23-73

EAST PORTAL STABILITY STUDY

CARLIN CANYON TUNNELS

ELKO CO. NEV.

CONT. #1441

NOVEMBER 1973

ENGINEERING GEOLOGY & FOUNDATION SECTION

EAST PORTAL

STABILITY STUDY

CARLIN CANYON TUNNELS

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CONTRACT 1441

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ATTACHMENTS:

CORRESPONDENCE FROM MR. McHURON

FIGURE 1 - EAST PORTAL AREA (PLAN)

FIGURE 2 - EAST PORTAL AREA (SECTION)

- INTRODUCTION -

In response to correspondence to the Resident Engineer on Contract 1441 (see attachment), it was decided by the Department to make an on-site investigation of the alleged hazardous conditions. This inspection was conducted on November 1st and 2nd by D. G. Cochran, Engineering Geologist; B. K. Replogle, Engineering Geologist; and Mr. C. H. Harned, Consulting Geological Engineer. The Resident Engineer, J. Cress and W. Marsh, Assistant Construction Engineer were also present during much of this examination.

This report presents the findings and recommendations of B. Replogle and D. Cochran, as reviewed and concurred in by D. S. Mosher, Chief Engineering Geology and Foundations Section, and Mr. C. H. Harned, Consulting Geological Engineer.

-GENERAL GEOLOGY -

The East Portal area lies within the Strathearn formation, a late Pennsylvanian age limestone and interbedded calcareous shale. These rocks are generally moderately to well jointed and fractured, strike generally N 20° W, and dip steeply 75° to 80° to the NE. For a more detailed discussion of this subject see:

"Geologic and Foundation Report for Carlin Canyon Tunnels," C. H. Harned, Clair A. Hill & Associates, pg. 4 - 8, Sept. 1964.

- PORTAL FACE CONDITIONS -

During the inspection of Nov. 1st and 2nd, 1973, several post-Pleistocene shear planes and faults were noticed above the East Portal area. These were previously noted in Mr. Harned's report of September, 1964:

"Effects of the faulting are seen in the limestone beds of the Strathearn formation in the vicinity of the East Portal area. Here a very high degree of fracturing, brecciation, and local strike and dip variations attest to the fault's presence. Minor parallel faults, adjacent to the main fault and within the limestone, no doubt accompanied the major faulting."

Since this report was made available to all contractors during the pre-bid period, to claim "changed conditions" now, indicates that either the contractor or his consulting engineer-geologist failed to properly review and evaluate this information.

The major fault trends N 15° - 20° W and dips 70° - 80° NE. This is apparently a bedding plane fault with dip and strike correlating quite closely to the dip and strike of the bedrock. Another smaller, steeply dipping shear zone, in some places less than 1/2" wide crosses the major fault approximately 100' west of the westbound centerline. About 140' behind the portal wall and approximately equidistant between the two bores, this plane intersects another shear zone along the bedding plane. The intersection of these three planes has produced a triangular area of potentially unstable material consisting of large "boulders" surrounded by highly sheared although essentially competent material. (See Figure 1.)

The East Portal face has been scaled and shaped under contract to approximately 3/4 to 1 slope. The original slope was approximately 1 1/2 to 1, and was covered by several feet of talus and colluvium, where outcrops were not present. Some blasting of the bedrock was undoubtedly necessary during the shaping of this slope as evidenced by shot boreholes exposed on some bedrock surfaces.

Construction of an access road above the portals during these operations exposed the footwall of the major fault above the east bound bore. The

bedrock face along the footwall is fractured, with the fractures filled with a black earthy manganese oxide, indicating that these cracks have existed for a very long period.

- POSSIBLE PROBLEM AREAS -

Three potentially hazardous conditions were observed during the inspection of November 1st and 2nd.

First, a large rock mass above the portal wall and between the tunnel bores was apparently loosened by the final portal excavation blast. Mr. Cress, the Resident Engineer, stated that 5335 lbs. of explosive was utilized for this blast as compared to only 800 to 1500 lbs. for previous shots. This obvious over-shooting at a tunnel portal area, where maximum weathering and associated rock incompetence is legendary, indicates contractor inattention at best and outright incompetence at worst. This unnecessarily large shot undoubtedly loosened and fractured this rock mass.

Second, higher up the face, some rock exposed on the bedding plane fault is fractured and appears to present a problem. However, close inspection of these fractures shows that they are filled with soil, thus indicating their existence over a long period of time.

Finally, higher on the face are the three large "boulders" that appear as if they could work loose and tumble to the portals. These could in reality be in-place bedrock and prove to be stable, but it is not known for sure.

- GENERAL STABILITY CONSIDERATIONS -

In designing the excavation and stability of a high rock cut such as the East Portal face, an engineering prediction can be made regarding the steepness of the angle at which it will safely stand. This evaluation is

predicated upon the attitude and combinations of rock jointing, bedding planes and faulting.

Such rock structures that dip into the slope face will generally have a minor effect on the stability of the excavation. Conversely, those planar discontinuities with dips that are oriented toward the open cut face of a slope must be carefully considered. Further, the detrimental effect on the stability of a slope increases as the strike of the joints become more nearly parallel to the slope face.

It is significant that the rock planar discontinuities at the East Portal area are nowhere near parallel to the slope face. In addition, the face is actually concave in plan, and should exhibit a strengthening effect because of compressive stresses.

For these reasons it is believed that this slope is quite stable, and no danger of a massive rockslide is likely.

- CONCLUSIONS AND RECOMMENDATIONS -

1. Our study of the bedrock characteristics indicates that no danger of a bedrock slide or other bedrock instability exists at the East Portal area. However, we would be very interested to see Mr. McHuron's "geometry of rock masses" referred to in his September 25 correspondence so we could better evaluate his concern.
2. It is our opinion that the only immediate hazard existing at this time results from the highly fractured material immediately above and between the tunnel bores. It is believed that this condition was caused by excessive blasting during the portal excavation, and that any corrective measures undertaken by the contractor to protect his workmen while working behind the portal walls are wholly his responsibility and

should be entirely at his expense.

A feasible solution to this possibly dangerous condition would be to place the portal wall backfill using a conveyor system. The backfill should be placed to the top of the portal wall, then large rock should be placed from the top of the wall at a 3/4 to 1 slope over the fractured area. (See Figure 2.) Grouting of the rock backfill and the fractured rock above the portals could then be accomplished without danger to the workmen.

7. The possible instability previously described as the "boulder" area could be corrected by the use of rock bolts. These bolts would tie the boulders together and also could be installed through the boulders and into the bedrock behind. Rock bolts up to 40 feet in length may be required to reach bedrock in this area.

8. Drainage above the portals should be such that no ponding can take place, and if any vertical fractures are discovered they should be filled with grout. Since the major fault zone is depressed in the upper area and acts as a drainage channel, as an extra precautionary measure to prevent water from entering this zone the depression could be cleaned and lined with concrete. (See Figure 1).

Submitted by:

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September 25, 1973

Mr. James E. Cress, Resident Engineer
Nevada Department of Highways
Elko
Nevada 89801

Dear Mr. Cress:

This letter about the potential instability of the East Portal area of the Carlin Canyon Tunnels and the engineering geological hazards envisioned, is intended to constitute notice of my professional concern regarding this matter.

Two way traffic through the East Bound Tunnel is intended about March 15, 1974, as I understand from you during our discussions of the above matter on the afternoon of August 30, 1973. Thus, time is of the essence. Unless you can refute my geometry of rock masses or repeal the Law of Gravity, a serious problem exists.

My concern says that I stay with your problem until you can say to me, "We see the conditions you speak of, we understand the effects you envision, but we are satisfied that the rock conditions encountered are suitable and satisfactory because our design anticipated such conditions; therefore, already both stability and safety have been prudently provided for in our design and construction of the East Portal area".

You may believe that I am suspect in this matter because the full impact of this occurred to me while pursuing work for your Contractor, Lockheed. Someone has to stand up and tell you what you have created. Today I may be suspect but hopefully tomorrow you will study this matter fully, possibly first walking it out with Stan Mosher and me to test the details at the full scale model itself. Also, take it to your consultants and designers and get their combined stamp of satisfactory approval as to this design for these ground conditions.

What I am saying is:

a) I do not want injury from a rock fall, or mass movement by inverted wedges now daylighted in the backslope or a portal collapse, if it is possible to prevent such.

b) I am bringing a potentially serious condition to your attention and will continue to do so until you have heard me out.

c) Then it is yours.

d) I do not think that this should be aired publicly but preferably resolved by engineers and other professionals in these matters.

DATE RECEIVED 10-10-73
Received by: J

e) The backslope may be stable until after the snows but clay seams are drying out and winds will unravel those rock masses separated by clay seams. There is no provision for drainage, so seepage into the clay seams is inevitable to lubricate them, then it is only a matter of time. Put another way, it is potentially unstable now, because the seams will be lubricated, and freezing and thawing will occur. It is not a question of whether it will come down but "How soon?" and "How much?". Time and gravity will have their effect.

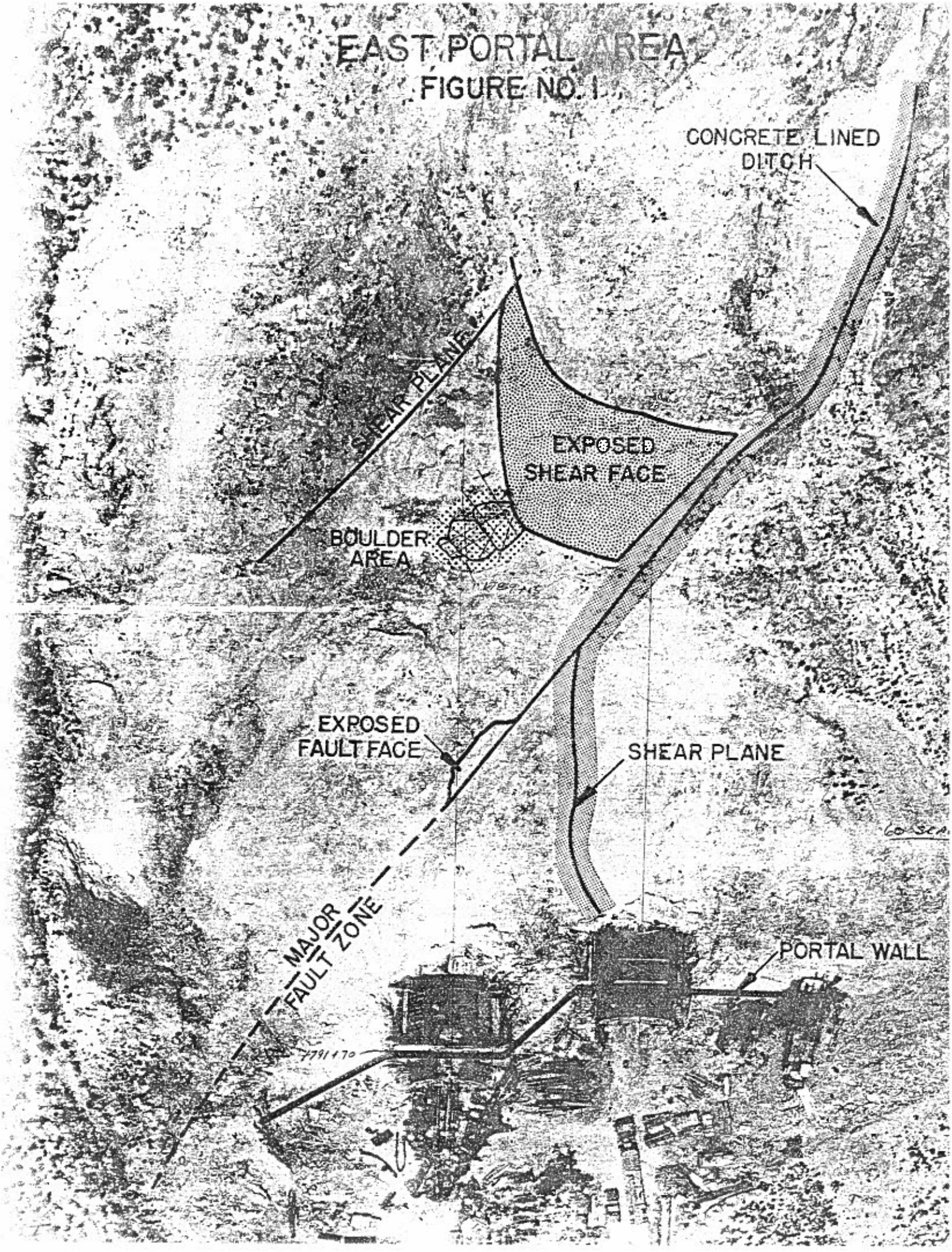
f) This serious condition warrants your immediate attention and prudent action.

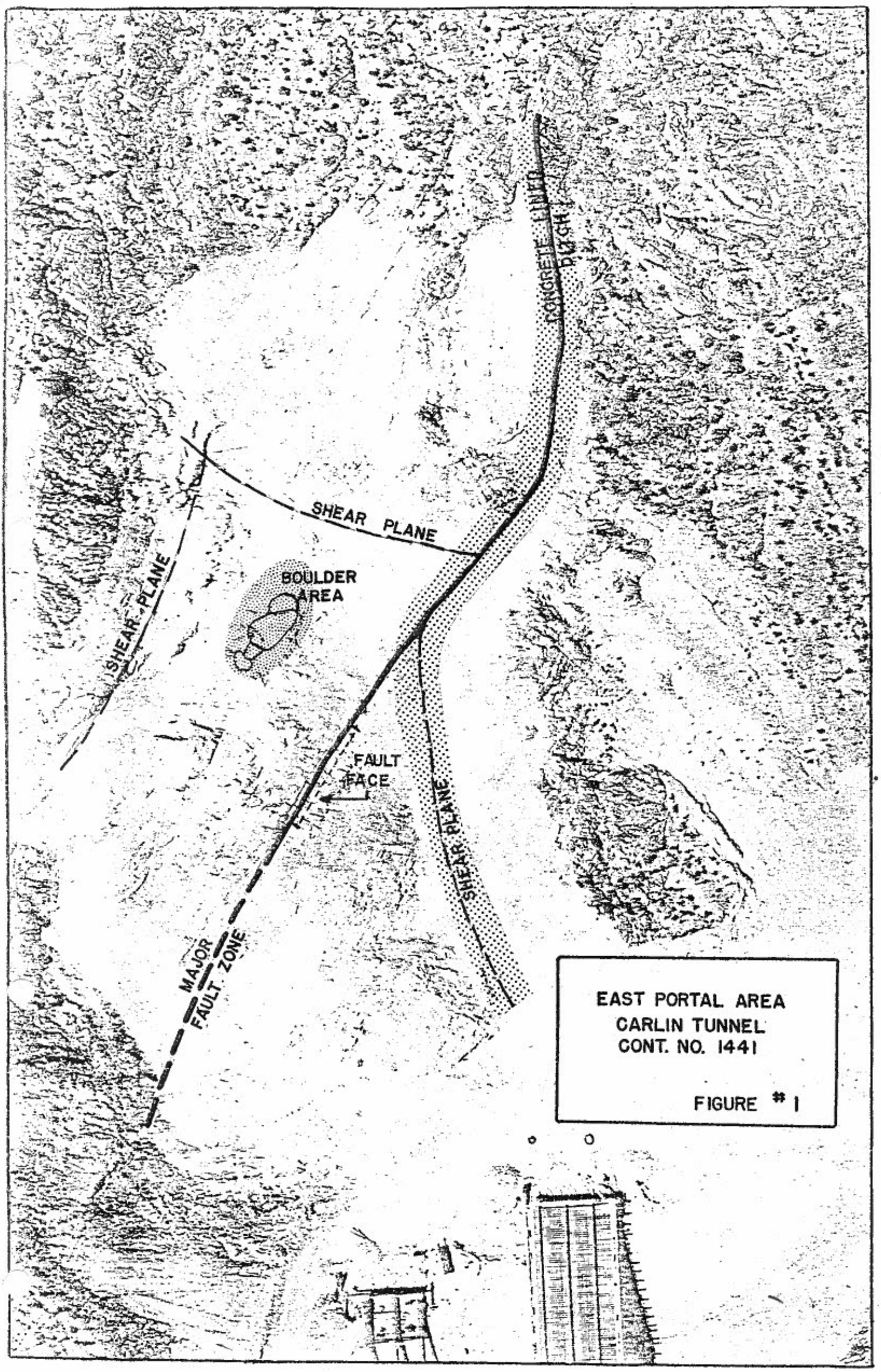
My intention is to help. Please advise me how I may assist you in bringing this problem to the attention of your superiors for such consideration that it may be resolved soon.

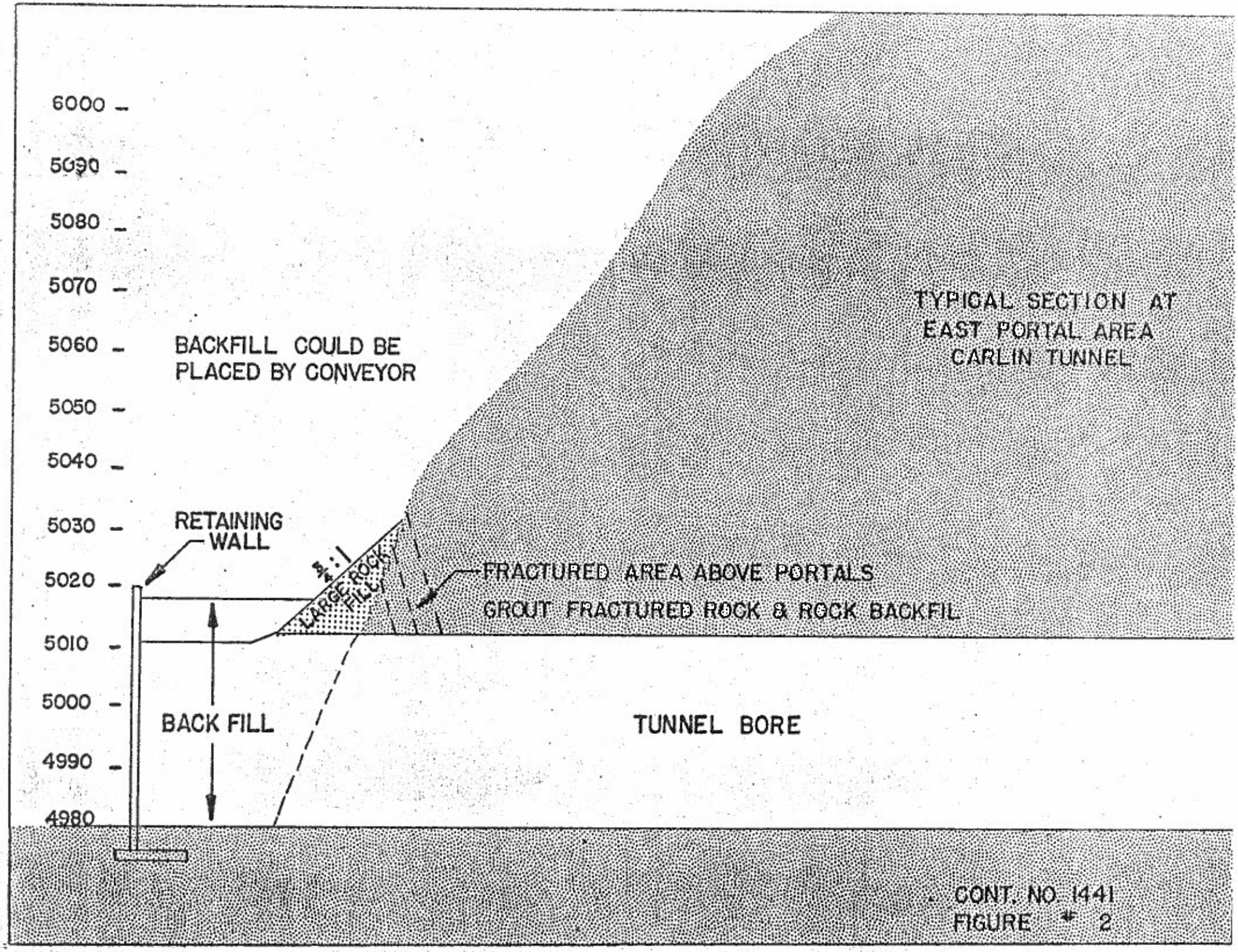
Respectfully submitted,

Clark E. McHuron

In duplicate
CEM:jj


EAST PORTAL AREA
FIGURE NO. 1
CONCRETE LINED DITCH
SHEAR PLANE
EXPOSED SHEAR FACE
BOULDER AREA
EXPOSED FAULT FACE
SHEAR PLANE
MAJOR FAULT ZONE
PORTAL WALL


CONCRETE LINED PUSH
SHEAR PLANE
SHEAR PLANE
BOULDER AREA
FAULT FACE
SHEAR PLANE
MAJOR FAULT ZONE
EAST PORTAL AREA
CARLIN TUNNEL
CONT. NO. 1441
FIGURE # 1


6000
5090
5080
5070
5060
5050
5040
5030
5020
5010
5000
4990
4980
BACKFILL COULD BE PLACED BY CONVEYOR
TYPICAL SECTION AT EAST PORTAL AREA CARLIN TUNNEL
RETAINING WALL
¾:1
LARGE ROCK FILL
FRACTURED AREA ABOVE PORTALS
GROUT FRACTURED ROCK & ROCK BACKFIL
BACK FILL
TUNNEL BORE
CONT. NO 1441
FIGURE # 2