Best Management Practices for Cornell Greenhouses (Ithaca)

-- Revision 3 --
October 20, 2005

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Introduction

The Best Management Practices (BMPs) outlined in this document have been prepared to satisfy special conditions in State Pollution Discharge Elimination System (SPDES) Permit # NY 023 1878; DEC #7-5007-00030/000001 for Cornell University (Ithaca). The BMPs were developed by a Cornell University Greenhouse BMP Task Force in 1998 and have been subsequently revised (2000, 2005) by the Cornell University Best Management Practices Implementation Steering Committee (BMP ISC).

The Best Management Practices for Cornell Greenhouses (Ithaca) assume that all federal, state and local regulations and Cornell policies are the operational baseline. The BMPs state management goals beyond these legal and institutional requirements.

The BMPs are specific to the greenhouses operated by the University in Ithaca. There are conditions present at Cornell's greenhouses that are not common in commercial operations that make it possible for Cornell to implement this program. These same conditions may limit Cornell's ability to implement certain BMPs that could affect research.

The greenhouses operated by Cornell University are diverse and unique because of their fundamental mission, teaching and research. For example, many individual greenhouses will contain hundreds of species of plants. Others will be used for the rearing of insects to support research and others may be used to study various growth conditions that dictate specific usage of water or nutrients.

Because of these unique issues, we believe the following statements must be considered when reviewing and implementing the BMP document:

1. The BMPs developed by Cornell University must take into careful consideration the teaching and research mission when evaluating preferred practices.

2. The BMPs were developed for an institution such as Cornell with diverse operations. These BMPs are not intended for the commercial greenhouse industry.

3. The categories – Level 1, Level 2, and Level 3 – all constitute Best Management Practices and outline the range of alternatives available. Any of these categories are intended to satisfy the BMP requirements and determinations will be made on a case-by-case basis to select the appropriate practice practical to achieve.

Implementation Plan for Ithaca Greenhouse Best Management Practices

Training: Training to meet BMP objectives is a continuous process. Supervisors will train newly hired greenhouse staff employees as outlined in each section of the BMP document. Training needs of current staff as well as the need for new or revised policies to meet BMP objectives are assessed at quarterly meetings of the BMP ISC. Ongoing training and policy refinement is the responsibility of this Committee. Records are kept by the BMP ISC and include what is taught, who teaches, and who is trained.

Implementation: Adherence to BMPs is the responsibility of each individual greenhouse user, greenhouse or maintenance staff person.

The operations manager overseeing each greenhouse facility assumes day-to-day responsibility. Facilitation of BMPs is coordinated and monitored by the BMP ISC, consisting of operation managers, University and College of Agriculture & Life Sciences administrative representatives, and faculty members.

The BMP ISC oversees the plan, and is responsible for:

- organizing quarterly Greenhouse BMP ISC meetings;
- monitoring progress at each facility;
- communicating novel, improved BMP ideas throughout the greenhouse management network; and
- continuous improvement of the best practices.

As part of contractual agreements related to space allocation at these facilities, project leaders (faculty members and technicians) are required to comply with written policies and procedures for greenhouse use. Operation managers are given authority to enforce adherence to BMPs.

Operations managers are required to report all instances of non-compliance with BMPs (e.g., spills or intentional disregard for the established practices) to the Chair of the Implementation Steering Committee.

Simultaneous to the introduction of BMPs into the CALS/Ithaca greenhouses, the greenhouse management developed a web-based greenhouse request instrument, which is completed by project personnel (faculty members, technicians, and graduate students). The request instrument identifies needs for space, equipment, and cultural practices and provides an opportunity for greenhouse staff and project managers to discuss management of plant material with respect to the BMPs.

Non-Compliance and Internal Control: The BMP ISC has developed an internal audit procedure that is used to audit the BMP Plan and evaluate conformance with this Plan. The BMP ISC modifies internal audit procedures as the BMP program evolves.

On an individual employee basis, Cornell encourages a culture of teamwork, collegiality, and cooperation. Employees are encouraged to meet group goals. Within that culture, enforcement of goals is achieved through each supervisor implementing established performance management practices for employees (professional improvement, level of salary improvement, and, if necessary, disciplinary action). Group achievement is nurtured through regular meetings, progress reports, and performance management intervention by the department or College, as needed.

Considerations

The BMP Plan incorporates several major themes, as identified by the New York State Department of Environmental Conservation (NYS DEC). These themes are outlined briefly here and are interwoven into the development and implementation of the BMP Plan.

Risk identification and assessment. The BMP Plan identifies greenhouse operational aspects that present the potential to have substantial consequences to the environment (e.g., pesticide use and storage, nutrient handling) and systematically presents the best practice options that minimize those risks.

Employee training. Training is intrinsic to the culture of Cornell. Cornell is fortunate to have relatively low turnover in greenhouse staff. However, new staff are hired on occasion and managers are responsible for training new greenhouse staff in all aspects of job performance, including the theory and implementation of Best

Management Practices (generally) and facility-specific practices. Much peer-to-peer training also occurs with regard to specific equipment and facility practices. Cornell greenhouse employees are required to take a University provided hazardous communication training. All greenhouse staff are required to be NYS commercially certified pesticide applicators, and applicators are required to take continuing education credits. Finally, the College of Agriculture and Life Sciences offers an annual greenhouse "update" for all employees with greenhouse-related responsibilities, as well as task and equipment-specific workshops (e.g., spill clean-up, fertilizer injector maintenance and repair).

Inspections and records. The BMP program has developed several standardized forms for pesticide and fertilizer inventory, sprayer maintenance, fertilizer injector maintenance, etc. Record keeping is sometimes voluntary (e.g., for sprayer maintenance) but sometimes mandatory (e.g., for pesticide applications). Training sessions and other communications remind greenhouse management and staff of record keeping tools and objectives.

Inspections occur along a continuum. Quarterly reminders sent to all greenhouse managers remind them to verify: 1) integrity of all pesticide containers; 2) all pesticides stored by compatibility; 3) ventilation functioning in all pesticide storage areas; 4) pesticide application equipment in proper operating condition; 5) fertilizer injectors in proper operating condition; 6) integrity of fertilizer reservoirs; 7) concentrations of fertilizer solutions; and 8) open fertilizer containers stored in secondary containment. University and College programs work with greenhouse managers to conduct more comprehensive, periodic, internal inspections.

Preventive maintenance. Greenhouse managers work in close cooperation with greenhouse facility staff to ensure mechanical, electrical, plumbing and structural systems are as well maintained as possible, and that issues with the potential to impact the environment are given the highest priority for repairs. Greenhouse staff report concerns to the greenhouse management in a timely manner to ensure that issues are addressed as early as possible before conditions worsen.

Good housekeeping. Good housekeeping is a fundamental principle of effective greenhouse operations. Good housekeeping prevents pest harborages, allows for easier and quicker problem identification, and sets a tone of discipline. Greenhouse staff and management put a priority on well-maintained, neat and orderly greenhouse facilities that create the proper conditions for successful production of research and teaching plant material.

Best Management Practices for Pesticide Storage

Rationale

Greenhouse pesticide storage areas can contain a wide range of concentrated chemicals, some in relatively large quantities. These chemicals must be stored and managed properly to prevent the potential release, through broken, damaged or leaking containers, of chemicals that may have the potential to cause harm to human health and the environment. Some potential problems associated with pesticide storage areas include risk of spills during storage, mixing or loading operations; loss of security; accumulation of unwanted, old, or unregistered materials; and the risk of fire, flooding or some other disastrous event. These problems can be minimized through the proper use of building security, temperature control, fire prevention and suppression equipment, inventory control, secondary containment, emergency mitigation/planning, preventive maintenance, good housekeeping and user education.

Environmental Principle: Greenhouse pesticide storage areas contain relatively large quantities of concentrated chemicals. These chemicals must be stored and managed properly to prevent the possibility for release to and contamination of the environment.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	all staff know to call 911 in the event of an emergency	emergency contact numbers posted; all staff trained to call emergency contact numbers; staff have basic training in cleaning up small pesticide spills	emergency contact numbers posted; all staff trained to call emergency contact numbers; staff have basic training in cleaning up small pesticide spills; emergency response plan located in storage area and on file with emergency contacts; staff trained to respond to different emergency scenarios
Environmental Awareness	staff are aware of hazards to the environment associated with pesticide spills and cross-contamination; hazards corrected when a problem occurs	staff are aware of hazards to the environment associated with pesticide spills and cross-contamination; hazards are actively reduced	staff are aware of hazards to the environment associated with pesticide spills and cross-contamination; hazards are identified and corrected; staff monitor regularly for new hazards

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Training	staff learn through on-the-job training with other staff members	staff receive instruction from experienced users regarding proper pesticide storage management activities	all staff who work in the pesticide storage area with pesticides and/or application equipment are trained by supervisor, qualified personnel and by attending continuing educational training opportunities as required by NYS DEC pesticide certification and the Cornell Health and Safety Policy 2.4; pesticide storage policy reviewed with staff
Communication	pesticide storage guidelines are posted and sometimes discussed during training sessions	pesticide storage guidelines are discussed on a regular basis with greenhouse staff	greenhouse staff gain knowledge of pesticide storage best practices through attendance at training programs, peer discussions, staff meetings, and work experiences
Management			
Inspection	inspection of pesticide storage area performed when a problem arises	regular inspection of pesticide storage area performed	regular inspection of pesticide storage, mixing/loading and facility areas performed; problems noted and addressed
Records Maintenance	pesticide storage facility documents not kept or posted	pesticide storage facility policy, emergency plan, emergency contact information and maintenance logs kept and posted, but not updated regularly	pesticide storage facility policy, emergency plan, emergency contact information and maintenance logs kept up-to-date and posted as appropriate
Storage			
Building Materials	common construction materials; no special properties; wooden shelves	some construction materials fire resistant; wooden shelves	almost all construction materials fire resistant; anti-spark electrical components; metal, water-resistant, or chemical-resistant shelves

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Chemical Compatibility and Segregation	pesticides and fertilizers stored in separate storage areas	pesticides stored in storage area; pesticides stored by hazard class and pesticidal function with incompatible materials stored physically separated from one another	pesticides stored in storage area; pesticides stored by hazard class and pesticidal function with incompatible materials stored physically separated from one another; flammable and combustible liquids stored in separate area; herbicides separated from fungicides and insecticides; potentially reactive materials separated from other materials by some physical barrier; designated "disposal" area for surplus pesticides and empty containers being held for disposal
Containers	all chemicals stored in their original containers unless damaged; labels are visible and readable; caps are secure; food or beverage containers are never used for storage	all chemicals stored in their original containers unless damaged; labels are visible and readable; caps are secure; food or beverage containers are never used for storage	all chemicals stored in their original containers unless damaged; labels are visible and readable; caps are secure; food or beverage containers are never used for storage
Container Arrangement	labels in plain sight; some containers on floor; all containers stored up-right	labels in plain sight; no containers on floor; all containers stored up-right; aisles wide enough to accommodate workers; containers not crowded on shelves	labels in plain sight; no containers on floor; all containers stored up-right; aisles wide enough to accommodate workers; containers not crowded on shelves; pesticide inventory does not block vents in storage cabinets
Containment	no floor drain; some secondary containment used for open containers	no floor drain; secondary containment routinely used for open containers	no floor drain; floor provides containment in the event of a spill; secondary containment routinely used for open containers

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Contents	storage area contains pesticides, other greenhouse chemicals (but not fertilizers), various application equipment; the storage area NEVER contains: food, drink, tobacco products, personal protective equipment, livestock feed, living plants, and/or seeds	storage area contains pesticides, other greenhouse chemicals (but not fertilizers), various application equipment; the storage area NEVER contains: food, drink, tobacco products, personal protective equipment, livestock feed, living plants, and/or seeds	storage area contains pesticides, other greenhouse chemicals (but not fertilizers), various application equipment; the storage area NEVER contains: food, drink, tobacco products, personal protective equipment, livestock feed, living plants, and/or seeds
Fire Prevention and Suppression	multi-media fire extinguisher immediately available and inspected annually	multi-media fire extinguisher immediately available and inspected annually	flammable materials stored separately; multi-media fire extinguisher immediately available and inspected annually; sprinkler system may be present; fire department notified at least annually of current inventory; staff are trained on proper use of extinguishers
Inventory	no inventory kept; outdated materials occasionally removed	inventory updated at least once per year; outdated pesticides removed annually	inventory actively maintained as pesticides added or removed from storage; containers are dated when purchased; outdated pesticides removed on a regular basis (at least annually)
Lighting	electrical lighting with few limited areas of view	electrical lighting allows view into all areas and cabinets within storage area	explosion-proof electrical lighting allows clear view into all areas and cabinets within storage area
Location of Storage Area	area within building structurally segregated from general work areas; site not considered in selecting storage area	wing or corner on ground floor of a building dedicated to other purposes; some consideration given to location of storage area away from extreme heat, flooding and environmentally sensitive areas	building or area dedicated to chemical storage; separated from offices, workshops, laboratories, surface water; flooding unlikely; downwind and downhill from sensitive areas such as houses & ponds; soil, geologic and hydrologic site characteristics will not lead to contamination of any water systems through runoff or percolation

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Security	separate entry with door	lock on door; windows prohibit access; access restricted to trained personnel	all entries locked at all times; windows prohibit access; access restricted to trained personnel; procedure implemented to track keys to storage area or facility; may be fenced; no holes or entrances for rodents and other pests; cracks and crevices sealed
Signage	warning sign(s) posted, but emergency contact info not posted	warning sign(s) posted; emergency contact information posted	weatherproof warning sign(s) posted in view of entrances; emergency contact information posted
Spill Preparedness	spill clean-up materials (e.g., vermiculite, Slik-Wik®, or other commercial product) available within the general area; some staff trained in proper use of these materials	spill clean-up materials (e.g., vermiculite, Slik-Wik®, or other commercial product) available at the storage area; all staff trained in proper use of these materials	spill clean-up materials (e.g., vermiculite, Slik-Wik®, or other commercial product) available at the storage area; all staff trained in the proper use of these materials; hydrated lime or high pH detergent also available for neutralization; designated shovel, dust pan, broom and empty bags and/or buckets available for clean-up
Storage of Small Quantities of Chemicals	always stored on shelf or other solid surface; never on floor	always stored on shelf or other solid surface; never on floor	always stored on shelf or other solid surface; never on floor, or overhead
Temperature Control	no mechanical temperature control	No mechanical temperature control; area insulated; no direct sources of heat (sunny windows, steam pipes, furnaces, etc.); area will not freeze	active mechanical temperature control; no direct sources of heat (sunny windows, steam pipes, furnaces, etc.)
Ventilation	room not particularly cool and dry; no mechanical ventilation	mechanical ventilation working and used	mechanical ventilation working and used; switch for ventilation located outside storage area

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Handling			
Partially-used Containers	open containers resealed and returned to storage	paper bags and boxes always opened with a box cutter or scissors; open containers resealed and returned to storage	paper bags and boxes always opened with a box cutter or scissors; open containers resealed and returned to storage; all drips are removed from rigid containers; all open paper bags are placed inside another, larger container, sealed and labeled; open containers of chlorates are never kept in storage
Damaged Containers	when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled	when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled; secondary label may lack complete information	pesticide containers checked often for corrosion, leaks, loose caps, or bungs; when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled; secondary label correct and complete
Disposal	unused pesticide products discarded in adherence with federal, state regulations and Cornell policy	transfer opportunities for registered, unused pesticide products are sought to minimize need for disposal; unregistered or unwanted pesticide products discarded in adherence with federal, state regulations and Cornell policy	sufficient planning is done to eliminate the need for disposal of excess pesticides; triple-rinsed empty pesticide containers are discarded according to current disposal regulations
Personal Protective Equipment - Worn in Storage	staff sometimes wear gloves in storage area	staff wear gloves in storage area when handling open containers or packages	employees wear gloves, chemically resistant boots, and protective eyewear in storage area when handling open packages
Personal Protective Equipment (PPE) Worn in Mixing Area	staff always wear protective gloves, chemically resistant boots, protective eyewear and respirators and/or other PPE as stated on the label when handling open pesticide containers	staff always wear protective gloves, chemically resistant boots, protective eyewear and respirators and/or other PPE as stated on the label when handling open pesticide containers	staff always wear protective gloves, chemically resistant boots, protective eyewear and respirators and/or other PPE as stated on the label when handling open pesticide containers

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Pesticide Mixing Area	area is ventilated, eyewash may or may not be easily accessible	area with good ventilation, adjacent to storage area, emergency shower and eyewash available in immediate vicinity	area with dedicated ventilation, adjacent to storage, emergency shower and eyewash; separate from production area but not isolated
Personal Protective Equipment (PPE) Storage	PPE, including gloves, aprons and respirators, is located in the general vicinity of the storage area; all those with access to storage know location of PPE and are familiar with proper donning, doffing, inspection and maintenance of PPE	PPE, including gloves, aprons and respirators, is located in the general vicinity of the storage area; all PPE stored away from pesticides; all those with access to storage know location of PPE and are familiar with proper donning, doffing, inspection and maintenance of PPE	PPE, including gloves, aprons and respirators, is located in the general vicinity of the storage area; all PPE stored away from pesticides; all those with access to storage know location of PPE and are familiar with proper donning, doffing, inspection and maintenance of PPE
Application Equipment Storage	all application equipment is stored in the chemical storage area or in another dedicated storage area	all application equipment is stored in the chemical storage area or in another dedicated storage area; all items used for handling pesticides are labeled “contaminated with pesticides” or otherwise clearly labeled to trained users	all application equipment is stored in the chemical storage area or in another dedicated storage area; all items used for handling pesticides are labeled “contaminated with pesticides” or otherwise clearly labeled to trained users

Best Management Practices for Fertilizer Storage and Nutrient Management

Rationale

Fertilizers can cause harm if they reach surface or ground water. For example, high nitrates in potable water cause heart damage in unborn and newly born infants and excessively high phosphorus in wetlands and estuaries causes eutrophication and loss of aquatic life. Potential problems associated with fertilizers fall into four primary phases of use. 1. Storage – greenhouse fertilizer storage areas contain relatively large quantities of concentrated chemicals. Risks in storage areas include release through broken, damaged, or leaking containers; loss of security leading to irresponsible use; accumulation of outdated materials leading to excessive quantity of fertilizer thus unnecessarily raising risk level; and combustion of oxidizing compounds in fertilizer (e.g., nitrates) caused by fire or another disaster event. 2. Handling – opening fertilizer product containers, measuring amounts, and transferring fertilizer to the delivery system involves some level of risk from spills. Since most products are granular, ease of containment and clean up is possible. 3. Delivery – containment tanks used to store concentrated solutions of fertilizer can cause a significant hazard. Broken, damaged or weak containers can lead to spills that may contaminate surface or groundwater. The possibility of backflow to, or cross connection with, potable water supplies is reduced. 4. Management – luxuriant or untimely application of fertilizer leads to excessive release from the production system to surface and/or ground water. Potential problems can be minimized through adequate environmental awareness, employee training, and emergency preparedness.

Environmental Principle: Fertilizer and concentrated and dilute nutrient solutions can have a significant impact on surface and groundwater when accidents or misapplications occur. Care in storage, handling, delivery system management, and nutrient management are essential to environmental stewardship. Application equipment must be maintained for proper use rate and to prevent backflow into wells and community water supplies, as well as to avoid cross connection with potable water supplies within the facility such as drinking fountains.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	all staff know to call 911 in the event of an emergency	emergency contact numbers posted	emergency contact numbers posted; emergency response plan on file
Environmental Awareness	employees are made aware of hazard to surface and groundwater by spills from tipped, damaged, or weak storage tanks of concentrated solutions of fertilizer	employees are made aware of hazards, and hazards are being reduced	hazards have been eliminated or are reduced and closely monitored

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Training	greenhouse manager assures all employees receive basic training	all employees receive basic training and updates, and are trained in the use and maintenance of the equipment used for fertilizer application and in the clean up of small spills	all employees receive basic training and updates in: use and maintenance of equipment, clean up of small spills, response to different emergency scenarios, proper interpretation of nutrient analysis reports, identification of nutrient deficiencies in plant material, and the correct selection of fertilizers and rates based on crop needs
Communication	greenhouse manager provides information to individual workers as necessary	greenhouse manager and all workers exchange information in a group setting	workers are encouraged to gain and exchange knowledge with the entire work group; meetings are held regularly
Management			
Application	occasional application of fertilizer at the discretion of the employee	fertilization at regular intervals with the proper dilution ratio and flow rate	automated controls monitor and apply fertilizers at the proper rate at each watering, based on crop nutrient status
Crop Nutrient Status	monitored as problems arise	monitored annually on each major crop	growing mix monitored before planting and 2 months into production of each crop
Employee Training	employees learn through on-the-job training	employees receive instruction from experienced users in monitoring crop nutrient status, selection and use of fertilizers, and selection and use of fertilizer injectors	supervisor provides employee with operating manuals plus instruction from qualified personnel; employees trained in identifying nutrient deficiencies, monitoring crop nutrient status, selection and use of fertilizers, and selection and use of fertilizer injectors
Leaching Volume	little consideration for the amount of water or fertilizer solution applied beyond saturation of the root zone; exceeds 10% leaching	conscious attempt to limit the amount of leaching of fertigated water to 10% of total volume applied	conscious attempt to limit the amount of leaching of nutrient solution to 10% of total volume applied; ebb and flow benches or other recirculating system used whenever practical

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Recordkeeping	records are sometimes kept of concentration and frequency of fertilizer application for each crop	records are routinely kept of concentration and frequency of fertilizer application for each crop	records are kept on quantities (concentration, volume, frequency) of fertilizer applied for each crop
Storage			
Compatibility	oxidizers are not stored on wood	oxidizers are not stored on wood	oxidizers are not stored on wood
Containers	all chemicals stored in their original containers unless damaged; labels are visible and readable; food or beverage containers are never used for storage	all chemicals stored in their original containers unless damaged; labels are visible and readable; food or beverage containers are never used for storage	all chemicals stored in their original containers unless damaged; labels are visible and readable; food or beverage containers are never used for storage
Container Arrangement	labels in plain sight; some containers in contact with floor; all containers stored up-right	labels in plain sight; no containers in contact with floor; all containers stored up-right; aisles wide enough to comfortably accommodate workers; containers not crowded on shelves or pallets	labels in plain sight; no containers in contact with floor; all containers stored up-right; aisles wide enough to comfortably accommodate workers; containers not crowded on shelves or pallets
Containment	no floor drain; some secondary containment used for open containers	no floor drain; secondary containment routinely used for open containers; bagged material on pallets or otherwise elevated above floor	no floor drain; floor provides containment in the event of a spill; secondary containment routinely used for most open containers; damaged or leaking containers are repaired and/or replaced as soon as possible; all spilled material is cleaned up upon discovery; and cleanup materials are discarded promptly and properly
Contents	storage area may also contain other greenhouse chemicals (no pesticides), and general greenhouse supplies	storage area does not contain pesticides, or other greenhouse chemicals; may contain general greenhouse supplies; no food, drink, tobacco products, or livestock feed is present	storage area does not contain pesticides, or other greenhouse chemicals; may contain general greenhouse supplies; no food, drink, tobacco products, or livestock feed is present

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Fire Prevention and Suppression	fire extinguisher available within general area	fire detection and alarm system present, fire extinguisher immediately available	fire detection and alarm system present, oxidizers and flammable materials stored separately; fire extinguisher immediately available; fire department notified at least annually of current inventory
Inventory and Recordkeeping	no inventory monitoring; materials no longer used are occasionally removed	records kept on amount of fertilizer purchased; materials no longer used are removed on a regular basis	inventory actively maintained as chemicals added or removed from storage; containers are dated when purchased; outdated materials removed on a regular basis; inventory is controlled to prevent the accumulation of excess material that may become difficult to use
Lighting	minimal electrical lighting provided	electrical lighting allows view into all areas and cabinets within storage area	electrical lighting allows view into all areas and cabinets within storage area
Location	site is not considered in selecting storage area	fertilizer storage within building is structurally segregated from general work areas, some consideration given to location of storage area away from environmentally sensitive areas, flooding is unlikely	fertilizer storage is separated from offices, workshops, laboratories, surface water, neighboring dwellings and bodies of water; flooding is unlikely
Management of Humidity, Flood Damage, and Clutter	area is dry	shelving is provided to keep materials off of the floor	area is clean and inventory arrangement is orderly; the floor, shelving and counters are kept free of debris and miscellaneous items
Monitoring	occasional inspection of storage for 1) signs of container corrosion or other damage - leaking or damaged containers are repackaged as appropriate, 2) faulty ventilation, electrical, and fire suppression systems – problems are reported and corrected	quarterly inspection of storage for 1) signs of container corrosion or other damage - leaking or damaged containers are repackaged as appropriate, 2) faulty ventilation, electrical, and fire suppression systems – problems are reported and corrected	monthly inspection of storage for 1) signs of container corrosion or other damage - leaking or damaged containers are repackaged as appropriate, 2) faulty ventilation, electrical, and fire suppression systems – problems are reported and corrected

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Security	no special provisions are made	fertilizer is stored in a dedicated room	storage room is locked, access is restricted to trained personnel
Signage	none	signs present; emergency contact information posted	signs posted; warning signs used as needed (e.g., for oxidizers); emergency contact information posted
Storage of Small Quantities of Chemicals	always stored on shelf or other solid surface; never on floor	always stored on shelf or other solid surface; never on floor	always stored on shelf or other solid surface; never on floor
Temperature Control	no mechanical temperature control; area not insulated	no mechanical temperature control; area insulated; no direct sources of heat (sunny windows, steam pipes, furnaces, etc.); area will not freeze	active mechanical temperature control; no direct sources of heat (sunny windows, steam pipes, furnaces, etc.)
Ventilation	room not particularly cool and dry; no mechanical ventilation	mechanical ventilation	mechanical ventilation working and used
Handling			
Storage and Record Keeping	fertilizer stock tanks are labeled with fertilizer formulation and concentration; no records are kept of application information	fertilizer stock tanks are labeled with fertilizer formulation and concentration; records are kept of frequency and location of fertilizer application	fertilizer stock tanks are labeled with fertilizer formulation and concentration; records are kept of fertilizer formulation, concentration, date, and location of application; records are kept of media nutrient analyses
Containment	concentrated stock solution stored near injector in heavy-duty plastic container	concentrated stock stored near injector in high density polyethylene or polypropylene containers with extra heavy duty walls	concentrated stock stored near injector in high density polyethylene or polypropylene containers with extra heavy duty walls; secondary containment provided
Partially-used Containers	open containers resealed and returned to storage	paper bags and boxes always opened with a box cutter or scissors; open containers resealed and returned to storage	paper bags and boxes always opened with a box cutter or scissors; open containers resealed and returned to storage; all open paper bags are sealed inside another, larger container, sealed and labeled

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Damaged Containers	when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled	when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled	containers checked often for damage; when damaged containers are noticed, contents are repackaged and labeled or placed in suitable secondary containment which can be sealed and labeled
Disposal	unused fertilizer products and concentrates are discarded using methods approved by environmental protection authorities	uses of unused products and concentrates are sought to minimize disposal	sufficient planning is made to eliminate the need for disposal; empty fertilizer containers are discarded based on latest advice from environmental protection authorities
Precipitate and Residue Disposal	fertilizer systems are cleaned and rinse solution is flushed to sanitary sewer	when fertilizer systems are cleaned, solids are removed first and discarded with solid waste before rinse solution is flushed to sanitary sewer	fertilizer systems are cleaned and solids and rinse solution are composted
Spill Prevention and Preparedness	secondary containment around fertilizer stock tanks is not used; spill clean-up materials for liquids (e.g., absorbent materials) and solids (e.g., shovel, dust pan, broom and empty and/or buckets) available within the general area	secondary containment is sometimes used for fertilizer stock tanks; spill clean-up materials for liquids (e.g., absorbent materials) and solids (e.g., shovel, dust pan, broom and empty and/or buckets) available within the general area	secondary containment used for fertilizer stock tanks routinely; spill clean-up materials for liquids (e.g., absorbent materials) and solids (e.g., shovel, dust pan, broom and empty and/or buckets) available within the general area
Delivery System			
Backflow Prevention (Building protection)	backflow prevention and inspection meets minimum local code requirements	backflow prevention and inspection meets minimum local code requirements	backflow prevention and inspection meets minimum local code requirements; redundant backflow prevention provided at each fertilizer injector
Cross-connection Avoidance	pipes and hoses carrying water for plant care are not cross-connected to pipes carrying potable water; local code requirements are met	pipes and hoses carrying water for plant care are not cross-connected to pipes carrying potable water; local code requirements are met	pipes and hoses carrying water for plant care are not cross-connected to pipes carrying potable water; local code requirements are met; signage instructs workers and visitors not to drink from hoses

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Equipment Maintenance	injector equipment maintained and calibrated when problems occur	injector equipment maintained as manufacturer recommends	all fertilizer containment tanks, injector pumps, backflow preventors, monitoring equipment and fertilizer lines are inspected regularly
Equipment Selection	venturi-type (“hozon” style) injectors used reluctantly and with awareness of their inaccuracy when pressure and flow vary	positive displacement or metering device injection used exclusively	computer or automatically controlled injection systems used
Fertilizer Injector and Surrounding Area	periodically - fertilizer injector is repaired when impairment of function is noticed; area surrounding fertilizer injector and concentrated solutions is cleaned periodically	semi-annual check of fertilizer injector function; clean surrounding area	monthly check of fertigation equipment accuracy; inspect containment tanks, back flow preventors and any equipment that holds fertilizer in the dry or liquid form; manufacturer recommendations are followed when calibrating or working on fertilizer injector equipment; stock solution tanks and the areas surrounding fertilizer injectors and concentrated solutions are kept clean and free of debris

Best Management Practices for Pest Control

Rationale

Chemical pesticides have the potential to cause harm to human health and the environment. Overuse, misuse, and careless application of chemical pesticides can result in the accumulation of toxic substances on greenhouse structures and on plants, and the possible development of pest resistance to the products applied.

The development of an integrated pest management program can reduce the need for chemical pesticides. Greenhouse staff should be trained to accurately identify pests, and to monitor insect populations. Records of pest problems and solutions should be maintained, and used in planning future control strategies.

Environmental Principle: It is important to incorporate an effective integrated pest control program to decrease reliance on pesticide use and increase the effectiveness of pesticides when needed. Decreased pesticide use will result in less potential harm to human health and the environment and will help to prevent pesticide resistance in target organisms.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	all staff know to call 911 in the event of an emergency	emergency contact numbers are posted; staff have basic training in cleaning up small pesticide spills	emergency contact numbers posted; staff have basic training in cleaning up small pesticide spills; emergency response plan on file
Environmental Awareness	employees are informed of the impact pesticides can have on the environment	employees are introduced to alternative pest control measures and encouraged to implement them when possible	as appropriate, a program is established to incorporate IPM practices to maximize the benefits of pesticide applications while reducing environmental risks
Training	all staff and greenhouse users are trained, minimally, as WPS Workers; all staff and greenhouse users responsible for pesticide applications are in compliance with Cornell, state and federal regulations regarding applicator training	all staff and greenhouse users are trained, minimally, as WPS Handlers; all staff and greenhouse users responsible for pesticide applications are in compliance with Cornell, state and federal regulations regarding applicator training	all staff and greenhouse users are trained, minimally, as WPS Handlers; all staff and greenhouse users responsible for pesticide applications are in compliance with Cornell, state and federal regulations regarding applicator training

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Communication	pest management plan is communicated orally and with fairly short notice to those responsible for implementation	pest management objectives are communicated well in advance to those responsible for implementation	written forms are submitted before each project begins, outlining research objectives, cultural requirements, pest management objectives, and pest tolerance threshold; meeting is held with greenhouse staff to discuss integrated pest management strategies as appropriate to the project
Management			
Monitoring and Recordkeeping	records kept of significant insect pests, disease and weed problems	records kept of weekly scouting results, sticky cards used to monitor	designated scout maintains records weekly, changes sticky cards, and makes pest control decisions
Biological Control (when appropriate to the greenhouse use)	pesticide applications are minimized to avoid killing natural enemies	appropriate beneficial insects or microbials are introduced early in the course of pest population growth; pesticides used offer least toxicity to beneficials	IPM program is in place; needs for beneficial insects and microbials are anticipated based on experience of past seasons; minimal pesticide use as appropriate to the research design
Pest Containment	infected or infested plants are tagged; movement of people, equipment or plants carrying pests is restricted	all new plants are carefully inspected before they enter greenhouse; infected or infested plants are tagged; movement of people, equipment or plants carrying pests is restricted; greenhouse staff and users avoid contact with infected or infested plants	if quarantine space is available, all new plants remain in quarantine for an appropriate period before they enter greenhouse; all new plants are carefully inspected; infected or infested plants are tagged; movement of people, equipment or plants carrying pests is restricted; greenhouse staff and users avoid contact with infected or infested plants; infected or infested plants are quarantined or destroyed if treatment is not effective

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Pest Exclusion	doors to greenhouse rooms are kept shut	doors to greenhouse rooms are kept shut; screens installed over vents whenever possible, integrity checked twice yearly; door seal checked regularly	doors to greenhouse rooms are kept shut; screens installed over vents whenever possible, integrity checked monthly; door seal checked regularly; cracks in structure between houses sealed to prevent movement of pests; foot bath or pad kept in place to clean shoes before entering
Chemical Selection	after pest identification, an appropriate recommended legal product for the crop and pest is used, applied only as needed and according to the label	after pest identification, an appropriate recommended legal product for the crop and pest is used, applied only as needed and according to the label; the development of pest resistance to products is mitigated through consideration of alternate modes of action	after pest identification, an appropriate recommended legal product for the crop and pest is used, applied only as needed and according to the label; development of pest resistance to products is mitigated through consideration of alternate modes of action; reduced risk pesticides, such as insect growth regulators, are selected whenever possible
Plant Care	water and fertilizer applied as needed	water and fertilizer applied as needed; plants transplanted to larger pots to maintain vigorous growth	water and fertilizer applied as needed; plants transplanted to larger pots to maintain vigorous growth; plants are pruned, staked and tied as needed
Sanitation	bench top, floors, pots & equipment are disinfected and plants are disease- and insect-free at beginning of project	bench top, floors, pots & equipment are disinfected and plants are disease- and insect-free at beginning of project; debris and infected plant material removed weekly during project	bench top, floors, pots & equipment are disinfected and plants are disease- and insect-free at beginning of project; debris and infected plant material removed weekly during project; a routine is planned and discussed with GH staff for disinfecting tools during project
Handling			
Pesticide Application Safety	telephone or 2-way communication available to pesticide applicator	two people always present during pesticide applications	two people always present during pesticide applications

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Pesticide Application Technique	calendar-based applications are avoided; spot sprays used when pesticide's mode of action is physical (soaps and oils)	calendar-based applications are avoided; spot sprays used when pesticide's mode of action is physical (soaps and oils); applications based on scouting results	calendar-based applications are avoided; spot sprays used when pesticide's mode of action is physical (soaps and oils); applications based on scouting results and timed to the susceptible stage of the pest or disease; application method (hydraulic, ULV, aerosol, etc.) is chosen to ensure good coverage of the target pest
Pruning and Rogueing	dead plants are discarded weekly; compost is removed from greenhouse immediately	infected or infested plant tissue is pruned and discarded when transplanting; dead plants are discarded daily; compost is removed from greenhouse immediately	infected or infested plant tissue is pruned and discarded weekly; dead plants are discarded daily; compost is removed from greenhouse immediately

Best Management Practices for Interior & Exterior Weed Control

Rationale

Weeds (unwanted plants) can harbor pests that have the potential to spread to greenhouse crops. It is important to remove weeds within and in the immediate exterior greenhouse environment. Appropriate use of cultural, mechanical and physical controls will reduce the need to apply chemical controls, thus minimizing potential runoff of pesticides to surface and ground waters. New York State commercially certified applicators apply herbicides as needed; priority is placed on least toxic chemicals and appropriate application timing to minimize environmental impact. Greenhouse staff apply interior herbicide applications. Cornell Grounds Department employees or greenhouse staff apply exterior herbicide applications. Good communication between greenhouse staff and Grounds employees minimize drift, exposure and contamination risks. Proper notifications, record keeping and reporting are emphasized.

Environmental Principle: Environmental impact is reduced when care is taken to prevent over-application and improper use of herbicides.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	Exterior & Interior: Staff educated on proper procedures to handle emergencies: spills, drift and plant material over-exposure	Exterior & Interior: Staff educated and written protocols exist for proper procedures to handle emergencies: spills, drift and plant material over-exposure	Exterior & Interior: Staff educated and written protocols exist for proper procedures to handle emergencies: spills, drift and plant material over-exposure
Environmental Awareness	Exterior & Interior: employees are made aware of the hazard to surface and groundwater from over application and toxic herbicides	Exterior & Interior: employees are aware of hazards, and hazards are being reduced through physical and mechanical weed controls, use of less toxic chemicals and application timing	Exterior & Interior: employees are aware of hazards, and hazards are being eliminated through physical and mechanical weed controls, use of less toxic chemicals, application timing and use of barriers, such as ground cloth below gravel and/or concrete floors
Training	Exterior & Interior: herbicide applicators are trained and are required to be NYS pesticide apprentice under direct supervision of NYS commercially certified applicator	Exterior & Interior: herbicide applicators are trained and are required to be NYS commercially certified applicator	Exterior & Interior: herbicide applicators are trained and are required to be NYS commercially certified applicator with recertification coursework in IPM

Operational Aspects	Environmental Assurance >>		
	Level 1	**Level 2**	**Level 3**
Communication	Exterior: Greenhouse staff and managers communicate application with Grounds team leaders Interior: Greenhouse staff communicate application schedule and equipment needs with other growers and greenhouse users	Exterior: Date, location, time and chemical to be applied communicated and agreed upon amongst greenhouse staff, greenhouse managers and Grounds team leaders with at least 24 hours notice Interior: Greenhouse staff communicates application schedule and equipment needs with other growers and/or researchers in the immediate area of application	Exterior: Date, location, time and chemical to be applied communicated and agreed upon amongst greenhouse staff, greenhouse managers and Grounds team leaders with 24 to 48 hours notice, including rain date Interior: Greenhouse staff and managers communicate application schedule and equipment needs with other growers and/or researcher in immediate area through postings and verbal communications
Management			
Physical & Mechanical Controls	Exterior: None Interior: gravel floor; benches free of soil media; weeds hand pulled	Exterior: gravel around greenhouse structures Interior: gravel floors use quality ground cover under gravel; benches free of soil media; weeds hand pulled and gravel raked	Exterior: ground cloth underlying gravel around greenhouse structures; occasional mechanical trimming and hand weeding Interior: concrete flooring; welded wire benches; drains & floor cracks free of soil media; field soil-based media is sterilized; weeds-specific research material grown in a greenhouse with concrete floors
Application Timing	Exterior & Interior: during normal work hours	Exterior: early morning, late afternoon, or early evening when greenhouse fans can be shut down Interior: late afternoons after final water for the day is complete or sunny day	Exterior: early morning, late afternoon, or early evening when greenhouse fans can be shut down; applicator has knowledge of interior locations of herbicide-sensitive and research plants Interior: late afternoons after final water for the day is complete or sunny day when greenhouse is free of plant material
Application Equipment	Exterior: high pressure application Interior: hand held pump sprayer	Exterior: hand held pump sprayer Interior: hand pump sprayer on wheels	Exterior: backpack sprayer Interior: backpack sprayer

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Chemical Selection	Exterior: any NYS registered herbicide product, appropriate for the weed species Interior: any NYS registered herbicide product, appropriate for the weed species with low residual activity	Exterior: any NYS registered herbicide product, appropriate for weed species; product chosen for effectiveness against particular weed species Interior: any NYS registered selective herbicide product, appropriate for the weed species	Exterior: NYS registered herbicide products, appropriate for weed species; product chosen for efficacy against particular weed species; product selected is the least toxic (relatively high LD_{50}) and least environmentally persistent among options Interior: any NYS registered selective herbicide product, appropriate for the weed species
Application Notification	Exterior: treated areas posted with signs as required by NYS DEC Interior: 24 hours advance notification by applicator and area posted with required signs	Exterior: treated area posted with signs as required by NYS DEC; application posted inside building Interior: applicators provide notification by posting signs 24 hours in advance and calling or e-mailing greenhouse users	Exterior: treated area marked with signs as required by NYS DEC; application posted inside building and occupants notified of application before it occurs Interior: applicators provide notification by posting signs 24 hours in advance and calling or e-mailing greenhouse users
Record Keeping & Reporting	Exterior & Interior: complies with NYS regulations	Exterior & Interior: complies with NYS regulations; scouting occurs and some records made	Exterior & Interior: complies with NYS regulations; scouting occurs; records of problems & solutions kept for multiple years
Application Frequency	Exterior: routine for maintenance Interior: as needed for maintenance	Exterior: scheduled periodically; consideration given to plant material in the greenhouse Interior: as needed for maintenance, consideration given to plant material in the greenhouse	Exterior: only as needed based on surveys; never “by-the-calendar”; consideration given to plant material in the greenhouse Interior: IPM Practices followed with consideration given to plant material in the greenhouse

Best Management Practices for Housekeeping

Rationale

Good housekeeping is a fundamental principle of effective greenhouse operations. Good housekeeping prevents pest harborages, allows for easier and quicker problem identification, and sets a tone of order and discipline. Housekeeping has safety implications; clean and orderly greenhouses reduce the risk of tripping or slipping, and facilitate identification of other hazards.

Proper arrangement and spacing of plants facilitates good airflow, efficient irrigation, and effective pesticide application, thereby decreasing pest and disease incidence and reducing pesticide use.

Control of watering and fertilizer applications by properly trained staff and greenhouse users can reduce overuse of water and fertilizer. Excess watering causes puddling on floors and, combined with warm temperatures and high light levels in greenhouses, provides excellent conditions for algal growth. Reduced water and fertilizer application lessens environmental impact, amount of algae, and potential accidents from slippery walkways. Algae growth on greenhouse glazing prevents adequate light transmission, and algae present on bench tops and in pots inhibits plant growth and attracts insects. Sanitation and environmental modifications are the preferred method of algae growth prevention and control.

Environmental Principle: With proper watering techniques, good sanitation practices, and correct spacing of plants there will be less environmental impact from excess fertilizers and chemicals, and a reduction of algae in the greenhouse setting.

Operational Aspects	Environmental Assurance		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	greenhouse staff trained to handle emergencies; spill kits are accessible	greenhouse staff trained to handle emergencies; spill kits are accessible; floors are kept as dry as possible	greenhouse staff trained to handle emergencies; spill kits are accessible; floors are kept as dry as possible
Environmental Awareness	staff are made aware of hazard to surface and groundwater by excess runoff and overuse of sanitizers and disinfectants	staff are made aware of hazard to surface and groundwater by excess runoff and overuse of sanitizers and disinfectants; staff are encouraged to reduce hazards	staff are made aware of hazard to surface and groundwater by excess runoff and overuse of sanitizers and disinfectants; hazards are identified and eliminated, or are reduced and closely monitored

Operational Aspects	Environmental Assurance		
	Level 1	Level 2	Level 3
Training	all employees are trained in the importance of good housekeeping, proper watering practices, sanitation, and appropriate use of disinfectants	all employees are trained in the importance of good housekeeping, proper watering practices, sanitation, and appropriate use of disinfectants ; employees are trained to operate disinfectant application equipment	all employees are trained in the importance of good housekeeping, proper watering practices, sanitation, and appropriate use of disinfectants ; employees are trained to operate disinfectant application equipment
Communication	staff communicate with greenhouse users, managers and fellow staff regarding housekeeping and disinfectant application where and when appropriate	staff communicate with greenhouse users, managers and fellow staff regarding housekeeping and disinfectant application where and when appropriate	staff communicate with greenhouse users, managers and fellow staff regarding housekeeping and disinfectant application where and when appropriate
Management			
Plant Care	plants are arranged to provide good airflow and access for effective watering and pesticide application; plants are watered only as needed; if present, algae layer manually removed from potting media surface to allow water and air flow, and decrease susceptibility to shore flies and fungus gnats	plants are arranged to provide good airflow and access for effective watering and pesticide application; plants are watered only as needed; if present, algae layer manually removed from potting media surface to allow water and air flow, and decrease susceptibility to shore flies and fungus gnats	plants are arranged to provide good airflow and access for effective watering and pesticide application; plants are watered only as needed; potting media surface is allowed to dry out between waterings; proper well drained growing media is selected for each crop; if present, algae layer manually removed from media surface; media is treated for gnats and flies if present
Sanitation	all surfaces are kept free of plant debris and weeds; floors are squeegeed to reduce puddling	all surfaces are kept free of plant debris and weeds; floors are squeegeed to reduce puddling; benches, floors, tools and plant containers are disinfected when possible	all surfaces are kept free of plant debris and weeds; floors are squeegeed to reduce puddling; benches, floors, tools and plant containers are disinfected pre-crop, during crop and post crop; physical weed mat barrier is in place over gravel or soil floors to reduce weeds and algae growth

Operational Aspects	Environmental Assurance		
	Level 1	Level 2	Level 3
Floor Construction	well drained gravel floors	concrete floors to reduce the amount of excess moisture in the greenhouse	concrete floors to reduce the amount of excess moisture in the greenhouse; floors sloped and grooved to drain properly and prevent pooling; concrete surface textured to reduce slipping
Ventilation	outdoor air inlets managed to prevent excessive greenhouse humidity	outdoor air inlets managed to prevent excessive greenhouse humidity; proper ventilation from horizontal airflow fans	outdoor air inlets managed to prevent excessive greenhouse humidity; proper ventilation from horizontal airflow fans
Light Reduction	opaque tubing is used for irrigation lines to exclude light; fertilizer tanks are covered to exclude light	opaque tubing is used for irrigation lines to exclude light; fertilizer tanks are covered to exclude light	opaque tubing is used for irrigation lines to exclude light; fertilizer tanks are covered to exclude light;
Disinfectant Use	in accordance with label; surfaces should be clean and free of debris before use	in accordance with label; surfaces should be clean and free of debris before use; disinfectants used for pre-crop clean up and regularly during crop production for sanitation	in accordance with label; surfaces should be clean and free of debris before use; disinfectants are part of a regular schedule before, during and after plants are in the greenhouse; applied to floors, walls, benches, tools and plant containers for sanitation
Safety			
Slipping hazard communication	staff, users and visitors are made aware of safety hazards of wet floors through training or signage	staff, users and visitors are made aware of safety hazards of wet floors through training and signage	staff, users and visitors are made aware of safety hazards of wet floors through training and signage
Footwear	Open-toed footwear is discouraged; use of non-skid footwear is encouraged	Open-toed footwear is prohibited; use of non-skid footwear is encouraged; non-skid footwear is provided to staff	Open-toed footwear is prohibited; staff are required to use non-skid footwear

Best Management Practices for Composting

Rationale

The research, teaching and display greenhouses on the Ithaca campus generate a large amount of waste plant material, media and other organic waste. To reduce solid waste, organic waste is composted on site or through the department of Farm Services in the College of Agriculture and Life Sciences. Specially designed compost bins are used to store the waste and eliminate environmental impact from excess run-off due to rain and snowmelt. Compost waste is removed upon request of greenhouse staff and efforts are made to prevent bins from being over-full, thus reducing environmental impact from odor and compost theft. Signs on compost bins describe appropriate and inappropriate compostable materials.

Environmental Principle: Environmental impact is reduced when organic waste is composted and compost is properly stored and promptly removed.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	greenhouse staff educated on proper composting procedures	greenhouse staff and users educated on proper composting procedures	greenhouse staff & users educated on proper composting procedures and
Environmental Awareness	staff are made aware of implications to surface and groundwater from excess runoff of compost material and fertilizers	staff are made aware of implications to surface and groundwater from excess runoff of compost material and fertilizers	staff are made aware of implications to surface and groundwater from excess runoff of compost material and fertilizers
Training	all employees are trained in the importance of proper composting procedures	all employees are trained in the importance of proper composting procedures and the prompt removal of full bins	all employees are trained in the importance of proper composting procedures and the prompt removal of full bins
Communication	staff communicate proper composting procedures to greenhouse users; managers and staff communicate with CALS Farm Services for full bin removal	staff communicate proper composting procedures to greenhouse users; managers and staff communicate with CALS Farm Services for full bin removal	staff communicate proper composting procedures to greenhouse users; managers and staff communicate with CALS Farm Services for full bin removal

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Management			
Compost Bin Construction & Design	steel; rust resistant paint; removable swinging door for easy access; elevated from the ground	steel; rust resistant paint; removable swinging door for easy access; elevated from the ground; sturdy easy-to-lift lid or stored under cover	steel; rust resistant paint; removable swinging door for easy access; elevated from the ground; sturdy easy-to-lift lid or stored under cover
Signage	bins are posted for no trash and plastic; compost handling procedures centrally posted; trash and compost cans are labeled	bins are posted for no trash and plastic; compost handling procedures posted in several locations in the greenhouse and around bins; trash cans and compost cans are clearly labeled; bins are posted to inform visitors of safety hazards of removing material from compost bins for personal use	bins are posted for no trash and plastic; compost handling procedures posted in several locations in the greenhouse and around bins; trash cans and compost cans are clearly labeled; bins are posted to inform visitors of safety hazards of removing material from compost bins for personal use
Ventilation	bins are located outside of greenhouses	bins are located outside of greenhouses away from conference room, break room and classroom windows	bins are located outside of greenhouses away from conference room, break room and classroom windows
Handling			
Procedures	staff and greenhouse users are educated in all aspects of composting procedures	staff and greenhouse users are educated in composting procedures; composting posters are displayed; written compost procedures are given to all new greenhouse users	staff and greenhouse users are educated in composting procedures; composting posters are displayed; written compost procedures are given to all new greenhouse users
Safety			
Prevention of Biological & Chemical Exposures	staff, users and visitors are aware of safety hazards of removing material from compost bins for personal use through training and signage	staff, users and visitors are aware of safety hazards of removing material from compost bins for personal use through training and signage	staff, users and visitors are aware of safety hazards of removing material from compost bins for personal use through training and signage

Best Management Practices for Maintenance

Rationale

Threats to the integrity of a facility and its systems include: frost heaving, poor drainage, poor electrical service, concrete deterioration, peeling or flaking paint, corrosions of steel equipment and reinforcing, puncturing of clay or synthetic liners, plumbing rupture, loss of backflow prevention, and loss of secondary containment systems. Preventive maintenance minimizes factors that cause deterioration. Timely repair of small problems prevents them from becoming larger issues, and minimizes algae growth and other pest problems.

Environmental Principle: Any deterioration of the greenhouse jeopardizes the safety of workers and the environment by facilitating the introduction of greenhouse chemicals into the soil and water.

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Overview			
Emergency Preparedness	staff can recognize equipment malfunctioning and are trained to notify supervisor in such an event	staff can recognize equipment malfunctioning and alarms and are trained to notify supervisor in such events	staff are trained in limited operational response (e.g., shutting off valves) when they recognize equipment malfunctioning or hear equipment alarms; staff then notify supervisor for further response and correction
Environmental Awareness	staff are trained in behaviors, but not impacts (e.g., poorly maintained or broken equipment is not good)	staff receive orientation to impacts (e.g., poorly maintained or broken equipment can lead to environmental impacts)	staff understand that poorly maintained or broken equipment can have environmental consequences and legal liabilities, and understand the necessity of personal action in responding to equipment maintenance needs
Training	staff are trained to recognize equipment and facility malfunctions	staff are trained to recognize and react to equipment and facility malfunctions	staff are trained to recognize and react to equipment and facility malfunctions

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Communication	individuals in the greenhouse community report maintenance concerns as they occur	individuals in the greenhouse community report maintenance concerns as they occur; greenhouse staff and maintenance personnel discuss repairs where appropriate to maximize long-term effectiveness of repairs	individuals in the greenhouse community report maintenance concerns as they occur; greenhouse staff and maintenance personnel discuss repairs where appropriate to maximize long-term effectiveness of repairs; greenhouse staff and maintenance personnel meet regularly to discuss preventive maintenance and foreseeable maintenance issues affecting greenhouse structural integrity and plant care
Management			
Preventive Maintenance (mechanical, electrical, plumbing & other environmental control equipment)	no preventive maintenance schedules (greenhouse and maintenance staff)	equipment list; work orders generated by calendar or season; subjective scheduling; no or informal record keeping; no tracking	work orders generated by electronic maintenance system; reports or receipts tracked and required by maintenance system; equipment-specific
Routine Maintenance (mechanical, electrical, plumbing & other environmental control equipment)	greenhouse staff note problems as they occur; report problems informally to greenhouse management	maintenance staff note problems as they occur; repair as needed	greenhouse and maintenance staff work together to identify problems as they occur; repairs are prioritized and implemented
Evaporative Cooling	evaporative cooling system leakage and bleed off are not monitored; cooling system is operated seasonally, regardless of actual ambient temperature	cooling system is periodically inspected and excessive leakage or bleed off is corrected; cooling system is operated only during hot weather	dissolved solids content of cooling system water is periodically monitored and water bleed off is adjusted appropriately; leaks are repaired promptly; cooling system operation is linked to environmental controls
Shading - Application	shading material is applied on schedule on a yearly or more frequent basis	shading material is applied as needed, but only when weather will remain clear until material is well-dried	automatic shading is provided by movable curtains in the greenhouse

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Shading - Removal	easily removed shading formulations are used where appropriate; shading material is allowed to be removed by snowfall or on schedule with water and scrubbing	easily removed shading formulations are always used; shading material is allowed to be removed by snowfall or on schedule with water and scrubbing	no removal of external shading is required; automatic shading is provided by movable curtains in the greenhouse
Spill Cleanup (maintenance-related chemicals)	maintenance staff know where spill clean-up materials are kept; spills are cleaned up fairly promptly	maintenance staff know where spill clean-up materials are kept; spills are cleaned up as soon as possible	maintenance staff know where spill clean-up materials are kept; spills are cleaned up as soon as possible; secondary containment or spill absorption material is used where appropriate
Disposal of Plastic Coverings	sanitary landfill	sanitary landfill	recycle
Water Control			
External & Internal Drainage	drainage problems are identified and prioritized for repair	drainage problems are identified and prioritized for repair; drainage issues are systematically resolved	drainage problems are identified and prioritized for repair; drainage issues are systematically resolved; drainage in and around structure is visually inspected as weather conditions determine; proper grading in and around structures prevents ponding; landscape plantings kept away from drainage system; pests prevented from tunneling in, under or around structure
Irrigation Systems	irrigation leaks are identified	irrigation systems are inspected; leaks are identified and prioritized for repair	hose couplings and other connections are kept tight and leak free; irrigation leaks are repaired immediately upon discovery; periodic inspections are conducted; algae accumulation on greenhouse floors is used as an indicator of system failure
Structural Leaks	greenhouse structural leaks are identified and prioritized for repair	structural leaks are repaired systematically	structural leaks are repaired systematically; glazing is inspected routinely

Best Management Practices for Renovation and New Construction

Rationale

Planning for major renovations or new construction must take into consideration all aspects of the Best Management Practices. Due to the amount of chemicals, both pesticides and fertilizers, used in the greenhouse, construction and renovation must be undertaken with regard to safe storage, containment and use. Steps should be taken to inhibit electrical fire, flooding and exposure to employees. Spills and leachate must not enter the ground and nearby water sources.

Environmental Principle: Renovation and new construction projects that are well planned and executed will allow greenhouse managers to more easily manage their environmental risks.

Operational Aspects	Environmental Assurance >>		
	Level 1	**Level 2**	**Level 3**
Overview			
Emergency Preparedness	emergency devices meet code requirements	emergency devices meet code requirements	emergency devices meet code requirements; emergency equipment is integrated wherever possible, and backup systems are installed to mitigate failures
Environmental Awareness	a person on the project team is assigned the responsibility for integrating BMP principles into design	a person on the project team is assigned the responsibility for integrating BMP principles into design	The entire project team is familiar with BMP principles; the project team includes a BMP lead advisor
Training	BMP principles are circulated to the project team as design criteria	BMP principles are circulated to the project team as design criteria; BMP principles are discussed during design meetings	BMP principles are circulated to the project team as design criteria; the design team can thoughtfully discuss BMP principles as the basis for design
Communication	environmental issues are not systematically addressed during design	environmental issues are considered; no consultation and guidance by qualified personnel	qualified environmental/experienced professionals are integral to the design process
Management			
Floor Construction	solid floor; drain to sanitary sewer	solid floor; drain to sanitary sewer	solid floor; drain to sanitary sewer; floors sloped and grooved to drain properly and prevent ponding
Building Controls	temperature control; passive ventilation	temperature and ventilation control	digital controls for environmental systems

Operational Aspects	Environmental Assurance >>		
	Level 1	Level 2	Level 3
Disposal Systems (all waste systems: trash, compost, universal waste)	no specific waste disposal area provided	waste disposal area provided for storage of empty containers and unwanted chemicals	waste disposal area provided for storage of empty containers and unwanted chemicals
Secondary Containment Systems – Chemical Storage	portable systems provided where needed; no fixtures	portable systems provided where needed; some fixtures	portable systems provided where needed; some permanent secondary containment built-in, e.g., for fertilizer injection systems; secondary containment decisions are based on fertilizer storage, pesticide storage, and mixing/loading activities; frost heaving, tank seats and tank anchors are considered in designing secondary containment systems
Support Facilities			
Laundry Facilities	no special provisions are made for cleaning PPE or contaminated clothing	no special provisions made for cleaning PPE or contaminated clothing; workers generally wear disposable PPE when mixing, handling or applying pesticides	workers generally wear disposable PPE when mixing, handling or applying pesticides; washing machine and dryer are provided
Restroom & Shower Facilities	building code requirements met	building code requirements met; at least one shower available to workers	building code requirements met; shower facilities with adequate locker space are provided for each sex
Safety			
Worker Safety Area	no special area for worker safety provided; at least half of the following are provided, but not in an organized way: eyewash, deluge shower, first aid kit, spill response kit, fire extinguishers, telephones or other 2-way communication system for emergency notification, emergency phone numbers, material safety data sheets	all of the following are provided, but not in an organized way: eyewash, deluge shower, first aid kit, spill response kit, fire extinguishers, telephones, emergency phone numbers, material safety data sheets	all of the following are provided in an organized way or in a common location, and all staff are trained in the proper location and use: eyewash, deluge shower, first aid kit, spill response kit, fire extinguishers, telephones, emergency phone numbers, material safety data sheets

Glossary

Backflow: The flow of a liquid by siphon pressure or gravity back to its source.

Backflow Prevention Device: A mechanical device that prevents the return flow of water and any dissolved chemicals back into the water supply.

Beneficial Organisms: Organisms used to control a pest population. These include:

> **Competitors**: Individuals that need to utilize the same limiting resource. Competition generally has negative effects on one or both competitors.
> **Microbials**: Microscopic organisms that are predators of greenhouse pests. These may include mites, fungi, nematodes and other organisms that feed on or disrupt pests.
> **Parasites**: Small organisms that live and feed in or on a larger host organism.
> **Parasitoids**: Parasitic insects that live in or on, and eventually kill, a larger host insect.
> **Pathogens**: Microorganisms that live and feed (parasitically) on or in a larger host organism, and thereby cause injury to the host.
> **Predators**: Animal that feed upon other animals.

Biological Control: The use of beneficial organisms to manage pest populations.

Composting: Managed aerobic decay of organic matter to produce a humus-like product that can be used as a plant growth medium or soil amendment.

Cross-connection: Interconnection between a potable water supply and a water supply intended for plant care which may contain fertilizer or other agricultural chemicals.

Cultural Control: Manipulation of growth factors such as genetics, the environment, or production timing to achieve an objective such as disease, pest, or growth control.

Curbed Concrete Pad: A containment method using concrete flooring constructed to restrict the movement of spilled materials within raised edges.

Decontamination/Clean Area: Designated area to don or store clean PPE, and perform personal decontamination (i.e., shower or sink).

Disinfectant: An antimicrobial intended to destroy or irreversibly inactivate infectious or other undesirable bacteria, pathogenic fungi, or viruses on surfaces or inanimate objects.

Electrical Conductivity (EC): A property of a nutrient solution used as a measure of nutrient concentration.

Eyewash: A piece of safety equipment that provides for quick flushing of the eyes; provided within a work area where the eyes of any person may be exposed to corrosive materials (such as some pesticides); installed and maintained according to regulations; for immediate emergency use.

Environmentally Persistent: A chemical compound that does not rapidly break down but remains in the environment for a prolonged period.

Evaporative Cooling: Evaporation of water by an air stream to reduce the air temperature.

Fertigation: Irrigation of plants with water containing fertilizer.

Fire Suppression System: A system designed to respond to smoke, heat, or spark with water or a chemical fire retardant.

Fumigants: A pesticide in the form of a poisonous gas that will kill destructive microorganisms, animals, or plants when absorbed or inhaled.

Glazing: Light-transmitting materials used to cover a greenhouse.

Growing mix: A material formulated to provide structural support, water, nutrients and air for roots to grow; a soil substitute.

Growth Regulator: Synthetic or naturally occurring plant substances that are effective in minute amounts to regulate or modify plant growth.

Hazard Class: A classification system designating the toxicity level of pesticides to humans, including: Danger/Poison, Danger, Warning, Caution – Slightly Toxic, Caution – Relatively Non-toxic. The classification is directly related to the suggested precautions for handling and use.

Herbicide: A pesticide formulated to inhibit growth of or kill plants. Non-selective herbicides work on may different types of plants, while selective herbicides are specific to a selected group of plant species.

Injector: Device that injects fertilizer stock solution into the irrigation line at a known dilution ratio.

Insect Growth Regulators (IGRs): Hormones or hormone-like substances that affect the ability of insects to grow and mature normally**.**

Integrated Pest Management (IPM): A pest control strategy based on knowledge of the crop and its pests using multiple management techniques, including cultural, biological, and chemical control.

Inventory Control: Detailed monitoring and recording of product identifications and quantities to ensure proper planning, use, distribution and disposal.

LC_{50}: "Lethal Concentration" of a substance suspended in the air or dispersed in water.

LD_{50}: "Lethal Dose" of a substance that will kill 50% of a population of organisms; this is generally expressed as milligrams of toxin per kilogram of body weight.

Leaching: Applying excess water or nutrient solution to wash chemicals and excess nutrients out of the root zone.

Material Safety Data Sheet (MSDS): an OSHA mandated collection of information provided by the manufacturer for the proper storage and use of a chemical, including toxicity and safety information.

Mode of Action: The mechanism by which a pesticide kills or controls the target organism (i.e., systemic, contact, etc.).

Natural Enemies: see Beneficial Organisms

Non-compost: Material not subject to aerobic decay, or excluded from composting for phytosanitary reasons, including: plastic coated paper; plastic stakes, labels, pots, bag, twist ties, gloves or any plastic material; large woody material; rock wool or manufactured soil media substitutes; transgenic, diseased or insect infested material unless it has been adequately autoclaved; wooden labels or stakes.

Nutrient: A mineral used by plants for growth or development.

Nutrient Analysis: Testing of growing mixes, water or plant material to determine actual nutrient content, pH, and/or electrical conductivity (saltiness).

Nutrient Deficiency: The lack of one or more mineral nutrients, which prevents optimum growth.

NY State Certified Pesticide Applicator: A commercial or private pesticide applicator who is certified by the NYS DEC to use, supervise the use of, or train another individual in the use of any pesticide in any category of use covered by the individual's certification. Applicators at Cornell must have commercial certification.

NY State DEC: Department of Environmental Conservation; the Pesticide Management Program within NYS DEC is the lead New York agency responsible for regulation of pesticides, compliance assistance and public outreach activities to ensure enforcement of State pesticide laws.

NY State Registered Pesticide Product: A DEC approved substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any insects, rodents, fungi, weeds, or other forms of plant or animal life or viruses (except viruses on or in living humans / or other animals); and any substance or mixture of substances intended as a plant regulator, defoliant (causes plants to drop leaves) or desiccant (promotes death of plants by drying).

Passive Temperature Control: Using non-motorized shutters, vents, shading and other systems to moderate indoor temperature without benefit of mechanical coolers or heaters; indoor temperature patterns tend to follow outdoor temperature trends.

Passive Ventilation: Non-automated ventilation such as opened windows and shutters that allow airflow in and out of the greenhouse without relying on motorized fans and vents.

Personal Protective Equipment (PPE): Clothing and accessories such as goggles and rubber boots worn for protection from exposure to or injury from chemicals during handling activities.

Personal Protective Equipment Area: An area designated for storage and donning of personal protective equipment.

Pest: Any organism causing an undesired effect on the health, growth or development of a plant, including weeds, rodents, insects and pathogens.

Pest Exclusion: The use of exclusion methods, such as caulking crevices or screening air vents, to limit or prevent pest access.

Pest Reservoir: An area or host population that supports pests.

Pesticide: Any substance or mixture of substances intended to prevent, destroy, repel, or mitigate any pest, or intended for use as a plant regulator, defoliant, or desiccant.

Pesticide Formulation: A classification of the physical form of pesticide products, including but not limited to: EC = emulsifiable concentrate, F = flowable microencapsulated, FP = flowable powder, G = granular, L = liquid, ME = microencapsulated, SP = soluble powder, W = wettable powder.

pH: The measure of the acidity or basicity of a solution.

Precipitate: Solids that have separated out of solution.

Proportioner: A device that injects fertilizer stock solution into the irrigation line at a known dilution ratio.

Residual: Leaving a residue that remains effective for an extended period.

Rogueing: The prompt removal, by bagging and carrying out of the greenhouse, of infested or infected plants.

Sanitizer: An antimicrobial intended to reduce the number of living bacteria or viable virus particles on inanimate surfaces, in water, or in air.

Scouting: The systematic checking of plants for insect and disease problems. Scouting records are kept and used in making predictions and decisions concerning pest and disease control.

Secondary Containment: A container or structural barrier placed under or around a vessel to contain the contents of the vessel in the event of an accidental spill or leak. The secondary containment should have at least 110% of the primary vessel's capacity.

Selectivity: Refers to the range of organisms or life stages of organisms affected by a pesticide; a selective pesticide is toxic to a narrow range of pests species or life stages.

Shading: The use of fabric or coatings applied to glazing to reduce the indoor light level or solar heat gain in a greenhouse.

Worker Protection Standard: A federal regulation administered by the US Environmental Protection Agency (EPA) intended to reduce the risk of pesticide poisonings and injuries among agricultural workers who are exposed to pesticide residues on plants. The WPS requires greenhouse owners to assure that workers receive basic pesticide safety information before they work with treated plants.