To: Sara Ahern, Superintendent of Schools, Town of Barnstable
From: Marina Brock, PhD, MS, RS, GSP
Date: November 10, 2024
RE: Sample Analysis from BUE – Classroom Examination

Overview:

At your request, I conducted a surface tape assessment for indoor air quality (IAQ) at Barnstable United School (BUE) on Monday, October 28, at 3 PM. Present during the assessment Assistant Director of Human Resources Tammy Cunningham. I collected 8 samples, five of which were from surfaces in instructor's room. We focused on collecting samples that would indicate the possibility of widespread contamination from mold or other indoor air quality contaminants, many of which were areas of concern to instructor, some that could indicate a level of historic issues. The primary areas of concern identified include:

- The pre-filter on the classroom HEPA air filter (1)
- The inside surface of the filter or beneath the prefilter (2)
- By the crack in the wall in the corner of the classroom (3)
- Surface wall with small discoloration in the abutting classroom but by the adjoining classroom walls. (4)
- Discoloration on top of trim in back wall of classroom and painted surface below it (5)
- Dehumidifier Surface intake fins (6)
- "Another classroom"-Tammy's request (7)
- Computer room (8)

These samples underwent microscopic analysis to identify any unusual indoor contaminants, spores, allergens, or materials taking specific note of quantities and concentrations on each sample which could be atypical to seasonally expected or standard analysis from this area and to indicate if there was anything considered to be detrimental to the health and safety of occupants..

Key Findings:

Sample 1 – Prefilter Analysis of Classroom HEPA Air Filter

The HEPA filtering unit was positioned atop the classroom univent, where it received a large volume of recirculated air from the HVAC system, along with outdoor air when adjacent windows were open.

Note: HEPA filters are designed with multiple sequential layers, including a prefilter to capture larger particles before air passes through finer filtration layers. In the case of this unit, I was able to access and remove the prefilter to examine its contents and reach the first internal, high-efficiency filter (Sample 2). According to maintenance staff, the filter had been replaced at the start of the school year.

The prefilter was heavily loaded with fibers, which aligns with its function to capture larger airborne particles in the initial layer. Fibers are typically larger than other airborne dust and debris, making them readily captured by the prefilter.

Organic Fiber Composition: The fibers observed in the prefilter included common organic and synthetic materials, likely sourced from:

- **Human or animal hair**
- **Textile fibers** from clothing, carpets, and upholstery (e.g., cotton, wool, polyester)
- **Plant fibers** originating from paper, wood, or other plant-based materials

Inorganic Fibers: Minimally present but less common but possible in a classroom, these might include:

- **Mineral dust** (e.g., silica from chalk or construction materials)
- **Synthetic mineral fibers** (e.g., fiberglass) if there's nearby construction or maintenance work

Classrooms typically contain a high concentration of organic fibers and particles due to human activity, clothing, fabrics, and paper products. The presence of these materials is reflected in the particles captured by air filters.

Key Particles Observed in the Classroom Air Filter

- **Skin Cells**:

A significant number of skin cells were observed on the filter. Given that humans continuously shed skin cells, especially in high-occupancy spaces with frequent movement, it is common for classroom air filters to accumulate these particles. Skin cells combine with other particles like hair and textile fibers, increasing the organic content of indoor dust.

- **Larger Particles**:

In addition to fibers and skin cells, other larger particles captured include:

- **Dust and Soil**: Fine particles from outdoor soil and dust are frequently brought indoors on shoes, clothing, or through open windows. These particles readily circulate in the classroom air.
- **Pollen**: Seasonal pollen, particularly during high pollen seasons, enters the classroom and is captured by air filters.
- **Pet Dander**: Though animals are not typically present, pet dander can be carried on students' or teachers' clothing, contributing to indoor dust.

- **Mineral and Construction Particles**: Particles such as silica and even asbestos (in older buildings) can enter, particularly if there is nearby construction or renovation. These particles are especially concerning due to their potential health risks.
- These materials reflect the diversity of airborne particles in indoor environments like classrooms, where large groups of people gather daily.

Additional Particles Captured Due to Proximity to an Open Window

Air filters positioned near a sporadically open window is likely to capture and entrain a wider range of outdoor particles, increasing the diversity of materials that were present on this sample and on the internal filter (Sample 2).

These may include:

1. **Increased Pollen**: Outdoor pollen levels tend to be higher than indoor levels, particularly in spring and fall. An open window allows more pollen particles to settle on the filter.
2. **Outdoor Dust and Soil**: Wind or nearby foot traffic can carry fine dust and soil particles through an open window, increasing the amount of outdoor dust collected.
3. **Plant Debris**: Small fragments from nearby trees, shrubs, or grasses—such as leaves or bark—may enter and accumulate on the filter.
4. **Insects and Insect Fragments**:
   - Small insects like gnats, flies, or even larger insects may get trapped on the filter, especially when windows are open. Common fragments include:
     - **Exoskeleton pieces**, such as wings or legs
     - **Moth scales** and small web filaments from spiders or outdoor insects
   - These fragments contribute to the biological content of airborne debris and can carry allergens or contaminants.
5. **Vehicle Emissions and Particulate Matter**: In classrooms near roads or parking lots, particles from vehicle emissions, exhaust, and brake dust can settle on the filter.
6. **Outdoor Fungal Spores**: Additional spores from outdoor fungi and mold, especially prevalent in damp conditions, may enter. These can supplement indoor mold spores already present in classroom air.
7. **Aerosols and Pollutants from Nearby Activities**: Construction dust, vehicle exhaust, smoke, or industrial pollutants from nearby areas may enter through an open window, adding to the diversity of particles collected and what we saw in the sample.
8. **Environmental Allergens and Natural Fibers**: Seasonal allergens like ragweed and natural plant fibers (e.g., cottonwood seeds) may be present depending on the outdoor environment.

NOTE: Placing a classroom air filter near an open window increases its exposure to a mix of outdoor and indoor particles, resulting in a wider range of materials captured compared to a filter placed further indoors. Although much of this material can be entrained in the layer filter of the unit, the placement of the unit on the direct air delivery also means that the blower can be blowing entrained material into the classroom air.

Sample 2 – Secondary Inner Filter Analysis of Classroom HEPA Air Filter

Following the capture of larger particles on the prefilter (Sample 1), the secondary (inner) filter layer primarily contained smaller particles. This inner layer effectively trapped some of the finer particulate matter circulating in the ambient air. This provided insight into the types of smaller constituents circulating in this classroom over time.

Observed Materials on Secondary Filter – Many smaller representations of Sample 1.

- **Fine Fibers**:
  - **Textile Microfibers**: Under compound microscopy, fine textile microfibers appear as thin, translucent strands, significantly smaller than the fibers seen on the prefilter. Likely sources include clothing, upholstery, and carpets, with fibers primarily composed of materials like **polyester, cotton, and nylon**.
  - **Plant-Based Microfibers**: Tiny plant-based fibers from paper, wood, or other organic materials are also visible. These fibers are generally short and fine, allowing them to pass through prefilter and collect on the inner filter.
- **Skin Cell Fragments**:
  - **Microscopic Skin Cells**: Observed as irregularly shaped, translucent particles, skin cells are a common component in indoor air, especially in high-occupancy spaces like classrooms. These fragments are smaller and more granular, often appearing alongside finer fibers.
- **Pollen and Plant Particles**:
  - **Pollen Grains**: Various pollen grains, particularly from outdoor sources, were observed. These grains are spherical or oval and slightly textured, with pollen from sources such as conifers, grasses, or ragweed being particularly common.
  - **Microscopic Plant Fragments**: Tiny particles from plant debris, such as cellulose fragments, are often seen as irregular shapes, often green with residual chlorophyll. Fragments can come from outdoor air or come from nearby classroom vegetation or plant-based materials used indoors.
- **Dust and Soil Particles**:
  - **Fine Dust**: Fine dust particles appear as irregular, semi-opaque grains. These particles are a mix of indoor and outdoor sources, brought in on shoes or through open windows.
  - **Soil and Mineral Particles**: Fine mineral particles from outdoor soil or building materials were seen, typically irregular in shape and vary in opacity.
- **Mineral Particles**:
  - **Silica and Other Suspended Outdoor Dust**: Silica and similar mineral particles appear as very fine, crystalline structures. These particles are often derived from nearby construction, blowing dust (like mowing or leaf clearing activities) and are frequently opaque and angular in appearance.
- **Biological Microorganisms and Spores**:
  - **Fungal Spores**: Mold spores' debris was seen from **Aspergillus/Penicillium, and trace Cladosporium. They were** visible with small, round, and smooth

    structures. The spores appear as fine, semi-transparent very varying shapes and sizes making them identifiable as an aggregate.
    - **Bacterial Clusters**: Although bacteria are generally too small to be individually resolved under a standard microscopy. There were what appeared to be random clusters of bacteria attached to dust or organic debris.
- **Insect Fragments**:
    - **Insect Parts and Fragments**: Small insect fragments, such as legs, wings, and antennae, were visible, most likely from dust mites and possibly from other tiny insects. These appear as irregularly shaped, translucent structures with a fibrous or segmented (cellular) appearance.
    - **Insect exoskeletons**: Small scales and fragments from insect exoskeletons appeared as flat, thin structures.
- **Environmental Pollutants and Aerosols**:
    - **Vehicle Emission Particles**: Soot and carbon particles from vehicle emissions were present as dark spots/smudges. These particles were opaque and small, often clustering with other dust.

Sample 3, 4, and 5 – Off of Several Areas with Wall Discolorations

Analysis of Sample Particulates and Surface Condition

Upon examination, no significant findings were observed in any of the samples beyond random fibers and traces of ambient particulate matter consistent with typical indoor debris or "dirt." The discoloration noted on surfaces may have been due to embedded surface dirt within the paint or possibly from older, inactive mold colonies that left residual pigmentation traces.

Specific Observations:

- **Sample 5**: This sample contained small white paint chips, likely from the painted surface, as well as tiny fragments from the black trim coating. These particles were consistent with minor chipping or wear in the finish and showed no evidence of active contamination or degradation.

The particulate findings across these samples reflect common environmental debris, with no indications of active microbial growth or significant contaminants.

Sample 6– Debris from Fins of Classroom Dehumidifier

Upon examining the fins of the classroom dehumidifier, I found a similar mix of materials consistent with those captured on the classroom air filter. The dehumidifier's placement near the windows poses an issue, as it likely draws in moisture-laden air from outside during certain weather conditions, diminishing its efficiency in controlling indoor humidity levels.

The fins effectively capture finer, lighter debris circulating in the classroom air, providing a snapshot of both indoor and occasional outdoor particulate matter. Regular cleaning of these fins is essential to ensure optimal air quality and maintain the dehumidifier's efficiency in moisture control. I have attached a document which can provide assistance to classroom teachers, custodians, and facility with respect to the optimal placement of these units within the classroom.

Sample 7, - Room 244

In this classroom sample, we observed a nearly identical mix of particles, including fine dust, textile fibers, skin cells, pollen, and small insect fragments. This composition reflects typical indoor air content often found in these high-occupancy spaces and compounded by occasional outdoor particles likely introduced through open windows and suspended by the classroom univent blower. The similarity in the findings reinforces the impact of environmental and occupancy factors on indoor air quality.

A singular difference in this classroom was an overwhelming fragrance which could not be determined. It may have been the occupant's perfume or an air freshener. Often these fragrances can trigger health responses in sensitive populations.

IMPORTANT NOTE: USE of Room Fresheners or Fragrances

Room fresheners and fragrances can have several effects on indoor air quality, both positive and negative, depending on their ingredients and the frequency of use. Here are some key impacts associated with using scented products in classroom indoor environments:

1. **Increased Volatile Organic Compounds (VOCs)**: Many room fresheners contain volatile organic compounds (VOCs) that are released into the air when the product is used. Common VOCs in room fresheners include **benzene, formaldehyde, and limonene**. These compounds can react with other chemicals in the air, potentially forming secondary pollutants, such as formaldehyde and other respiratory irritants, which can degrade air quality over time.
2. **Respiratory Irritation**: Prolonged exposure to fragrances, especially in enclosed spaces like classrooms or offices, can irritate the respiratory system, leading to symptoms like coughing, sneezing, throat irritation, or exacerbated asthma symptoms. Individuals with respiratory sensitivities, such as those with asthma or allergies, may experience heightened effects, especially with prolonged or frequent exposure.
3. **Sensory Irritation and Headaches**: Some fragrance ingredients are known to cause sensory irritation, leading to symptoms like eye irritation, headaches, dizziness, or nausea. This is particularly common with strong scents or in poorly ventilated rooms, where fragrance particles can accumulate.
4. **Potential Allergic Reactions**: Certain ingredients in air fresheners, such as synthetic fragrances or preservatives, can trigger allergic reactions in sensitive individuals. Symptoms may include skin irritation, rashes, or respiratory discomfort, especially in those with sensitivities to specific chemicals or fragrances.
5. **Impact on Indoor Allergen Levels**: Some air fresheners contain particles that may cling to surfaces, potentially trapping other allergens like dust or pet dander. Over time, this can contribute to indoor allergen levels, especially in high-traffic areas.

6. **Masking Underlying Odors**: While fragrances can improve perceived air quality by masking odors, they do not remove the source of the smell or contaminants. This can lead to a false sense of improved air quality, with pollutants or allergens remaining unaddressed in the environment.
7. **Impact on Indoor Air Chemistry**: The interaction of fragrance compounds with other indoor air pollutants, such as ozone, can result in complex chemical reactions that produce secondary pollutants. For example, the reaction of certain VOCs with ozone can form ultrafine particles and formaldehyde, which are both respiratory irritants and may impact long-term indoor air quality.

IMPORTANT NOTE: Recommendations for Minimizing Negative Impacts

To reduce the potential negative effects of room fresheners or fragrances on indoor air:

- **Use sparingly** and opt for products labeled as low-VOC or fragrance-free when possible.
- **Improve ventilation** by opening windows or using air purifiers, especially in enclosed spaces where fresheners are used.
- **Avoid aerosol-based fresheners**, which disperse fine particles that can linger in the air and contribute to respiratory irritation.
- **Consider natural alternatives** like essential oils in controlled amounts, though these can also contain VOCs, so they should be used cautiously and in well-ventilated areas.

In summary, while room fresheners and fragrances can enhance perceived air quality by masking odors, they can introduce or exacerbate indoor air pollutants, affecting respiratory health and overall indoor air quality, particularly in spaces with limited ventilation or for those with sensitivities.

Sample 8 – Room 117 - Computer Room Tape Sample from Near Windows on outside Wall

Similar to samples from walls in instructor's classroom and upon examination, no significant findings were observed in any of the samples beyond random fibers and traces of ambient particulate matter consistent with typical indoor debris or “dirt.” The discoloration noted on surfaces may have been due to embedded surface dirt within the paint or possibly from older, staining that left residual pigmentation traces.

Lactation Room

Note: No samples were taken from the "Lactation" room. The room was exceptionally clean. Several areas were observed to have incomplete paint coverage on the concrete cinder block walls. Darker paint had previously been applied, and lighter paint was later rolled over it. However, the lighter paint did not fully penetrate the crevices of the cinder blocks, leaving some recessed pits dark and creating an appearance that resembles spotty mold.

An attempt was made to collect tape samples from these areas, but no material was present or could be transferred and gathered on the tape surface, indicating no debris, dirt, or mold residue present for sampling. The observed dark spots are likely due to insufficient paint coverage rather than previous or actual mold growth.

Vice Principal's Office:

We conducted a follow-up assessment of this office, inspecting drawers and enclosed areas for any materials that might harbor mold. At the time of our inspection, we found no visible signs or odors indicative of mold or mildew on any surfaces.

This area has a history of air quality complaints, and our goal was to investigate potential historical causes. While these findings are somewhat speculative, they may provide insight into factors that could have impacted air quality and flooring conditions over time.

Observations

The room is serviced by a wall-mounted univent HVAC system that draws in outside air through wall louvers, tempers it, and distributes it indoors. During our assessment, we noted that extensive vegetation had previously been present outside the window, as evidenced by stumps, roots, and other vegetative debris that had been removed earlier in the year. However, we observed large roots still extending beneath the foundation and around the air intake, suggesting that a large shrub or small tree had previously grown close to the outside wall and under the existing slab foundation, potentially cause ruptures, fractures, or hairline cracks. Roots, branches and stems from this previous vegetation were still visible at the exterior of the intake unit.

Potential Causes of Air Quality and Flooring Issues

These findings suggest several possible contributing factors to historic air quality issues and mineral deposits on the tile floor within this office and the adjacent office area. These observations are merely suppositions as the possible causational factors have been eliminated. i.e. the vegetation was removed earlier this fall.

1) Efflorescence on Tile Flooring

One likely cause of the mineral deposits observed on the tile floor is **efflorescence**, a phenomenon where moisture seeps through concrete or grout and brings dissolved salts and minerals to the surface as it evaporates, leaving a white, powdery residue.

Efflorescence is often a sign of underlying moisture issues, which could stem from groundwater seepage, inadequate waterproofing, or structural breaches in the foundation. These moisture problems can damage flooring and even lead to mold growth or other structural deterioration if left unaddressed.

- **Impact of Plant Roots on the Foundation**

The presence of large roots extending beneath the foundation raises the possibility that these roots may have fractures, rutted, cracked or breached the concrete slab over time. Such breaches can allow moisture to penetrate or permeate the concrete slab foundation and reach the subflooring, contributing to moisture load and the efflorescence on the tile surface.

Root intrusion can also create small fissures or openings in the concrete, providing pathways for water and dissolved minerals to rise to the surface. This moisture source may cause minerals to crystallize on the tile floor, especially if there is ongoing exposure. The slab should be assessed for damage if any exists.

- **Hard Mineral Deposits**

In cases where moisture exposure is continuous, efflorescence can sometimes appear as hard, cakey, or crusty deposits instead of the usual fine, powdery layer. Prolonged moisture exposure can lead to the crystallization of minerals, such as calcium carbonate and magnesium, in thicker, harder layers. These deposits can form a solid crust that may require mechanical scraping or specific cleaning agents for removal and can collect surface dirt from foot traffic and shoes.

2) Roof or Surface Drainage Issues - Assessment of External Drainage Characteristics and Their Contribution to the Area's Issues

A critical factor potentially contributing to the observed issues is the alteration of drainage characteristics in the proximal outdoor space. Historically, the area was covered with dense vegetation that likely played a significant role in managing surface water runoff and may have impacted natural drainage patterns, leading to unintended consequences of diverting stormwater towards the slab foundation.

Key considerations for assessment include:

1. **Historical Drainage Patterns:**
   - Did the original vegetative cover facilitate drainage away from the building, redirect water toward the structure, or facilitate standing water?
2. **Current Roof Drainage Management:**
   - Evaluate how roof runoff is managed in this area. Are downspouts, gutters, or drainage systems in place and maintained to direct water safely away from the structure?
   - Is roof drainage properly distributed, directed away, or concentrated in a manner that may exacerbate water accumulation around the building?
3. **Surface Water Diversion:**
   - Are there functional diversion features such as gutters, downspouts, or leaching basins to manage surface water flow effectively?

4. **Stormwater Management Systems:**
    - Investigate whether stormwater management systems in the area, including drainage channels, catch basins, or other infrastructure, are functioning optimally.
    - Determine if overflow conditions or poor maintenance are leading, or did lead to localized flooding or water infiltration.

A thorough assessment of these factors is essential to ensure the area is adequately protected against stormwater inundation and to prevent the recurrence of the observed issues. Recommendations should include assessment, evaluation, and enhancements to drainage systems, re-establishment of manageable vegetation where, or if appropriate, or the addition of engineered solutions to manage and mitigate roof and surface water runoff impacts effectively

The combination of the possibility of breached slab foundation, potential moisture intrusion from the surrounding vegetation, and efflorescence provides a possible or plausible explanation for the historic air quality complaints and mineral deposits in this office and the immediate area. Addressing and correcting moisture management, improving ventilation, and evaluating the integrity of the foundation may help mitigate these issues moving forward.

3) Historic Entrainment of Allergenic Material Through Office Univent

Potential Impact of Vegetation Entrainment on Historical Indoor Air Quality Issues

An additional explanation for the historical issues in this area is the potential of the office's univent intake entrainment of outdoor allergens, mold spores, and decaying organic materials into the indoor environment when the outside area was dense with overgrown vegetation.

Key Factors for Consideration:

1. **Role of Vegetation in Airborne Contaminant Accumulation:**
    - The dense vegetation near the univent intake likely acted as a catchment area for airborne particulates, including pollen, mold spores, and organic debris.
    - As vegetation naturally sheds material and traps moisture, the decay of organic matter could have created localized conditions conducive to mold and fungal growth.
    - Wind or other environmental factors may have dispersed these contaminants into the air, where they were drawn into the univent intake.
2. **Mechanism of Contaminant Entrainment:**
    - With the univent intake entangled with overgrowing vegetation, airflow through the system may have carried these outdoor contaminants directly into the indoor air supply.
    - Fine particulates, including pollen, fungal spores, and other allergens, could bypass standard filtration systems if filters were not adequately maintained or designed for such conditions.

- Moisture retention within the vegetation could further exacerbate microbial growth, creating an ongoing source of airborne biological pollutants.

3. **Impact on Indoor Air Quality and Occupant Health:**
    - The introduction of allergens and mold spores into indoor air over time may contribute to a range of health effects, including allergic reactions, respiratory issues, and symptoms associated with "sick building syndrome."
    - Decaying plant materials, combined with moisture accumulation, could lead to microbial proliferation within HVAC components, creating persistent air quality issues.
4. **Historical Vegetation Characteristics:**
    - Although the specific species of plants, shrubs, or trees previously present are unknown, the observed density of vegetation strongly suggests the potential for a diverse range of airborne particulates and organic matter.
    - Certain plant species, particularly those with high pollen production or susceptibility to fungal colonization, may have exacerbated the entrainment of allergens and microbial pollutants.
5. **Mitigation Considerations:**
    - Assessing the historical layout and conditions of the vegetated area could provide insights into the types and concentrations of airborne contaminants likely to have been introduced.
    - Ensuring the external intake area remains free of vegetation and implementing proper filtration systems designed for high-pollen or microbial environments are critical for preventing similar issues in the future.
    - Regular maintenance of univent systems and surrounding areas should focus on debris removal and inspection for microbial growth or material decay.

Summary and Conclusion

The analysis of the surface tape samples collected at Barnstable United School (BUE) provided a comprehensive understanding of the indoor air quality (IAQ) in the classroom and adjacent areas of concern. While the findings do not reveal any immediate hazards or unusual contaminants outside the expected seasonal or environmental norms, several contributing factors and potential risks were identified that warrant attention for maintaining and improving the overall health and safety of the indoor environment.

Key Findings Recap:

1. **HEPA Air Filter Efficiency:**
    - The HEPA filter and prefilter effectively captured a diverse range of particles, including organic fibers, skin cells, pollen, and environmental dust.
    - Placement near open windows introduced additional outdoor particles, including pollen, soil, fungal spores, and insect fragments, which were captured in higher concentrations.

2. **Wall Discolorations:**
   - The discoloration observed on various wall surfaces appears to result from surface dirt or residual pigmentation from older mold colonies. No active microbial growth was detected.
3. **Dehumidifier Performance:**
   - The placement of the dehumidifier near windows may have reduced its effectiveness by drawing in moisture-laden outdoor air. Regular cleaning and proper placement are critical to maintaining its efficiency.
4. **Additional Environmental Observations:**
   - Fragrances or air fresheners were noted in one classroom, raising concerns for individuals sensitive to volatile organic compounds (VOCs).
   - The Vice Principal's office exhibited signs of historical moisture intrusion, potentially due to root intrusion, drainage issues, and efflorescence on the flooring.

Recommendations for Proactive Measures:

To enhance IAQ and address potential contributors to discomfort or health concerns:

1. **Air Filtration and Ventilation Improvements:**
   - Relocate HEPA filters and dehumidifiers away from open windows or direct airflow paths that introduce outdoor contaminants.
   - Conduct regular maintenance, including cleaning or replacing filters and inspecting units for optimal performance.
2. **Management of Wall Surfaces and Discoloration:**
   - Clean and repaint discolored areas to restore surface integrity and prevent further accumulation of embedded dirt.
   - Monitor wall surfaces for any signs of moisture-related damage or microbial activity.
3. **Limiting Fragrances and VOC Sources:**
   - Educate staff on the impact of air fresheners and strongly encourage the use of low-VOC or fragrance-free alternatives.
   - Improve ventilation in classrooms to dilute any residual odors or pollutants.
4. **Addressing Moisture Intrusion in the Vice Principal's Office:**
   - Conduct a structural assessment of the foundation to identify and repair potential cracks or breaches caused by root intrusion.
   - Evaluate and upgrade drainage systems, including gutters and downspouts, to direct water away from the foundation.
   - Reassess flooring conditions and address any remaining mineral deposits caused by efflorescence.
5. **Vegetation Management Around Air Intakes:**
   - Maintain a vegetation-free buffer zone around HVAC intakes to prevent the entrainment of outdoor allergens, spores, and organic materials.
   - Implement regular inspections to ensure clear airflow and proper filtration efficiency.

Conclusion:

While the analysis identified no immediate hazards, the findings underscore the importance of proactive measures to maintain and enhance IAQ across Barnstable United School. The seasonal and environmental particles observed are consistent with typical classroom environments; however, addressing the identified contributors—such as improper air filter placement, historical drainage issues, and the use of fragrances—will significantly reduce potential health impacts on sensitive individuals and prevent long-term IAQ challenges.