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GEOTECHNICAL ENGINEERING STUDY
PROPOSED MIXED-USE BUILDING
LOT 8, BLOCK 11, GRAND LAKE
900 GRAND AVENUE
GRAND LAKE, COLORADO

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PURPOSE AND SCOPE OF STUDY

This report presents the results of a geotechnical engineering study for a proposed mixed-use building to be located at Lot 8, Block 11, Grand Lake, with a physical address of 900 Grand Avenue, Grand Lake, Colorado, as shown on Fig. 1. The purpose of the study was to develop recommendations for the foundation and floor slab design. The study was conducted in accordance with our Proposal No. P6-24-286 for geotechnical engineering services, dated November 7, 2024.

A field exploration program consisting of an exploratory boring and a site reconnaissance was conducted to obtain information on the surface and subsurface conditions. Samples of the subsoils obtained during the field exploration were tested in the laboratory to determine their classification and other engineering characteristics. The results of the field exploration and laboratory testing were analyzed to develop recommendations for foundation types, depths, and allowable pressures for the proposed structure foundation and floor slab design.

This report summarizes the data obtained during this study and presents our conclusions, design recommendations and other geotechnical engineering considerations based on the proposed construction and the subsoil conditions encountered.

PROPOSED CONSTRUCTION

Conversations with the Project Team and review of preliminary plans indicate the project consists of the construction of a mixed-use, commercial and residential building on the subject site. The building will be a three-level structure, with commercial development on the ground level and residential space on the second and third levels, situated as shown on Figure 1. We assume the building will have a slab-on grade lower level, and substantial below grade construction is not anticipated. Excavation cut depths of up to about 4 feet are assumed. Structural loads are anticipated to be light to moderate and typical of the proposed construction.

If construction plans are different than those described above, we should be notified to re-evaluate the recommendations presented in this report.

SITE CONDITIONS

The project site is an approximate 0.11-acre commercial lot located on the southeast corner of Grand Avenue and Ellsworth Street in Grand Lake, as shown on Figure 1. The lot is relatively flat, with a single-level building occupying the south portion of the lot at the time of our field exploration. We understand the building will be razed and removed to accommodate the proposed new construction. The north portion of the lot consists of a gravel surfaced parking area, and a concrete patio in front of the existing structure.

FIELD EXPLORATION

The field exploration for the project was conducted on December 23, 2024. One exploratory boring was drilled adjacent to the existing building, as site access allowed, to evaluate the subsurface conditions, as shown on Fig. 1. The boring was advanced with 4-inch diameter continuous flight solid stem augers powered by a truck-mounted CME-45 drill rig. The boring was logged by a representative of Kumar and Associates, Inc.

Samples of the subsoils were taken with a 1 3/8-inch I.D. split spoon sampler. The sampler was driven into the subsoils at various depths with blows from a 140-pound hammer falling 30 inches. This test is the standard penetration test described by ASTM Method D-1586. The penetration resistance values are an indication of the relative density of the granular subsoils. Depths at which the samples were taken, and the penetration resistance values, are shown on the Log of Exploratory Boring, Figure 2. The samples were returned to our laboratory for review by the project engineer and for laboratory testing.

SUBSURFACE CONDITIONS

Soil Types Encountered: A graphic log of the subsurface conditions encountered at the site is shown on Figure 2. Subsoils encountered in the exploratory boring consisted of approximately 12-inches of sand and gravel existing fill overlying medium dense, poorly graded clayey sand (SP-SC), with gravel and scattered cobbles, extending to a depth of 17 feet below the existing site grade, at which depth medium dense, silty sand (SM) with gravel and cobbles was encountered, extending to the full depth of exploration of 25 feet. The walls of the exploratory boring caved below a depth of about 9 feet, apparently due to the relatively dry and clean (low percentage of fines) granular soils.

Groundwater: Groundwater was not encountered in the boring at the time of drilling. The depth to groundwater can vary based on seasonal and climatic factors, and perched water can occur seasonally over frozen ground.

LABORATORY TESTING

Laboratory testing performed on samples obtained from the exploratory boring consisted of natural moisture content and percent passing the No. 200 sieve. The laboratory test results are shown on the Log of Exploratory Boring, Figure 2, and summarized in Table 1.

GEOTECHNICAL ENGINEERING CONSIDERATIONS

Subsurface data indicate that medium dense, natural sand with gravel and cobbles, will likely be the predominant soil type encountered beneath shallow foundation, floor slab and concrete flatwork areas. The anticipated natural granular soils at the foundation level are considered good for shallow foundation support. Existing fill, building and utility remnants should be removed from the proposed building area to expose the underlying natural granular soils.

Kumar and Associates should observe the building addition footing excavations prior to placement of footing concrete or structural fill to assess bearing conditions. Structural fill placement should be observed, and the fill tested for compaction by Kumar and Associates to document that the recommendations in this report are implemented.

SITE GRADING

The following recommendations should be followed for grading, site preparation, and fill compaction.

1. Where fill is to be placed, existing fill, building and utility remnants (if encountered), loose, or otherwise unsuitable material should be removed prior to placement of new fill. The exposed soils should then be scarified to a depth of 8 inches, moisture conditioned and compacted preferably by vibratory compaction equipment to the minimum requirements of the overlying fill. Soils should be compacted with appropriate equipment for the lift thickness placed. Lift thickness should be no more than 8 loose inches compacted at the recommended moisture content and to the minimum required density.
2. Permanent unretained cut and fill slopes should be graded at 2 horizontal to 1 vertical (2:1) or flatter and protected against erosion by revegetation or other means. The risk of slope instability will be increased if seepage is encountered in cuts and flatter slopes may be necessary. If seepage is encountered in permanent cuts, an investigation should be conducted to determine if the seepage will adversely affect the cut stability. This office should review site grading plans for the project prior to construction.
3. Slopes of 4:1 or steeper should be benched to provide a sufficiently wide level bench surface for compaction. All backfill should be processed so that it does not contain rock fragments and/or cobbles larger than 6-inches in diameter and placed at the recommended moisture content.
4. The fill should be uniformly graded to prevent nesting of large size gravel and cobbles.

5. The following compaction requirements should be used:

TYPE OF FILL PLACEMENT	MOISTURE CONTENT	SOIL TYPE - Compaction Percent (ASTM D698 – Standard Proctor)
Below Foundations	± 2% Optimum	Structural Fill – 98%
Foundation Wall Backfill	± 2% Optimum	Processed On-site or Structural Fill – 95%
Below Floor Slabs	± 2% Optimum	Structural Fill – 95%
Landscape Areas	± 2% Optimum	Processed On-site – 90%
Below Concrete Flatwork/Pavements	± 2% Optimum	Structural Fill – 95%
Utility Trenches	As they apply to the finished area	

Suitability of On-Site Soil

The on-site granular soils are suitable as backfill after processing to remove all plus 6-inch material and moisture treatment. The on-site existing fill should be suitable for use as structural fill, after process, but should be further evaluated by Kumar & Associates for suitability at the time of excavation.

Structural Fill

Structural fill used for support of the proposed construction should consist of the on-site processed granular soils, approved existing fill, or a relatively well-graded imported granular material with 5 to 25 percent material passing the No. 200 sieve, 60 percent or more passing the No. 4 sieve and no rocks larger than 6 inches. Structural fill should be properly placed and compacted to reduce the risk of settlement and distress. The Geotechnical engineer should evaluate the suitability of any proposed import fill for its intended use.

Temporary Excavation Slopes: We assume that the temporary excavations will be constructed by excavating the slopes to a stable configuration or stabilized using properly designed shoring. **All excavations should be constructed in accordance with OSHA requirements, as well as state, local and other applicable requirements.**

In our opinion, the natural granular soil and existing fill should be classified as OSHA Type C soils. Excavations where perched water exists and seeps into the excavation are possible and could require much flatter side slopes than those allowed by OSHA. All excavations greater than 20 feet should be designed by a registered professional engineer.

Where insufficient lateral space is available due to the proximity of property boundaries and underground facilities, temporary shoring may be required. **It is our experience that temporary shoring systems are typically designed and built by specialty contractors and that the designers will typically develop their own design criteria based on soil data presented in the owner's geotechnical study report.**

FOUNDATIONS

Considering the subsoil conditions encountered in the exploratory boring and the nature of the proposed construction, we recommend the building be founded with spread footings bearing on the undisturbed natural granular soils or properly compacted new structural fill extending to the natural soils.

The design and construction criteria presented below should be observed for a spread footing foundation system.

1) Footings placed on the undisturbed natural granular soils or compacted new structural fill should be designed for an allowable soil bearing pressure of 2,000 pounds per square foot (psf). Based on experience, we expect settlement of footings designed and constructed as discussed in this section will be about 1 inch or less, with movement likely to be differential with respect to the existing structure.
2) The footings should have a minimum width of 18 inches for continuous walls and 2 feet for isolated pads.
3) Exterior footings and footings beneath unheated areas should be provided with adequate soil cover above their bearing elevation for frost protection. Placement of foundations at least 40 inches below exterior grade, or in accordance with local building code requirements, is recommended for foundations bearing on the sand and gravel soils. Concrete should not be placed on frost, frozen soil, snow, or ice.
4) Continuous foundation walls should be reinforced top and bottom to span local anomalies such as by assuming an unsupported length of at least 10 feet. Foundation walls acting as retaining structures should also be designed to resist lateral earth pressures as discussed in the "Foundation and Retaining Walls" section of this report.
5) Existing fill, building and utility remnants, and any loose or disturbed soils should be removed, and the footing bearing level extended down to the relatively undisturbed granular soils or replaced with properly compacted structural fill.
6) The exposed soil in footing areas should then be adjusted to near optimum moisture content and compacted. If water seepage is encountered, the footing areas should be dewatered before concrete placement and we shall be contacted for further evaluation.

7) Structural fill used for support of the foundation should meet the requirements listed in the SITE GRADING section of this report.
8) A representative of the geotechnical engineer should observe all footing excavations prior to forming footings and concrete placement to evaluate bearing conditions.

FOUNDATION AND RETAINING WALLS

Although significant below grade construction is not currently anticipated, foundation walls and retaining structures (if constructed) which are laterally supported and can be expected to undergo only a slight amount of deflection should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 45 pounds per cubic foot (pcf) for backfill consisting of the on-site processed granular soils or suitable granular import. Cantilevered retaining structures which are separate from the building foundation and can be expected to deflect sufficiently to mobilize the full active earth pressure condition should be designed for a lateral earth pressure computed on the basis of an equivalent fluid unit weight of at least 35 pcf for backfill consisting of the processed on-site granular soil or suitable granular import. The backfill should not contain rock larger than about 6 inches in diameter.

The lateral resistance of foundation or retaining wall footings will be a combination of the sliding resistance of the footing on the foundation materials and passive earth pressure against the side of the footing. Resistance to sliding at the bottoms of the footings can be calculated based on a coefficient of friction of 0.45. Passive pressure of compacted backfill against the sides of the footings can be calculated using an equivalent fluid unit weight of 420 pcf. The coefficient of friction and passive pressure values recommended above assume ultimate soil strength. Suitable factors of safety should be included in the design to limit the strain which will occur at the ultimate strength, particularly in the case of passive resistance. Fill placed against the sides of the footings to resist lateral loads should be a suitable granular material compacted to at least 95% of the maximum standard Proctor dry density at a moisture content near optimum.

All foundation and retaining structures should be designed for appropriate hydrostatic and surcharge pressures such as adjacent footings, traffic, construction materials and equipment. The pressures recommended above assume drained conditions behind the walls and a horizontal backfill surface. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on a foundation wall or retaining structure. An underdrain should be provided to limit hydrostatic pressure buildup behind walls.

Backfill in pavement, and walkway areas should be placed in uniform lifts and compacted to at least 95% of the maximum standard Proctor (ASTM D-698) dry density. Backfill placed in landscape areas should be compacted to at least 90% of the maximum standard Proctor dry density at a moisture content near optimum. Care should be taken not to overcompact the backfill or use large equipment near the wall, since this could cause excessive lateral pressure on the wall. Some settlement of deep foundation wall backfill should be expected, even if the material is placed correctly, and could result in distress to facilities constructed on the backfill.

FLOOR SLABS

The on-site natural granular soils or properly compacted new structural fill are suitable to support lightly loaded slab-on-grade construction. Existing fill should be removed in floor slab areas to expose the underlying natural granular soil and replaced with new structural fill.

To reduce the effects of some differential movement, floor slabs should be separated from all bearing walls and columns with expansion joints which allow unrestrained vertical movement. Floor slab control joints should be used to reduce damage due to shrinkage cracking. The requirements for joint spacing and slab reinforcement should be established by the designer based on experience and the intended slab use. All backfill under floor slabs should be placed in accordance with the SITE GRADING section of this report.

We recommend vapor retarders conform to at least the minimum requirements of ASTM E1745 Class C material. Certain floor types are more sensitive to water vapor transmission than others. For floor slabs bearing on angular gravel or where flooring system sensitive to water vapor transmission are utilized, we recommend a vapor barrier be utilized conforming to the minimum requirements of ASTM E1745 Class A material. The vapor retarder should be installed in accordance with the manufacturers' recommendations and ASTM 1643.

EXTERIOR FLATWORK

Structural fill placed beneath concrete flatwork, such as pedestrian only sidewalks and patios, can consist of processed on-site granular soils or an imported, well-graded granular material, meeting the requirements for structural fill in the SITE GRADING section of this report. Structural fill should be spread in thin horizontal lifts, adjusted to at or above optimum moisture content, and compacted to at least 95% of the maximum standard Proctor dry density. Existing fill, loose, or disturbed soil should be removed prior to fill placement.

UNDERDRAIN SYSTEM AND DAMP-PROOFING

Groundwater was not encountered during our exploration, but it has been our experience in mountainous areas that groundwater levels can rise, and that local perched groundwater can develop during times of heavy precipitation or seasonal runoff. Frozen ground during spring runoff can create a perched condition. We recommend below-grade construction (if constructed), such as retaining walls, crawlspace, and basement areas, be protected from wetting and hydrostatic pressure buildup by an underdrain and wall drain system. **Slabs on grade, constructed at grade, should not require an underdrain or dampproofing.**

The underdrain should consist of drainpipe placed in the bottom of the wall backfill surrounded above the invert level with free-draining gravel. The drain should be placed at each level of excavation and at least 12-inches below lowest adjacent finish grade and sloped at a minimum 1% to a suitable gravity outlet, sump and pump system or drywell. Free-draining gravel used in the underdrain system should contain less than 2% passing the No. 200 sieve, less than 50% passing the No. 4 sieve and have a maximum size of 1-inch. The drain gravel backfill should be at least 1½ feet deep and protected by filter fabric. A typical drain detail is shown on Figure 3.

For exterior below grade foundation walls, we recommend, as a minimum, damp-proofing consist of bituminous material, 3 lbs per square yard, extending from the top of the footing to above ground level. A wall drain system consisting of a geocomposite, MiraDrain 6000, or equivalent, should be placed adjacent to below grade construction walls, with 100 percent coverage on the foundation wall facing the uphill slope and a minimum of 50 percent coverage for the adjacent foundation walls. The wall drain system should connect into the underdrain and extend to within 1 to 2 feet of the ground surface.

SURFACE DRAINAGE

The following drainage precautions should be observed during construction and maintained at all times after the building has been completed:

1) Inundation of the foundation excavations and underslab areas should be avoided during construction.
2) Backfill in pavement and slab areas should be compacted to at least 95% of the maximum standard Proctor dry density at a moisture content within 2% of optimum. Exterior backfill placed in landscape areas should be compacted to at least 90% of the maximum standard Proctor dry density at a moisture content near optimum.
3) The ground surface surrounding the exterior of the building should be sloped to drain away from the foundation in all directions. We recommend a minimum slope of 6 inches in the first 10 feet in unpaved areas and a minimum slope of 2½ inches in the first 10 feet in paved areas.
4) Roof downspouts and drains should discharge well beyond the limits of all backfill.

CONTINUING SERVICES

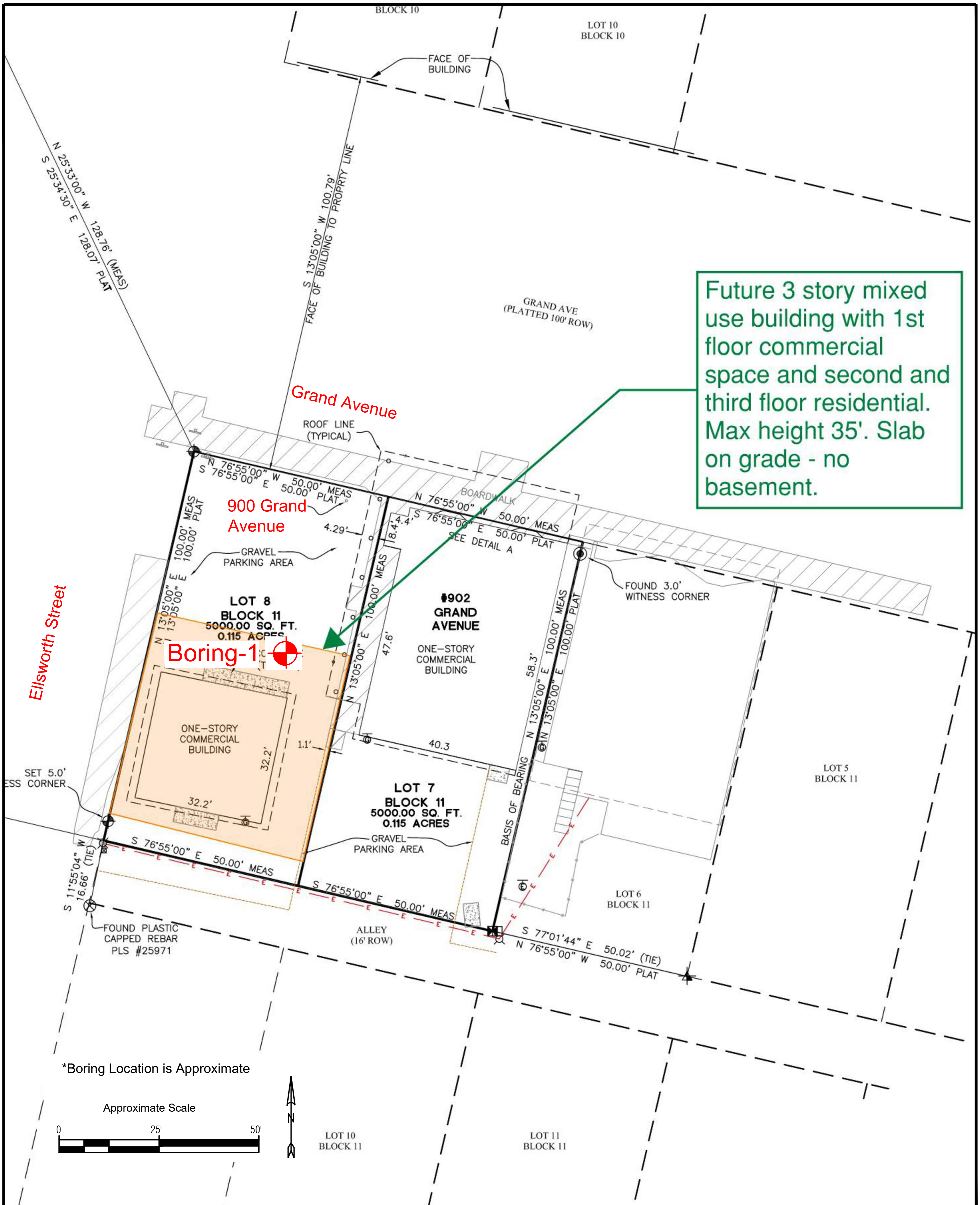
Two additional elements of geotechnical engineering service are important to the successful completion of this project.

1) Consultation with design professionals during the design phases. This is important to ensure that the intentions of our recommendations are properly incorporated in the design, and that any changes in the design concept properly consider geotechnical aspects.
2) Observation and monitoring during construction. A representative of the Geotechnical engineer from our firm should observe the foundation excavation, earthwork, and foundation phases of the work to determine that subsurface conditions are compatible with those used in the analysis and design and our recommendations have been properly implemented. Placement of backfill should be observed and tested to judge whether the proper placement conditions have been achieved. We recommend a representative of the geotechnical engineer observe the drain and dampproofing phases of the work, if constructed, to judge whether our recommendations have been properly implemented.

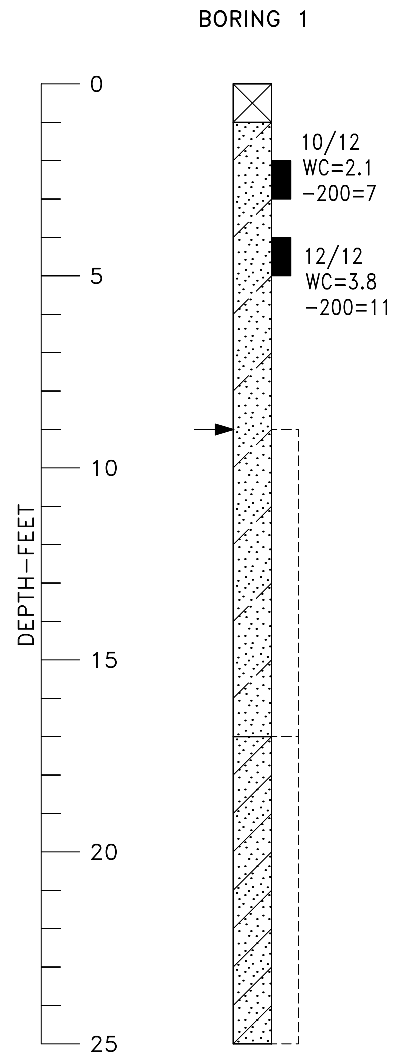
LIMITATIONS

This study has been conducted in accordance with generally accepted geotechnical engineering principles and practices in this area at this time. We make no warranty either express or implied. The conclusions and recommendations submitted in this report are based upon the data obtained from the exploratory boring at the location indicated on Figure 1, the proposed type of construction and our experience in the area. Our services do not include determining the presence, prevention or possibility of mold or other biological contaminants (MOBC) developing in the future. If the client is concerned about MOBC, then a professional in this special field of practice should be consulted. Our findings include interpolation and extrapolation of the subsurface conditions identified at the exploratory boring and variations in the subsurface conditions may not become evident until excavation is performed. If conditions encountered during construction appear different from those described in this report, we should be notified so that re-evaluation of the recommendations may be made.

This report has been prepared for the exclusive use by our client for design purposes. We are not responsible for technical interpretations by others of our information. As the project evolves, we should provide continued consultation and field services during construction to review and monitor the implementation of our recommendations, and to verify that the recommendations have been appropriately interpreted.



24–6–246	Kumar and Associates	LOCATION OF EXPLORATORY BORING	Fig. 1



LEGEND

FILL; SILTY SAND AND GRAVEL, MOIST, BROWN.

POORLY GRADED CLAYEY SAND (SP–SC); WITH GRAVEL AND SCATTERED COBBLES, MEDIUM DENSE, SLIGHTLY MOIST TO MOIST, BROWN.

SILTY SAND (SM); WITH GRAVEL AND COBBLES, MEDIUM DENSE, MOIST, BROWN.

DRIVE SAMPLE, 1 3/8–INCH I.D. SPLIT SPOON STANDARD PENETRATION TEST.

DISTURBED BULK SAMPLE.

10/12 DRIVE SAMPLE BLOW COUNT. INDICATES THAT 10 BLOWS OF A 140–POUND HAMMER FALLING 30 INCHES WERE REQUIRED TO DRIVE THE SAMPLER 12 INCHES.

→ DEPTH AT WHICH BORING CAVED DURING DRILLING.

NOTES

1. THE EXPLORATORY BORING WAS DRILLED ON DECEMBER 23, 2024 WITH A 4–INCH DIAMETER CONTINUOUS FLIGHT POWER AUGER.
2. THE LOCATION OF THE EXPLORATORY BORING WAS MEASURED APPROXIMATELY BY PACING FROM FEATURES SHOWN ON THE SITE PLAN PROVIDED.
3. THE ELEVATION OF THE EXPLORATORY BORING WAS NOT MEASURED AND THE LOG OF THE EXPLORATORY BORING IS PLOTTED TO DEPTH.
4. THE EXPLORATORY BORING LOCATION SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
5. THE LINES BETWEEN MATERIALS SHOWN ON THE EXPLORATORY BORING LOG REPRESENT THE APPROXIMATE BOUNDARIES BETWEEN MATERIAL TYPES AND THE TRANSITIONS MAY BE GRADUAL.
6. GROUNDWATER WAS NOT ENCOUNTERED IN THE BORING AT THE TIME OF DRILLING OR WHEN CHECKED # DAYS LATER.
7. LABORATORY TEST RESULTS:
   WC = WATER CONTENT (%) (ASTM D 2216);
   –200 = PERCENTAGE PASSING NO. 200 SIEVE (ASTM D 1140);

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24–6–246	Kumar & Associates	LOG, LEGEND AND EXPLANATORY NOTES OF BORING	Fig. 2

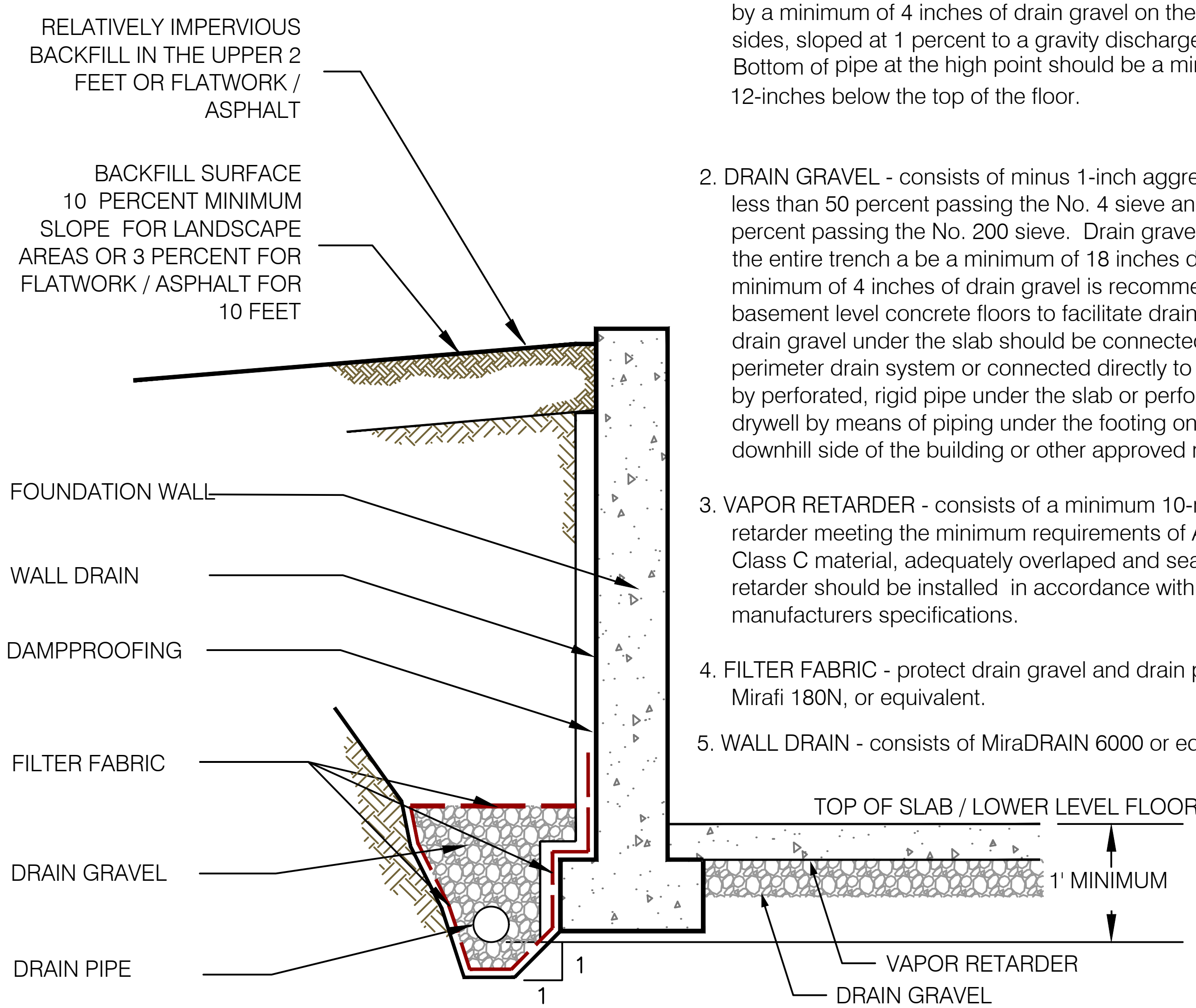
1. DRAIN PIPE - consists of 4-inch perforated PVC, surrounded by a minimum of 4 inches of drain gravel on the top and sides, sloped at 1 percent to a gravity discharge or drywell. Bottom of pipe at the high point should be a minimum of 12-inches below the top of the floor.

2. DRAIN GRAVEL - consists of minus 1-inch aggregate with less than 50 percent passing the No. 4 sieve and less than 2 percent passing the No. 200 sieve. Drain gravel should fill the entire trench a be a minimum of 18 inches deep. A minimum of 4 inches of drain gravel is recommended under basement level concrete floors to facilitate drainage. The drain gravel under the slab should be connected to the perimeter drain system or connected directly to the drywell by perforated, rigid pipe under the slab or perforation in the drywell by means of piping under the footing on the downhill side of the building or other approved method.

3. VAPOR RETARDER - consists of a minimum 10-mil vapor retarder meeting the minimum requirements of ASTM E1745 Class C material, adequately overlaped and sealed. Vapor retarder should be installed in accordance with the manufacturers specifications.

4. FILTER FABRIC - protect drain gravel and drain pipe with Mirafi 180N, or equivalent.

5. WALL DRAIN - consists of MiraDRAIN 6000 or equivalent.



NOT TO SCALE

24-6-246	Kumar & Associates	TYPICAL DRAIN DETAIL	FIG. 3

Kumar & Associates

JOB NO: 24-6-246
JOB NAME: PROPOSED COMMERCIAL BUILDING - 900 GRAND AVENUE

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

SAMPLE LOCATION		NATURAL MOISTURE CONTENT	NATURAL DRY UNIT WEIGHT	GRADATION			ATTERBERG LIMITS		SWELL-COMPRESSION		HVEEM STABILOMETER	WATER SOLUBLE SULFATES	SOIL OR BEDROCK DESCRIPTION
BORING (#)	DEPTH (feet)	(%)	(pcf)	GRAVEL (%)	SAND (%)	SILT & CLAY (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SWELL (%)	SUR-CHARGE (psf)	(R-VALUE)	(%)	
1	2	2.1				7							POORLY GRADED CLAYEY SAND WITH GRAVEL
	4	3.8				11							POORLY GRADED CLAYEY SAND WITH GRAVEL