Resource for Greening Chemical Manufacturing
Pollution Prevention Information

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Greening Chemical Manufacturing

Toronto's ChemTRAC program includes an Environmental Reporting and Disclosure Bylaw (Municipal Code Chapter 423) that requires local businesses to track and report their use and release of 25 priority substances. The ChemTRAC program provides an opportunity for you to identify strategies for improving your environmental performance. Strategies include those that reduce the use and release of the 25 priority substances. Strategies may also reduce the use and release of other chemicals that may have a health and/or an environmental impact. This Greening Resource for Chemical Manufacturing will help you understand the chemicals that you are using and find ways to reduce or eliminate their use. For additional resources, including a Guide to Reporting visit http://www.toronto.ca/chemtrac/.

Chemical Manufacturing

The Chemical Manufacturing Sector includes a diverse group of manufacturing industries that transform organic and inorganic raw materials into new products. The major industry groups within this sector include:

- Basic Chemical Manufacturing (e.g., synthetic dye and pigment manufacturing; basic organic chemical manufacturing)
- Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing
- Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
- Pharmaceutical and Medicine Manufacturing
- Paint, Coating, and Adhesive Manufacturing
- Soap, Cleaning Compound, and Toilet Preparation Manufacturing
- Other Chemical Product and Preparation Manufacturing

Priority Substances and Other Chemicals of Concern

Toronto Public Health has identified 25 substances of priority health concern that are commonly used and released by businesses in the City of Toronto. As part of ChemTRAC, the Environmental Reporting and Disclosure Bylaw requires businesses and facilities to track and report on any of the listed priority substances that a facility manufactures, uses or releases to the environment if the amounts are equal to or above the reporting limits. In addition to the priority substances, industrial processes commonly use and release other chemicals of concern that may have a health and/or an environmental impact that are not subject to the by-law.

The Chemical Manufacturing sector may use and produce some of these priority substances and other chemicals of concern. Each of these chemicals may have an impact on human health and/or the environment. Below are the substances that may be used or produced by your facility and its operation. This is not an exhaustive list.

Substances that may be used or produced by your chemical manufacturing facility and its general operations

Chemical Sources	Priority Substances Tracked by ChemTRAC	Other Chemicals of Concern*
Basic Organic Chemical Manufacturing:	• Volatile Organic Compounds (VOCs)[1] (e.g., methanol, xylene, toluene) • Benzene • Formaldehyde • Acetaldehyde • Dichloromethane • 1,3-Butadiene • Polycyclic Aromatic Compounds • Chromium compounds • Manganese compounds • 1,2-Dichloroethane • Chloroform • Nickel • Lead and its compounds • Trichloroethylene • Tetrachloroethylene • Acrolein • Carbon tetrachloride • Mercury and its compounds • Vinyl Chloride • 1,4-Dichlorobenzene • Nitrous oxides • Particulate Matter 2.5[2] ($PM_{2.5}$)	• Ammonia • Chlorine • Nitrate compounds • Sulphur oxides (SOx) • Carbon monoxide (CO) • Carbon dioxide (CO_2)
Basic Inorganic Chemical Manufacturing:	• VOCs (e.g., methanol, toluene) • Chromium and its compounds • Lead compounds • Manganese compounds • Formaldehyde • Mercury • Carbon tetrachloride • Cadmium compounds • Chloroform • Nickel • Manganese • Benzene • Acetaldehyde	• Acids(Sulphuric, Hydrochloric, nitric) • Caustics • Ammonia • Chlorine
Synthetic Dye and Pigment Manufacturing:	• VOCs • Nitrogen oxides (NOx) • Chromium • Mercury • 1,4-Dichlorobenzene • Acetaldehyde • Benzene • Cadmium • 1,2-Dibromo ethane • Formaldehyde • Trichloroethylene	• Hydrogen chloride • Sulphur oxides (SOx) • Copper • Products themselves may be hazardous

Chemical Sources	Priority Substances Tracked by ChemTRAC	Other Chemicals of Concern*
Plastic Resins Manufacturing:	• VOCs (e.g., methanol, ethylene glycol) • Dichloromethane • Vinyl chloride • Formaldehyde • Acetaldehyde • Trichloroethylene • 1,2-Dichloroethane • 1,3-Butidiene • Benzene • Lead compounds • Chromium compounds • Nickel compounds • Chloroform • Manganese compounds • Acrolein	• Ethylene • Propylene • Ammonia • Nitrate compounds • Acetonitrile • 1-Chloro-1,1-difluoroethane • Plasticizers • Pigments and dyes
Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing:	Fertilizer Manufacturing: • Nitrogen oxides (NOx) • Particulate Matter ($PM_{2.5}$) • Manganese and its compounds • VOCs (e.g., methanol) • Formaldehyde • Cadmium • Chromium compounds • Nickel compounds • Lead compounds Pesticide Formulation: • VOCs (e.g., methanol, xylene) • Particulate Matter ($PM_{2.5}$) • Manganese compounds • Formaldehyde • Dichloromethane • Cadmium • Chromium compounds • 1,4-Dichlorobenzene • 1,2-Dichloroethane • Lead compounds • Carbon tetrachloride • Vinyl chloride • 1,3-Butidiene	Fertilizer Manufacturing: • Ammonia • Urea • Phosphoric acid • Zinc compounds • Nitrate compounds • Sulphur oxides (SOx) • Carbon monoxide (CO) • Hydrocarbons • Carbon dioxide (CO_2) Pesticide Formulation: • Carbon disulfide • Ammonia • 1,2,4-trimethylbenzene • Products themselves may be hazardous chemicals
Pharmaceutical and Medicine Manufacturing:	• VOCs (e.g., methane, toluene) • Dichloromethane • Chloroform • Formaldehyde • Manganese compounds • 1,2-Dichloroethane • Nickel compounds • Benzene • Tetrachloroethylene	• Nitrate compounds • Ammonia • N,N-dimethylformamide • Pharmaceutical compounds (e.g., Penicillin, Acetaminophen)

Chemical Sources	Priority Substances Tracked by ChemTRAC	Other Chemicals of Concern*
Paint, Coating, and Adhesive Manufacturing:	• VOCs (e.g., methanol, xylene, toluene) • Chromium compounds • Cadmium • Lead • Mercury • Particulate Matter ($PM_{2.5}$)	• Particulate Matter (PM_{10}) • Ammonia • Copper • Zinc • Nonylphenol and its Ethoxylates (NPE)

Notes:

* Chemicals that may have a health and/or an environmental impact.

1. VOCs are emitted as gases from certain solids or liquids. Smog forms when VOCs are combined with nitrous oxides (NOx) in sunlight.
2. Particulate matter (PM) consists of airborne particles in solid or liquid form (e.g., dust). $PM_{2.5}$ is airborne particulate matter with a mass median diameter less than 2.5 µm.

Understanding Your Company's Impacts: Chemical Manufacturing

Due to the nature of the chemical manufacturing sector, there are several activities or processes that contribute to the use and release of priority substances and other chemicals of concern. The use and release of chemicals depends on the industry, the type of process, the equipment, and the chemicals that are used.

The Chemical Manufacturing sector is very diverse, and there are a number of sub-sectors and industries found within the City of Toronto. This guide outlines the general processes for **seven** chemical manufacturing industry groups or industries, indicating where the priority substances and other chemicals of concern may be used or released. The seven chemical industry groups or industries covered are:

- Basic Chemical Manufacturing (e.g., synthetic dye and pigment manufacturing; basic organic chemical manufacturing)
- Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing
- Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
- Pharmaceutical and Medicine Manufacturing
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- Other Chemical Product and Preparation Manufacturing

Your facility may have more specialized processes or different processes than those outlined below; however, you may find relevant chemical release information and pollution prevention opportunities in this guide.

In general, chemical manufacturing processes involve four major stages:

1. Feedstock preparation, such as purification of raw materials
2. Chemical reactions, when feedstock materials are converted into other products
3. Finishing operations, such as product separation and chemical purification, and
4. Supporting activities, including chemical handling, storage and transport, as well as equipment cleaning.

The chemical inputs and outputs significantly vary among chemical industries and manufacturing processes. Chemical releases can be associated with all stages of the manufacturing process, with pollution releases to air, land and water. Common releases include:

- Fugitive[1] and point-source[2] air emissions of volatile organic compounds (VOCs), Particulate Matter ($PM_{2.5}$ and PM_{10}), nitrogen oxides (NOx), and other priority substances and chemicals of concern
- Wastewater, containing heavy metals, VOCs and chemical by-products

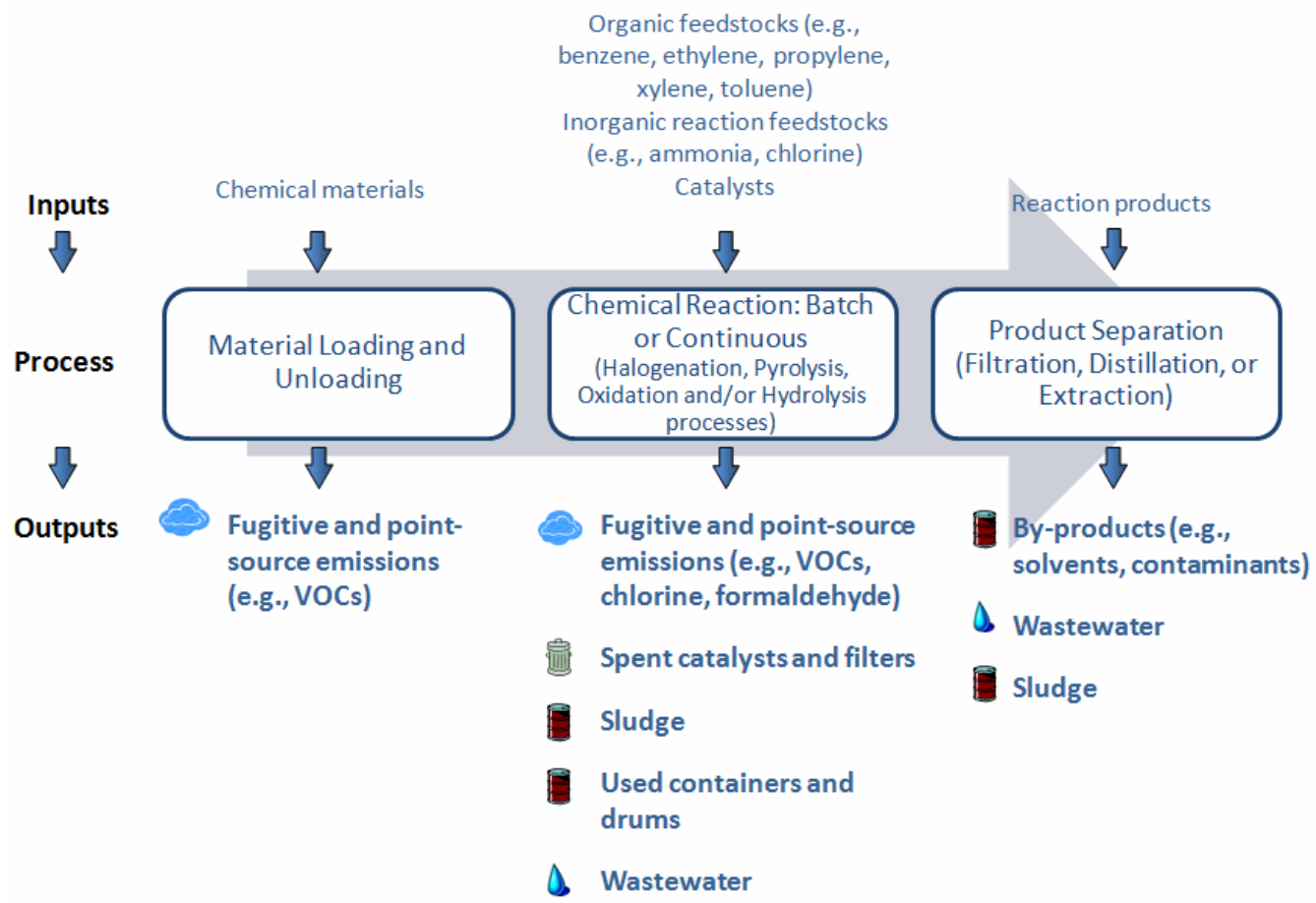
[1] Fugitive air emissions are from losses from equipment leaks or evaporative losses from impoundments, spills, or leaks

[2] Point sources are emissions confined air streams as found in stacks, ducts, or pipes.

- Leaks / spills of chemical raw materials and end-products from process equipment, storage areas and transportation areas, and
- Solid and liquid wastes (e.g., spent catalysts, process by-products, sludges and container residues), that may contain priority substances and other chemicals of concern.

The following diagrams show the raw materials that may go into each of the seven general processes and the releases that may come out of each process. Symbols show whether the wastes typically go to air, landfill, sewer systems and/or treatment facilities (as liquid or hazardous wastes).

Figure 1: Basic Organic Chemical Manufacturing Processes



Symbols used in the flow diagram

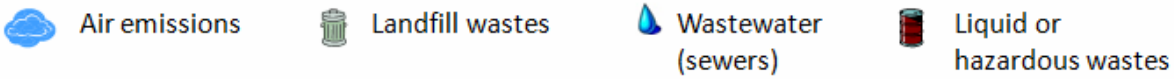
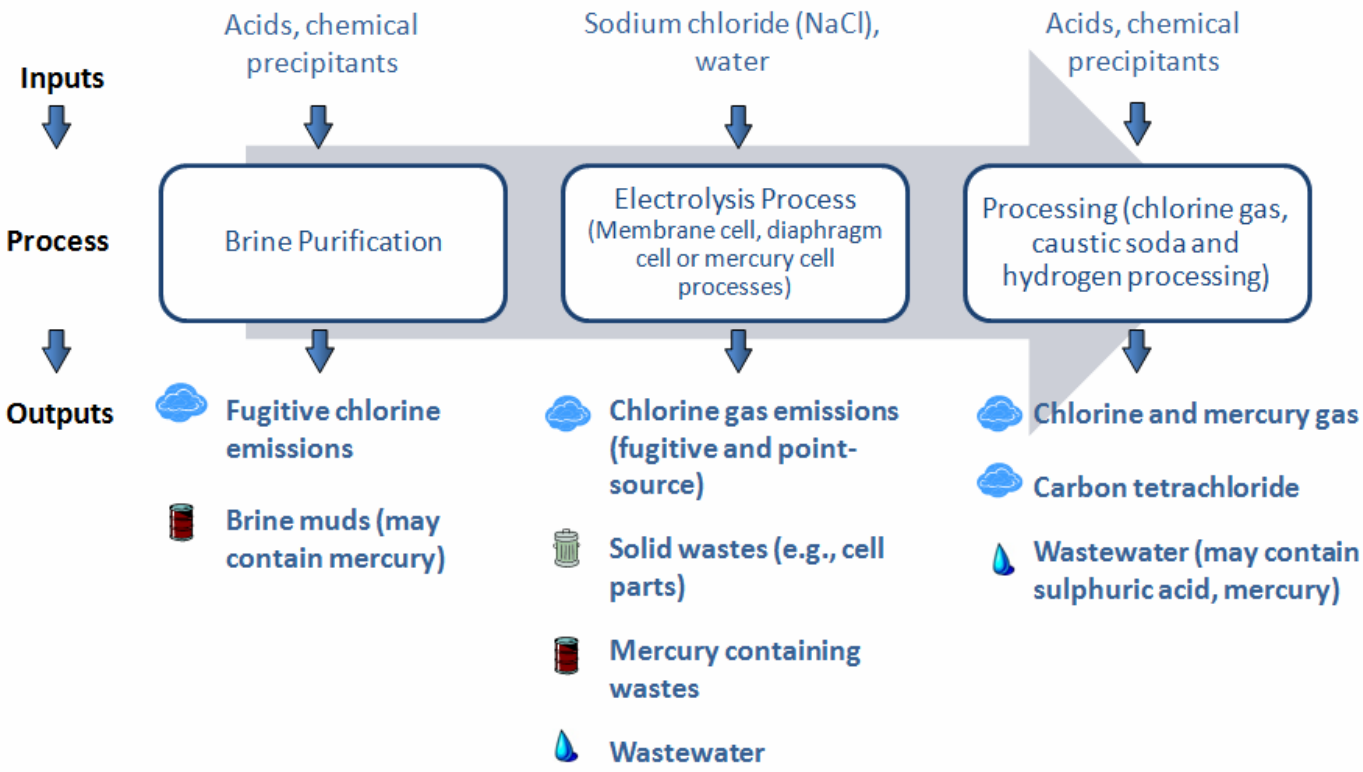


Figure 2: Basic Inorganic Chemical Manufacturing Processes



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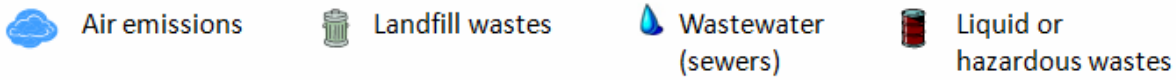

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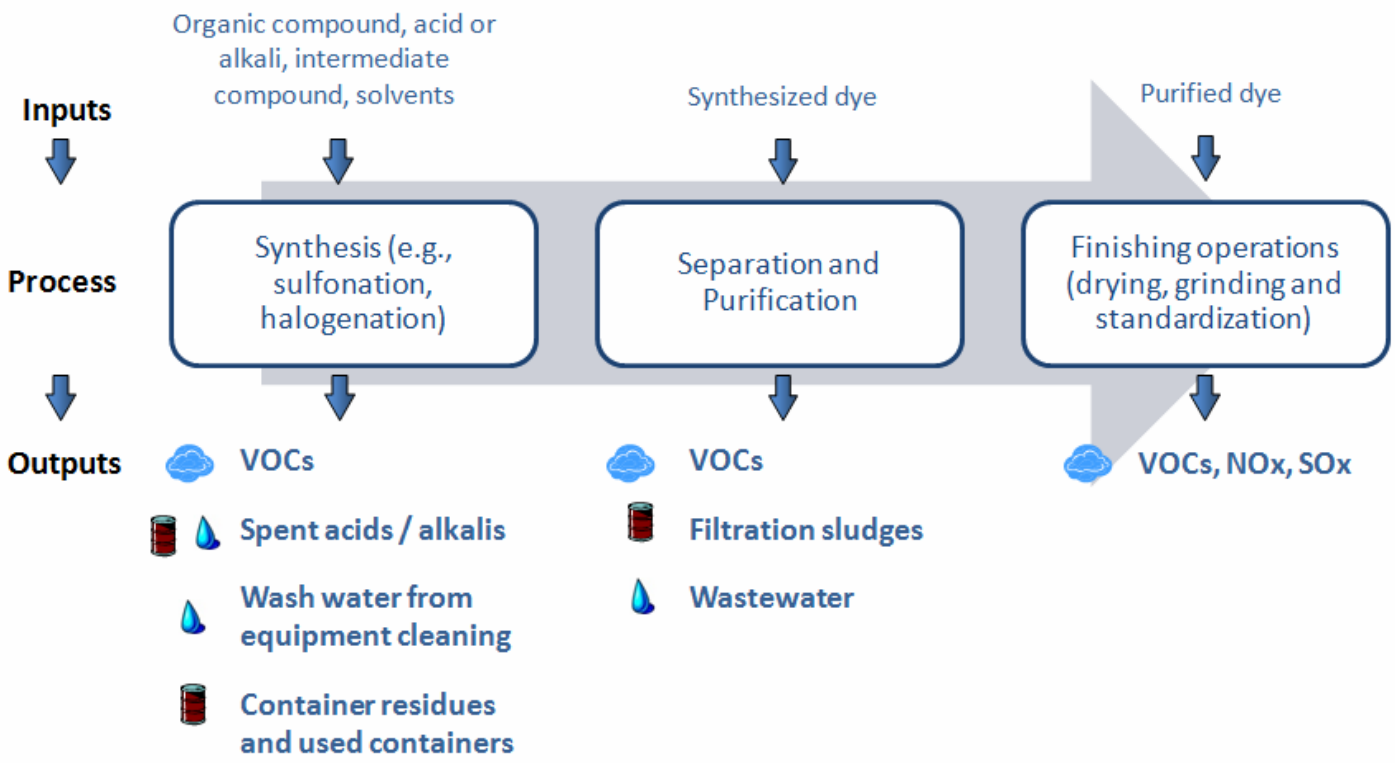
Figure 3: Synthetic Dye and Pigment Manufacturing Processes



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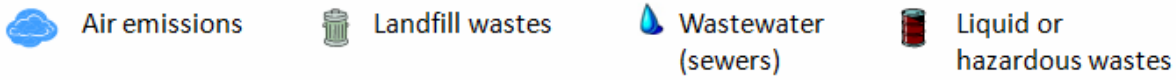
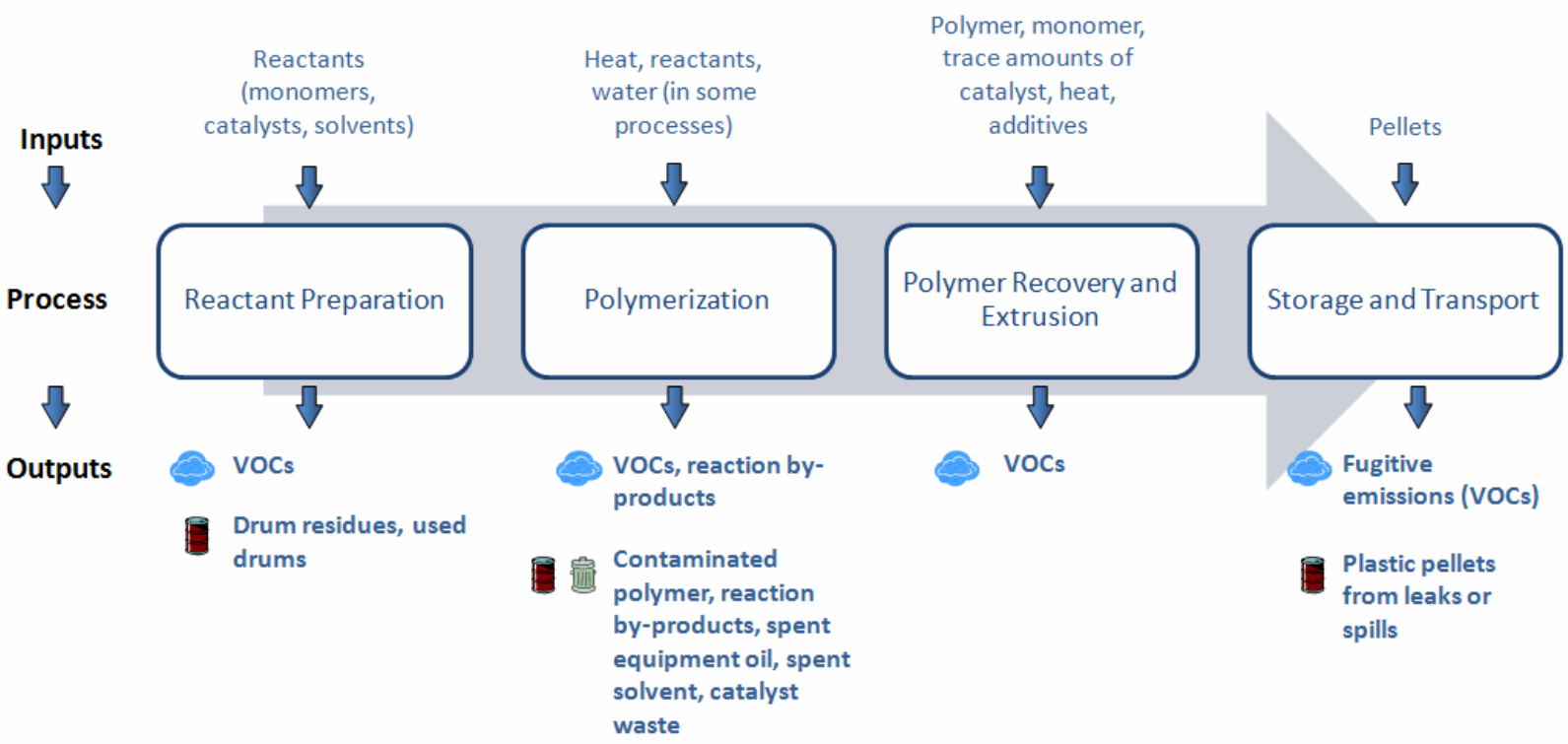


Figure 4: Plastic Resins Manufacturing Process



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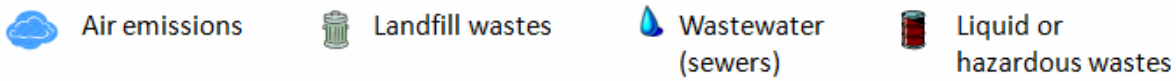
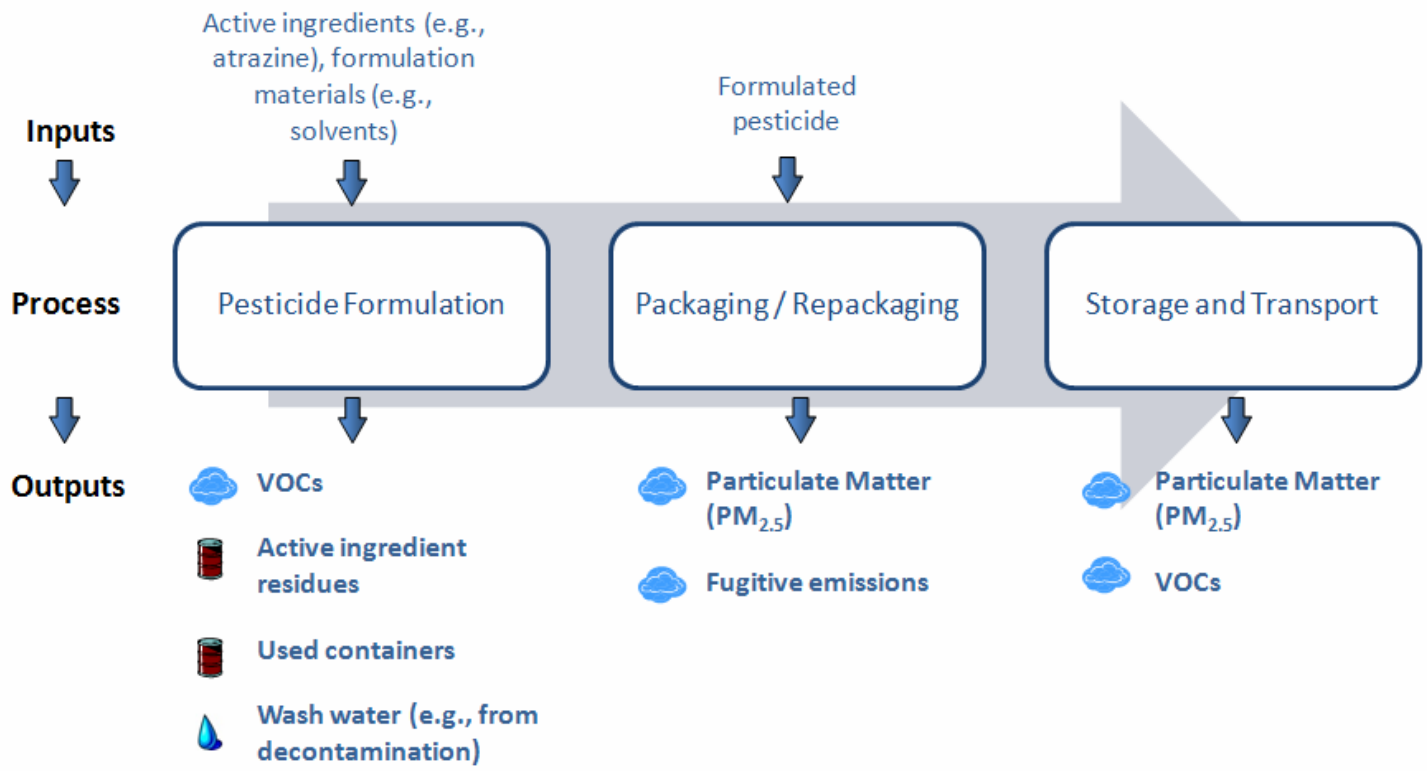


Figure 5: Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing Processes

Pesticide Formulation



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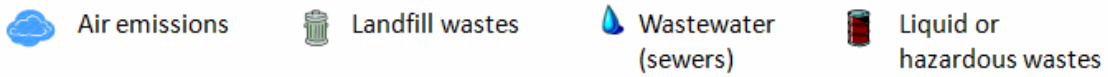
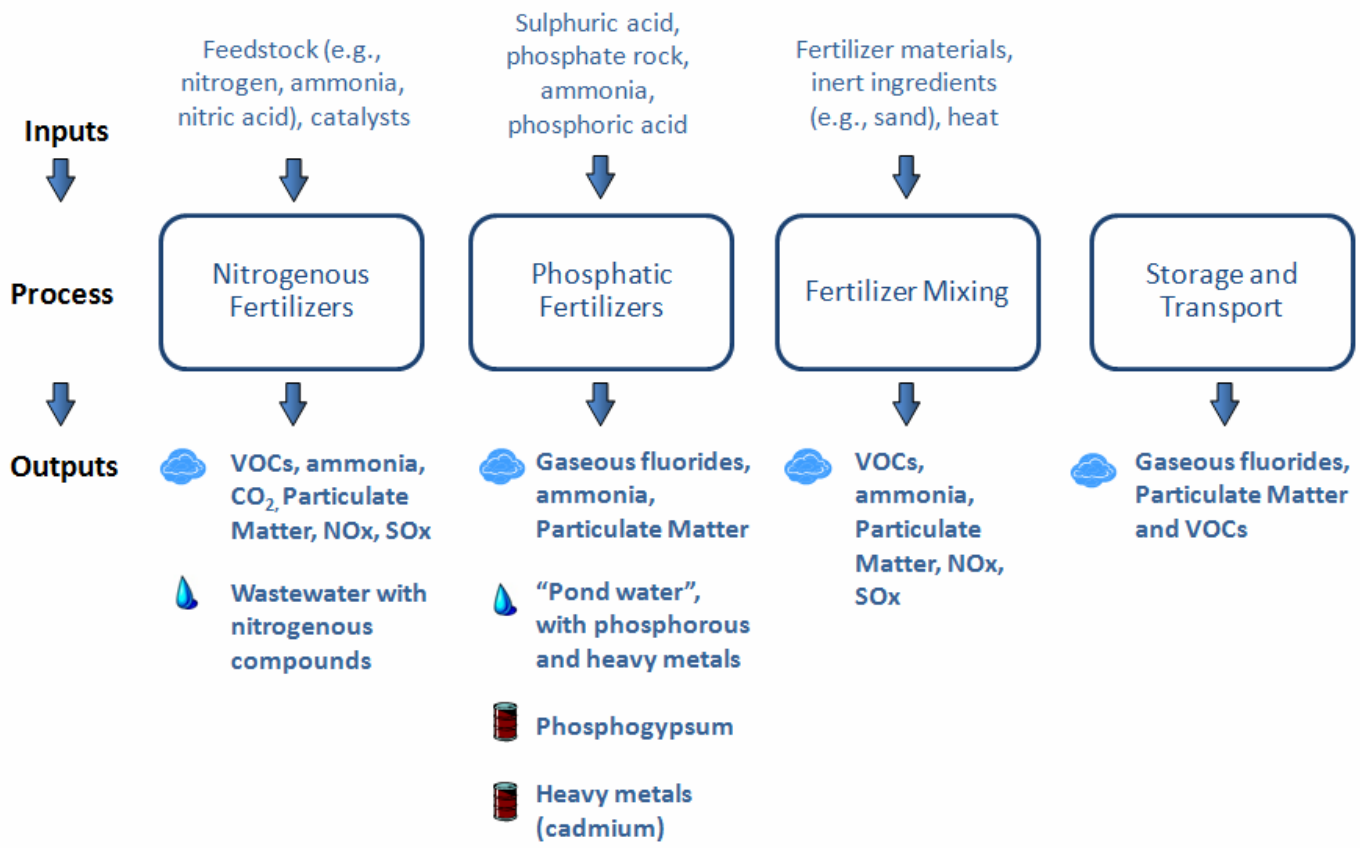


Fertilizer Manufacturing (distinct processes)



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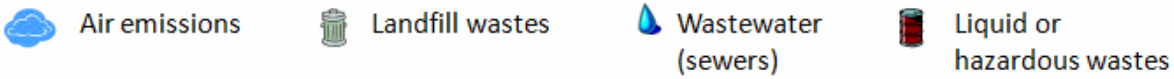
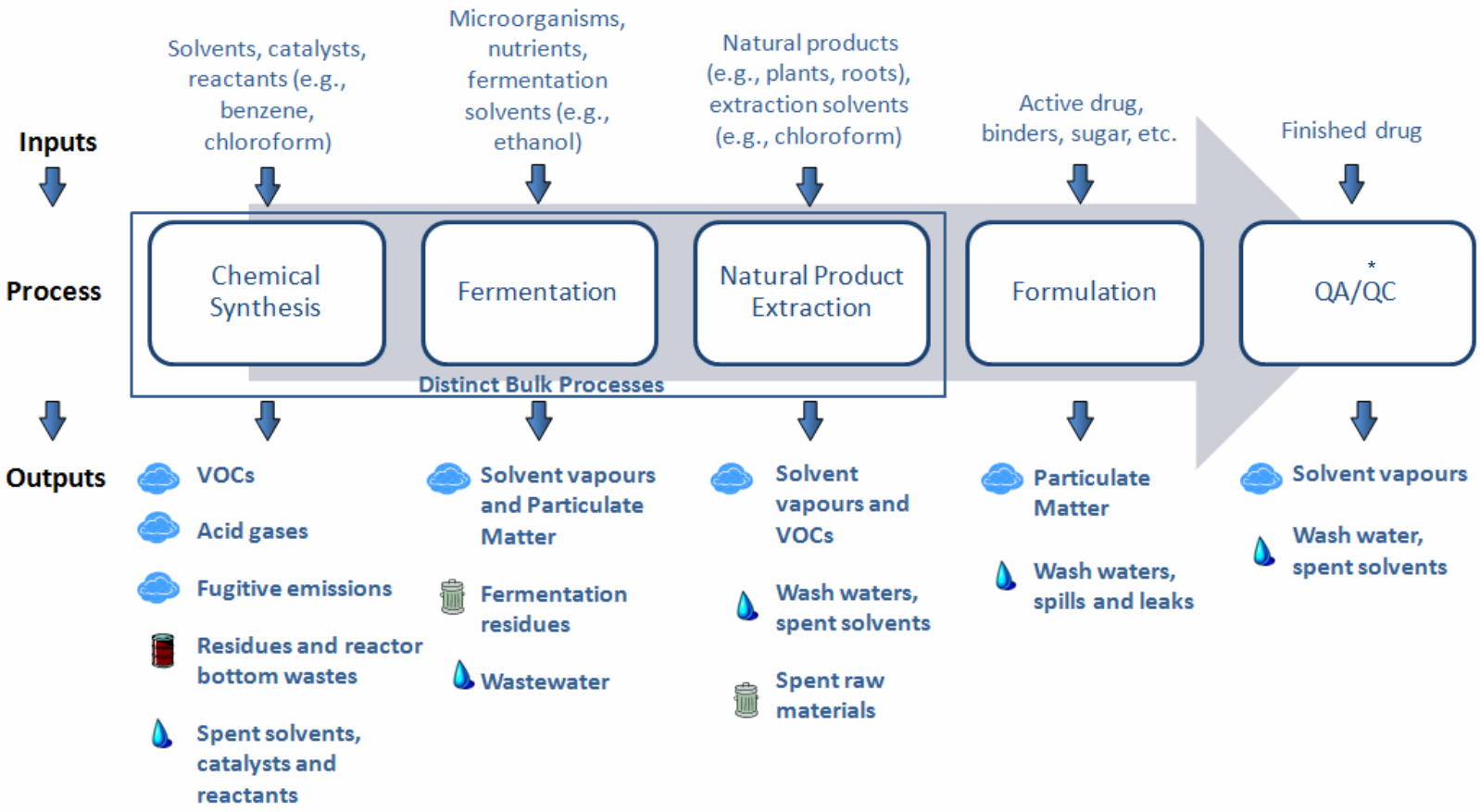


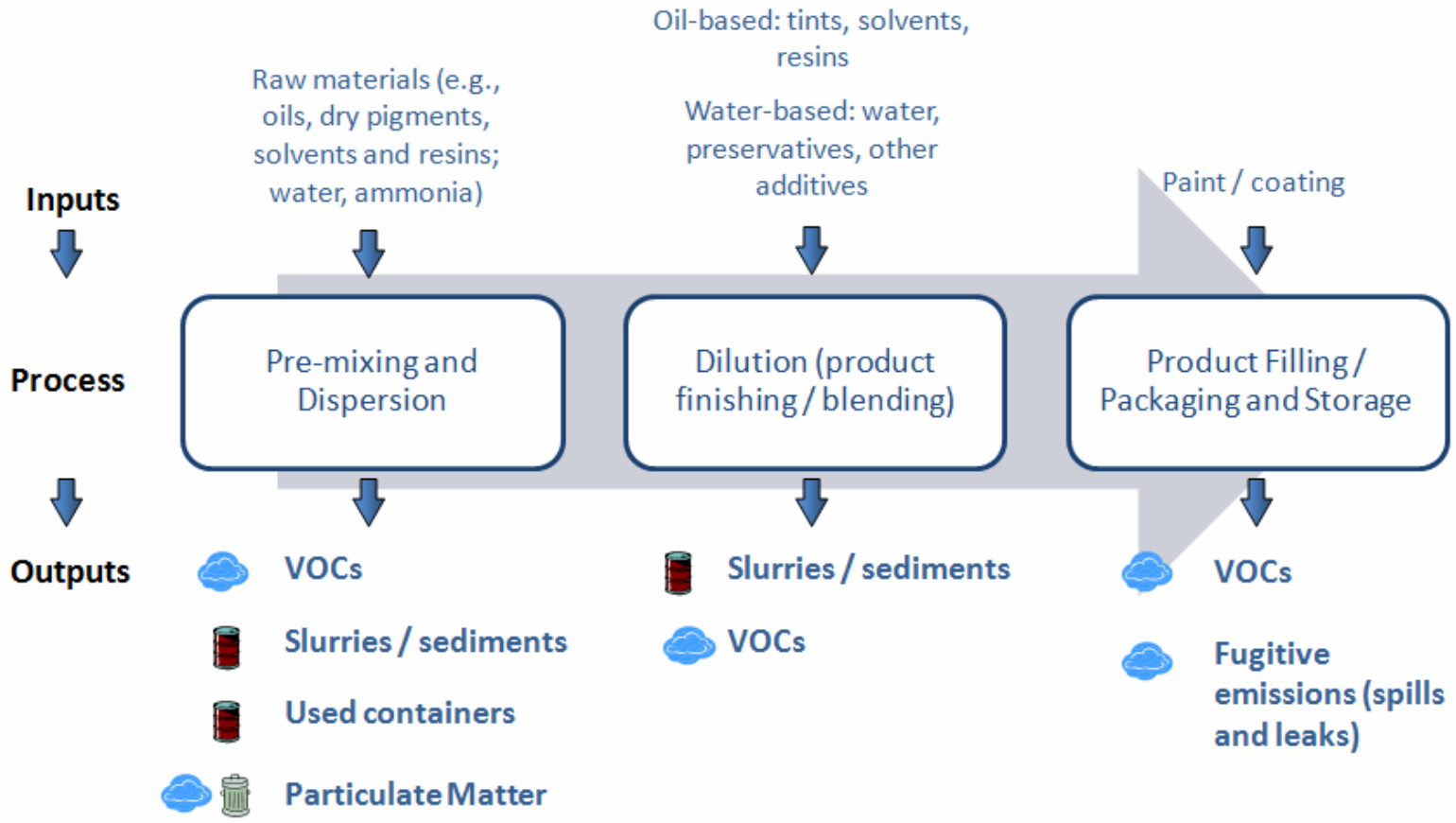
Figure 6: Pharmaceutical and Medicine Manufacturing Process



Symbols used in the flow diagram

** QA/QC = Quality Assurance / Quality Control*

Figure 7: Paint, Coating and Adhesive Manufacturing Process



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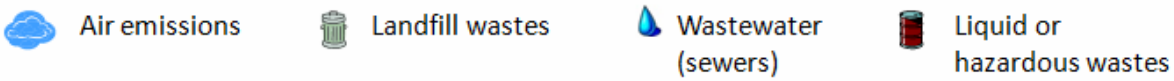
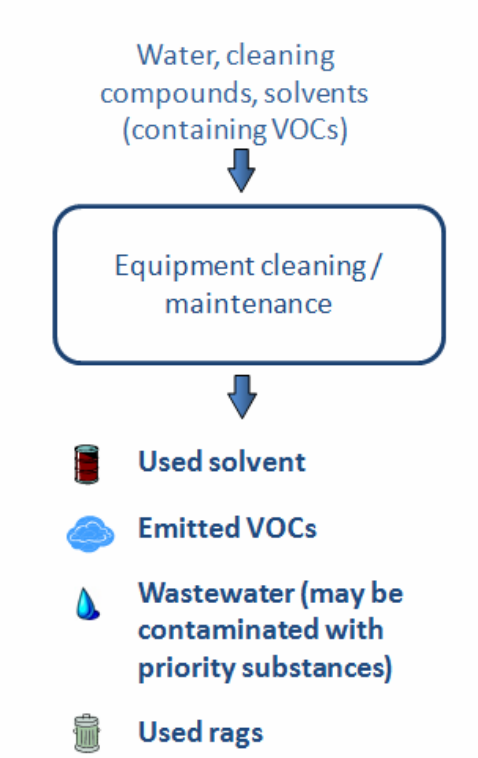
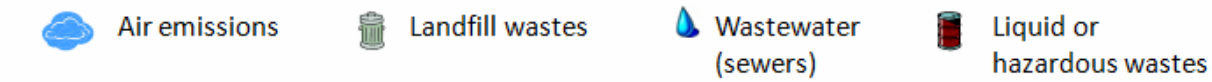


Figure 8: Equipment Cleaning and Maintenance



Symbols used in the flow diagrams



Pollution Prevention Steps You Can Take

This information sheet identifies steps you can take to reduce or eliminate your use of the priority substances and other chemicals that may have a health and/or an environmental impact, and to prevent pollution in the Chemical Manufacturing sector.

The pollution prevention measures identified in this information sheet can reduce costs and/or increase profits. 

Pollution Prevention Assessments – A Good First Step

Before you go too far with any given measure, you may want to do a Pollution Prevention Assessment of your business. You may need an outside expert to help. A typical Pollution Prevention Assessment will include mapping process flows, reviewing equipment uses, evaluating the way you use and store chemicals, evaluating the way you use energy, as well as reviewing waste handling practices and discharges. This assessment helps you to identify many pollution prevention opportunities (and any regulatory compliance issues) and decide which steps to take first.

Pollution Prevention - A Key to Good Management

Good management of your chemical purchases, chemical use and waste disposal is very important. You can improve your environmental performance through Pollution Prevention by:

- identifying how you are using the priority substances and other chemicals of concern that may have a health and/or an environmental impact
- figuring out how much you are using of each chemical and estimating the related emissions (see the earlier description for more information on how to estimate chemical use and emissions)
- discussing the options to reduce or to eliminate these chemicals and, where feasible, taking action. Actions could include:
    - using a different product
    - changing how you apply or clean up the chemical product/waste
    - training staff on how best to apply and clean up the chemical product/waste, or
    - installing new technology
    - maintaining equipment to ensure that leaks and general efficiencies are managed
- tracking the amount of chemicals you use and see if it goes down over time, and
- reviewing progress and identifying whether or not you need to make changes to the company's practices and procedures.

Changes you could make in your facility

The following table lists many options to help you reduce or stop using the priority substances and other chemicals of concern in your facility. Some measures will cost more than others, and some will be easier to implement than others. Operators can implement certain measures by making minor changes in their day-to-day approaches; while others will require management to invest in new technologies.

The table provides a quick and simple way to take stock of what measures your business has already put into place and those measures that your business could apply. In completing the table, you are encouraged to prioritize the actions you would take. While it is not exhaustive, the table identifies many pollution prevention opportunities for the Chemical Manufacturing sector. When assessing the options, please consider your facility-specific conditions and how each option might affect pollution releases to the air, land and water.

The table identifies three general types of options and distinguishes each with a symbol:

Low-cost, good operating procedures – These measures involve operational and managerial changes that can reduce chemical use. They include simple changes to normal practices, process improvements, as well as training and good housekeeping opportunities. This measure does not need new technology purchases.

Choosing an alternative chemical – These measures involve replacing traditional products (such as solvents and cleaning products) with products that have less harmful properties. The ease and cost of these measures depends on the product and the process used.

New technology or system – These measures involve the installation of a new system, machine or process. The cost varies depending on the technology / system.

See **More Resources** for a list of helpful resources related to pollution prevention in the Chemical Manufacturing sector.

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
All Chemical Manufacturing Industries							
Processing							
Automate start-ups, shutdowns and product changeover to optimize use of chemicals and reduce waste generation.		☐	☐	☐	H	M	L
Where feasible, convert from batch to continuous processing to reduce evaporation loss.		☐	☐	☐	H	M	L
Improve catalysts by: • Using a more selective catalyst to reduce the yield of undesired by-products. • Obtaining catalysts in the active form or providing in situ activation with appropriate processing/activities facilities to reduce effluent generation. • Switching from heavy metal catalysts to noble metal catalysts to reduce hazardous waste generation.	 	☐	☐	☐	H	M	L
Recover and re-use materials by: • Reusing by-products as raw materials or as raw material substitutes in other processes. • Recovering solvents by distillation or other methods. • Venting equipment through a vapour recovery system.	 	☐	☐	☐	H	M	L
Review sampling procedures to find ways to reduce the number and quantity of samples. Recycle samples into the process, where feasible.		☐	☐	☐	H	M	L
Optimize reactor design and/or improve reactor mixing/contracting to increase catalyst effectiveness.		☐	☐	☐	H	M	L
Use high efficiency heat exchangers, pumps, and compressors.		☐	☐	☐	H	M	L
Purchasing and Inventory							
Purchase higher purity / higher quality raw materials to reduce unwanted by-products and waste.		☐	☐	☐	H	M	L
Substitute less toxic or non-toxic raw materials, where feasible (e.g., less volatile materials; less water soluble materials to reduce wastewater contamination).		☐	☐	☐	H	M	L
Purchase only the amounts and types of chemicals needed for specific projects to minimize storage times and reduce waste from expired products. Use computer inventory control methods to minimize the amount of stock purchased.	 	☐	☐	☐	H	M	L
Monitor inventory in storage to reduce accumulation of over-aged products.		☐	☐	☐	H	M	L
Keep an accurate inventory of products used (including chemical name, manufacturer, and Material Safety Data Sheet (MSDS).		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Purchase products in refillable, reusable or at least recyclable containers. Request suppliers to take back containers.		☐	☐	☐	H	M	L
Receiving and Sorting Items							
Inspect raw materials, packages, and containers before accepting them from suppliers and return damaged good so they do not become waste.		☐	☐	☐	H	M	L
Receive chemicals in sealed containers in closed docks, or in bulk rail or truck shipments from suppliers with a minimal history of spills.		☐	☐	☐	H	M	L
Return unused, obsolete chemicals or empty containers to suppliers.		☐	☐	☐	H	M	L
Equipment Cleaning and Maintenance							
Substitute cleaning products with less harmful cleaning products, such as water-based biodegradable cleaners (no-VOC or low-VOC) or use recyclable solvents.		☐	☐	☐	H	M	L
Use caustic cleaning solutions instead of solvents.		☐	☐	☐	H	M	L
Maximize equipment dedication to reduce the need to clean equipment.		☐	☐	☐	H	M	L
Use multiple stage rinsing, where equipment is rinsed with increasingly clean rinse solvent (e.g., flush equipment with used solvent before cleaning with new solvent).		☐	☐	☐	H	M	L
Use dry clean up methods, where possible. Clean up spills without washing down with water.		☐	☐	☐	H	M	L
Recover more product from process equipment by scraping tanks, using 'pigs' in product lines or blowing the product from the lines.		☐	☐	☐	H	M	L
Repair leaks and other problems immediately as they occur to reduce cleaning efforts, extend life of equipment, and reduce solvent use.		☐	☐	☐	H	M	L
Sweep or vacuum dry production areas prior to rinsing with water.		☐	☐	☐	H	M	L
Storage							
Keep storage areas free from traffic or exposure to the elements and away from floor drains.		☐	☐	☐	H	M	L
Store chemicals according to need, with minimum inventory kept on hand.		☐	☐	☐	H	M	L
Clearly date and label hazardous materials so they can be easily identified.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Keep chemical containers covered to reduce potential leaks, spills and evaporation from chemical additives. Sealed containers should have air space between the chemical and the container cover to minimize spills and "puffing" losses when the container is opened.		☐	☐	☐	H	M	L
Perform periodic inspections of all chemicals in storage and install leak detection equipment.		☐	☐	☐	H	M	L
Store chemicals in sealed containers away from drains to sewers and place secondary containment mechanisms around all containers to protect from leaks and spills.		☐	☐	☐	H	M	L
Mark all containers to identify the contents to avoid improper handling or disposal.		☐	☐	☐	H	M	L
Date containers when opened to ensure you use them before they expire to reduce waste from expired products.		☐	☐	☐	H	M	L
Spills and Leaks							
Develop a spill response plan and post it so that it is available for all employees.		☐	☐	☐	H	M	L
Make spill kits available at the chemical storage rooms or racks for easy access.		☐	☐	☐	H	M	L
Train workers in emergency spill response.		☐	☐	☐	H	M	L
Use spigots and pumps when dispensing new materials and funnels when transferring wastes to storage containers to reduce spillage.		☐	☐	☐	H	M	L
Establish a leak detection and repair program to inspect leaks from storage tanks, hoses, pipes, valves, pumps and seals.		☐	☐	☐	H	M	L
Collect and reuse spillages, wherever feasible.		☐	☐	☐	H	M	L
Prevent vapour leaks by installing "leakless" equipment or recover vapour by installing vapour recovering lines.		☐	☐	☐	H	M	L
Waste, Wastewater and Residue							
Document sources of waste streams.		☐	☐	☐	H	M	L
Keep waste streams separate for reuse, recycling or treatment.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Keep nonhazardous materials from becoming contaminated.		☐	☐	☐	H	M	L
Pre-treat wastewater prior to discharge to the municipal sanitary sewer.		☐	☐	☐	H	M	L
Install a closed-loop water cooling or heating system to reduce water contamination through reuse and recycling.		☐	☐	☐	H	M	L
Perform preventive maintenance of processing equipment to reduce the volume of waste discharged from worn seals and gaskets.		☐	☐	☐	H	M	L
If your facility has a direct sewage discharge, use an appropriate pre-treatment method (e.g., solids/oil/water separator or DAF unit). Ensure compliance with the City of Toronto's Sewer Use Bylaw if applicable.		☐	☐	☐	H	M	L
Regularly check operation of pre-treatment units and remove collected contaminants. Dispose collected contaminants at a waste management facility.		☐	☐	☐	H	M	L
Reduce water consumption and associated wastewater releases by: • Educating and involving employees in water conservation. • Locating all water use sources (bathrooms, wash sinks, hoses, dish machines, HVAC, cooling water, etc.) in the facility and identifying and implementing water conservation options.		☐	☐	☐	H	M	L
Use equipment that reduces wastewater generation, such as low-volume/high-pressure hoses, spray nozzle attachments for hoses, and squeegees and absorbent "pigs".		☐	☐	☐	H	M	L
Instruct maintenance personnel to routinely inspect and repair any leaking water or steam lines as well as pumps and valves.		☐	☐	☐	H	M	L
Communicate hazardous waste disposal information through the Material Safety Data Sheets. Refer to these sheets for further instruction.		☐	☐	☐	H	M	L
Transport hazardous materials and wastes in completely sealed containers to avoid the possibility of fugitive emissions of VOCs into the atmosphere.		☐	☐	☐	H	M	L
Training							
Ensure employees are properly trained Workplace Hazardous Materials Information System (WHMIS).		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Document all employees' WHMIS training and keep records on hand.		☐	☐	☐	H	M	L
Train workers to follow the standard work procedures (such as cleaning and set up), good housekeeping, and correct material handling methods to make sure all operators follow the same steps to reduce chemical use and waste.		☐	☐	☐	H	M	L
Train employees to properly handle and dispose of chemicals.		☐	☐	☐	H	M	L
Other							
Ask employees for pollution prevention suggestions.		☐	☐	☐	H	M	L

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Basic Organic and Inorganic Chemical Manufacturing							
Select operating temperatures at or near ambient temperature, whenever possible, to improve process conditions.		☐	☐	☐	H	M	L
Use staged heating to minimize product degradation and unwanted side reactions.		☐	☐	☐	H	M	L
Reduce material contamination and equipment failures by reducing corrosion of equipment (e.g., use corrosion inhibitors).		☐	☐	☐	H	M	L
Recycle unreacted reagents to increase product yield and reduce quantities of spent catalyst and by-products.		☐	☐	☐	H	M	L
Reduce impurities in process streams by improving distillation process, by means such as maintaining a clean column and increasing reflex ratio.		☐	☐	☐	H	M	L
Synthetic Dye and Pigment Manufacturing							

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Avoid the manufacture of toxic dyes (azo) and provide alternative dyestuffs to consumers (e.g., textile manufacturers).		☐	☐	☐	H	M	L
Plastic Resins							
Implement plastic pellet waste management to reduce plastic wastes in wastewater. Implement plastic resin pellet spill prevention and cleanup procedures to minimize spills. Promptly and thoroughly clean up spills.		☐	☐	☐	H	M	L
Pesticide, Fertilizer and Other Agricultural Chemical Manufacturing							
Rinse raw material shipping containers directly into the formulation of the same product to recover all raw materials.		☐	☐	☐	H	M	L
Package products directly from formulation vessels to avoid using and cleaning interim storage tanks and transfer hoses.		☐	☐	☐	H	M	L
Install separate dedicated baghouses for each production line to allow for the collected pesticide dust to be recycled.		☐	☐	☐	H	M	L
Dedicate laboratory sinks to certain products, and collect any wastewater generated from the testing of those products either for reuse in the same product or for transfer back to the active ingredient manufacturer.		☐	☐	☐	H	M	L
Conduct all operations indoors or cover outdoor storage tanks and dikes with roofs to prevent fugitive emissions and leaks and spills.		☐	☐	☐	H	M	L
Pharmaceutical and Medicine Manufacturing							
Switch to aqueous-based coating films to reduce hazardous waste.		☐	☐	☐	H	M	L
Monitor reaction parameters (temperatures, pH, etc.) to improve manufacturing efficiency.		☐	☐	☐	H	M	L
Paint, Coating and Adhesive Manufacturing							
Blend off-spec materials into new products to prevent excess discharge to wastewater.		☐	☐	☐	H	M	L
Schedule batches from light to dark products to reduce the need to clean equipment.		☐	☐	☐	H	M	L

 Low-cost, good operating procedures	 Choosing an alternative chemical	 New technology or system

Pollution Prevention Opportunities	Type of Activity	Is the opportunity in place? Yes	No	N/A	If 'No', indicate the level of priority for action (High, Medium or Low)		
Where feasible, re-use baghouse dust in products.		☐	☐	☐	H	M	L

Contact us to provide your feedback on this resource or to suggest any additional pollution prevention resources (email chemtrac@toronto.ca or call 416-338-7600).

More Resources

Australian Government: Department of the Environment and Water Resources. 2007. Emission Estimation Technique Manual for Paint and Ink Manufacturing (v2.0). URL: http://www.npi.gov.au/publications/emission-estimation-technique/index.html

- Provides a process description for the paint and ink manufacturing process, as well as an overview of the general emission sources for the industry and techniques for estimating emissions.

Canadian Pollution Prevention Information Clearing House (CPPIC). 2010. Home Page. http://www.ec.gc.ca/cppic/En/index.cfm

- The CPPIC provides a comprehensive list of pollution prevention resources for Canadian sectors and industries, such as best management practices, fact sheets and sector profiles. Conduct a 'Sector Search' to find resources most relevant to your industry (Chemical Manufacturing is found under the 'Manufacturing' sector link).

Delaware Department of Natural Resources and Environmental Control. 1996. A Pollution Prevention Guide for Small Chemical Manufacturing Operations. URL: http://www.dnrec.state.de.us/del-chem.htm

- This document includes waste reduction suggestions for small chemical manufacturing operations, under the following categories:
  - Improving Operating Procedures (e.g., Keep storage and work areas clean and well organized and keep all containers properly labelled)
  - Production Process and Equipment Modifications (e.g., Improved scheduling. Scheduling the production of chemicals that use the same production line can reduce cleaning requirements)
  - Reusing and Recycling Other Wastes (e.g., Segregate and reuse emissions in the production process)
  - Demonstrating Management Commitment
  - Following up

Ohio EPA. 1995. Chemical Manufacturing Industry: Pollution Prevention Information Packet. URL: http://www.p2pays.org/ref/12/11291.pdf

- The information packet includes thirteen articles related to pollution prevention opportunities for the chemical manufacturing industry, such as:
  - Waste Minimization: Prepare an Effective Pollution Prevention Program
  - Minimize Emissions of Air Toxics via Process Changes
  - Explore Waste Minimization via Process Simulation

Regional Municipality of Waterloo, Water Services Division. 1998. Water Pollution Prevention Fact Sheet: Chemical and Chemical Products Manufacturing. URL: http://www.ec.gc.ca/cppic/En/refView.cfm?refId=1204

- This fact sheet provides a list of pollution prevention opportunities for the chemical and chemical products manufacturing sector, such as:
  - Maintain an accurate inventory of materials stored on site
  - Use dry cleanup methods and mopping, and avoid flooding with water

Washington State Department of Ecology. 2002. Paint and Coatings Manufacturing Sector: A Pollution Prevention Assessment and Guidance. URL: http://www.ecy.wa.gov/pubs/98410.pdf

- This document is the result of a Washington state-wide technical assistance project for the paint and coatings manufacturing industry sector. It includes a description of pollution prevention opportunities already in place at facilities and additional opportunities for consideration, such as:
  - Increasing the use of reusable and recyclable containers (for raw materials and for finished product)
  - Using high-pressure tank and tote wash systems, including re-circulating systems to reuse the wash water

World Bank Group. 1999. Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production. URL: http://smap.ew.eea.europa.eu/media_server/files/l/v/poll_abatement_hanbook.pdf

- The Handbook was designed to be used in the context of the World Bank Group's environmental policies. It consists of three parts:
  - Part 1: key policy lessons in pollution management
  - Part 2: good practice notes on implementation of policy objectives
  - Part 3: detailed guidelines covering close to 40 industrial sectors, including pollution prevention opportunities for each sector

U.S. EPA Sector Profiles

U.S. EPA. 2000. Profile of the Agricultural Chemical, Pesticide, and Fertilizer Industry. URL: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/chemical.html

- A comprehensive document providing background information on the size, geographic distribution, employment, production, sales and economic condition of the agriculture chemical, pesticide, and fertilizer industry in the United States. Descriptions of the manufacturing processes are also provided, along with pollution prevention opportunities in the areas of:
  - Improved production practices (e.g., scheduling production to minimize cleanouts)
  - Housekeeping practices (e.g., performing preventative maintenance on all valves, fittings and pumps)
  - Equipment cleaning (e.g., rinse empty drums prior to disposal to capture the raw material residue for direct reuse in future formulations)
  - New equipment (e.g., purchasing low-volume/high-pressure hoses)

U.S. EPA. 1995. Profile of the Inorganic Chemical Industry. URL: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/inorganic.html

- The EPA profile provides an overview of the inorganic chemical industry in the United States and a general description of the processes involved in inorganic chemical manufacturing. The profile describes the chemical releases and transfers and highlights pollution prevention opportunities, such as:
  - Substitute raw materials
  - Improve reactor efficiencies
  - Improve catalyst
  - Optimize processes

U.S. EPA. 2002. Profile of the Organic Chemical Industry. 2nd Edition. URL: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/organic.html

- The EPA profile provides a comprehensive overview of the organic chemical industry in the United States and a general description of the processes involved in organic chemical manufacturing. The profile describes the chemical releases and transfers for the industry and highlights pollution prevention opportunities, such as:
  - Process/product modifications, including: obtaining catalysts in the active form; modifying reaction sequence to reduce amount or changing composition of intermediates; selecting operating temperatures at or near ambient temperature whenever possible
  - Modifications to equipment, including: improving online controls, using continuous rather than batch processes

U.S. EPA. 1997. Profile of the Pharmaceutical Manufacturing Industry. URL: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/pharmaceutical.html

- A comprehensive document providing background information on the size, geographic distribution, employment, production, sales and economic condition of the pharmaceutical industry in the United States. Descriptions of the pharmaceutical manufacturing process are also provided, along with pollution prevention opportunities in the areas of:
  - Material substitution
  - Process modifications, such as changing processes to reduce solvent usage

- Good operating practices, such as introducing an employee training program and instigating an efficient inventory tracking system

U.S. EPA. 1997. Profile of the Plastic Resin and Manmade Fiber Industry. URL: http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/plastic.html

- The EPA profile provides a comprehensive overview of the plastic resin and manmade fiber industry in the United States and a general description of the processes involved in plastic resin and manmade fiber manufacturing. The profile describes the chemical releases and transfers for the industry and highlights pollution prevention opportunities, such as:
  - Substituting raw materials, such as eliminating benzene from the manufacturing process
  - Improving catalysts, such as using more active catalysts
  - Optimizing processes, such as developing more reliable reactor operations with fewer upsets
  - Adopting good operating practices, such as including pollution prevention objectives in research and new facility design
  - Preventing leaks and spills
  - Optimizing cleaning practices

Ontario Ministry of the Environment: Best Management Practices Documents

XCG Consultants Ltd. 2007. Best Management Practices: 1,4-Dichlorobenzene, 3,3-Dichlorobenzidine, Hexachlorobenzene, and Pentachlorophenol; Non-sector Specific Practices. Prepared for the Ontario Ministry of the Environment (MOE), Land and Water Policy Branch. URL: http://www.ene.gov.on.ca/en/publications/forms/index.php

- MOE's Sewer Use Best Management Practices (BMP) Documents provide BMPs to eliminate or reduce specific harmful pollutants potentially found in wastewater effluents of six industrial sectors in Ontario. This particular guide does not focus on a specific sector, but instead identifies BMPs to eliminate or reduce four substances in wastewater (as identified in the document's title). All of the BMP documents provide background on the substances of interest and a comprehensive list of pollution prevention opportunities to eliminate or reduce the release of substances in wastewater. A few examples of pollution prevention options included in this document:
  - Eliminate 1,4-dichlorobenzene containing space deodorizers
  - Minimize the use of chlorinated solvents

XCG Consultants Ltd. 2007. Best Management Practices. Chemical Manufacturing Sector; Cadmium, Chromium, Copper, Mercury, Zinc, Nonylphenol and its Ethoxylates, and Vinyl Chloride. Prepared for the Ontario Ministry of the Environment (MOE), Land and Water Policy Branch. URL: http://www.ene.gov.on.ca/en/publications/forms/index.php

- This guide identifies BMPs to eliminate or reduce cadmium, copper, mercury, zinc, nonylphenol and its ethoxylates (NPE), and vinyl chloride (VC) in wastewater effluents of sub-sectors of the chemical manufacturing sector, including: Basic Chemical Manufacturing (NAICS 3251), Pharmaceutical and Medicine Manufacturing (NAICS 3254); Soap, Cleaning Compound and Toilet Preparation Manufacturing (NAICS 3256); and Other Chemical Product Manufacturing (NAICS 3257). It provides background information on the uses of the substances in this sector and a comprehensive list of pollution prevention opportunities, such as:
  - Automate control systems
  - Modify products
  - Recover and re-use materials

XCG Consultants Ltd. 2007. Best Management Practices. Chemical Manufacturing Sector: Paint, Coating and Adhesive Manufacturing; Cadmium, Chromium, Copper, Mercury, Zinc, Nonylphenol and its Ethoxylates, and Vinyl Chloride. Prepared for the Ontario Ministry of the Environment (MOE), Land and Water Policy Branch. URL: http://www.ene.gov.on.ca/en/publications/forms/index.php

- This guide identifies BMPs to eliminate or reduce cadmium, copper, mercury, zinc, nonylphenol and its ethoxylates (NPE), and vinyl chloride (VC) in wastewater effluents of the chemical paint,

coating and adhesive manufacturing sub-sector. It provides background information on the uses of the substances in this sector and a comprehensive list of pollution prevention opportunities, such as:

- Blending off-spec materials into new product prevents product being discharged to wastewater
- Scheduling from light to dark products results in less cleaning
- Re-using baghouse dust in products. Dedicating baghouses and re-using baghouse dust in formulations is a potential future opportunity for some facilities

XCG Consultants Ltd. 2007. Best Management Practices. Chemical Manufacturing Sector: Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing; Cadmium, Chromium, Copper, Mercury, Zinc, Nonylphenol and its Ethoxylates, and Vinyl Chloride. Prepared for the Ontario Ministry of the Environment (MOE), Land and Water Policy Branch. URL: http://www.ene.gov.on.ca/en/publications/forms/index.php

- This guide identifies BMPs to eliminate or reduce cadmium, copper, mercury, zinc, nonylphenol and its ethoxylates (NPE), and vinyl chloride (VC) in wastewater effluents of the pesticide, fertilizer, and other agricultural chemical manufacturing sub-sector. It provides background information on the uses of the substances in this sector and a comprehensive list of pollution prevention opportunities, such as:
  - Rinse raw material shipping containers directly into the formulation
  - Use a staged drum rinsing station (counter-current rinsing)
  - Dedicate equipment to specific products or groups of products

XCG Consultants Ltd. 2007. Best Management Practices. Chemical Manufacturing Sector: Resin, Synthetic Rubber, and Artificial and Synthetic Fibres and Filaments Manufacturing; Cadmium, Chromium, Copper, Mercury, Zinc, Nonylphenol and its Ethoxylates, and Vinyl Chloride. Prepared for the Ontario Ministry of the Environment (MOE), Land and Water Policy Branch. URL: http://www.ene.gov.on.ca/en/publications/forms/index.php

- This guide identifies BMPs to eliminate or reduce cadmium, copper, mercury, zinc, nonylphenol and its ethoxylates (NPE), and vinyl chloride (VC) in wastewater effluents of the resin, synthetic rubber, and artificial and synthetic fibres and filaments manufacturing sub-sector. It provides background information on the uses of the substances in this sector and a comprehensive list of pollution prevention opportunities, such as:
  - Improve catalysts - reduce or eliminate by-product formation
  - Automate control systems
  - Modify products (e.g., Substitute hazardous raw materials with less water soluble materials)