DAKOTA STATE UNIVERSITY – BEACOM CENTER
GIRTON SITE
MADISON, SOUTH DAKOTA
OSE #R0415- -01X
SCHEMATIC DESIGN NARRATIVE
NOVEMBER 13, 2015

TSP, Inc.
1112 North West Avenue
Sioux Falls, South Dakota 57104
605-336-1160

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DAKOTA STATE UNIVERSITY – BEACOM CENTER
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SCHEMATIC DESIGN NARRATIVE
NOVEMBER 13, 2015

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DAKOTA STATE UNIVERSITY
BEACOM INSTITUTE OF TECHNOLOGY
GIRTON SITE
MADISON, SOUTH DAKOTA
MECHANICAL LEED NARRATIVE
NOVEMBER 13, 2015

BASIS OF DESIGN

Reference Standards and Codes

2012 International Building Code (IBC)

2012 International Mechanical Code

2012 International Fire Code.

Uniform Plumbing Code-2009.

ASHRAE Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings

Handbooks of American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE)

Ventilation for Acceptable Indoor Air Quality, ASHRAE Standard 62.1-2010

NFPA-13 Installation of Fire Sprinkler Systems

LEED Version 4 Prerequisite and Credit Requirements as Applicable

Climatic Conditions

Source: ASHRAE 2013 Fundamentals Handbook, Chapter 14, 0.4% summer and 99.6% winter criteria for Sioux Falls, SD.

Summer Outdoor Design Temperature: 92.2ºF DB, 73.6ºF mean coincident WB

Summer Outdoor Design Wet Bulb Temperature: 77.2ºF WB, 87.2ºF mean coincident DB

Winter Outdoor Design Temperature: -15ºF DB

Indoor Design Conditions

Classroom and Lab Spaces: 70ºF heating, 75ºF / 50% RH cooling. No mechanical humidification.

Equipment Rooms: 60ºF heating, No mechanical cooling or humidification.

Public Spaces: 70ºF heating, 75ºF / 50% RH cooling. No mechanical humidification.

Load Analysis

Trane Trace 700 Analysis Program for heating / cooling load calculations.

Occupancy will be based on ASHRAE 62.1 – 2010 recommendations where actual occupancy levels are unknown.

Lighting loads will be based on ASHRAE Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Building and per Electrical Engineers selected lighting power densities.

Equipment loads will be based on recommendations in ASHRAE 2013 Handbook Fundamentals, owner provided IT equipment information and on manufacturer's data where available.

Wall, roof and glass thermal characteristics as developed by the project architects.

SITE UTILITY CONNECTIONS:

Sanitary Sewer Service:

A sanitary sewer line will extend from the new building to city utility piping. Extensions from building connections are work of Division 33.

Storm Drain Service:

Multiple storm lines will extend from the new building to city utility piping. Extensions from building connections are work of Division 33.

Domestic Water Service:

New water service will be extended to the new building from city utility piping. Piping to the building will be provided as work of Division 33.

Fire Protection Water Service:

New water service will be extended to the new building from city utility piping. Piping to the building including a post indicator valve in the yard will be provided as work of Division 33.

Natural Gas Service:

New gas service will be extended to the new building from gas utility piping. Piping to the building will be provided as work of Division 33.

PLUMBING - DOMESTIC WATER PIPING

Piping will be type L hard drawn copper tubing with solder-joint fittings for small sizes; mechanical grooved joints and fittings for large sizes. Recirculating hot water pumps will be provided to maintain domestic hot water temperature at fixtures and equipment. All piping will be routed concealed above ceilings and within pipe chases.

Water Piping Insulation:

Water piping will be insulated with pre-molded fiberglass with all service jacket. Thicknesses will be as required by the Energy code. Exposed piping will be covered with a PVC jacket.

Domestic Water Heater(S):

High-efficiency, gas-fired condensing storage water heater(s) located in mechanical rooms. Water heated and stored at 140 deg F. A thermostatic master mixing valve will be used to deliver 120 F water to fixtures.

Water Softener(S):

Water softeners will be provided for domestic hot water and heating system make-up water systems. Unit(s) located in mechanical room at water service entrance.

PLUMBING - SANITARY WASTE AND VENT SYSTEMS

Sanitary Waste and Vent Piping:

Cast-iron piping with no-hub fittings above grade. Below grade piping will be PVC. Piping routed underground, and concealed within piping chases, above ceilings and within walls from fixtures and equipment. Piping will be routed by gravity to service lines.

Plumbing Fixtures: Commercial Quality Fixtures Include:

Water closets will be low flow (1.28 gpf), wall mounted with battery powered sensor flush valves.

Urinals will be ultra-low flow (0.125 gpf) with battery powered sensor flush valves. Lavatories will be drop in or under counter mounted china with low flow (0.35 gpm) battery powered sensor faucets. Electric water coolers will be wall hung dual level stainless steel with bottle filler.

PLUMBING – STORM DRAIN SYSTEMS

Storm Drain Piping:

Cast-iron piping with no-hub fittings above grade. Below grade piping will be PVC. Piping routed underground, and concealed within piping chases, above ceilings and within walls from fixtures and equipment. Piping will be routed by gravity to service lines.

Roof drain systems will include primary and overflow drains. Primary drains will be collected below the floor slab and discharge to the city storm sewer system. Overflow drains will discharge to grade.

Storm drain piping will be insulated with pre-molded fiberglass with all service jacket.

Thicknesses will be as required by the Energy code. Exposed piping will be covered with a PVC jacket.

FIRE PROTECTION SYSTEMS

The building will be protected with a wet-pipe fire sprinkler system in accordance with the requirements of NFPA and the local fire authority. System shall be designed to provide a level of fire protection consistent with the fire hazard. Piping will be threadable lightwall steel piping with threaded or mechanical grooved-end fittings.

Sprinklers will be flush pendants with white-painted covers, semi-recessed pendants with white-painted or chrome-plated escutcheons, or brass upright or pendent sprinklers where exposed and in service areas.

A dry pipe system and zone will be provided to serve the areas below the overhung 2nd Level (exposed floor areas at NW and SW corners of the building). Dry pipe valve and air compressor shall be located adjacent to the fire service entrance.

It is assumed that the municipal water system has adequate capacity to serve the building fire sprinkler system without need for a fire pump. However, this assumption will need to be confirmed by performing a hydrant flow test. The City of Madison has indicated that the city water system is currently operating under temporary modified operational conditions and that these conditions will not be what is experienced when the building in in operation. It is expected that permanent conditions will be set in May of 2016. Consequently, any flow test performed prior to that date may give inaccurate results.

MECHANICAL HVAC PIPING – HEATING WATER SYSTEM

Hot Water Boilers:

1. High efficiency, gas-fired condensing hot water boilers. Two Aerco Benchmark boilers at approximately 1,500 MBH each. Burners shall be dual fuel capable of operating on natural gas and propane with separate gas trains. Self-contained microprocessor controllers to cascade and to modulate firing rate to generate heating water for air-handling unit preheating coils, perimeter space heating, vestibule and equipment room heating and air terminal unit heating coils for space temperature control.
2. Heating water supply temperature will be designed for 160 deg F but will be controlled to reset to 120 deg F as outside air temperatures moderate.
3. Boilers provided with combustion air intake and discharge exhaust venting through the roof.
4. A 500 gallon propane tank will be provided as back up fuel source.

Perimeter Heating:

1. Hydronic fin-tube radiation and/or radiant ceiling panels will be provided at all exterior walls for space heating. Fin-tube enclosure shall be 16 ga. Factory painted steel and extend wall to wall. Radiant panels will be either linear or modular styles.
2. Radiation will be piped separately from the terminal reheat coils with separate control valves and used as the 1st stage of heat.
3. Primary heating for the 2-story collaboration center will be by an in-floor radiant system fed from the main boiler plant.

Air-Cooled Water Chiller:

1. Mechanical cooling will be provided by a single packaged, rotary screw, air-cooled, high-efficiency chiller located on grade. Unit will include variable speed compressors and sound package.
2. Basis of design: Trane Sintesis RTAF, 125 Ton capacity.10.5 EER, 16.2 IPLV.

Heating and Chilled Water Pumps And Equipment:

1. Duplex base-mounted centrifugal pumps with full standby capability selected for a full range of GPM loads. Variable frequency drives provided for pump motors.
2. Provide in-line boiler pumps with variable frequency drives to assure water circulation through hot water boilers.
3. Heating and chilled water system equipment will include air separators, diaphragm-type compression tanks, and auxiliaries.
4. An automatic glycol feeder unit will be provided for makeup water. Heating water will be a 30 percent propylene glycol solution. Chilled water system will be a 25% propylene glycol solution.

Heating and Chilled Water Piping:

1. Schedule 40 black steel piping with threaded, flanged, or mechanical grooved-end fittings. Type L copper tubing with lead-free solder joints could be used for smaller pipe sizes. Heating water piping extended to air-handling unit heating coils and to hydronic terminal units throughout the building.
2. Hydronic terminal units will include air terminal unit heating coils, unit heaters, radiant ceiling panels, and finned tube radiation. Perimeter heating will be primarily with continuous radiant panels, but also with finned tube radiation under full height curtain wall glass. Provide cabinet unit heaters at entrance vestibules.
3. Piping routed concealed above ceilings, within piping chases and walls to fixtures and equipment. Piping will not be routed underground or in unheated spaces.
4. Provide water flow meters on heating and chilled water mains to measure total flow.

Hydronic Piping Insulation:

1. Heating water piping insulated with pre-molded fiberglass with all-service jackets.
2. Insulation thicknesses as required by the Energy Code to reduce thermal losses and to minimize condensation.
3. Provide PVC jackets where piping is run exposed and subject to damage.
4. All outdoor chilled water piping shall be covered with an aluminum jacket.

MECHANICAL HVAC – VENTILATION AND AIR CONDITIONING SYSTEMS

HVAC Systems:

The building heating, ventilation and air conditioning will be achieved with indoor variable air volume air-handling systems supplemented with perimeter heating equipment.

Modular Indoor Air-Handling Units With Energy Recovery:

1. Factory-fabricated modular air-handling unit, double-wall insulated. One unit will be provided to serve each of the two floor levels.
2. Cataloged (non-custom) air-handling units.
3. Air-handling units will consist of the following components:

    a. Return air opening in top back of unit.
    b. Centrifugal airfoil plenum return fan with variable speed motor drive. Direct drive fans.
    c. Return/ relief air plenum. Relief air discharged horizontally to a wall louver or roof gravity hood.
    d. Outside air/ return air plenum. Mixing dampers with top outside air opening. Provide provision and 100 percent outside air economizer capability. Provide an air flow measuring station with capability to measure minimum outside air. Outside air intake from a wall louver.
    e. Energy recovery wheel sized for approximately 1/3 of the total unit supply air flow.
    f. 80-85 percent efficient (MERV 13) filters with MERV 8 pre-filters. Selected for 500 FPM or less.
    g. Hot water heating coil. Selected for 500 FPM or less. 60 deg F LAT.
    h. Chilled water cooling coils. Selected for 500 FPM or less. 53.0 deg F LAT. 8 rows minimum.
    i. Centrifugal airfoil plenum supply fan with variable speed motor drive. Direct drive fans.

Preliminary Unit Service and Capacities:

1. AHU-1: Level 1: 22,000 CFM
2. AHU-2: Level 2: 22,000 CFM

Telecom and Server Room Air Conditioning Units.

1. The Server Sim Lab will be cooled with an air-cooled computer room cooling unit (Liebert or equal). Unit will be floor or ceiling mounted depending upon capacity requirement. System will include an integral humidifier and electric reheat coil. Air cooled condensing unit will be located on the roof.
2. Telecom spaces will be provided with dedicate duct free split system cooling unit capable of operating to -20 deg F. Air cooled condensing units will be located on grade or roof.

Energy Recovery Ventilator/Exhaust Fans

1. Toilet rooms and Janitor closets will be exhausted with roof mounted energy recovery ventilator with enthalpy wheel. Supply air from the ERV will be ducted to the outdoor connection of the air handling units. ERV shall include electric preheat coil for frost control.
2. A dedicated power roof ventilator will be provided to exhaust the Game Design Studio on Level 1. This fan will be controlled from a wall switch and will operate intermittently.

Air Distribution Ductwork:

1. Low pressure supply air, return air, outside air, relief air, and exhaust air ductwork fabricated of galvanized steel sheet metal in rectangular and round shapes according to space requirements. SMACNA 2-inch duct pressure classifications, with Class A duct sealing.
2. Medium pressure supply air ductwork between supply fans and air terminal units (and between return air terminals and return fans) fabricated of galvanized steel sheet metal in rectangular and round shapes according to space requirements. SMACNA 4-inch duct pressure classifications, with Class A duct sealing.
3. Exposed ductwork outside of equipment rooms shall be paint grip metal for field painting.
4. Insulated fiberglass-reinforced-plastic for underfloor ductwork.

External Duct Insulation:

1. Concealed supply and return air duct shall be insulated with 1-1/2-1.0 pound density fiberglass blanket with a foil-scrim-kraft vapor barrier.
2. Exposed supply and return air duct shall be insulated with 1-1/2-inch thick, 3.0 pound density fiberglass board insulation with and all-service jacket. Ductwork in pool areas will not be insulated.
3. Outside air and relief air ducts shall be insulated continuously and exhaust air ducts shall be insulated within 5 feet of a wall or roof opening with 2-inch thick, 3.0 pound density fiberglass board insulation with and all-service jacket.

Air Terminal Units:

1. Pressure-independent, single duct, variable volume air terminal units with hot water reheating coils.

Registers, Grilles And Diffusers:

1. Square louvered supply diffusers, lay-in and surface-mounted.
2. Linear slot diffusers.
3. Linear bar-type diffusers.
4. Sidewall double-deflection registers.
5. Lay-in and surface-mounted egg crate return air registers.
6. Sidewall and ceiling return and exhaust registers.

MECHANICAL HVAC – AUTOMATIC CONTROL SYSTEM

Automatic Control System:

1. Microprocessor-based direct digital control system with electronic sensors and electronic valve and damper operators. System capability will include building HVAC building controls, operating and maintenance software, energy conservation software, and system graphics.
2. BACnet or LonWorks compatible open protocol devices and components.
3. The system will be compatible with and interface to the existing Siemens Apogee building automation system currently serving the DSU campus.
4. Space temperature sensors shall include setpoint adjustment, display and user occupancy override feature.
5. Densely occupied spaces will be provided with carbon dioxide sensors.

DAKOTA STATE UNIVERSITY
BEACOM INSTITUTE OF TECHNOLOGY
GIRTON SITE
MADISON, SOUTH DAKOTA
ELECTRICAL LEED NARRATIVE

November 13, 2015

Electrical Service

The campus is served with a 4,160 volt medium-voltage loop. A new switchgear cabinet will be added to intercept the existing 15KV feeder and feed a new transformer at the new Beacom building. The medium voltage switchgear will be located in the service enclosure on the east side of the new building (location shall be reviewed, could also be installed on the east side of Heston Hall). Electrical service will consist of incoming conductors to the buildings from a college-owned outdoor transformer located at a coordinated location on the east side of the building. Service conductors will be run underground to the new facility. Preliminary size is to be determined based on load study of the building. Transformer secondary voltage into the facility will be 480Y/277 volts. Note that other transformers on campus are rated 120/208Y volts. TSP suggests the use of 480Y/277 volts to serve lighting and large mechanical equipment loads (especially the chiller), and 120/208Y to serve receptacles and smaller equipment loads. The main service gear shall have a meter and connected into the BAS.

Power Distribution System

The power distribution system will provide electrical energy at 480Y/277 volts, 3 phase, 4 wire, (plus ground) 60 HZ for general lighting, elevators and (generally) motors larger than 3/4 HP. Dry type transformers will be used to provide 208/120 volt, 3 phase, 4 wire, (plus ground) service for convenience receptacles, motors smaller than 3/4 HP, selected communication equipment and other miscellaneous equipment. Power will be distributed from the main electrical equipment room and through branch circuit panelboards as required. Each circuit will be provided with a separate neutral and equipment grounding conductor.

Electrical Motor and Power Equipment

Motor controls will be via individual motor starters and VFD's, located adjacent to each motor served. All starters will be combination type with fused disconnect or circuit breaker capable of being padlocked in the off position. Variable Frequency Drives (VFDs) will be installed as specified by the Mechanical Engineer. All automatically controlled starters will have a local hand off-auto switch to allow for individual testing of the motor. All starters will contain pilot lights to visually indicate operation. A disconnecting means to be installed within sight of motors and other equipment where specifically indicated. Motors 25 HP and larger will be equipped with reduced voltage starters.

Miscellaneous Equipment Connections

Power will be provided for mechanical equipment and water heaters furnished and installed by Division 22/23, automatic door operators, and all miscellaneous equipment furnished by Owner that is coordinated with engineer.

Floor boxes containing duplex receptacles and provisions for voice/data/audio-visual connections will be provided throughout the building in locations to be coordinated with the owner. Receptacles will be incorporated into the grand staircase in the gathering space.

Grounding

Grounding will be provided in accordance with power company guidelines and the National Electric Code. A ground bar will be provided in the main electrical services for bonding of all required electrodes. All feeders and individual branch circuits will be provided with a separate grounding conductor. Ground busses will be provided in all electrical distribution equipment. All communication rooms will be provided with a ground bar and connected to building grounding electrode system.

There shall be an isolated ground system for computer systems as coordinated with University.

Lightning Protection

A lightning protection system will be provided for this Facility.

Lighting Systems

High efficiency LED light sources will be utilized throughout and will operate at 277 volts. Lighting system to be designed within the IES recommended limits. The classroom/labs will have either pendant direct/indirect fixtures or recessed direct/indirect fixtures. Each classroom/lab will have zone lighting control (presentation, task, and all on). LEED v4 requires for all shared multi-occupant spaces to have multi-zone control with at least three lighting levels [on, off, midlevel (midlevel is 30% to 70% of maximum)].

Emergency Egress Lighting

Emergency egress lighting will be provided in lobbies, corridors/public areas, toilets, and electrical/mechanical rooms. Battery operated emergency lighting will be provided in emergency egress areas (interior and exterior).

An emergency backup generator is not planned for this Facility.

Exterior Lighting System

Exterior doors will be provided with LED egress/security lighting. Exterior lighting will include soffit lighting and sidewalk lighting. Exterior lighting shall match the Campus LED Halophane Granville series.

Lighting Control Systems

Lighting controls will be provided to conform to LEED standards. All lighting, indoors and outdoors, will be automatically controlled by a computerized, programmable lighting control system. Lighting control system will be capable of interfacing with the Energy Management Controls System. Exterior lighting controls will reside inside the building. Automatic control shall be achieved via time-of-day (via astronomical time clock), occupancy control (i.e. occupancy sensors), and photoelectric control (i.e. daylight harvesting). A whole building control system is anticipated.

Telephone/Data Systems

A telecommunications room will be provided for all communication and signal systems. Painted plywood panels will be provided for terminal equipment and mounting system boxes and panels. A ground wire will be brought to a ground bar in all telecommunication rooms and closets from the building service ground.

A conduit system is to be installed as required with distribution conduits, sleeves, and outlet boxes. Two 4 inch PVC raceways will be extended to the tunnel for fiber, cable TV, and analog/copper feeds for communication connections to Campus links. Separate Utility entrances are not needed.

Backbone cabling to the Science Center servers will consist of 24 strands of 50 micron, laser optimized multi-mode fiber, 25-pair of copper (analog), and RG-11 coax. Existing Campus server room will remain in the Science Center. A single, radial fiber will be used to feed Beacom from the Science Center.

Horizontal cabling within the Facility will consist of Cat 6 cables. Two cables will be brought to the standard workstation.

The telephone system can be mounted, by the Owner, on the plywood backboards, if required.

Telephone cross-connects are by Owner.

Data patch cords quantity shall be coordinated with Engineer.

Video (TV) Distribution System

A conduit system is to be installed as required with distribution conduits, sleeves, and outlet boxes. All required power equipment, connections and the raceway system to be provided as determined by the Owner. Rough-in for Owner installed devices shall be coordinated with Engineer.

Audio/Visual Systems

TSP will coordinate rough-in and power requirements with AV Consultant.

Sound System

Sound system is not planned.

Paging System

Paging system is not planned.

Mass Notification System

A mass notification system is not planned.

Clock System

Clock system is not planned.

Access Control System

Rough-in for Owner installed devices shall be coordinated with Engineer. Biometrics at entrances into building are anticipated in the future.

Intrusion Detection System

Rough-in for Owner installed devices shall be coordinated with Engineer.

Video Surveillance System

Rough-in for Owner installed devices shall be coordinated with Engineer.

Cable Tray

Cable tray will be provided for main routing of low-voltage cabling on both floors.

Fire and Smoke Alarm Systems

An addressable, multi-plexed, microprocessor based, electrically supervised fire management type system will be provided complete with central processing unit, power supplies, data gathering panels (transponders), remote annunciators, campus tie, audible (voice evacuation where required) and visual signal devices, manual stations, automatic devices including ionization smoke detectors, combination fixed temperature/rate of rise detectors, OS&Y switches, etc. as required. All devices shall be connected together to provide a complete system designed to NFPA standards. The system will be designed in accordance with ADA standards. The main control panel will be located in main telecom room. System will be provided in accordance with local and state requirements. A smoke detector will be provided above the fire alarm panel in the electrical room as required. Smoke and/or heat detectors will be provided in electrical rooms and closets that are not sprinkled, if required by local and state fire codes. Smoke duct detectors will be provided in air moving systems where required by code. The system will be addressable by device to allow easy identification of the activated area and type of device. Smoke detectors will be provided in conjunction with magnetic door holders, when applicable. A voice evacuation system is not planned at this time. Occupancy: B + A (in Gathering space). Requirements for voice evacuation: A-occupancy, 1000+. The fire alarm system must be fully compatible communicating with the Campus' main Siemens panel to notify the Campus (Physical Plant) of troubles. Physical Plant alarms monitoring station. Siemens will be base bid and alternate bid for others (must by UL Listed to be compatible with interfacing with existing Siemens main campus central control panel and digital communicator in Physical Plant).

Area of Rescue Systems

Area of Rescue system will not be required (2012 IBC 1007.3 exc 2).

LEED

The project will be built to comply with LEED 4.0 US Green Building Council (USGBC), minimum of silver.

For LEED, per ASHRAE 90.1-2010, 50% of the receptacles will need to be automatically controlled to remove power from these outlets.
Advanced metering will be designed. Systems will need to be distributed individually (HVAC, lighting, and receptacles) and fed out of separate panels for monitoring.

Commissioning

The Owner will engage in a Commissioning Agent for enhanced commissioning. The Contractor will need to be available during this start-up and testing.

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AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
- ENVIRONMENTAL
- GEOTECHNICAL
- MATERIALS
- FORENSICS

REPORT OF GEOTECHNICAL EXPLORATION AND REVIEW

Proposed Beacom Institute of Technology
Alternate Site
Dakota State University
Madison, South Dakota

Report No. 32-01856

Date:

November 3, 2015

Prepared for:

Office of the State Engineer
Foss Building
523 East Capitol Avenue
Pierre, South Dakota 57501

www.amengtest.com

AMERICAN ENGINEERING TESTING, INC.

CONSULTANTS
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• MATERIALS
• FORENSICS

November 3, 2015

Office of the State Engineer
Foss Building
523 East Capitol Avenue
Pierre, South Dakota 57501

Attn: Rich Ivey, PE

RE: Geotechnical Exploration and Review
Proposed Beacom Institute of Technology
Alternate Site
Dakota State University
Madison, South Dakota
Report No. 32-01856

Dear Mr. Ivey:

American Engineering Testing, Inc. (AET) is pleased to present the results of our subsurface exploration program and geotechnical engineering review for your proposed building at Dakota State University in Madison, South Dakota. These services were performed according to our proposal to you dated October 26, 2015 and our modified contract with the Office of the State Engineer dated March 2, 2015. We are submitting an electronic copy of the report to you as well as to the party noted below.

Please contact us if you have any questions about the report. We can also be contacted for arranging construction observation and testing services during the earthwork phase.

Sincerely,
American Engineering Testing, Inc.

Bruce W. Card, PE
Senior Engineer
Phone: (605) 332-5371
Fax: (605) 332-8488
bcard@amengtest.com

BWC/bc

cc: TSP

SIGNATURE PAGE

Prepared for:

Office of the State Engineer
Foss Building
523 East Capitol Avenue
Pierre, South Dakota 57501

Attn: Rich Ivey, PE

Prepared by:

American Engineering Testing, Inc.
601 East 48th Street North
Sioux Falls, South Dakota 57104
(605) 332-5371/www.amengtest.com

Authored by:

Bruce W. Card, PE
Senior Engineer

Reviewed by:

Bradley C. Letcher, EIT
Project Manager

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- Unified Soil Classification System
- Site Location Map
- Boring Location Map
- Subsurface Boring Logs

APPENDIX B – Geotechnical Report Limitations and Guidelines for Use

1.0 INTRODUCTION

You are proposing to construct a new Beacom Institute of Technology building at Dakota State University in Madison, South Dakota. To assist in planning and design, you have authorized American Engineering Testing, Inc. (AET) to conduct a subsurface exploration program at the site, conduct soil laboratory testing, and perform a geotechnical engineering review for the project. This report presents the results of the above services, and provides our engineering recommendations based on this data. A previous report for this project at another site was submitted to you under report #32-01755 dated August 17, 2015.

2.0 SCOPE OF SERVICES

AET's services were performed according to our proposal to you dated October 26, 2015 and our contract with the Office of the State Engineer dated March 2, 2015. The authorized scope consists of the following:

- Contact South Dakota One Call to clear utilities in the area of the subsurface exploration.
- Four (4) standard penetration test borings to a depth of 21 feet.
- Soil laboratory testing.
- Geotechnical engineering analysis based on the gained data and preparation of this report.

These services are intended for geotechnical purposes. The scope is not intended to explore for the presence or extent of environmental contamination.

3.0 PROJECT INFORMATION

The site is located in an existing parking lot to the east of Washington Avenue North and south of 8th Street NE in Madison, South Dakota. We understand the project will consist of the construction of a new building occupying approximately 42,000 square feet. The structure will likely be two-story, slab-on-grade construction with steel framing and masonry exterior walls.

Actual loadings were not available at the time of this report, however, we normally associate light to moderate loadings for a structure of this type.

The above stated information represents our understanding of the proposed construction. This information is an integral part of our engineering review. It is important that you contact us if there are changes from that described so that we can evaluate whether modifications to our recommendations are appropriate.

4.0 SUBSURFACE EXPLORATION AND TESTING

4.1 Field Exploration Program

The subsurface exploration program conducted for the project consisted of four (4) standard penetration test (SPT) borings. The logs of the borings and details of the methods used appear in Appendix A. The logs contain information concerning soil layering, soil classification, geologic description, and moisture condition. Relative density or consistency is also noted for the natural soils, which is based on the standard penetration resistance (N-value).

The boring locations are shown on the Boring Location Map included in Appendix A. The borings were staked in the field by AET personnel by measuring from nearby site features. Surface elevations at the boring locations were obtained by others and furnished to AET personnel. The elevation at each boring location based on the furnished elevation is shown on the top of the logs included in Appendix A.

4.2 Laboratory Testing

The laboratory test program included water content, dry density and unconfined compression tests. The test results appear in Appendix A on the individual boring logs adjacent to the samples upon which they were performed.

5.0 SITE CONDITIONS

5.1 Surface Observations

The site is located southeast of the intersection of 8th Street NE and Washington Avenue North in Madison, South Dakota. The general topography of the proposed building area is relatively level with surface elevations at the boring locations in the proposed building area ranging from 1690.1' to 1696.9' based on the furnished elevations. The site is an existing concrete surfaced parking lot.

5.2 Subsurface Soils/Geology

The site geology consists of a layer of fill at the surface underlain by clay fine alluvium followed by sandy lean clay till which extended to the termination depth of the borings at 21' below existing grade. The clay alluvium was brown mottled with a consistency ranging from firm to soft. The sandy lean clay was brown mottled with a consistency ranging from firm to stiff.

5.3 Ground Water

Ground water was encountered at a depth of 19.5' to 13.5' in borings 1 and 2 respectively during our subsurface exploration program. Ground water levels should be expected to fluctuate seasonally and yearly. The time of year that the borings were drilled, and the history of precipitation prior to drilling, should be known when using the water level information on the soil boring logs to extrapolate water levels at other points in time.

Based upon our previous experience with clay till soils in the general project area, it is our opinion that the subsurface water levels at the site could be quite near the ground surface during periods of significant precipitation, particularly during the spring of the year.

5.4 Review of Soil Properties

5.4.1 Fill

The existing fill is mostly clayey sand over a mixture of lean clay and sandy lean clay which was brown to dark brown to black in color. The existing fill is generally low to moderate strength material and is judged to be at least moderately frost susceptible.

5.4.2 Fine Alluvium

The fine alluvial soils are classified as brown mottled lean clay. These soils are relatively slow draining and are judged to be at least moderately frost susceptible.

5.4.3 Glacial Till

The non-organic till soils are moderate strength materials and are not judged to be significantly compressible under foundation loadings. The glacial till soils are classified as brown mottled sandy lean clay. These soils are also relatively slow draining and are judged to be at least moderately frost susceptible.

6.0 RECOMMENDATIONS

6.1 Approach Discussion

The underlying sandy lean clay till soils are capable of supporting the proposed structure on spread footing foundations. The existing fill and fine alluvial clay soils are low to moderate strength material and are judged to be potentially compressible under fill and structure loads. We recommend that all fill and fine alluvial lean clays be completely removed from beneath the foundation areas. The fine alluvial lean clay soils could be left in place beneath floor slab areas.

We wish to note that the clay soils encountered at the site may be sensitive to disturbance and potential strength loss under construction traffic and/or excessive moisture. The soils can lose strength with the combination of additional moisture and construction traffic. Disturbance of these

soils should be prohibited. Water should not be allowed to pond on these soils for any length of time.

6.2 Building Grading

6.2.1 Excavation

To prepare the building area for foundation support, we recommend complete excavation of the existing fill and fine alluvial clay soil deposits, thereby exposing the stiffer sandy lean clay till soils. This would result in an excavation depth at the boring locations as shown in Table A.

Table A – Recommended Excavation Depths

Boring Location	Surface Elevation (ft)	Excavation Depth (ft)	Approximate Excavation Elevation (ft)
1	1692.6	9.0	1683.6
2	1696.9	6.0	1690.0
3	1690.1	3.5	1686.6
4	1691.9	4.0	1687.9

The depth of excavation indicated above is based on the soil conditions at the specific boring location. Since conditions will vary away from the boring location, it is recommended that AET geotechnical personnel observe and confirm the competency of the soils in the entire excavation bottom prior to new fill or footing placement.

If the excavation extends below foundation grade, the excavation bottom and resultant engineered fill system must be oversized laterally beyond the planned outside edges of the foundations to properly support the lateral loads exerted by that foundation. This excavation/engineered fill lateral extension should at least be equal to the vertical depth of fill needed to attain foundation grade at that location (i.e., 1:1 lateral oversize).

The risk of soil disturbance increases significantly when water is present. The amount of water encountered by the excavation at the site will be dependent upon seasonal fluctuations, the excavation depths required and the amount of sands encountered. Because of the impermeable

nature of the majority of the soils present at the boring locations and the depth to groundwater, it likely will be possible to control water entering into the excavation with normal sump pumping procedures. Any water which does collect in the open excavation should be quickly removed and surface drainage away from the excavation should be provided during construction. Any tile or utility lines present should be rerouted around the proposed building areas.

6.2.2 Fill Placement and Compaction

The non-organic site soils are suitable for use as grading fill outside the proposed building area for the project. We do not recommend using any existing topsoil for fill except for cover material. Prior to the placement of fill, the exposed subgrades should be scarified to a depth of 6-inches, the moisture content of the scarified soils should be adjusted to within 3% of the optimum moisture content and the soils compacted to at least 95% of maximum Standard Proctor dry density.

Fill placed to attain grade for foundation or floor slab support should be compacted in thin lifts, such that the entire lift achieves a minimum compaction level of 95% of the standard maximum dry unit weight per ASTM:D698 (Standard Proctor test).

For ease of placement and compaction, we recommend using a granular material with a maximum size of 2" and less than 12% fines for any fill transported to the site.

Any fill placed in or near water should be medium/coarse grained, free draining sand with less than 40% passing the #40 sieve and 5% passing the #200 sieve. Additionally, the initial lift of fill should be about 2' to lessen the risk of disturbing the natural soils present at the site.

6.2.3 Foundation Design

Spread Footing Foundations

The structure can be supported on conventional spread footing foundations placed on the clay mixed alluvium, sand coarse alluvium, clay till or new granular engineered fill above the natural soils. We recommend perimeter foundations for heated building space be placed such that the bottom is a minimum of 48 inches below exterior grade. We recommend foundations for unheated building space be extended to a minimum of 60 inches below exterior grade.

Based on the soil conditions encountered, it is our opinion the building foundations can be designed based on a net maximum allowable soil bearing pressure of 2,500 psf. It is our judgment this design pressure will have a factor of safety of at least 3 against localized shear or base failure. We judge that total settlements under this loading should not exceed 1 inch. We also judge that differential settlements should not exceed ½ inch.

6.2.4 Floor Slab Design

For concrete slab design, we estimate the new granular fill should provide a Modulus of Subgrade Reaction (k-value) of at least 150 pci.

For recommendations pertaining to moisture and vapor protection of interior floor slabs, we refer you to the attached standard sheet entitled "Floor Slab Moisture/Vapor Protection."

6.3 Exterior Building Backfilling

Many of the on-site soils are at least moderately frost susceptible. Because of this, certain design considerations are needed to mitigate these frost effects. For details, we refer you to the attached sheet entitled "Freezing Weather Effects on Building Construction."

6.4 Lateral Earth Pressures

Assuming that any portion of the structure that will experience lateral earth pressures will be rigid and no deflection can take place during or following backfilling, we recommend an at-rest equivalent fluid pressure of 60 pcf be used above the groundwater level for the on-site clay soils or new granular engineered fill soils. If an active equivalent fluid pressure is desired, we recommend using 40 pcf for the on-site clay soils or new granular engineered fill soils above the groundwater level. For submerged conditions, we recommend that an at-rest equivalent fluid pressure of 100 pcf or an active equivalent fluid pressure of 90 pcf be used.

The pressures recommended above assume drained conditions behind the walls and 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. Adequate drainage should be provided behind any below grade walls as described in the "Basement/Retaining Wall Backfill and Water Control" standard sheet included with this report. The values calculated for the above parameters would provide ultimate values. We recommend a minimum safety factor of at least 1.5 be applied to the calculated lateral values. The above noted equivalent fluid pressures assume the backfill soils adjacent to the walls will be compacted to a range of 95% to 100% of the Standard Proctor density.

6.5 Drain Tile

For the portions of the structure extending below grade and at the bottom of any granular fill above the clay soils, a filtered drain tile should be placed at the base of the perimeter footing excavations at the bottom of the granular engineered fill. The drain tile lines should be drained to a sump (where it can be pumped) or to a gravity outlet. We recommend that all below grade walls be adequately water proofed to help prevent the intrusion of water into the structure.

6.6 Exterior Slabs

Exterior slabs can be supported on the existing soil profile once all topsoil is removed. Where exterior slabs connect to the new building and where granular soils are not already present, we recommend that a significant layer (at least 18") of granular fill be placed beneath the slabs. In addition, drain tile should be placed at the base of the granular layer and be connected to a suitable outfall to provide drainage of the granular layer. A combination of the granular soils and drain tile system should significantly reduce potential frost heave of exterior slabs or sidewalks.

7.0 CONSTRUCTION CONSIDERATIONS

7.1 Potential Difficulties

7.1.1 Runoff Water in Excavation

Water can be expected to collect in the excavation bottom during times of inclement weather or snow melt. To allow observation of the excavation bottom, to reduce the potential for soil disturbance, and to facilitate filling operations, we recommend water be removed from within the excavation during construction. Based on the soils encountered, we anticipate the ground water can be handled with conventional sump pumping.

7.1.2 Disturbance of Soils

The on-site soils can become disturbed under construction traffic, especially if the soils are wet. If soils become disturbed, they should be subcut to the underlying undisturbed soils. The subcut soils can then be dried and recompacted back into place, or they should be removed and replaced with drier imported fill.

7.1.3 Winter Construction

If construction occurs during the winter, it is necessary for the contractor to protect the base soils from freezing each day and each night before new fill is placed. Fill should not be placed over frozen soils, snow, or ice, nor should the use of frozen fill soils be permitted. The contractor

must protect base soils from freezing before and after fill placement, and before, during, and after concrete placement. If the interior footings will be exposed to freezing temperatures during construction, we recommend that you consider lowering the footings to protect against frost penetration into the footing subgrade soils. We recommend that a special pre-construction meeting be held to discuss the procedures and precautions that must be followed.

7.2 Excavation Backsloping

If excavation faces are not retained, the excavations should maintain maximum allowable slopes in accordance with *OSHA Regulations (Standards 29 CFR), Part 1926, Subpart P, "Excavations"* (can be found on www.osha.gov). Even with the required OSHA sloping, water seepage or surface runoff can potentially induce sideslope erosion or running which could require slope maintenance.

7.3 Observation and Testing

The recommendations in this report are based on the subsurface conditions found at our test boring locations. Since the soil conditions can be expected to vary away from the soil boring locations, we recommend on-site observation by a geotechnical engineer/technician during construction to evaluate these potential changes. Soil density testing should also be performed on new fill placed in order to document that project specifications for compaction have been satisfied.

8.0 LIMITATIONS

Within the limitations of scope, budget, and schedule, our services have been conducted according to generally accepted geotechnical engineering practices at this time and location. Other than this, no warranty, either expressed or implied, is intended.

Important information regarding risk management and proper use of this report is given in Appendix B entitled "Geotechnical Report Limitations and Guidelines for Use."

EXCAVATION AND REFILLING FOR STRUCTURAL SUPPORT

EXCAVATION

Excavations for structural support at soil boring locations should be taken to depths recommended in the geotechnical report. Since conditions can vary, recommended excavation depths between and beyond the boring locations should be evaluated by geotechnical field personnel. If ground water is present, the excavation should be dewatered to avoid the risk of unobservable poor soils being left in-place. Excavation base soils may become disturbed due to construction traffic, ground water, or other reasons. Such soils should be subcut to underlying undisturbed soils. Where the excavation base slopes at an angle steeper than 4H:1V, the excavation bottom should be benched across the slope parallel to the slope contour.

Soil stresses under foundations spread out with depth. Therefore, the excavation bottom and subsequent fill system should be laterally oversized beyond foundation edges to support these stresses. A lateral oversize equal to the depth of fill below the foundation (i.e., 1:1 oversize) is usually recommended. The lateral oversize is usually increased to 1.5:1 to 2:1 where compressible organic soils are exposed on the excavation sides. Variations in oversize requirements may be recommended in the geotechnical report or can be evaluated by the geotechnical field personnel.

Unless the excavation is retained, the backslopes should be maintained in accordance with OSHA Regulations (Standards - 29 CFR), Part 1926, Subpart P, "Excavations" (found on www.osha.gov). Even with the required OSHA sloping, ground water can induce sideslope raveling or running which could require that flatter slopes or other approaches be used.

FILLING

Filling should proceed only after the excavation bottom has been approved by the geotechnical engineer/technician. Approved fill material should be uniformly compacted in thin lifts to the compaction levels specified in the geotechnical report. The lift thickness should be thin enough to achieve specified compaction through the full lift thickness with the compaction equipment utilized. Typical thicknesses are 6" to 9" for clays and 12" to 18" for sands. Fine grained soils are moisture sensitive and are often wet (water content exceeds the "optimum water content" defined by a Proctor test). In this case, the soils should be scarified and dried to achieve a water content suitable for compaction. This drying process can be time consuming and labor intensive, and will require favorable weather.

Select fill material may be needed where the excavation bottom is sensitive to disturbance or where standing water is present. Sands (SP) which are medium to coarse grained are preferred, and can be compacted in thicker lift thicknesses than finer grained soils.

Filling operations for structural support should be closely monitored for fill type and compaction by a geotechnical technician. Monitoring should be on a full-time basis in cases where vertical fill placement is rapid; during freezing weather conditions; where ground water is present; or where sensitive bottom conditions are present.

EXCAVATION/REFILLING DURING FREEZING TEMPERATURES

Soils that freeze will heave and lose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density loss depends on the soil type and moisture condition; and is most pronounced in clays and silts. Foundations, slabs, and other improvements should be protected from frost intrusion during freezing weather. For earthwork during freezing weather, the areas to be filled should be stripped of frozen soil, snow, and ice prior to new fill placement. In addition, new fill should not be allowed to freeze during or after placement. For this reason, it may be preferable to do earthwork operations in small plan areas so grade can be quickly attained instead of large areas where much frost stripping may be needed.

FLOOR SLAB MOISTURE/VAPOR PROTECTION

Floor slab design relative to moisture/vapor protection should consider the type and location of two elements, a granular layer and a vapor membrane (vapor retarder, water resistant barrier or vapor barrier). In the following sections, the pros and cons of the possible options regarding these elements will be presented, such that you and your specifier can make an engineering decision based on the benefits and costs of the choices.

GRANULAR LAYER

In American Concrete Institute (ACI) 302.1R-04, a "base material" is recommended over the vapor membrane, rather than the conventional clean "sand cushion" material. The base layer should be a minimum of 4 inches (100 mm) thick, trimmable, compactable, granular fill (not sand), a so-called crusher-run material. Usually graded from 1½ inches to 2 inches (38 to 50 mm) down to rock dust is suitable. Following compaction, the surface can be choked off with a fine-grade material. We refer you to ACI 302.1R-04 for additional details regarding the requirements for the base material.

In cases where potential static water levels or significant perched water sources appear near or above the floor slab, an under floor drainage system may be needed wherein a draintile system is placed within a thicker clean sand or gravel layer. Such a system should be properly engineered depending on subgrade soil types and rate/head of water inflow.

VAPOR MEMBRANE

The need for a vapor membrane depends on whether the floor slab will have a vapor sensitive covering, will have vapor sensitive items stored on the slab, or if the space above the slab will be a humidity controlled area. If the project does not have this vapor sensitivity or moisture control need, placement of a vapor membrane may not be necessary. Your decision will then relate to whether to use the ACI base material or a conventional sand cushion layer. However, if any of the above sensitivity issues apply, placement of a vapor membrane is recommended. Some floor covering systems (adhesives and flooring materials) require installation of a vapor membrane to limit the slab moisture content as a condition of their warranty.

VAPOR MEMBRANE/GRANULAR LAYER PLACEMENT

A number of issues should be considered when deciding whether to place the vapor membrane above or below the granular layer. The benefits of placing the slab on a granular layer, with the vapor membrane placed **below** the granular layer, include **reduction** of the following:

- Slab curling during the curing and drying process.
- Time of bleeding, which allows for quicker finishing.
- Vapor membrane puncturing.
- Surface blistering or delamination caused by an extended bleeding period.
- Cracking caused by plastic or drying shrinkage.

The benefits of placing the vapor membrane over the granular layer include the following:

- A lower moisture emission rate is achieved faster.
- Eliminates a potential water reservoir within the granular layer above the membrane.
- Provides a "slip surface", thereby reducing slab restraint and the associated random cracking.

If a membrane is to be used in conjunction with a granular layer, the approach recommended depends on slab usage and the construction schedule. The vapor membrane should be placed above the granular layer when:

- Vapor sensitive floor covering systems are used or vapor sensitive items will be directly placed on the slab.
- The area will be humidity controlled, but the slab will be placed before the building is enclosed and sealed from rain.
- Required by a floor covering manufacturer's system warranty.

The vapor membrane should be placed below the granular layer when:

- Used in humidity controlled areas (without vapor sensitive coverings/stored items), with the roof membrane in place, and the building enclosed to the point where precipitation will not intrude into the slab area. Consideration should be given to slight sloping of the membrane to edges where draintile or other disposal methods can alleviate potential water sources, such as pipe or roof leaks, foundation wall damp proofing failure, fire sprinkler system activation, etc.

There may be cases where membrane placement may have a detrimental effect on the subgrade support system (e.g., expansive soils). In these cases, your decision will need to weigh the cost of subgrade options and the performance risks.

FREEZING WEATHER EFFECTS ON BUILDING CONSTRUCTION

GENERAL

Because water expands upon freezing and soils contain water, soils which are allowed to freeze will heave and loose density. Upon thawing, these soils will not regain their original strength and density. The extent of heave and density/strength loss depends on the soil type and moisture condition. Heave is greater in soils with higher percentages of fines (silts/clays). High silt content soils are most susceptible, due to their high capillary rise potential which can create ice lenses. Fine grained soils generally heave about 1/4" to 3/8" for each foot of frost penetration. This can translate to 1" to 2" of total frost heave. This total amount can be significantly greater if ice lensing occurs.

DESIGN CONSIDERATIONS

Clayey and silty soils can be used as perimeter backfill, although the effect of their poor drainage and frost properties should be considered. Basement areas will have special drainage and lateral load requirements which are not discussed here. Frost heave may be critical in doorway areas. Stoops or sidewalks adjacent to doorways could be designed as structural slabs supported on frost footings with void spaces below. With this design, movements may then occur between the structural slab and the adjacent on-grade slabs. Non-frost susceptible granular soils (with less than 12% passing a #200 sieve) can be used below such areas. Depending on the function of surrounding areas, the granular soil layer may need a thickness transition away from the area where movement is critical. With granular soil placement over slower draining soils, subsurface drainage would be needed for the granular layer. High density extruded insulation could be used within the granular soils to reduce frost penetration, thereby reducing the granular soil thickness needed. We caution that insulation placed near the surface can increate the potential for ice glazing of the surface.

The possible effects of adfreezing should be considered if clayey or silty soils are used as backfill. Adfreezing occurs when backfill adheres to rough surfaced foundation walls and lifts the wall as it freezes and heaves. This occurrence is most common with masonry black walls, unheated or poorly heated building situations and clay backfill. The potential is also increased where backfill soils are poorly compacted and become saturated. The risk of adfreezing can be decreased by placing a low friction separating layer between the wall and backfill.

Adfreezing can occur on exterior piers (such as deck, fence or other similar pier footings), even if a smooth surface is provided. This is more likely in poor drainage situations where soils become saturated. Additional footing embedment and/or widened footings below the frost zones (which include tensile reinforcement) can be used to resist uplift forces. Specific designs would require individual analysis.

CONSTRUCTION CONSIDERATIONS

Foundations, slabs, and other improvements which may be affected by frost movements should be insulated from frost penetration during freezing weather. If filling takes place during freezing weather, all frozen soils, snow, and ice should be stripped from areas to be filled prior to new fill placement. The new fill should not be allowed to freeze during transit, placement, or compaction. This should be considered in the project scheduling, budgeting, and quantity estimating. It is usually beneficial to perform cold weather earthwork operations in small areas where grade can be attained quickly rather than working large areas where a greater amount of frost stripping may be needed. If slab subgrade areas freeze, we recommend the subgrade be thawed to prior floor slab placement. The frost action may also require reworking and recompaction of the thawed subgrade.

BASEMENT/RETAINING WALL BACKFILL AND WATER CONTROL

DRAINAGE

Below grade basements should include a perimeter backfill drainage system on the exterior side of the wall. The exception may be where basements lie within free draining sands where water will not perch in the backfill. Drainage systems should consist of perforated or slotted PVC drainage pipes located at the bottom of the backfill trench, lower than the interior floor grade. The drain pipe should be surrounded by properly graded filter rock. A filter fabric should then envelope the filter rock. The drain pipe should be connected to a suitable means of disposal, such as a sump basket or a gravity outfall. A storm sewer gravity outfall would be preferred over exterior daylighting, as the latter may freeze during winter. For non-building, exterior retaining walls, weep holes at the base of the wall can be substituted for a drain pipe.

BACKFILLING

Prior to backfilling, damp/water proofing should be applied on perimeter basement walls. The backfill materials placed against basement walls will exert lateral loadings. To reduce this loading by allowing for drainage, we recommend using free draining sands for backfill. The zone of sand backfill should extend outward from the wall at least 2', and then upward and outward from the wall at a 30° or greater angle from vertical. As a minimum, the sands should contain no greater than 12% by weight passing the #200 sieve, which would include (SP) and (SP-SM) soils. The sand backfill should be placed in lifts and compacted with portable compaction equipment. This compaction should be to the specified levels if slabs or pavements are placed above. Where slab/pavements are not above, we recommend capping the sand backfill with a layer of clayey soil to minimize surface water infiltration. Positive surface drainage away from the building should also be maintained. If surface capping or positive surface drainage cannot be maintained, then the trench should be filled with more permeable soils, such as the Select Granular Backfill defined in SD/DOT Specification 850. You should recognize that if the backfill soils are not properly compacted, settlements may occur which may affect surface drainage away from the building.

Backfilling with silty or clayey soil is possible but not preferred. These soils can build-up water which increases lateral pressures and results in wet wall conditions and possible water infiltration into the basement. If you elect to place silty or clayey soils as backfill, we recommend you place a prefabricated drainage composite against the wall which is hydraulically connected to a drainage pipe at the base of the backfill trench. High plasticity clays should be avoided as backfill due to their swelling potential.

LATERAL PRESSURES

Lateral earth pressures on below grade walls vary, depending on backfill soil classification, backfill compaction and slope of the backfill surface. Static or dynamic surcharge loads near the wall will also increase lateral wall pressure. For design, we recommend the following ultimate lateral earth pressure values (given in equivalent fluid pressure values) for a drained soil compacted to 95% of the Standard Proctor density and a level ground surface.

	Equivalent Fluid Density	
Soil Type	**Active (pcf)**	**At-Rest (pcf)**
Sands (SP or SP-SM)	35	50
Silty Sands (SM)	45	65
Fine Grained Soils (SC, CL or ML)	70	90

Basement walls are normally restrained at the top which restricts movement. In this case, the design lateral pressures should be the "at-rest" pressure situation. Retaining walls which are free to rotate or deflect should be designed using the active case. Lateral earth pressures will be significantly higher than that shown if the backfill soils are not drained and become saturated.

Appendix A

Geotechnical Field Exploration and Testing
Boring Log Notes
Unified Soil Classification System
Site Location Map
Boring Location Map
Subsurface Boring Logs

Appendix A
Geotechnical Field Exploration and Testing
Report No. 32-01856

A.1 FIELD EXPLORATION

The subsurface conditions at the site were explored by drilling and sampling standard penetration test borings. The locations of the borings appear on the Boring Location Map, preceding the Subsurface Boring Logs in this appendix.

A.2 SAMPLING METHODS

A.2.1 Split-Spoon Samples (SS

Standard penetration (split-spoon) samples were collected in general accordance with ASTM: D1586. The ASTM test method consists of driving a 2-inch O.D. split-barrel sampler into the in-situ soil with a 140-pound hammer dropped from a height of 30 inches. The sampler is driven a total of 18 inches into the soil. After an initial set of 6 inches, the number of hammer blows to drive the sampler the final 12 inches is known as the standard penetration resistance or N-value.

A.2.2 Disturbed Samples (DS)/Spin-up Samples (SU)

Sample types described as "DS" or "SU" on the boring logs are disturbed samples, which are taken from the flights of the auger. Because the auger disturbs the samples, possible soil layering and contact depths should be considered approximate.

A.2.3 Sampling Limitations

Unless actually observed in a sample, contacts between soil layers are estimated based on the spacing of samples and the action of drilling tools. Cobbles, boulders, and other large objects generally cannot be recovered from test borings, and they may be present in the ground even if they are not noted on the boring logs.

Determining the thickness of "topsoil" layers is usually limited, due to variations in topsoil definition, sample recovery, and other factors. Visual-manual description often relies on color for determination, and transitioning changes can account for significant variation in thickness judgment. Accordingly, the topsoil thickness presented on the logs should not be the sole basis for calculating topsoil stripping depths and volumes. If more accurate information is needed relating to thickness and topsoil quality definition, alternate methods of sample retrieval and testing should be employed.

A.3 CLASSIFICATION METHODS

Soil descriptions shown on the boring logs are based on the Unified Soil Classification (USC) system. The USC system is described in ASTM: D2487 and D2488. Where laboratory classification tests (sieve analysis or Atterberg Limits) have been performed, accurate classifications per ASTM: D2487 are possible. Otherwise, soil descriptions shown on the boring logs are visual-manual judgments. Charts are attached which provide information on the USC system, the descriptive terminology, and the symbols used on the boring logs.

Visual-manual judgment of the AASHTO Soil Group is also noted as a part of the soil description. A chart presenting details of the AASHTO Soil Classification System is also attached.

The boring logs include descriptions of apparent geology. The geologic depositional origin of each soil layer is interpreted primarily by observation of the soil samples, which can be limited. Observations of the surrounding topography, vegetation, and development can sometimes aid this judgment.

A.4 WATER LEVEL MEASUREMENTS

The ground water level measurements are shown at the bottom of the boring logs. The following information appears under "Water Level Measurements" on the logs:

- Date and Time of measurement
- Sampled Depth: lowest depth of soil sampling at the time of measurement
- Casing Depth: depth to bottom of casing or hollow-stem auger at time of measurement
- Cave-in Depth: depth at which measuring tape stops in the borehole
- Water Level: depth in the borehole where free water is encountered
- Drilling Fluid Level: same as Water Level, except that the liquid in the borehole is drilling fluid

The true location of the water table at the boring locations may be different than the water levels measured in the boreholes. This is possible because there are several factors that can affect the water level measurements in the borehole. Some of these factors

include: permeability of each soil layer in profile, presence of perched water, amount of time between water level readings, presence of drilling fluid, weather conditions, and use of borehole casing.

A.5 LABORATORY TEST METHODS

A.5.1 Water Content Tests
Conducted per AET Procedure 01-LAB-010, which is performed in general accordance with ASTM: D2216 and AASHTO: T265.

A.5.2 Atterberg Limits Tests
Conducted per AET Procedure 01-LAB-030, which is performed in general accordance with ASTM: D4318 and AASHTO: T89, T90.

A.5.3 Sieve Analysis of Soils (thru #200 Sieve)
Conducted per AET Procedure 01-LAB-040, which is performed in general conformance with ASTM: D6913, Method A.

A.5.4 Particle Size Analysis of Soils (with hydrometer)
Conducted per AET Procedure 01-LAB-050, which is performed in general accordance with ASTM: D422 and AASHTO: T88.

A.5.5 Unconfined Compressive Strength of Cohesive Soil
Conducted per AET Procedure 01-LAB-080, which is performed in general accordance with ASTM: D2166 and AASHTO: T208.

A.5.6 Laboratory Soil Resistivity using the Wenner Four-Electrode Method
Conducted per AET Procedure 01-LAB-090, which is performed using Soil Box apparatus in the laboratory in general accordance with ASTM: G57

A.6 TEST STANDARD LIMITATIONS

Field and laboratory testing is done in general conformance with the described procedures. Compliance with any other standards referenced within the specified standard is neither inferred nor implied.

A.7 SAMPLE STORAGE

Unless notified to do otherwise, we routinely retain representative samples of the soils recovered from the borings for a period of 30 days.

BORING LOG NOTES

DRILLING AND SAMPLING SYMBOLS

Symbol	Definition
B,H,N:	Size of flush-joint casing
CA:	Crew Assistant (initials)
CAS:	Pipe casing, number indicates nomial diameter in inches
CC:	Crew Chief
COT:	Clean-out tube
DC:	Drive casing; number indicates diameter in inches
DM:	Drilling mud or bentonite slurry
DR:	Driller (initials)
DS:	Disturbed sample from auger flights
FA:	Flight Auger; number indicates outside diameter in inches
HSA:	Hollow stem auger; number indicates inside diameter in inches
LG:	Field logger (initials)
MC:	Column used to describe moisture condition of samples and for the ground water level symols
N (BPF):	Standard penetration resistance (N-value) in blows per foot (see notes)
NQ:	NQ wireline core barrel
PQ:	PQ wireline core barrel
RD:	Rotary drilling with fluid and roller or drag bit
REC:	In california-spoon, split-spoon (see notes) and thin-walled tube sample, the recovered length (in inches) of sample. In rock coring, the length of core recovered (expressed as percent of the total core run.) Zero indicates no sample recovered.
REV:	Revert drilling fluid
2L:	California-spoon sampler (stee; 2" inside diameter with 4" long brass liners; 3" outside diameter)
SS:	Standard split-spoon sample (steel; 1⅜" inside diameter; 2" outside diameter); unless indicated otherwise
SU:	Spin-up sample from hollow stem auger
TW:	Thin-walled tube; number indicates inside diameter in inches
WASH:	Sample of material obtained by screening returning rotary drilling fluid or by which has collected inside the borehole after "falling" through drilling fluid
WH:	Sampler advanced by static weight of drill rod and 140-pound hammer
WR:	Sampler advanced by static weight of drill rod
94mm:	94 millimeter wireline core barrel
▼:	Water level directly measured in boring
▽:	Estimated water level based solely on sample appearance

TEST SYMBOLS

Symbol	Definition
CONS:	One-dimensional consolidation test
DEN:	Dry density; pcf
DST:	Direct shear test
E:	Pressuremeter Modulus, tsf
HYD:	Hydrometer analysis
LL:	Liquid Limit, %
LP:	Pressuremeter Limit Pressure, tsf
OC:	Organic Content, %
PERM:	Coefficient of permeablility (K) test; F- Field; L - Laboratory
PL:	Plastic Limit, %
q_p:	Pocket Penetrometer strength, tsf (approximate)
q_c:	Static cone bearing pressure, tsf
q_u:	Unconfined compressive strength, psf
R:	Electrical Resistivity, ohm-cms
RQD:	Rock Quality Designation of Rock Core, in precent (aggregate length of core pieces 4" or more in length as a percent of total core run)
SA:	Sieve Analysis
TRX:	Triaxial compression test
VSR:	Vane shear strength, remoulded (field), psf
VSU:	Vane shear strength, undisturbed (field) psf
WC:	Water content, as percent of dry weight
%-200:	Percent of material finer than #200 sieve

STANDARD PENETRATION TEST NOTES

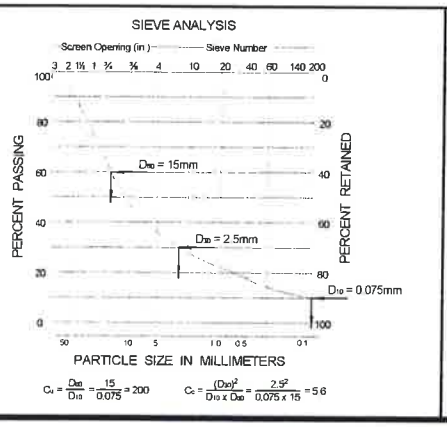
The standard penetration test consists of driving the sampler with a 140 pound hammer and counting the number of blows applied in each of three 6" increments of penetration. If the sampler is driven less than 18" (usually in highly resistant material), permitted in ASTM:D1586, the blows for each complete 6" increment and for each partial increment is on the boring log. For partial increments, the number of blows is shown to the nearest 0.1' below the slash.

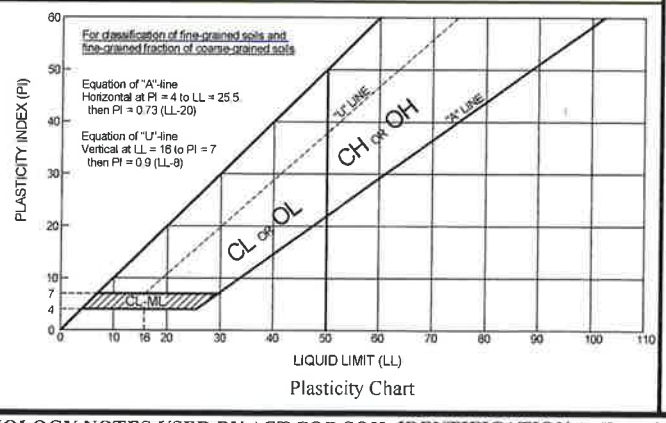
The length of the sample recovered, as shown on the "REC" column, may be greater than the distance indicated in the N column. The disparity is because the N-value is recorded below the intial 6" set (unless partial penentration defined in ASTM:D1586 is encountered) whereas the length of sample recoveres is for the entire sampler driver (which may even extend more than 18").

UNIFIED SOIL CLASSIFICATION SYSTEM
ASTM Designations: D 2487, D2488

AMERICAN ENGINEERING TESTING, INC.

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu≥4 and 1≤Cc≤3[E]	GW	Well graded gravel[F]
			Cu<4 and/or 1>Cc>3[E]	GP	Poorly graded gravel[F]
		Gravels with Fines more than 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[F,G,H]
			Fines classify as CL or CH	GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu≥6 and 1≤Cc≤3[E]	SW	Well-graded sand[I]
			Cu<6 and 1>Cc>3[E]	SP	Poorly-graded sand[I]
		Sands with Fines more than 12% fines[D]	Fines classify as ML or MH	SM	Silty sand[G,H,I]
			Fines classify as CL or CH	SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve (see Plasticity Chart below)	Silts and Clays Liquid limit less than 50	inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit–oven dried / Liquid limit – not dried <0.75	OL	Organic clay[K,L,M,N] / Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		organic	Liquid limit–oven dried / Liquid limit – not dried <0.75	OH	Organic clay[K,L,M,P] / Organic silt[K,L,M,Q]
Highly organic soil			Primarily organic matter, dark in color, and organic in odor	PT	Peat[R]





Plasticity Chart

Notes

[A] Based on the material passing the 3-in (75-mm) sieve.

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

[C] Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay

[D] Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay

[E] $Cu = D_{60} / D_{10}$, $Cc = (D_{30})^2 / D_{10} \times D_{60}$

[F] If soil contains ≥15% sand, add "with sand" to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add "with organic fines" to group name.

[I] If soil contains ≥15% gravel, add "with gravel" to group name.

[J] If Atterberg limits plot is hatched area, soils is a CL-ML silty clay.

[K] If soil contains 15 to 29% plus No. 200 add "with sand" or "with gravel", whichever is predominant.

[L] If soil contains ≥30% plus No. 200, predominantly sand, add "sandy" to group name.

[M] If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[N] PI≥4 and plots on or above "A" line.

[O] PI<4 or plots below "A" line.

[P] PI plots on or above "A" line.

[Q] PI plots below "A" line.

[R] Fiber Content description shown below.

ADDITIONAL TERMINOLOGY NOTES USED BY AET FOR SOIL IDENTIFICATION AND DESCRIPTION

Grain Size

Term	Particle Size
Boulders	Over 12"
Cobbles	3" to 12"
Gravel	#4 sieve to 3"
Sand	#200 to #4 sieve
Fines (silt & clay)	Pass #200 sieve

Gravel Percentages

Term	Percent
A Little Gravel	3% - 14%
With Gravel	15% - 29%
Gravelly	30% - 50%

Consistency of Plastic Soils

Term	N-Value, BPF
Very Soft	less than 2
Soft	2 - 4
Firm	5 - 8
Stiff	9 - 15
Very Stiff	16 - 30
Hard	Greater than 30

Relative Density of Non-Plastic Soils

Term	N-Value, BPF
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	Greater than 50

Moisture/Frost Condition (MC Column)

D (Dry): Absence of moisture, dusty, dry to touch.

M (Moist): Damp, although free water not visible. Soil may still have a high water content (over "optimum").

W (Wet/ Waterbearing): Free water visible intended to describe non-plastic soils. Waterbearing usually relates to sands and sand with silt.

F (Frozen): Soil frozen

Layering Notes

Laminations: Layers less than ½" thick of differing material or color.

Lenses: Pockets or layers greater than ½" thick of differing material or color.

Fiber Content of Peat

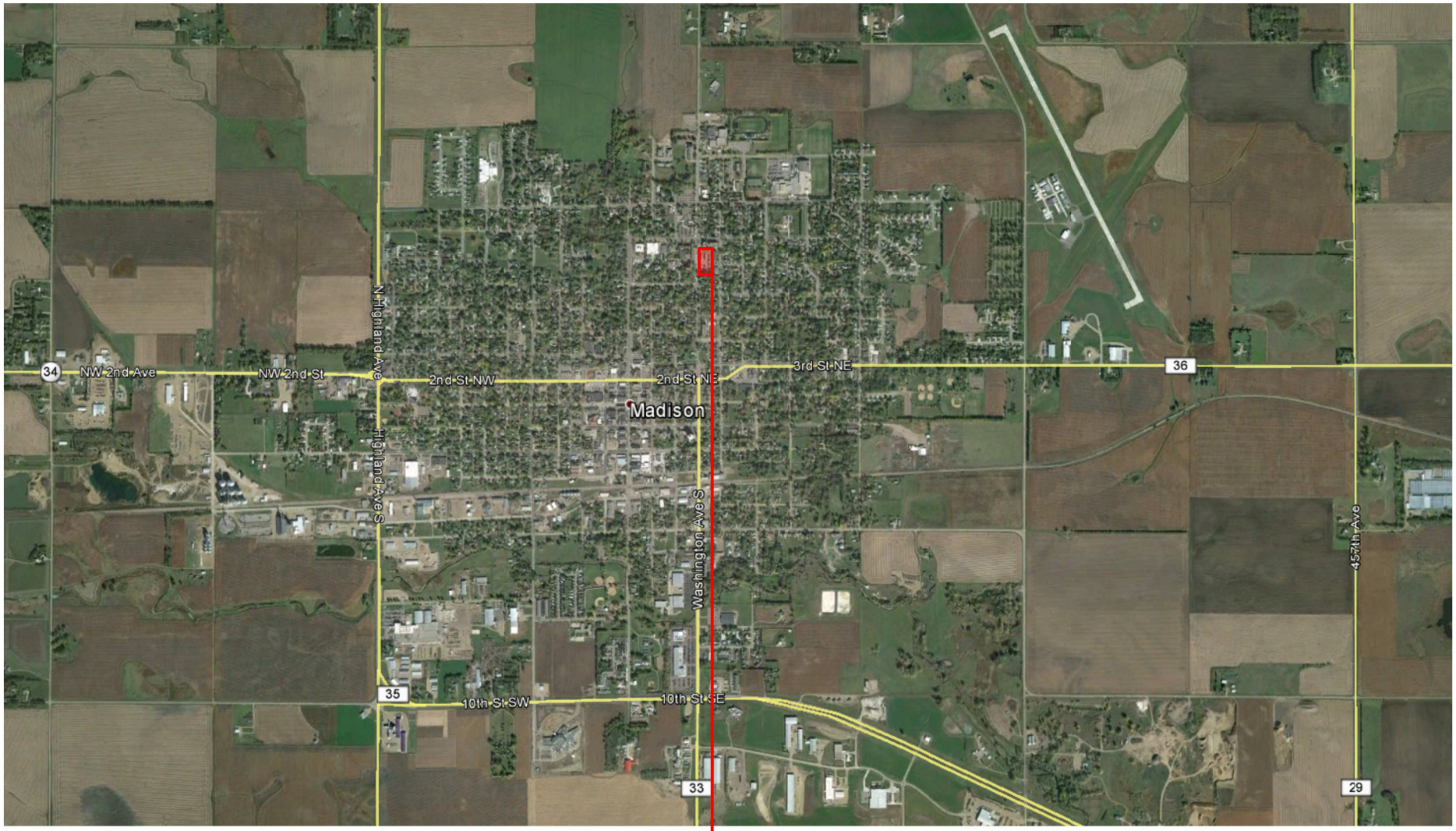
Term	Fiber Content (Visual Estimate)
Fibric Peat:	Greater than 67%
Hemic Peat:	33 – 67%
Sapric Peat:	Less than 33%

Organic/Roots Description (if no lab tests)

Soils are described as *organic*, if soil is not peat and is judged to have sufficient organic fines content to influence the soil properties. *Slightly organic* used for borderline cases.

With roots: Judged to have sufficient quantity of roots to influence the soil properties.

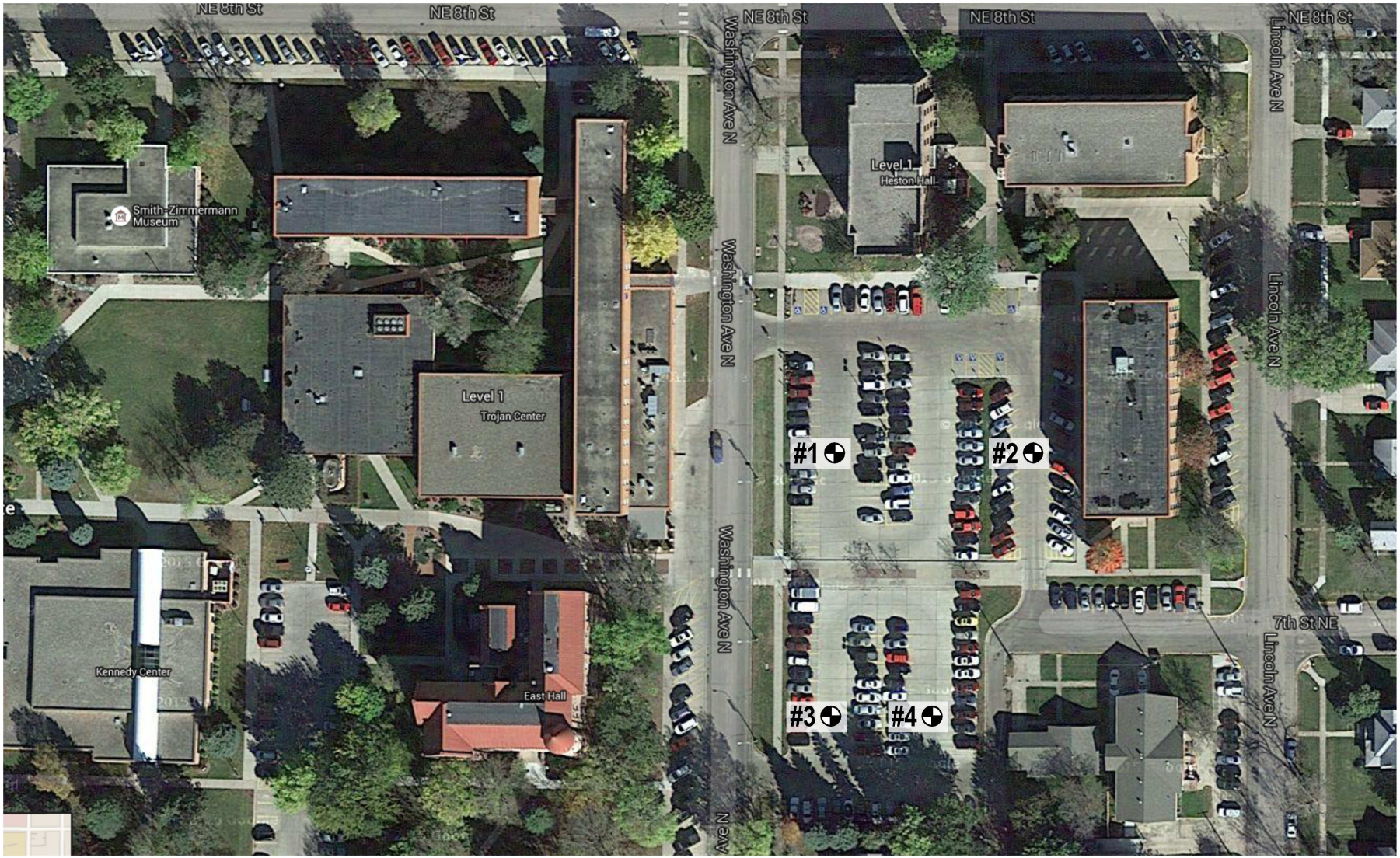
Trace roots: Small roots present, but not judged to be in sufficient quantity to significantly affect soil properties.



SCALE (MILES)

0 0.5

AMERICAN ENGINEERING TESTING, INC.	PROJECT: PROPOSED BEACOM INSTITUTE OF TECHNOLOGY ALTERNATE SITE DAKOTA STATE UNIVERSITY; MADISON, SOUTH DAKOTA		PROJECT NO. 32-01856
	SUBJECT: SITE LOCATION MAP		DATE: 11 / 03 / 2015
	SCALE: 1 INCH = 0.5 MILES	DRAWN BY: BCL	REVIEWED BY: BWC



SCALE
(FEET)

0 100

◒ -APPROXIMATE BORING LOCATIONS

N

AMERICAN ENGINEERING TESTING, INC.

PROJECT:	PROPOSED BEACOM INSTITUTE OF TECHNOLOGY ALTERNATE SITE DAKOTA STATE UNIVERSITY; MADISON, SOUTH DAKOTA		PROJECT NO. 32-01856
SUBJECT:	BORING LOCATION MAP		DATE: 11 / 03 / 2015
SCALE:	1 INCH = 100 FEET	DRAWN BY: BCL	REVIEWED BY: BWC

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01856** LOG OF BORING NO. **1 (p. 1 of 1)**

PROJECT: **P. Beacom Institute of Technology Alternative Site; Madison, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: 1692.6' MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	6" of CONCRETE over 1.5' of CLAYEY SAND, with gravel, brown, moist	FILL	15	M	SS	18					
3	FILL, mixture of SANDY LEAN CLAY and LEAN CLAY, dark brown and brown, moist to very moist, some concrete from 5.6' to 5.8'		10	M	SS	18					
5			6	M	SS	16					
6	LEAN CLAY, brown mottled, very moist, firm (CL)	FINE ALLUVIUM									
8			6	M	SS	18	33	94.0			
9	SANDY LEAN CLAY, with a little gravel, brown mottled, very moist to moist, firm to stiff, a lens of fat clay, a lens of sand at 10.3' (CL)	TILL									
10			8	M	SS	18	25				
13			9	M	SS	18					
15			11	M	SS	18					
19	▼										
20	SANDY LEAN CLAY, with a little gravel, gray, moist, stiff (CL)		12	M	SS	18					
21	**END OF BORING**										

DEPTH: DRILLING METHOD	WATER LEVEL MEASUREMENTS						
	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-19½' 3.25" HSA	**10/27/15**	**1:06**	**21'**	**19.5'**	**21'**		**19.5**
BORING COMPLETED: **10/27/15**							
DR: **RH** LG: **MH** Rig: **66**							

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

06/04

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01856** LOG OF BORING NO. **2 (p. 1 of 1)**

PROJECT: **P. Beacom Institute of Technology Alternative Site; Madison, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: 1696.9' MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	5.75" of CONCRETE over 3" of CLAYEY SAND, with gravel, brown, moist	FILL									
2	FILL, mostly LEAN CLAY, dark brown, very moist		4	M	SS	10					
3	LEAN CLAY, brown mottled, very moist to wet, firm to soft (CL)	FINE ALLUVIUM	5	M	SS	10	30				
4											
5			2	M	SS	10	29				
6	SANDY LEAN CLAY, with a little gravel, brown mottled, very moist to moist, firm to stiff (CL)	TILL									
7											
8			5	M	SS	16	28				
9											
10			5	M	SS	18					
11											
12											
13			9	M	SS	18					
14											
15			10	M	SS	18					
16											
17											
18											
19											
20			13	M	SS	18					
21	**END OF BORING**										

DEPTH: DRILLING METHOD

0-19½' 3.25" HSA

BORING COMPLETED: **10/27/15**

DR: **RH** LG: **MH** Rig: **66**

WATER LEVEL MEASUREMENTS

DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
10/27/15	**1:58**	**21'**	**19.5'**	**21'**		**None**
10/27/15	**2:09**	**21'**	**---**	**14'**		**13.5'**

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01856** LOG OF BORING NO. **3 (p. 1 of 1)**

PROJECT: **P. Beacom Institute of Technology Alternative Site; Madison, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: 1690.1' MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	5.75" of CONCRETE over 3" of CLAYEY SAND, with gravel, brown, moist	FILL									
2	FILL, mostly LEAN CLAY, dark brown, very moist		3	M	SS	10					
3	LEAN CLAY, brown mottled, very moist, firm (CL)	FINE ALLUVIUM	5	M	SS	10	19				
4	SANDY LEAN CLAY, with a little gravel, brown mottled, very moist to moist, firm to stiff (CL)	TILL		M	3T		22	104.0			2100
5											
6			5	M	SS	16	23				
7											
8			5	M	SS	16					
9											
10			6	M	SS	17					
11											
12											
13			8	M	SS	18					
14											
15			9	M	SS	18					
16											
17											
18											
19											
20			10	M	SS	18					
21	**END OF BORING**										

DEPTH: DRILLING METHOD	WATER LEVEL MEASUREMENTS							NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG
	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL	
0-19½' 3.25" HSA	**10/27/15**	**11:41**	**21'**	**19.5'**	**21'**		**None**	
BORING COMPLETED: **10/27/15**								
DR: **RH** LG: **MH** Rig: **66**								

06/04

AMERICAN ENGINEERING TESTING, INC.

SUBSURFACE BORING LOG

AET JOB NO: **32-01856** LOG OF BORING NO. **4 (p. 1 of 1)**

PROJECT: **P. Beacom Institute of Technology Alternative Site; Madison, South Dakota**

DEPTH IN FEET	SURFACE ELEVATION: 1691.9' MATERIAL DESCRIPTION	GEOLOGY	N	MC	SAMPLE TYPE	REC IN.	FIELD & LABORATORY TESTS WC	DEN	LL	PL	qu
1	5.75" of CONCRETE over 3" of CLAYEY SAND, with gravel, brown, moist	FILL									
2	FILL, mostly LEAN CLAY, dark brown, very moist		3	M	SS	10					
3	LEAN CLAY, brown mottled, very moist, firm (CL)	FINE ALLUVIUM	7	M	SS	14	18				
4											
5	SANDY LEAN CLAY, with a little gravel, brown mottled, very moist to moist, firm to stiff (CL)	TILL	5	M	SS	14	23	94.0			
6											
7											
8			8	M	SS	16	20				
9											
10			7	M	SS	18					
11											
12											
13			9	M	SS	18					
14											
15			10	M	SS	18					
16											
17											
18											
19											
20			13	M	SS	18					
21	**END OF BORING**										

DEPTH: DRILLING METHOD	WATER LEVEL MEASUREMENTS						
	DATE	TIME	SAMPLED DEPTH	CASING DEPTH	CAVE-IN DEPTH	DRILLING FLUID LEVEL	WATER LEVEL
0-19½' 3.25" HSA	**10/27/15**	**10:36**	**21'**	**19.5'**	**21'**		**None**
BORING COMPLETED: **10/27/15**							
DR: **RH** LG: **MH** Rig: **66**							

NOTE: REFER TO THE ATTACHED SHEETS FOR AN EXPLANATION OF TERMINOLOGY ON THIS LOG

Appendix B

Geotechnical Report Limitations and Guidelines for Use

Appendix B
Geotechnical Report Limitations and Guidelines for Use
Report No. 32-01856

B.1 REFERENCE

This appendix provides information to help you manage your risks relating to subsurface problems which are caused by construction delays, cost overruns, claims, and disputes. This information was developed and provided by ASFE[1], of which, we are a member firm.

B.2 RISK MANAGEMENT INFORMATION

B.2.1 Geotechnical Services are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared solely for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. And no one, not even you, should apply the report for any purpose or project except the one originally contemplated.

B.2.2 Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

B.2.3 A Geotechnical Engineering Report is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typically factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, always inform your geotechnical engineer of project changes, even minor ones, and request an assessment of their impact. Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.

B.2.4 Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. Do not rely on a geotechnical engineering report whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. Always contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

1 ASFE, 8811 Colesville Road/Suite G106, Silver Spring, MD 20910
Telephone: 301/565-2733: www.asfe.org

B.2.5 Most Geotechnical Findings Are Professional Opinions
Site exploration identified subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ, sometimes significantly, from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

B.2.6 A Report's Recommendations Are Not Final
Do not overrely on the construction recommendations included in your report. Those recommendations are not final, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.

B.2.7 A Geotechnical Engineering Report Is Subject to Misinterpretation
Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

B.2.8 Do Not Redraw the Engineer's Logs
Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should never be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, but recognizes that separating logs from the report can elevate risk.

B.2.9 Give Contractors a Complete Report and Guidance
Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, but preface it with a clearly written letter of transmittal. In the letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. Be sure contractors have sufficient time to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

B.2.10 Read Responsibility Provisions Closely
Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their report. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. Read these provisions closely. Ask questions. Your geotechnical engineer should respond fully and frankly.

B.2.11 Geoenvironmental Concerns Are Not Covered
The equipment, techniques, and personnel used to perform a geoenvironmental study differ significantly from those used to perform a geotechnical study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. Unanticipated environmental problems have led to numerous project failures. If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. Do not rely on an environmental report prepared for someone else.

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DAKOTA STATE UNIVERSITY
BEACOM INSTITUTE OF TECHNOLOGY
GIRTON SITE
MADISON, SOUTH DAKOTA
LEED SCHEMATIC DESIGN UPDATE

NOVEMBER 13, 2015

The South Dakota Office of the State Engineer has indicated that the Dakota State University (DSU) – Beacom Institute of Technology will pursue LEED certification at the Silver level under LEED version 4. The design team held a sustainable design/LEED workshop on August 19th 2015 to help educate the owners team on the new LEED v4 as well as establish a preliminary assessment of the project's potential to achieve LEED Silver certification. The Silver level requires a minimum achievement of 50 points. The project should target a minimum of 5 points above the low threshold or a total of 55 in case the Green Building Certification Institute (GBCI) has any unfavorable rulings during the certification review. Based on the relocation of the project to the east of Washington Avenue and orientation of the building, specific credits that were targeted previously are no longer possible. The project is currently targeting **53 points** which places it within the lower range of Silver and therefore **the team should identify an additional 2 to 3 points to pursue to be on the safe side** when the project is ready for certification review.

The attached scorecard identifies the credits with the greatest opportunity for achievement as well as the credits that are currently considered as potential "Maybe's" and the credits with the likelihood of being unachievable. Further analysis will be required throughout the design and construction process.

Location and Transportation (Lt)

The location and transportation category rewards thoughtful decisions about building location, with credits that encourage compact development, alternative transportation and connection with amenities. The LT category is an outgrowth of the Sustainable Sites category which formerly covered location related topics. The LT category considers the existing features of the surrounding community and how the infrastructure affects occupants' behavior and environmental performance. The project is located within a rural community of Madison, South Dakota and because of this location, the project will not be able to take advantage of aspects that would reward other projects located within a community that has more density and developed infrastructure. The Office of the State Engineer has indicated that the project cannot pursue two credits under this category. Currently the project has the potential to achieve 5 points out of the 16 available under this category. The following represents what credits are still achievable and what is no longer achievable from the previous Schematic Design analysis:

Credits that are achievable:

- **Sensitive Land Protection**
- **Surrounding Density and Diverse Uses**
- **Reduced Parking Footprint**: Hinged upon providing/assigning no parking (new or existing) for the project.

Credits that are no longer achievable:

High Priority Site: Due to project location outside of Historic District.

Sustainable Sites (Ss)

The Sustainable Sites category rewards decisions about the environment surrounding the building, with credits to emphasize the vital relationships among buildings, ecosystems and ecosystem services. It focuses on restoring project site elements, integrating the site with local and regional ecosystems, and preserving the biodiversity that natural systems rely on. 100% of the new project site is considered previously developed as it encompasses an existing parking lot. The project has a real opportunity to restore the site back to native habitat and in order to maintain previous anticipated LEED site credits, the project must at a minimum convert 30% of the previously developed area to vegetation, otherwise it may make it difficult to reach the Silver certification level. Currently the project still has the potential to achieve 6 points out of the 10 available under this category. The following represents what credits are still achievable from the previous schematic design and what credits have the best opportunity for additional points as needed:

Credits that are achievable:

- **Site Development – Protect or Restore Habitat**: Need to at least restore approximately 18,000 square feet with native/adapted vegetation.
- **Open Space**: Similar to above
- **Heat Island Reduction**: All new paving to have Solar Reflectivity of 0.33.

Credits that have potential for additional points:

- **Rainwater Management**: Meet the 95th percentile of regional/local rainfall events which would require bioswales along the west and south edges of the site.
- **Light Pollution Reduction**: There are concerns where the project is located close to the project boundary. Requires the proper design of exterior lighting to meet uplight and trespass requirements. This is thru fixture selection which may not require additional cost.

Water Efficiency (We)

The Water Efficiency category addresses water holistically, looking at indoor use, outdoor use and specialized uses as well as metering. The section is based on an ‘efficiency first’ approach to water conservation thru the prerequisites that recognizes the use of non-potable and alternative sources of water for further reductions. The project has the ability to be aggressive relative to the reduction in potable water use and has the potential to achieve 6 points out of the 11 available under this category. The following represents what credits are still achievable from the previous schematic design and what credits have the best opportunity for additional points as needed:

Credits that are achievable:

- **Outdoor Water Use Reduction**: Two options for compliance. Provide landscaping that doesn’t require irrigation after the 2 year establishment period or reduce irrigation by 50% from a calculated baseline. Installing native/adapted plant species can potentially eliminate the cost of irrigation.
- **Indoor Water Use Reduction**: By installing 1.28 gpf toilets, 0.125 gpf urinals, 0.35 gpm lavatories and 0.5 breakroom sinks, the project has an opportunity to reduce potable water by at least 40%.

Credits that have potential for additional points:

- **Water Metering**: Install water metering for 2 of the following use: Irrigation (most likely required if irrigation was provided), indoor plumbing fixtures, domestic hot water, boiler, other process water. This may be minimal cost above a whole building water meter which is required.

Energy and Atmosphere (Ea)

The Energy and Atmosphere category approaches energy from a holistic perspective, addressing energy use reduction, energy efficient design strategies and renewable energy sources. Energy efficiency in buildings start with a focus on design that reduces overall energy needs, such as building orientation and glazing selection, and the choice of climate-appropriate building materials. Strategies such as passive heating and cooling, natural ventilation, and high-efficiency HVAC systems partnered with smart controls further reduce a buildings energy use. The current building orientation has a different impact on the energy performance of the envelope which will affect mechanical and electrical systems. Even though there is less overall glazing, there is more glazing oriented to the west. Currently the project has the potential to achieve 18 points out of the 33 available under this category. The following represents what credits are still achievable from the previous schematic design and what credits have the best opportunity for additional points as needed:

Credits that are achievable:

- **Enhanced Commissioning**: OSE requirement.
- **Optimize Energy Performance**: OSE Requirement.
- **Enhanced Refrigerant Management**

Credits that have potential for additional points:

- **Advanced Metering**: Besides whole building level metering, credit also requires that individual energy related end uses that represent 10% or more of total annual consumption be metered. This will require additional cost but may be offset by what level of metering is already required by the college and programmed thru the building management system.

Materials and Resources (Mr)

The Materials and Resources category focuses on minimizing the embodied energy and other impacts associated with the extraction, processing, transport, maintenance, and disposal of building materials. The requirements are designed to support a life-cycle approach that improves performance and promotes resource efficiency. Each requirement identifies a specific action that fits into the larger context of a life-cycle approach to embodied impact reduction. Currently the project has the potential to achieve 3 out of the 13 available under this category. The following represents what credits are still achievable from the previous schematic design:

Credits that are achievable:

- **Building Product Disclosure and Optimization – Sourcing of Raw Materials:** Specify, procure and install materials that meet sustainability attributes such as certified wood, recycled content and regional sourcing requirements.

- **Construction and Demolition Waste Management:** Achieve a minimum 75% diversion of construction waste

Indoor Environmental Quality (Eq)

The indoor Environmental Quality category rewards decisions made by project teams about indoor air quality and thermal, visual and acoustic comfort. Green buildings with good indoor environmental quality protect the health and comfort of building occupants. High-quality indoor environments also enhance productivity, decrease absenteeism, improve the building's value and reduce liability for building designers and owners. The category addresses the myriad design strategies and environmental factors – air quality, lighting quality, acoustic quality, and control over one's surroundings – that influence the way people learn, work and live. Currently the project has the potential to achieve 11 out of the 16 available under this category. The following represents what credits are still achievable, credits are no longer achievable from the previous Schematic Design analysis and credits that have the best opportunity for additional points as needed:

Credits that are achievable:

- **Enhanced Indoor Air Quality Strategies**: requires entryway systems at main building access points, exhausting of areas where chemicals are stored (Janitors closest), MERV 13 filtration. Also would require CO2 sensors in all densely occupied spaces such as conference room, classrooms, collaboration center etc.
- **Low Emitting Materials**: Specify, procure and install low impact materials.
- **Construction Indoor Air Quality Management Plan**: Contractor to employ air quality measures during construction.
- **Indoor Air Quality Assessment**: Requires a building flush or air quality testing.
- **Interior Lighting**: Proper design and specification of lighting fixtures.
- **Quality Views**: Every spaces has access to exterior views.

Credits that are no longer achievable:

- **Daylight**: Based on a more compact design, floor plates and room depth became deeper making it difficult to meet the LEED requirements.

Credits that have potential for additional points:

- **Thermal Comfort**: Based on providing individual control for 50% of the occupants in individual occupants spaces. Since there are very few actual individual occupant spaces in the cost would be considered minimal.

Innovation and Design (In)

This category is to recognize projects for innovative building features and sustainable building practices and strategies. The project has not had a discussion on what innovations to pursue and will do so in the near future. Currently the project is targeting 4 out of the 6 available under this category with the potential of pursuing 2 additional innovation points if needed.

Regional Priority (Rp)

Based on the location of the project within zip code 57042 the six credits that are eligible for bonus points and the four credits that are most likely achievable are:

- LT Credit Sensitive Land Protection - **Achievable**
- EA Credit Optimize Energy Performance - **Achievable**
- EA Credit Renewable Energy - **Unachievable**
- MR Credit Product Disclosure and Optimization – EPD's - **Potential**
- EQ Credit Enhanced IAQ Strategies - **Achievable**
- EQ Credit Indoor Air Quality Assessment - **Achievable**

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LEED v4 for BD+C: New Construction and Major Renovation

Project Checklist

Project Name: DSU BEACOM Institute of Technology
Date: 8/20/2015

Y	?	N			
	1		Credit	Integrative Process	1

4	0	12	Location and Transportation		16
			Credit	LEED for Neighborhood Development Location	16
1			Credit	Sensitive Land Protection	1
		2	Credit	High Priority Site	2
2		3	Credit	Surrounding Density and Diverse Uses	5
		5	Credit	Access to Quality Transit	5
		1	Credit	Bicycle Facilities	1
1			Credit	Reduced Parking Footprint	1
		1	Credit	Green Vehicles	1

5	4	1	Sustainable Sites		10
Y			Prereq	Construction Activity Pollution Prevention	Required
	1		Credit	Site Assessment	1
2			Credit	Site Development - Protect or Restore Habitat	2
1			Credit	Open Space	1
	2	1	Credit	Rainwater Management	3
2			Credit	Heat Island Reduction	2
	1		Credit	Light Pollution Reduction	1

6	1	4	Water Efficiency		11
Y			Prereq	Outdoor Water Use Reduction	Required
Y			Prereq	Indoor Water Use Reduction	Required
Y			Prereq	Building-Level Water Metering	Required
2			Credit	Outdoor Water Use Reduction	2
4		2	Credit	Indoor Water Use Reduction	6
		2	Credit	Cooling Tower Water Use	2
	1		Credit	Water Metering	1

17	5	11	Energy and Atmosphere		33
Y			Prereq	Fundamental Commissioning and Verification	Required
Y			Prereq	Minimum Energy Performance	Required
Y			Prereq	Building-Level Energy Metering	Required
Y			Prereq	Fundamental Refrigerant Management	Required
6			Credit	Enhanced Commissioning	6
10	2	6	Credit	Optimize Energy Performance	18
	1		Credit	Advanced Energy Metering	1
	2		Credit	Demand Response	2
		3	Credit	Renewable Energy Production	3
1			Credit	Enhanced Refrigerant Management	1
		2	Credit	Green Power and Carbon Offsets	2

3	1	9	Materials and Resources		13
Y			Prereq	Storage and Collection of Recyclables	Required
Y			Prereq	Construction and Demolition Waste Management Planning	Required
		5	Credit	Building Life-Cycle Impact Reduction	5
	1	1	Credit	Building Product Disclosure and Optimization - Environmental Product Declarations	2
1		1	Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
		2	Credit	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit	Construction and Demolition Waste Management	2

10	3	3	Indoor Environmental Quality		16
Y			Prereq	Minimum Indoor Air Quality Performance	Required
Y			Prereq	Environmental Tobacco Smoke Control	Required
2			Credit	Enhanced Indoor Air Quality Strategies	2
3			Credit	Low-Emitting Materials	3
1			Credit	Construction Indoor Air Quality Management Plan	1
1	1		Credit	Indoor Air Quality Assessment	2
	1		Credit	Thermal Comfort	1
2			Credit	Interior Lighting	2
		3	Credit	Daylight	3
1			Credit	Quality Views	1
	1		Credit	Acoustic Performance	1

4	2	0	Innovation		6
3	2		Credit	Innovation	5
1			Credit	LEED Accredited Professional	1

4	0	0	Regional Priority		4
1			Credit	Regional Priority: ٤ (LT) Sensitive Land Protection	1
1			Credit	Regional Priority: ٤ (EA) Optimize Energy Performance	1
1			Credit	Regional Priority: ٤ (EQ) Enhanced IAQ Strategies	1
1			Credit	Regional Priority: ٤ (EQ) Indoor Air Quality Assessment	1

53	17	40	TOTALS	Possible Points:	110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

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033000 Cast-In-Place Concrete
033543 Polished Concrete Finishing

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042000 Unit Masonry

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051200 Structural Steel Framing
052100 Steel Joist Framing
053100 Steel Decking
054000 Cold-Formed Metal Framing
055000 Metal Fabrications
055100 Metal Stairs
055213 Pipe and Tube Railings
057000 Decorative Metal
057300 Decorative Metal Railings

DIVISION 06 – WOOD ANDPLASTICS

061053 Miscellaneous Rough Carpentry
061600 Sheathing
062023 Interior Finish Carpentry - *Grand Stair*
064116 Plastic Laminate Faced Architectural Cabinets
066400 Plastic Paneling
066510 Solid Surface Fabrications

DIVISION 07 – THERMAL ANDMOISTURE PROTECTION

071326 Self-Adhering Sheet Waterproofing
072100 Thermal Insulation
072119 Foamed-In-Place Insulation
072500 Weather Barriers
074213.16 Metal Plate Wall Panels
074213.23 Metal Composite Material Wall Panels
074213.53 Metal Soffit Panels
075323 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
076200 Sheet Metal Flashing and Trim
077200 Roof Accessories
078413 Penetration Firestopping
078446 Fire-Resistive Joint Systems

079200 Joint Sealants

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084113 Aluminum-Framed Entrances and Storefronts
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087113 Automatic Door Operators
088000 Glazing
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092216 Non-Structural Metal Framing
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096513 Resilient Base and Accessories
096516 Resilient Sheet Flooring
096519 Resilient Tile Flooring
096813 Tile Carpeting
097200 Wall Coverings
098433 Sound Absorbing Wall Units
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101200 Display Cases
101419 Dimensional Letter Signage
101423 Panel Signage
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102800 Toilet, Bath, and Laundry Accessories
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123661 Simulated Stone Countertops
124813 Entrance Floor Mats and Frames

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211316 Dry Pipe Sprinkler Systems
212200 Clean Agent Fire Extinguishing Systems

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220519 Meters and Gages for Plumbing Piping
220523 General Duty Valves for Plumbing Piping
220529 Hangers and Supports for Plumbing Piping and Equipment
220553 Identification for Plumbing Piping and Equipment
220716 Plumbing Equipment Insulation
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221413 Storm Drainage Piping
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221429 Sump Pumps
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224000 Plumbing Fixtures
224713 Drinking Fountains and Water Coolers

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