Healthy Schools are Clean, Dry, and Productive

By

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A Fresh Look at School Environments

The focus on school environments has evolved from an initial discussion on indoor air to a comprehensive view recognizing that total environmental quality is related to teaching and learning performance. Environmental management of school facilities has not traditionally received priority attention. If our national educational objectives are to be achieved, school officials must recognize the value of cleaning and maintenance programs to positive educational performance.

A school's interior climate, appearance, and cleanliness send either a positive or negative message to students, teachers, and staff. Emerging evidence suggests that environmental conditions that create a sense of "well-being" and send a "caring message" contribute directly to positive attitudes and elevated performance as measured by fewer health complaints, improved student attendance, teacher retention, and higher test scores.

Schools are special environments that exist for the purpose of teaching and learning. Schools are environments that house sensitive segments of the population. Schools are high-activity environments that need constant attention in the form of cleaning, maintenance, and repair. When essential environmental management and hygiene does not occur in the highly active school environment, we find deteriorated air quality accompanied by health complaints.

In the United States there are about 120,000 schools (approximately 85,000 public schools) providing for the educational needs of approximately 54 million students. On average, students receive 20% of their environmental exposure in schools. It is estimated that more than 50% of the school facilities throughout the United States have environmental problems caused by water intrusion, inoperable HVAC systems, and ineffective or non-existent cleaning programs. These conditions adversely affect indoor environmental quality. These problems are preventable and need not exist.

Deteriorated conditions in schools need not exist and are preventable. Environmental quality and risk are managed to an acceptable level indoors by source and activity management, ventilation, cleaning, maintenance, and restoration. Environmental quality of a school is a matter of "willingness to pay" for the management necessary to keep the school environment healthy.

There is growing evidence that when a school building is in disrepair, teaching and student achievement suffers; the school environment works against the educational process.

Public school systems too often elect to postpone repairs and delay construction of new facilities to divert money during periods of financial austerity. Making cuts in roof repair, maintenance, and cleaning is mistakenly considered less devastating than slashing academic programs. The consequences of choosing to defer school maintenance include premature building deterioration, poor indoor air, increased repair and replacement costs, and reduced operating efficiency of equipment. The price tag for deferring school maintenance has two very big and unacceptable costs.

First, the health effect and poor educational performance cost. Second, the cost of accelerated damages and premature replacement of the school facility itself.

The Ecology of a Wet School Environment

Public health literature indicates that moisture control, as it affects indoor environmental quality and the human condition, will receive increased attention and scrutiny in the next few years as it relates to growing concern over asthma. The professional restoration industry has long recognized the importance of rapid drying. We should reinforce and encourage this practice, particularly in sensitive environments such as schools, because it is critical to the successful management of indoor environments, biopollutants, and, ultimately, the protection of health.

Biopollutants are defined as living organisms or substances derived from them. Like outdoor environments, indoor environments harbor a variety of biopollutants primarily bacteria and fungi. They are normal components of dust, soil, and vegetation, as well as residue of humans and animals. Their survival and growth is dependent primarily upon available moisture and an organic food supply. Biopollutants may be airborne particles, large molecules, or gaseous compounds excreted from living organisms. Some biopollutants produce negative health effects such as asthma, cancer, pneumonia, fever, rhinitis, membrane irritation, and headache. Water or moist organic material, without exception, is the root cause of biopollutant proliferation indoors.

Biopollutants are the target of public health protection concern and action because they harm people the most. Under most conditions, the quality of an indoor environment can be brought to a high level and a healthy state. However, an environment extensively taken over by biopollutants sometimes must be abandoned. Persistent and excessive amounts of water/moisture are almost always the primary cause of such contamination.

Three conditions are necessary for biopollutants cause problems indoors. First, there must be a reservoir. Most biopollutants are found in reservoirs, particularly in bodies of standing water or decomposing matter. Second, there must be amplification. Biopollutants must grow or increase in concentration before they can harm people. Third, dissemination in high enough numbers must occur for the biopollutant to be harmful. The biopollutant must have a way and a means to leave its reservoir and get at the human receptor.

All living things pass through four stages of survival: lag, exponential, stability, and death. This is an important, time-dependent, life model, especially for water or moisture management. Timely moisture management is critical in preventing microorganisms from entering the exponential or stability phase of their life cycle.

Moisture determines the extent of biopollutants found indoors. When materials are saturated with water and relative humidity reaches 70% or higher, sufficient moisture is available to support microbial growth. When humidity is uncontrolled, or if water is not properly managed by extraction, outflow, or drying, a reservoir is established and the overgrowth of fungal and/or bacterial species occurs. This can lead to damaging effects on materials and human health. When moisture persists in the indoor environment, the microbial ecology is altered, predominate organisms amplifying, and eventually disseminate throughout the building. During amplification, rapid vegetative growth of bacteria and fungi occurs, usually by spore-forming organisms. As growth proceeds, spores are routinely formed and billions at a time can be dispersed into the air through normal occupant activities, airflow, and HVAC operation.

Microorganisms grow in water film on a variety of surfaces and within porous materials. It is a well established that water, if allowed to persist beyond 24 hours, alters the ecology of an indoor environment. Once growth begins, amplification of fungi such as Penicillium and Aspergillus can occur with as little as 2% moisture content in porous materials. Wet indoor environments, particularly those with cellulose-based materials such as drywall and ceiling tiles, support the growth of species like Stachybotrys. Stagnant water in HVAC can harbor gram-negative bacteria such as Flavobacterium and Legionellia. Fungi, such as Cladosporium and Aspergillus, as well as bacteria, such as Actinomycetes, can be found in persistently damp, dirty, textiles.

In addition to visible microbial growth and detection of moisture in porous materials, an obvious indicator of biopollutant contamination is a “musty”, “moldy”, or “mildewy” odor. Bacteria and fungi produce a variety of volatile organic compounds (VOCs). Most of the microbial VOCs detectable by the olfactory senses are excreted by the fungi and actinomycete bacteria, and are complex mixtures of alcohols, esters, aldehydes, and various hydrocarbons and aromatics.

We have little control over biopollutants outdoors, but indoors we can control their reservoirs and amplification by removing food supplies, cleaning, and controlling moisture. Routine cleaning and preventive maintenance are the most effective means of controlling biopollutants in buildings. To keep biopollutants under control, we must keep the environment clean. It is essential to remove dirt and water to prevent the conditions that promote microbial growth.

A basic strategy for managing indoor biopollutants includes:

1. Control the temperature and moisture.
2. Take away food supplies.
3. Keep any organism or other non-viable pollutant away from humans. Kill it, remove it, or contain it.

Step 1 attempts to create conditions under which the organism cannot live. A building’s environment is largely controlled by how we design and operate it. We also control it when we properly clean and restore it. If we use and leave behind too much water or do not control moisture when we clean, conditions are created that allow reservoirs of biopollutants to grow.

Steps 2 and 3 are included in cleaning and restoring an environment. Following environmental principles of cleaning extracts the most pollutants possible from the environment. Many pollutants, especially organic substances, feed on biopollutants. When deprived of food and given an unsuitable environment, such as a dry one, the living pollutant or its source will die or be unable to flourish.

If food supplies of living organisms in an environment could be fully controlled, biopollutants would disappear after a while and cease to be a problem. But, their environments and food sources can never be controlled completely. Therefore, we must go after them directly. They must be killed, removed, reduced or contained so they do not spread throughout the environment.

Air flow and ventilation are critical to the indoor management process. Like water, air is a fluid. As air flows, it carries suspended materials with it, including water. Air flow is necessary to achieve drying. Drying occurs only when suspended moist air is displaced by dry air on, above, and through an environment that has been cleaned with a liquid solvent. Many problems occur in the process of cleaning when environments do not dry. Wet environments can become breeding grounds for living organisms.

When Schools Have Environmental Problems

The main causes of environmentally related illness in schools are water, food sources for the various biopollutants, non-existent or ineffective cleaning, and poor ventilation. Assessment of environmental risk in school environments must not be done in a short-sighted manner. Extensive time is often spent looking at air quality alone, especially in recent times with regard to mold. This narrow focus is necessary, but by no means sufficient to protect the health of our children and their teachers and the quality of our school environments.

Total exposure, not just the air route of exposure, must be examined. Bacteria from direct contact with other humans and surfaces cause over 80% of environmentally related illnesses. The main routes of exposure are dermal and ingestion, not via air. The most serious threat air exposure poses is delivering bacteria and viruses to sensitive receptors. Sufficiently concentrated airborne mold spore and other airborne allergens, such as cockroach antigen, frequently trigger allergic reactions in sensitized individuals, particularly asthmatics.

Indoor air quality is a powerful management measure for a school environment. Excessive levels of dominant species of mold spores indoors are a good indication of environmental system malfunction or mismanagement. Abnormally high levels of mold spores, beyond those levels we find in surrounding outdoor air, are almost always associated with water damage, water intrusion, failed HVAC systems, or non-existent or ineffective cleaning programs. Water, when combined with an organic nutrient for extended time periods at elevated temperatures, will result in mold growth and excessive spore levels.

There is nothing profound in understanding what it takes to keep the most threatening indoor air pollutants (biopollutants) at a sanitary level in a school. With an understanding of basic life science, we can successfully manage molds and other biopollutants. Constant attention to environmental conditions can prevent mold colonies from decomposing organic materials and growing. Mold does not usually degrade matter by itself but often degrades matter in collaboration with bacteria and insects that are fully compatible with environments in which molds live and die. These other organisms are also biopollutants that affect air quality and should also be of concern in the discussion of healthy school environments. Biopollutants in general, particularly mold growth and mold spore levels in schools, can be controlled by keeping interiors and materials in them *clean and dry*.

High Performance Schools Send Positive Messages

Education decision makers, in many cases, must readjust their thinking about the full value and contribution of the school environment to the learning process. More effort is required to provide healthy school facilities by properly identifying and correcting the causes of environmental degradation before they get out of control; not simply to draw attention to the deteriorated IAQ and adverse health effects that are only symptoms of the real problem.

The importance of a healthy school environment in enhancing the learning process is described in many studies. There is a direct connection between environmental quality, comfort, health and well-being, positive attitudes and behavior, and higher levels of educational performance. The quality of the school environment shapes attitudes of students, teachers and staff. Attitudes affect teaching and learning behavior. Behavior affects performance. Educational performance determines future outcomes of individuals and society as a whole.

Recent studies of high performance schools find that an academically successful school radiates a sense of “well-being”. This sense of “well-being” is the essence of a healthy environment.

For school environments to be healthy there must be a serious, if not passionate desire accompanied by positive action, to keep the environment sanitary or to restore non-performing schools to a constant healthy state.

High performance schools manifest common traits.

- Adequate space and opportunities for students and teachers to spread out, reflect, interact, exchange information, and examine and test ideas.
- An inviting appearance.
- Adequate natural lighting that enhances productivity.
- Student-friendly conditions throughout the building.
- An environment that is inviting to good teachers and supports their retention.
- Designed to reduce stress, comfortable, has a consistent temperature, and manages noise.
- Very small risk of adverse health effects.

These conditions are always accompanied by good indoor air quality. But, most importantly, these traits are functional in a school only when that school is clean, dry, and sanitary.

Case Studies Point the Way

Previous studies have shown that cleaning, maintenance and restoration, when consistently implemented, are cost-effective and can lead to measurable environmental improvements in school environments. An EPA-sponsored study, "The Total Building Cleaning Effectiveness Study," conducted in collaboration with the professional cleaning industry, demonstrated that an organized cleaning program contributes to reductions in particles, volatile organic compounds (VOCs), and biological pollutants in the range of 50-90%, even in an extraordinarily complex and sensitive school environment.

In the recent case of the Charles Young School, Washington, D.C., the improvements in educational performance that have accompanied restoration have been exemplary. The Charles Young Elementary School case is so important because, up to this point, evidence indicating that when a school building is in disrepair, student achievement suffers, is scanty. There are few cases that demonstrate that schools, restored in a thoughtful manner, greatly improve educational achievement in the way we measure it today.

In 199,7 the environmental conditions at Charles Young School were, by any environmental health standard, fully unacceptable. Water damage was evident throughout the building. Water was entering the building constantly through numerous roof leaks, rotting windows, and broken steam pipes. On several occasions, students mistook escaping steam as an indication that the building was on fire. Mismanaged moisture caused visible mold growth on plaster walls, ceiling tiles, window frames, carpet and hard floors, and in ventilation ducts.

The HVAC system in the school was in disrepair. Most exhaust fans were broken, and the heating air-conditioning system did not work. Temperature fluctuated from 60 to 100 degrees F, and humidity levels often exceeded 90%.

Pest infestation was serious with cockroach remains and fecal material evident in all parts of the building. Birds had nested in the upper regions of the building interior and their droppings had seriously contaminated the air intakes of the HVAC system.

Floor surfaces throughout the building looked uninviting, and worked against the educational benefits derived from open classrooms. Carpet surfaces could not be restored; they were extensively water damaged, worn, and separated. In many areas deteriorated carpet posed tripping hazards.

Hazardous materials and conditions also existed in the school. Peeling lead-based paint was found on window frames, doors, and stairwell banisters. Discarded unlabeled chemicals were leaking onto the floor in the school's mechanical room.

Prior to 1997, Charles Young was a school where nearly half the students were below national test averages for math and reading. In the minds of DC officials, there was an obvious link between the students' environment and their educational performance. The facility was rapidly deteriorating. Additionally, students were exposed to a surrounding neighborhood with a high level of social instability, unemployment, rising drug use and crime rates, and violence.

Most of the Charles Young Elementary School restoration was accomplished between June and September 1997. Two hundred and thirty-two windows were replaced to create brighter rooms and keep moisture and peeling lead paint out of the school. All lead-based paint was contained and removed. Roofing and brickwork was repaired to prevent water intrusion. Moldy, water-damaged materials were removed. Leaking ductwork, steam, and water pipes were replaced. Abandoned 55-gallon drums of chemicals in basement rooms were removed as hazardous waste. The basement area was decontaminated to eliminate residual chemical hazards. Pest management measures were instituted. Bird nests and dropping were removed; pest barriers were installed, and food and water sources were removed.

The carpet industry donated the replacement of over 45,000 square feet of carpet. Selected carpet floor coverings came from a variety of manufacturers and were matched to comfort, lighting, color and texture and sound control needs of rooms throughout the school. Most important to the restoration effort, the carpet industry insisted on effective maintenance. The carpet industry provided training, maintenance schedules, and effective vacuums, as well as carpet cleaning equipment and supplies to sustain a healthy condition and inviting appearance of their product.

The school's HVAC system required a major overhaul. The central fan system was made operational, and fan motors were replaced as necessary. The chiller was replaced; new boilers were installed for heating; and exhaust systems were upgraded. Over 100 ventilators were overhauled through electrical repairs, part replacement, and cleaning.

The school and its educational strategy depend on an environment that is attractive, comfortable, open, and free of glare and noise. The inviting open classroom design of Charles Young Schools has been demonstrated to provide a well lighted, comfortable environment, highly effective in developing the educational performance of students. The use of carpet in the Charles Young School makes satisfactory sound control simple and economical to achieve. Effective sound control in open space classrooms is virtually impossible to achieve without carpet (School Facilities and Transportation Division, State of California, 1986).

Table 1 illustrates data collected in the most health-sensitive areas of the building: the fully-carpeted pre-k kindergarten area, and lunch room, which has a hard floor surface. The data suggest that the indoor environment of Charles Young School is properly maintained and exhibits no sign or traits of an unsanitary environment or of an indoor air quality (IAQ) problem building. Maintenance of the school emphasized daily vacuuming of high traffic areas, disinfection of hard floors, scheduled extraction cleaning of all parts of the building including carpet.

Table 1. Summary of Environmental Quality for School Year 1998-1999

Location	*June 1998*	*December 1998*	*June 1999*	*Observation*
Outdoor Air Quality Fungi	460-780 CFU/ m^3	490 CFU/m^3	610-1020 CFU/m^3	Normal range no dominant species
IAQ Fungi Over Carpet (Pre-K)	250-260 CFU/ m^3	180-240 CFU/ m^3	670-1640 CFU/m^3	Normal in relation to outside
IAQ Fungi Over Hard Floor(Lunch R)	270-720 CFU/m^3(*)	440 CFU/m^3(*)	290-510 CFU/ m^3	Normal and in some cases (*) slightly higher than over carpet
Outdoor AQ Bacteria	<10 CFU/m^3	10 CFU/m^3	20 CFU/m^3	Normal
IAQ Over Carpet Bacteria	40 CFU/m^3	<10 CFU/m^3	<10 CFU/m^3	Normal in relation to outside
IAQ Over Hard Floor Bacteria	210 CFU/m^3	20 CFU/m^3	40 CFU/m^3	Normal but higher than carpet
Respirable Suspended Particles (RSP) Outdoors	35 ug/m^3	22 ug/m^3	29 ug/m^3	Normal City RSP
RSP Over Carpet	33 ug/m^3	15 ug/m^3	32 ug/m^3	Normal RSP IAQ in relation to outside
RSP Over Hard Floor	64 ug/m^3	40 ug/m^3	40 ug/m^3	Elevated, <40 desirable
TVOC Over Carpet	31.4 ug/m^3	152 ug/m^3	35.6 ug/m^3	No problem likely
TVOC Over Hard Floor	24.1 ug/m^3	93.6 ug/m^3	87.9 ug/m^3	No problem likely

*Collected and Submitted to the Carpet and Rug Institute by Air Quality Sciences, Inc., 1999.

A high level of housekeeping and maintenance are essential in making the classrooms work. In August 2001, prior to the school year cleaning of the facility, a cleaning effectiveness analysis was conducted throughout the building with a focus on the sanitation condition of flooring. A pre-sampling investigation found there were no health complaints related to the building in any way. There were no indications of IAQ problems or occupant health responses to allergens. An environmental cleaning effectiveness sampling technique was applied throughout the building to a variety of flooring materials prior to their cleaning. Levels of measured bacteria and fungi exhibited no sign of an unsanitary or problem building, even at a time of year when the building's cleaning state was stressed by a year of continuous use and summer relative humidity levels in excess of 90% on some days.

Since the restoration, the school radiates a sense of well-being. It is widely reported by teachers and staff that many students are reluctant to leave in the afternoons because they like the school environment that many call a "safe haven." Teachers and staff throughout the school district want to there. Many of the best teachers at the school have elected to delay their retirement. The restored school is the pride of the community. Parents often visit the school, and some even take classes in reading. Attendance, prior to the restoration, has risen from 89% to 93%. Many parents

in the community had previously moved their children to private and special schools; however, since the restoration, many of these students have returned. Students from other schools throughout the district are seeking admission to Charles Young Elementary. The District of Columbia is using Charles Young Elementary as the model for restoring 9 other schools in DC.

An analysis of test results shows that the school is much more than an indoor environment showpiece. Since the restoration in 1997, there have been many remarkable and documented improvements in the common measures of academic performance.

Table 2. National Test Results

Standard Test Results	***Before Restoration Y1996***	***Post Restoration Y 2000***	***Observation***
Math Scores	Below Basic 49% Basic or Above 51%	Below Basic 24% Basic or Above 76%	25% of non performing students have been motivated
Reading Scores	Below Basic 41% Basic or Above 59%	Below Basic 25% Basic or Above 75%	Reading improvement suggests better mental concentration

Charles Young Elementary School has been successfully restored to a healthy environment. The school building that had acute indoor environmental problems has been transformed into a model school environment. The essentiality of continuous cleaning, maintenance and repair for the prevention of future indoor environmental quality problems has been demonstrated. The most important result in this restoration example is the documented and measured fact that educational performance and achievement has risen dramatically at the school. It is the strong suggestion and demonstration that there is a direct connection between healthy school environments; behaviors and attitudes of students, parents, and educators; and academic performance and achievement.

Every School Can Be Healthy

Healthy school environments are planned to send caring messages. When there is a healthy school, there is a management system that creates the healthy condition. The system is a continual cyclic management process that begins with the formulation of an environmental policy followed by planning, policy implementation, inspection and corrective action, management review, and adjustment of the policy if necessary.

The following are recommended as the focus of an environmental management program for virtually any school:

- Environmental coordinator and reporting system.
- Awareness training on the operation of a school building.
- Moisture management that emphasizes roof maintenance and drainage improvement.
- Water damage response plan.
- Mold management and removal program.
- Mechanical ventilation systems assessment and repair.
- Cleaning and restoration effectiveness emphasizing effective cleaning equipment, well-designed cleaning program, and scheduling.

There are steps a school can take to achieve a healthy condition.

First, there must be an awareness of how the school building functions. The lack of awareness often creates poor environmental conditions inside the school building. A communication program should inform students, faculty and staff about technical issues behind the school environment. For example, the building is a shelter designed to keep the outside environment (water and dirt) out. Everyone must help to keep the indoor environment clean and practice good personal hygiene. There must be an understanding of the nature and role of HVAC systems especially as they controls moisture levels.

Second, moisture in a school building is the main cause of structural damage and health risks. In order to effectively keep water from leaking into the building, the roof must be structurally sound and in good repair. All leaks must be repaired in a timely manner. In order to mitigate future costs and leaks, a simple low-gradient structure above the all-too-common flat school roof can be installed to channel water off the roof.

Third, drainage systems must work. No standing water should be allowed on or around a school. Drainage systems must divert water from the building. Assess and improve current drainage systems. Schools should install a drain system for the building as well as guttering where necessary.

Fourth, HVAC aids in the regulation of moisture mitigation and the circulation of fresh air. Assess HVAC system performance, repair, and maintain HVAC systems regularly. A ventilation system is necessary to maintain a dry environment. A primary purpose of airflow is to control moisture and prevent the growth of biopollutants, especially important in a room like the library where books provide a continuous food supply to the organisms. Biopollutants (primarily bacteria and fungi) depend upon the availability of moisture and an organic food supply in order to survive and grow. Relative humidity of 70% or higher creates a moisture level best suited for microbial growth. Air conditioners must be kept on to control moisture during humid summer months, and dehumidifiers should be used during periods of high humidity or if the school facility is unresponsive to the ventilation system.

Fifth, if significant amounts of mold exist in a school, the water source must be corrected, and the growing mold and spores removed properly. Any material containing wet paper is a likely site for mold. Damp wallboard and sheet rock provide excellent hosts for mold and bacteria. Even worse are ceiling tiles and the wooden wall studs, which, if they become wet, will breed fungi. If mold is not managed properly, spores become airborne and spread throughout the building. Every school should establish a training program for the identification and safe removal of mold in the building.

Finally, cleaning is the most effective means of achieving a sustainable high level of environmental quality in a school. The primary objective of cleaning is to keep our or remove pollutants from the building envelope in order to reduce exposure.

A cleaning effectiveness program includes:

- Training programs for custodians and teachers.
- Adequately sized doormats as particle barriers.
- High efficacy extraction cleaning equipment (vacuum cleaners).
- Hot water extraction of carpet.
- Damp mopping of hard surfaces.
- Reduced VOC emissions of products.

Every school should establish a training program for the custodial staff to learn effective and efficient cleaning methods. Instruction in the proper use of cleaning materials and techniques, achieves a much healthier environment with far less wasted labor.

The best available cleaning technology and supplies should be provided to school custodians. Exposure to particles, biopollutants and VOC can be greatly reduced with effective cleaning equipment and an organized cleaning program that emphasizes the correct use of equipment and the importance of extraction.

A simple doormat is enormously effective in keeping dirt and debris out of a school building.

It is important to remember not to focus just on the floor as a primary site hosting particles, allergens and infectious microorganisms. The bulk of potentially harmful agents are situated higher than that. Hard surfaces on tables, chairs, counters, walls, doors, sinks in rest rooms, and eating areas carry a particularly heavy bio-burden.

The majority of school environments have carpet and proper equipment must be available to clean it. Schools with dirty carpet either do not know how to clean or choose not to. Clean carpet poses no health risk in schools. Some individuals have pointed to carpet as a primary cause of deteriorated IAQ. In fact, some say to tear out the carpet if you really want to clean things up and improve IAQ. Unfortunately, this occurs mostly in public schools with limited accountability for decision making outcomes. It dodges the issue and responsibility of cleaning, transfers pollutants to hard surfaces and indoor air, and is unnecessarily costly to the taxpayer. Most importantly, this incorrect cause-and-effect decision does not address the real need to keep the environment clean and dry, regardless of flooring type. It is a disservice to students, teachers, and staff who deserve and need an elevated level of comfort in their school environment. Carpet offers a soft surface on which to stand long hours, warm and energizing colors, glare reduction, and excellent noise control.

There is no inherent reason why any surface, including carpet and fabrics, in a school cannot be kept clean. There must be a scheduled program for cleaning with two key elements: a high flow water extraction system and high-quality vacuum cleaner, both of which minimize air contamination during and after cleaning.

Effective vacuuming alone removes 90 to 95% of all dry particles with a routine cleaning schedule. Periodic hot water extraction of carpet removes remaining particles and biopollutant food sources.

Air filtration is an important consideration when choosing a vacuum for a school environment. An effective vacuum cleaner promotes good indoor air quality. If not constructed properly, vacuum cleaners can be aerosol generators, spreading dust and dirt throughout the air. If dust and other particulates are allowed to pass directly through the vacuum, high airflow becomes irrelevant to the removal of particles. Instead of being extracted from the environment, particles become airborne right back into the sensitive environment from which they came.

Conclusion

There is clear evidence that a scientifically-based cleaning process provides an immediate improvement in the indoor environmental quality of schools. Through an organized environmental

management program that emphasizes effective cleaning and maintenance, exposure to a range of microorganisms, particles, and other harmful substances are reduced or kept at a sanitary level. Based on research, there is every reason to anticipate a reduction or prevention of adverse health effects.

The enhanced management and cleanliness of school environments sends a “we care” message to students, teachers, and staff. The evidence suggests that environmental conditions shape attitudes and eventually teaching and learning performance.

School environments influence the educational process far beyond that which we have previously recognized. Schools have flexible management options for creating healthy productive environments. The key to a healthy school is to know the importance of “clean and dry” and the necessary tools, techniques, and management systems to achieve those conditions. Following the “clean and dry” principle will provide for healthy IAQ, but, more importantly, provide environments where teachers and students can perform at their best.

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