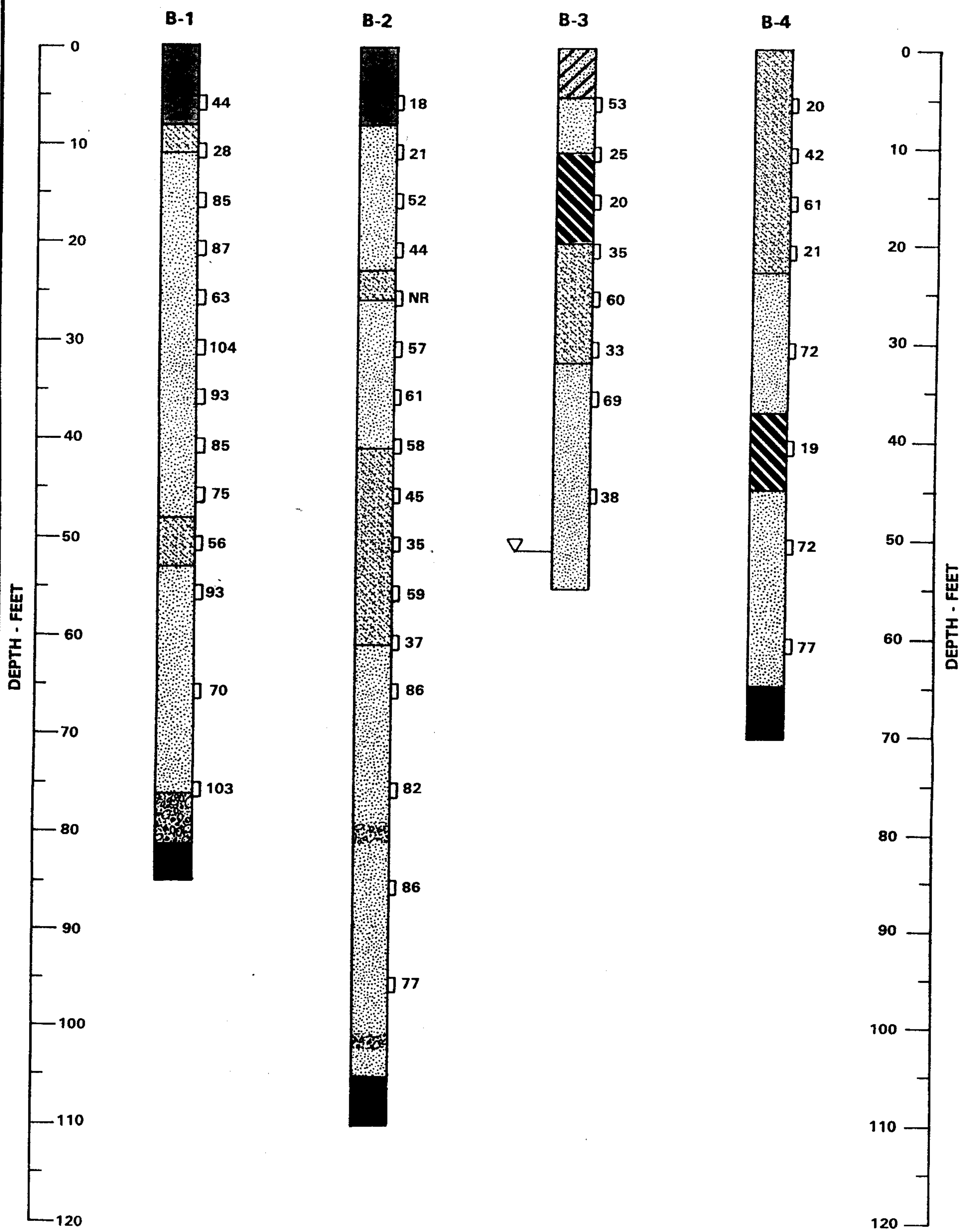

ARS SAND & GRAVEL
BORING LOGS

Project No.: 7-317-000099
Figure 2

AGRA
Earth & Environmental

Silty Sand (SM); fine to medium grained, loose to medium dense, slightly moist to moist, medium brown

Lean Clay with Sand and Silt (CL-SC); stiff, moist, gray-brown

Sand, Well-Graded (SW-SM-SC); with silt and gravel, some clayey lenses, medium dense to dense, slightly moist to moist, buff-brown to medium brown, occasionally reddish brown

Sand, Well-Graded (SW-SM); with silt and gravel, generally not clayey, medium dense to dense, slightly moist to moist, pink to buff-brown, occasionally reddish-brown

Sand, Well-Graded (SW-GW); with gravel and cobbles, dense, moist, gray-pink-brown

Fat Clay (CH); stiff, very moist, gray

Claystone Bedrock; Upper Denver Formation, lean to fat claystone, sandy, non to partly cemented, medium hard to very hard, moist, olive-gray to blue-gray with depth

Location of Split Spoon Sample; 2 in. I.D., 3 in. O.D.

44 Sample Blow Count; Indicates that 34 standard hammer blows were required to drive the sampler 12 inches

1. Exploratory borings were drilled on March 18-19, 1997 with a 3-3/4-inch diameter hollow-stem, continuous flight power auger.
2. Locations of exploratory borings were measured approximately, by pacing from features shown on the site plan furnished to us, as presented on Fig. 1A.
3. Elevations of exploratory borings were not measured.
4. The exploratory boring locations should be considered accurate only to the degree implied by the method used.
5. The lines between materials shown on the exploratory boring logs represent the approximate boundaries between materials types; the transitions may be gradual.
6. Ground-water was not encountered in any of the borings at the time of drilling. Fluctuations in the water level may occur with time.

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Golden, Colorado 80401

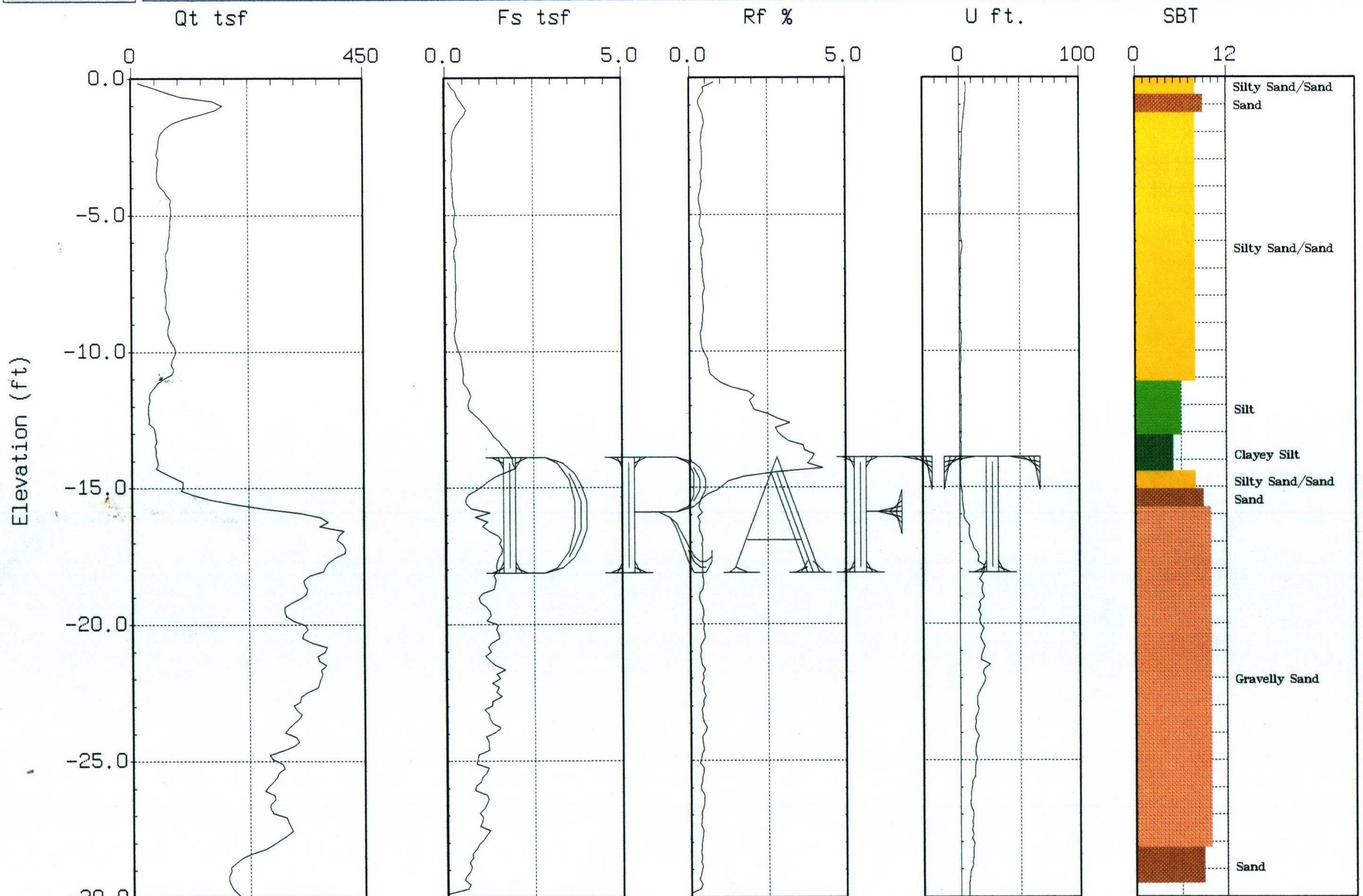
LEGEND & NOTES

Project No. 7-317-000099
Figure 2A

ASCE DEMO

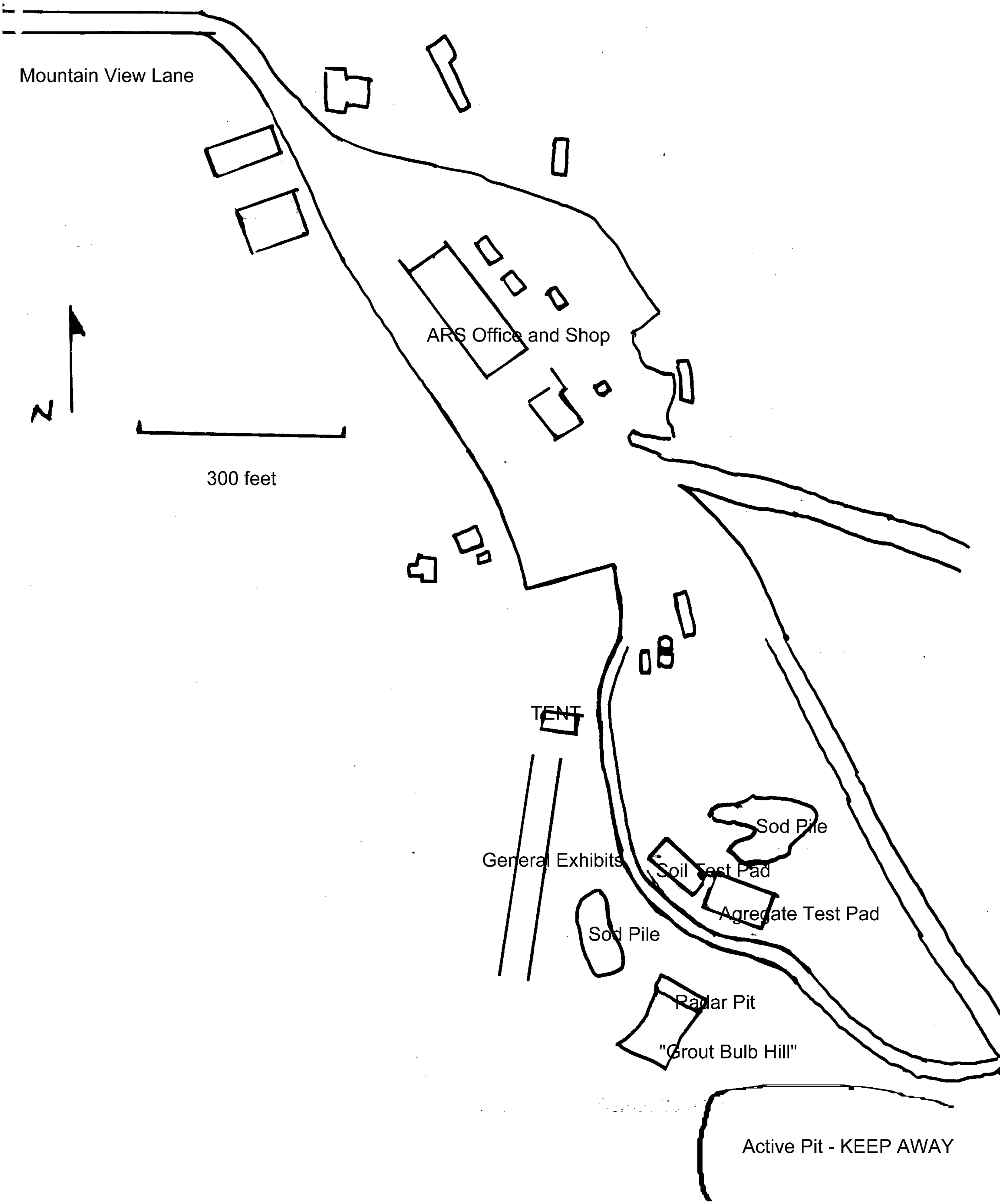
Site: TEST-01
Location: GEO-DENVER

Cone: 20 TON A 098
Date: 08:07:00 15:24



Max. Depth: 30.02 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson and Campanella 1988)


Mountain View Lane
ARS Office and Shop
N
300 feet
TENT
Sod Pile
General Exhibits
Soil Test Pad
Agregate Test Pad
Sod Pile
Radar Pit
"Grout Bulb Hill"
Active Pit - KEEP AWAY

August 5-8, 2000
Pre-conference short courses August 3-4, 2000
Denver Marriott Tech Center - Denver, Colorado

Soil Descriptions

ARS, Inc. AEE Project No. Pit Evaluation June 2,1997 Douglas County, Colorado

3.0 FIELD AND LABORATORY INVESTIGATION

On March 18 and 19, 1997, we iogged and sampled four exploratory borings made at the site. The borings were advanced with a CME 55 truck-mounted drill, utilizing 3-3/4 inch ID hollow-stem auger. Samples were taken at 5-foot depth intervals with a 2-1/2 inch ID (3-inch OD) split spoon barrel sampler, driven with standard hammer energy (in substantial accordance with ASTM D1586 procedures). The sampler was driven 18 inches at most locations. The number of hammer blows for each ~inch increment was recorded. The Boring Logs, Fig. 2, show an interpretation of the materials encountered and the hammer blow counts for the last 12 inches of sampling are presented at each sample location. A legend and notes related to the field investigation are presented on Fig. 2A. The number of hammer blows required to penetrate the strata can be used as an indication of the density or consistency of a deposit, with experience and judgement. The hammer blows are not similar to the "Standard Penetration Test" because the sampler presents a considerably larger frontal area than the standard split spoon sampler.

We found that, in general, the finer-grained materials (clays, silty clays) had lower penetration resistance than the predominantly coarse materials. During drilling, only Boring 3 encountered groundwater, at a depth of 51 feet. The other borings remained dry while drilling.

The project engineer visually classified all of the samples retrieved and formulated a laboratory testing plan. Tests included grain size analysis, moisture content, Atterberg Limits, Hveem RValue to gain a measure of the stability of the material under load and sodium sulfate soundness to determine the resistance of the material to weathering. The test results are summarized on Table 1. Graphical presentations of the grain size analysis and R-Value testing are presented on Figs. 3-16.

Starting with the deposits at the highest elevation, the following sections describe the strata encountered:

3.1 Silty Sand

Borings 1 and 2, located on the upper terrace, encountered about 8 feet cf medium brown, slightly calcareous, silty to slightly clayey sand from the ground surface. This material was formed by the forces of wind, plucking fine to medium sands from the South Platte River, depositing them on the plain between the South Platte and Plum Creek. This material is absent from the lower terrace on the property, and has been stripped from portions of the upper terrace.

Figures 3 and 7 present gradation curves for representative samples of this material, both non-plastic, with about 22% fines. In general, the deposit is cleaner near the upper part and becomes more clayey at its base. Of the many samples tested of the silty sand, the range of fines is between 13 and 32% and most have non-plastic fines. Liquid limits, where obtainable, are generally 16 to 20%.

The silty sand has been used for trail topping, ballfield skinned infield and pitcher’s mound fill.

The material has qualities of non-cohesiveness to avoid sticking to cleats and allowing quick drainage and drying without overly hard compaction, mostly fine to medium sand content for ease of working and traction, and a medium brown color for aesthetics. The material is fairly unique in the area, due to its thickness and general lack of plastic clay fines.

3.2 Clayey, Gravelly Sand

Several feet of reddish, clayey, gravelly sand separates the upper silty sand from cleaner sand deposits in the upper terrace. The reddish color is common in Slocum Alluvium deposits. The deposit appears to be only ~5 feet thick. Previous testing (Feb. 13, 1997) indicates the material has a gradation simiiar to CDOT Class 6 Road Base, but with a liquid limit (LL) of 22-23 and plasticity index (Pl) of 7-10, would be considered too clayey for specification material. The material would make a good quality light-duty road base for driveways because of its tendency of slight cohesion and high compact-ability, at the expense of somewhat less drainage capacity when compared to specification road base.

3.3 Well-Graded Sand with Gravel

Below the above-described materials, the next 30-40 feet in Borings 1 ~ 2 consist of well-graded sand with gravel. About 10% of the thickness of the deposit appears to contain clayey sand layers of medium plasticity. Gravel, to the 1/2-inch size represents about 18-22% of the material, with about ~8% mostly non-plastic fines. Close examination of the gravel particles indicates that most are sound, subangular mineral aggregates of orthoclase-biotite-quartz granite. The sand particles are chiefly subangular crystalline quartz and pink orthoclase feldspar. Fines are silty, with muscovite mica flakes. Rare particles of lightweight igneous rock (Castle Rock Welded Tuff) were noted on the surface of the pit, but were not found in samples from the borings. Although generally considered a detrimental material, its rarity is believable considering the large size of the Plum Creek drainage and the very limited outcrop of these materials south of Castle Rock. We do not consider these materials as detrimental to the overall quality of the deposit.

The coefficient of uniformity is generally high, on the order of 10 to 25, indicating well-graded material with a wide size variety. We obtained H-veem Stabilometer R-Value test results from two composited samples of this material. The results of 71 and 76 indicate excellent stability for road subgrade materials. Because of a relative deficiency of gravel and somewhat variable fines content, the deposit does not make a specification road base as a pit-run, but could be used, with sieving, for asphalt or concrete fine aggregate, or without sieving for high-quality select fill where close packing, relatively free-draining fill with very high stability is required, such as road subbase or Mechanically Stabilized Earth (MSE) retaining wall backfill. The angle of internal friction would vary somewhat with density and confining pressure, but a conservative estimate would be 38 degrees for the well-graded sand. If sieved, the resulting gravel would be a saleable product. The results of a sodium sulfate soundness test indicate negligible loss over the sieve sizes, with weighted loss of 0.01 to 0.07% in the No. 30 to No. 100 Std. Sieve sizes.

3.4 Interlayered Micaceous Clay and Clean Medium Sands

Encountered at a depth of 48 feet in B-1, 41 feet in B-2, and from the surface in B-3 and B-4, we noted a layer that contained mixed micaceous lean to fat clay with clean sand lenses. The deposit was only about 5 feet thick in B-1 and about 20 feet thick in B-2, with mostly thin sand lenses separated by silty lean clay layers. In B-3 and B-4, the upper 20 and 45 feet, respectively were predominantly fat ciay and clayey sand, with the exception of a 5-1/2 foot thick layer of wellgraded sand with gravel in B-3 and a 14 foot thick layer in B-4.

Generally well graded sands with gravel were found below the clay in ali borings. Near bedrock in B-1 and B-2, we encountered what appeared to be small cobbles in the sand.

The interiayered micaceous day and ciean sands are assumed to be waste material, because of the thin layers that will generally preclude sorting.

3.5 Bedrock

Hard, blue-gray claystone bedrock was encountered in B-1, B-2 and B-4 at depths of 81, 105.5 and 65 feet respectively. We did not drill down to bedrock in B-3, because we encountered groundwater at a depth of 51 feet in sands and gravels.

4.0 PIT RESERVES

We assume that this mining operation would not be able to utilize large quantities of water for washing aggregate products. Where silty, non-plastic fines exist, particularly the surface layer and the weil-graded sand with gravel, a variety of products could be made by utilizing dry sieving. The area studied has available the following saleable products:

Fine to medium grained silty sand; currently of value as ballfield skinned infield surface and pitchefs mound fill Clayey road base; suitable for driveways and light-duty gravel-surfaced roads

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