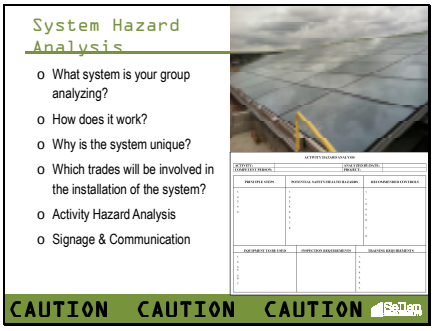
Slide 1

Now that we have walked through a few examples of new green building systems, it is your turn to investigate a specific system to develop the safety procedures and protocol we can use on our jobsites to keep all of our workers injury free.

INSTRUCTOR: Break audience into groups of 5 or 6 people. Walk through each of the following sample green building systems explaining what it is, referencing the definition. Provide illustrations/images of installation as a handout for groups to walk through as a team.

Slide 2



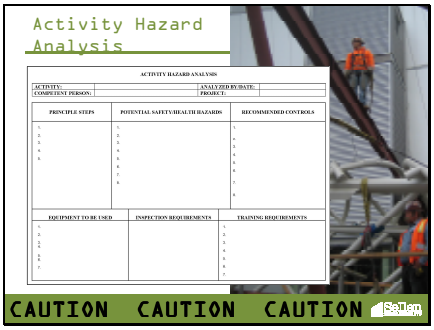
Each group will be given a specific green building system. Your group is responsible for telling the rest of the participants:

- What system is your group analyzing?
- How does it work?
- Why is the system unique?
- Which trades will be involved in the installation of the system?

In addition, your group will be tasked with developing a:

- Activity Hazard Analysis
- Safety Signage & a Communication plan to help trades understand the risks associated with the system they are installing

Slide 3



What does an Activity Hazard Analysis include? At a minimum your group should identify:

- Principle steps for installing the system
- Potential Safety/Health Hazards
- Recommended Controls
- Equipment to be used
- Inspection Requirements
- Training Requirements if necessary

Slide 4

Here are a few examples of standard jobsite safety signage.

Slide 5

Signage reduces confusion, sends a message, and helps ensure everyone is aware of the work that is being conducted and the associated safety hazards. What would it look like if we developed green building system specific signage for all of the new systems we are installing on our jobsites?

Shown here are a few potential examples of signage. What would signage look like for your specific system?

Slide 6

The following systems are those that should be assigned to each of the groups of participants.

INSTRUCTOR: After each group presents make sure to supplement the information they provide with information provided in the following slides.

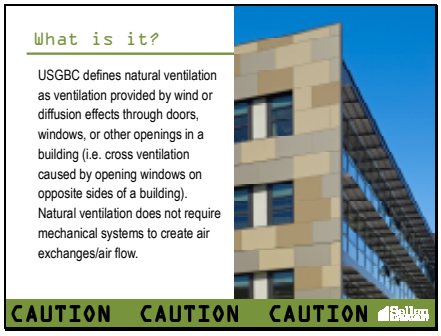
Slide 7

The first group to present will be Natural Ventilation.

INSTRUCTOR: Walk through installation of Natural Ventilation as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Natural Ventilation systems.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 8



USGBC defines natural ventilation as ventilation provided by wind or diffusion effects through doors, windows, or other openings in a building (i.e. cross ventilation caused by opening windows on opposite sides of a building). Natural ventilation does not require mechanical systems to create air exchanges/air flow.

INSTRUCTOR: Ask the audience – How natural ventilation different from operable windows? Answer: Operable windows can exist with mixed mode ventilation. While operable windows are a strategy for achieving natural ventilation they may be installed in projects that have active mechanical systems.

Slide 9

As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 10

The installation of most natural ventilation systems in no different than that of standard glazing minus the addition of an opening for operable windows of some kind. With that in mind, green buildings do typically install more glazing and more operable windows than standard projects to maximize daylighting and ventilation.

Slide 11

Shown here is an installation of a series of operable windows.

INSTRUCTOR: Ask the audience – Can you think of any safety hazards that are present with operable windows vs. traditional glazing systems?

Potentially additional fall hazards with added openings in the building façade.

Slide 12

Operable windows should be marked during construction to both, A) let field teams know that the window can create a fall hazard and B) to let field teams know that they can be utilized to improve IAQ during construction. Opening a window in a confined workspace is one of the best ways to promote a healthier safer jobsite, an added benefit associated with operable windows.

Slide 13

The image above shows craftspeople installing insulation and exterior cladding around the window system.

Slide 14

Cleaning windows is fairly straightforward. With operable windows and natural ventilation it will be important to have windows closed during maintenance. Operable windows require a little more maintenance than traditional glazing that has no moving parts and openings, but still a fairly straightforward task.

Slide 15

Maintaining natural ventilation systems and operable windows may become a bit more complex when they are combined with systems like the exterior shading devices shown here.

Slide 16

Key takeaways to ensure safety when installing or working on natural ventilation include:

- **Access –** If operable windows will be installed via the exterior of the building it is important to identify access points for the installation. Will a manlift be used? Will scaffolding be required? By planning for the access points we can develop a plan to keep workers safe while installing the system. If the windows are installed via the interior of the building employees should tie off within the space to prevent falls through the window openings.
- **Sequencing –** Operable windows should be sequenced to prevent work from occurring underneath the installation. If work must take place on the exterior of the project while the operable windows are going in, the area should be isolated and blocked off to prevent materials from falling and striking workers below.
- **Material Handling**
  - **Hoisting –** Depending on the size of the installation hoisting will present a safety risk. How will materials be delivered to the space for installation? Will we use a crane? Will we use an elevator or a manlift? What are the associate safety risks with either of these hoisting methods?
  - **Overhead Protection –** The area where operable windows will be installed should be clearly marked and trades should be notified to remain clear of the space to prevent materials from falling and striking workers below.
- **Fall Protection –** Operable windows will be installed at heights that will require fall

protection. Whether you are working on the inside or the outside of the project, tie offs and harnesses should be used at all times when handling/installing glazing.

- **Environmental Factors -** Strong winds are always a concern when working at heights. Additionally, rain may cause glazing to be slippery.

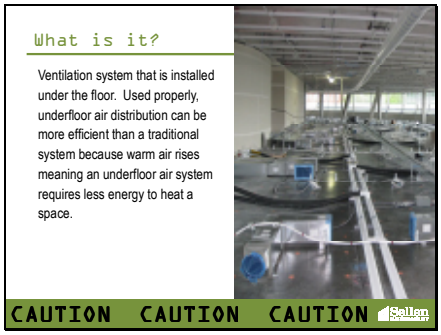
Slide 17

The next group to present will be Underfloor Air Distribution.

INSTRUCTOR: Walk through installation of Underfloor Air Distribution as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Underfloor Air Distribution systems.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 18



Underfloor air distribution is simply a ventilation system that is installed under the floor. Used properly, underfloor air distribution can be more efficient than a traditional system because warm air rises meaning an underfloor air system requires less energy to heat a space. In the case of cooling the system is much closer to the occupants requiring less fan power than a conventional system that would be pushing cold air down from above.

Slide 19

As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 20

The first step in installing an Underfloor Air Distribution system is to layout and install the HVAC, mechanical system, plumbing and low voltage wiring.

Slide 21

After the HVAC and mechanical equipment has been laid out the elevated flooring can be installed. The raised floor starts with a series of pedestals that are spaced out to hold the corners of each floor panel.

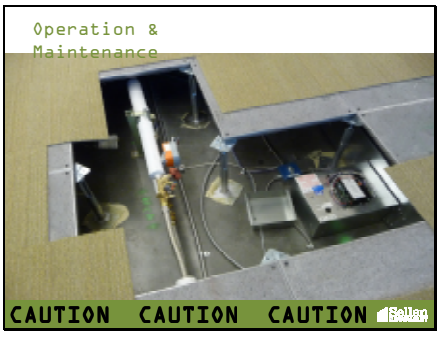
Slide 22

After the pedestals have been laid out the elevated floor can begin to take place. Typically the floor panels come in a specific shape or size which may have to be cut to fit certain areas of a given installation.

Slide 23

Certain areas of the jobsite may present unique safety concerns when installing Underfloor Air Distribution systems. For example, in the image shown here, both the curve of the building and the stairwell represent additional safety concerns that add to the existing concerns for the Underfloor Air Distribution system. Fall protection around the stairway becomes even more important with the trip hazards associated with Underfloor Air distribution.

Slide 24



Shown in the image above is an open section of a completed Underfloor Air Distribution system. As can be seen, all of the mechanical equipment is housed below the floor which means access to the system requires sections to be opened. Areas where operating equipment is housed should be easily identifiable for maintenance crews. Areas where maintenance is required should be clearly marked off with caution tape as these openings can create serious trip hazards. Dust control inside of the system is very important and the entire underfloor area should be kept clean to prevent contaminants from being disbursed throughout the building.

Slide 25

Key takeaways to ensure safety when installing or working on underfloor air distribution include:

- **Access** – When installing underfloor air distribution systems it is important to create a safe and secure walkway. The area of the installation should be isolated and only those required for the installation should be allowed to enter the space.
- **Trip Hazards –** With all of your HVAC equipment moving from the ceiling to the floor there is a wide range of trip hazards associated with this installation. From the equipment to the pedestals to the floor panels trip hazards are one of the biggest concerns with this system which makes access and area isolation that much more

important.

- **Impalement –** With all of the pedestals and equipment standing around the site a trip or fall can become significantly more serious with an impalement injury caused by the edges of all of the equipment. Caps should be placed on pedestals and a safe walkway is key to ensuring safety.
- **Fall Hazards**
  - **Change in Elevation –** As the underfloor air system progresses you move from trip hazards to fall hazards. When working on the elevated area it is very important to be aware of any edges that may lead to a fall.
  - **Balancing and O&M –** Before the equipment can be run it must be balanced. During balancing the system is completely installed a few select panels are removed to test the flow of air. This can almost be even more dangerous than the construction of the system because people are not looking for falls and trips when all of the floor around them is covered. Any panels that are removed for balancing or maintenance should be marked with a flag or taped off to prevent people from falling through.
- **Material Handling –** Floor panels can be heavy and there are often a large number that need to be installed. Add in the trip hazards and material handling becomes a serious concern. Proper procedures should be put into place to prevent employees from getting strains or sprains and to prevent trips and falls when handling and moving materials.

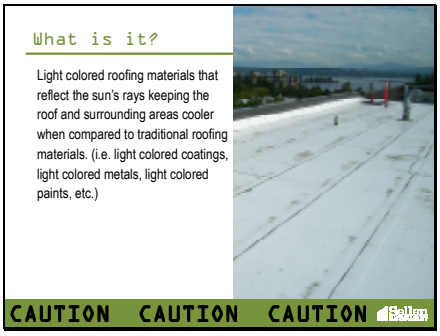
Slide 26

The next group to present will be the group responsible for Cool Roofing Materials.

INSTRUCTOR: Walk through installation of Cool Roofing Materials as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Cool Roofing Materials.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 27



Cool roofing materials are light colored roofing materials that reflect the sun's rays keeping the roof and surrounding areas cooler when compared to traditional roofing materials. (i.e. light colored coatings, light colored metals, light colored paints, etc.)

INSTRUCTOR – Ask the audience – Can anyone explain the Heat Island Effect?
Answer: The USGBC defines the Heat Island Effect as "the absorption of heat by hardscapes, such as dark, nonreflective pavement and buildings, and its radiation to surrounding areas. Particularly in urban areas, other sources may include vehicle exhaust, air-conditioners, and street equipment; reduced airflow from tall buildings and narrow streets exacerbates the effect."
Basically, the Heat Island Effect is what you experience if you go outside on a hot day in a dark shirt vs. a light shirt. The variation in temperatures between urban and rural areas caused by the heat island effect can be up to 15 degrees and as cities warm up buildings require more cooling which only adds to the problem.

INSTRUCTOR – Ask the audience – Can you see any correlations between overexertion and dark roofing?

Slide 28

As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 29

Cool roofing materials are installed just like standard roofing systems. Material needs to be hoisted to the roof and stored in a way that does not prevent or hinder roof/work access.

Slide 30

One of the biggest concerns with cool roofing materials is the perception that they may be more slick or slippery than traditional roofing materials. Regardless of whether or not cool roofing materials are more slippery fall protection and overhead work protection are very important safety aspects to make sure to address.

Roof edges should be protected and tie offs are critical to ensure everyone is safe.

Slide 31

As work progresses field teams should remain tied off no matter how far they are from a roof edge. Additionally, glare from the bright white surfaces should be addressed using the right eye protection.

Slide 32

Cool roofing materials have actually been shown to last longer than darker materials that are broken down by the sun more quickly. That said, roof maintenance is inevitable and the roof should incorporate features to ensure maintenance can be performed safely. Shown here you can see a no-slip walkway that has been installed to prevent maintenance crews from slipping and falling on the roof. A number of manufactures are now making white, no-slip walk mats, to replace black ones shown here, that would help support the cool material selection for the roof.

Slide 33

Key takeaways to ensure safety when installing or working with cool roofing materials are similar to most systems that are installed on the roof and include:

- **Access** – How will workers get to the cool roofing installation? Is there stair access? Will scaffolding or a ladder be required? Have we put in place safety procedures to ensure everyone can get to the installation properly?
- **Fall Protection -** All employees working on the roof should be tied off unless additional safety features such as a guardrail have been put into place.
- **Material Delivery**
  - **Placement** – Where will the

materials be delivered? How long will they remain in that location? Where will the material be stored? Are there any trip hazards associated with storage/placement?

- **Point Loading** – Roof structures can only withstand a specific weight load. If we are dropping all of our material onto one location, has that location been designed to bear all of that extra weight?
- **Overhead Protection** – Will work be taking place beneath the cool roofing installation? If so, what steps have we taken to prevent materials from falling off the roof and striking workers below? Do workers beneath the installation know that there is overhead work taking place? Do workers on the roof know there is work taking place below?
- **Hoisting –** How will the materials be delivered? Will a crane drop them off? If so, are there pinch point concerns we have to worry about when rigging the material to the crane? Who will be responsible for landing and removing the materials? Have they been properly trained to direct the crane operator?
- **Equipment Conveyance –** What equipment will need to be delivered to the roof to install this system? How will those materials be delivered to the roof? Have we located a proper location to store equipment that will be required for the install?

- **Environmental Factors –** Are we doing the installation during the winter? If so how are we dealing with rain/slip hazards? Is there a chance there may be ice on the roof? Additional environmental concerns include strong winds, lighting, and excessively hot days where workers on the roof are at a greater risk of heat exhaustion.

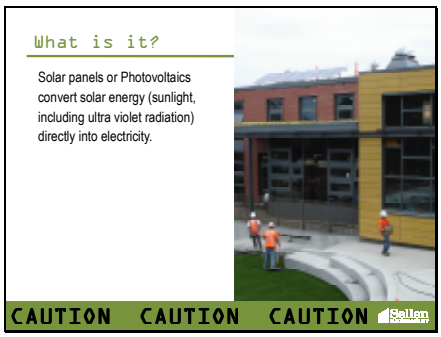
Slide 34

The next group to present will be our Solar Panel group.

INSTRUCTOR: Walk through installation of Solar Panels as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Solar Panel systems.

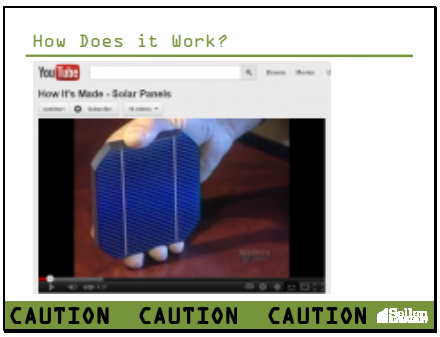
INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 35



Solar panels or Photovoltaics convert solar energy (sunlight, including ultra violet radiation) directly into electricity

Slide 36



INSTRUCTOR: Play video clip.

http://www.youtube.com/watch?v=qYeynLy6pj8

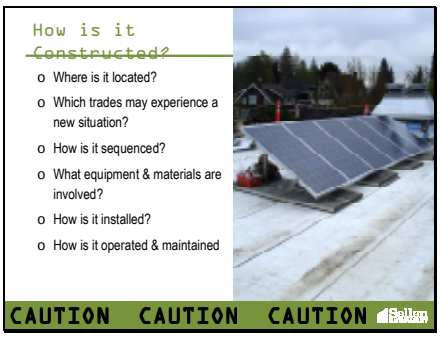
Additional Information:
PV modules when exposed to low level light source will produce high voltages. Many believe that on a cloudy day that a PV devices is not producing electricity (Power). The truth is that these devices output at almost maximum voltage when exposed to even the lowest light levels. Current output is what increases as the level of irradiance (sun light) increases; voltage is at maximum from the moment the sun rises. **Even when the disconnect to a PV array is turned off voltage potential is still present until the Pv modules are blacked out or the sun sets.** Most understand that by opening a disconnect to a piece of electrical equipment it will isolate this equipment ensuring no electrical energy is present. With PV devices this is not the case, the array will become an open circuit stopping the flow of current however voltage potential is still present.

Slide 37

There are a wide range of solar energy systems. Typically when you think of solar power you think of solar panels. Additional systems include but are not limited to the following:

- Evacuated Solar Tubes / Solar Hot Water
- Solar Powered Fans
- Solar Shingles
- Power Film
- Solar Glazing
- Solar Sunshades

Slide 38



As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

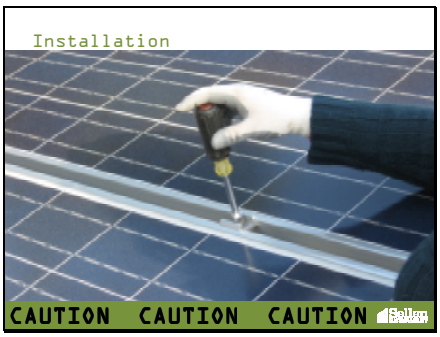
Slide 39

Solar panels are commonly installed on a roof or a cover like the carport shown here. The roof/cover and any additional systems integrated into the those areas of the project, such as the skylights, should be prepped to ensure it is safe to begin installation.

Slide 40

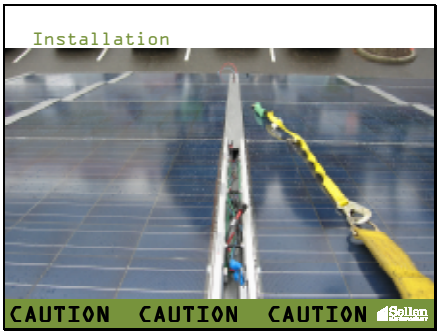
Once the frame is in place the array can be fastened to the frame. Solar arrays can often be very heavy and can get incredibly hot on a sunny day. It is important that multiple people are available to handle and position the array onto the frame.

Slide 41



Once the frame is in place the array can be fastened to the frame. Solar arrays can often be very heavy and can get incredibly hot on a sunny day. Additionally, most PV modules are very delicate and have to be handled and worked around carefully. PV modules are essentially an aluminum framed window making them extremely fragile and easy to damage. The glass that makes the bulk of the PV module is very easy to crack or shatter if care is not taken. The aluminum frames are very thin in most cases and can be easily bent or distorted. Pv modules should never be walked on or have any tool or equipment sat on them. If a PV module is damaged the system must be turned off immediately and the contractor notified ASAP. A damaged module can short circuit internally leading to a fire hazard.
It is important that multiple people are available to handle and position the array onto the frame.

Slide 42



After the array is in place it will need to be wired by the electrician to be able to produce power for the project. It is important to note that the cables connecting PV modules together if disconnected under load can generate a large arcs leading to severe burn, shock and fire. Most PV installations are completed using exposed insulated conductors that connect the modules together in series configurations. These cables are often hung by tye wraps or special clips from the array racking and connected together with male/female style connections. If these connections are pulled apart while the PV system is operating a large electrical arc will be generated. This arc created by DC current much like an electric welder can lead to severe burns for the person handling the connectors as well a possibility of shock. If not properly extinguished the arc will continue to burn up the conductors further leading to the possibility of fire.

Slide 43

The PV system will be connected to a set of inverters and potentially batteries to store energy for the hours when the system is not generating power. PV Systems operate at very high voltage of DC current making them very dangerous. Most grid-connected PV systems operate at 350-550 VDC making them just as dangerous as any AC system in a building. DC is different from AC in some way however, it is neither safer or in any way less dangerous than AC. Severe shock, burn and even electrocution can occur because of a contact with live DC parts. Proper PPE and training should be administered to all electricians working on wiring PV systems to prevent injury.

Slide 44

In addition to routine maintenance, solar panels will have to be kept clean to ensure they function properly. More often than not the roof of a project is designed for a given look without much consideration for maintenance crews. With installations like the one shown above it is extremely important to ensure proper safety equipment and procedures have been put in place to help maintenance crews perform their work.

Slide 45

Key takeaways to ensure safety when installing or working on solar panels are similar to most systems that are installed on the roof and include:

- **Access –** How will workers access the solar panel installation? Is there stair access? Will scaffolding or a ladder be required? Have we put in place safety procedures to ensure everyone can get to the installation properly?
- **Fall Protection -** All employees working on the roof should be tied off unless additional safety features such as a guardrail have been put into place.
- **Material Delivery**

- **Placement** – Where will the materials be delivered? How long will they remain in that location? Where will the material be stored? Are there any trip hazards associated with storage/placement?
- **Point Loading** – Roof structures can only withstand a specific weight load. If we are dropping all of our material onto one location, has that location been designed to bear all of that extra weight?
- **Overhead Protection** – Will work be taking place beneath the solar panel installation? If so, what steps have we taken to prevent materials from falling off the roof and striking workers below? Do workers beneath the installation know that there is overhead work taking place? Do workers on the roof know there is work taking place below?
- **Hoisting –** How will the materials be delivered? Will a crane drop them off? If so, are there pinch point concerns we have to worry about when rigging the material to the crane? Who will be responsible for landing and removing the materials? Have they been properly trained to direct the crane operator?
- **Equipment Conveyance –** What equipment will need to be delivered to the roof to install this system? How will those materials be delivered to the roof? Have we located a proper location to store equipment that will be required for

the install?

- **Environmental Factors -** Are we doing the installation during the winter? If so how are we dealing with rain/slip hazards? Is there a chance there may be ice on the roof? Additional environmental concerns include strong winds, lighting, and excessively hot days where workers on the roof are at a greater risk of heat exhaustion. Solar panels get extremely hot in the sun so it is important to wear proper PPE if the panels are exposed to heat.

Slide 46

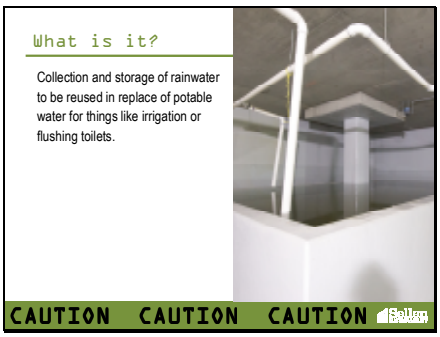
Rainwater Harvesting will be the next group to walk us through what they came up with.

INSTRUCTOR: Walk through installation of a Rainwater Storage Tank as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Rainwater Harvesting systems.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Note: The image here depicts the inside of a 1 million gallon rainwater storage tank that will be used to flush all of the toilets and meet all of the irrigation demands of a large office campus in Seattle, WA.

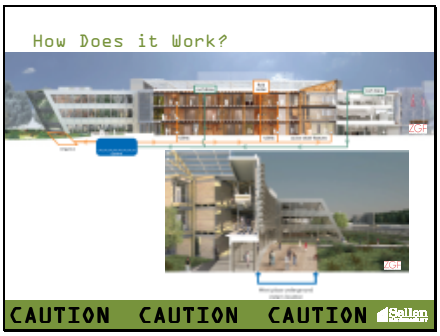
Slide 47



Rainwater Harvesting is the collection and storage of rainwater to be reused in replace of potable water for things like irrigation or flushing toilets.

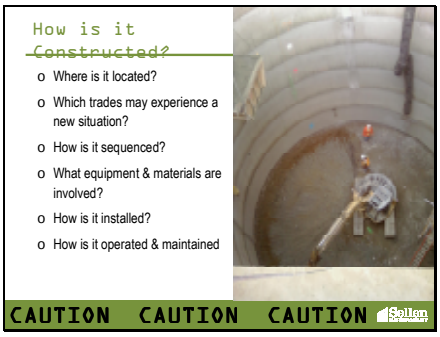
Note: The image here is a section of a 1 million gallon rainwater storage tank being filled by rainwater.

Slide 48



Shown here is a diagram of a project in Tukwila that is installing a 25,000 gallon cistern. The cistern will collect and reuse water from the building roof for toilet flushing, irrigation, rooftop cooling and “source stone” water features in the interior atrium and greenscape areas. Each year, 401,000 gallons of water will be harvested, resulting in a reduction of building sewage conveyance by 78% and a reduction of irrigation demand by an additional 14%.

Slide 49



As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Note: The image shown here depicts one step in the construction of a 900,000 gallon Thermal Energy Storage tank.

Slide 50

The first step in building a larger scale rainwater storage tank is to dig out the dimensions of the tank. Larger rainwater harvesting tanks are commonly poured as a concrete tank and then they must be lined with a waterproofing membrane to prevent water from leaking through the concrete. Shown here is a look at a 900,000 gallon rainwater collection tank being waterproofed. While not quite a confined space, the water proofing is being installed in an enclosed area and special respiratory precautions should be implemented.

Slide 51

After the tank has been waterproofed and initial plumbing has been installed the tank will have to be sealed off. A tank this size requires a lot of scaffolding to be put into place to form the lid. The open tank presents fall hazards and it is important to be ready to coordinate material hoisting, temporary ventilation and temporary power during scaffolding installation.

Slide 52

Once the lid has been put into place on a rainwater storage tank access, temporary lighting and temporary ventilation become your biggest concern. With the lid on a rainwater collection tank the system becomes a confined space and should be dealt with accordingly. As you can see here air gets circulated by the exhaust fans that run down into the tank through the stairwell.

Slide 53

Material handling should be properly planned for when building a rainwater storage tank. Once the tank is closed in, how will you get materials in and out? If the material needs to be hoisted like the image above, how are we protecting anyone working inside the space from materials that may fall out or drop off?

Slide 54

Another example of a poured in place concrete cistern. Instrucor: Ask the audience what hazards might be associated with this installation?

Slide 55

While rainwater cisterns come in all shapes and sizes, additional rainwater harvesting systems that are currently being installed more frequently include:

- o Rain barrels
- o Thermal Energy Storage
- o Rainwater Hog Tank
- o Sloan Aqus – Sink to toilet reuse system

Slide 56

In addition to setting up rainwater collection systems for safe maintenance practices, there are certain operational requirements that need to be put in place. Rainwater needs to be separated from potable water and should be easy to identify. Some jurisdictions require a colorant be added to rainwater to ensure there will be no cross contamination of drinkable, potable water and rainwater or greywater.

Slide 57

Key takeaways to ensure safety when installing or working on rainwater storage systems include:

- o **Confined Space**
  - **Air Quality –** When working in a confined space air quality becomes incredibly important. Proper procedures should be put into place to ensure fresh air is moving through the space during construction.
  - **MSDS & Chemical Exposure –** Even with air moving through a confined space, employees are at greater

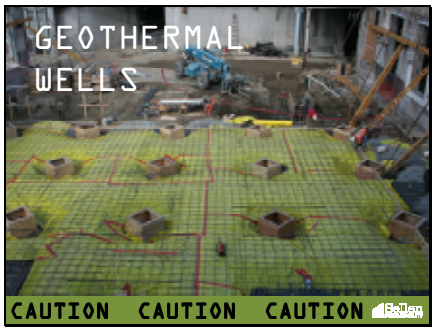
risk of chemical exposure and damaging effects associated to unhealthy building materials. It is critical to review MSDS sheets to be sure we are using the healthiest materials possible.

- **Lighting –** Rainwater storage tanks are enclosed and dark making lighting very important. Lighting helps reduce trips and falls and ensures everyone has a sightline to an access point in case of an emergency. Backup and emergency lighting is very important to put in place in case power is lost.

- **Access –** Depending on the size of the system access plays a big part in safety. Large collection tanks may require scaffolding or equipment to get workers in and out. Smaller systems may simply use a ladder. It is important that whatever access point ends up being installed is routinely inspected to ensure safety.
- **Lockout / Tagout –** All water lines and electrical lines need to be locked out when workers are inside the rainwater collection tank to prevent engulfment or electrical shock.
- **Engulfment –** Rainwater collection tanks are designed to store water. Thus they pose a potential engulfment risk if the tank fills up while workers are stuck inside the space. Proper emergency exit procedures should be put into place before water is ever allowed to enter the tank.
- **Overhead Protection –** In a large tank materials and equipment will need to be hoisted out meaning we need to pay particular attention to overhead

protection. Overhead protection becomes very important when working on the lid or roof of the tank as well.

Slide 58

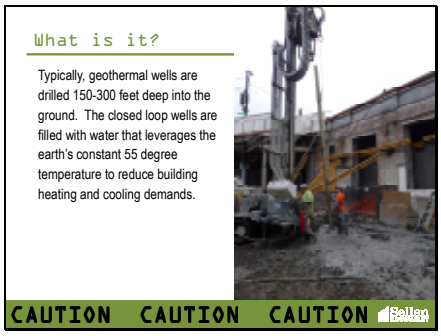


The next group will be Geothermal Wells.

INSTRUCTOR: Walk through installation of Geothermal Wells as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Geothermal Wells.

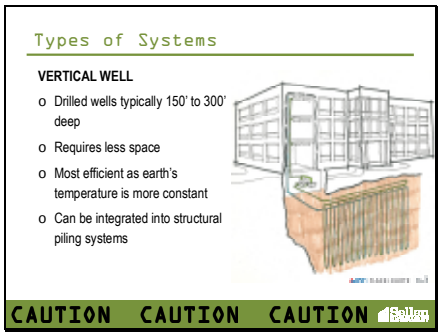
INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 59



Typically, geothermal wells are drilled 150-300 feet deep into the ground. The closed loop wells are filled with water that leverages the earth's constant 55 degree temperature to reduce building heating and cooling demands.

Slide 60

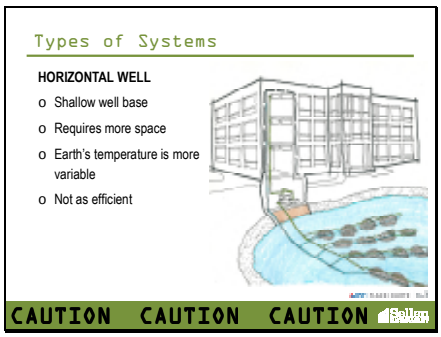


There are multiple geothermal/ground source heat pump systems that projects can install including:

VERTICAL WELL

- Drilled wells typically 150' to 300' deep
- Requires less space
- Most efficient as earth's temperature is more constant
- Can be integrated into structural piling systems

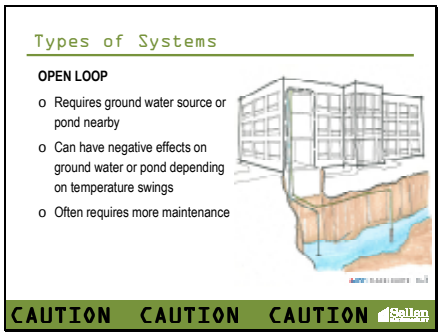
Slide 61



HORIZONTAL WELL

- Shallow well base
- Requires more space
- Earth's temperature is more variable
- Not as efficient

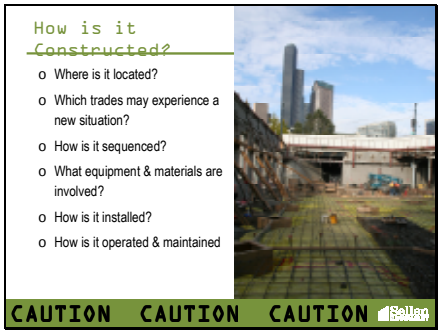
Slide 62



OPEN LOOP

- Requires ground water source or pond nearby
- Can have negative effects on ground water or pond depending on temperature swings
- Often requires more maintenance

Slide 63



As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 64

Geothermal wells require a decent amount of space for their installation. The drilling rig that is used to put in the wells is rather tall which makes installing geothermal wells in renovation projects challenging. In this case the team demolished an existing roof to free up space for the well drilling equipment. In addition to allowing room for the geothermal wells, the roof was redesigned into a public park space that collects rainwater for reuse within the building.

Slide 65

Once the drilling equipment is in place the wells can start to be bored out. The equipment runs a long pipe down into the ground in sections that are connected and act as a guide for the actual geothermal well.

Slide 66

Again, the equipment is rather large and requires ample space. The drilling process is fairly messy and requires quite a bit of water to support the drilling of the wells. Slip hazards and being struck by the equipment are issues that need to be adequately addressed.

Slide 67

After the wells are drilled they are sealed off and connected to the pumps that circulate the water to the mechanical system. In the image above the wood diamonds are where each of the wells have been installed.

Slide 68

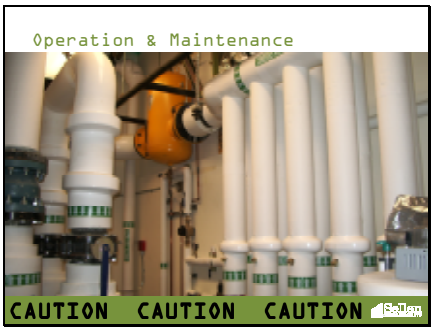
One of the advantages of geothermal wells is that the majority of the mechanical system is essentially buried underground. That means there is a very small mechanical room, minimal wiring, material, and maintenance needs which can actually greatly increase safety. Shown here is an example of the wells brought together into the future pump room. The valves are connected to heat pumps that regulate the heating and cooling demands for the building.

Slide 69

Shown here is an example of a unique geothermal well installation. The soil at this specific location is very soft and required 150 foot pilings to be drilled to support the building. The project team decided that if they were already going to be driving piles 150 feet into the ground why not just integrate geothermal wells into the piles? And that is exactly what they did. The piles had to be designed to be 20-25 feet apart to ensure the wells worked as efficiently as possible. Ultimately the team placed 135 geothermal wells into the piles in about half the time it would have taken them if they had been installed separately.

INSTRUCTOR: Ask the audience – Is an installation like this more or less safe than doing the work as two separate tasks?
Answer: More safe. Less equipment time reduces equipment failure concerns and hazards associated with the installations such as caught between or struck by and pinch points.

Slide 70



The image above is a look inside a pump room for a geothermal well system. Geothermal wells require far less mechanical equipment, have longer operating lives, and require very little physical maintenance. It is important to ensure geothermal wells and ground source heat pumps are calibrated and functioning as they were designed to function or the system will not run as efficiently as possible.

Slide 71

Key takeaways to ensure safety when installing or working on geothermal wells include:

- **Equipment Failure –** Drilling equipment is required for geothermal well installations. Equipment should be routinely checked and maintained to prevent failure or blow outs that may cause injury.
- **Struck-by / Caught Between –** The drilling equipment used for the wells is big and heavy and constantly being hoisted into place. Anyone working around the well rig should be made aware of and kept clear from struck-by/caught between hazards.
- **Hearing Protection –** Drilling equipment is very loud. All employees working with or around drilling equipment should wear hearing protection and proper ppe.
- **Slip / Trip Hazards –** The geothermal well drilling process uses water to support the drilling of the wells and thus creates a lot of slurry which can be a serious slip/trip hazard. Proper protocol should be put into place to reduce slips and trips especially around moving equipment.
- **Trenching –** Certain geothermal installations require small trenches to be dug for the individual wells. Trenches should be marked or tapped off if possible to prevent trips and falls.
- **Electrical Shock –** As with any mechanical or electrical system geothermal wells present potential electrical shock hazards especially when tying the wells to the heat pumps.

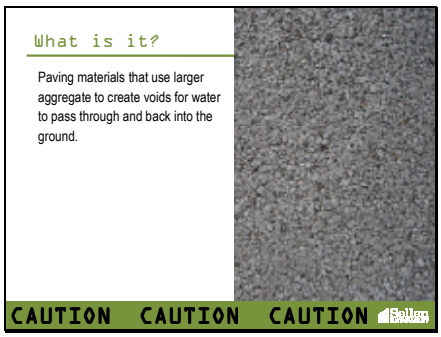
Slide 72

Pervious Surfaces will be next.

INSTRUCTOR: Walk through installation of Pervious Surfaces as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on pervious surfaces.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 73



Pervious surfaces are paving materials that typically use larger aggregate to create voids for water to pass through and back into the ground.

Slide 74

INSTRUCTOR: Show video clip.

http://www.youtube.com/watch?v=BREd1TbF_MQ

This video shows 1,700 gallons of water dumped for a period of 70 seconds and there is no runoff.

Slide 75

As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 76

After the area that will be paved is graded pervious concrete or surfaces start with a large aggregate that is set into place.

Slide 77

Once the larger drainage aggregate is laid out crews can begin to cover that aggregate with a mix that is made with aggregate that is smaller than the initial layer but still larger than what would be found under typical concrete mixes. This mix is set in sections that are defined by forms that help during the compression of the aggregate.

Slide 78

As you can see here, as the top layer aggregate is laid out crews must compress and compact the mix to ensure it is sturdy and there are no voids that will harm the integrity of the system. Unlike typical concrete mixes, pervious mixes are hard to vibrate into place and thus require more manual labor to install, spread, and compress.

Slide 79

After the aggregate is compacted it is rolled as a final step to ensure the system is even. The larger aggregate also removes the need for reinforcing rebar which reduces trip hazards but requires more physical labor during installation.

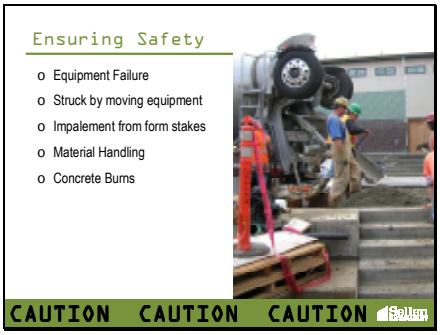
Slide 80

Once the system has been installed project teams must conduct water testing to ensure that the mix allows water to infiltrate through the aggregate. Water testing should be conducted in multiple areas throughout the installation.

Slide 81

As dirt collects in the mix the perviousness of the system begins to decrease making it important to routinely clean pervious surfaces. Aside from routine cleaning, there is little maintenance required of pervious surfaces.

Slide 82



Key items to be aware of when addressing safety concerns for pervious surfaces include:

- **Equipment Failure –** Pervious surfaces require cement trucks and pumps for installation. Anytime you require heavy equipment for a new system it is important to have the equipment inspected and maintained properly to prevent failure during the actual installation.
- **Struck by moving equipment –** Cement trucks and pumps move quickly throughout the site and pose potential struck by hazards. Workers should be kept clear from cement trucks and pumps wherever possible.

- **Impalement from form stakes –** Like most flat surface concrete or asphalt installations, pervious surfaces require forms to complete the installation. Form stakes present an impalement hazard especially with moving equipment present. Caps should be used on form stakes to reduce exposure to impalement.
- **Material Handling –** Pervious surfaces often require more labor than typical concrete or asphalt pours and the mixes can be more difficult to move into place. Job rotation and ergonomics become important when handling pervious surface pours to prevent strains and overexertion.
- **Concrete Burns –** Concrete burns are present when pouring pervious concrete. Proper PPE should be utilized at all times during the installation.

Slide 83

Next up we have Bioswales.

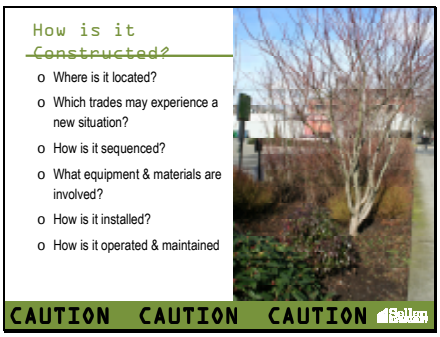
INSTRUCTOR: Walk through installation of a Bioswale as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on Bioswales.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed.

Slide 84

A bioswale can be described as a vegetated ditch that is typically installed by sidewalks or driveways to capture and treat stormwater before it can infiltrate back into the aquifer.

Slide 85



As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 86

Bioswales start by trenching out a designated space. The trench is lined with silt fabric and then layered with large creek rock to create voids for water to pass through and be stored.

Slide 87

After the creek rock is installed smaller aggregate and then soil is put over the top.

Slide 88

The soil is planted with vegetation and the bioswale is fairly complete. When it rains the swale fills with water and looks like a pond. Slowly the water infiltrates through the vegetation, roots, soil, drain rock, silt fabric, and then back into the ground where it can make its way back into the natural system that we rely on for drinking water.
Maintenance will be very similar to standard landscaping, the only difference being that when it rains the swale may fill temporarily and thus may not be accessible until the swale drains.

Slide 89

Key takeaways to ensure safety when installing or working on bioswales include:

- **Heavy Equipment –** Bioswales require heavy equipment for trenching and often material handling. Field employees should watch out for moving equipment and the equipment itself should be routinely checked and maintained to prevent failure.
- **Struck-by / Caught Between –** With moving equipment and bed rock employees should be aware of potential struck-by/caught between hazards that may be present during the construction of a bioswale.
- **Trenching –** As noted earlier a bioswale is essentially a vegetated ditch meaning that it needs to be trenched out before it can be filled and planted. During trenching all employees on the site should be made aware of trip/fall hazards and if possible any trenching should be isolated and marked off.
- **Material Handling –** When handling heavy rocks and plants employees should take necessary precautions to prevent overexertion
- **Utilities –** Before any trenching begins the project team must make sure to identify any utilities that may be underground to prevent any safety concerns that may be associated with damaging a utility line.

Slide 90

The final group to pre

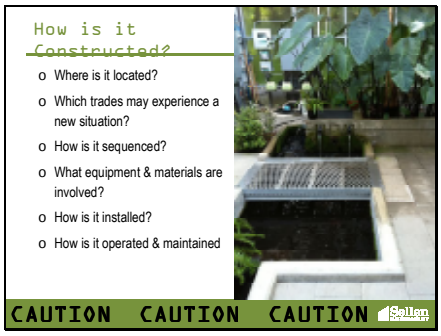
INSTRUCTOR: Walk through installation of a Living Machine as the group describes the system, walks through their task hazard analysis, discusses communication and signage for the system, and provides the audience with their top tips for ensuring safety when working on a Living Machine.

INSTRUCTOR: Use information provided in the following slides to fill in any gaps the group assigned to this system may have missed. sent will be the Living Machine.

Slide 91

A Living Machine is a natural wastewater treatment system that uses a series of pools, organisms, plant and animal life to treat wastewater onsite.

Slide 92



As we are walking through the installation it is important to be thinking about the following questions:

- Where is it located?
- Which trades may experience a new situation?
- How is it sequenced?
- What equipment & materials are involved?
- How is it installed?
- How is it operated & maintained

INSTRUCTOR: Ensure group presenting has covered each of the questions above. Provide support when necessary.

Slide 93

A living machine utilizes a series of tanks to naturally treat wastewater onsite. The first step in installing a living machine is to install the two or more initial storage tanks that are housed under the ground. The first two tanks are where solids are broken down and kept out of site. That said, installing storage tanks underground requires specific safety procedures you may not think about when looking at this system for the first time.

Following the first storage tanks, the structure itself can be built out. The living machine itself is very similar to a green house. The structure is the same, the difference is the tanks that are installed throughout the space. Depending on the type of system the wastewater treatment tanks can be permanently installed or more temporary to provide flexibility in the sizing for different demands.

Once the tanks have been installed vegetation, wildlife including fish, and other organisms are added to the tanks and the treatment of wastewater can commence.

Slide 94

INSTRUCTOR: Play video clip

http://www.youtube.com/watch?feature=player_embedded&v=S2pVVJCpfMQ

Slide 95

Maintenance for a Living Machine introduces unique responsibilities. Maintenance crews that have not worked with a Living Machine before may feel overwhelmed by all that is going on within the system. Currently, maintenance is the biggest issue that buildings are having with Living Machines. Maintenance crews are having a tough time figuring out proper sizing of a system, the right combination of plants and animals to treat the wastewater, and a number of additional issues that they have never had to deal with before.

If a Living Machine is installed, safety, maintenance crews, and the engineers that designed the system should work together to develop a program to support the safe and effective maintenance of the system throughout its lifetime.

Slide 96

Key takeaways to ensure safety when installing or working on living machines include:

- **Trip Hazards –** As the living machine is being installed there will be exposed tanks that may present trip hazards. As plants and additional tanks move into the system it is important to identify any potential trip hazards and make sure there is always a clear path of access for the work that needs to be performed.
- **Fall Protection –** During the installation of the first two underground storage tanks project teams need to have a proper safety plan for potential fall hazards. The tanks will require trenching which creates a fall hazard and then if they remain open once they are put into place they present a separate fall hazard.
- **Overexertion –** From the tanks to the vegetation, a lot of the material that will need to be installed into the system are heavy. Additionally, the living machine acts as a greenhouse in a way and can be very hot and humid. Teams should have a plan in place to prevent overexertion.

- **Confined Space (depending on size of underground tanks) –** Large Living Machines will require large underground storage tanks which will have to be either constructed or installed on site. This means some systems will require field crews to work in confined spaces. Safety procedures should be developed for confined spaces if the tanks are big enough to require workers to be inside of them.
- **Potential Waterborne Pathogens –** Waterborne pathogens become a serious concern once the system is in operation. When working around any waste water it is always important to be aware of the risks and to have safety procedures in place in case of an emergency. Workers should not work within the space if they have open wounds.