CBC Engineers

July 1, 2005

City of Moraine Parks & Recreation
Recreation Center
3800 Main Street
Moraine, OH 45439

Attn: Mr. Roger D. Jeffers
Director

Re: Geotechnical Engineering Investigation for the Proposed New Natatorium Facility, Moraine, Ohio; CBC Report No. 6879-1-0705-02

Gentlemen:

We are pleased to submit our report of the geotechnical engineering investigation for the above-referenced project. The purpose of the study was to provide an evaluation of the physical characteristics of the soil strata and net allowable bearing capacities at the locations tested. Also noted are other conditions that might affect the design and/or construction of the proposed Natatorium based on the results of the testing.

For your convenience, the samples collected that were not used to perform the laboratory tests will be kept in our office for a period of three months. If you have any questions, or if we can help you in any way, please call us.

Respectfully submitted,

CBC Engineers & Associates, Ltd

STATE OF OHIO
DAVID C. COWHERD
30871
REGISTERED
PROFESSIONAL ENGINEER

David C. Cowherd, M.S., P.E.
CEO and Chief Engineer

DCC/smh
3-Client
1-File

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1.0 INTRODUCTION

Authorization to proceed with this investigation was given by Mr. Roger Jeffers of City of Moraine Parks & Recreation. Work was to proceed in accordance with CBC Engineers & Associates, Ltd. Quotation No. 05-217-02 dated 05-23-05 and the terms and conditions of the contract attached thereto.

The proposed facility is to be a new Natatorium in Moraine, Ohio. A Vicinity Map is presented in Figure 1 in Section III of this document.

2.0 WORK PERFORMED

2.1 FIELD WORK

Four (4) borings were made in the relative positions shown on the Boring Location Plan (Figure 2 in Section III. The boring logs and resulting data are also included in Section III. The borings were made with a truck-mounted boring rig using hollow-stem augers and employing standard penetration resistance methods (ASTM D-1586, which includes 140-pound hammer, 30-inch drop, and two-inch-O.D. split-spoon sampler) at maximum depth intervals of five feet or at major changes in stratum, whichever occurred first. The disturbed split-spoon samples were visually classified, logged, sealed in moisture-proof jars, and taken to the CBC Engineers & Associates, Ltd. laboratory for study. The depths where these "A"-type split-spoon samples were collected are noted on the boring logs.

2.2 LABORATORY WORK

Eight (8) natural moisture content determinations were made in accordance with ASTM D-4643. The results of these tests are tabulated in Table 1 as follows, and are also included in Section III of this report:

TABLE 1

RESULTS OF NATURAL MOISTURE CONTENT TESTS (ASTM D-4643)

BORING NO.	DEPTH INCREMENT, (FT.)	NATURAL MOISTURE CONTENT, %
CBC-2	1.0-2.5	13.6
CBC-2	3.5-5.0	18.3
CBC-2	6-7.5	20.5
CBC-3	1.0-2.5	21.4
CBC-3	3.5-5.0	18.9
CBC-4	1.0-2.5	16.1
CBC-4	3.5-5.0	20.8
CBC-4	6-7.5	18.6

3.0 SOIL CONDITIONS AND GROUNDWATER LEVELS

Geologically, the site is situated in a glacial valley train composed of thick and extensive deposits of sand and gravel deposited in the pre-glacial Teays drainage system by melt water from the glacier. The site is overlain by topsoil or concrete extending to depths varying between 5" and 13". Beneath the fill and extending to depths of 13" to 7.5' is a stratum of dark brown silt with some clay, some sand and a trace of gravel. This stratum is alluvium and is slightly organic. This stratum is underlain by a stratum of brown sand and gravel or fine sand extending to the bottom of the borings.

Groundwater observations were made during the drilling operations (by noting the depth of water on the drilling tools) and in the open boreholes following withdrawal of the drilling augers. Free groundwater was generally noted at the depths tabulated in Table 3 as follows at the time of drilling activities:

TABLE 3

DEPTH TO FREE GROUNDWATER AT THE TIME OF DRILLING ACTIVITIES
(AS MEASURED BENEATH THE EXISTING SITE GRADE)

BORING NO.	DEPTH TO GROUNDWATER DURING DRILLING ACTIVITIES
CBC-1	9'-1"
CBC-2	9'-2"
CBC-3	9'-3"
CBC-4	9'-3"

However, it should be noted that short-term water level readings are not necessarily a reliable indication of the groundwater level and that significant fluctuations may occur due to variations in rainfall and other factors. For specific questions relative to the soil conditions, please refer to the individual boring logs in Section III.

Based on the encountered soil conditions at the project site, the site classification was determined to be "Site Class D" per the Ohio Building Code. A "Site Class D" suggests that the soil materials are stiff with standard penetration test "N-values" between 15 and 50 in the upper 100 feet of the soil profile.

4.0 DISCUSSION AND RECOMMENDATIONS

4.1 PROJECT DESCRIPTION

No detailed structural loading information is available at this time. Therefore, for the purpose of this study, it is assumed that the maximum column, wall and floor loads will not exceed about 100 kips/col., 4 kips/lin. ft. and 150 lbs./sq. ft., respectively. No unusual loading conditions or special settlement restrictions have been specified. The following recommendations are based on this information. Consequently, if the above information is incorrect or if changes are made, CBC Engineers & Associates, Ltd. should be notified so that the new data can be reviewed.

4.2 BUILDING AREA

All topsoil or other deleterious materials should be stripped from the entire footprint of the proposed building area. These deleterious materials are tabulated in Table 4 as follows:

TABLE 4
APPROXIMATE DEPTH EXTENT OF DELETERIOUS OLD FILL MATERIAL
(AS MEASURED BENEATH THE EXISTING SITE GRADE)

BORING NO.	DEPTH EXTENT OF OLD FILL MATERIAL (ELEVATION)
1	13"
2	2.5'
3	3.0'
4	7.5'

Subsequently, the top foot of the stripped ground surface should be compacted to at least 95% of the maximum dry unit weight as determined by ASTM D-1557 (modified Proctor). Excavated fill material that is free of organic or objectionable materials can be reused as fill for the building pad. Engineered fill placed below the foundation bearing elevation should be compacted to at least 95% of the maximum dry unit weight with a moisture content within 2% of the optimum moisture content as determined by the modified Proctor test. The engineered fill placed above the foundation elevation as a subgrade for the floor slab should be compacted to 90% of the maximum dry unit weight within 2% of the optimum moisture content as determined by the modified Proctor test. Excavated material that is free of organic or objectionable materials can be reused as fill. In general, any non-organic naturally-occurring soils can be used for structural fill. Cohesive soils with a Liquid Limit (LL) greater than 50, a Plasticity Index (PI) of greater than 25, or an organic content greater than 7 percent as determined by Loss-on-Ignition (ASTM D2974) should not be used for engineered fill. The fill should contain no fragments whose greatest dimension is larger than the thickness of the lift being placed. Except for the upper organic soils encountered in our borings, the on-site soils appear to be suitable for reuse as engineered fill. Once the building pad is prepared according to these recommendations, spread-footing foundations can be placed on the original soil or new fill. The spread footing elements can be designed with a net allowable bearing pressure of 2000 lbs. /sq. ft. for square. These net allowable bearing pressures can be increased by a factor of one-third when designing for transient loadings such as wind or earthquake ground motions. All exterior foundations should bear at a depth of at least 30 inches below the final grade for frost heave considerations. Interior footings (within permanently heated areas) can be located at nominal depths below the finished floor provided the topsoil and other undesirable surface materials are removed and replaced with engineered fill. Square and continuous footings for the building should be designed at least 2.5 feet and 1.5 feet wide, respectively, even if the anticipated structural loadings would allow for smaller foundation element sizes.

The water table was encountered at a depth of approximately 9'. It should be expected that any excavation below 9' will encounter extensive groundwater.

All soil bearing foundations settle as the result of the externally applied loads. Settlement of the proposed structure should be anticipated, although such movements are estimated (based upon our experience in similar soils) to be well within the tolerable limits for the structure (i.e., the total settlement will be less than about 1 inch, while differential settlement will be limited to about one half of this value).

Backfill for utility trenches, foundation excavations, etc., within structures, driveways, or parking lot areas should be placed in successive, horizontal layers. Each layer should be compacted to 95% of the maximum modified Proctor dry unit weight with 2% of the optimum moisture content beneath the foundation elevation, and to 90% above the foundations, beneath slabs-on-grade, or beneath driveways before the next layer is added. In no instance should puddling or jetting the backfill material be allowed as a compaction method. Any silty or clayey soils at foundation depth will soften and the bearing capacity will be reduced if water ponds in the excavation. Soils exposed in the bases of all satisfactory foundation excavations should be protected against any detrimental change in condition such as from disturbance, rain and freezing. Surface run-off water should be drained away from the excavation and not allowed to pond. If possible, all foundation concrete should be placed the same day the excavation is made. If this is not practical, the foundation excavations should be adequately protected. Also, for this reason, proper drainage should be maintained after construction.

All foundations should be located so that the least lateral clear distance between any two foundations will be at least equal to the difference in their bearing elevations (see Figure 3 in Section III of this document). If this distance cannot be maintained, the lower foundation should be designed to account for the load imparted by the upper foundation. If this condition occurs adjacent to a below-grade wall, the wall should be designed for the additional lateral earth pressure due to the upper foundation.

All existing footings, floors, utilities, pavements, sidewalks, etc. should be suitably protected from undermining due to excavation for the new structure. Depending on the relative depths and locations of the new and existing footings and the need to remove unsuitable soils and/or bedrock at new footing locations, bracing or underpinning may be needed to protect the existing building. All Federal, State and Local safety regulations should be followed in this regard (if applicable).

It is recommended that at least a four-hour waiting period be observed between installation of any two auger cast piles spaced less than 8 ft. apart (center-to-center). This is to preclude horizontal grout migration during the installation process, which can result in piles being structurally deficient.

4.2.1 LATERAL AND UPLIFT FORCES ON SHALLOW FOOTINGS

Lateral forces on the foundation elements can be resisted by passive lateral earth pressures against the opposite vertical face of the foundation and by friction along the soil/foundation interface. An allowable resisting passive earth pressure of 300 lbs. /sq. ft., and coefficient of friction of 0.35, respectively, can be used for design purposes. The passive resistance should only be used for that portion of the foundation located at a depth greater than 2.5 feet beneath the final grade (Please see Figure 4 in Section III of this text). A factor of safety of 1.5 relative to the lateral capacity should be used in design. It should be noted that lateral movements, on the order of up to 0.5 inch, may occur to mobilize this lateral resisting force.

It is further recommended that only the weight of the footing and the total weight of the soil above and within the periphery of the footing be used for resisting uplift forces. A total soil unit weight of 120 lbs./cu. ft. should be used for these computations for backfill material compacted as recommended in Section 4.2 (Please see Figure 5 in Section III of this document). It is also recommended that a factor of safety of at least 1.5 be used in calculating uplift resistance due to the weight of the footing and the backfill soil.

4.2.2 LATERAL EARTH PRESSURES ON BELOW GRADE WALLS

The magnitude of lateral earth pressure against subsurface walls is dependent on the method of backfill placement, the type of backfill soil, drainage provisions and whether or not the wall is permitted to yield during and/or after placement of the backfill. When a wall is held rigidly against horizontal movement, the lateral pressure against the wall is greater than the "active" earth pressure that is typically used in the design of free-standing retaining walls. Therefore, rigid walls should be designed for higher, "at-rest" pressures (using an at-rest lateral earth pressure coefficient, K_o), while yielding walls can be designed for active pressures (using an active lateral earth pressure coefficient, K_a).

For use in these computations, a total soil unit weight of 130 lbs/cu. ft. should be used. For below-grade walls, a coefficient of earth pressure at-rest (K_o) of 0.45 and a coefficient of "active" earth pressure of 0.30 are recommended, provided a well-graded granular material is used for backfill (Please see Figure 6 in Section III of this document). Also, a passive earth pressure coefficient of 2.75 should be used in design. The granular backfill material should extend upward and outward from the base of the wall on a slope not steeper than about 1 (horizontal) to 1 (vertical). This method of computation presumes that there will be no hydrostatic pressure due to water build-up.

It is recommended that the static weight per axle of equipment utilized for the compaction of the backfill materials not exceed 2 tons per axle for non-vibratory equipment and 1 ton per axle for vibratory equipment. All heavy equipment, including compaction equipment heavier than recommended above, should not be allowed closer to the wall (horizontal distance) than the vertical distance from the backfill surface to the bottom of the wall. If it is desired to use heavier compaction equipment adjacent to the below grade wall, it is recommended that this office be connected to determine the resulting earth pressures.

4.2.3 SLABS-ON-GRADE

Slabs-on-grade can be supported on firm natural soils or on new compacted structural fill. The slab subgrade should be prepared as described in Section II of this report.

It is recommended that all slabs-on-grade be "floating", that is, fully ground supported and not structurally connected to walls or foundations. This is to minimize the possibility of cracking and displacement of the slabs-on-grade because of differential movements between the slab and the foundation. Although the movements are estimated to be within the tolerable limits for structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations.

It is furthermore recommended that the slabs-on-grade be supported on 4 to 6-inch layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and equalize moisture conditions beneath the slab. Proper drainage must be incorporated into this granular layer to preclude future wet areas in the finished slab-on-grade. However, all topsoil and/or other deleterious materials (such as described in Section 3.0 of this text) encountered during site preparation must be removed and replaced with select engineered fill that is compacted to the specifications previously outlined in Section 4.2 of this report. Provided that a minimum of 4 inches of granular material is placed below the new slab-on-grade, a modulus of subgrade reaction (k_{30}) of 100 lbs. /cu. in. can be used for design of the slabs.

4.2.4 FOUNDATION EXCAVATIONS

Each foundation excavation should be inspected to insure that all loose, soft or otherwise undesirable material is removed and that the foundation will bear on satisfactory material.

If pockets of soft, loose or otherwise unsuitable material are encountered in the footing excavations and it is inconvenient to lower the footings, the proposed footing elevations may be re-established by backfilling after the undesirable material has been removed. The undercut excavation beneath each footing should extend to suitable bearing soils and the dimensions of the excavation base should be determined by imaginary planes extending outward and down on a 1 (vertical) to 1 (horizontal) slope from the base perimeter of the footing as illustrated in Figure 7 in Section III. The entire excavation should then be refilled with a well-compacted engineered fill, or lean concrete (Please note that the width of the lean concrete zone should be equal or wider than the width of the overlying footing element). Special care should be exercised to remove any sloughed, loose or soft materials near the base of the excavation slopes. All Federal, State, and Local regulations should be strictly adhered to relative to excavation side-slope geometry.

5.0 SLOPE CONSIDERATIONS

A detailed slope stability analysis is beyond the scope of this study. However, it is, therefore, recommended that fill slopes less than 10 feet in height be designed for slopes not steeper than 2.5 (horizontal) to 1 (vertical). For any fill greater than 10 feet in height, it is recommended that slopes be not steeper than 3 (horizontal) to 1 (vertical).

In general, temporary cut slopes of 2 (horizontal) to 1 (vertical) should remain stable during a reasonable construction period provided they are not higher than about 10 feet and are not subjected to excessive vibration from construction equipment and are protected from surface erosion. The need for temporary bracing of utility trenches should be anticipated. In general, any permanent cut slopes should be no steeper than about 3 (horizontal) to 1 (vertical).

6.0 CONSTRUCTION DEWATERING

At the time of our investigation, the free groundwater level was noted to be generally below the anticipated footing depth. However, it is likely that some seepage into foundation excavations will occur, depending on the seasonal conditions. Excavations which intercept saturated, discontinuous sand and gravel lenses (which are common in glacial till soils) or other wet granular zones may encounter significant quantities of free groundwater. It is anticipated that any such seepage can be intercepted by open sumps from which the water can be pumped. However, care must be exercised when pumping from sumps that extend into silts or other granular soils, as a general deterioration of the bearing soils and a localized "quick" condition could result. If significant groundwater influxes are noted within the excavations, other dewatering techniques should be determined at the time of construction.

7.0 SITE PREPARATION

All areas that will support slabs-on-grade and pavements should be properly prepared. After rough grade has been established in cut areas and prior to placement of fill in all fill areas, the exposed subgrade should be carefully inspected by probing and testing as needed. Any topsoil or other organic material still in place, frozen, wet, soft or loose soil, and other undesirable materials should be removed and replaced with engineered fill. Based on the test results presented in Table 1 of this document, aeration of the near-surface in-situ soils should be anticipated prior to their placement as engineered fill (or lime stabilization can also be used). The exposed subgrade should furthermore be inspected by proofrolling with a medium-weight roller or other suitable equipment to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed should be removed and replaced with well-compacted, engineered fill as outlined in the specifications of this document. However, it may also become necessary (due to the presence of soft exposed soil materials) to employ lime stabilization or to locally incorporate ODOT No. 2 aggregate into the subgrade to increase its stiffness.

Care should be exercised during the grading operations at the site. Due to the nature of the near surface soils, the traffic of heavy equipment, including heavy compaction equipment, may create pumping and general deterioration of the shallower soils, especially if excess surface water is present. If this occurs, it may be necessary to utilize a biaxial geogrid, lime stabilization, or other methodology (such as the incorporation of ODOT No. 2 aggregate into the subgrade) to stabilize the disturbed subgrade. The grading, therefore, should be done during a dry season, if at all possible.

In addition, it must be emphasized that once engineered fill is properly placed on the project site, that these materials can also degrade significantly due to the effects of heavy construction traffic and wet weather. This degradation may in some cases require the excavation and replacement of the engineered fill with aerated, lime-stabilized fill materials; hence, caution should be exercised to avoid such degradation of these soil materials.

It should be noted that when vibratory rollers are utilized on certain soils types (such as fine grain sands or silts), that shear induced pore water pressures may be developed within these materials which will result in significant "pumping" of these materials (even though these soils may be stiff and pass moisture density tests on engineered fills). Therefore (in these types of soils), it is imperative that the vibrator not be utilized and that these soils be statically rolled in order to preclude the development of such shear induced pore water pressures. These shear induced pore water pressures dissipate over a number of days (depending on the permeability of the soil materials); however in the short term, significant "pumping" of these materials can be witnessed in the field.

8.0 SOIL SWELLING POTENTIAL

Based upon the laboratory tests performed for this study and the mineralogy of typical glacial silty clay soils from the general vicinity of the project site, no significant soil swelling is anticipated. To our knowledge, there are no instances of problems associated with soil swelling in the project vicinity.

9.0 LIQUEFACTION

When certain soils (generally only granular soils) below the groundwater table are subjected to dynamic loads, such as those produced by earthquakes, a sudden increase in pore water pressure as the result of shearing of the soil particles passed one another. In extreme cases, when these shear induced pore water pressures exceed the strength of the soil, the soil strength can reduce to zero thereby resulting in a phenomenon known as "liquefaction." Conditions at this site have been examined to determine the likelihood for liquefaction of the natural soils during earthquake ground motions.

Soil type, relative density, initial confining pressure (i.e., the depth of the potentially liquefiable soil below the ground surface) and the magnitude of potential ground motions are the most important factors in determining the liquefaction potential of a soil mass. It is generally agreed that saturated, relatively loose (with blow counts or "N" values typically less than about 13) in the upper 50 feet or so are most susceptible to liquefaction.

Clayey soils are generally considered to be non-vulnerable to liquefaction. It is, therefore, concluded that liquefaction (or any significant loss of strength) of the soils underlying the project site during earthquake ground motions is extremely unlikely. To our knowledge, there are no recorded cases of liquefaction of subsurface materials similar to those at this project site. Therefore, no special design measures relative to soil liquefaction appear to be warranted.

10.0 BURIED UTILITY PIPES

Excavations for buried utility pipelines should follow the guidelines set forth previously in this report. Depending on the pipeline material, a minimum thickness of at least 0.5 foot of select fine-grained granular bedding material should be used beneath all below-grade pipes, with a minimum cover thickness of at least 3 feet to afford an "arching" effect and reduce stresses on the pipe. The cover thickness may be reduced if the external loading condition on the pipe is relatively light or if the pipe is designed to withstand the external loading condition. It is not recommended that "pea-gravel" or other "open-work" aggregates be used for trench backfill since these materials are nearly impossible to compact and have a tendency to pond water within their interstices.

11.0 DRAINAGE

Adequate drainage should be provided at the site to minimize any increase in moisture content of the foundation soils. The exterior grade (including all parking areas) should be sloped away from all facility structures to prevent ponding of water.

12.0 CLOSURE

12.1 BASIS OF RECOMMENDATIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our understanding of the project and our experience with similar sites and subsurface conditions. Data used during this exploration included, but were not necessarily limited to:

- Four (4) exploratory borings performed during this study,
- observations of the project site by our staff,
- results of the laboratory soil tests,
- site plans and drawings furnished by City of Moraine Parks & Recreation,
- limited interaction with Roger Jeffers of City of Moraine Parks & Recreation ; and
- published soil or geologic data of this area.

In the event that changes in the project characteristics are planned, or if additional information or differences from the conditions anticipated in this report become apparent, CBC Engineers & Associates, Ltd., should be notified so that the conclusions and recommendations contained in this report can be reviewed and, if necessary, modified or verified in writing.

12.2 LIMITATIONS OF STUDY/RECOMMENDED ADDITIONAL SERVICES

The subsurface conditions discussed in this report and those shown on the boring logs represent an estimate of the subsurface conditions based on interpretation of the boring data using normally accepted geotechnical engineering judgments. Although individual test boring are representative of the subsurface conditions at the boring locations on the dates shown, they are not necessarily indicative of subsurface conditions at other locations or at other times.

Regardless of the thoroughness of a subsurface exploration, there is the possibility that conditions between borings will differ from those at the boring locations, that conditions are not as anticipated by designers, or that the construction process has altered the soil conditions. As variations in the soil profile are encountered, additional subsurface sampling and testing may be necessary to provide data required to re-evaluate the recommendations of this report. Consequently, after submission of this report it is recommended that CBC Engineers & Associates, Ltd. be authorized to perform additional services to work with the designer(s) to minimize errors and omissions regarding the interpretation and implementation of this report.

Prior to construction, we recommend that CBC Engineers & Associates, Ltd.:

- work with the designers to implement the recommended geotechnical design parameters into plans and specifications,
- consult with the design team regarding interpretation of this report,
- establish criteria for the construction observation and testing for the soil conditions encountered at this site; and
- review final plans and specifications pertaining to geotechnical aspects of design.

During construction, we recommend that CBC Engineers & Associates, Ltd.:

- observe the construction, particularly the site preparation, fill placement, and foundation excavation or installation,
- perform in-place density testing of all compacted fill,
- perform materials testing of soil and other materials as required; and

- consult with the design team to make design changes in the event that differing subsurface conditions are encountered.

If CBC Engineers & Associates, Ltd. is not retained for these services, we shall assume no responsibility for construction compliance with the design concepts, specifications or recommendations.

12.3 WARRANTY

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. No other warranty, express or implied, is made.

While the services of CBC Engineers & Associates, Ltd. are a valuable and integral part of the design and construction teams, we do not warrant, guarantee, or insure the quality or completeness of services provided by other members of those teams, the quality, completeness, or satisfactory performance of construction plans and specifications which we have not prepared, nor the ultimate performance of building site materials.

12.3.1 SUBSURFACE EXPLORATION

Subsurface exploration is normally accomplished by test borings, although test pits are sometimes employed. The method of determining the boring location and the surface elevation at the boring is noted in the report, and is presented on the Boring Location Plan or on the boring log. The location and elevation of the boring should be considered accurate only to the degree inherent with the method used.

The boring log includes sampling information, description of the materials recovered, approximate depth of boundaries between soil and rock strata and groundwater data. The boring log represents conditions specifically at the location and time the boring was made. The boundaries between different soil strata are indicated at specific depths; however, these depths are in fact approximate and are somewhat dependent upon the frequency of sampling (The transition between soil strata is often gradual). Free groundwater level reading are made at the times and under conditions stated on the boring logs (Groundwater levels change with time and season). The borehole does not always remain open sufficiently long for the measured water level to coincide with the groundwater table.

12.3.2 LABORATORY AND FIELD TESTS

Laboratory and field tests are performed in accordance with specific ASTM standards unless otherwise indicated. All determinations included in a given ASTM standard are not always required and performed. Each test report indicates the measurements and determinations actually made.

12.3.3 ANALYSIS AND RECOMMENDATIONS

The geotechnical report is prepared primarily to aid in the engineering design of site work and structural foundations. Although the information in the report is expected to be sufficient for these purposes, it is not intended to determine the cost of construction or to stand alone as a construction specification.

Our engineering report recommendations are based primarily on data from test borings made at the locations shown on a boring location drawing included. Soil variations may exist between borings and these variations may not become evident until construction. If significant variations are then noted, the geotechnical engineer should be contacted so that field conditions can be examined and recommendations revised if necessary.

The geotechnical engineering report states our understanding as to the location, dimensions and structural features proposed for the site. Any significant changes in the nature, design, or location of the site improvements MUST be communicated to the geotechnical engineer such that the geotechnical analysis, conclusions, and recommendations can be appropriately adjusted. The geotechnical engineer should be given the opportunity to review all drawings that have been prepared based on their recommendations.

12.3.4 CONSTRUCTION MONITORING

Construction monitoring is a vital element of complete geotechnical services. The field engineer/inspector is the owner's "representative" observing the work of the contractor, performing tests as required in the specifications, and reporting data developed from such tests and observations. The field engineer or inspector does not direct the contractor's construction means, methods, operations or personnel. The field inspector/engineer does not interfere with the relationship between the owner and the contractor and, except as an observer, does not become a substitute owner on site. The field inspector/engineer is responsible for his own safety but has no responsibility for the safety of other personnel at the site. The field inspector/engineer is an important member of a team whose responsibility is to watch and test the work being done and report to the owner whether that work is being carried out in general conformance with the plans and specifications.

12.3.5 GENERAL

The scope of our services did not include an environmental assessment for the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater or air, on, within or beyond the site studied. Any statements in the report or on the boring logs regarding odors, staining of soils or other unusual items or conditions observed are strictly for the information of our client.

To evaluate the site for possible environmental liabilities, we recommend an environmental assessment, consisting of a detailed site reconnaissance, a record review, and report of findings. Additional subsurface drilling and samplings, including groundwater sampling, may be required. CBC Engineers & Associates, Ltd. can provide this service and would be pleased to provide a cost proposal to perform such a study, if requested.

This report has been prepared for the exclusive use of Moraine Parks and Recreation for specific application to the proposed Natatorium (see Figure 1 in Section III of this report). Specific design and construction recommendations have been provided in the various sections of the report. The report shall, therefore, be used in its entirety. This report is not a bidding document and shall not be used for that purpose. Anyone reviewing this report must interpret and draw their own conclusions regarding specific construction techniques and methods chosen. CBC Engineers & Associates, Ltd. is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploratory and laboratory test data presented in this report.

SECTION II

SPECIFICATIONS

I - ENGINEERED FILL BENEATH STRUCTURES

CLEARING AND GRADING SPECIFICATIONS

1.0 GENERAL CONDITIONS

The Contractor shall furnish all labor, materials, and equipment, and perform all work and services necessary to complete in a satisfactory manner the site preparation, excavation, filling, compaction and grading as shown on the plans and as described therein.

This work shall consist of all clearing and grading, removal of existing structures unless otherwise stated, preparation of the land to be filled, filling of the land, spreading and compaction of the fill, and all subsidiary work necessary to complete the grading of the cut and fill areas to conform with the lines, grades, slopes, and specifications.

This work is to be accomplished under the constant and continuous supervision of the Owner or his designated representative.

In these specifications the terms "approved" and "as directed" shall refer to directions to the Contractor from the Owner or his designated representative.

2.0 SUBSURFACE CONDITIONS

Prior to bidding the work, the Contractor shall examine, investigate and inspect the construction site as to the nature and location of the work, and the general and local conditions at the construction site, including without limitation, the character of surface or subsurface conditions and obstacles to be encountered on and around the construction site; and shall make such additional investigation as he may deem necessary for the planning and proper execution of the work. Borings and/or soil investigations shall have been made. Results of these borings and studies will be made available by the Owner to the Contractor upon his request, but the Owner is not responsible for any interpretations or conclusions with respect thereto made by the Contractor on the basis of such information, and the Owner further has no responsibility for the accuracy of the borings and the soil investigations.

If conditions other than those indicated are discovered by the Contractor, the Owner should be notified immediately. The material which the Contractor believes to be a changed condition should not be disturbed so that the Owner can investigate the condition.

3.0 SITE PREPARATION

Within the specified areas, all trees, brush, stumps, logs, tree roots, and structures scheduled for demolition shall be removed and disposed of.

All cut and fill areas shall be properly stripped. Topsoil will be removed to its full depth and stockpiled for use in finish grading. Any rubbish, organic and other objectionable soils, and other deleterious material shall be disposed of off the site, or as directed by the Owner or his designated representative if on site disposal is provided. In no case shall such objectionable material be allowed in or under the fill unless specifically authorized in writing.

Prior to the addition of fill, the original ground shall be compacted to job specifications as outlined below. Special notice shall be given to the proposed fill area at this time. If wet spots, spongy conditions, or groundwater seepage is found, corrective measures must be taken before the placement of fill.

4.0 FORMATION OF FILL AREAS

Fills shall be formed of satisfactory materials placed in successive horizontal layers of not more than eight (8) inches in loose depth for the full width of the cross-section. The depth of lift may be increased if the Contractor can demonstrate the ability to compact a larger lift. If compaction is accomplished using hand-tamping equipment, lifts will be limited to 4-inch loose lifts. Engineered fill placed below the structure bearing elevation shall be compacted to at least 95% of the maximum dry unit weight with a moisture content within 2% of the optimum moisture content as determined by the modified Proctor test below foundation level. The degree of compaction can be lowered to 90% above foundation level and in parking and driveway areas.

All material entering the fill shall be free of organic matter such as leaves, grass, roots, and other objectionable material.

The operations on earth work shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing weather, or other unsatisfactory conditions. The Contractor shall keep the work areas graded to provide the drainage at all times.

The fill material shall be of the proper moisture content before compaction efforts are started. Wetting or drying of the material and manipulation to secure a uniform moisture content throughout the layer shall be required. Should the material be too wet to permit proper compaction or rolling, all work thus affected shall be delayed until the material has dried to the required moisture content. The moisture content of the fill material should be no more than two (2) percentage points higher or lower than optimum unless otherwise authorized. Sprinkling shall be done with equipment that will satisfactorily distribute the water over the disced area. Any areas inaccessible to a roller shall be consolidated and compacted by mechanical tampers. The equipment shall be operated in such a manner that hardpan, cemented gravel, clay or other chunky soil material will be broken up into small particles and become incorporated with the other material in the layer.

In the construction of filled areas, starting layers shall be placed in the deepest portion of the fill, and as placement progresses, additional layers shall be constructed in horizontal planes. Original slopes shall be continuously, vertically benched to provide horizontal fill planes. The size of the benches shall be formed so that the base of the bench is horizontal and the back of the bench is vertical. As many benches as are necessary to bring the site to final grade shall be constructed. Filling operations shall begin on the lowest bench, with the fill being placed in horizontal eight (8) inch thick loose lifts unless otherwise authorized. The filling shall progress in this manner until the entire first bench has been filled, before any fill is placed on the succeeding benches. Proper drainage shall be maintained at all times during benching and filling of the benches, to insure that all water is drained away from the fill area.

Frozen material shall not be placed in the fill nor shall the fill be placed upon frozen material.

The Contractor shall be responsible for the stability of all fills made under the contract, and shall replace any portion, which in the opinion of the Owner or his designated representative, has become displaced due to carelessness or negligence on the part of the Contractor. Fill damaged by inclement weather shall be repaired at the Contractor's expense.

5.0 SLOPE RATIO AND STORM WATER RUN-OFF

Slopes shall not be greater than 2 (horizontal) to 1 (vertical) in both cut and fill, or as illustrated on the construction drawings. Excavations shall be constructed in accordance with all Federal, State and local codes relative to slope geometry.

6.0 GRADING

The Contractor shall furnish, operate, and maintain such equipment as is necessary to construct uniform layers, and control smoothness of grade for maximum compaction and drainage.

7.0 COMPACTING

The compaction equipment shall be approved equipment of such design, weight, and quantity to obtain the required density in accordance with these specifications.

8.0 TESTING AND INSPECTION SERVICES

Testing and inspection services will be provided by the Owner.

SECTION III

BORING LOGS, LAB TESTING RESULTS, & PRINTS

CBC Engineers & Associates, Ltd.
125 Westpark Road
Centerville, OH 45459
(P) (937) 428-6150 / (F) (937) 428-6154

BORING LOG

CLIENT: Moraine Parks & Recreation, Moraine, Ohio
PROJECT: Natatorium
LOCATION: As Shown on the Boring Location Plan
REPORT NO.: 6879
DATE STD.: 6/28/05
DRILLERS: CBC
METHOD: 3 ¼ HSA
BORING NO.: B1
DATE FINISHED: 6/28/05
GROUND ELEV.:

SCALE, FT.	STRATUM DEPTH, FT.	CLASSIFICATION OF MATERIAL (Major Soil Components: Gravel, Silt, Sand, Clay; Minor Component Term: Trace 1-10%, Some 11-35%, And 36-50%)	SAMPLE NUMBER & SAMPLE TYPE	DEPTH OF SAMPLE, FT. FROM	TO	BLOWS ON SAMPLER PER SPT (6" INTER-VAL)	SPT "N", OR RECOVERY (IN. FOR SHELBY TUBES, % FOR ROCK CORE)
0.0	0.0	Dark brown SILT, some clay, some sand, trace gravel (moist) (slightly organic) (Alluvium)					
1.0	13"	Medium dense brown SAND and gravel, trace silt (moist)	1A	1.0	2.5	8-8-7	15
2.0							
3.0		Becomes loose at 3.5'	2A	3.5	5.0	8-4-5	9
4.0							
5.0							
6.0			3A	6.0	7.5	4-4-4	8
7.0	7.5	Very loose brown fine SAND, some silt (wet)					
8.0			4A	8.5	10.0	3-1-2	3
9.0							
10.0	10.5	Dense brown SAND and gravel, trace silt (wet)					
11.0							
12.0							
13.0			5A	13.5	15.0	21-24-25	49
14.0							
15.0							
16.0							
17.0							
18.0		Becomes very dense at 18.5'	6A	18.5	20.0	26-28-29	57
19.0							
20.0		BOTTOM OF BORING 20'					

WATER LEVEL OBSERVATIONS
Noted on rods 9'-1" ft.
At completion 9'-1" ft.
After – hours – ft.

BORING METHOD
HSA Hollow Stem Auger
CFA Continuous Flight Auger
DC Driven Casing
MD Mud Drilling
RC Rock Coring
CA Casing Advancer

TYPE SAMPLE
A - Split Spoon
B - Rock Core
C - Shelby Tube
D - Other

*These Shelby Tube Samples Obtained In An Auxiliary Boring Drilled A Few Feet From This Boring

CBC Engineers & Associates, Ltd.
125 Westpark Road
Centerville, OH 45459
(P) (937) 428-6150 / (F) (937) 428-6154

BORING LOG

CLIENT: Moraine Parks & Recreation, Moraine, Ohio — REPORT NO.: 6879 — BORING NO.: B2
DATE STD.: 6/28/05 — DATE FINISHED: 6/28/05
PROJECT: Natatorium — DRILLERS: CBC — GROUND ELEV.:
LOCATION: As Shown on the Boring Location Plan — METHOD: 3 ¼ HSA

SCALE, FT.	STRATUM DEPTH, FT.	CLASSIFICATION OF MATERIAL (Major Soil Components: Gravel, Silt, Sand, Clay; Minor Component Term: Trace 1-10%, Some 11-35%, And 36-50%)	SAMPLE NUMBER & SAMPLE TYPE	DEPTH OF SAMPLE, FT. FROM	TO	BLOWS ON SAMPLER PER SPT (6" INTER-VAL)	SPT "N", OR RECOVERY (IN. FOR SHELBY TUBES, % FOR ROCK CORE)
0.0	0.0	Topsoil					
	5"	Very stiff dark brown SILT, some clay, some sand, trace gravel (moist)(slightly organic)(alluvium)					
1.0			1A	1.0	2.5	9-8-8	16
2.0							
	2.5	Very stiff brown SILT, some clay, some sand, trace gravel (moist)					
3.0			2A	3.5	5.0	6-8-9	17
4.0							
5.0							
6.0	6.0	Medium dense brown SAND and gravel, trace silt, (moist)	3A	6.0	7.5	11-9-10	19
7.0							
8.0			4A	8.5	10.0	9-12-13	25
9.0		(Becomes wet at 9.2')					
10.0							
11.0							
12.0							
13.0			5A	13.5	15.0	15-9-9	18
14.0							
15.0							
16.0							
17.0							
18.0			6A	18.5	20.0	8-9-14	23
19.0							
20.0		BOTTOM OF BORING 20'					

WATER LEVEL OBSERVATIONS
Noted on rods 9'-2" ft.
At completion 9'-2" ft.
After – hours – ft.

BORING METHOD
HSA Hollow Stem Auger
CFA Continuous Flight Auger
DC Driven Casing
MD Mud Drilling
RC Rock Coring
CA Casing Advancer

TYPE SAMPLE
A - Split Spoon
B - Rock Core
C - Shelby Tube
D - Other

*These Shelby Tube Samples Obtained In An Auxiliary Boring Drilled A Few Feet From This Boring

CBC Engineers & Associates, Ltd.
125 Westpark Road
Centerville, OH 45459
(P) (937) 428-6150 / (F) (937) 428-6154

BORING LOG

CLIENT: Moraine Parks & Recreation, Moraine, Ohio — REPORT NO.: 6879 — BORING NO.: B3
DATE STD.: 6/28/05 — DATE FINISHED: 6/28/05
PROJECT: Natatorium — DRILLERS: CBC — GROUND ELEV.:
LOCATION: As Shown on the Boring Location Plan — METHOD: 3 ¼ HSA

SCALE, FT.	STRATUM DEPTH, FT.	CLASSIFICATION OF MATERIAL (Major Soil Components: Gravel, Sand, Silt, Clay; Minor Component Term: Trace 1-10%, Some 11-35%, And 36-50%)	SAMPLE NUMBER & SAMPLE TYPE	DEPTH OF SAMPLE, FT. FROM	TO	BLOWS ON SAMPLER PER SPT (6" INTER-VAL)	SPT "N", OR RECOVERY (IN. FOR SHELBY TUBES, % FOR ROCK CORE)
0.0	0.0	Concrete					
	3"	Medium stiff dark brown SILT, some clay, some sand, trace gravel (moist) (slightly organic) (Alluvium)					
1.0			1A	1.0	2.5	3-4-4	8
2.0							
3.0	3.0'	Medium stiff brown SILT, some clay, some sand, trace gravel (moist)					
			2A	3.5	5.0	4-4-6	10
4.0							
5.0							
	5.5	Medium dense brown SAND and gravel, trace silt, (moist)					
6.0			3A	6.0	7.5	6-8-10	18
7.0							
8.0							
		Becomes dense at 8.5'	4A	8.5	10.0	18-27-22	49
9.0		Becomes wet at 9.2'					
10.0							
11.0							
12.0							
13.0							
		Becomes very dense at 13.5'	5A	13.5	15.0	26-28-30	58
14.0							
15.0							
16.0							
17.0							
18.0							
		Becomes medium dense at 18.5'	6A	18.5	20.0	13-13-17	30
19.0							
20.0		BOTTOM OF BORING 20'					

WATER LEVEL OBSERVATIONS
Noted on rods 9'-3" ft.
At completion 9'-3" ft.
After -- hours -- ft.

BORING METHOD
HSA Hollow Stem Auger — MD Mud Drilling
CFA Continuous Flight Auger — RC Rock Coring
DC Driven Casing — CA Casing Advancer

TYPE SAMPLE
A - Split Spoon
B - Rock Core
C - Shelby Tube
D - Other

*These Shelby Tube Samples Obtained In An Auxiliary Boring Drilled A Few Feet From This Boring

CBC Engineers & Associates, Ltd.
125 Westpark Road
Centerville, OH 45459
(P) (937) 428-6150 / (F) (937) 428-6154

BORING LOG

CLIENT: Moraine Parks & Recreation, Moraine, Ohio	REPORT NO.: 6879	BORING NO.: B4	
PROJECT: Natatorium	DATE STD.: 6/28/05	DATE FINISHED: 6/28/05	
LOCATION: As Shown on the Boring Location Plan	DRILLERS: CBC	GROUND ELEV.:	
	METHOD: 3 ¼ HSA		

SCALE, FT.	STRATUM DEPTH, FT.	CLASSIFICATION OF MATERIAL Major Soil Components: Gravel, Sand, Silt, Clay Minor Component Term: Trace 1-10%, Some 11-35%, And 36-50%	SAMPLE NUMBER & SAMPLE TYPE	DEPTH OF SAMPLE, FT. FROM	TO	BLOWS ON SAMPLER PER SPT (6" INTER-VAL)	SPT "N", OR RECOVERY (IN. FOR SHELBY TUBES, % FOR ROCK CORE)
0.0	0.0	Topsoil					
	4"	Medium stiff dark brown SILT, some clay, some sand, trace gravel (moist) (slightly organic) (Alluvium)(with shells)					
1.0			1A	1.0	2.5	3-3-4	7
2.0							
3.0							
		Becomes stiff at 3.5'	2A	3.5	5.0	4-5-6	11
4.0							
5.0							
6.0		Becomes very stiff at 6.0'	3A	6.0	7.5	7-7-13	19
7.0							
	7.5'	Medium dense brown SAND and gravel, trace silt (moist)					
8.0							
			4A	8.5	10.0	8-10-9	19
9.0		Becomes wet at 9.2'					
10.0							
11.0							
12.0							
13.0							
			5A	13.5	15.0	10-10-15	25
14.0							
15.0							
16.0							
17.0							
18.0							
		Becomes dense at 18.5'	6A	18.5	20.0	13-14-19	33
19.0							
20.0		BOTTOM OF BORING 20'					

WATER LEVEL OBSERVATIONS
Noted on rods 9'-3" ft.
At completion 9'-3" ft.
After – hours – ft.

BORING METHOD
HSA Hollow Stem Auger — MD Mud Drilling
CFA Continuous Flight Auger — RC Rock Coring
DC Driven Casing — CA Casing Advancer

TYPE SAMPLE
A - Split Spoon
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C - Shelby Tube
D - Other

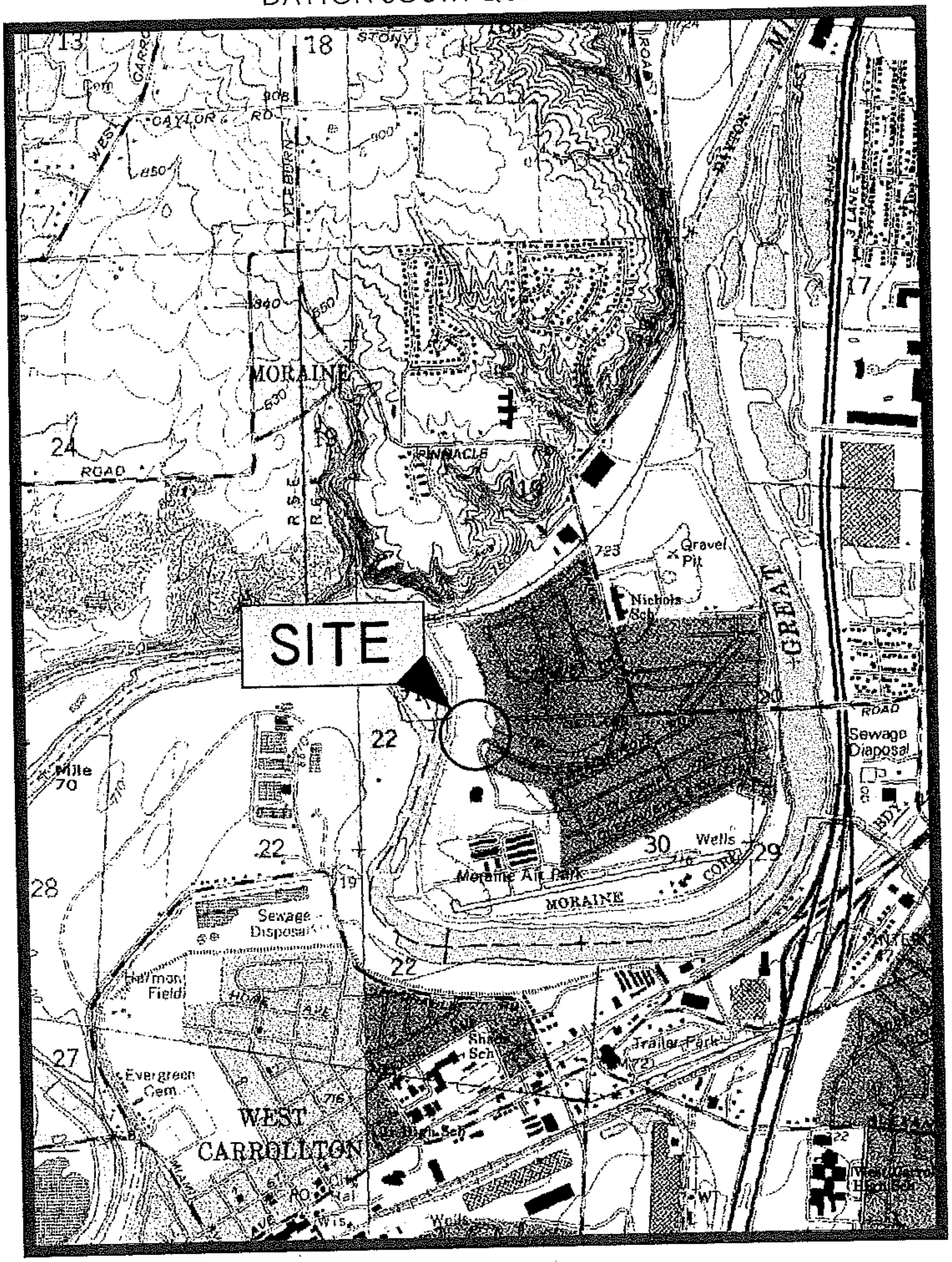
*These Shelby Tube Samples Obtained In An Auxiliary Boring Drilled A Few Feet From This Boring

TABLE 1

RESULTS OF NATURAL MOISTURE CONTENT TESTS (ASTM D-4643)

BORING NO.	DEPTH INCREMENT, (FT.)	NATURAL MOISTURE CONTENT, %
CBC-2	1.0-2.5	13.6
CBC-2	3.5-5.0	18.3
CBC-2	6-7.5	20.5
CBC-3	1.0-2.5	21.4
CBC-3	3.5-5.0	18.9
CBC-4	1.0-2.5	16.1
CBC-4	3.5-5.0	20.8
CBC-4	6-7.5	18.6

DAYTON SOUTH QUADRANGLE



VICINITY MAP

CITY OF MORAINE PARKS & RECREATION
PROPOSED NEW NATATORIUM FACILITY
MORAINE, OHIO

PROJECT NO. CBC-6879	CBC ENGINEERS DAYTON, OHIO
SCALE 1" = 2000'	
FIGURE NO.	1