ROLLINS, BROWN AND GUNNELL, INC.
PROFESSIONAL ENGINEERS

May 12, 1980

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Utah Power & Light Company
Mining and Exploration Division
1407 West North Temple
Salt Lake City, UT 84110

ATTENTION: Willie J. Whitney Jr., Project Engineer

Gentlemen:

In accordance with your request, we have investigated the waste dumps associated with the proposed Cottonwood Mine in Cottonwood Canyon west of Orangeville, Utah. The purpose of this investigation was to obtain an indication of the stability of the waste dumps and to provide recommendations for maintaining the stability of these facilities during the interim period before beginning mining operations.

The work has been completed in a manner to accomplish the basic objective, and the results of the investigation are outlined in the following sections of this report. Specifically, the report includes: (1) location and existing conditions throughout the dump area, (2) physical characteristics of the material existing within the waste dumps, (3) stability considerations, (4) conclusions and recommendations.

1. Location and Existing Conditions Throughout the Dump Area

The proposed Cottonwood Mine is located several miles west of Orangeville, Utah, in Section 25 of Township 17 South, Range 6 East, Salt Lake Base and Meridian.

The material within the waste dumps throughout the area consist of materials stripped from the coal seams upslope from the dumps. Three waste dumps exist throughout the area as shown in Figure No. 1. Waste Dump No. 1 is located immediately downslope from the area where the portals for the mine will be located. Waste Dump No. 2 is so-called topsoil stripped from the mine area, and Waste Dump No. 3 was excess material which could not be dumped downhill from the mine portal.

Figure No. 2 and No. 3 show ground surface profiles through Waste Dump No. 1 before and after the dump placement. The slope of the ground relative to the horizontal is shown for both the natural slopes prior to the dump placement and for the dump slope. It will be observed that the maximum height of the dump is 90 feet.

Dump No. 2 is a relatively small dump and consists of topsoil removed from the mine area. Dump No. 3 is approximately the same height as Dump No. 1, except that it is more massive and has a number of large boulders stacked up at the top of the slope.

Based upon our observation of the site, the following comments are made.

A. The slope angle throughout the site prior to any excavation varies from 29 to 39.5 degrees.

B. An examination of the contour map of the area prior to any excavation at the site shows no indication of any slides throughout the general area of the mine. Hence, the existing overburden appears to have been entirely stable throughout this area for a number of years.

C. The existing slope angle of the 3 dumps existing throughout the area is about 36 degrees, which is not too different from some of the natural slopes throughout the site.

D. The precipitation which has occurred in the area during the past winter and spring is substantially greater than the normal precipitation throughout the area. Considerable rain has occurred in this area during the past few weeks.

E. No evidence of any springs or drainage of water from the canyon slope exists in this area.

F. There is no evidence that the fills are saturated at the present time or that they may become saturated. Even though precipitation has been high during the present year, erosion of the slope of dumps has not been appreciable.

G. Tension cracks exist at the top of the slope of Dump No. 1. However, no evidence of any slope movement exists along the face of the dump. No tension cracks were observed in either Dump No. 2 or No. 3, and no slope movement is occurring in these dumps at the present time.

2. Physical Characteristics of the Material Existing Within the Waste Dumps

In order to obtain an indication of the in-place density of the material within the dumps, in-place density tests were performed along the face of each of the 3 dumps. The in-place unit weights obtained along the face of the dumps are presented in Table No. 1, Summary of Test Data. It will be observed that the in-place unit weight of the dump material varied from 98.4 to 124 pounds per cubic foot and that in most instances, the unit weight exceeded 100 pounds per cubic foot.

It will also be noted that the natural moisture content varied from 12.9 to 26.2 percent. Classification tests were also performed on each of the samples obtained along the face of the dumps. The results of these tests are also presented in Table No. 1, Summary of Test Data.

It will be observed from the mechanical analyses that a substantial amount of material in the silt and clay-size range existed in the dump material. The results of the atterberg limits performed on this material indicate that the plasticity characteristics of the material in the silt and clay-size range are medium to low plasticity type soils.

No shear tests were performed on the waste dump material. However, the results of visual observations and laboratory tests indicate that the natural moisture content of the dump material is only a few percentage points above the plastic limit. Under these conditions, it is our opinion that a cohesion of 500 psf and a friction angle of 26 degrees is a reasonable estimate of the drained shear strength of this material.

As indicated above, all tests were performed on materials located along the face of the dump. It is our opinion that the in-place unit weight and the strength characteristics of materials taken in this area are smaller than at other locations throughout the dump material.

3. Stability Considerations

In order to obtain an indication of the stability of the existing waste dumps, a computer stability analysis was performed for Waste Dump No. 1. In performing the stability analysis, Spencer's method, which satisfies both force and moment equilibrium, was used in the analysis. A complete search for the most critical failure surface was performed in the analysis.

In performing the stability analysis, it was assumed that the waste dump material would have an in-place unit weight of 105 pounds per cubic foot and that the dump material would be not be saturated. It is our opinion that this is a reasonable assumption for the following reasons.

A. There are no environmental conditions throughout the area which would suggest seepage from the canyon walls into the dump.

B. If the dumps are properly drained, infiltration from the storms will be insufficient to saturate the dump.

C. The dumps are not saturated at the present time, even though a considerable amount of precipitation has occurred in the area during recent months.

The stability analysis was performed for various combinations of friction angles and cohesions. The various combinations required to provide a factor of safety of 1.5 are tabulated in Table No. 2 below.

TABLE NO. 2
REQUIRED FRICTION ANGLES AND COHESION TO OBTAIN A FACTOR OF SAFETY OF 1.5

Cohesion (psf)	Friction Angle (degrees)	Factor of Safety
350	32	1.53
400	30	1.52
450	28	1.53
500	26	1.52
550	24	1.50

It is apparent from the above data that if the in-place material has a cohesion of 500 psf and a friction angle of 26 degrees, the slope has a factor of safety of 1.5. It may be desirable to perform a few triaxial shear tests on representative samples of the dump material to verify our estimate of the drained shear strength parameters.

4. Conclusions and Recommendations

A. Conclusions

(1) Since no slope failure has occurred in any of the dumps as of this date, the existing factor of safety is greater than 1.0.

(2) Stable natural slopes exist throughout the site which have a slope angle equal to or greater than the slope angle of the dumps. However, the natural slope angle is less than the slope of the dumps in many cases.

(3) The dumps are not saturated at the present time, and it is our opinion that the materials within the dump will not become saturated if appropriate measures are taken to provide satisfactory drainage.

(4) In-place density tests performed on the face of the dumps indicated unit weights varying from about 98 to 104 pounds per cubic foot, with moisture contents varying from about 13 to 26 percent.

(5) The material making up the dumps consists of both granular and cohesive type soils. Cohesive material in excessive of 40 percent exists in much of the dump material.

(6) The plasticity characteristics of the dump material are relatively low and generally classifies as a CL-1 type soil according to the Unified Soil Classification System.

(7) The erosion which has occurred along the dump surfaces is relatively small, even though a considerable amount of rain has occurred throughout the area during the last several weeks. The cohesive characteristics of the subsurface materials are responsible for the low rate of erosion occurring on the dump surfaces.

(8) A stability analysis performed for Dump No. 1, using the shear strength parameters obtained from the direct shear tests indicates a factor of safety of at least 1.5 for this dump in its existing condition.

(9) Since the height of the other dumps are no greater than Dump No. 1, it is our conclusion that these two dumps are stable with a factor of safety of at least 1.5 in their existing condition.

B. Recommendations

The stability analysis performed during this investigation assumed that the dumps would not become saturated during the interim period. In view of this consideration, it is imperative that the surface drainage be performed throughout the dump areas in such a manner that no appreciable infiltration will occur in the dumps.

The following recommendations regarding drainage are made.

(1) The surface of Dump No. 1 slopes toward the hillside and downward in a northerly direction. Water falling on the surface of this dump will flow readily off the surface. It is recommended, however, that the dump be graded in such a manner that no ponding will occur in any localized areas throughout the surface. It is also recommended that all large boulders existing on the surface or on the edge of the top of the slope be removed from the area.

(2) Dump No. 2 should be regraded and reshaped to permit a downward slope in all areas throughout the dump.

(3) The boulders which currently exist on the top of Dump No. 3 should be removed prior to any grading operations in this area. The top of this dump is wider than the other two dumps, and more care will be required in the grading operations at this location. Grading should be performed in such a manner that no ponding can occur throughout the top of the slope. A continuous downward slope should be established along the top of the slope to permit water to drain freely from the area.

(4) Excessive precipitation in the future may cause excessive erosion on the dump slopes. In order to reduce the likelihood of erosion along the dump slopes, it is recommended that a berm be constructed about half way down the slopes to intercept drainage water falling on the upper portion of the slope. The berm should be graded with a gentle downward slope to permit intercepted water to flow freely from the dump surface. This action will intercept any erosion channel which tends to develop along the slope surface.

It is our opinion that if the above action is taken, the dumps will remain stable in their existing condition with a satisfactory factor of safety.

If there are any questions relative to the information contained herein, please advise us.

Yours truly,

ROLLINS, BROWN AND GUNNELL, INC.

Ralph L. Rollins JN

Ralph L. Rollins

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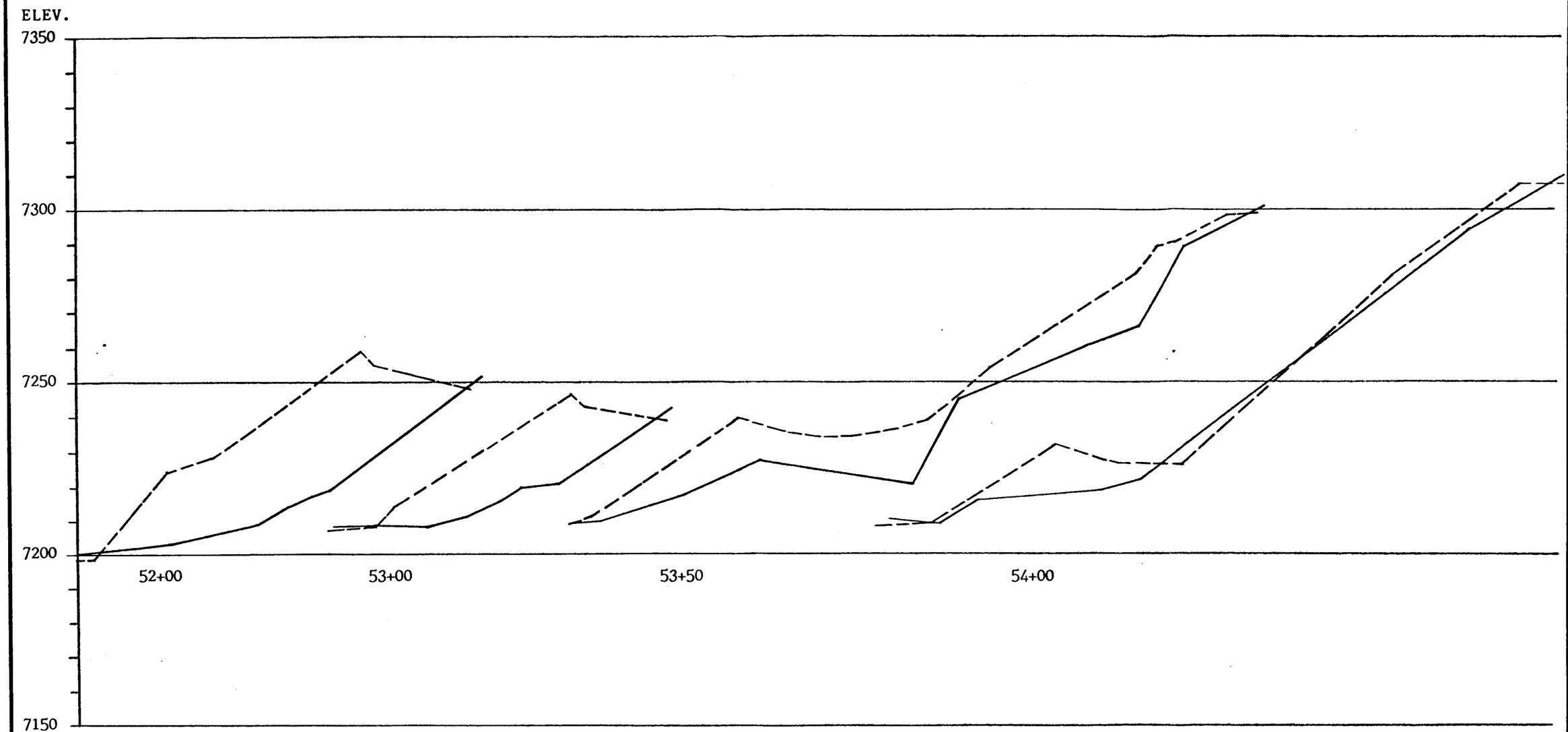
Enclosures

TABLE NO. SUMMARY OF TEST DATA

PROJECT Cottonwood Portal/ Slope Stability FEATURE Waste Dump LOCATION Wilbert Coal Mine

HOLE NO.	DEPTH BELOW GROUND SURFACE	STANDARD PENETRATION BLOWS PER FOOT	IN-PLACE			UNCONFINED COMPRESSIVE STRENGTH LB/FT^2	FRICTION ANGLE Φ	CONSISTENCY LIMITS			MECHANICAL ANALYSIS			UNIFIED SOIL CLASSIFICATION SYSTEM
			UNIT WEIGHT LB/FT^3	MOISTURE PERCENT	VOID RATIO			L.L. %	P.L. %	P.I. %	% GRAVEL	% SAND	% SILT & CLAY	
1.	+ 10' from road		124.0	15.1				18.8	15.7	3.1	22.7	29.0	48.3	ML
	+ 35' from road		113.0	20.2				26.0	14.9	11.1	8.2	24.4	67.4	CL-1
	+ 55' from road		100.4	14.7				22.2	16.2	6.0	12.9	33.0	54.0	CL-ML
2.	+ 6' from base		109.6	19.8				26.7	18.3	8.4	18.8	29.6	51.6	CL-1
	+ 15' from base		108.4	20.9				25.4	16.7	8.7	7.0	31.4	61.6	CL-1
	+ 25' from base		99.6	15.7				21.8	15.3	6.5	17.9	34.4	47.7	CL-ML
3.	+ 5' from bottom		114.2	27.5				31.5	20.2	11.3	18.0	37.8	44.2	CL-1
	+ 18' from bottom		110.6	30.2				28.8	20.3	8.5	5.7	35.4	58.9	CL-1
	+ 30' from bottom		108.1	32.1				29.6	21.3	8.3	15.3	34.4	50.3	CL-1
	+ 45' from bottom		89.4	35.0				32.2	22.2	10.0	9.6	37.0	53.4	CL-1



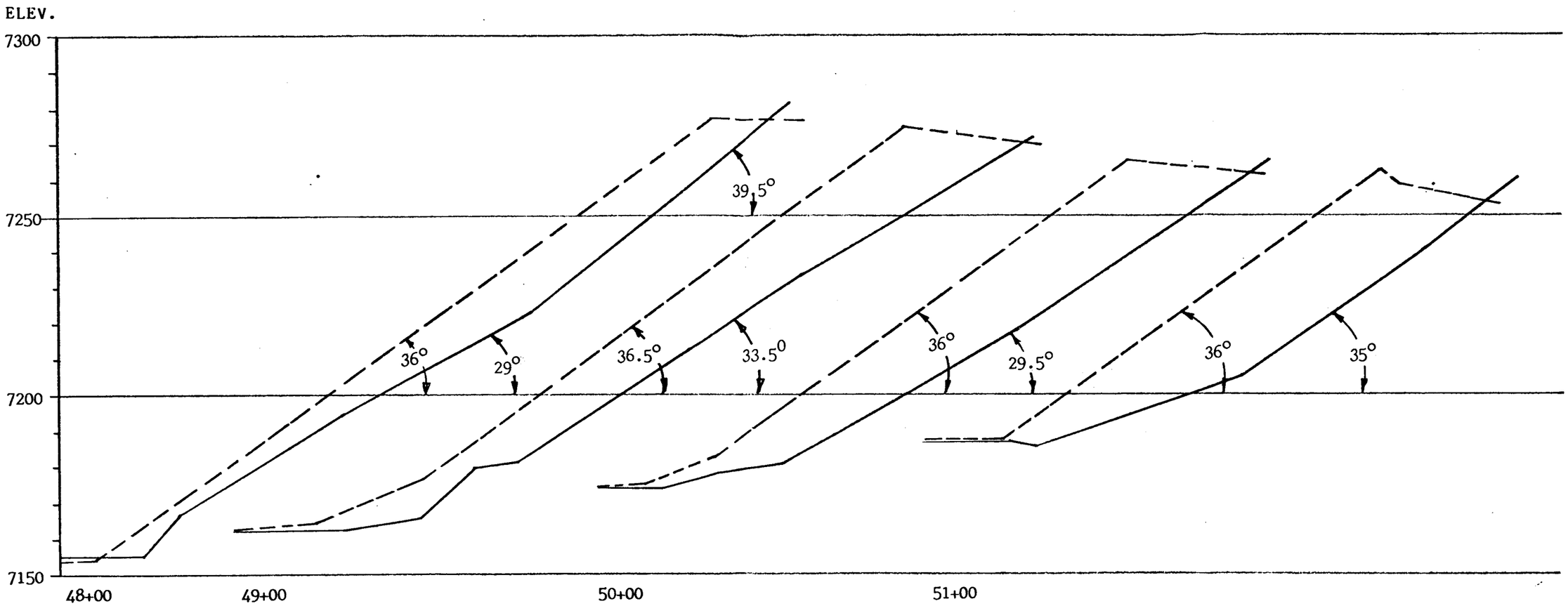
SCALE: 1" = 30'

——— =Original ground Line

– – – – – – – – = Existing ground Line

SCALE DESIGNED CHECKED DRAWN DATE APPROVED LICENSE NO.	**ROLLINS, BROWN & GUNNELL, Inc.** **CONSULTING ENGINEERS**	UTAH POWER AND LIGHT COMPANY COTTONWOOD MINE WASTE DUMP STABILITY	Figure No. 3

Bruning "500"



SCALE: 1" = 30'

SCALE DESIGNED CHECKED DRAWN DATE APPROVED LICENSE NO.	**ROLLINS, BROWN & GUNNELL, Inc.** **CONSULTING ENGINEERS**	UTAH POWER AND LIGHT COMPANY COTTONWOOD MINE WASTE DUMP STABILITY	Figure No. 2

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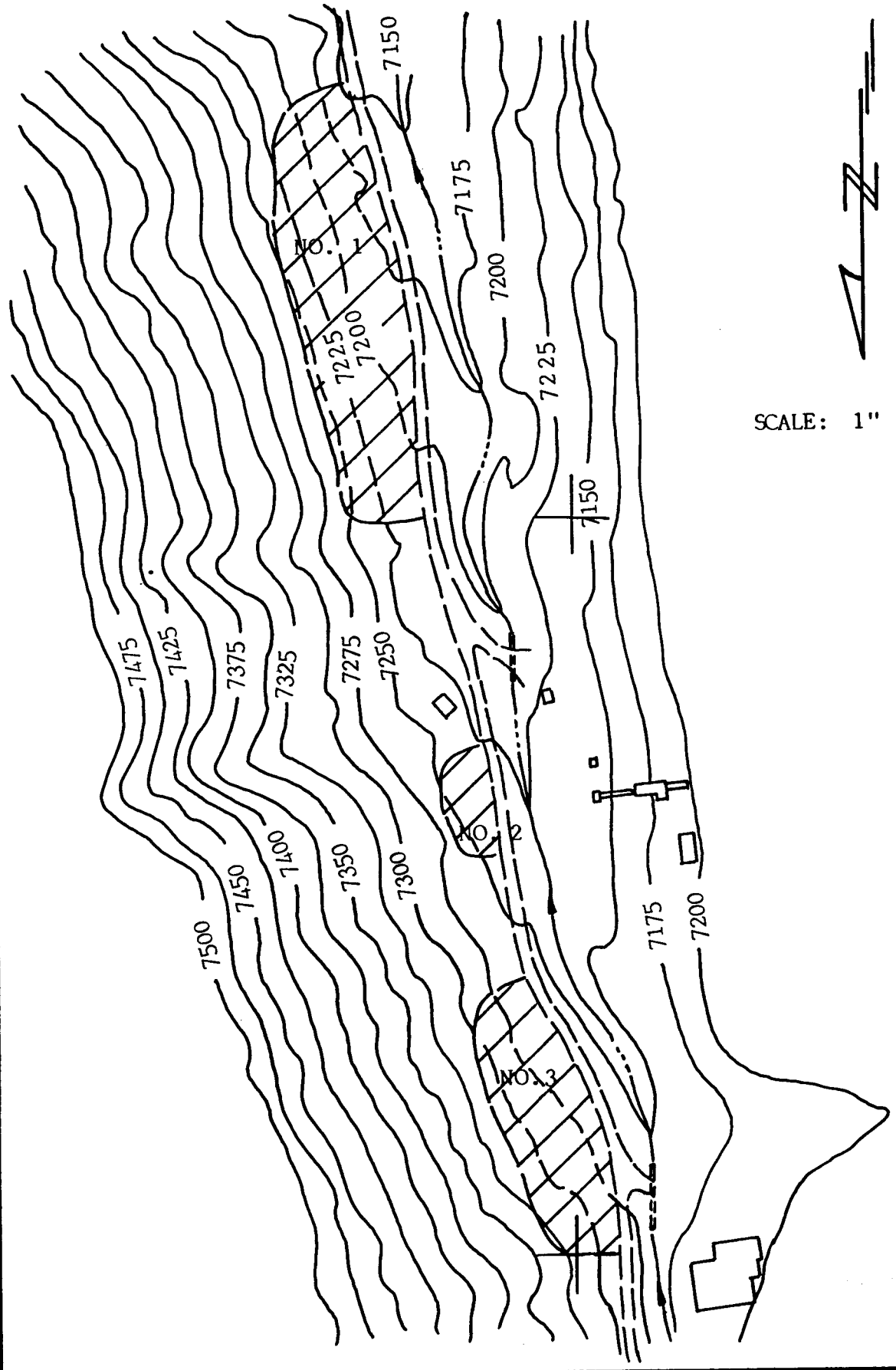

ROLLINS, BROWN & GUNNELL, INC. **CONSULTING ENGINEERS**	Utah Power and Light Company Cottonwood Mine Waste Dump Stability	Figure No. 1

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