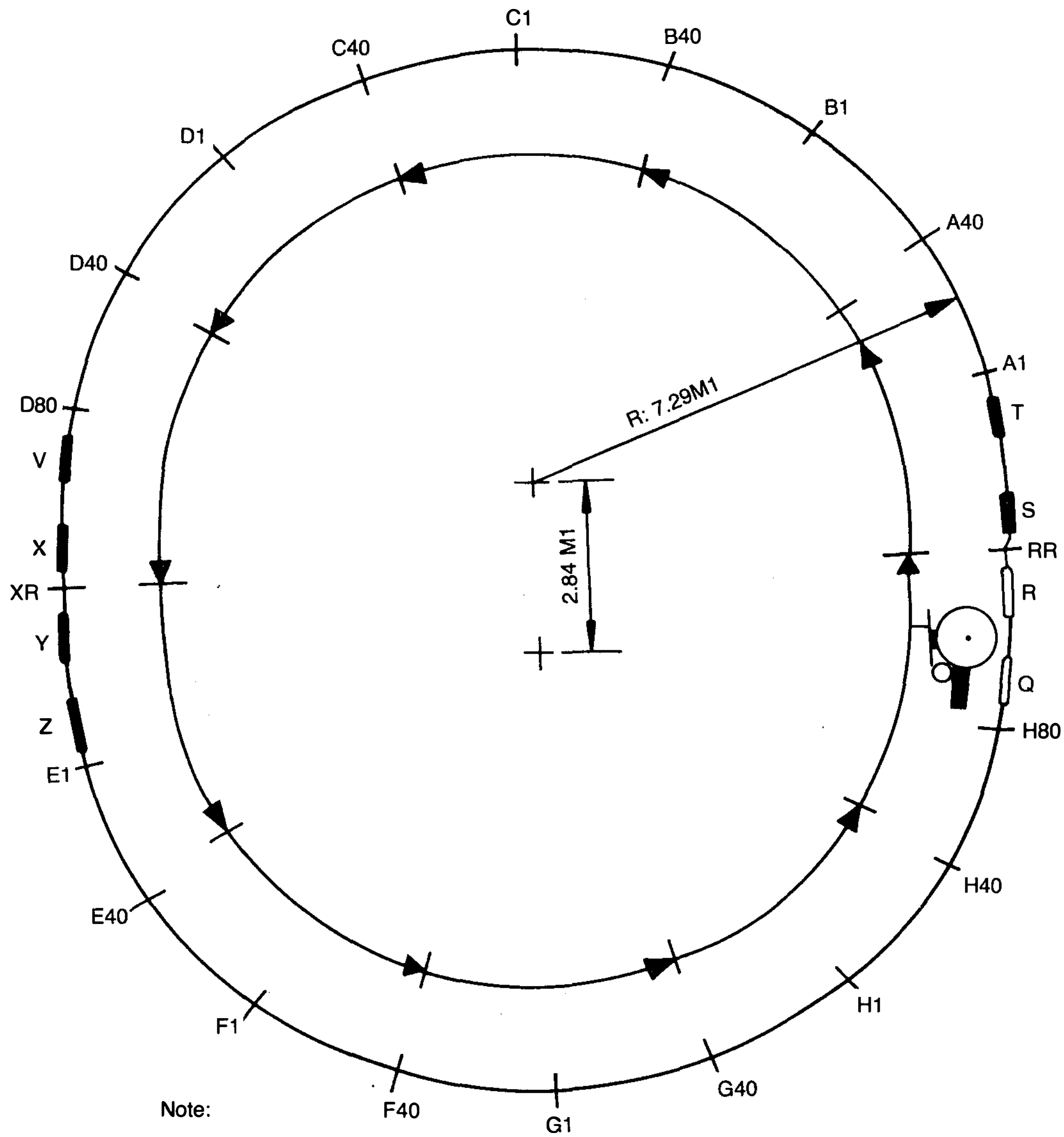
2.1 STONE AND SAND AND GRAVEL PRODUCTION IN THE SSC AREA

About 6.2×10^6 tons of sand and gravel and 2.3×10^6 tons of stone are produced annually in Kane, DuPage, Kendall, and DeKalb counties. Sixteen companies produce sand and gravel having a total value of about $18 million, and 8 companies produce stone having a total value of $9 million.

2.2 EXCAVATED ROCK MATERIAL IN RELATION TO CURRENT MARKETS

The SSC project will produce an estimated 4.6×10^6 tons of EREM over a 30-month period. About 94 percent of this material will be dolomite and dolomitic limestone. The remaining 6 percent will consist of shale, sand and gravel, and glacial till. The total amount of sand and gravel will be about 14,000 tons. Although most of the sand and gravel will be generated in the first year of the project, the market impact is likely to be negligible because the total sand and gravel production in the area currently is 6.2×10^6 tons.

In contrast, the stone excavated from the SSC project may have a significant impact on current markets. About 4.3×10^6 tons of dolomite and dolomitic limestone are expected to be produced over 30 months, or about 1.74×10^6 tons per year. About 41 percent of the rock will be produced by drilling-and-blasting techniques (shot rock), and about 59 percent by a TBM. According to the Illinois Association of Aggregate Producers (IAAP), the TBM material alone is not suitable in size or shape



Note:

Series 40 (A-H) RR, XR, S, T, Y, and Z represent 30 ft. inside diameter shafts. Series 1 (A-H), D80 and H80 represent 20ft. inside diameter shafts.

Source: Harza Engineering Co., 1986, Construction Cost Estimate, Underground Excavation.

FIGURE 1 PLAN VIEW OF SSC RING

TABLE 2

Volume and Tonnage of Excavated Material to be Removed from the Illinois SSC

Assumption: Material to be removed only from 30-ft. inside diameter shafts.

Shafts	In Situ Volume CY	Stockpile Volume CY	Dry Weight Tons	Wet Weight Tons
A1	5,880	11,760	12,877	13,521
A40	135,062	270,124	295,786	310,575
B1	5,034	10,068	11,024	11,575
B40	133,870	267,740	293,175	307,834
C1	4,822	9,644	10,560	11,088
C40	133,274	266,548	219,870	230,864
D1	4,963	9,926	10,869	11,412
D40	142,304	284,608	311,646	327,228
D80	5,457	10,914	11,951	12,549
XR	144,685	289,370	316,860	332,703
Y	103,420	206,840	226,490	237,815
Z	105,058	210,116	230,077	241,581
E1	6,937	13,874	15,192	15,952
E40	139,681	279,362	305,901	321,196
F1	7,995	15,990	17,509	18,384
F40	141,022	282,044	308,838	324,280
G1	6,867	13,734	15,039	15,791
G40	136,552	273,104	299,049	314,001
H1	6,585	13,170	14,421	15,142
H40	291,062	582,124	637,426	669,297
H80	6,232	12,464	13,648	14,330
RR	143,971	287,942	315,296	331,061
S	99,422	198,844	217,734	228,621
T	98,955	197,910	216,711	227,547
	2,009,110	4,018,220	4,399,951	4,619,949

TABLE 3

Volume and Tonnage of Excavated Material to be Removed from the Illinois SSC

Assumption: Material to be removed from 30 ft. and 20 ft. inside diameter shafts.

Shafts	In Situ Volume CY	Stockpile Volume CY	Dry Weight Tons	Wet Weight Tons
A1	71,579	143,158	156,758	164,596
A40	73,297	146,594	160,520	168,546
B1	66,798	133,596	146,288	153,602
B40	72,105	144,210	157,910	165,805
C1	66,587	133,174	145,826	153,117
C40	71,509	143,018	156,605	164,435
D1	66,728	133,456	146,134	153,441
D40	76,620	153,240	167,798	176,188
D80	71,140	142,280	155,797	163,586
XR	79,004	158,008	173,019	181,670
Y	103,420	206,840	226,490	237,814
Z	105,058	210,116	230,077	241,581
E1	72,621	145,242	159,040	166,992
E40	77,916	155,832	170,636	179,168
F1	69,759	139,518	152,772	160,411
F40	79,257	158,514	173,573	182,251
G1	68,631	137,262	150,302	157,817
G40	74,787	149,574	163,784	171,973
H1	68,349	136,698	149,684	157,169
H40	79,898	159,796	174,977	183,725
H80	217,395	434,790	476,095	499,900
RR	78,274	156,548	171,420	179,991
S	99,423	198,846	217,736	228,623
T	98,955	197,910	216,711	227,547
	2,009,110	4,018,220	4,399,951	4,619,948

to produce good quality construction aggregates. However, appropriate blending of TBM material with quarry stone could make good quality products that are marketable. Current producers in the area have the know-how for such processing.

Although not all the 1.74 x 10^6 tons of rock per year will be marketable, even a 20 percent marketability would add about 348,000 tons of stone to the market. This represents a 15 percent increase in the total supply to the area, which may affect stone prices adversely.

Price elasticities of supply for stone are not available at this time. However, prices are expected to be sensitive to supply levels because aggregates are essentially local commodities; high transportation costs compared to the unit value of the material make it infeasible to transport the aggregate over long distances. The seasonal demand fluctuations tied to the construction activities add to the short-term sensitivity of prices to supply levels. Therefore, close cooperation with current aggregate producers is planned in disposing of the excavated material.

3. PROPOSED DISPOSAL ALTERNATIVES

A disposal plan identifies economical and environmentally sound options that assure safe and efficient movement and final disposition of EREM.

Because selling the EREM for profit is ruled out as an option for disposing of the greater part of the excavated material, using EREM to fill abandoned or played-out sand and gravel pits and rock quarries becomes the foremost option. Forty-six active and abandoned sand and gravel pits and rock quarries, excluding those adjacent to housing developments, are within 10 miles of the proposed SSC ring (Figure 2). These pits and quarries have an estimated holding capacity of over 79 x 10^6 CY (Table 4)--about 18 times that needed to contain the 4.4 x 10^6 CY of EREM.

The first three proposed disposal alternatives are based on using sand and gravel pits and rock quarries as disposal sites. The fourth proposed alternative suggests spreading and landscaping the EREM around each access shaft to eliminate the cost associated with transportation, access road construction, and road maintenance costs.

3.1 Alternative 1: Reconstructing the Kaneville Esker.

The excavated material would be used to restore the esker to its form prior to the extensive sand and gravel mining, which started in the 1930s. The 1,115 acres involved in the restoration (pit/quarry Nos. 27, 35, 36, and 37 of Figure 2) would become a glacial park and natural area. This idea was suggested by local government.

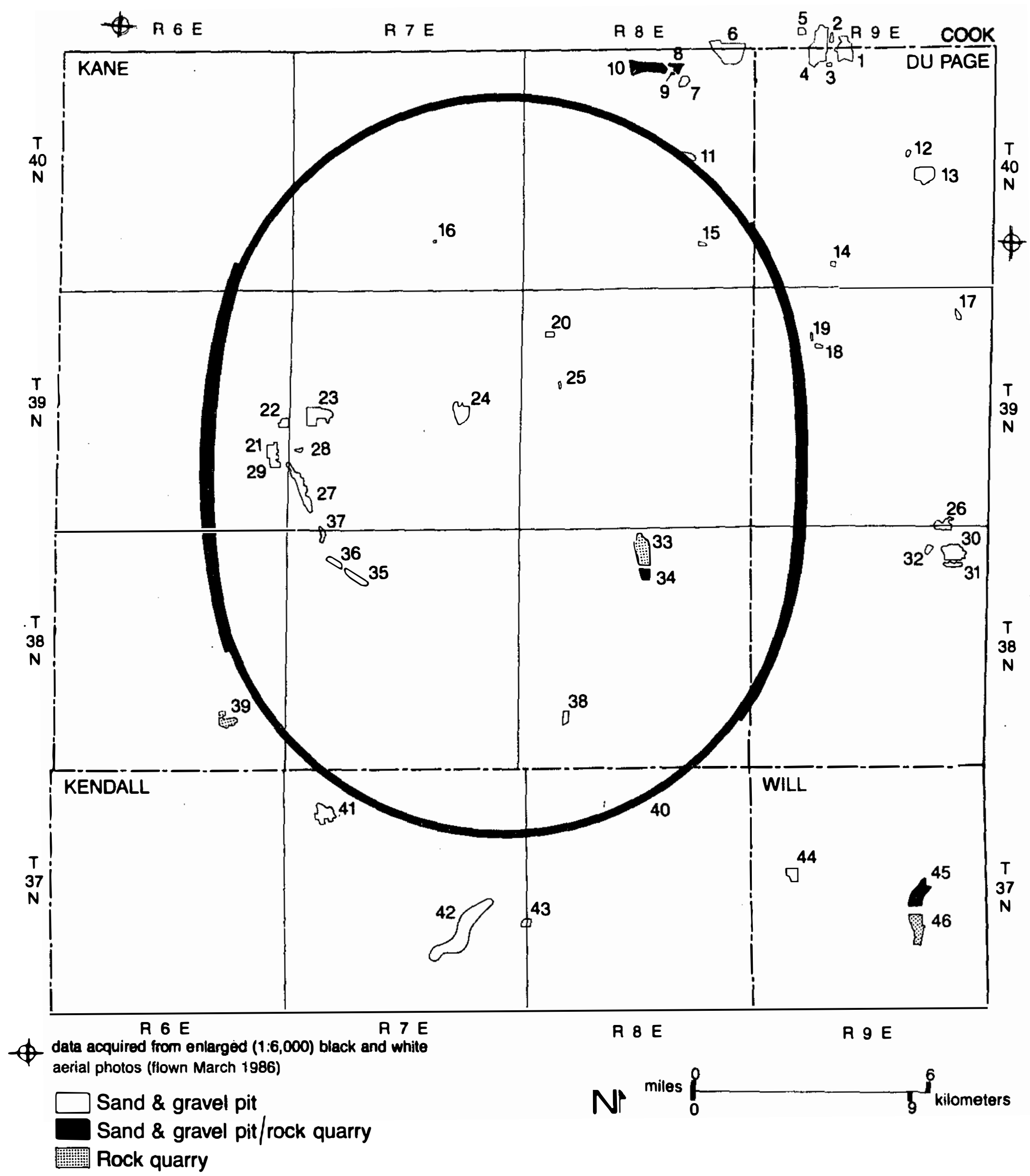


FIGURE 2

Sand and Gravel Pits and Rock Quarries Within Northeastern Illinois SSC Site

TABLE 4

Volume Capacities of Potential Disposal Sites for Material Excavated from the Proposed Illinois SSC

Pit/Quarry No.	Capacity CY	County	Location
1	1,759,030	Cook/	T41N R9E sec 33
		DuPage	T41N R9E sec 4,5
2	444,312	Cook	T41N R9E sec 32
3	115,938	DuPage	T40N R9E sec 5
4	5,320,935	Cook/	T41N R9E sec 32
		DuPage	T40N R9E sec 5
5	314,403	Cook	T41N R9E sec 32
6	1,141,290	Kane	T40N R8E sec 1,2
7	1,226,016	Kane	T40N R8E sec 2,11
8	259,386	Kane	T40N R8E sec 2,3
9	3,110	Kane	T40N R8E sec 3
10	6,082,099	Kane	T40N R8E sec 3,4
11	2,647,632	Kane	T40N R8E sec 14,15
12	202,748	DuPage	T40N R9E sec 15
13	2,438,928	DuPage	T40N R9E sec 23
14	115,856	DuPage	T40N R9E sec 32,33
15	173,751	Kane	T40N R8E sec 26,27
16	259,875	Kane	T40N R7E sec 27
17	152,468	DuPage	T39N R9E sec 1
18	130,772	DuPage	T39N R9E sec 8
19	87,790	DuPage	T39N R9E sec 8
20	96,903	Kane	T39N R8E sec 11
21	1,868,870	Kane	T39N R6E sec 24,25
22	1,116,381	Kane	T39N R6E sec 24
23	3,653,160	Kane	T39N R7E sec 19,20
24	88,491	Kane	T39N R7E sec 14,23
25	3,517,521	Kane	T39N R8E sec 17
26	2,771,843	DuPage	T39N R9E sec 35,36
			T38N R9E sec 1,2
27	1,895,321	Kane	T39N R7E sec 30,31
			T39N R6E sec 25
28	75,496	Kane	T39N R7E sec 30
29	346,236	Kane	T39N R6E sec 25
30	3,075,975	DuPage	T38N R9E sec 1,2
31	1,438,352	DuPage	T38N R9E sec 1,2,11,12
32	743,029	DuPage	T38N R9E sec 2
33	4,167,726	Kane	T38N R8E sec 3
34	2,273,484	Kane	T38N R8E sec 10
35	215,644	Kane	T38N R7E sec 8,9
36	653,207	Kane	T38N R7E sec 5,8
37	484,440	Kane	T38N R7E sec 5,6
38	2,636,064	Kane	T38N R8E sec 29
39	6,537,257	Kane	T38N R6E sec 26
40	738,695	Kendall	T37N R8E sec 3
41	5,613,135	Kendall	T37N R7E sec 5,6,7,8
42	2,084,906	Kendall	T37N R7E sec 23,24,26,27
43	902,066	Kendall	T37N R7E sec 24
			T37N R8E sec 19
44	102,634	Will	T37N R9E sec 17
45	2,217,207	Will	T37N R9E sec 11,14
46	7,480,066	Will	T37N R9E sec 14,23
Total Volume	79,670,448 CY		

3.2 Alternative 2: Disposal in three rock quarries. Three rock quarries (pit/quarry Nos. 10, 33/34, and 39 of Figure 2) have agreed to take all of the excavated material. No dumping fee will be charged.

3.3 Alternative 3: Disposal in those of the 46 pits and quarries closest to each shaft, given capacity constraints. The 46 pits and quarries of Figure 2 have been identified for this purpose. None of the 46 is adjacent to housing developments, and all are easily accessible.

3.4 Alternative 4: Use of the excavated material from each shaft in the landscape around the shaft. The objective of this alternative is to eliminate transportation, road maintenance, and access road construction costs associated with the first three options. Here, the SSC project would maintain complete control of the excavated material.

4. COSTS OF DISPOSAL

Common costs associated with Alternatives 1, 2, and 3 are transportation costs; construction and land easement or acquisition costs of access roads (from shaft to hauling road); maintenance costs of hauling roads; and dumping fees or acquisition costs of disposal sites. All of the costs except that of land easement or acquisition for the access roads are included in the estimate. Factors of access road land easement and acquisition include land use and ownership at each site and the life-expectancy of the access roads. These factors have not been described to the extent that cost estimates can be made. Additional costs of Alternative 2 will be the bulldozing to reconstruct the esker and revegetating the excavated rock with prairie grass. There are several supplemental costs associated with Alternative 3 that cannot be estimated with an acceptable degree of certainty at this stage of planning. They are discussed under section 4.5. The costs of Alternative 4 are spreading and revegetating the material around each shaft.

4.1 TRANSPORTATION COSTS

A linear programming model was developed to estimate transportation costs and specify the hauling routes that minimize these costs for Alternatives 1, 2, and 3.

4.1.1 METHODS AND PROCEDURES OF ESTIMATING TRANSPORTATION COSTS

Linear programming (LP) is a mathematical technique designed to assist in allocating resources. The general type of problem maximizes or minimizes some dependent variable that is a function of independent variables, where the independent variables are subject to various constraints. A linear relationship between the dependent variable and its determinants is assumed.

The LP technique was used to estimate the total transportation cost and define the most economical routes to move 4.6×10^6 tons of EREM from the 24 access shafts to as many as 46 possible disposal sites. The independent variables are the amount of material trucked from each shaft to each disposal site, subject to supply constraints (the amount of excavated material expected from each shaft) and demand constraints (the volume or utilization capacity of each disposal site).

4.1.1.1 OBJECTIVE FUNCTION OF LINEAR PROGRAMMING MODEL

The objective of the LP model is to minimize the transportation costs associated with each of the three disposal alternatives that involve relocating the excavated material. For example, the objective function for Alternative 3 (disposing of the material from the 24 access shafts to those of the 46 sand and gravel pits and rock quarries in the area that minimize transportation costs) would be mathematically represented as:

Minimize: Transportation Costs, T

T = $/ton X1P1 + $/ton X1P2 + $/ton X1P3 + ... $/ton X24X46

Note: X1P1 represents the tons of material being transferred from shaft 1 to pit/quarry 1. Therefore, there are 1,104 (24 x 46) variables in this objective function.

The coefficients of the variables in the objective function ($/ton) were determined by estimating the relationship between miles traveled and transportation costs. Trucking costs compiled from five sources from within the Chicago and Milwaukee area were examined. From these a linear approximation of cost per ton and miles traveled is represented by the equation:

$/ton = 1 + .09 (miles traveled)

This relationship is graphically represented in Figure 3. The distance traveled (in miles) from each source to each destination was measured. Hauling routes should be limited to state roads, rather than county and township roads, as much as possible, because they are of a more resistant construction, and if repairs were needed, money would be more readily accessible at the state level.

4.1.1.2 SUPPLY CONSTRAINTS OF LINEAR PROGRAMMING MODEL

The objective function of this LP model is subject to supply and demand constraints. The supply constraints of our disposal alternatives are the amount of excavated material to be

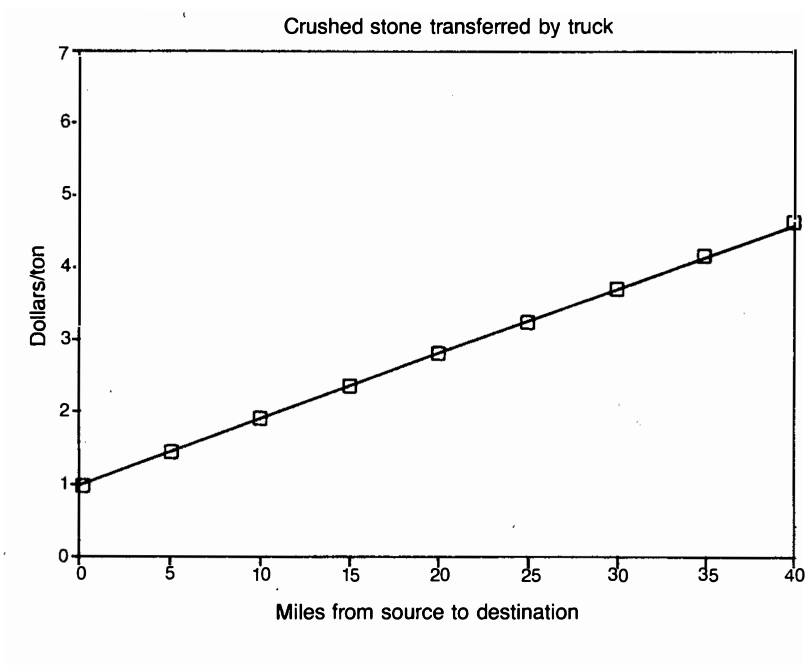


FIGURE 3 ESTIMATED TRANSPORTATION COSTS

removed from each access shaft. The amount of excavated material anticipated from each of the 24 access shafts is described in Tables 2 and 3 (Curran, 1986). Two excavation scenarios are presented because it is uncertain if contractors will remove excavated material from the tunnel only from 30-foot inside diameter shafts (Scenario 1), or if the 20-foot inside diameter shafts will also be used (Scenario 2).

4.1.1.3 DEMAND CONSTRAINTS OF LINEAR PROGRAMMING MODEL

The demand constraints are the volume capacities at each disposal site (Table 4). The boundaries of the pits and quarries were mapped from enlarged, black and white, 1:6,000 scale aerial photos, taken in March 1986. These boundaries were digitized and added to the Illinois Department of Energy and Natural Resources' Geographical Information System (GIS) data base. The area of each pit and quarry was calculated by the GIS. The average depth of each of the 46 pits and quarries was measured using the parallax photogrammetry method on 1:24,000-scale, aerial photos taken in March 1986. The results of these procedures indicate that the 46 active and abandoned sand and gravel pits and rock quarries have a total holding capacity of over 7.9×10^7 CY.

In addition to the volume of material needed to fill the disposal site to ground level, the demand constraints for Alternative 1, reconstructing the Kaneville Esker, include the volume of material needed to return the sinuous ridge to its elevation prior to sand and gravel excavation. A 1929 edition, 15-minute topographic map was used to determine pre-excavation elevations. A 35-degree angle of repose (slope of the rebuilt esker) was assumed.

4.1.1.4 OPTIMIZATION OF LINEAR PROGRAMMING MODEL

The formulated objective function and supply and demand constraints were run on interactive linear programming systems that use the Simplex Method to optimize. Alternatives 1 and 2 (both having fewer than 120 variables) were solved using LINDO (Linear INteractive Discrete Optimizer) on the CYBER mainframe at the University of Illinois. The linear program for Alternative 3 was too large for LINDO (1,104 variables); it required the more powerful program of APEX III which is also on the CYBER.

4.1.2 RESULTS OF LINEAR PROGRAMMING MODEL

The results of the linear programming models for Alternatives 1, 2, and 3 are given in Tables 5-12. These tables specify the amount of EREM from each shaft to be transported to disposal sites to minimize transportation costs. Excavation Scenarios 1 and 2 are presented for each alternative.

Two plans have been proposed for reconstructing the Kaneville Esker (Alternative 1). Reconstructing the esker is estimated to require only 3.25×10^6 of the 4.4×10^6 CY of EREM from the whole project. Two plans have been developed for disposing of the excess 1.15×10^6 CY. Plan 1, Tables 5 and 6, assumes that the excess will be disposed of in the vicinity of pit No. 27. The total transportation costs of Plan 1 are $9.9 million for excavation Scenario 1, and $10.5 million for Scenario 2.

Plan 2 for reconstructing the Kaneville Esker, Tables 7 and 8, assumes that the excess 1.15×10^6 CY of material will be disposed of in quarry No. 33. The owners of quarry No. 33 have agreed to dispose of excavated material from the SSC without charging a dumping fee. The quarry is located east of the Kaneville Esker. Its location reduces the transportation cost of hauling all of the material to the Kaneville Esker area, which is located in the southwest interior section of the proposed ring. The total transportation cost for Plan 2 is $9.3 million for Scenario 1, or $9.5 million for Scenario 2.

The transportation costs associated with Alternative 2, disposing of material at three rock quarries, are summarized in Tables 9 and 10. The total cost under Scenario 1 is $8.7 million, and $8.9 million under Scenario 2.

Alternative 3 uses those of the 46 pits and quarries in the vicinity that minimize transportation costs, given capacity constraints. This requires 18 pits and quarries for Scenario 1, at a cost of $6.5 million (Table 11); and 17 are used for Scenario 2, at a cost of $6.7 million (Table 12).

4.2 COSTS OF CONSTRUCTING SHAFT ACCESS ROADS

The construction cost of access roads from each shaft to the nearest existing haul road is estimated at $104,000 per mile for a 3-inch asphalt surface.

4.3 ROAD MAINTENANCE COSTS

Road maintenance costs are estimated at $2,500 per mile per year.

The Illinois Department of Transportation (IDOT) will provide detailed road maintenance cost estimates for disposal Alternatives 1, 2, and 3 by July 1987.

4.4 DUMPING OR ACQUISITION COSTS AT DISPOSAL SITE

Unless the pit/quarry owner has indicated that a dumping fee will not be charged, an acquisition cost/dumping fee of $700 per acre with an average disposal pile depth of 6 yards

TABLE 5

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Reconstructing the Kaneville Esker--excess material disposed of in pit No. 27

Assumption: Material to be removed only from 30-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	27	11,760	13,521	22.5	$3.03	$40,969
A40	27	270,124	310,575	22.5	$3.03	$941,042
B1	27	10,068	11,576	20.4	$2.84	$32,875
B40	27	267,740	307,834	19.0	$2.71	$834,230
C1	27	9,644	11,088	15.5	$2.40	$26,612
C40	27	266,548	306,464	12.0	$2.08	$637,444
D1	27	9,926	11,412	10.5	$1.95	$22,254
D40	27	284,608	327,228	11.0	$1.99	$651,184
D80	27	10,914	12,548	8.0	$1.72	$21,583
XR	37	289,370	332,703	4.0	$1.36	$452,476
Y	27	11,770	13,533	5.4	$1.49	$20,164
Z	36	210,116	241,581	7.0	$1.63	$393,777
E1	27	13,784	15,848	9.0	$1.81	$28,685
E40	35	215,644	247,937	7.0	$1.63	$404,137
	36	63,718	73,260	8.0	$1.72	$126,007
F1	27	15,990	18,385	10.0	$1.90	$34,931
F40	36	282,044	324,280	9.0	$1.81	$586,947
G1	36	13,734	15,791	14.0	$2.26	$35,687
G40	27	273,104	314,001	19.0	$2.71	$850,944
H1	27	13,170	15,142	18.0	$2.62	$39,673
H40	27	498,529	573,184	16.0	$2.44	$1,398,568
	36	83,595	96,113	13.5	$2.22	$213,372
H80	27	12,464	14,330	18.0	$2.62	$37,546
RR	27	287,942	331,061	16.0	$2.44	$807,790
S	27	198,844	228,621	17.0	$2.53	$578,411
T	27	197,910	227,547	22.0	$2.98	$678,090
					Total Cost	$9,895,398

TABLE 6

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Reconstructing the Kaneville Esker--excess material disposed of in pit No. 27

Assumption: Material to be removed from 30-foot and 20-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	27	143,158	164,632	22.5	$3.03	$498,834
A40	27	146,594	168,583	22.5	$3.03	$510,807
B1	27	133,596	153,635	20.5	$2.84	$436,325
B40	27	144,210	165,842	19.0	$2.71	$449,430
C1	27	133,174	153,150	15.5	$2.40	$367,560
C40	27	143,018	164,471	12.0	$2.08	$342,099
D1	27	133,456	153,474	10.5	$1.95	$299,275
D40	27	153,240	176,226	11.0	$1.99	$350,690
D80	27	142,280	163,622	8.0	$1.72	$281,430
XR	27	158,008	181,709	6.5	$1.59	$288,918
Y	27	206,840	237,866	5.5	$1.49	$354,420
Z	27	210,116	241,633	10.5	$1.95	$471,185
E1	27	145,242	167,028	9.0	$1.81	$302,321
E40	27	155,832	179,207	10.5	$1.95	$349,453
F1	27	139,518	160,446	10.0	$1.90	$304,847
F40	27	158,514	182,291	11.5	$2.04	$371,874
G1	37	137,262	157,851	15.0	$2.35	$370,951
G40	35	78,946	90,788	16.0	$2.44	$221,522
	36	58,621	67,414	17.0	$2.53	$170,558
	37	12,007	13,808	18.0	$2.62	$36,177
H1	35	136,698	157,203	15.0	$2.35	$369,426
H40	36	159,796	183,765	13.5	$2.22	$407,959
H80	36	434,790	500,008	15.5	$2.40	$1,200,020
RR	27	156,548	180,030	16.0	$2.44	$439,274
S	27	61,585	70,823	17.0	$2.53	$179,182
	37	137,261	157,850	17.0	$2.53	$399,361
T	37	197,910	227,596	23.5	$3.11	$707,825
					Total Cost	$10,481,723

TABLE 7

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Reconstructing the Kaneville Esker--excess material disposed of in pit No. 33

Assumption: Material to be removed only from 30-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	33	11,760	13,521	11.5	$2.04	$27,583
A40	33	270,124	310,575	11.0	$1.99	$618,044
B1	33	10,068	11,576	10.0	$1.90	$21,994
B40	27	267,740	307,834	19.0	$2.71	$834,230
C1	27	9,644	11,088	15.5	$2.40	$26,612
C40	27	266,548	306,464	12.0	$2.08	$637,444
D1	27	9,926	11,412	10.5	$1.95	$22,254
D40	27	284,608	327,228	11.0	$1.99	$651,184
D80	27	10,914	12,548	8.0	$1.72	$21,583
XR	37	289,370	332,703	4.0	$1.36	$452,476
Y	27	11,770	13,533	5.5	$1.49	$20,164
	37	195,070	224,282	3.0	$1.27	$284,838
Z	36	210,116	241,581	7.0	$1.63	$393,777
E1	27	13,874	15,952	9.0	$1.81	$28,872
E40	35	189,446	217,816	7.0	$1.63	$355,039
	36	89,916	103,381	8.0	$1.72	$177,815
F1	27	15,990	18,385	10.0	$1.90	$34,931
F40	36	282,044	324,280	9.0	$1.81	$586,947
G1	35	13,734	15,791	13.0	$2.17	$34,266
G40	27	273,104	314,001	19.0	$2.71	$850,944
H1	27	13,170	15,142	18.0	$2.62	$39,673
H40	27	510,993	587,514	16.0	$2.44	$1,433,535
	36	71,131	81,783	13.5	$2.22	$181,558
H80	35	12,464	14,330	14.5	$2.31	$33,103
RR	27	207,040	238,044	16.0	$2.44	$580,828
	33	80,902	93,017	6.5	$1.59	$147,897
S	33	198,844	228,621	7.5	$1.68	$384,083
T	33	197,910	227,547	11.0	$1.99	$452,819
					Total Cost	$9,334,493

TABLE 8

Linear Programming Results for Minimizing Transportation Costs
of Disposing of Material Excavated from
the Proposed Illinois SSC

Disposal Alternative: Reconstructing the Kaneville Esker--excess material disposed of in pit No. 33

Assumption: Material to be removed from 30-foot and 20-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	33	143,158	164,596	11.5	$2.04	$335,776
A40	33	146,594	168,546	11.0	$1.99	$335,407
B1	33	133,596	153,602	10.0	$1.90	$291,844
B40	27	144,210	165,805	19.0	$2.71	$449,333
C1	27	133,174	153,117	15.5	$2.40	$367,480
C40	27	143,018	164,435	12.0	$2.08	$342,025
D1	27	133,456	153,441	10.5	$1.95	$299,210
D40	27	153,240	176,188	11.0	$1.99	$350,614
D80	27	142,280	163,586	8.0	$1.72	$281,369
XR	37	158,008	181,670	4.0	$1.36	$247,071
Y	37	206,840	237,814	3.0	$1.27	$302,024
Z	35	179,404	206,270	6.0	$1.54	$317,655
	36	30,712	35,311	7.0	$1.63	$57,557
E1	27	145,242	166,992	9.0	$1.81	$302,256
E40	35	36,240	41,667	7.0	$1.63	$67,917
	37	119,592	137,501	9.0	$1.81	$248,877
F1	27	139,518	160,411	10.0	$1.90	$304,781
F40	36	158,514	182,251	9.0	$1.81	$329,875
G1	36	137,262	157,817	14.0	$2.26	$356,666
G40	27	149,574	171,973	19.0	$2.71	$466,046
H1	27	136,698	157,169	18.0	$2.62	$411,782
H40	27	159,796	183,725	16.0	$2.44	$448,290
H80	27	108,071	124,255	18.0	$2.62	$325,547
	36	326,719	375,645	15.5	$2.40	$901,548
RR	27	8,198	9,426	16.0	$2.44	$22,999
	33	148,350	170,565	6.5	$1.59	$271,199
S	27	198,846	228,623	17.0	$2.53	$578,417
T	33	197,910	227,547	11.0	$1.99	$452,819
					Total Cost	$9,466,384

TABLE 9

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Using three rock quarries: Conco and Western (No. 33 & 34), Fox River (No. 10), and Meyer (No, 39)

Assumption: Material to be removed only from 30-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	33	11,760	13,521	11.5	$2.04	$27,583
A40	10	270,124	310,575	8.5	$1.77	$549,718
B1	10	10,068	11,576	6.5	$1.59	$18,405
B40	10	267,740	307,834	5.0	$1.45	$446,359
C1	10	9,644	11,088	12.0	$2.08	$23,063
C40	10	266,548	306,464	13.0	$2.17	$665,026
D1	10	9,926	11,412	16.5	$2.49	$28,417
D40	33	284,608	327,228	19.5	$2.76	$903,149
D80	39	10,914	12,548	18.0	$2.62	$32,877
XR	39	289,370	332,703	15.0	$2.35	$781,852
Y	39	206,840	237,814	14.0	$2.26	$537,460
Z	39	210,116	241,581	12.5	$2.13	$514,567
E1	39	13,874	15,952	11.0	$1.99	$31,744
E40	39	279,362	321,196	2.0	$1.18	$379,012
F1	39	15,990	18,385	7.0	$1.63	$29,967
F40	39	282,044	324,280	8.0	$1.72	$557,762
G1	34	13,734	15,791	9.0	$1.81	$28,581
G40	34	273,104	314,001	11.0	$1.99	$624,863
H1	34	13,170	15,142	10.0	$1.90	$28,770
H40	34	582,124	669,297	7.0	$1.63	$1,090,954
H80	34	12,464	14,330	9.0	$1.81	$25,938
RR	33	287,942	331,061	6.5	$1.59	$526,387
S	33	198,844	228,621	7.5	$1.68	$384,083
T	33	197,910	227,547	11.0	$1.99	$452,819
					Total Cost	$8,689,356

TABLE 10

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Using three rock quarries: Conco and Western (No. 33 & 34), Fox River (No. 10), and Meyer (No. 39)

Assumption: Material to be removed from 30-foot and 20-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	33	143,158	164,596	11.5	$2.04	$335,776
A40	10	146,594	168,546	8.5	$1.77	$298,327
B1	10	133,596	153,602	6.5	$1.59	$244,227
B40	10	144,210	165,805	5.0	$1.45	$240,418
C1	10	133,174	153,117	12.0	$2.08	$318,483
C40	10	143,018	164,435	13.0	$2.17	$356,824
D1	10	133,456	153,441	16.5	$2.49	$382,068
D40	33	153,240	176,188	19.5	$2.76	$486,278
D80	39	142,280	163,586	18.0	$2.62	$428,596
XR	39	158,008	181,670	15.0	$2.35	$426,924
Y	39	206,840	237,814	14.0	$2.26	$537,460
Z	39	210,116	241,581	12.5	$2.13	$514,567
E1	39	145,242	166,992	11.0	$1.99	$332,314
E40	39	155,832	179,168	2.0	$1.18	$211,418
F1	39	139,518	160,411	7.0	$1.63	$261,470
F40	39	158,514	182,251	8.0	$1.72	$313,473
G1	34	137,262	157,817	9.0	$1.81	$285,649
G40	34	149,574	171,973	11.0	$1.99	$342,226
H1	34	136,698	157,169	10.0	$1.90	$298,620
H40	34	159,796	183,725	7.0	$1.63	$299,472
H80	34	434,790	499,900	9.0	$1.81	$904,819
RR	33	156,548	179,991	6.5	$1.59	$286,186
S	33	198,846	228,623	7.5	$1.68	$384,087
T	33	197,910	227,547	11.0	$1.99	$452,819
					Total Cost	$8,942,501

TABLE 11

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Using all sand and gravel pits and rock quarries within the area

Assumption: Material to be removed only from 30-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume(CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	19	11,760	13,521	2.0	$1.18	$15,955
A40	11	96,373	110,805	5.4	$1.49	$165,099
	15	173,751	199,770	2.0	$1.18	$235,729
B1	11	10,068	11,576	1.6	$1.14	$13,196
B40	10	267,740	307,834	5.0	$1.45	$446,359
C1	11	9,644	11,088	9.5	$1.86	$20,624
C40	16	266,548	306,464	8.0	$1.72	$527,117
D1	16	9,926	11,412	6.5	$1.59	$18,146
D40	16	284,608	327,228	6.5	$1.59	$520,293
D80	21	10,914	12,548	3.0	$1.27	$15,936
XR	29	289,370	332,703	4.0	$1.36	$452,476
Y	37	206,840	237,814	3.0	$1.27	$302,024
Z	35	210,116	241,581	6.0	$1.54	$372,035
E1	35	5,528	6,356	7.5	$1.68	$10,678
	36	8,346	9,596	8.5	$1.77	$16,985
E40	39	279,362	321,196	2.0	$1.18	$379,012
F1	41	15,990	18,385	1.6	$1.14	$20,958
F40	41	282,044	324,280	3.6	$1.32	$428,050
G1	43	13,734	15,791	3.6	$1.32	$20,844
G40	40	273,104	314,001	1.0	$1.09	$342,261
H1	40	13,170	15,142	3.6	$1.32	$19,988
H40	38	582,124	669,297	6.5	$1.59	$1,064,182
H80	38	12,464	14,330	8.5	$1.77	$25,365
RR	26	287,942	331,061	4.6	$1.41	$466,796
S	26	198,844	228,621	5.4	$1.49	$340,645
T	18	130,772	150,355	1.6	$1.14	$171,405
	19	67,138	77,192	1.6	$1.14	$87,999
					Total Cost	$6,500,157

TABLE 12

Linear Programming Results for Minimizing Transportation Costs of Disposing of Material Excavated from the Proposed Illinois SSC

Disposal Alternative: Using all sand and gravel pits and rock quarries within the area

Assumption: Material to be removed from 30-foot and 20-foot inside diameter shafts

Shaft	Destination Pit/Quarry No.	Volume (CY) Transferred	Tonnage Transferred	Miles Traveled One-Way	$/Ton	Transportation Cost Per Shaft
A1	17	122,506	140,851	7.5	$1.68	$236,630
	18	20,652	23,745	2.0	$1.18	$28,019
A40	15	146,594	168,546	2.0	$1.18	$198,885
B1	11	133,596	153,602	1.6	$1.14	$175,106
B40	10	144,210	165,805	5.0	$1.45	$240,418
C1	11	106,017	121,893	9.5	$1.86	$226,721
	15	27,157	31,224	8.0	$1.72	$53,705
C40	16	143,018	164,435	8.0	$1.72	$282,828
D1	16	133,456	153,441	6.5	$1.59	$243,971
D40	16	153,240	176,188	6.5	$1.59	$280,138
D80	21	142,280	163,586	3.0	$1.27	$207,755
XR	37	158,008	181,670	4.0	$1.36	$247,071
Y	37	206,840	237,814	3.0	$1.27	$302,024
Z	35	70,402	80,945	6.0	$1.54	$124,655
	36	139,714	160,636	7.0	$1.63	$261,837
E1	35	145,242	166,992	7.5	$1.68	$280,547
E40	39	155,832	179,168	2.0	$1.18	$211,418
F1	41	139,518	160,411	1.6	$1.14	$182,868
F40	41	158,514	182,251	3.6	$1.32	$240,572
G1	43	137,262	157,817	3.6	$1.32	$208,318
G40	40	149,574	171,973	1.0	$1.09	$187,450
H1	40	136,698	157,169	3.6	$1.32	$207,462
H40	38	159,796	183,725	6.5	$1.59	$292,123
H80	38	434,790	499,900	8.5	$1.77	$884,823
RR	26	156,548	179,991	4.6	$1.41	$253,787
S	26	198,846	228,623	5.4	$1.49	$340,649
T	18	110,120	126,610	1.6	$1.14	$144,336
	19	87,790	100,937	1.6	$1.14	$115,068
					Total Cost	$6,659,184

is assumed.

Alternative 1, reconstructing the Kaneville Esker, requires the purchase of land for a glacial park. It is estimated that the 1,115 acres required can be purchased for $869 per acre. The 13 structures on this land are valued at $49,279 per structure.

4.5 MISCELLANEOUS COSTS AND BENEFITS

A number of cost items must be added to Alternative 3 that cannot be estimated with an acceptable degree of certainty at this stage of planning.

1. State and/or county permits for rock disposal in abandoned pits and quarries have to be obtained.

2. If pits and quarries cannot be purchased, contracts (including liability agreements) with the owners must be negotiated.

3. A bulldozer must be posted at each disposal site in order to level and dress the rock material. The cost of operating a bulldozer is estimated to be $50 per hour, or $286,000 for 30 months. The number of bulldozers needed will depend on the number of TBMs operating simultaneously.

4. In some cases the disposal sites will have to be revegetated by bringing in topsoil and seeding.

Two beneficial aspects of disposal that have not been assigned dollar values are the public benefit of having a glacial park and natural area (Alternative 1); and the esthetic value of landscaping (Alternatives 3 and 4). These are important considerations in the overall evaluation of the four disposal alternatives.

4.6 SPREADING AND LANDSCAPING COSTS

Alternative 4 involves the spreading and the landscaping of EREM around each access shaft. The cost of spreading EREM is estimated at $2 per CY of EREM. The additional costs of topsoil (12 inches deep), fertilizer, mulch, and seed are $17,500 per acre. This estimate is also used for the revegetation cost of reconstructing the Kaneville Esker.

4.7 ENVIRONMENTAL ISSUES AND COSTS

The air and water quality aspects have been studied separately by Barnard et al. (1986), and Krapac et al. (1987). The following discussion is based on these reports.

4.7.1 AIR QUALITY

An unpublished Illinois State Water Survey report, "Assessment of the Potential Air Quality Impacts Resulting from Siting the Superconducting Super Collider in Illinois" (Barnard, et al., 1986), identified Total Suspended Particulates (TSP) caused by truck traffic during the construction stage of the project as the only air quality issue to be dealt with. This conclusion was based on the assumption that access roads from the shaft would be unpaved. This assumption no longer holds true. Current plans for the construction of the access roads specify that all will be paved--mitigating the TSP pollution potential.

4.7.2 WATER QUALITY

Krapac et al. (1987) studied the leaching properties of the materials to be excavated from the Illinois SSC. The pH value of the extracts ranged from 7.6 to 10.1. The mean constituent concentration for all extracts was below drinking and surface effluent discharge standards. The results of the laboratory studies indicate that the leachates would have minimal impact on the local ground and surface waters. The disposal of the excavated material into pits and quarries will also have minimal environmental impact. Therefore, no water treatment is likely to be necessary and no costs would be involved.

5. COMPILED COSTS FOR PROPOSED DISPOSAL ALTERNATIVES

In all cases, the transportation costs are based on the highest cost excavation scenario.

5.1 ESTIMATED COST OF ALTERNATIVE 1

5.1.1 ALTERNATIVE 1: PLAN 1

Transportation Costs:	$10,500,000
Access Road Construction Costs:	
3.5 mi @ $104,000/mi	364,000
Road Maintenance Costs:	
130 mi @ $2,500/mi per yr x 2.5 yrs	812,500
Land Acquisition/Dumping Fee Costs:	
1,115 acres @ $869/acre	968,935
13 structures @ 49,279/structure	640,627
Bulldozing to Reform the Esker:	
$2,000/wk x 52 wks x 2.5 yrs	260,000

Revegetation: 333 acres x $17,500/acre	5,827,500
Total Cost	$19,373,562

5.1.2 ALTERNATIVE 1: PLAN 2

Transportation Costs:	$ 9,500,000
Access Road Construction Costs: 3.5 mi @ $104,000/mi	364,000
Road Maintenance Costs: 110 mi @ $2,500/mi per yr x 2.5 yrs	687,500
Land Acquisition/Dumping Fee Costs: 1,115 acres @ $869/acre	968,935
13 structures @ 49,279/structure	640,627
Bulldozing to Reform the Esker: $2,000/wk x 52 wks x 2.075 yrs	215,800
Revegetation: 256 acres x $17,500/acre	4,480,000
Total Cost	$16,856,862

5.2 ESTIMATED COST OF ALTERNATIVE 2

Transportation Costs:	$ 9,000,000
Access Road Construction Costs: 3.5 mi @ $104,000	364,000
Road Maintenance Costs: 115 mi @ $2,500/mi per yr x 2.5 yrs	718,750
Land Acquisition/Dumping Fee Costs:	0
Total Cost	$10,082,750

5.3 ESTIMATED COST OF ALTERNATIVE 3

Transportation Costs:	$ 6,600,000
Access Road Construction Costs: 3.5 mi @ $104,000	364,000
Road Maintenance Costs: 72 mi @ $2,500/mi per yr x 2.5 yrs	450,000
Land Acquisition/Dumping Fee Costs: 175 acres @ $700/acre	122,500
Total Cost	$ 7,536,500

Note: Additional costs of Alternative 3 that have not been assigned a dollar value are described under section 4.5.

5.4 ESTIMATED COST OF ALTERNATIVE 4

Spreading Costs: 4,400,000 CY @ $2/CY	$ 8,800,000
Topsoil, Fertilizer, Mulch and Seed Costs: 312 acres x $17,000/acre	$ 5,304,000
Total Cost	$14,104,000

REFERENCES

Barnard, William R., et al., April 1986, Assessment of the potential air quality impacts resulting from the Superconducting Super Collider in Illinois, Illinois State Water Survey, (Unpublished report, Illinois State Geological Survey Library, SSC Archives), 32 pp.

Curran, Lucille M., December 1986, Northeastern Illinois SSC site: spoil volume and distribution, Illinois State Geological Survey, (Unpublished report, Illinois State Geological Survey Library, SSC Archives), 18 pp.

Cyrier, Richard, Engineer, Metropolitan Sanitary District of Greater Chicago, Telephone conversation on 31 March 1987.

Harza Engineering Company, 1986, Construction Cost Estimate, Underground Excavation, (Unpublished report, Illinois State Geological Survey Library, SSC Archives), 58 pp.

IIT Research Institute, January 1986, Evaluation of TBM produced rock, Final Report No. IITRI-M08206-5.

Krapac, Ivan G., et al., April 1987, Impact of Superconducting Super Collider (SSC) tunnel spoil on surface and groundwater supplies, Illinois State Geological Survey, Unpublished report, Illinois State Geological Survey Library, SSC Archives), 19 pp.

Lui, T.K., D.G. Gifford, R.P. Stulgis, and D.L. Freed, 1977, Muck utilization in urban transportation tunneling process, Rpt. No. UMTA-MA-06-0025-77-15, Prepared by Haley and Aldrich, Inc. for the U.S. Department of Transportation, Urban Mass Transportation Association, 596 pp.

Milwaukee Metropolitan Sewerage District, 1983, Spoil disposal plan for the cross town interceptor and inline pump station, Milwaukee Water Pollution Abatement Program, Prepared by CH2M Hill, Inc., 36 pp.