

December 5, 2017

Mr. Jeff Klenk
Howard County Public School System (HCPSS)
10910 Route 108
Ellicott City, MD 21043

RE: Indoor Air Quality Assessments during Renovations at Swansfield Elementary School
Project #J16-971 (November 10, 16 and 29, 2017)

Dear Mr. Klenk,

Aria Environmental, Inc. (AE) is pleased to present this report of findings for indoor air quality assessments conducted at Swansfield Elementary School (Swansfield). Jeff Klenk of HCPSS requested AE make frequent visits to Swansfield to monitor indoor air quality that may be affected by the current major renovation of the school. The visits discussed in this report were performed on November 10, 16 and 29, 2017 and included work site observations, and real-time measurements for particles, indoor air quality parameters (temperature, humidity, carbon monoxide (CO) and carbon dioxide (CO₂)) and volatile organic compounds (VOCs). These assessments were performed by Tony Schwegmann, Industrial Hygienist, of AE. Presented below are observations and recommendations made based upon conditions readily observed on the reported dates. A building drawing is included as an attachment.

Particles

Particulate matter or PM is the term for a mixture of solid particles and liquid droplets found in the air. It does not distinguish between the types of particles in the air (e.g., pollen, skin cells, soil, etc.). Particulate matter includes "inhalable coarse particles," with diameters larger than 2.5 micrometers and smaller than 10 micrometers (PM₁₀) and "fine particles," with diameters that are 2.5 micrometers and smaller (PM_{2.5}). A micrometer is also called a micron and is one millionth of a meter. To put these particle diameters in perspective, the average human hair is about 70 micrometers in diameter – making it 30 times larger than the largest fine particle. Particle loads expected to be a part of the school environment include carpet and clothing fiber, soil tracked in from outside, paper dust and dust and fibers from building materials.

ANSI/ASHRAE Standard 62.1–2016 suggests target indoor concentrations for PM_{2.5} and PM₁₀ of 15 µg/m³ and 50 µg/m³, respectively. These concentrations are taken from the EPA's National Ambient Air Quality Standards (NAAQS) based on annual arithmetic means deemed acceptable for outdoor air quality. Occupational standards and guidelines for particles are nearly an order of magnitude higher than concentrations typically found in non-occupational settings and are not appropriate for comparison. Particle measurements were taken with an Aerocet 531 particulate monitor. The particle monitor takes a two minute averaged sample of particle concentrations in 5 size fractions (PM₁, PM_{2.5}, PM₇, PM₁₀ and total suspended particles (TSP)). Results of particulate monitoring are presented in Tables 1, 2, and 3.

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Discussion of Particle Results for November 10, 2017

The PM_{2.5} particle concentrations ranged from 0 to 1 µg/m³ and PM₁₀ particle concentrations ranged from 4 to 14 µg/m³. Particle concentrations were below the target concentration in all areas monitored. The building was occupied as usual for a normal school day. Results of particulate monitoring are presented in Table 1.

Table 1 – Results of Particulate Monitoring Swansfield Elementary School on November 10, 2017

Location	Time	PM1 (µg/m ³)	PM2.5 (µg/m ³)	PM7 (µg/m ³)	PM10 (µg/m ³)	TSP (µg/m ³)
Lobby	10:26	0	0	7	12	35
Guidance Counselor Office	10:28	0	0	3	7	17
Pod 139 – Center	10:33	0	0	3	4	19
Pod 144 – Center	10:36	0	1	8	14	37
Gym	10:40	0	0	9	13	60
Pod 159 - Center	10:43	0	0	4	5	16
Outside	10:49	0	0	2	2	6

Bold-faced results indicate results above target concentrations

Discussion of Particle Results for November 16, 2017

The PM_{2.5} particle concentrations were 0 µg/m³ in all areas measured. PM₁₀ particle concentrations ranged from 2 to 12 µg/m³. Particle concentrations were below the target concentration in all areas monitored. The building was occupied as usual for a normal school day. Results of particulate monitoring are presented in Table 2.

Table 2 – Results of Particulate Monitoring Swansfield Elementary School on November 16, 2017

Location	Time	PM1 (µg/m ³)	PM2.5 (µg/m ³)	PM7 (µg/m ³)	PM10 (µg/m ³)	TSP (µg/m ³)
Lobby	11:27	0	0	7	12	41
Guidance Counselor Office	11:30	0	0	4	11	27
Pod 159 – Center	11:33	0	0	8	12	24
Pod 144 – Center	11:38	0	0	2	3	14
Pod 139 - Center	11:40	0	0	6	7	17
Gym	11:43	0	0	2	2	33
Outside	11:47	0	0	1	1	22

Bold-faced results indicate results above target concentrations

Discussion of Particle Results for November 29, 2017

The PM_{2.5} particle concentrations were 0 µg/m³ in all areas measured. PM₁₀ particle concentrations ranged from 0 to 9 µg/m³. Particle concentrations were below the target concentration in all areas monitored. The building was occupied as usual for a normal school day. Results of particulate monitoring are presented in Table 3.

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Table 3 – Results of Particulate Monitoring Swansfield Elementary School on November 29, 2017

Location	Time	PM1 ($\mu\text{g}/\text{m}^3$)	PM2.5 ($\mu\text{g}/\text{m}^3$)	PM7 ($\mu\text{g}/\text{m}^3$)	PM10 ($\mu\text{g}/\text{m}^3$)	TSP ($\mu\text{g}/\text{m}^3$)
Lobby	10:20	0	0	6	7	18
Guidance Counselor Office	10:25	0	0	7	9	14
Pod 144 – Center	10:28	0	0	6	9	28
Pod 139 – Center	10:31	0	0	4	8	30
Pod 159 - Center	10:37	0	0	0	0	2
Gym	10:35	0	0	3	6	31
Inside New Construction Area	10:40	0	0	7	9	24
Outside	10:43	0	1	3	5	8

Bold-faced indicates results outside of recommended comfort ranges or target concentrations.

Indoor Air Quality Measurements

Industry guidelines or standards for seasonal temperature and humidity ranges for thermal comfort are established by the American National Standards Institute (ANSI) and the American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) standard 55-2013. These ranges are presented in Table 4. The U.S. Environmental Protection Agency (EPA) recommends maintaining indoor relative humidity below 60% and ideally between 30 and 50%. Low humidity is expected in buildings that do not add humidity during the heating season. The comfort ranges are only set for the Summer and Winter seasons when temperatures are usually consistent. There are no Fall or Spring ranges because these seasons can include both heating and cooling modes of HVAC operation. Carbon dioxide and carbon monoxide measurements are used to assess ventilation system performance. The exhaled breath of building occupants is the main indoor source of carbon dioxide; therefore, the build-up of carbon dioxide indicates inadequate ventilation. Results of temperature, relative humidity, carbon dioxide and carbon monoxide monitoring are presented in Tables 5-7 below.

Table 4- Acceptable Ranges of Temperature and Relative Humidity in Summer and Winter^a

Relative Humidity	Winter Temperature	Summer Temperature
30%	68.5°F – 76.0°F	74.0°F – 80.0°F
40%	68.5°F - 75.5°F	73.5°F – 79.5°F
50%	68.5°F - 74.5°F	73.0°F – 79.0°F
60%	68.0°F - 74.0°F	72.5°F – 78.0°F

^aadapted from ASHRAE Standard 55-2013

Real Time Volatile Organic Compounds Measurements

Instantaneous measurements for volatile organic compounds (VOCs) were collected using a ppbRae 3000 monitor calibrated using isobutylene gas. This instrument is used as a screening tool for VOCs in general with a limit of detection of 1 ppb. VOCs include a variety of chemicals, some of which may cause adverse health effects. Concentrations of many VOCs are generally higher indoors than outdoors. VOCs are emitted by many common products including paints, paint strippers, cleaning supplies, building materials, furnishings, fuels, office equipment and supplies, glues, and permanent markers, as well as cosmetics, perfumes and other personal hygiene products. These products can release organic compounds while being used or stored. It is important to note that the measurements taken are instantaneous and are intended to aid the

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inspector in detecting potential sources of VOC contamination. A VOC source is suspected when the measured concentration is significantly higher than the outdoor concentration or if a spike in concentration is seen in one location compared to others. Results of VOC monitoring are also presented in Tables 5-7 below.

Discussion of IAQ and VOC Measurements for November 10, 2017

The indoor temperatures for November 10, 2017 ranged from 67.5°F to 72.0°F. Temperature measurements in classrooms and occupied areas of the school were within the recommended comfort ranges, with exception of the area near the Lobby, which was 67.5°F. Indoor relative humidity measurements were all between 30.4% and 41.4%. All were within the recommended range of 30 to 60%.

Indoor carbon dioxide concentrations ranged from 466 to 780 ppm within indoor occupied areas. The concentration of concern for carbon dioxide is set by ANSI/ASHRAE standard 62.1 as 700 ppm above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide was 284 ppm; therefore, concentrations were below the target concentration in all areas monitored. Measurements were made on a normal school day.

Carbon monoxide is mainly attributed to incomplete combustion. Concentrations of CO ranged from 0.0 ppm to 1.1 ppm for all indoor and outdoor locations monitored and were below the ASHRAE concentration of concern (9 ppm).

Indoor concentrations of VOCs measured on November 10, 2017 were 0 ppb in all areas monitored, and the outdoor measurement was 0 ppb. The measurements are considered low and do not indicate any obvious source of VOCs. Results of IAQ and VOC monitoring are presented in Table 5.

**Table 5 – Results of Indoor Air Quality (IAQ) Measurements
at Swansfield Elementary School on November 10, 2017**

Location	Time	Temperature (°F)	Relative Humidity (Rh%)	Carbon Monoxide (CO)	Carbon Dioxide (CO ₂)	Volatile Organic Compounds (VOCs)
Lobby	10:26	67.5	41.4	0.0	780	0
Guidance Counselor Office	10:28	69.6	35.8	0.0	466	0
Pod 139 – Center	10:33	71.4	36.4	0.0	642	0
Pod 144 – Center	10:36	71.9	34.2	0.0	680	0
Gym	10:40	72.0	33.5	0.0	650	0
Pod 159 - Center	10:43	71.4	30.4	0.0	629	0
Outside	10:49	50.3	29.1	1.1	284	0

Bold-faced indicates results outside of recommended comfort ranges or target concentrations.

Discussion of IAQ and VOC Measurements for November 16, 2017

The indoor temperatures for November 16, 2017 ranged from 68.5°F to 72.9°F. Temperature measurements in classrooms and occupied areas of the school were within the recommended comfort ranges. Indoor relative humidity measurements ranged from 34.7% to 36.9%. All were within the recommended range of 30 to 60%.

Carbon dioxide concentrations ranged from 496 to 676 ppm within indoor occupied areas. The concentration of concern for carbon dioxide is set by ANSI/ASHRAE standard 62.1 as 700 ppm

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above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide was 264 ppm; therefore, concentrations were below the target concentrations in all areas monitored. Measurements were made during a normal school day when the building was fully occupied.

Carbon monoxide is mainly attributed to incomplete combustion. Concentrations of CO ranged from 0.0 ppm to 0.1 ppm for all indoor and outdoor locations monitored and were below the ASHRAE concentration of concern (9 ppm).

Indoor concentrations of VOCs measured on November 16, 2017 were 0 ppb in all areas monitored, and the outdoor measurement was 0 ppb. The measurements are considered low and do not indicate any obvious source of VOCs. Results of IAQ and VOC monitoring are presented in Table 6.

**Table 6 – Results of Indoor Air Quality (IAQ) Measurements
at Swansfield Elementary School on November 16, 2017**

Location	Time	Temperature (°F)	Relative Humidity (Rh%)	Carbon Monoxide (CO)	Carbon Dioxide (CO₂)	Volatile Organic Compounds (VOCs)
Lobby	11:27	68.5	36.9	0.0	498	0
Guidance Counselor Office	11:30	70.2	35.2	0.0	496	0
Pod 159 – Center	11:33	71.2	34.7	0.0	572	0
Pod 144 – Center	11:38	71.7	36.1	0.0	529	0
Pod 139 - Center	11:40	72.7	35.8	0.0	613	0
Gym	11:43	72.9	35.5	0.0	676	0
Outside	11:47	59.9	39.1	0.1	264	0

Bold-faced indicates results outside of recommended comfort ranges or target concentrations.

Discussion of IAQ and VOC Measurements for November 29, 2017

The indoor temperatures for November 29, 2017 ranged from 70.6°F to 72.2°F. Temperature measurements in classrooms and occupied areas of the school were within the recommended comfort ranges. Indoor relative humidity measurements ranged from 26.0% to 32.1%. All were within the recommended range of 30 to 60%.

Carbon dioxide concentrations ranged from 453 to 762 ppm within indoor occupied areas. The concentration of concern for carbon dioxide is set by ANSI/ASHRAE standard 62.1 as 700 ppm above outdoor air. On the day of monitoring, the outdoor air concentration of carbon dioxide was 290 ppm; therefore, concentrations were below the target concentrations in all areas monitored. Measurements were made during a normal school day when the building was fully occupied.

Carbon monoxide is mainly attributed to incomplete combustion. Concentrations of CO ranged from 0.0 ppm to 0.1 ppm for all indoor and outdoor locations monitored and were below the concentration of concern (9 ppm).

Indoor concentrations of VOCs measured on November 29, 2017 ranged from 0 ppb in non-construction occupied parts of the school and 993 ppb in the new construction area. The outdoor measurement was 0 ppb. The measurements are considered low and do not indicate any obvious source of VOCs. Results of IAQ and VOC monitoring are presented in Table 7.

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**Table 7 – Results of Indoor Air Quality (IAQ) Measurements
at Swansfield Elementary School on November 29, 2017**

Location	Time	Temperature (°F)	Relative Humidity (Rh%)	Carbon Monoxide (CO)	Carbon Dioxide (CO ₂)	Volatile Organic Compounds (VOCs)
Lobby	10:20	70.6	28.6	0.0	476	0
Guidance Counselor Office	10:25	71.3	28.5	0.0	453	0
Pod 144 – Center	10:28	71.8	30.0	0.0	620	0
Pod 139 – Center	10:31	72.2	31.2	0.0	621	0
Pod 159 - Center	10:37	71.8	26.0	0.0	471	0
Gym	10:35	72.2	31.9	0.0	762	0
Inside New Construction Area	10:40	71.8	32.1	0.0	709	993
Outside	10:43	66.2	29.1	0.1	290	0

Bold-faced indicates results outside of recommended comfort ranges or target concentrations.

Conclusions and Recommendations

Based upon our observations and sampling results on November 10, 16 & 29, 2017 at Swansfield Elementary School, measures are being taken to prevent construction dust and odors from entering the occupied areas of the school. Only a few measurements were above the recommended concentrations in a few areas during these 3 school visits. The school is fully occupied. Elevated concentrations are expected and are not entirely due to construction activities. The tiled floors were being kept clean of visible dust. Fluctuations of dust and VOC concentrations are influenced by the types of construction activities occurring and also by student and staff activities and are expected to vary over time. A floor plan with measurement locations for the school is attached.

AE will continue to make weekly visits to Swansfield Elementary School as requested. Thank you for choosing Aria Environmental, Inc. for your industrial hygiene consulting needs. Should you have any questions about the information contained herein, please do not hesitate to contact us at 410-549-5774.

Sincerely,
Aria Environmental, Inc.

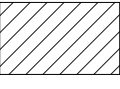
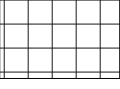


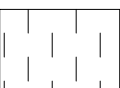




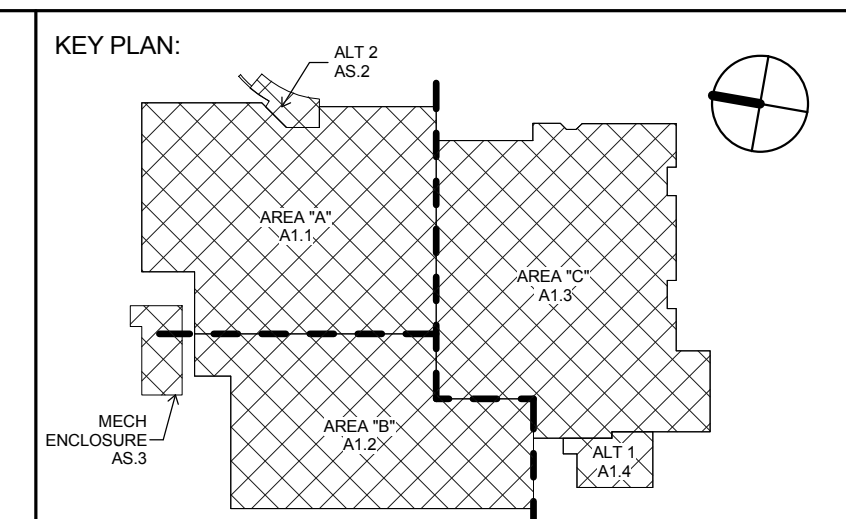
Julie Barth, CIH, CSP, LEED Green Associate

Attachments

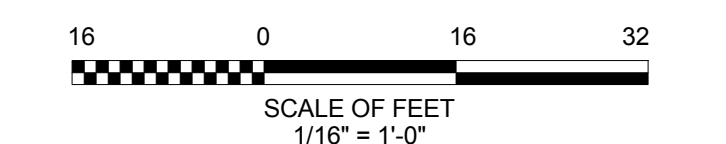
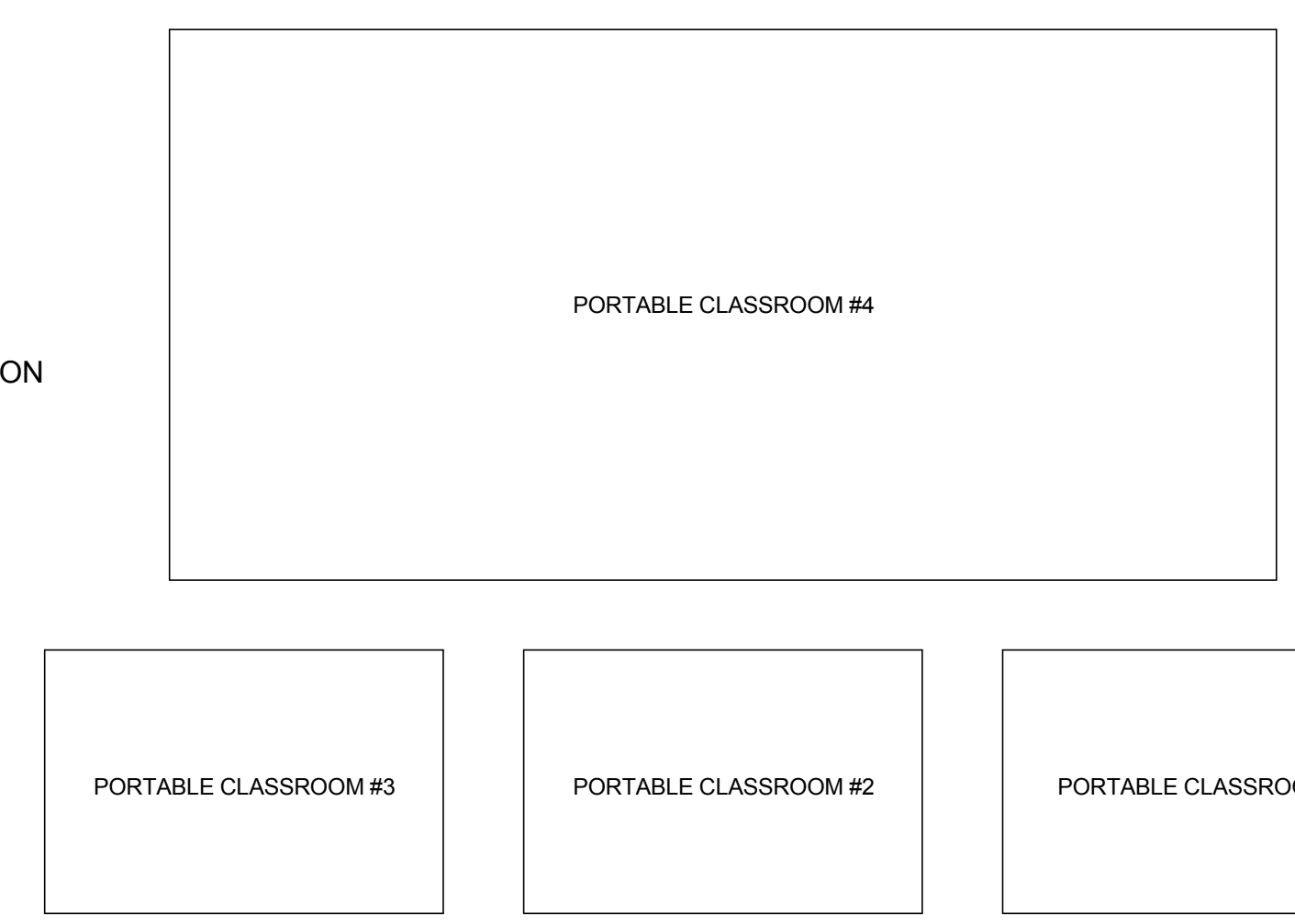
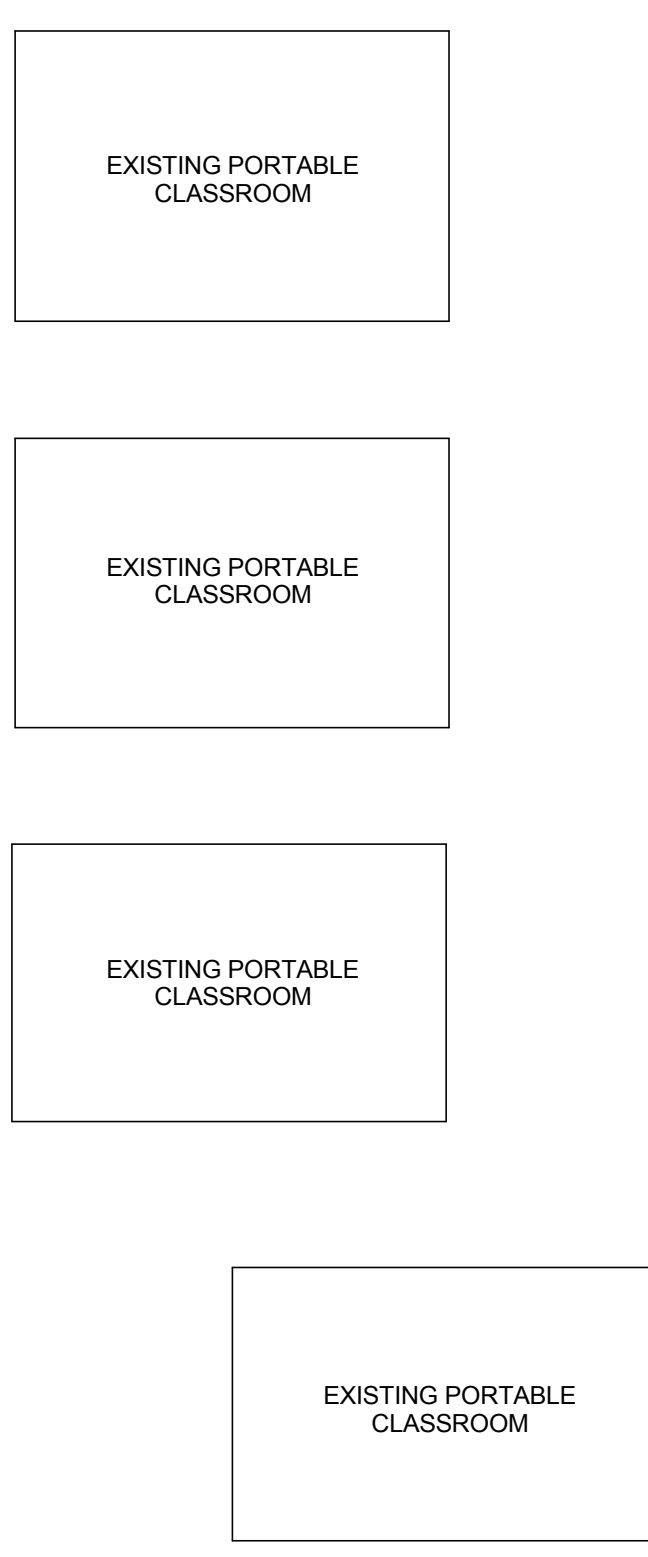
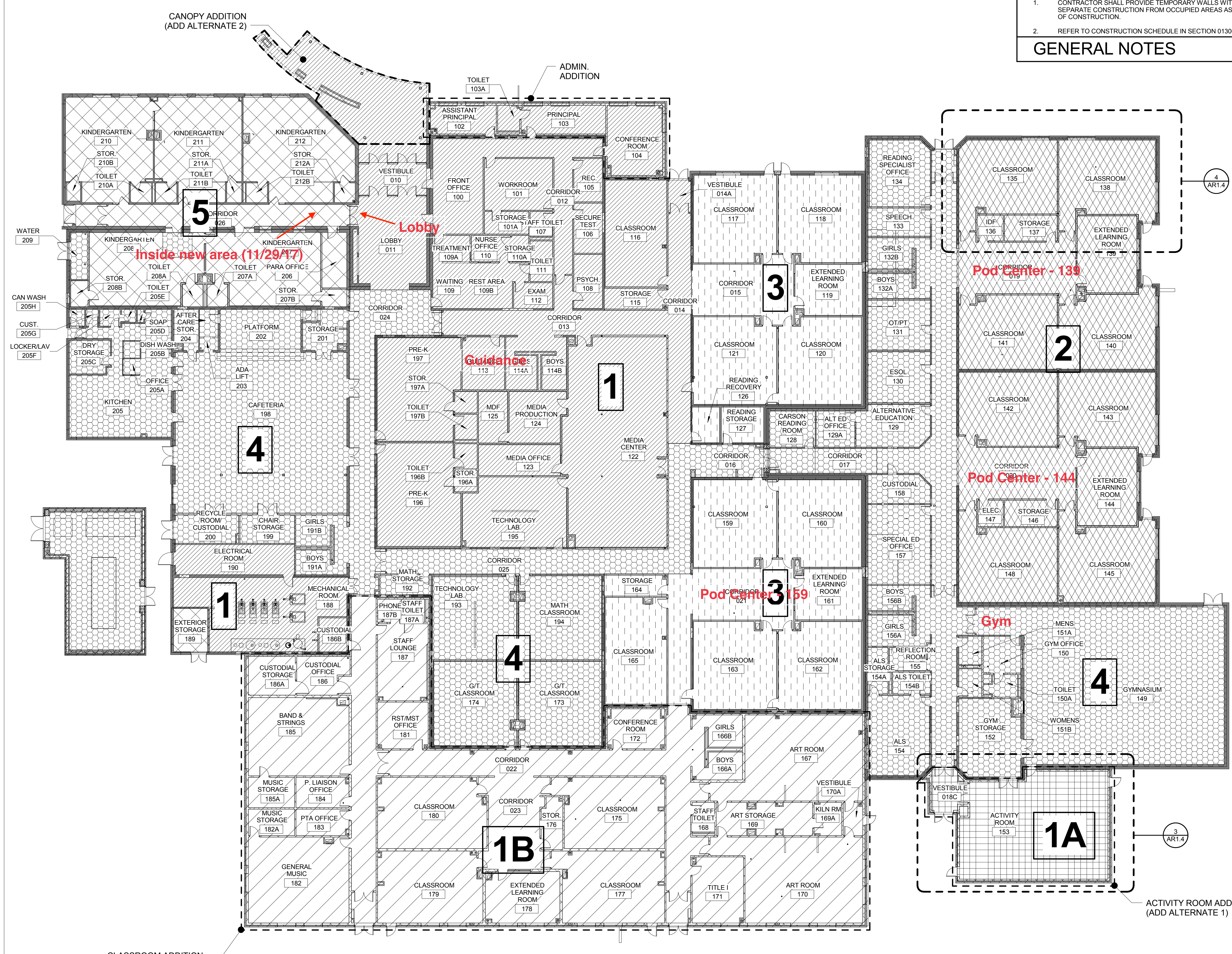
1. CONTRACTOR SHALL PROVIDE TEMPORARY WALLS WITH LOCKABLE DOORS TO SEPARATE CONSTRUCTION FROM OCCUPIED AREAS AS NEEDED DURING EVERY PHASE OF CONSTRUCTION.
 2. REFER TO CONSTRUCTION SCHEDULE IN SECTION 013000.

GENERAL NOTES

-  **PHASE 1: 6/16- 8/16**
-  **PHASE 1A: 6/16- 12/16**
SEE DETAIL 4/AR1.4 FOR TEMPORARY PARTITION LOCATIONS
-  **PHASE 1B: 6/16- 8/17**
-  **PHASE 2: 9/16- 12/16**
SEE DETAIL 3/AR1.4 FOR TEMPORARY PARTITION LOCATIONS
-  **PHASE 3: 1/17- 5/17**
-  **PHASE 4: 6/17- 8/17**
-  **PHASE 5: 9/17- 12/17**

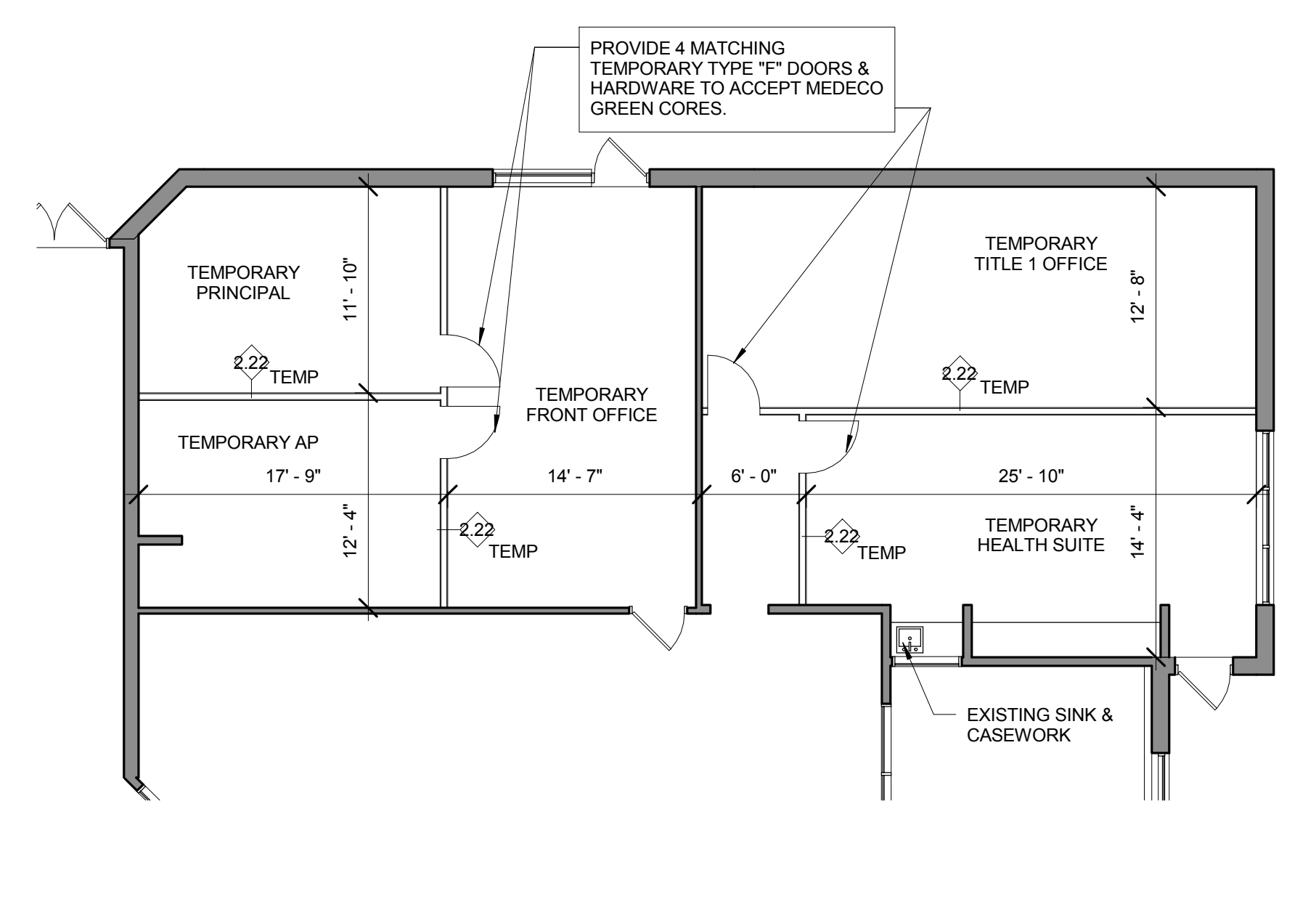
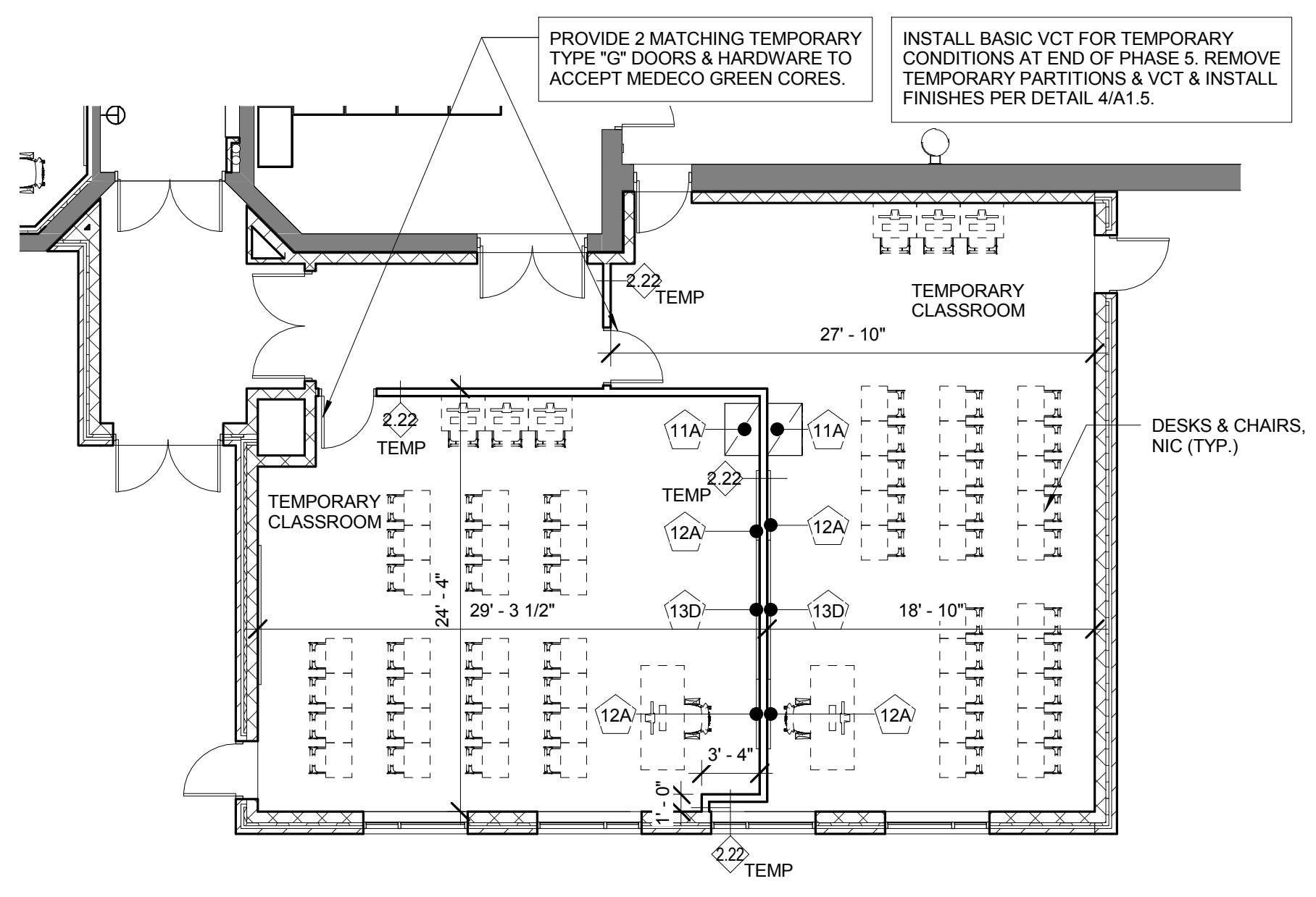


KEYNOTES LISTED ON THIS SHEET ARE FOR CONVENIENCE ONLY. REFER TO SHEET CS.2 FOR COMPLETE LIST



BID DOCUMENTS

1 PHASING PLAN
1/16" = 1'-0"



3 PHASE 3-5 TEMPORARY PARTITIONS 1/17-12/17
1/16" = 1'-0"

4 PHASE 1 TEMPORARY PARTITIONS 8/16-10/16
1/16" = 1'-0"

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I CERTIFY THAT THESE DOCUMENTS WERE PREPARED OR APPROVED BY ME, AND THAT I AM A DULY LICENSED ARCHITECT UNDER THE LAWS OF THE STATE OF MARYLAND. LICENSE NUMBER 10910, EXPIRATION DATE 11/04/16.

Revisions:	No.	Date	Description

SWANSFIELD ELEMENTARY SCHOOL
 HOWARD COUNTY PUBLIC SCHOOL SYSTEM

Job No.	1448	GEW	Drawn
Scale	As indicated	GEW	Checked
Date	01/13/2016	PLH	Approved
Drawing Title	REFERENCE PHASING PLAN	AR1.4	Drawing Number