CropLife INTERNATIONAL

# Pollution Prevention in Crop Protection Product Manufacturing

## Crop Life International: Water Risk Assessment Project

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# 1. Introduction

Protection of the water environment is critical to prevent adverse impacts to aquatic habitats, ecology, and water resources. The "water environment" includes surface waters, such as rivers, lakes and the sea, and groundwater. Activities involving hazardous materials can cause harm by directly entering these features, or indirectly through mechanisms such as run-off from the ground surface or migration through soils.

Processes and activities that use or manufacture hazardous materials that can result in harm to the water environment are common in many industries. The ways in which pollution can be controlled or prevented are therefore standard practices, or at least commonly used, across many industries. The toxicity and properties of some materials handled in crop protection manufacturing operations make it especially important that appropriate pollution prevention measures are taken.

It is critical to identify processes and activities within an operation that have the potential to cause harm to the water environment. There are two key mechanisms through which this can occur: i) by unintentional or accidental release of materials into the environment; or ii) by intentional discharge of materials that result in harm. This guidance document focuses on "pollution prevention," in which different measures are used to prevent or minimize the occurrence of adverse practices or events unintentionally causing impact.

This guidance covers the following aspects of pollution prevention:

- Understanding site setting and environmental sensitivity;
- Storing and handling hazardous materials;
- Wastewater management;
- Procedural and administrative controls; and
- Managing incidents and emergencies.

Further Crop Life International (CLI) guidance is in development relating to potential impacts on the water environment from wastewater discharges.

# 2. Managing Potential Environmental Impacts

## 2.1. Introduction

Different approaches can be used to manage an organization or operation's impact on the environment. Potential impacts can be managed with a dedicated Environmental Management System (EMS), such as ISO14001:2015, as part of a wider Health, Safety and Environment (HSE) management system or using dedicated processes and procedures independent of a clearly defined management system.

The principal aims of an environmental management system are typically more than just preventing pollution. Generally, they also promote sustainable use of resources, mitigation of climate change, protection of biodiversity and ecosystems, as well as managing regulatory compliance and minimizing potential liabilities. Usually formal management systems are also structured in a way that drives continuous improvement through the use of a Plan-Do-Check-Act (PDCA) cycle, including aspects such as setting objectives, monitoring progress against action plans, and conducting ongoing reviews and updates.

ISO14001:2015, which is widely used across many industries globally and is the most well-known EMS, defines the following terms, which are also used commonly in other systems:

- *Environmental Aspect* – Element of an organization's activities or products or services that interacts or can interact with the environment. *Note 1: An environmental aspect can cause (an) environmental impact(s). A significant environmental aspect is one that has or can have one or more significant environmental impact(s). Note 2: Significant environmental aspects are determined by the organization applying one or more criteria.*
- *Environmental Impact* – Change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization's environmental aspects.

While the approach, content and terminology may vary between methodologies, the following elements are usually part of the system:

- Identifying environmental aspects / hazard identification;
- Identifying and understanding potential environmental impacts associated with the aspects / identifying risks;
- Understanding the sensitivity of the environment / environmental receptors in which an operation is located;
- Determining the significance of environmental impacts in the context of site sensitivity / risk assessment; and
- Identifying and implementing controls to prevent or mitigate environmental impacts.

As is usual with other risk management processes, once hazards have been identified and risks evaluated, consideration should be given (in order of preference) to i) excluding the hazard; ii) substituting it with something less hazardous; and then iii) identifying technical measures / controls to reduce the risk.

## 2.2. Environmental Sensitivity and Site Setting

The significance of a potential environmental impact depends on a range of factors, including the location of the operation and the type of "receptors" that could be impacted by an environmental aspect. Therefore, the consequence of an event, such as a leak from a chemical storage tank, could be much more significant in one location compared with the same incident occurring in a lower sensitivity environment.

The importance of understanding the environment in which a particular operation is located increases as the processes, activities, or materials used become more hazardous. For low hazard activities it may be sufficient to use standard controls to manage a risk adequately, with limited understanding of environmental sensitivity. However, this is generally not the case in crop protection manufacturing operations, as materials that have the potential to cause significant adverse impact to the environment are inevitably used. It is therefore important to have a comprehensive understanding of an operation's surroundings.

## 2.3. Baseline Environmental Assessment

A formal assessment should be carried out to identify and document:

- Processes and activities with the potential to impact the environment;
- Receptors that may be impacted by those activities;
- The sensitivity of the receptors; and
- Environmental factors with the potential to adversely affect the operation.

Activities with the potential to impact the environment include those that cause pollution or contamination or reduce the quality or availability of natural resources. These may result in regulatory non-compliance, liabilities, business disruption, and reputational damage.

## 2.4. Typical Environmental Impacts for Crop Protection Product Manufacturing

Typical processes and activities in crop protection product manufacturing operations that may result in adverse environmental impacts include:

- Storing and handling materials that may harm the environment;
- Waste generation, storage, or treatment;
- Wastewater treatment and discharge;
- Air emissions discharge;
- Using groundwater or surface water as a resource;
- Energy use and generation;
- Using materials and natural resources; and
- Activities that could create nuisance to third parties.

Pollution and its prevention are commonly associated with inadequate use and handling of hazardous materials, including wastes and wastewaters. Other aspects can lead to adverse impact, but these may cause effects other than pollution, and may not be directly observable at the facility or in its immediate surroundings.

As well as impacts directly related to an operator's own facilities, impacts and pollution can also result from activities carried out off-site by contractors or suppliers. For example, if an inappropriate waste contractor is used for the treatment or disposal of waste, adverse impacts can be caused by poor practices. These should also be considered within an environmental impact assessment, although they may not be the initial focus.

## 2.5. Environmental Receptors

Receptors are natural resources, habitats, organisms, or people that could be adversely impacted by an activity, process, or an environmental release (whether intentional or unintentional). They include:

- Soils;
- Sediments;
- Groundwater;
- Surface waters (rivers, lakes, the sea);
- Ecology (flora and fauna, including microbiology) and sensitive habitats; and
- Neighbors and local communities.

## 2.6. External Environmental Factors

As well as impacts that an operation may have on its surroundings, it is also possible that an operation can be affected by external environmental factors. These include:

- Adverse weather;
- Flooding;
- Natural disasters / hazards (e.g. earthquakes);

- Water scarcity; and
- Hazardous activities undertaken by nearby operators.

It is important to understand these factors to ensure appropriate controls are in place to prevent or reduce the likelihood of an adverse event occurring, or to reduce its impact. For example, the location, design, and specifications of a tank farm may need to be different if it is positioned in an area that is subject to flooding or earthquakes.

## 2.7. Using Environmental Assessment Information

When designing, modifying, and operating processes and equipment that could harm the environment potential impacts should be considered. In particular, impacts should be evaluated for processes and equipment that involve:

- Waste generation, storage, or treatment;
- Wastewater treatment or discharge;
- Air emissions control or discharge;
- Groundwater or surface water abstraction or use;
- Storing or handling materials that may harm the environment;
- Environmental permits / licenses / consents; or
- Factors that could create nuisance.

Potential impacts on the operation from the surrounding environment should also be assessed when designing, modifying, and operating processes and equipment.

# 3. Storing and Handling Hazardous Materials

## 3.1. Hazardous Materials

### *3.1.1. Overview*

Hazardous materials are those that can harm people or the environment due to properties such as toxicity, flammability, eco-toxicity, or corrosiveness. They include raw materials, intermediates, final products, and other process chemicals, as well as by-products, wastes, and wastewaters. In the context of this guidance, hazardous materials are those that represent a risk to the water environment. As well as acute and chronic ecotoxicity this includes other properties that could adversely affect the water environment and organisms living within it.

To protect the water environment and prevent pollution it is essential to understand the properties and hazards of materials that are used, stored, and manufactured at a facility. The same principles apply to managing health and safety, therefore key processes to understand and manage chemical hazards should generally be common.

An introduction to the key processes associated with hazardous materials is provided in the following sections, with an emphasis on pollution prevention and protecting the water environment.

In addition to the general principles covered within this guidance, operations are frequently subject to regulations concerning the use, handling, and production of hazardous materials. In the European Union, for example, there are many requirements on the manufacturers and importers of hazardous materials under the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) regulations. While other regulations specifically cover crop protection products, REACH applies to other chemicals used in crop protection product manufacturing. Similar legislation exists in other

countries and it is the responsibility of an operator to ensure all applicable regulations are understood and complied with.

### 3.1.2. Hazardous Materials Inventory / List

Knowing exactly what is handled is the starting point for managing hazardous materials appropriately. To do this, a list or inventory of all hazardous materials stored and handled at a facility should be maintained. This should include:

- Raw materials;
- Intermediates;
- Finished products;
- Fuels; and
- Maintenance products, such as oils and greases.

In addition, by-products, wastes and wastewaters should be considered.

A process should also be in place to understand the quantity of hazardous materials held. For large volume or high hazard products it may be necessary to continuously monitor inventory, perhaps as part of a stock management or warehousing system. For other materials, or at facilities using smaller quantities or lower hazard materials, it may be sufficient to carry out a routine stock-take (at a defined frequency).

A formal process should be in place to control how hazardous materials are ordered. This should ensure that:

- Only approved individuals can place orders;
- Unnecessary stock is not held;
- Materials are only stored in the correct locations;
- New materials are understood, and risks assessed before ordering and use; and
- Compliance with regulations and permit conditions.

### 3.1.3. Understanding Chemical Hazards

A Safety Data Sheet (SDS) should be available for each hazardous material, so that the hazards and controls needed can be evaluated and understood. Information about the hazards, toxicology and properties of materials can change, so actions should be taken to ensure that SDSs remains current. In some cases, suppliers communicate updates to customers, but this cannot be relied upon. A robust process is therefore needed to check, routinely or within a defined period, whether newer versions of SDSs are available. It is important that the SDS is obtained from the supplier of the actual material used at the facility, as there are frequently variations in constituents and impurities, even for widely used bulk chemicals.

A system or procedure should be implemented to “approve” and introduce new hazardous materials. It is likely that this is driven by, or linked to, key processes such as Management of Change (MOC) and risk assessment. In particular, the approval process should include:

- Reviewing SDSs to understand the hazards and any controls necessary;
- Obtaining other data on hazards and material properties;
- Assessing potential environmental impacts;
- Providing appropriate labelling to ensure safe handling;
- Determining appropriate emergency measures that could result from foreseeable incidents;

- Understanding associated wastes and wastewaters that may be produced and evaluating disposal or treatment options.

Safety Data Sheets and any other relevant hazard data should be readily available to workers who use or may be exposed to those materials through routine work activities or their involvement in emergency management.

## 3.2. Crop Protection Product Active Ingredients

In facilities that manufacture and or formulate crop protection products, the crop protection product active ingredients are typically among the hazardous materials handled that require the most rigorous control as a consequence of their toxicology. As well as health and safety aspects, it is critical to understand potential impacts if they are released into the environment.

Some crop protection products have very low (sub-µg/l) thresholds / acceptable concentrations / environmental quality standard in the aquatic environment. Therefore, the concentration allowed in a surface water, such as a river, is very small and could easily be exceeded as a consequence of the inappropriate routine actions or emergency situations that are inadequately controlled.

## 3.3. Minimizing the use of Hazardous Materials

Efforts should be made to minimize the hazards associated with the materials used, stored, and manufactured to reduce potential risks and environmental impacts. By doing this it may also be possible to reduce the amount of infrastructure, engineering control or procedural effort needed.

Reducing hazards and risks can be achieved through activities including:

- Substituting hazardous materials for less or non-hazardous alternatives;
- Storing only the quantity of hazardous material needed on site;
- Using suitably sized containers and tanks for the hazardous material used in manufacturing activities; and
- Minimizing or preventing the generation of waste and wastewater containing hazardous materials.

## 3.4. Primary Containment

Primary containment is the equipment and infrastructure designed to store, hold, or transfer materials during normal use, such as tanks, vessels and pipework. The term primary containment also applies to mobile storage containers such as IBCs, drums, and big bags.

### *3.4.1. Design and Construction of Primary Containment*

Primary containment holding materials that are hazardous to people or the environment should be:

- Constructed from appropriate materials that are chemically resistant to the material contained;
- Suitable for the temperatures, pressures and physical conditions of the material(s) contained;
- Suitable for the environment and weather conditions in which they are located; and
- Designed to prevent leaks and spills.

### 3.4.2. Preventing and Identifying Losses from Primary Containment

Significant losses of containment most frequently take place during transfer operations, such as filling, rather than catastrophic failure of equipment. Overfill protection should therefore be used for all tanks and vessels containing hazardous materials to prevent it occurring. This may include:

- Manual overfill procedures (i.e. operators observing levels during filling);
- Sensors or alarms to give notification that the level has reached a defined point;
- Back-up sensors in case a primary level sensor has failed; and / or
- Automated shut-off controls combined with level sensing.

The appropriate controls for a particular situation should be determined by conducting a risk assessment that considers the hazards of the materials involved and the associated risks.

## 3.5. Secondary Containment

Secondary containment is equipment and infrastructure designed to contain spills or leaks from primary containment, to prevent them entering the workplace or wider environment. Secondary containment includes infrastructure such as:

- Double-skinned tanks (with leak detection between skins);
- Bunds or dykes around tanks;
- Double-lined pipes (with an air space between linings); and
- Spill containment pallets, decks, and trays.

### 3.5.1. When is Secondary Containment Needed?

Storage containers, vessels and equipment containing hazardous materials should be located within secondary containment where failure of primary containment could result in harm to people or the environment. Therefore, hazardous material storage areas and equipment, and areas in which these materials are handled, require secondary containment.

### 3.5.2. Secondary Containment Design

Secondary containment should be constructed using impermeable materials that are appropriate for the materials held and the environmental conditions in which it is located.

Unless a greater volume is required by local regulations, the capacity of secondary containment should be:

- At least 110 % of the volume of the of the largest single inventory (contained volume); or
- At least 25 % of the cumulative inventory, whichever is larger.

Primary containment infrastructure and associated equipment should be positioned to ensure that secondary containment is effective in the event that it is needed. In particular, the following should be considered:

- All filling and dispensing pipework, connections and equipment are located within secondary containment; and
- Vents and overflow pipework are directed into the secondary containment.

Secondary containment design often focuses on large items of equipment, such as tanks, but leaks are typically more common from joints or more delicate or vulnerable associated equipment, such as pumps, pipes, and valves.

The integrity, strength and durability of secondary containment should not be compromised by pipework or other infrastructure passing through containment walls.

### 3.5.3. Segregation and Separation of Secondary Containment

Incompatible materials, particularly those that could undergo a chemical reaction if mixed, resulting in fire, explosion, or release of toxic gases, should not be stored within the same secondary containment, such that spills could mix. There are many examples of incompatible combinations including strong acids with alkalis and flammable materials with oxidizing agents.

The principles of separation and segregation apply to small-scale container storage, as well as permanent installations such as tank farms. Where possible, it is advised that tank farms are allocated to the storage of materials with similar properties, so compatibility issues can be eliminated. Even when this is the case, the properties of a material must be reviewed in detail and in the context of other materials stored before storage is used for the first time.

### 3.5.4. Identifying and Preventing Spills from Secondary Containment

Whenever possible, measures should be implemented to reduce the likelihood of spills and leaks or reduce potential severity should they occur. Equipment or procedures must be in place to detect or identify leakage into secondary containment.

## 3.6. Flooring

Flooring in areas where hazardous materials are routinely handled or spills are likely to occur should be impermeable; free from cracks and joints; regularly cleaned; routinely inspected; and repaired when defects are identified.

This includes the flooring within secondary containment, as well as general areas in which hazardous materials are handled. Concrete is generally not impermeable, even when there are no visible cracks. To ensure sufficiently low permeability to contain spills, concrete and other typical construction materials must be coated. Epoxy-based coatings are often used for this, but other suitable materials are also available. Repairs to secondary containment should be performed using approved materials of construction with appropriate properties, including chemical compatibility.

## 3.7. Hazardous Materials Storage

### 3.7.1. Introduction

Hazardous materials can be stored in a wide variety of formats and scales. These range from mobile containers such as bottles, drums and totes, IBCs, to bulk storage in tanks, tank farms and tanker trucks. The locations and conditions in which materials are stored are also highly variable.

Whatever scale and type of storage is used, it should be designed and operated based on the concepts outlined above, including:

- Suitable primary containment;
- Adequate secondary containment;
- Separation and segregation of incompatible materials; and
- Use of impermeable flooring and impermeable storage infrastructure / equipment.

To ensure this is always the case it is important that storage locations are formally defined for all hazardous materials and everyone who handles the materials is suitably trained and understands their hazards and where they can and cannot be stored.

In addition to measures required to prevent pollution, other controls are needed to manage potential health and safety hazards. This guidance does not cover those aspects. For further details on managing associated health and safety risks see the CropLife International "Guidelines for the Safe Warehousing of Crop Products" (CLI, 2019).

### 3.7.2. Chemical Stores and Other Small-Scale Storage

For storing hazardous materials in containers, the following is advised to minimize the potential for pollution:

- Storage within a roofed building;
- Impermeable flooring;
- No drainage from the room (i.e. any material spilled is contained on the floor surface, until it is cleaned up);
- Secondary containment for all liquids;
- Storage infrastructure (such as racking / shelving) that is securely attached and constructed from chemically resistant and impermeable materials;
- Drip trays or other forms of secondary containment for containers stored at the point use; and
- Solids should not be stored below liquids (to reduce the amount of material damaged in the event of a spill).

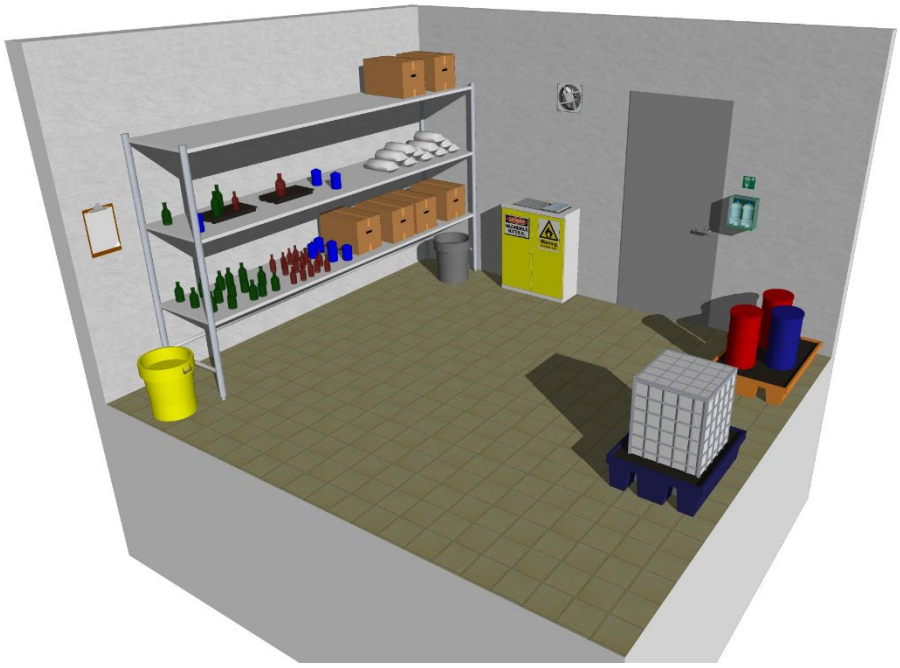


*Figure 1. Container storage in a typical chemical store*

Other measures advised for chemical storage rooms include:

- Access restricted to approved employees only;
- Spill kits / spill management equipment;
- Separate storage equipment for high hazard materials such as flammables, or where access to materials must be further restricted;
- Separation of incompatible materials;
- Inspection of the store as part of a routine program; and
- Appropriate room ventilation.

Other measures (outside the scope of this guidance) will also be needed to control potential health and safety risks associated with the materials stored.

### 3.7.3. Warehousing

Many of the pollution prevention principles that apply to storage in warehouses are similar to those for small-scale storage. In particular, these include:

- Impermeable flooring;
- No drainage directly from the warehouse floor;
- Secondary containment (typically achieved by containment of the whole warehouse, and / or specific compartments, rather than more localized containment); and
- Storage infrastructure (such as racking / shelving) constructed from impermeable materials.

At this larger scale, however, other factors become more critical in the design and operation of the facility. These include:

- Segregation and separation of materials in different “compartments” based on incompatibility and hazards requiring specific controls;
- Measures that permit (and restrict) vehicle movements and allow access into areas of secondary containment;
- Fire-protection measures, such as the installation of sprinklers, smoke alarms, fire walls and fire doors;
- Fire-water retention capacity (within the warehouse and / or external infrastructure connected to the warehouse);
- Additional signage and other communications materials indicating materials held and their hazards;
- Additional access controls; and
- Infrastructure and procedures to protect equipment and workers from vehicle movements.

Further information can be found in the CropLife International “Guidelines for the Safe Warehousing of Crop Products” (CLI, 2019).

### 3.7.4. Bulk Storage: Tanks and Tank Farms

Bulk materials can be stored in the containers in which they are delivered, such as a tanker trailers or ISO tanks, but it is generally better practice and much more common to use permanent storage tanks. While underground storage tanks are still used in some circumstances, and historically were more frequently used, above ground storage tanks are standard practice for most applications. Maintenance and inspection are much simpler, and leaks are more easily detected. If it is not possible to use an above-ground storage tank (which is very rarely the case), underground tanks should have secondary containment (double-walled) with a leak detection system. Secondary containment of pipework is also needed.

For storing hazardous materials (chemicals or fuels) in single tanks, the following is advised:

- Suitable primary containment (materials and construction);
- Secondary containment volume should be at least 110 % of the tank volume;
- Use of impermeable flooring and secondary containment construction materials;
- Rainwater management, preferably preventing ingress by using a roof;
- Secondary containment should not be compromised by installing pipework, inlets, outlets, or other equipment through its walls; and
- For fuel tanks, in particular, dispensing equipment must be contained within secondary containment (either shared with the tank or separate).

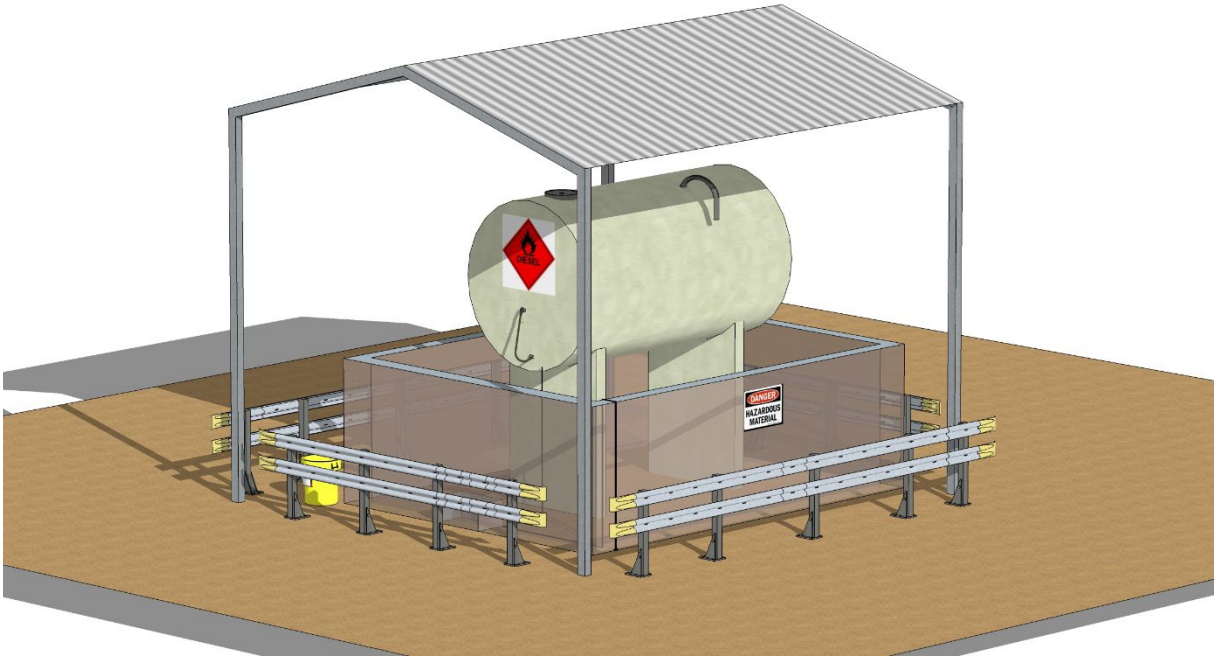



*Figure 2. Secondary containment and protection measures for a typical fuel storage tank*

For tank farms, where multiple tanks are located within the same containment, other measures such as the following are advised:

- Secondary containment should be at least 110 % of the volume of the largest tank inventory (contained volume) or 25 % of the cumulative volume of all of the tanks within the secondary containment, whichever is larger;
- Incompatibility of materials within the tank farm must be considered; and
- Prevention of rainwater ingress is rarely possible using a roof, so other measures are needed to manage accumulated rainwater (see section 4.9).

### 3.7.5. Outdoor Storage

Rain falling on containers of hazardous materials, or into secondary containment, has the potential to become contaminated with those materials. Whenever possible, this situation should be avoided by storing hazardous materials under a roof (i.e. indoor storage). When this is not practical, procedures should be in place to:

- Prevent the accumulation of rainwater in secondary containment;
- Ensure appropriate disposal / discharge of any accumulated water; and
- Ensure secondary containment remains clean and empty during normal operating conditions.

Further guidance on managing potentially contaminated stormwater in given in section 4.9.

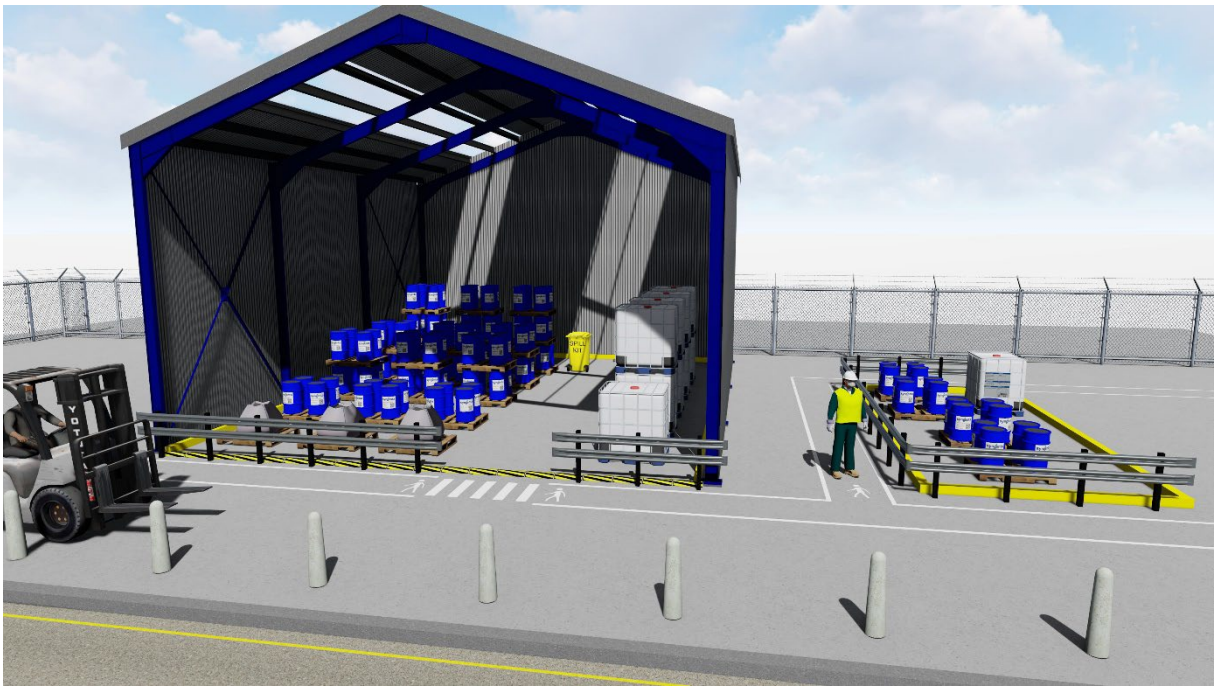


*Figure 3. Indoor and outdoor drum and IBC storage*

## 3.8. Loading and Unloading of Bulk Hazardous Materials

### 3.8.1. Introduction

The likelihood of leaks and spillage during loading and unloading operations is typically much greater than during storage. Adequate controls must therefore be in place to minimize the risk of this occurring and control the situation if a loss of containment does occur. As always, these activities should be subject to risk assessment.

Loading and unloading operations vary significantly and depend on a wide range of factors. To determine what is necessary to control risks, factors including the following should be considered:

- Type of storage facilities on site;
- How materials are delivered to, or taken from the site (e.g. road tanker, rail wagon, barge, pipeline);
- Type of tanker / vehicle / containers the materials are held in;
- Hazards of the materials involved;
- Volume of materials being loaded / unloaded;
- Frequency of loading / unloading;
- Whether the activity is controlled by specific regulations or permit conditions;
- Environmental sensitivity of the area in which the activity takes place;
- Number of personnel involved; and
- Infrastructure and equipment involved, and the extent of automation.

The controls needed to mitigate potential risks may include:

- Use of equipment and connections that avoid spillages, such as dry-break couplings;

- Infrastructure, such as dedicated loading / unloading facilities protected with secondary containment;
- Use of temporary / mobile secondary containment equipment;
- Procedural controls, such as supervision, following written procedures and inspection of loading / unloading areas and equipment;
- Training of personnel; and
- Emergency measures, such as the provision of equipment needed to mitigate the consequence a spill and to clean up after a spill.

When moving materials to or from manufacturing sites or storage facilities, applicable regulations on the transportation of dangerous goods must be followed.

### 3.8.2. Tankers and Other Road Vehicles

For the safe transfer of bulk hazardous materials between a road tanker and a storage tank or tank farm, dedicated unloading facilities with secondary containment and additional physical controls are needed. For other types of storage involving transfer of materials in containers, simpler controls involving less infrastructure may be adequate.

In most situations, following a formal procedure is an important way to ensure the activity is completed correctly and risks are minimized, and in the event of an incident the appropriate course of action is understood by personnel involved. Procedures used may be in the form of a checklist, to prompt operators to follow defined actions. Operations involving greater hazards and risks, may require a detailed procedure to be followed step-by-step, as well as identifying other necessary actions and controls.

Procedures may vary significantly depending on the nature of the activity, installation, and equipment. However, they should usually include aspects such as:

- Inspection of tankers / vehicles in a reception parking area (adequately protected by oil-water separators and / or secondary containment) before entering a facility to ensure they are suitable and there are no leaks;
- Supervision requirements;
- Preparing or checking the availability of emergency equipment;
- Confirming that vehicles have been immobilized and cannot be moved during the operation;
- Controls that ensure a material is delivered into the correct tank;
- Electrical grounding for tankers carrying flammable or combustible materials;
- Inspecting hoses before and after loading and unloading activities;
- Ensuring all hoses, gaskets, and valves have been installed correctly;
- Necessary precautions for tank venting have been followed; and
- Inspection of vehicles leaving the facility.

In all cases potential risks to health and safety, such as exposure to workers, working at height, and fire or explosion must also be assessed.

*Figure 4. Typical bulk chemical storage and handling infrastructure: warehouse (left), tank farm (center) and trailer tanker / ISO tank loading / unloading facilities (right)*

In addition to the loading / unloading infrastructure, and procedures involved in the transfer activity, other controls should also be considered to minimize risks. This could include:

- Provision of vehicle parking / holding areas in well-protected low risk areas;
- Identifying low risk routes across a site, considering aspects such as infrastructure, drainage systems that are (or can be) isolated, other vehicles and pedestrians; and
- Escorting vehicles to the correct location.

### 3.8.3. Rail Tankers

Some larger manufacturing facilities are equipped with rail infrastructure to transfer chemicals to or from rail tankers. Operation of such facilities is typically subject to permitting and extensive regulations relating to aspects such as the control of major accident hazards and pollution prevention. The controls needed to manage loading and unloading activities are typically similar to road tankers, as most of the inherent hazards are the same. How this is achieved, however, may vary significantly due to the nature of infrastructure and associated activities.

As with road tankers, rail loading and unloading should be a carried out in accordance with a detailed procedure. This would include similar steps, in addition to some that are specific to rail transfers.

In some cases rail tankers are used as a temporary measure to prevent the need for additional permanent tanks during periods when more storage capacity is needed, as allowed by local regulations and site permits. Permanent tanks are always preferred as it is generally much easier to implement controls to minimize leakage and maintain effective secondary containment. Given the nature of rail tracks, a much larger area would be needed within secondary containment, and it is more difficult to maintain the integrity of the ground surface and infrastructure such as drainage gullies and pipes in such a situation. Long-term storage in mobile tankers should generally therefore be avoided.

### 3.8.4. Boat Tankers, Barges and Docks

As with rail infrastructure, some large facilities transfer chemicals from boats or barges directly from waterways such as rivers or canals. This requires a jetty or other secure mooring position and permanent loading and unloading infrastructure. Again, the nature of such facilities would mean that they would operate under major accident hazard regulations and permits, and any associated procedures would need to be approved by the regulating authorities.

The potential of a spill or leak having significant consequences is very high with a boat transfer, as it would generally enter the watercourse directly. The level of control to prevent this happening would therefore need to be extremely high. As with other types of chemical loading and unloading, procedures would need to be followed, including activities such as inspecting the area before starting loading or unloading, supervision by appropriately trained personnel at all times. In addition to more typical requirements, specific emergency equipment, such as a floating containment system, and emergency response and spill management procedures would also be mandatory.

### 3.8.5. Pipelines

Some very large chemical manufacturing facilities receive raw materials from off-site through pipelines. This is not common in the crop protection industry, however, and would be most likely in large-scale operations involving the manufacturing of other types of chemicals. The complexity and volumes of a raw material needed to make this a cost-effective option are likely to be very large, unless the supplier is located nearby.

Pipelines would generally be connected directly to permanent storage tanks, so transfers are automated and during routine operation should involve few manual activities such as connecting and disconnecting pipes or hoses. Many of the primary pollution prevention controls would follow the principles of primary and secondary containment. This may include use of a double pipe and a leak detection system. Alternative controls such as pressure monitoring systems may also be used.

## 3.9. Handling Hazardous Materials in Production Areas

### 3.9.1. Introduction

All areas in which hazardous materials are handled should be designed based on the concepts of containment described in sections 3.4 to 3.6 to prevent accidental release of hazardous materials to the environment.

### 3.9.2. Processes / Automated Operations

Processes in which significant quantities of hazardous materials, such as flammable, toxic and ecotoxic chemicals, are handled or stored should be formally evaluated in a Process Risk Assessment (PRA). This is a systematic process in which hazards are identified, risks assessed, and appropriate controls defined and put in place before the process is first carried out.

As with processes that have the potential to cause harm to people, those with the potential to cause pollution should be carried out in accordance with defined operating conditions, engineering controls identified by risk assessment and administrative controls such as procedures (see section 5.1) reflecting the potential severity of events that could result.

Change is a significant factor that can result in HSE-related events, including those that cause pollution. It is particularly important that any changes to processes are carried out in accordance with a formal Management of Change (MOC) process (see section 5.4).

### 3.9.3. Manual Operations

Routine manual operations should be assessed through a Workplace Risk Assessment, or similar process, to ensure hazards in a workplace are recognized, risks are assessed, and suitable controls are implemented to prevent harm to people and the environment.

Workers carrying out routine activities with the potential to cause pollution should work in accordance with defined procedures (see section 5.1) and receive training (see section 5.5) in the procedures, understanding the hazards present and the risks involved in the activity (or workplace), how the risks should be controlled, and what to do in the case of an adverse situation or emergency.

Non-routine activities should be managed though a Permit to Work (PTW) / Safe Work Permit (SWP) process. This is a documented procedure that authorizes certain people to carry out specific work within a specified time frame. It identifies the precautions required to complete the work safely and prevent harm to the environment based on a risk assessment and states how the work will be done.

Certain activities in crop protection product manufacturing facilities are common causes of loss of containment, which can result in pollution as well as risks to workers. “Line-breaking” is a common activity requiring equipment and pipes to be disconnected and re-connected during activities such as maintenance and cleaning, and between production campaigns. When this occurs particular care should be taken to ensure joints and connections have been completed correctly and that they are specifically checked during start-up to ensure there are no leaks. Systematic checking observation of pipework and equipment at the start of operation to identify visible issues is often described as “walking the line.”

Another common source of leaks are open ends, where the ends of pipes and equipment such as valves are not physically sealed with a cap, blank, blind, or similar. Even when no material is expected to flow in the line, it is good routine practice to always close ends unless they specifically need to be open, and thereby prevent leaks. Flexible hoses must be properly stored and cleaned after use to prevent spills.

# 4. Wastewater Management

## 4.1. Introduction

Wastewater is water that must be discharged or disposed of because it is unwanted or cannot be used due to adverse quality. Wastewaters can originate from domestic, industrial, commercial, or agricultural activities, or from rainwater runoff. A wastewater and an aqueous liquid waste could have the same composition, but they are defined by how they are managed and how they are considered under local regulations. Typically, and within this guidance, it would be considered a wastewater if it is discharged from site by pipe, e.g. to municipal sewer, to a third-party wastewater treatment plant, from a site wastewater treatment plant, or directly into a surface water or into the ground. It would be considered a waste when it is transported (e.g. in drums, IBCs or by tanker) to a third-party for treatment or destruction in processes such as incineration.

As in most industries, crop protection product manufacturing facilities generate different types of wastewater, typically including process wastewater; sanitary wastewater; cooling water; rainwater; and firewater (i.e. water used for firefighting).

Different types of wastewater are often called wastewater streams. Not only does this describe the different broad categories, but it is also used for different wastewater types within those categories.

A wastewater stream defined by its composition and properties, the process or activity that generated it, and the method of treatment or disposal.

A wastewater stream will be distinct from other wastewaters generated on the basis of these factors, and, as a result, a typical facility will generate many different wastewater streams, each of which should be considered separately when determining how they should be managed.

Wastewaters containing harmful constituents can be a significant potential source of contamination for surface waters such as rivers or the ocean into which they are discharged. This occurs when potential risks are not understood or are not managed appropriately, for example as the result of inadequate treatment before discharge. Significant impact can also occur through unintended contact of wastewaters with potential contaminants or through losses of containment or leakage wastewater directly into soil and groundwater. To prevent unwanted adverse effects and ensure regulatory compliance, wastewater systems must be understood, and appropriate controls must be implemented and maintained.

This guide provides information on the key principles and the physical and administrative controls typically implemented to prevent pollution during the generation and handling of different wastewaters. In particular the guidance focusses on unintended releases of wastewater. Separate guidance from CropLife International is in development to cover operational and management aspects associated with the treatment and discharge of wastewaters.

## 4.2. Key Principles of Wastewater Management

For effective pollution prevention and to minimize adverse impacts to the water environment, crop protection manufacturing sites need to develop robust wastewater management programs based on a range of important key principles. These include:

- Identifying each different wastewater stream;
- Characterizing each wastewater stream to understand how it is generated, its composition and when and how much is generated;
- Identifying and understanding all locations where wastewater is discharged or released into the environment;
- Understanding the location, construction, and connection of all wastewater infrastructure, including drainage pipes, sumps, soakaways and treatment equipment;
- Developing a compliance program that meets all regulations and permit conditions relating to wastewater management, including aspects such as monitoring requirements and discharge limits, and often compliance with standards set internally to minimize potential liabilities;
- Implementing a program of monitoring when it is necessary to understand the wastewater quality and variability in composition, evaluate impacts that many result when discharged and to comply with regulations or permit conditions;
- Using equipment and infrastructure in accordance with operating parameters and procedures; and
- Inspecting and maintaining all wastewater equipment an infrastructure.

Following such principles is particularly important in the crop protection manufacturing industry as some chemicals used can be harmful to the environment at very low concentrations, if discharged, or accidentally released without full understanding of the potential impacts, regardless of whether they directly covered by regulations and permits or not.

## 4.3. Wastewater Infrastructure and Design

### 4.3.1. Introduction

Historically wastewater drainage systems were usually installed below ground to maximize the use of space, minimize obstruction at the ground surface, and facilitate the use of gravity, thereby minimizing pumping and the associated infrastructure, complexity, and cost. However, underground infrastructure is much more difficult to inspect and maintain, and problems are often difficult to identify, particularly in their early stages. And because wastewaters rarely have any value to the producer, significant leaks from failed infrastructure can occur over long periods without being noticed, unless appropriate measures are in place to monitor and prevent this.

For process wastewaters and other wastewaters known to contain hazardous substances, current industry best practice is to install drainage infrastructure above ground. However, this is rarely enforced directly through regulations, so the benefits must be recognized by designers, owners, and operators of facilities. Moving existing underground drainage systems above ground can be more problematic than the design and installation of new systems, but this should always be considered during modification works and when significant failings in underground drainage infrastructure are identified.

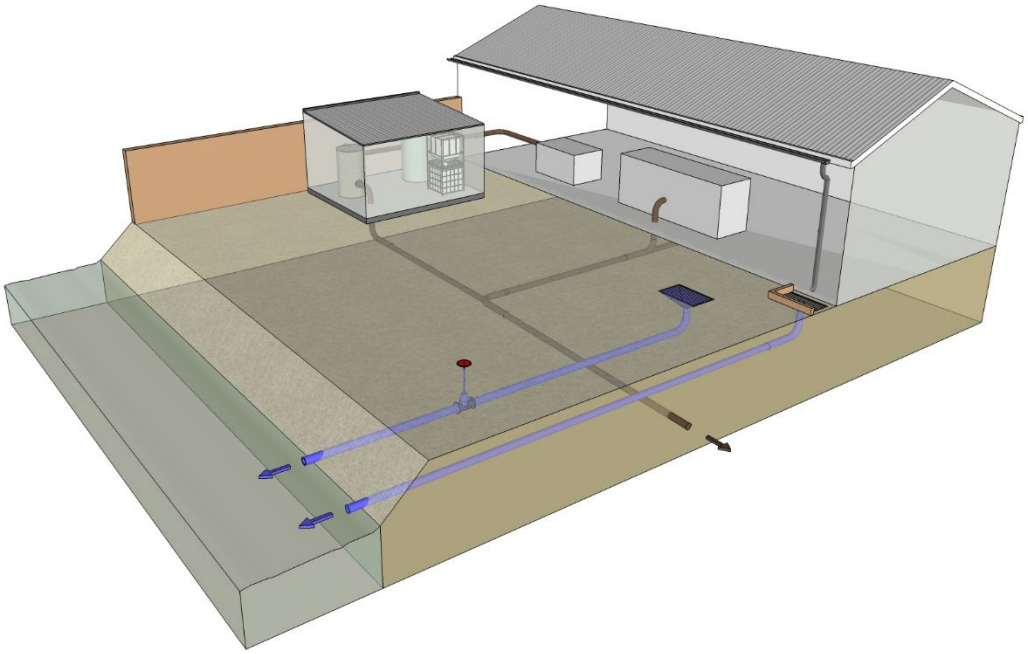


*Figure 5. Typical site drainage systems*

It is still typical to install the majority of sanitary wastewater and stormwater infrastructure below ground, which in many cases remains appropriate. However, this should be assessed to understand whether there is potential for contaminants to enter the drainage systems and in all cases an appropriate inspection and maintenance programs should be implemented (see section 4.5).

The simplified schematic in Figure 5 shows a typical scenario involving a network of underground drainage pipes of different types, which is typical at most crop protection product manufacturing facilities. Best practice, however, would no longer include locating process wastewater pipes underground.

### 4.3.2. Design and Construction

Infrastructure used for wastewater containing hazardous constituents should be designed based on the concepts of containment described in sections 3.4 to 3.6 to prevent the accidental release of hazardous materials into underlying ground and groundwater.

The following practices and controls will help to prevent environmental pollution from drains and drainage infrastructure:

- Use construction materials suitable for the composition of the wastewaters being held and the environmental conditions;
- Where constituents with the potential to cause pollution are held, the principles of secondary containment should be followed and additional controls installed;
- Whenever possible drainage pipes and equipment used for process wastewaters and other wastewaters with the potential to cause pollution should be located above ground;
- When this is unavoidable, double-walled piping with intrinsic leak detection should generally be used; for short sections of underground drainage it may be appropriate to locate them within lined concrete gullies with access for regular visual inspection;
- Drainage systems should be mapped, surveyed and documented, the sophistication of which may vary based on the design, extent and complexity of the systems present;
- Measures should be implemented to prevent accidental connection of different wastewater drainage systems that require different control measures;
- Color coding or a labelling should be used for visible drainage infrastructure (e.g. for manholes and gullies) belonging to different wastewater systems to help avoid accident releases into incorrectly identified drains; and
- In areas where hazardous materials are handled or stored, physical measures should be in place to ensure they cannot enter drainage systems during routine operations or emergencies.

### 4.3.3. Wastewater Sumps

A wastewater sump is structure used to collect wastewater before treatment, disposal, or re-use or to provide containment or additional containment capacity in the event of an abnormal event. They are usually filled under gravity and therefore located at a low point of the system, generally below or partially below ground level.

As with all underground wastewater infrastructure, they have potential to leak and cause soil and groundwater contamination if they are not designed, operated, and maintained correctly. This is particularly the case for sumps that frequently or continuously contain contaminated wastewater, rather than those that are empty under normal operating conditions.

Current best practice is to avoid the use of sumps wherever possible. So for new installations and when evaluating existing sub-surface installations, alternative arrangements should be evaluated and above ground options used whenever possible.

Where underground sumps are used the general controls for primary and secondary containment described above (sections 3.4 and 3.5) should be used. In addition, the following measures should also be employed to prevent, reduce, or minimize the potential impacts from sumps used for process wastewaters and other wastewaters containing harmful constituents:

- Leak detection (automated or procedural) to identify leakage from primary into secondary containment;
- Installing pipework (inlets and outlets) above the sides of the primary containment;

- Where pipework is not positioned above the primary containment any joints or penetrations through the containment walls should be constructed to prevent leaks;
- Level sensing (automated or procedural) to prevent overfilling;
- Supporting the primary containment above the secondary containment floor to allow inspection and the identification of issues;
- Preventing ingress of rainwater (and other liquids and solid materials) from the surface using a cover or roof and elevated structure around the top of the sump; and
- Implementing an inspection, testing, and maintenance program (see sections 4.4, 5.2 and 5.3).

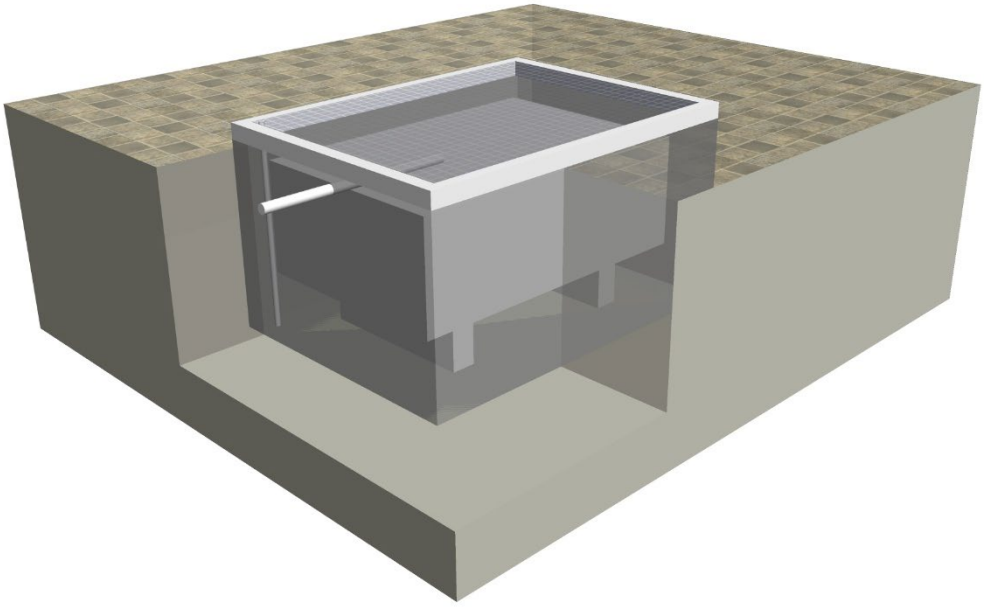


*Figure 6. Simplified design of a typical wastewater sump (roof / cover not shown)*

## 4.4. Wastewater Monitoring

Wastewater composition is variable even within consistent manufacturing processes as the result of many factors. Implementation of a wastewater discharge monitoring program is an important way to understand variability and changes in wastewater composition, comply with applicable quality standards and prevent adverse impacts and liabilities. Monitoring typically includes chemical constituents, general water quality indicators (such as Chemical Oxygen Demand (COD) dissolved carbon, dissolved oxygen, and suspended solids), physical parameters (such as pH, temperature, and conductivity) and wastewater flow rate.

The simplest monitoring programs address:

- Permit limits and conditions;
- Other applicable regulatory requirements; and
- Third-party wastewater treatment plant limits / criteria.

Frequently, however, these aspects alone are not enough to prevent all possible adverse impacts. Discharge permit conditions often do not include all parameters and possible contaminants relating to an operation's activities. In many countries permits for sites manufacturing or handling crop protection products do not include limits for crop protection product active ingredients specific to that operation. Often only a general list of crop protection products will be covered. Given the toxicity and hazards of some active ingredients, these must be evaluated in detail, regardless of whether they are covered in a permit or not. A monitoring plan is then defined based on the outcome of the evaluation. Typically, there will be regulations that cover situations in which adverse environmental impact is caused, so regulatory action can be taken even though specific parameters are not listed in the regulations or permit conditions may not have been breached.

In addition to these external factors, internal factors must also be considered, such as:

- Wastewater storage capacity;
- Wastewater discharge capacity that the infrastructure is designed to handle;
- Materials of construction and their suitability;
- Criteria for wastewater treatment processes and equipment; and
- Occupational health and safety.

The frequency of monitoring and location the testing / analysis required will depend on:

- The nature and composition of the wastewater stream;
- The variability in production activities and wastewater generation;
- How and where wastewater is discharged;
- Operational arrangements and conditions; and
- Regulatory and third-party requirements.

In some case wastewater quality is monitored routinely or continuously as part of the operational control of a production operation. Continuous monitoring is typically carried out using indicator parameters such as pH, conductivity, turbidity, and temperature, to show that it remains in the normal operating range. Online monitoring is often linked to control systems to give a rapid indication that there may be a process upset and allow action to be taken early.

Ideally, monitoring results are available before wastewater is discharged. However, this is often not the case for wastewaters that are generated continuously and / or there are storage or analytical limitations. Where this is not possible, more rigorous procedures are needed to maintain control and ensure compliance.

Monitoring and testing should be carried out with appropriate equipment operated, calibrated, and maintained in accordance with manufacturers' instructions. Where chemical analysis of wastewaters is needed to demonstrate compliance, it must be carried out in an accredited laboratory using approved testing methods and equipment.

## 4.5. Maintenance and Inspection

Wastewater infrastructure and equipment should be included in preventative maintenance, testing and inspection programs (see sections 5.2 and 5.3). The frequency and nature of these activities should reflect the potential of the wastewater to cause adverse impacts and result in regulatory compliance breaches.

Inspection, testing, and maintenance can be particularly challenging with underground infrastructure. Common inspection and testing methods for underground drainage are summarized in Table 1.

***Table 1. Methods of inspecting and testing drainage infrastructure***

| Type of Inspection | Description | Advantages | Limitations |
|---|---|---|---|
| Visual | Inspection without the use of specialist equipment to identify defects visually | Inexpensive<br>Specialist equipment not required<br>Minimal disruption<br>Quick | Accessibility typically limits applicability<br>Can be inaccurate<br>Only larger defects typically visible |
| Closed-Circuit Television (CCTV) / Video | Use of a CCTV camera inserted into pipe | Reasonable accuracy<br>Moderate cost<br>Relatively quick | Typically requires drain cleaning in advance<br>Interruption to drainage use during inspection<br>Only visible defects visible |
| Specialty Non-Destructive Pipe Diagnostics | Includes various testing methods within the pipe such as ultrasonic testing to check pipe wall thickness and eddy current testing to detect cracks. | Reliably detects imperfections in construction materials<br>May determine life of pipework as well as leaks<br>Relatively quick (generally) | Typically requires drain cleaning in advance<br>Interruption to drainage use during testing / inspection<br>More expensive |
| Hydrostatic | Filling with water and monitoring for water loss or pressure change. | Reliably detects leaks<br>Moderate cost | Not all systems are amenable to this testing<br>Interruption to drainage use during testing<br>Location(s) of leakage not direct identified |
| Pneumatic | Pressuring system with air and monitoring pressure loss through leakage. | Reliably detects leaks<br>Moderate cost | Not all systems are amenable to this testing<br>Interruption to drainage use during testing<br>Location(s) of leakage not direct identified |

An important aspect of maintenance is the cleaning of drainage, sumps, and other wastewater infrastructure to enable proper inspection. Sludges, sediment, and other debris can accumulate and must be removed and disposed of appropriately. Contaminants are often contained within these solid materials and adequate controls are not put in place to contain them during cleaning impacts or non-compliance can result.

## 4.6. Process Wastewaters

Process wastewaters are those that are generated by processing, production or manufacturing activities, including cleaning equipment and working areas. The composition of process wastewaters depends on a wide range of factors including:

- The processes and activities that generate them;
- The chemicals involved;
- The quality of the water originally used;
- Interactions with equipment and materials;
- Residual contamination on or in any equipment or materials the wastewater contacts; and
- Chemical, physical, or biological processes taking place in the wastewater.

Manufacturing facilities generally carry out many different processes in separate parts of a site and at different times within individual areas. As a consequence they generate multiple process wastewater streams with different compositions and concentrations of constituent contaminants.

In general, the following should be carried out for each wastewater stream:

- Documenting how, where, and when much of the wastewater stream is produced;
- Characterization to determine composition based on process knowledge and chemical analysis (including likely variability in parameter values and contaminant concentrations);
- Identification of applicable regulatory standards / limits or other third-party limits for the wastewater stream and its constituents;
- Determination of "internal" limits where regulatory limits are not given, based on ecotoxicology data, or adopted from other regulatory regimes;
- Identification of suitable options for treatment, discharge, or disposal;
- Implementation of necessary infrastructure for storage, handling, and treatment on-site; and
- Determination of a suitable monitoring program to ensure regulatory compliance and pollution prevention.

Different process wastewaters from a single production plant at a manufacturing facility often need to be managed very differently and should not necessarily be combined to create a single wastewater stream until detailed evaluation has taken place. In some cases it is more appropriate to segregate particularly concentrated or hazardous wastewaters and dispose of them as a waste (e.g. by incineration on-site or at a third-party waste management facility) or pre-treat them before combining with other wastewaters. In other cases, it may be appropriate to discharge them directly to a wastewater treatment plant.

At many crop protection product manufacturing facilities wastewater resulting from cleaning equipment comprises a significant proportion of the process wastewater generated. A common example is the wash water generated by cleaning formulation lines (for water-based products) between campaigns. Large volumes of water are often used to achieve the low levels of residual impurity required when changing between products containing different crop protection active ingredients to prevent cross-contamination and potential adverse impacts. Sometimes wastewater management strategies for this type of activity may involve collecting and subsequently re-using "first flush" wash water containing high concentrations of active ingredients and disposal of subsequent higher volumes of more dilute wastewater.

As with most aspects of pollution prevention, efforts should be made to prevent, avoid or minimize the generation of process wastewater. In the example of formulation line cleaning this might include:

- Minimizing changeovers between campaigns of different products, through an effective production planning, to reduce wastewater generation;
- Mechanical removal and recovery of products from pipes (e.g. "pigging") before using water;
- Using hot water for washing to increase chemical solubility; or

- Minimizing the quantity wash water needed through the use of Clean In-place (CIP) devices (such as spray heads) installed inside equipment, which are typically much more efficient that more manual types of cleaning.

Any change wastewater management through to the use of these approaches should be formally evaluated through a Management of Change (MOC) process as changes is wastewater quality may well affect activities such as wastewater treatment. Following water-use reduction activities it is common for contaminant concentrations in wastewaters to increase and this can change the effectiveness of treatment.

## 4.7. Cooling Water

Water is commonly used for heat removal from industrial processes and equipment, including within crop protection product manufacturing. The abundant availability, low cost, and thermal properties of water make it very suitable for many cooling applications. Cooling, however, often generates wastewater requiring suitable disposal to prevent adverse impacts. Waste cooling water is a type of process wastewater, but the scale of cooling water use and subsequent discharge mean it can be a significant consideration and managed differently to other process wastewaters.

Cooling water may be used in a single pass through a process or item of equipment, in a “Once Through Cooling” (OTC) system, or within a continuous or multiple-use recirculating system. OTC systems and recirculating systems that rely on evaporative cooling, which require ongoing addition of fresh water, are described as open systems. When heat removal is achieved using heat exchangers with negligible evaporative loss, and minimal ongoing addition of water, they are described as closed systems.

Cooling water is described as non-contact when it passes through a heat exchanger or condenser and is separated from process or material being cooled. When the wastewater flows directly over the equipment or material being cooled (for example in a drilling or sawing activity) it is called contact cooling water. Within the crop protection industry the most common and largest volume applications use non-contact cooling.

Wastewater from large volume once-through systems are often discharged into rivers. This can be directly, following temporary storage and testing, or after treatment, depending on the nature and composition of the water and the regulations or permit conditions that apply. Other cooling waters are disposed of through a sanitary sewage system (often municipal), again depending on composition and permit conditions.

Cooling towers and other recirculating cooling systems cycle water numerous times before the cooling water becomes saturated with unwanted dissolved or suspended solids such as salts. To manage this, water referred to as “blow down” must be discharged from the system and replaced with fresh “make up” water. Blow down water is often discharged to sanitary sewage systems.

The temperature of waste cooling water is usually subject to regulatory limits because it can cause adverse impact to aquatic ecology when discharged. This is also typically the case in municipal sanitary sewage systems because unusually high or low temperatures can upset biological processes in wastewater treatment works and damage infrastructure and equipment.

As well as increased temperature, cooling water can change composition or become contaminated during use. This can result from the addition of chemicals in cooling systems such as corrosion inhibitors, biocides for microbiological control, and chemicals to increase the solubility of salts. Contamination with constituents such as heavy metals, scale, or organic matter can also come from

contact between the water and the cooling equipment and pipework. Furthermore, mechanical failure within a closed system may result in cooling water becoming contaminated (e.g. with heat transfer fluid in a heat exchanger). And contact cooling waters are often contaminated by the equipment and materials they touch. Detailed understanding of cooling processes and wastewater composition and identifying potential issues through risk assessment is therefore imperative to adopt appropriate management practices.

Cooling water and other liquids from closed systems may contain high concentrations of chemicals such as corrosion inhibitors, glycols, ammonia, or ethanol. In most circumstances these should not be treated as wastewaters and must be disposed of as waste, in accordance with local regulations.

## 4.8. Sanitary Wastewater

Sanitary wastewater is generated by sanitation and related activities and includes wastewater from toilets, sinks, showers, kitchens, and general cleaning (unrelated to chemical handling or production). When sanitary wastewater generation is restricted to activities similar to those of a domestic household or an office environment, the approach to managing the sanitary wastewater is often similar as the risks involved are comparable.

This might include discharge to a municipal sewage network and treatment in a conventional sewage treatment works. Alternatively, an on-site wastewater treatment plant, or one located within an industrial zone serving multiple facilities, might be used. On-site systems and those located with industrial zone often combine sanitation and process wastewater treatment.

Potential risk of pollution from sanitary wastewater systems exist on sites handling chemicals such as crop protection products when there is not clear separation between activities generating domestic wastewaters with those that may contain contamination from production-related chemicals. These can result from situations such as:

- Accidental discharge of chemicals through sinks in laboratories and maintenance workshops;
- Rising or washing contaminated clothing or Personal Protective Equipment (PPE); and
- Using, rinsing or emptying cleaning equipment or floor wash water from production areas.

Where sites have separate sanitary and process wastewater systems, equipment and installations such as drains and sinks must be clearly marked indicating how they can or cannot be used. Training must also be given to all personnel whose activities may generate wastewater with the potential to cause adverse impacts.

As with all drainage networks, programs must be in place to inspect and maintain sanitary wastewater systems and equipment and ensure that they comply with all applicable regulations, permits, and discharge conditions.

### *4.8.1. Cesspits*

A cesspit is an underground collection tank designed to contain sanitary wastewater and solids, without any material being discharged or soaked away. Cesspits must be frequently emptied to prevent overflow.

Cesspits are not a preferred approach to sanitary wastewater management and are generally unsuitable for crop protection facilities. They are typically only be encountered at small sites in rural locations. In some cases, they are used for isolated buildings at large facilities due to the complexity or cost of connecting to main sanitary wastewater system. In such cases it is advised that they are

connected to the general or main sanitary systems for the site to minimize the associated risks and ongoing need to empty them.

Where cesspits are used, typical controls needed for appropriate management include:

- The use of septic tanks must comply with regulations;
- Equipment or procedures to prevent overflow, e.g. level measurement and / or control;
- Use of a suitable contractor to empty the cesspit and dispose of the waste appropriately (which is generally done at an off-site sewage treatment works);
- Cleaning, inspection of the cesspit to ensure the integrity of the structure is maintained; and
- Measures to ensure they only receive sanitary wastewater and no wastewaters relating to production activities.

### 4.8.2. Septic Tanks

A septic tank is an underground tank or structure designed to manage sanitary wastewater by retaining the sludge and separating the liquid, which is usually discharged into the ground via a soakaway. As with cesspits, septic tanks are typically used where connection to a municipal or centralized sewage system is difficult or not possible. Similarly, they are generally unsuitable for crop protection facilities and typically only encountered at small sites in rural locations. Again, they are sometimes used for isolated buildings at large facilities due to the complexity or cost of connecting to main sanitary wastewater system. As with cesspits it is generally advised that whenever possible they are connected to the main sanitary systems.

Septic tanks require less frequent emptying as liquids are discharged to ground. However, this discharge can represent a significant risk to the groundwater environment and users of groundwater. In particular, microbiological issues in groundwater supplies are frequently linked to the discharge of sanitary wastewater through structures such as septic tanks.

Typical controls needed for appropriate management of septic tanks include:

- The design capacity of the septic tank must be defined based on the maximum wastewater output predicted;
- They must be constructed with suitable materials;
- The designed and maintenance must prevent leakage and infiltration by groundwater, except parts of the system designed for soakaway;
- The drainage field of the soakaway must be designed based on the discharge rate required and permeability of the surrounding soils;
- Sludge must be emptied routinely by a licensed contractor and disposed of offsite in accordance with regulations;
- Septic tanks must be located far enough away from water sources (groundwater abstraction boreholes / wells, rivers, and streams) and outside groundwater protection zones to prevent impacts;
- The use of septic tanks must comply with regulations;
- Inspection and maintenance programs must be in place; and
- Measures must be in place to ensure that they only receive sanitary wastewater and no wastewaters relating to production activities.

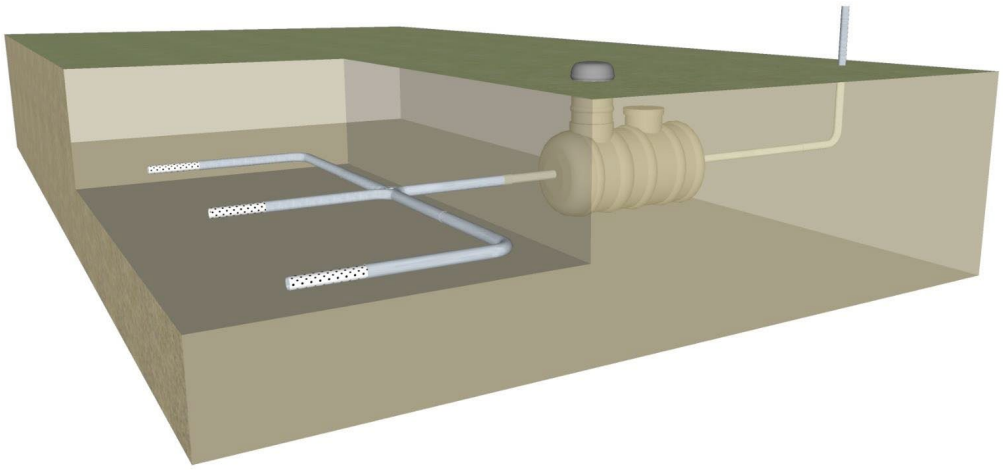


*Figure 8. Schematic design of a typical septic tank system with soakaway*

## 4.9. Stormwater

Stormwater is water generated from rainfall and melting snow and ice. When rain falls on permeable surfaces such as soil and vegetated areas it will infiltrate into the ground and subsequently recharge groundwater. However, when rainfall or melted snow and ice does not infiltrate – either because the surface is low permeability, the rate of precipitation is greater than the rate of infiltration, or the ground has reached saturation – stormwater will accumulate and flow at the ground surface.

Measures are needed to manage stormwater in urban areas and developed land such as industrial facilities. Excessive accumulated stormwater can result in flooding and can cause erosion as it flows across and against vulnerable surfaces, causing damage to buildings, infrastructure, and ground surfaces. Stormwater can also become contaminated by materials it flows over or interacts with, as well as transporting and depositing large quantities of sediment. Precautions must therefore be taken at crop protection product manufacturing facilities to minimize potential contamination of stormwater and to ensure stormwater does not cause adverse impact to surface waters and groundwater when it is discharged or infiltrates.

Typical controls for stormwater include:

- *Rainwater / Stormwater Retention:* Measures must be in place to ensure potentially contaminated rainwater or stormwater is retained (see section 4.9.1) and tested appropriately before discharge.
- *Outdoor Storage of Hazardous Materials:* Measures must be in place to prevent impacts from outdoor hazardous materials storage areas (see section 3.7.5). This includes minimizing rainwater accumulation by using roofs over stored materials and reducing potential interactions between stormwater and contaminated materials.
- *Isolation of Drainage Systems:* Stormwater systems must not be connected to other drainage or wastewater systems.
- *Rainwater Testing:* Before discharge, retention water must be tested for potential contaminants (based on site operations).
- *Discharge Procedures:* Procedures must be in place to ensure retained water is tested and discharged as soon as possible and ensure maximum retention capacity is available.

- *Drainage Integrity:* Drainage infrastructure must be designed and maintained to prevent leakage, and infiltration by groundwater.
- *Erosion and Sedimentation:* Measures must be in place to minimize erosion and sedimentation associated with rainwater discharge and run-off.
- *Oil-Water Separators:* Rainwater collected from high-risk parking areas and roads, and in sensitive locations, must pass through an oil-water separator before discharge.
- *Inspection and Maintenance:* Programs must be in place to inspect and maintain rainwater / stormwater infrastructure.

Some regulatory authorities require site operators to develop and maintain a "Stormwater Pollution Prevention Plan," describing the measures taken to manage stormwater. Other sites have conditions relating to stormwater management imposed through an integrated pollution prevention permit, license to operate or other types of authorization.

As with most themes in pollution prevention, the concepts of avoidance and minimization should be adopted as a first priority. This includes reducing hard cover, such as concrete and tarmac, on ground surfaces at to increase infiltration potential rainwater. This, however, should not be done where a low permeability surface is needed to protect soil and groundwater from potential contamination. In areas where there is no potential for contamination stormwater should be infiltrated to ground, whenever possible and practical. Infiltration methods include soakaways and permeable paving.

### 4.9.1. Stormwater Retention

Stormwater retention is the practice of accumulating and temporarily storing rainwater and snow / ice melt before it is discharged into off-site drainage systems or the environment. It is typically needed to:

- Prevent damage to infrastructure and the ground surface from erosion and damage from large quantities of flowing water;
- Reduce water flowing into drainage systems and surface waters to buffer peak flow rates and minimize flooding;
- Reduce the capacity of other parts of a drainage system, thereby reducing engineering or construction effort;
- Allow sediment and particles to settle or be filtered out before discharge
- Allow water to be tested for contamination, and if necessary be treated, before it is released; and
- Collect water for re-use and recycling.

At crop protection product manufacturing sites the greatest consideration is usually managing the potential for contamination of stormwater by hazardous materials and preventing impact to the water environment as it is discharged.

In many locations it is not practical to create retention systems that can store all rainwater – the quantities can be very large, especially in monsoonal areas or climates subject to prolonged rainfall. It is therefore necessary to adopt a stormwater management strategy to retain the stormwater of greatest risk of being contaminated. This may be based on different areas of the sites where higher risk activities take place. Generally, it is also assumed that after a dry period, the stormwater at greatest risk of being contaminated, is at the beginning of the rainfall event. This is sometimes referred to as the "first flush" when it is assumed that most of the hazardous material on exposed surfaces will be dissolved or picked up by the rainwater. Many retention strategies are therefore designed to capture this initial rainwater for a defined period of time – for example the first 15

minutes of a rainfall event. To do this, the frequency and intensity of rainfall events at the location must be understood through the use of meteorological data.

There are different regulatory requirements and varying practices in different countries, so before designing a retention system these must be understood. As an example, a typical requirement might be that the minimum capacity of rainwater retained must be based on:

- 2-year 24-hour storm intensity;
- 250 $m^3$/ha (2.5 cm), if rainfall intensity data is not available;
- 2-year 15 minutes storm intensity in monsoonal areas; or
- Local regulations, where greater.

The management strategy for stormwater at a site is likely to include different approaches for separate areas of the site. The need for retention is greater in higher risk areas of the site, where the potential for contamination is greater.

Sources of uncontaminated stormwater, such as roof run-off, may be permitted by the regulatory authorities to be discharged directly to a surface water or drainage ditch without retention or additional controls. However, operators of facilities like crop protection product manufacturing sites must be aware that some air emissions have the potential for aerial deposition of particulates or droplets containing substances that could contaminant stormwater. Assessment of air emissions should therefore be included as part of defining a stormwater management strategy.

As with any body of surface water there is a potential risk of drowning. Access to retention ponds must therefore be restricted, for example by fencing off the area, to manage potential hazards. Other safety measures are also likely to be necessary.

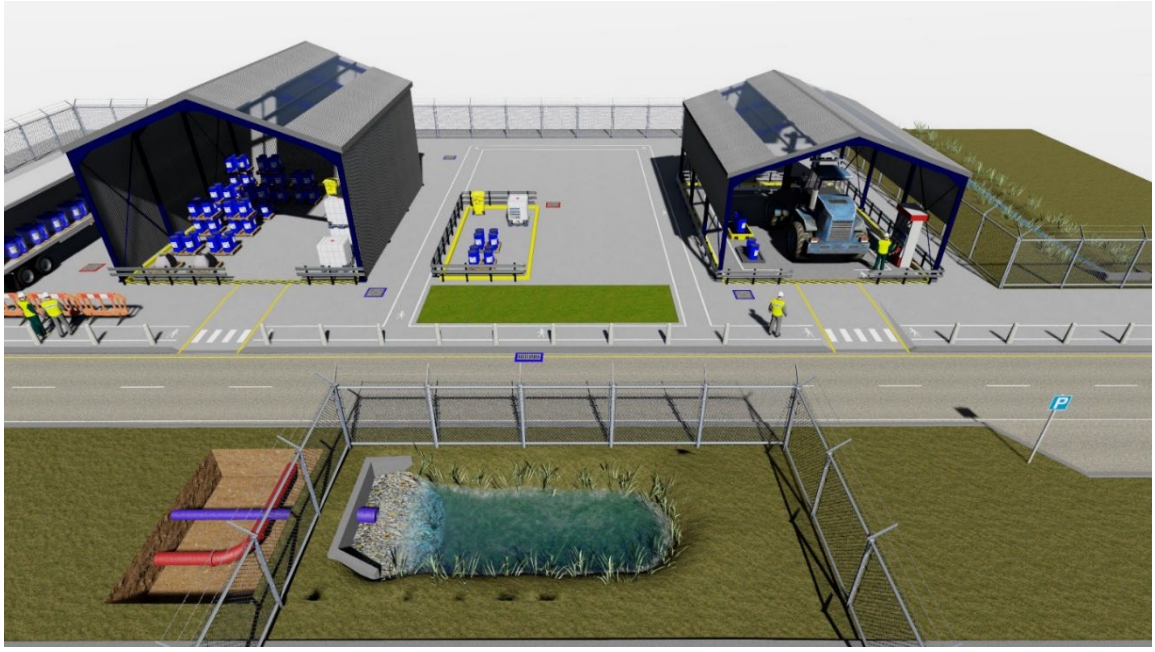


*Figure 7. Surface water retention pond (foreground)*

Standard controls, reducing the need for retention, may be appropriate and permitted by regulators to manage some common stormwater discharge scenarios. For example, oil-water separators and sediment traps are typically required to remove oil and sediment or debris coming from high-risk areas like vehicle parking areas and roads before discharge. Additional controls may be needed when vehicles include tankers carrying hazardous materials.

## 4.10. Firefighting Water

### 4.10.1. Overview

Water used to extinguish fires (typically referred to as firewater or firefighting water) is likely to be contaminated during use. During a fire at a facility that stores or handles hazardous materials there will inevitably be losses in containment. It is therefore imperative that firefighting water is contained within the structure of a building or in a dedicated storage structure so it is not released into the environment and can be managed appropriately once the fire has been extinguished.

Significant environment incidents have occurred at crop protection product manufacturing and storage facilities as a consequence of fire. A well-known example of this happened in 1986 at the Schweizerhalle industrial complex near Basel, Switzerland. A fire destroyed a warehouse that contained materials including agrochemicals. Contaminated firefighting water was released into the River Rhine, turning it red. The plume of contaminated water flowed through Switzerland, France, Germany, and the Netherlands into the North Sea, causing extensive water pollution, damaging fish stocks, and threatening drinking water supplies. It was the contaminated firefighting water, rather than the initial damage from the fire, that caused such extensive impact.

The clean-up of contaminated water following a fire can be a lengthy and expensive task. Significant efforts should therefore be made to prevent fires, minimize fire water generation, and ensure any contaminated water generated is adequately contained.

### 4.10.2. Fire Protection

The first and most important step in minimizing firewater generation is fire protection. This includes fire prevention, fire detection, and firefighting. Detailed information on this subject is outside the scope of this guide, but the key concepts of fire protection are outlined in CropLife International's "Guidelines for the safe warehousing of crop protection products" (2019).

Understanding the potential for fires at a facility must be evaluated by risk assessment and appropriate controls must be implemented to reduce likelihood and potential severity of a fire. Many factors must be considered in doing this, such as:

- Minimizing and eliminating potential ignition sources;
- Limiting fuel available for fires by:
    - Minimizing the use of combustible materials in construction;
    - Employing protection measures for combustible materials that are used;
    - Storage of flammable materials and other hazardous chemicals appropriately, segregating them from incompatible materials such as oxidizers
    - Creating "fire compartments" to reduce the spreading of fires;
- Use of fire detection measures to identify smoke and heat sources;
- Providing appropriate equipment and infrastructure for fire suppression and to fight fires;
- Appropriate installation and maintenance of electrical systems.

Fire protection is subject to extensive regulations, permitting and inspection of facilities by fire authorities. A detailed understanding of applicable regulations and guidelines is therefore needed to address fire protection appropriately. Some aspects may require the use of specialist or approved consultants and contractors.

### 4.10.3. Firewater Management

Given the complexity of the subject and the need to comply with variable local regulations, a detailed account of all aspects of firewater management is beyond the scope of this guide. However, in most circumstances controls necessary to manage firewater appropriately include:

- *Firewater Retention:* Measures must be in place to ensure firewater is retained (see *section 4.10.4*).
- *Run-off Control*: Impermeable surfaces and run-off controls must be in place to ensure firewater is directed to the retention, and to prevent seepage of firewater into the ground and off-site.
- *Isolation of Drainage Systems*: If firewater retention requires isolation of other drainage systems during an event procedures or equipment linked to site emergency response plans must be in place (see *section 6.1*).
- *Construction Materials*: Infrastructure designed to hold firewater must be constructed from suitable materials that can resist the chemicals that may be contained during use.
- *Firewater Analysis*: Appropriate analysis of firewater must be carried out to determine appropriate discharge, treatment, or disposal options, for retained firewater.
- *Fire Management Strategies*: Methods of fire suppression that would prevent / minimize firewater generation must be considered in the fire management strategy, e.g. foam, carbon dioxide, and "controlled burn" strategies.

### 4.10.4. Firewater Retention

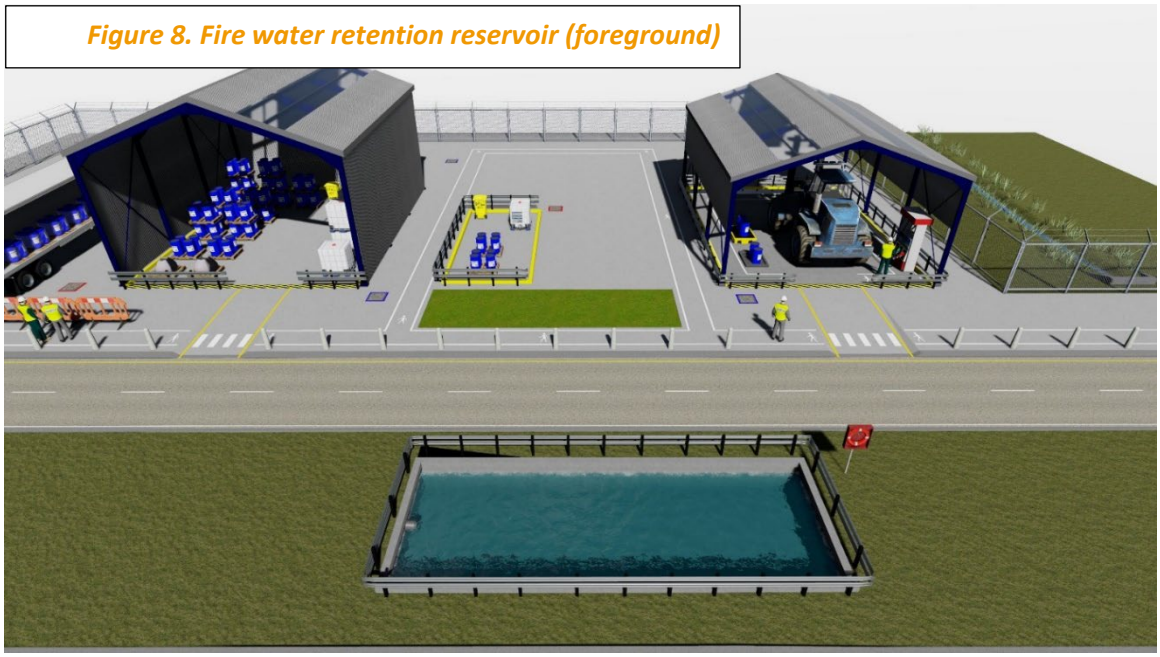
The key principles of firewater retention are:

- *Capacity*: Firewater retention capacity based on the likely worst-case event must be provided.
- *Design*: Retention can be within a dedicated retention structure, the bottom of buildings, or within a drainage network.
- *Construction*: Firewater retention ponds must be constructed of impermeable materials that will resist the chemicals that may be contained during use.
- *Combined Firewater / Stormwater Systems*: Where firewater and stormwater systems use shared retention infrastructure, the capacity must be adequate to manage the likely worst-case events.
- *Maintaining Capacity*: Procedures must be in place to ensure the intended firewater retention capacity is available at all times (e.g. and not taken up by rainwater after storms).
- *Inspection and Maintenance*: Programs must be in place to inspect and maintain firewater retention infrastructure and equipment.
- *Access*: Access to firewater retention ponds must restricted to manage potential hazards such as drowning.

To determine the capacity needed for a firewater retention system a range of factors must be considered, including:

- Total volume of water likely to be used during a firefighting event;
- Volume or rate of supply of fire-fighting water available;
- Volume or rate of supply of fire-fighting water from fire suppression systems such as sprinklers;
- Volume of firewater that may be retained within building structures designed to contain liquids (such as tank storage bunds and containment built into the base of warehouses);

*Figure 8. Fire water retention reservoir (foreground)*



- Volume of contaminated water needed to be retained from the largest likely to be impacted by a fire;
- Volume of liquid materials in storage that may become part of the firewater volume; and
- Quantity of rainfall that may occur during a firefighting event (as this will also need to be retained.

As with all aspects of fire management, it is likely that that local regulations and guidance will apply to firewater retention.

For retention of firefighting water in warehouses CropLife International's "Guidelines for the safe warehousing of crop protection products" (2019) states the following:

- There must be the means to retain any spillages and all the firefighting water. The volume to be expected in fighting a fire can be several cubic meters ($m^3$) of water per ton of product stored, unless special precautions are provided such as sprinklers, foam systems, or automatic alarms.
- Generally, volume of water containment may be calculated as $m^2$ (floor size) x 0.3 = V($m^3$).
- Some retention can be achieved within the building by enclosing the floor area with ramps or sills at all entry points. Building walls can be sited on bunds, lined with impervious material to a height of 14 cm and/or a bund can be constructed around the building."
- The thresholds should be at least 14 centimeters above finished floor level with ramps inclined to a gradient of not greater than 1 in 10 (10%, 5.7°) for access of forklift trucks. It is recommended that arrangements be made to increase the threshold height by fitting boards or sandbags in case of emergency.
- Enclosing the loading and unloading area and other paved ground outside the warehouse can sometimes provide additional containment volume. If this is done, equipment must be installed either to pump away rainwater or to shut existing drains in the event of fire.
- For warehouses with a floor area larger than 250 $m^2$, it is recommended to have a containment volume of at least 200 $m^3$. Containing the total expected volume of firefighting water generally requires a catchment basin. This can be shared between various warehouses or sections separated by a fire wall, as it is not likely that more than one section will catch fire at any one time.

- It is recommended to have a pit outside the warehouse to collect the firefighting water/effluent; from there it should be pumped into a larger collection pond.
- If it is difficult in existing warehouses to provide a sufficiently large containment volume, it is recommended to reduce the expected volume of firefighting water, e.g. by automatic alarms or extinguishing systems or by making provisions to cease fire fighting once the available capacity has been reached.

# 5. Procedural and Administrative Controls

## 5.1. Written Procedures

A written procedure is a formal document, such as a manual, method statement, checklist, instruction, or standard operating procedure that aims to ensure processes and tasks are performed consistently. Procedures are used to ensure activities are carried out as intended, including any procedural controls that have been identified through risk assessment. In hazardous operations, written procedures are a critical part of mitigating potential environmental impacts such as unintended releases of hazardous substances into the water environment.

### *5.1.1. When are Written Procedures Needed?*

All potentially hazardous activities (i.e. those that may cause harm to people or the environment) that are part of normal working practices should be described in a written procedure, unless controlling the risk requires no more than routine care and attention from working or general training. Examples of activities that could give rise to pollution covered by written procedures are:

- Operating a wastewater treatment plant;
- Filling bulk chemical and fuel storage tanks;
- Removing rainwater from secondary containment;
- Discharging rainwater that has accumulated in a storage reservoir; and
- Cleaning up chemical spills.

For non-routine work, other HSE management processes, such as Permit to Work (PTW), should be in place to manage the risks.

### *5.1.2. Content of Written Procedures*

Written procedures for critical activities should describe each step of the activity in sufficient detail that it can be followed step-by-step when completing the task. Procedures should represent an accurate description of the task or process and be written in such a way that it can realistically be performed as described with the available resources.

Written procedures should be consistent and ensure there are no conflicting instructions and there is a standardized approach to similar tasks, and to other management processes. Written procedures should explain what is required to prevent deviations from the procedure that could cause harm to people or the environment or result in regulatory non-compliance.

### *5.1.3. Writing and Reviewing Procedures*

Written procedures should be developed or reviewed in consultation with people who perform the task or job function to ensure they are understood correctly and can be followed as intended. Procedures must be available in a language(s) understood by personnel that will use them and written and presented in a way that can be easily understood.

Written procedures should be formally reviewed and approved by the person accountable for the activity or the location in which it takes place. Written procedures should be reviewed and updated to ensure they remain current. Following any change to a process or equipment subject to a written procedure, or after an incident, the document should be reviewed. It is also good practice to review written procedures on a routine basis, e.g. every three years.

### *5.1.4. Using Written Procedures*

Personnel whose role includes a process or activity covered by written procedure should be formally trained in its use. Written procedures should be available (electronically or in hard copy) to personnel at the location in which the process or activity takes place. For higher hazard activities, the procedure should be followed step-by-step, and may even need to be documented, each time it takes place.

## 5.2. Preventative Maintenance

All equipment and infrastructure used for pollution prevention and control should be maintained and tested to prevent foreseeable failures that could lead to loss of containment of hazardous materials or unplanned release to the environment.

A formal plan should be in place for the maintenance and testing of equipment that:

- Is required for environmental control / pollution prevention;
- Could cause a significant loss of containment or pollution due to a foreseeable failure; or
- Is required to maintain regulatory compliance.

Examples include primary and secondary containment, components of wastewater treatment systems and water quality monitoring systems (such as in-line test meters and alarms). Maintenance and testing carried out should be documented and records retained.

When defects or degradation are identified that may give rise to an environmental risk, or increase the likelihood of it happening, action should be taken to repair the equipment; manage the risks using temporary controls; or remove the equipment from service.

Critical spare parts and consumables needed to maintain regulatory compliance, even when processes or equipment are taken out of commission, should be identified and available whenever needed. This is typically applicable for equipment that is required as part of a permit condition such pollution control devices and online monitoring equipment.

## 5.3. Inspection

All areas in which hazardous materials are handled, and any equipment or infrastructure associated with pollution prevention or control, should be routinely inspected to prevent foreseeable failures that could lead to environmental impact, e.g. through loss of containment, and to identify situations, such as leaks, that require immediate action.

Different types of inspection can be carried out in a single area of a facility. For example a general inspection may be undertaken on a daily basis, and a more detailed inspection of flooring and secondary containment walls may be carried out at a different frequency, or by different personnel.

Inspections are most effective when they are carried out in accordance with a checklist to ensure that all relevant items are inspected and the inspection is carried out consistently, even when different personnel are involved.

The need to carry out inspections should be considered in the design of equipment and installations. It should be possible to easily identify leaks during inspections, and access should be such that appropriate action can quickly be taken.

## 5.4. Management of Change

Management of Change (MOC) is a formal process carried out before making changes to equipment, processes, or organizations to assess and evaluate potential consequences and avoid adverse or unforeseen situations. The use of an appropriate MOC process is critical to prevent pollution of the water environment, as well as preventing other environmental impacts, serious injuries and fatalities, property damage, and regulatory non-compliance.

Key aspects of an appropriate MOC process include:

- Defining what constitutes a change;
- Ensuring all changes are evaluated formally within the MOC process;
- Including organizational and personnel as well as equipment, infrastructure, and process changes;
- Defining roles and responsibilities of personnel involved;
- Using a system based on written change requests that are formally assessed and reviewed;
- Approving different steps within a change;
- Identifying and assessing risks relating to the change and implementing controls / mitigations appropriately;
- Completing actions needed to control risks before implementation of a change;
- Considering the impact of a change on regulatory compliance;
- Including temporary changes within the procedure;
- Communicating information about changes to those affected and giving training, if required;
- Updating written procedures and other formal documentation to reflect any changes;
- Maintaining a formal record of all changes, storing MOC documentation systematically; and
- Monitoring the MOC process and measuring compliance with it using defined metrics.

Important factors that must be evaluated as part of a change to protect the environment and prevent pollution of the water environment include:

- Waste storage and treatment;
- Wastewater management, treatment, and discharge;
- Air emissions discharge;
- Use of water resources (groundwater or surface water);
- Handling and storage of materials harmful to the environment;
- Changing or obtaining environmental permits / licenses / consents; and
- Factors that could create nuisance.

## 5.5. Training

Training is needed to ensure all employees and contractors understand the activities they are responsible for and are able to protect themselves, other people, and the environment while carrying out those activities. Training needed for workers to understand the hazards and risks of their workplaces and job function should be identified and delivered accordingly. Workers should be trained and competent to follow the required procedures consistently, during both normal operations and abnormal occurrences.

An appropriate training system / program includes:

- Identifying the training needed for all roles;
- Training required by law / to meet regulations;
- How training courses are developed and delivered;
- Training plans for all employees;
- How non-attendance of training is managed;
- How training is validated to ensure it met its objectives;
- Maintaining training recordkeeping; and
- Minimum training for new employees, contractors, and visitors to a facility.

Related or additional processes are also needed to ensure that contractors are adequately trained, experienced and competent to undertake the work for which they are contracted.

# 6. Managing Incidents and Emergencies

## 6.1. Emergency Management

All industrial facilities should have emergency response plans to deal with adverse events or situations that may originate within the facility (e.g. a fire) or may originate off-site or result from natural events that could adversely affect the facility, such as a flood, earthquake, or hurricane. The first objective of most emergency plans is to protect people, but measures must also be in place to prevent pollution and protect the environment.

Emergency management plans / procedures should include:

- Identifying all significant foreseeable events and emergencies;
- Emergency response planning;
- Organizations needed, and roles and responsibilities;
- Infrastructure and equipment required to manage emergencies;
- Emergency detection systems (e.g. gas detection system and emergency alarms);
- Contingency plans;
- Training and testing emergency response and management plans; and
- Communication and escalation relating to emergencies with an organization.

Aspects relating to pollution prevention and protection of the water environment including the following must be identified and evaluated:

- Fires and explosions.
- Emergencies affecting equipment, infrastructure, or activities with the potential for significant loss of primary and secondary containment of hazardous materials, including:
    - production plants;
    - tanks and tank-farms;
    - waste management area;
    - chemical loading and unloading.
- Emergencies affecting wastewater management, including:
    - situations that may significantly affect wastewater quality;
    - activities with the potential to contaminate wastewater drains;
    - issues that could adversely affect wastewater discharges.

- Significant natural hazards such as earthquakes, flooding, hurricanes, or other extreme meteorological conditions.

Environmental assessment and understanding the site setting and environmental sensitivity are important factors in identifying emergency scenarios, situations that may result in emergencies, and the potential severity of those emergencies.

## 6.2. Spill Management Procedures

Leaks and spills in crop protection product manufacturing facilities typically range from those associated with small containers in production areas, warehouses, and stores, to larger scale spills from tanks, tankers, or failure of equipment/infrastructure. Procedures must be in place to manage all foreseeable leaks or spills of hazardous chemicals.

Personnel should be trained and equipped to manage the types of spill anticipated. For anything other than small spills that can be easily dealt with by personnel in the area in which a spill happens, it is likely that spills will need be escalated and managed through a facility's emergency response system. However the response is managed, it is critical that everyone understands who is responsible for responding to different types of incidents.

In the event of a spill, clear signage should be used to prevent access by people not involved in managing the spill to minimize further incident or injury. It is also very important that any equipment used does not introduce unnecessary additional hazards to the situation.

Measures should be in place to ensure that residual harmful materials are removed following a leak or spill to ensure that further environmental impact does not occur. Spilled chemicals and materials that have been contaminated during a spill or leak, or its clean-up, should be managed as hazardous waste, in accordance with local regulations. Typically the most appropriate disposal method is high-temperature incineration at a suitable facility. This type of waste facility should already have been identified to dispose of hazardous wastes generated during routine manufacturing operations.

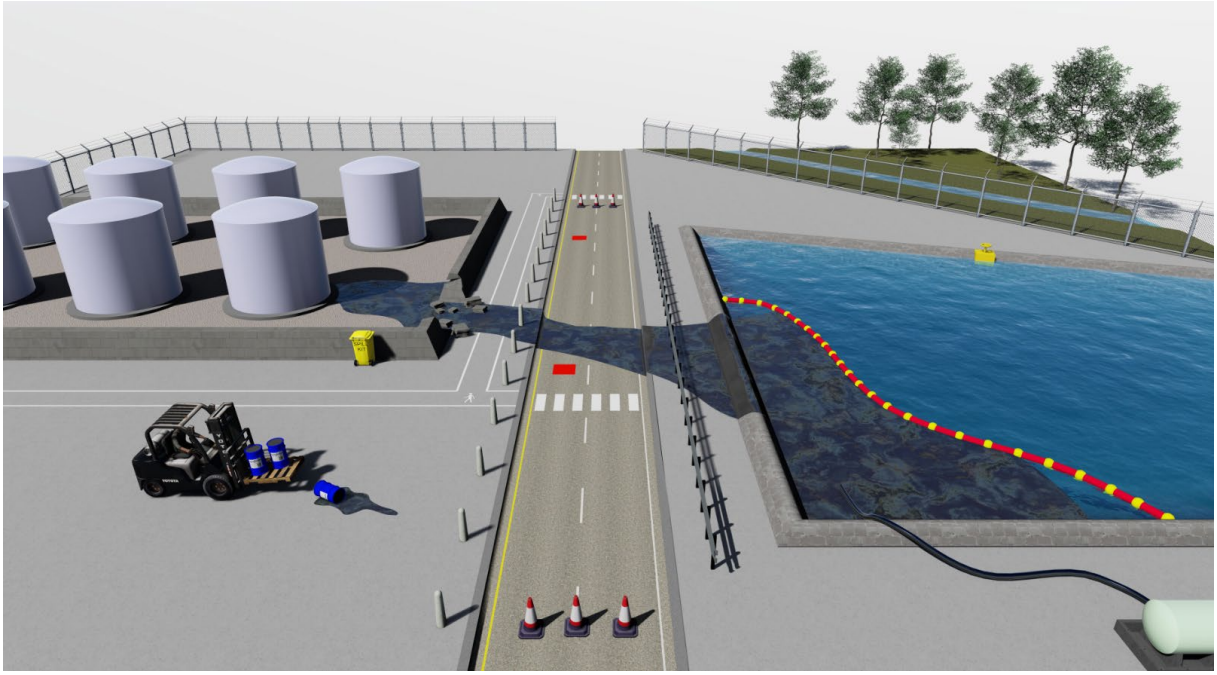


*Figure 9. Possible spill scenario*

## 6.3. Spill Management Equipment

The equipment required to manage spills and leaks appropriately varies depending on the nature of the materials involved, the scale of the foreseeable release, and the sensitivity of the environment in which it may occur. For smaller spills equipment such as the following should typically be used:

- Spill kits: containers of inert, absorbent material such as granular clay;
- Neutralization agents and detergents;
- Broom, shovel (non-sparking if there is a risk of ignition) and rubber wiper;
- Large heavy-duty plastic bags (empty)
- Open-topped drums (empty);
- Cleaning cloths / materials for washing surfaces;
- Bags of sand or absorbent booms to build a protective barrier; and
- Industrial vacuum cleaners or pumps to remove liquids.

For larger spills, especially at facilities where bulk hazardous materials are stored or handled, additional equipment or infrastructure may be needed, such as equipment for sealing drains in areas where the potential for spills to enter is possible.

Spill management equipment should be used only for emergencies, not for routine operations, to ensure that it always available. It should be located in a readily accessible position in areas where spills or leaks could occur.

## 6.4. Incident Reporting and Investigation

A formal system should be in place to report incidents that result in loss of containment of hazardous materials or unintended releases to the environment, and near misses that could result in these events happening.

Reporting and incident investigation should be used to take corrective actions directly associated with the incident; learn from incidents and communicate them with an organization; revise processes and procedures; and drive continuous improvement.

# 7. Summary

This guidance introduces the key principles of pollution prevention, in which different measures are used to prevent or minimize the occurrence of adverse practices or events unintentionally causing impact to the water environment. In particular, it highlights issues most relevant to crop protection product manufacturing facilities. Further Crop Life International guidance is available addressing potential impacts on the water environment from wastewater discharges.

Many aspects of pollution prevention can be managed through systems and processes needed to manage other HSE risks. Integrating environmental management and pollution prevention into a wider HSE management system should therefore make processes more efficient and effective and reduce administrative effort.

Managing crop protection product manufacturing facilities and preventing pollution are subject to extensive regulation in most countries. Significant manufacturing and storage operations therefore almost always require permits, licenses, and other types of authorization, which usually include conditions relating to pollution prevention and protection of the environment. A detailed understanding of local regulations and associated guidance is therefore imperative.

# 8. Glossary / Definitions

| Abbreviation | Term | Definition |
|---|---|---|
| AI | Active Ingredient | The substance within a crop protection product formulation that exhibits a general or specific action against harmful organisms or plants, parts of plants or plant products. |
| | Cesspit | An underground collection tank designed to contain sanitary wastewater and sludge, without any material being discharged or soaked away. |
| ETP | Effluent Treatment Plant | Equipment or infrastructure designed to treat wastewater by removal of physical, biological and/or chemical contaminants. Also known as a "Wastewater Treatment Plant" (WWTP). |
| | Environmental Aspect | Element of an organization's activities or products or services that interacts or can interact with the environment.<br>*Note 1*: An environmental aspect can cause (an) environmental impact(s). A significant environmental aspect is one that has or can have one or more significant environmental impact(s).<br>*Note 2*: Significant environmental aspects are determined by the organization applying one or more criteria.*(ISO14001:2015 definition)* |
| | Environmental Impact | Change to the environment, whether adverse or beneficial, wholly, or partially resulting from an organization's environmental aspects.<br>*(ISO14001:2015 definition)* |
| | Firewater | Water that has been used for firefighting / extinguishing fires. |
| | Hazard | Something that can cause harm e.g. damage to the environment. A hazard can be an object, a property of a substance (e.g. toxicity or flammability), a condition or an activity. |
| | Hazardous Material | A material that can harm people or the environment due to properties such as toxicity, flammability, eco-toxicity or corrosiveness. |
| IBC | Integrated Bulk Container | A pallet-mounted, plastic container housed in a galvanized steel cage for the transport and storage of bulk liquids and granulated substances. Also known as a tote or pallet tank. IBCs are sized between drums and tanks: most commonly 1000 litres (275 US Gallons), but other sizes such as 1250 litres and 600 litres are also available. |
| LOPC | Loss of Primary Containment | An unplanned or uncontrolled release of material from primary containment. |
| | Nuisance | Something resulting from the actions of others that affects a person's ability to enjoy their property or land or disturbs them. Typical examples include light, noise, vibration, odor, dust, and traffic. |
| PRA | Process Risk Assessment | Systematic risk assessment methodology used to assess high hazard manufacturing processes. |
| PTW | Permit to Work | A documented procedure that authorizes certain people to carry out specific work within a specified time frame. It sets |

| Abbreviation | Term | Definition |
|---|---|---|
| | | out the precautions required to complete the work safely, based on a risk assessment and how it will be done. |
| | Primary Containment | Equipment and infrastructure designed to store or hold materials during normal use e.g. tanks, drums, mixing vessels. |
| REACH | Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation | Regulation (EC) No 1907/2006 of the European Union. A regulation that aims to improve the protection of human health and the environment from the risks that can be posed by chemicals. |
| | Risk | The combination of severity of an incident and the probability / frequency of it occurring with that severity. |
| | Run-off | Stormwater that flows on the ground surface, finally entering surface waters, infiltrating into the ground, or evaporating. |
| SDS | Safety Data Sheets | A document that provides information on the potential health, safety, and environmental hazards of a chemical. It also contains information on use, storage, handling and emergency procedures for the chemical based on the defined hazards. |
| | Sanitary Wastewater | Wastewater generated by sanitation and related "domestic" activities. |
| | Secondary Containment | Equipment and infrastructure designed to contain spillages, or leakage of materials from primary containment, to prevent them entering the workplace and / or wider environment. |
| | Septic Tank | An underground tank / structure designed to manage sanitary wastewater by retaining the sludge and separating the liquid, which is usually discharge into the ground via a soakaway. |
| | Soakaway | A feature or construction that allows water or wastewater to infiltrate the ground surrounding and beneath it. |
| | Spill Kit | Materials or equipment designed to absorb spilled chemicals and / or to limit further movement before they can be removed / cleaned-up. Absorbent materials include pads, booms, and granules. |
| | Stormwater | Water generated from rainfall events or melting snow / ice. It can run-off into surface waters, infiltrate into the ground or remain on the ground surface until it evaporates. |
| | Sump | A structure in a drainage / wastewater system used collect wastewater before treatment / disposal / re-use or in the event of an abnormal event. They are located at a low point of the system below or partially below ground level and are usually filled under gravity. |
| TOC | Total Organic Carbon | The concentration of organic carbon present in a material that is commonly used a simple, non-specific indicator of water or wastewater quality. |
| | Wastewater Stream | A specific wastewater type defined by:<br>• its composition and properties;<br>• the process / activity that generated it; and<br>• the method of treatment or disposal. |

| Abbreviation | Term | Definition |
|---|---|---|
| | | A wastewater stream will be distinct from other wastewaters generated on the basis of these factors and as a result a typical facility will generate different wastewater streams. Also known as a Safe Work Permit (SWP). |
| WWTP | Wastewater Treatment Plant | Equipment or infrastructure designed to treat wastewater by removal of physical, biological and/or chemical contaminants. Also known as an "Effluent Treatment Plant" (ETP). |
| WRA | Workplace Risk Assessment | A risk assessment process to ensure hazards in a workplace or associated with a task are recognized, risks are assessed, and suitable controls are implemented to prevent harm to people and the environment. |

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