DATE: March 17, 2022

DEPARTMENT OF GENERAL SERVICES
BUREAU OF CAPITAL PROJECT DESIGN MANAGEMENT
1800 HERR STREETS
HARRISBURG, PENNSYLVANIA

ADDENDUM NO. 4

on

PROJECT NO. DGS C-1101-0053 PHASE 001
PROJECT TITLE - Lincoln University - Vail Hall Renovations
PROFESSIONAL:
Voith & Mactavish Architects
2401 Walnut Street, 6th Floor
Philadelphia, PA, 19103

If you submitted a bid through e-Builder prior to this Addendum being issued, your bid has been discarded and you must re-submit your bid(s) through e-Builder prior to the bid opening date and time. Please see Section 4.C. of the Instruction to Bidder

1. General Changes - All Contracts
2. Specification Changes - All Contracts
3. Drawing Changes - All Contracts

Refer to attached for Addendum information.

DEPARTMENT OF GENERAL SERVICES
BUREAU PRE-CONSTRUCTION
1800 HERR STREET
HARRISBURG, PENNSYLVANIA

ADDENDUM NO. 4

on

PROJECT NO. DGS C-1101-0053 PHASE 1
Vail Hall Renovations – Lincoln University – Oxford Township, Chester County, Pennsylvania

Voith and Mactavish LLC
2401 Walnut Street 6th floor
Philadelphia, PA 19103

ADMINISTRATIVE CHANGES – ALL CONTRACTS

GENERAL CHANGES – ALL CONTRACTS

RFI RESPONSES - CONTRACT DGS C-1101-0053 ALL PHASES

RFI RESPONSES - CONTRACT DGS C-1101-0053 PHASE 1.1

RFI RESPONSES - CONTRACT DGS C-1101-0053 PHASE 1.2

RFI RESPONSES - CONTRACT DGS C-1101-0053 PHASE 1.3

Item 1 – Attic
Response: Yes, the ductwork will be exposed at the attic and will be insulated with board insulation.

Item 2 – PVC
Response: No, PVC jacketing is not required at the attic.

Item 3 – Pumps & Equipment
Response: See revised spec section 230716 HVAC Equipment Insulation.

Item 4 – Geothermal Well Test
Response: A test well report was conducted by Duffield. (See attached)

Item 5 – Geothermal Test Well
Response:
1. The number of holes needed for the geothermal system is 26. Per keynote 3 on HS1-01, there is one existing test hole with 25 holes that need to be drilled. Total number of wells is 26.
2. The depth of the geothermal holes is 400 feet as indicated on HS1-01, detail 2.
3. SDR-11 pipe is acceptable for loop installation.
4. Test bores were drilled and the report and well log can be referenced in the Duffield Report. (See attached.)
5. Casing to bedrock per detail 2 on HS1-01 is 140 feet. (See also Duffield Report attached.)
6. Correct, water should only be used for testing after the loops are in the holes.

RFI RESPONSES - CONTRACT DGS C-1101-0053 PHASE 1.4

Item 1 – Who owns cameras and NVR's?
Response: Cameras, along with indoor and outdoor WAP's, will be supplied by the university.

Item 2 – Who provides wireless access points?
Response: Cameras, along with indoor and outdoor WAP's, will be supplied by the university.

Item 3 – EC vs. AVC
Response: See spec section 115201, which is included for reference only and not part of this project. The Parts & Material List/Proposal Form at the end of section 115201 is not to be completed. There is no separate AVC on this project. The AV infrastructure as shown in the EC scope is required in EC contract. AV equipment and installation outside of that scope are outside of this project.

SPECIFICATION CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.1

SPECIFICATION CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.2

SPECIFICATION CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.3

Item 1 – Section 230716 HVAC Insulation

- This section was previously missing and addresses RFI's regarding insulation of HVAC equipment.

SPECIFICATION CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.4

DRAWING CHANGES – CONTRACT NO. DGS C-1101-0053 ALL CONTRACTS

DRAWING CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.1

DRAWING CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.2

DRAWING CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.3

DRAWING CHANGES – CONTRACT NO. DGS C-1101-0053 PHASE 1.4

Item 1 – Sheet T1.01

- Drawing shows the conduit extension of the ductbank into the building's MDF.

Item 2 – Sheet T2.01

- Drawing shows the incoming fiber cable, ductbank extension into the building, and fiber termination field.

SECTION 230716 - HVAC EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 STIPULATIONS

A. The specifications sections “General Conditions of the Construction Contract”, “Special Conditions”, and “Division 1 – General Requirements” form a part of this Section by this reference thereto and shall have the same force and effect as if printed herewith in full.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:
   1. Hydronic-water pumps.
   2. Expansion/compression tanks.
   3. Buffer tanks.
   4. Air separators.
   5. Control valves.

B. Related Sections:

   1. Section 230713 "Duct Insulation."
   2. Section 230719 "HVAC Piping Insulation."

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities

having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Owens Corning.

H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Owens Corning.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corporation.

b. Johns Manville; a Berkshire Hathaway company.
c. Owens Corning.

2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Owens Corning.

2.2 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

1.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.

d. Mon-Eco Industries, Inc.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Dow Corning Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. P.I.C. Plastics, Inc.
d. Speedline Corporation.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SEALANTS

A. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F.
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.

2. Materials shall be compatible with insulation materials, jackets, and substrates.

3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.5 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Speedline Corporation.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated tank heads and tank side panels.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Width: 3 inches.

2. Thickness: 11.5 mils.
3. Adhesion: 90 ounces force/inch in width.
4. Elongation: 2 percent.
5. Tensile Strength: 40 lbf/inch in width.
6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

1. Width: 2 inches.

2. Thickness: 6 mils.
3. Adhesion: 64 ounces force/inch in width.
4. Elongation: 500 percent.
5. Tensile Strength: 18 lbf/inch in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Width: 2 inches.

2. Thickness: 3.7 mils.
3. Adhesion: 100 ounces force/inch in width.
4. Elongation: 5 percent.
5. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with closed seal.
2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

2.8 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

   a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.6 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Hydronic pump insulation **(all project pumps)** shall be the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

D. Expansion/compression tank insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inch thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 2 inch thick.

E. Air-separator insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inch thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 2 inch thick.
3.

F. Buffer tank insulation shall be one of the following:
1. Mineral-Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Pipe and Tank: 2 inches thick.

END OF SECTION 230716

DUFFIELD ASSOCIATES
Soil, Water & the Environment

Duffield Associates, LLC
5400 Limestone Road
Wilmington, DE 19808
Phone: 302.239.6634
Fax: 302.239.8485
duffnet.com

February 1, 2021

Ms. Katrina Virbitsky
Voith & Mactavish Architects, LLP
2401 Walnut Street, 6th Floor
Philadelphia, PA 19103

RE: Project No. 8503.GD.03
Geothermal Conductivity Testing
DGS Project No. C-1101-0053
Lincoln University
Vail Memorial Hall Building Renovations
Oxford, Pennsylvania

Dear Ms. Virbitsky:

Duffield Associates, LLC (Duffield) has completed our geothermal formation thermal conductivity testing for the Vail Memorial Hall Building Renovation project at Lincoln University. These services were provided in general accordance with our proposal dated October 26, 2020.

Well installation was performed on December 30, 2020 by K. L. Madron Well Drilling of Avondale, Pennsylvania. The approximate well location is indicated on the enclosed site plan. The well was drilled to a depth of 450 feet, and closed, u-bend loop consisting of 1¼-inch diameter HDPE pipe was installed and grouted in place with thermally enhanced grout. The well permit and well completion log are enclosed.

The subsurface conditions at the site consisted of predominately granular soils and weathered rock overlying the bedrock formation (schist and limestone). Weathered rock was first encountered at approximately 30 feet below grade, and intact bedrock was encountered at a depth of 140 feet. No permanent casing was installed.

From January 14 to 17, 2021, formation thermal conductivity testing was performed on the test well. The testing was performed by Duffield's representatives utilizing equipment leased from Geothermal Resource Technologies, Inc. The testing was conducted in general accordance with ASHRAE's recommended procedures by circulating water through the well for a total period of approximately 61 hours while measuring the heat input and the entering and exiting temperature of the circulated fluid.

The results of the testing are as follows:

- Formation Thermal Conductivity = 2.14 Btu/hr-ft-°F;
- Formation Thermal Diffusivity = 1.36 ft^2/day;
- Average Heat Capacity = 37.7 Btu/ft^3 -°F ; and
- Undisturbed Formation Temperature = 55.6 to 56.1°F.

Further details regarding the testing methods and test results are provided in the enclosed report.

Following completion of the thermal conductivity testing, the testing equipment was removed and the exposed ends of the piping were covered with end caps taped in place. The pipe loop was left filled with water. The wells should be flushed prior to continued construction of the geothermal loop system.

We appreciate this opportunity to be of service to you and your team on this project. Should you have any questions concerning this study, please do not hesitate to contact us.

Very truly yours,

DUFFIELD ASSOCIATES, LLC

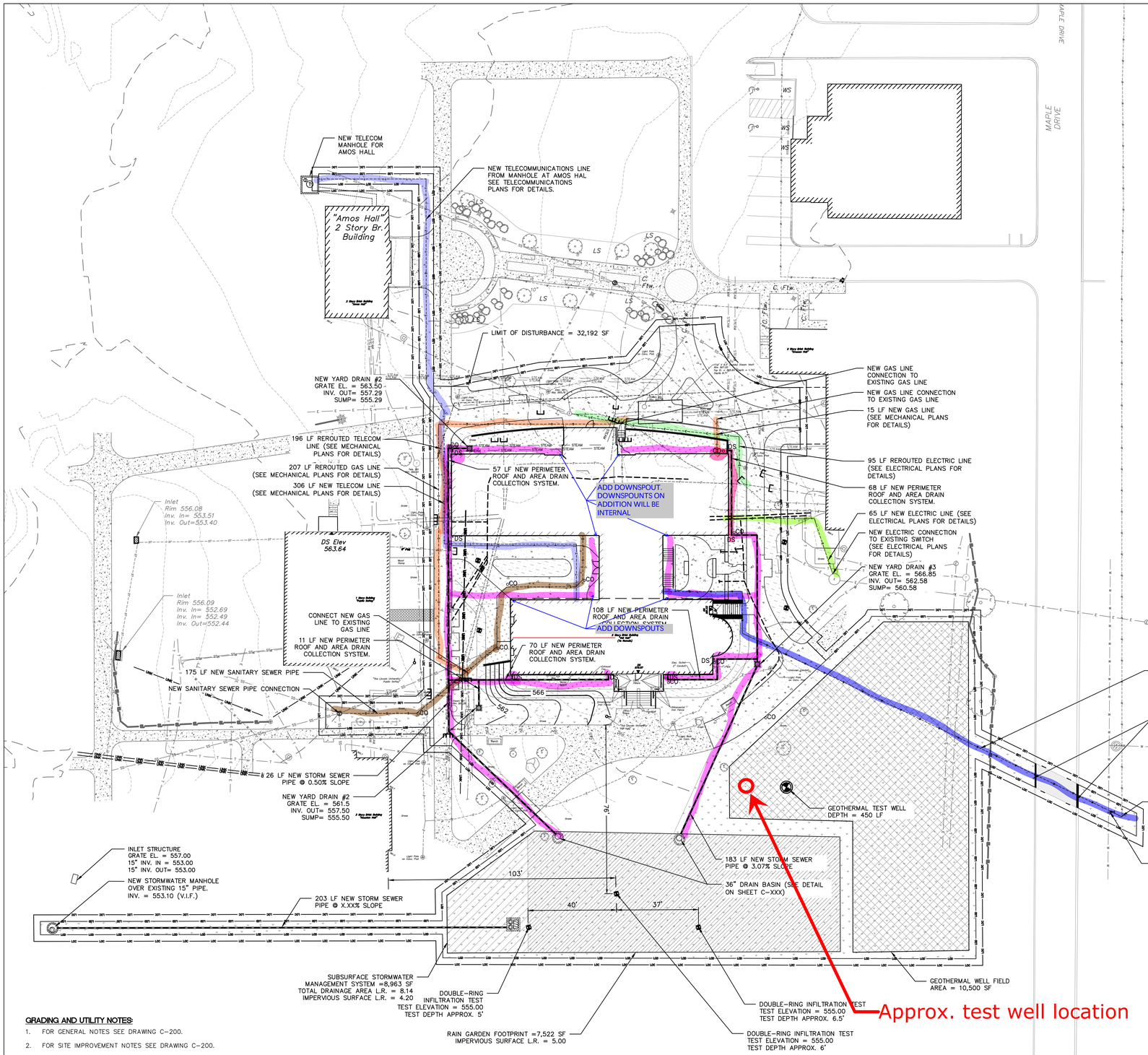
Matthew B. Van Rensler, P.E.
Geotechnical & Field Services Division Director

SBZ/MBV:acj
8503GD.0121.LINCOLN UNIV VAIL HALL GEOTHERMAL TEST WELL.RPT

Enclosures:	Attachment 1:	Well Location Plan
	Attachment 2:	Well Permit
	Attachment 3:	Well Completion Report
	Attachment 4:	Formation Thermal Conductivity Test and Data Analysis Report

ATTACHMENT 1

WELL LOCATION PLAN



LEGEND

EXISTING		NEW
	LIMIT OF CONTRACT LINE	N/A
	RIGHT-OF-WAY LINE	N/A
	BUILDING	
	CURB	
	DEPRESSED CURB	
Asphalt Pavement	ASPHALT PAVEMENT	
	BRICK SIDEWALK	N/A
	PARKING LOT STRIPING	
	FENCE	N/A
N/A	GRASS PAVE AREA	
Conc. Sidewalk	CONCRETE SIDEWALK	
Grass	GRASS AREA	
	ELECTRIC MANHOLE	
	TELECOMM. MANHOLE	
CO	CLEANOUT	C.O.
	SANITARY SEWER MANHOLE	
	FIRE HYDRANT	N/A
	WATER VALVE	
	INLET / CATCH BASIN	
	STORM SEWER MANHOLE	
DS	DOWNSPOUT	DS
	UTILITY POLE	N/A
OR	LIGHT	
	ELECTRIC JUNCTION BOX	
	SIGN	
GM	GAS METER	GM
OR	TREE	N/A
D.W.S.	DETECTABLE WARNING STRIP	
W.S.	WHEEL STOP	N/A
	OVERHEAD WIRES	N/A
	ELECTRIC LINE	
	WATER LINE	
N/A	FIRE SERVICE LINE	
	GAS LINE	
	TELECOMM. LINE	
	STORM SEWER LINE	P1
	SANITARY SEWER LINE	
	HVAC LINE	N/A
N/A	UNDERDRAIN	
565	INDEX CONTOURS	565
564	CONTOURS	564
+566.3	SPOT ELEVATION	566.20 x
	INFILTRATION TEST	N/A

ALL LOCATIONS OF EXISTING UTILITIES SHOWN ON THE PLAN HAVE BEEN DEVELOPED FROM EXISTING UTILITY RECORDS AND/OR ABOVE GROUND EXAMINATION OF THE SITE. COMPLETENESS OR ACCURACY OF LOCATION AND DEPTH OF UNDERGROUND UTILITIES OR STRUCTURES CANNOT BE GUARANTEED. CONTRACTOR MUST VERIFY DEPTH AND LOCATION OF ALL UNDERGROUND UTILITIES AND FACILITIES BEFORE START OF WORK, AS PER ACT 287 OF 1974, AS AMENDED.

Before You Dig Anywhere

STOP! CALL 1-800-242-1776 TOLL FREE

PA Act 287 OF 1974, as amended requires notification to one call system 3 working days for construction phase and 10 working days for design phase before you excavate.

PA ONE CALL SYSTEM, INC.

EXCAVATIONS, TRENCHING AND SHORING

ALL EXCAVATIONS, TRENCHING, AND SHORING OPERATIONS SHALL COMPLY WITH THE REQUIREMENTS OF ALL UNITED STATES DEPARTMENT OF LABOR OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION (OSHA) PUBLICATIONS OF THE LATEST REVISION.

NOT FOR CONSTRUCTION

1			

RECORD REVISIONS

SIGNATURE DATE

VMA
Voith & Mactavish Architects LLP
2401 Walnut Street, 6th Floor
Philadelphia, PA 19103
phone 215-545-4544 fax 215-545-3299
www. voithandmactavish.com

HUNT ENGINEERING COMPANY
P.O. BOX 537
22 EAST KING STREET
MALVERN, PA 19355
PHONE: 610-644-4600
FAX: 6106442488
WWW.HUNTENGINEERING.COM

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No. DGS C-1101-0053 PHASE 002

Vail Hall Building Renovations
Lincoln University
Lower Oxford Township, Chester County, PA

OVERALL GRADING & UTILITIES PLAN

ALL WORK ON THIS DRAWING IS BY THE ,1 CONTRACTOR

VERIFY SCALE
BAR IS ONE (1) INCH LONG ON ORIGINAL DRAWING:
IF BAR IS NOT ONE (1) INCH LONG, ADJUST SCALE ACCORDINGLY

CONTRACTOR SHALL FIELD VERIFY ALL DIMENSIONS. VARIANCE FROM CONTRACT DOCUMENTS NOT PERMITTED WITHOUT PROFESSIONAL & BUREAU OF CONSTRUCTION APPROVAL.

DRAWN BY	DATE	DRAWING No.
CCC	10/16/2020	C-300
CHECKED BY	SCALE	
JAE	1"=20'	

FILE PATH: N:\Projects\2019\2195009-Lincoln-Voit Hall\dwg\cd\Sheets\C-300_Grading Plan.dwg
LAST SAVED: 2020.10.15 01:41 PM PLOTTED: 2020.10.15 02:04 PM PLOTTED BY: Cindy Carola

GRADING AND UTILITY NOTES:

1. FOR GENERAL NOTES SEE DRAWING C-200.
2. FOR SITE IMPROVEMENT NOTES SEE DRAWING C-200.
3. FOR EROSION AND SEDIMENTATION CONTROL NOTES & DETAILS SEE DRAWING C-600.
4. THE PURPOSE OF THIS PLAN IS TO SHOW THE PROPOSED IMPROVEMENTS, UTILITIES AND GRADING.
5. NEW WALKWAYS AND PAVEMENTS SHALL BE CONSTRUCTED TO THE GRADES INDICATED ON THE GRADING & UTILITIES PLAN AND SHALL MEET THE EXISTING GRADES AT THE LIMITS OF WORK.
6. COORDINATE THE LOCATION OF LANDSCAPING WITH ALL UNDERGROUND UTILITIES.

NOTES:

1. TOPOGRAPHIC INFORMATION SHOWN ON THIS PLAN IS TAKEN FROM A FIELD SURVEY BY HUNT ENGINEERING COMPANY PERFORMED IN JULY 2014 AND UPDATED BASED ON FIELD OBSERVATIONS IN OCTOBER 2019.
2. SOURCE OF WATER: PUBLIC (CHESTER WATER AUTHORITY).
3. SOURCE OF SEWERAGE: PRIVATE (LINCOLN UNIVERSITY CONVEYANCE SYSTEM AND TREATMENT PLANT).

ATTACHMENT 2

WELL PERMIT

PERMIT

For

WELL CONSTRUCTION AND INSTALLATION

CHESTER COUNTY HEALTH DEPARTMENT

Pursuant to Application for Sewage Disposal System Number: **076074**

a permit is hereby issued to:

Lincoln University		Test
Name of Applicant	Telephone Number	Workclass
P.O. Box 179, Lincoln University, PA 19352	Other	Test
Address of Applicant	Well Use	Type of Construction
1500 BALTIMORE PK, LOWER OXFORD, PA	Lower Oxford Township	56-4-63-E
Site Address	Municipality	Tax Parcel ID #

This permit issued pursuant to the Rules and Regulations of the Chester County Health Department, Chapter 500, § 501, is subject to the following conditions:

1. No Individual, Semi-Public Water Supply Well, or Geothermal Well, may be used unless approved by the Chester County Health Department.

2. This Permit may be revoked for the reasons set forth in Chapter 500, § 501.12.7.

3. This Permit will expire on **11/18/2023**, which is 3 years from the issue date, unless construction of the building and the water supply has commenced.

4. Any relocation of the proposed well site must be approved by the Chester County Health Department prior to drilling.

APPROVAL TO USE

MAINTAIN ALL MINIMUM ISOLATION DISTANCES

APPROVAL TO DRILL

Date Approved

11/18/2020

Date of Permit Issuance

Official Signature

Signature of EHS: Lynch, Patty

The basis for the issuance of this Permit is the information supplied in the Well Permit Application. This Permit only indicates that the Chester County Health Department is satisfied that the installation of the Well is in accordance with the Rules and Regulations of the Chester County Health Department, Chapter 500, § 501, formulated pursuant to Act 315, Local Health Administration Law, § 11(c), as amended. The issuance of a Permit shall not preclude the enforcement of other health laws, ordinances or regulations in the case of contamination of the Waters of the Commonwealth.

TO BE POSTED AT THE DRILLING SITE.

076074

Chester County Health Department
Bureau of Environmental Health Protection
Division of Water and Sewage

Well Permit Application

Well Owner: LINCOLN UNIVERSITY

Site Address: 1500 BALTIMORE PIKE
Street, Box No.

Mailing Address: PO BOX 179

LINCOLN UNIVERSITY PA 19352
Post Office State Zip

LINCOLN UNIVERSITY PA 19352

Subdivision Name Lot #

Telephone #: 1-302-562-5248

Lower Oxford (56-04-63.E)
Municipality UPI

Owner's Signature: [signature] STAN ZIMLER
(AUTHORIZED TO SIGN FOR OWNER)

Well Use

____ Individual/Residential
____ Agricultural
____ Semi-Public
X Public (Geothermal)
X Other

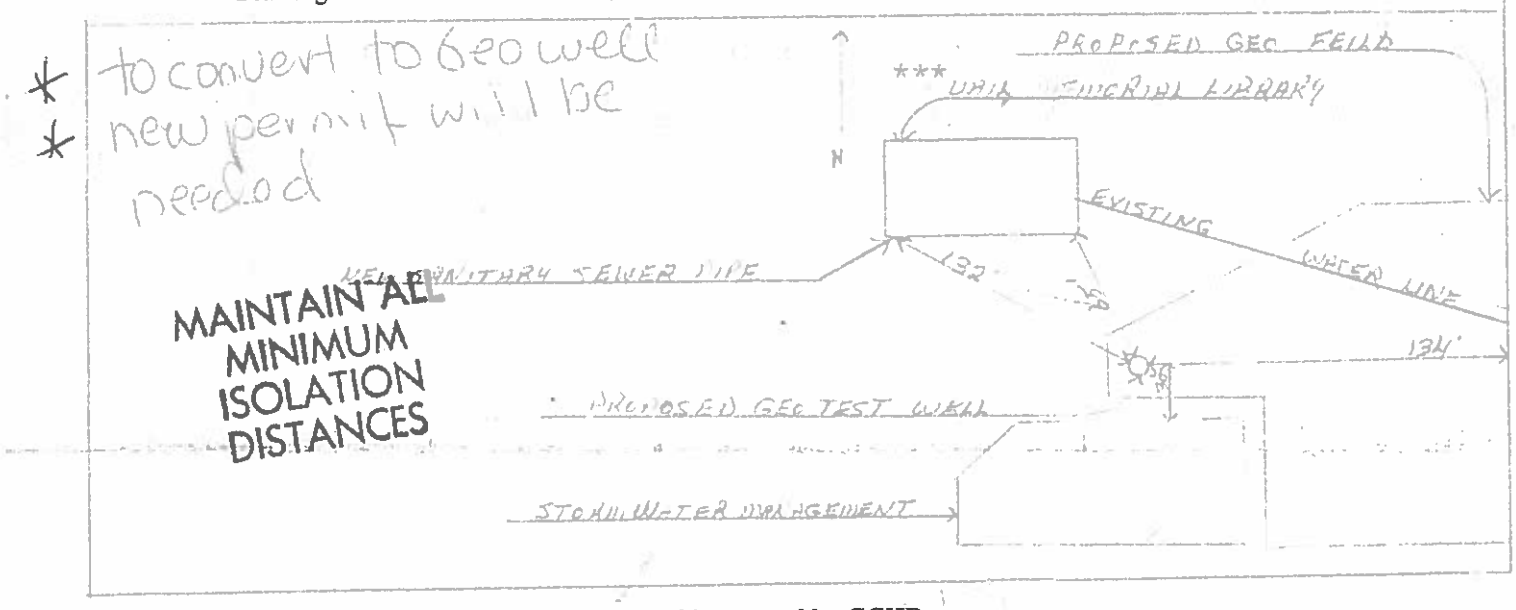
Type of Construction

____ New Well
____ Deepen Existing Well
____ Additional Well on Property
____ GEO closed ____ open ____
____ GEO Casing Included
X Test Well

Sewage Permit # PUBLIC
If Existing, Year Installed ____
Date Issued ____
Date Finaled ____
Site Plume ____

Plot Plan

Drawing must be neat and accurate; it need not be to scale. (See example plot plan in instructions.)



Note: The water supply cannot be used until final approval is granted by CCHD.

Directions to Site: GOING S. on Old Baltimore Pike, go Left on Ashmun Ave. to 1st entry gate, go R. site is Approx. 1/16th of mile on Right.

Driller Declaration: I certify that the location herein proposed is accessible and meets all Chapter 500, §501 isolation distances.

Driller Name: John Madron Driller Signature: [signature] CCHD License #: 1045

Phone #: 610-444-4500

Approval to Drill

X Granted ____ Denied
CCHD Signature: [signature]
Date: 11-18-20

Approval to Use

____ Granted ____ Denied
CCHD Signature: ____
Date: ____

Decommission Approval

____ Granted ____ Denied
CCHD Signature: ____
Date: ____

Fee Paid: $ 150 Receipt #: 125032 Date: 11-16-20

C.K 65273

Health/ENV. – Form #128.5 Rev. 7/09

ATTACHMENT 3

WELL COMPLETION REPORT

Chester County Health Department

Well Completion Form

Permit Application # 076074 Date / /

Owner Name Lincoln University

Mailing Address PO Box 179 Lincoln University PA 19352

Site Address: 1500 Baltimore Pike Lincoln University PA 19352

Site Municipality Lower Oxford

Subdivision Name

Tax Parcel No. 56-4-63-E Lot # Geothermal Borehole # 1 TEST WELL

Well Type Test Well Type of Construction Geothermal

WELL INFORMATION

Date Drilled 12/30 / 2020 # of bags of grout 24 Type of Grout Thermo Grout

Well Depth 450 ft Pump Depth Distance to House/Structure

Casing Depth Date Installed / / Nearest Septic Tank

Static Water Level (measured from grade) HP Nearest Absorption Area

Well Diameter Pump Model

Yield (GPM)

MINIMUM YIELD/ STORAGE CAPACITY

_____ Well Storage Capacity = (pump depth – static water level) x (1.33 gal. / foot)*

_____ Tank Storage Capacity

_____ otal Storage Capacity

Well yield in gallons per minute _____ x120 min. + Total Storage = _____ -480 = _____ gallons. If this number is > 0, the well is adequate.

(For a six inch well with pump and delivery line displacement included)

WELL DRILLER

I, John Madron, hereby certify that the above referenced well was drilled in accordance with all Chester County health Department regulations, Chapter 500, §501.

John Madron CCHD LICENSE # 1045 DATE 1 20 2021
(well driller's signature)

PUMP INSTALLER

I, _____, hereby certify that the above referenced pump was installed in accordance with all Chester County Health Department Regulations, Chapter 500, §501.

_____ CCHD LICENSE # _____ DATE / /
(pump installer's signature)

rev. 1/14/09

CCHD-WA/F-01

CHESTER COUNTY HEALTH DEPARTMENT

Bureau of Environmental Health Protection

Division of Water &, Sewage

2nd Well/ Well Abandonment Information

(fill in all applicable data)

CCHD Replacement Permit # 076074 Date: _____

CCHD Original Permit # 076074 Date of final approval _____

Municipality Lower Oxford Tax parcel # 56-4-63-E

Property Owner's Name: Lincoln University Phone: 302-562-5248

Mailing Address: PO Box 179 Lincoln University PA 19352

New Well Data

Site Address: _____

Municipality Lower Oxford

Subdivision: _____ Lot #: _____

New Well Depth: _____ Driller: John Madron

Reason(s) for drilling new well: GEO TEST WELL

Original Well Data

Original well source: (check one) Spring _____ Dug Well _____ Drilled Well xx

Depth of Abandoned Well GEO Test Well 450 ft Date of Abandonment 12/30/2020

Type of material used for abandonment Thermo Grout

Amount of material used for abandonment 24 bags

Reason(s) for abandoning well: GEO TEST WELl

(if transferring to public water please list public water supplier name)

I, John Madron, hereby certify that the above referenced
(name of Well Driller)
well was abandoned in accordance with all Chester County Health Department Rules and Regulations, Chapter 500, §501.

Signature of Well Driller _____

CCHD License # 1045 Date 1/19/2021

Rev. 5/06

ATTACHMENT 4

FORMATION THERMAL CONDUCTIVITY TEST
AND DATA ANALYSIS REPORT

Formation Thermal Conductivity
Test & Data Analysis

Test Location	**Vail Memorial Hall** **Lincoln University, PA**
Test Date	January 14-17, 2021
Analysis For	Duffield Associates, Inc. 5400 Limestone Road Wilmington, DE 19808 Phone: (302) 239-6634
Test Performed By	Duffield Associates, Inc.

Executive Summary

A formation thermal conductivity test was performed on the geothermal bore with a GPS location of N 39.809594°, W 75.925991° at Vail Memorial Hall at 1570 Baltimore Pike, Lincoln University, Pennsylvania. The vertical bore was completed on December 30, 2020 by K L Madron Well Drilling. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the afternoon of January 14, 2021.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

Formation Thermal Conductivity = 2.14 Btu/hr-ft-°F

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

Formation Thermal Diffusivity ≈ 1.36 ft^2/day

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

Undisturbed Formation Temperature ≈ 55.6-56.1°F

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at www.grti.com.

Test Procedures

The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below:

Grouting Procedure for Test Loops – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

Time Between Loop Installation and Testing – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

Undisturbed Formation Temperature Measurement – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

Required Test Duration – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours**.**

Data Acquisition Frequency - Test data is recorded at five minute intervals.

Equipment Calibration/Accuracy – Transducers and datalogger are calibrated per manufacturer recommendations. Manufacturer stated accuracy of power transducers is less than ±2%. Temperature sensor accuracy is periodically checked via ice water bath.

Power Quality – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

Input Heat Rate – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

Insulation – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

Retesting in the Event of Failure – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

Data Analysis

Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. Applying the line source method to a u-bend grouted in a borehole, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In the analysis of the data from the formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger was plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear coefficients were calculated that produce a line that fit the data. This procedure was repeated for various time intervals to ensure that variations in the power or other effects did not produce inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

Contact: Galen Streich
Regional Managing Engineer
Elkton, SD
Ph: 866-991-4784
gstreich@grti.com

Test Bore Details
(As Provided by Duffield Associates, Inc.)

Site Name ..... Vail Memorial Hall
Location ..... Lincoln University, PA
Driller ..... K L Madron Well Drilling
Installed Date ..... December 30, 2020
Borehole Diameter ..... 6 inches
U-Bend Size ..... 1 1/4 inch HDPE
U-Bend Depth Below Grade ..... 450 ft
Grout Type ..... GeoPro TG Select
Grout Mixture ..... 29% solids
Grouted Portion ..... Entire bore

Drill Log

Formation Description	Depth (ft)
Brown sandy silt	0'-15'
Silty gravel	15'-25'
Sand	25'-30'
Weathered sandstone	30'-80'
Weathered rock	80'-140'
Bedrock - gray schist	140'-195'
Bedrock - limestone	195'-210'
Bedrock - gray schist	210'-450'

Note: Bore produced approx. 10 gpm water at 240 ft and 10 gpm at 310 ft.

THERMAL CONDUCTIVITY TEST DATA

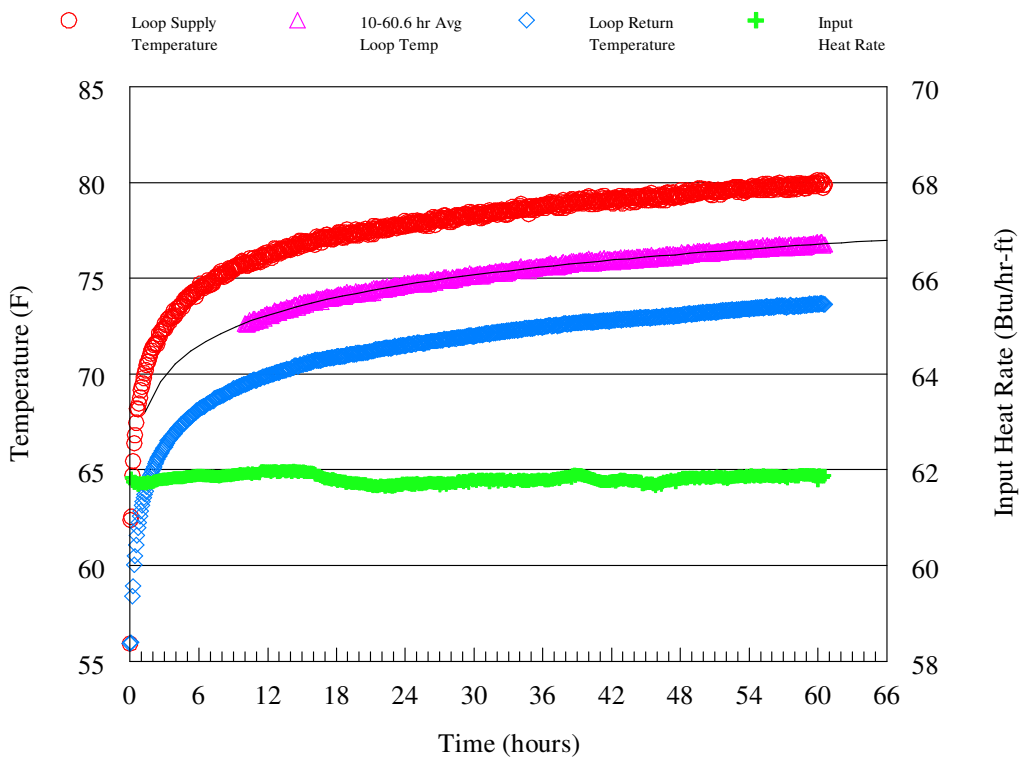


FIG. 1: TEMPERATURE & HEAT RATE DATA VS TIME

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on the left axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

SUMMARY TEST STATISTICS

Test Date	January 14-17, 2021
Undisturbed Formation Temperature	Approx. 55.6-56.1°F
Duration	60.6 hr
Average Voltage	238.9 V
Average Heat Input Rate	27,816 Btu/hr (8,152 W)
Avg Heat Input Rate per Foot of Bore	61.8 Btu/hr-ft (18.1 W/ft)
Circulator Flow Rate	8.8 gpm
Standard Deviation of Power	0.14%
Maximum Variation in Power	0.30%

Line Source Data Analysis

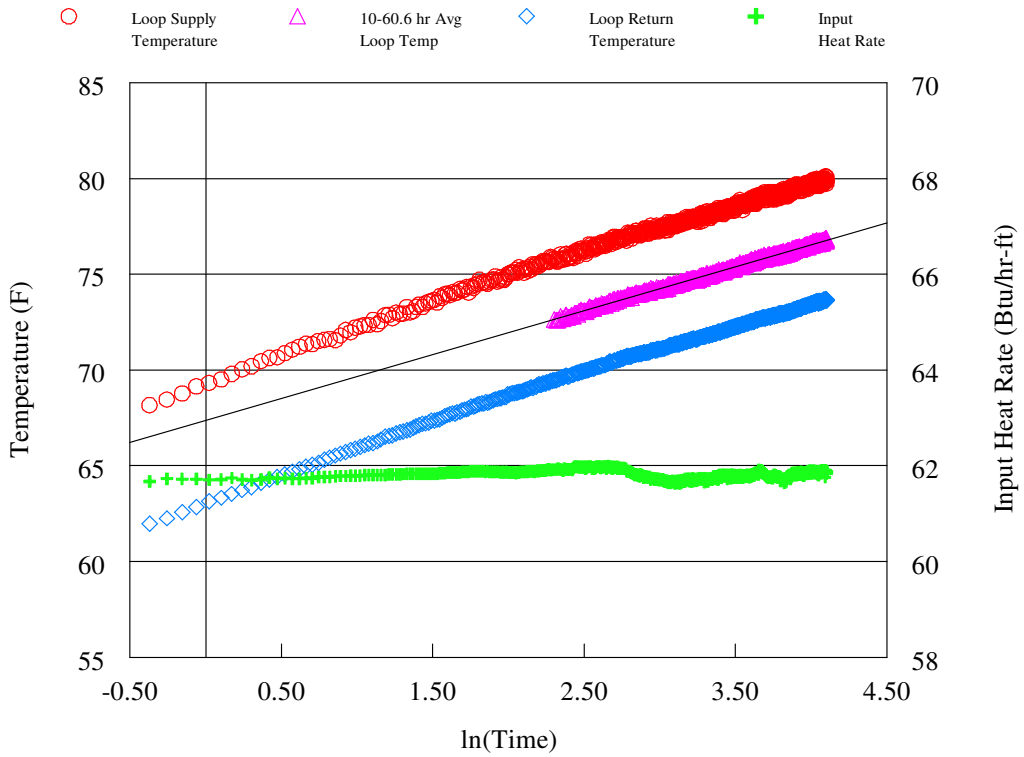


Fig. 2: Temperature & Heat Rate Vs Natural Log of Time

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 60.6 hours. The slope of the curve fit was found to be 2.29. The resulting thermal conductivity was found to be **2.14 Btu/hr-ft-°F**.

Thermal Diffusivity

The reported drilling log for this test borehole indicated that the formation consisted of silt, sand, gravel, sandstone, schist and limestone. Heat capacity values for sandstone, schist and limestone were calculated from specific heat and density values listed by Kavanaugh and Rafferty[1]. A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 37.7 Btu/ft^3-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **1.36 ft^2/day**.

[1]Stephen P. Kavanaugh and Kevin Rafferty, Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems (Atlanta: ASHRAE, 2014), 75.

Certificate of Calibration

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a regular schedule. The components are calibrated by the manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

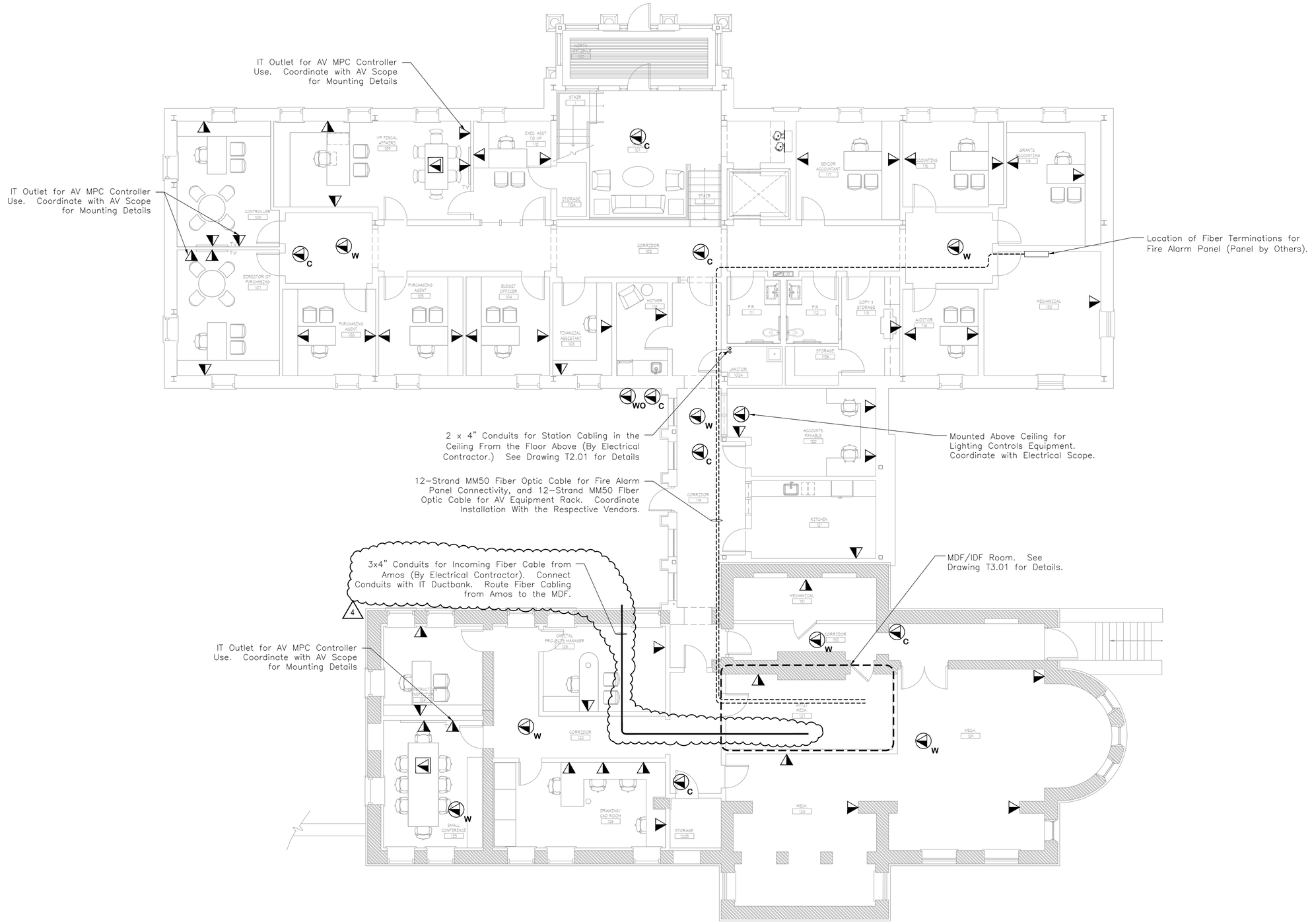
FTC Unit 227

DA Unit 45

Primary Equipment		
Component	Calibration Date	Calibration Due Date
Datalogger	7/20/2018	7/20/2021
Current Transducer	7/23/2018	7/23/2021
Voltage Transducer	7/23/2018	7/23/2021

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via a water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

Date	9/25/2018			2/15/2019			11/1/2019			8/25/2020		
Thermocouple 1 (°F)	31.9	31.9	32.0	66.3	66.4	66.4	32.0	32.1	32.1	32.1	32.0	31.9
Thermocouple 2 (°F)	32.0	32.0	32.0	66.4	66.4	66.4	32.1	32.1	32.1	32.1	32.0	31.9
Thermocouple 3 (°F)	32.0	32.1	32.1	66.4	66.4	66.4	32.1	32.1	32.1	32.0	31.9	31.8
Thermocouple 4 (°F)	32.0	32.0	32.0	66.4	66.4	66.4	32.0	32.1	32.1	32.1	32.0	31.8
Digital Thermometer (°F)	32.1	32.1	32.2	66.4	66.4	66.4	32.2	32.2	32.2	32.1	32.1	32.0



T1.01 IT Device Locations First Floor

A Scale: 3/16" = 1'-0" When Viewed on 30" x 42" Sheet

	09/02/20 - CE SUBMISSION		07/02/21 - PERMIT SET
	09/25/20 - SD SUBMISSION		08/23/21 - CD SUBMISSION
	12/14/20 - DD SUBMISSION	1	03/10/22 - ADDENDUM 4
	06/14/21 - ICD ISSUE		

RECORD REVISIONS

SIGNATURE DATE

VMA
Voith & Mactavish Architects LLP
2401 Walnut Street, 6th Floor
Philadelphia, PA 19103
phone 215-545-4544 fax 215-545-3299
www. voithandmactavish.com

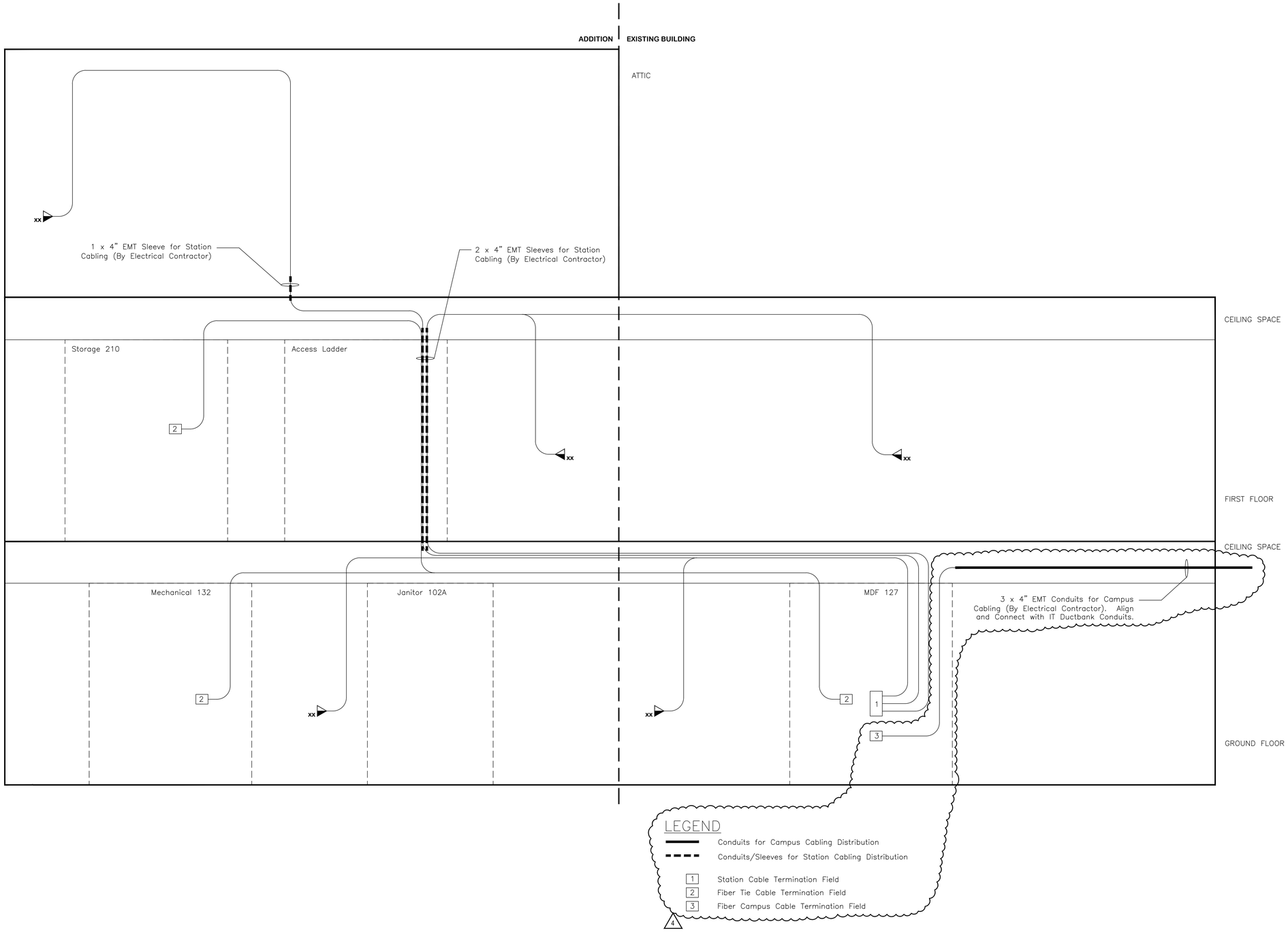
COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
DGS C-1101-0053 PHASE 001

VAIL HALL BUILDING RENOVATIONS
Lincoln University
Lower Oxford Township, Chester County, PA

IT DEVICE LOCATIONS - FIRST FLOOR

DRAWN BY	DATE	DRAWING No.
V. Krastev	08/23/2021	T1.01
CHECKED BY	SCALE	
T. Knauss	AS NOTED	



T2.01 A — Telecommunications Riser Diagram
Scale: No Scale

	09/02/20 - CE SUBMISSION		07/02/21 - PERMIT SET
	09/25/20 - SD SUBMISSION		08/23/21 - CD SUBMISSION
	12/14/20 - DD SUBMISSION	4	03/10/22 - ADDENDUM 4
	06/14/21 - ICD ISSUE		

RECORD REVISIONS

SIGNATURE DATE

VMA
Voith & Mactavish Architects LLP
2401 Walnut Street, 6th Floor
Philadelphia, PA 19103
phone 215-545-4544 fax 215-545-3299
www. voithandmactavish.com

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF GENERAL SERVICES
HARRISBURG, PENNSYLVANIA

D.G.S. PROJECT No.
DGS C-1101-0053 PHASE 001

VAIL HALL BUILDING RENOVATIONS
Lincoln University
Lower Oxford Township, Chester County, PA

TELECOMMUNINCATIONS RISER DIAGRAM

DRAWN BY	DATE	DRAWING No.
V. Krastev	08/23/2021	T2.01
CHECKED BY	SCALE	
T. Knauss	AS NOTED	