



FÉDÉRATION DES PRODUCTEURS DE PORCS DU QUÉBEC

Guide for the design and layout of pig trailer wash stations

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Guide for the design and layout of pig trailer wash stations

Project No.: 18605 (60ET)

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FOREWORD

The writing of the *Guide for the design and layout of pig trailer wash stations* is part of an approach undertaken in the past few years by the *Fédération des producteurs de porcs du Québec* to, first, ensure the safety of Quebec pork for local and distant consumers and second, to improve the biosecurity and health stability of Quebec pig farms. The guide compiles pertinent technical and economic information for designing a wash station, taking into consideration the aspects relevant to livestock biosecurity and consequently meat safety.

The guide was written for pig breeders who wish to improve the biosecurity of their farms through improved management of infectious agents that infiltrate their production sites. It is also intended for live pig transporters who wish to construct a new wash station, renovate an existing station or improve certain features that are more specific to their operations. In addition, the guide contains much information that may be of interest to other agricultural production sectors where biosecurity is an important issue. In fact, as regards the transport of agricultural products, whether it is pigs, other livestock or fruits & vegetables, the requirements for designing, constructing or equipping a wash station are basically the same.

We wish to thank all those who have directly or indirectly contributed to the production of the present guide, particularly the members of the work committee for their involvement. We also wish to highlight the fact that this guide could not have been produced without the financial contribution of the *Conseil pour le développement de l'agriculture du Québec* and the *Fédération des producteurs de porcs du Québec*.

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INTRODUCTION

In the past several years, the pork industry has developed several quality programs to manage food safety risks, particularly the Canadian Quality Assurance (CQA®) on-farm programs, and the plan for monitoring and control of salmonella (MCS) and the Food Safety Enhancement Program (FSEP by the CFIA) for slaughterhouses. Moreover, recognizing the biosecurity risks to meat safety caused by a certain number of pathogens, particularly salmonella, certain pathogenic types of E. coli and several viruses (for example Circovirus and PRRSV) associated with transport activities, the pork industry has developed and implemented the Best Practices for the Transport of Pigs (BPTP) program.

The development of the BPTP programme has raised questions as to the requirements concerning washing, disinfecting and drying (WDD) of vehicles and the availability of the infrastructures needed for washing pig transport vehicles in Québec. A characterization of these infrastructures was conducted and several factors limiting the application of the BPTP program were identified:

- The large ratio of independent companies that perform WDD operations outside ;
- The large number of stations that do not meet the BPTP Guide criteria;
- The lack of wash stations in certain areas of Québec;
- Poor knowledge of the costs relating to WDD operations;
- Underuse of existing wash stations due to inadequate perception of biosecurity risks;
- Insufficient utilization of assisted drying of transport vehicles.

In view of these observations and in line with the recommendations expressed in the project description¹, the present guide gathers available information on the design and layout of wash stations for live pig transport vehicles. It includes both the technical and economic aspects of the infrastructure as well as the constraints related to pig-farm biosecurity and meat safety of the livestock transported by such vehicles.

The guide first covers the location of such infrastructures in relation to the breeding sites, human activities or natural features and the risks of their proximity. It then discusses the layout of the wash site and presents points relating to the parking and movement of vehicles, the design and drainage of road surfaces and the vehicle washing locations. The guide then covers the design of the building itself, in particular the configuration and layout of the various rooms and relevant construction details. Wash station equipment is analyzed and covered in two sections, according to specificity: first relevant to WCC operations and second relevant to the mechanical functions of the building (heating, ventilation). Special attention is paid to water management due to the large quantities required to operate a wash station. Finally, a cost and operating estimate based on certain parameters is presented and the case of existing wash stations is discussed, along with potential general improvements which can be made.

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1. WASH STATION LOCATION

1.1 BIOSECURITY

The objective of a wash station is to disinfect vehicles. Therefore, when possible, it should be located in such an area as to prevent the recontamination of clean vehicles. Slaughterhouses, farms, burial sites, meat rendering sites and wastewater treatment sites are the greatest sources of contamination as they host microbiological pathogens and contribute to their proliferation. The contamination may occur by aerial or mechanical propagation. In that case, birds in the vicinity of burial sites or other farms, insects and vermin (rats, mice, etc.) are potential vectors of contamination.

It has been demonstrated that certain porcine pathogens, such as Porcine Reproductive and Respiratory Syndrome virus (PRRSV) and *Mycoplasma hyopneumoniae* (porcine Enzootic Pneumonia) can travel as far as 3 km^{2, 3, 4} or more, under favorable meteorological conditions⁵ such as cool weather, high degree of humidity or light winds and low light conditions. Insects such as flies and mosquitoes are potential pathogenic vectors for Porcine Reproductive and Respiratory Syndrome virus and transmissible gastroenteritis⁶. Furthermore, it has been demonstrated that vermin carry a certain number of pathogens such as *Brachyspira hyodysenteriae*, Salmonella and Leptospira⁶. However, the extent of contamination is usually less than 100 meters from their nests.

Table 1-1 gives the recommended distances separating different infrastructures from a wash station, required for meeting the biosecurity constraints of the station activities. The separation distances take into account the type of pathogens that the various infrastructures may host, as well as the potential vectors of the pathogens. **The distances listed here are not regulatory but indicate separation distances under which an increased risk of contamination must be considered.** The infrastructures are listed by decreasing level of risk. It is important to note that livestock production sites (other than pig farms) may be potential sources of pathogens for pigs, and vice-versa, particularly Salmonella and Influenza. A biosecurity perimeter should therefore be observed, even though it is less restrictive than for pig farms owing to the lower risk.

In addition to the infrastructures listed, the spreading pig manure within the perimeter of the wash station must also be considered, even though this activity is intermittent. A distance equivalent to that of farms is recommended, i.e. 3 km from the spreading site for pig manure and 1 km from other livestock manure. In addition, the road near the wash station may also represent a risk if it is regularly used by vehicles transporting slaughter pigs. Consequently, measures must be taken at the wash station to reduce the risk of contaminating washed and disinfected vehicles or another location should be considered for washing vehicles transporting breeding animals.

Table 1-1
Recommended separation distance from a wash station
by decreasing level of risk

Type of infrastructure	Priority	Recommended distance (km)
Slaughterhouse	1	3
Pig farm	2	3
Meat rendering site	3	3
Landfill site	4	3
Livestock farm other than pigs	5	1
Wastewater treatment site	6	1

1.2 HUMAN HEALTH & SAFETY

The risk wash stations could pose to public health is mitigated. Various porcine pathogens, such as Influenza, Hepatite E, Salmonella, Campylobacter, Leptospirosis, E. coli, *Erysipelothrix rhusiopathiae*, *Strep. suis*, *Toxoplasma gondii*, *Trichinella spiralis*, and *Yersinia enterocolitica* can potentially develop into zoonoses ^{7,8}. In practice, humans are very rarely infected by these pathogens or seldom develop a disease following the contact of porcine infectious agents. Although there is no scientific data on the recommended separation distances, it is advised that as a precautionary measure, a one-kilometer buffer zone be maintained between the wash station and the perimeter of the urbanized area.

1.3 OTHER IMPORTANT POINTS

The location of a wash station is also subjected to different provincial and municipal regulations, which are not specifically related to wash station activities. These deal with relative distances to different surface water points (lake, stream, marsh, floodable area, riverbank or shoreline strip, etc.) and groundwater points, lot lines, public roadways, and areas of human activity such as protected buildings, private residences, public buildings, administrative or commercial buildings and tourist establishments. Most of these regulations are administered by the *Ministère du Développement durable, de l'Environnement et des Parcs du Québec* (MDDEP) and by each municipality, but this does not exclude the involvement of other organizations (*Commission de Protection du Territoire agricole, Ministère des Affaires municipales, des Régions et de l'Occupation du territoire, etc.*). It is up to the owner to ensure compliance with all regulations.

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2. OUTDOOR LAYOUT

The layout of the outdoor area comprises all or some of the following items:

- The site entrance point for dirty vehicles and the exit point for clean vehicles;
- Parking for dirty vehicles and clean vehicles;
- Washing and drying infrastructures;
- The areas for cleaning and disposal of soiled bedding (although it is preferable that the latter be stored on another site than the wash station).

The layout should minimize the risk of contaminating clean vehicles by dirty vehicles already parked on the site, entering the wash station or circulating on a road in the vicinity. Careful consideration should be given to the road surface and vehicle cleaning.

2.1 SITE CONFIGURATION

The configuration of a site is variable and is determined by the level of activity of the wash station, the characteristics of the available site, the types of livestock transported (breeders, piglets, commercial pigs) and the desired level of biosecurity. The dominant wind direction around the site also impacts the configuration.

Figure 2-1 illustrates a wash site configuration with the greatest potential in terms of possibilities, and which also offers the highest level of biosecurity. This configuration is suitable for large companies; it makes it possible to separate the types of livestock transported into two separate systems:

- Transport of slaughter pigs and breeding pigs and piglets, or ;
- Transport within a given production system (piglets) and outside the system (slaughter pigs and breeding pigs).

In this configuration, the entrance point for dirty vehicles entering the site is separate from the exit point for clean vehicles, for each of the two transport systems. This offers a single direction for circulating vehicles, thereby preventing them from crossing a path they have already taken or preventing two different systems (slaughter pigs vs. piglets) from passing each other. This approach reduces the risk of pathogen propagation by direct contact with the contaminated ground, by dust or by airborne transmission between dirty vehicles and clean vehicles, and between vehicles used for different transport systems. A cleaning area and soiled bedding disposal area common to both transport systems, as well as a drying room for one transport system is also planned. Furthermore, the clean-vehicle infrastructures are located upwind of the washing infrastructure. In addition, a 48-hour “quarantine” parking area can be planned in the same area as the clean vehicles parking, if this option is considered.

The configuration in Figure 2-2 does not separate two different transport systems and does not include a special drying room. However, this configuration does provide unidirectional vehicle circulation paths. Figure 2-3 illustrates the simplest configuration, suitable for a small company, as the vehicles enter and exit the wash station directly at the same point. In this configuration, a clean vehicle cuts across its own path when leaving the wash room. Therefore, it is of the utmost importance that the road surface be good quality. It is also possible to allow clean vehicles to park inside the wash room.

These configurations are given only as examples; several other configurations are possible and just as effective, provided the following principles are observed:

- Locate the dirty vehicle infrastructures (site entrance, parking, cleaning and bedding disposal) downwind of the washing infrastructure;
- Oppositely, locate the clean vehicle infrastructures (site exit, parking, drying room, quarantine area) upwind of the drying infrastructure and where possible, as far as possible from the public roadway;
- Plan the directions of circulating vehicles such as to minimize the risks of cross-contamination between dirty vehicles and clean vehicles.

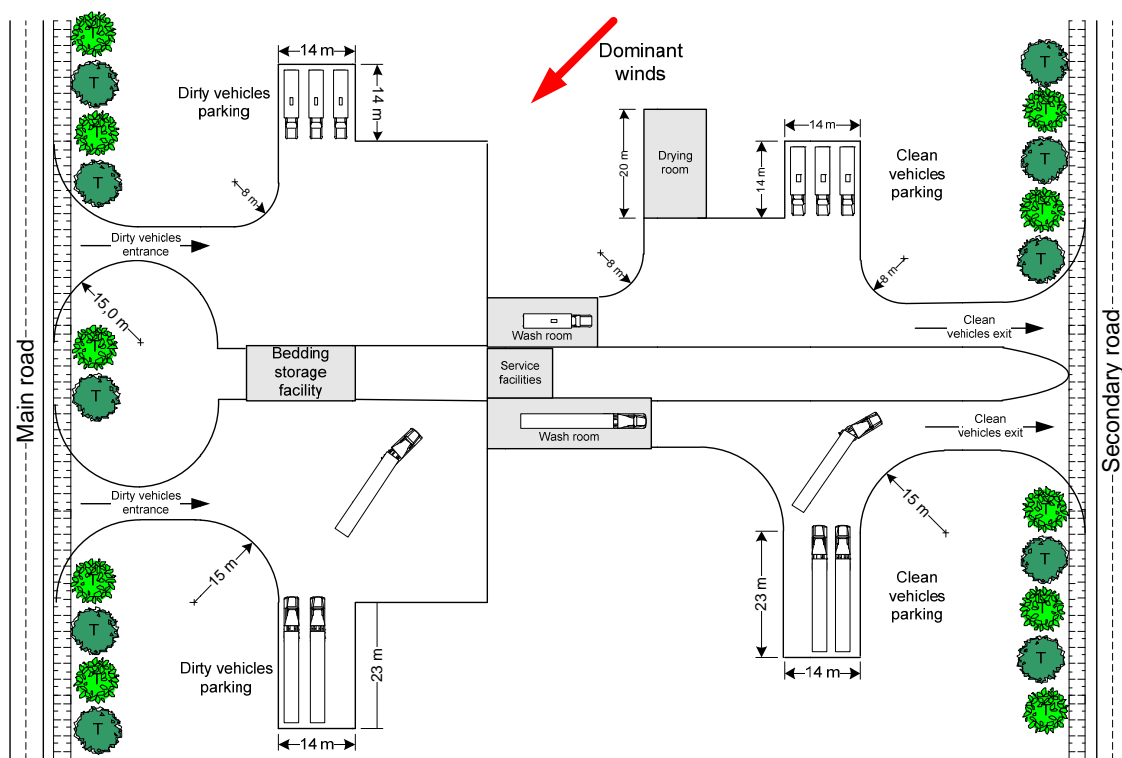


Figure 2-1
Comprehensive wash station layout

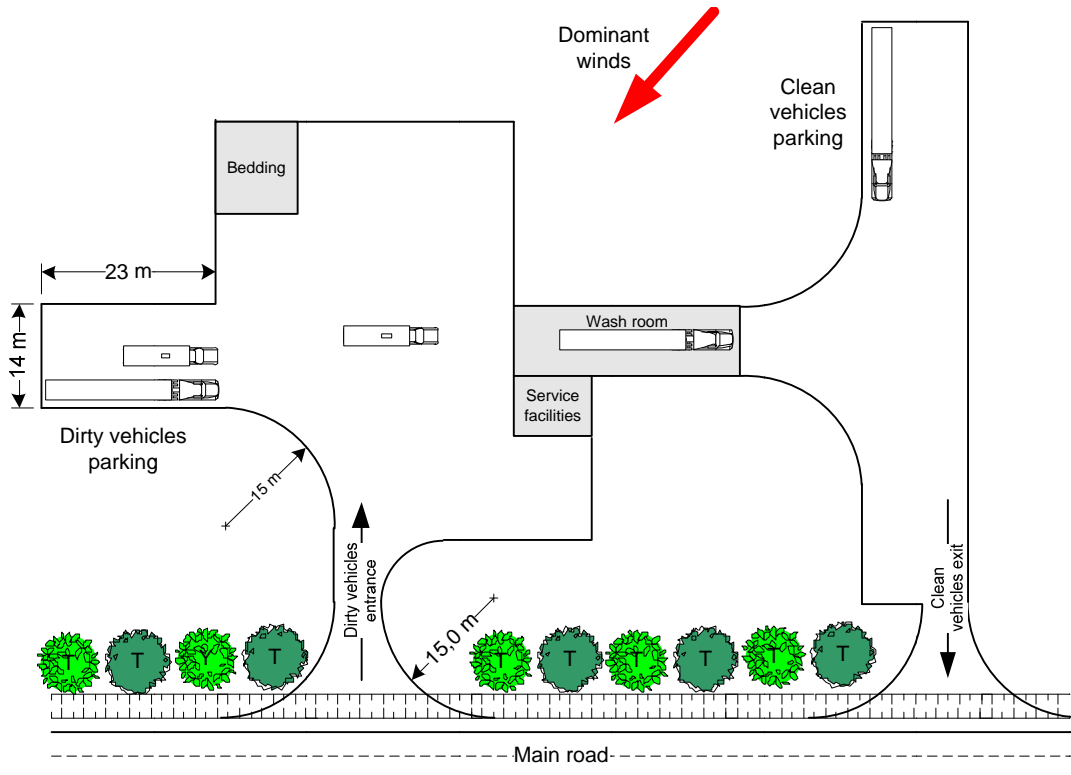


Figure 2-2

Layout of a wash station with one wash room and separate entrance and exit

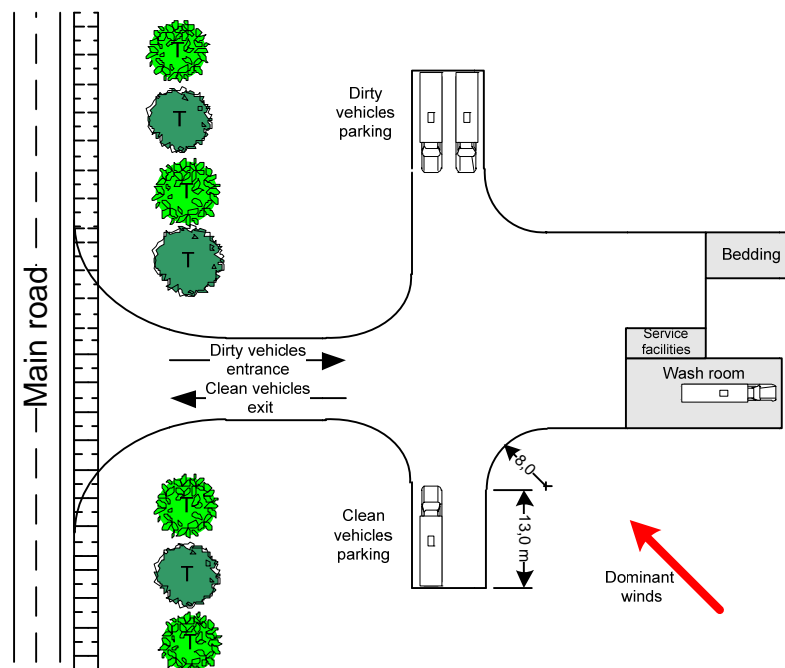


Figure 2-3

Configuration of a wash station with a wash room and a single access road

2.2 ROAD SURFACE

The road surface of the outdoor area must be durable, permit vehicle circulation in all seasons, and ensure rapid drainage of rainwater or melt water, for practical reasons and to limit pathogen development. A hard impermeable surface made of conventional concrete or Roller Compacted Concrete (RCC) or a soft surface made of asphalt or gravel with surface treatment (bitumen emulsion) is recommended. A gravel pavement is satisfactory if it is properly designed, well built and maintained. Oppositely, pavements made of dirt, sand or grass must be banned.

A well-designed road surface comprises 3 layers of variable thickness, depending on the chosen pavement and the infrastructure of the soil (Table 2-1). A minimum slope of 3% (4% if the pavement is made of granular material GM-20 (0-3/4")) to drain water from the station yard to the ditch and a vegetative filter strip with a maximum slope of 6% to reduce particle runoff (Figure 2-4).

Table 2-1
Design of the road surface of the outdoor station yard

Layer	Material	Thickness (mm)	Road infrastructure
Pavement	Concrete (32 MPa with reinforcement)	150	n.a.
	Roller-compacted concrete	150	n.a.
	Asphalt covered	60	n.a.
	GM-20 Crushed aggregates (with or without surface treatment)	75	n.a.
Road base	GM-20 Crushed aggregates (98% PM compacted)	150	n.a.
Sub-base	GM-112 Crushed aggregates (98% PM compacted)	300-400 ¹	Coarse-grained ²
		375-525 ¹	Medium-grained ²
		450-600 ¹	Fine-grained ²

¹ The highest value is usually applied in excavated or cut-and-fill areas, poor load-bearing capacity soils or soils with high swelling potential due to freezing.

² Coarse: silty, loamy or shaly soils; Medium: silty or shaly sands; fine: silt, shale or fine-grained.

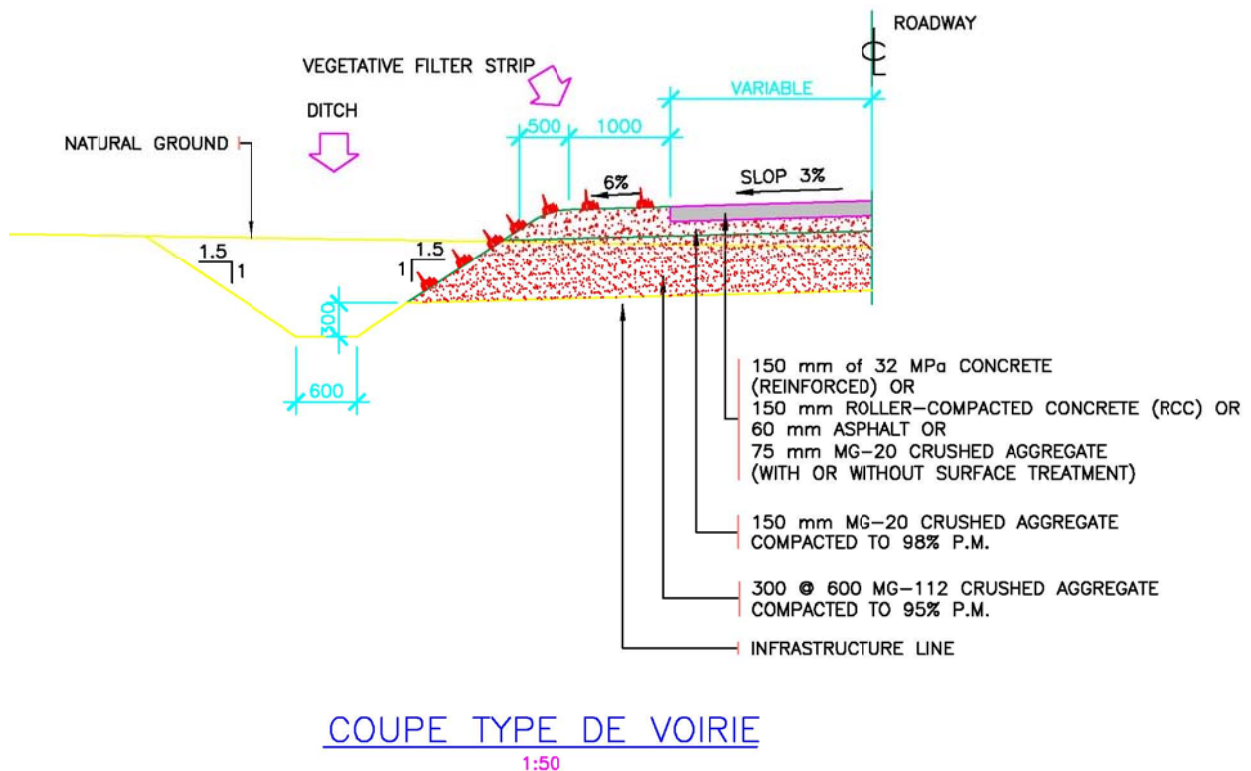


Figure 2-4
Wash station road surface profile

2.3 CLEANING AREA

When the bedding has been used on the floor of the vehicle, it must be removed before the latter is washed and disinfected. Areas must be provided for cleaning the vehicle and disposing of the soiled bedding. Ideally, for reasons of biosecurity, the disposal area should be located on a site that is separate from the wash station. But for practical and logistical reasons, it is often located adjacent to the washing station. In that case, the cleaning and disposal areas should be located such as to minimize the risk of contaminating parked clean vehicles and the air inlets of the wash station.

2.4 ACCESS

Access to the site is secured and personnel and visitor access to the building is controlled.¹⁷

A wash station used only for slaughter transport vehicles could be used by vehicles transporting other species of livestock provided it meets the same standards for washing, disinfection and drying.

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3. INDOOR LAYOUT

The wash station's indoor layout must suitably meet the needs of the company, in terms of its capacity and the required biosecurity level. The following points must be considered when it is designed:

- The number and type of vehicles to be washed and dried per day;
- The required biosecurity level;
- The personnel who must have access to the various wash station rooms;
- The biosecurity relations between the rooms;
- The type of surface and materials used.

To meet all of these constraints, a wash station may include one or more distinct rooms. The most elaborate wash station configuration comprises:

- One or more wash rooms for the vehicles;
- One or more drying rooms;
- An office;
- A room for the washing equipment (high pressure pump, detergents and disinfectants, etc.);
- A mechanical room for the building (heating, ventilation, water treatment, etc.);
- A laundry room;
- A clothing room;
- Toilet facilities (sink, toilet, etc.).

3.1 WASH ROOM

3.1.1 Dimensions

The wash room dimensions are determined by the dimensions of the vehicles that will be using the washing facilities and by the clearance that should be maintained to perform the different operations. Table 3-1 gives, as an indication, the maximum dimensions authorised by the *Ministère des Transports du Québec*¹⁹, for vehicles using the provincial roadways.

Table 3-2 also gives the minimum and recommended clearances all around the vehicles inside the wash station. Obviously, the dimensions indicated are given for the most sizeable vehicles that will be washed in the station. The recommended width clearance takes into account the space required for washing removable floor panels (Figure 3-1) and winter panels and for the installation (if necessary) of equipment (washer, water heater, product reservoirs, etc.). The length clearance takes into account the space required for opening the loading ramp. Finally, the vertical clearance takes into account the installation of ceiling lights and the operation of the station's doors. Moreover, an additional 0.60 m clearance above the highest vehicle must be included in the doorways.

Table 3-3 gives the recommended dimensions for a wash room accommodating the largest vehicles authorised on Quebec roadways.

If the station has two or more adjacent wash rooms, a common wall should be planned to reduce the risk of cross-contamination during different simultaneous operations (e.g. rinsing and disinfection). However, if the risk level is known to be low, a removable curtain is a good economical alternative (Figure 3-2).

Table 3-1
Maximum vehicle dimensions authorised in Québec (MTQ, 2005)



Parameter	Truck 	Tractor-trailer 
Length	12.5 m	23.0 m
Width		2.6 m
Height		4.15 m

Table 3-2
Clearance required in the wash room




Clearance	Length ¹	Width ²	Height ³
Minimum	4.0 m	4.0 m	1.0 m
Recommended	7.0 m	6.5 m	1.6 m

¹ Minimum : 2.0 m in front and in back of the vehicle; recommended : 5.0 m in back of the vehicle so as to be able to open the loading ramp

² Minimum : 2.0 m on each side; recommended : 3.25 m on each side for placing removable floor panels and winter panels

³ Minimum : 0.50 m clearance for the door and 0.50 m, when opened; recommended : 0.60 m and 1.0 m, respectively

Table 3-3
Recommended wash room dimensions

Type of vehicle	Length	Width	Height
	15.0 m ¹	9.1 m	6.1 m
	19.5 m		
	30 m		

¹ Typical length (no relation with authorised MTQ length (2005))



Figure 3-1
Wall mounts for washing the floor panels



Figure 3-2
Removable curtain separating two wash areas

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3.1.2 Construction

Considering the humidity conditions and the sanitary requirements relating to the operation of a wash station, the materials used for the inner lining of the walls and ceiling, and for the floor must be made of non-putrescible, easily cleaned, smooth material with watertight assemblies.

The inner lining of the walls and ceiling (Figure 3-3) is typically composed of insulating fibreboard, a vapour barrier (polyethylene film) and PVC panels or pre-painted or galvanised steel sheets fixed to laths (Figure 3-4). The panels must be installed such that the sheets are vertical to increase surface drainage towards the floor. The joints between the sheets (PVC or steel) and the finishing in the corners (wall-wall, wall-ceiling) must be as watertight as possible. Special moldings are also available for each product to enhance watertightness. The panels should overlap the concrete foundation wall by at least 100 mm; otherwise they should be supported by a molding fixed to the foundation wall (Figure 3-5). The vapour barrier must be installed very carefully due to the high level of humidity in the wash room. Even minor leaks in the vapour barrier can rapidly lead to loss of insulation (thereby increasing heating costs) and accelerate the deterioration of the insulation and potentially that of the structure.

The floor should be made of a concrete slab with a minimum resistance of 25 MPa and a minimum thickness of 200 mm (8 inches) with a 152 x 152 MW9.1 x MW9.1 (6 x 6 x W1.4/W1.4) steel meshwork reinforcement centered in the slab (Figure 3-3). As regards the watertightness, it is preferable that the concrete slab be poured in a single operation without control joints. A moist cure must be applied for at least seven (7) days to reduce surface cracking. The concrete slab can also be poured in several phases, with construction joints (in that case the floor forms a checkerboard pattern but the reinforcement is continuous; the joints do not have to be sealed) or in a single operation but with control joints which must be sealed.

In all cases, it is highly important to support the mesh using chocks so that it remains centered in the slab while the concrete is poured, otherwise the effectiveness of the mesh can be sensitively reduced, especially if it is located too closely to the upper surface of the concrete slab. The concrete is finished with a flat steel trowel to obtain a smooth surface. If a higher quality surface is required, special epoxy surface coating is applied instead of simple concrete paint. The cost of such a coating varies significantly depending on the level of preparation of the floor surface and the thickness of the coating (from 15 to 70 \$/m²). A sealing strip and a sealant ensure the watertightness between the foundation wall and the floor slab.

The wash water is evacuated through a floor drain which can be installed according to several possible configurations (Figure 3-6):

- Centered longitudinally in the wash room (a);
- Transversally behind the vehicle (b);
- Between two adjacent wash tracks without a separation wall (c);
- A combination of these positions or other configurations.

A minimum floor slope of 2% to 3% towards the drain should be applied. Moreover, additional reinforcement is needed when constructing a drain in the floor (Figure 3-7).

Note that when installing a radiating floor, no particular quality is required for the concrete. However, for the sake of comfort, a maximum floor temperature of 30°C (85°F) should be maintained, for a heat transfer fluid temperature ranging between 37°C et 50°C (100°F et 120°F). In this type of installation, a rigid insulation (50 mm thick) should be installed beneath the slab to reduce heat loss to the floor.

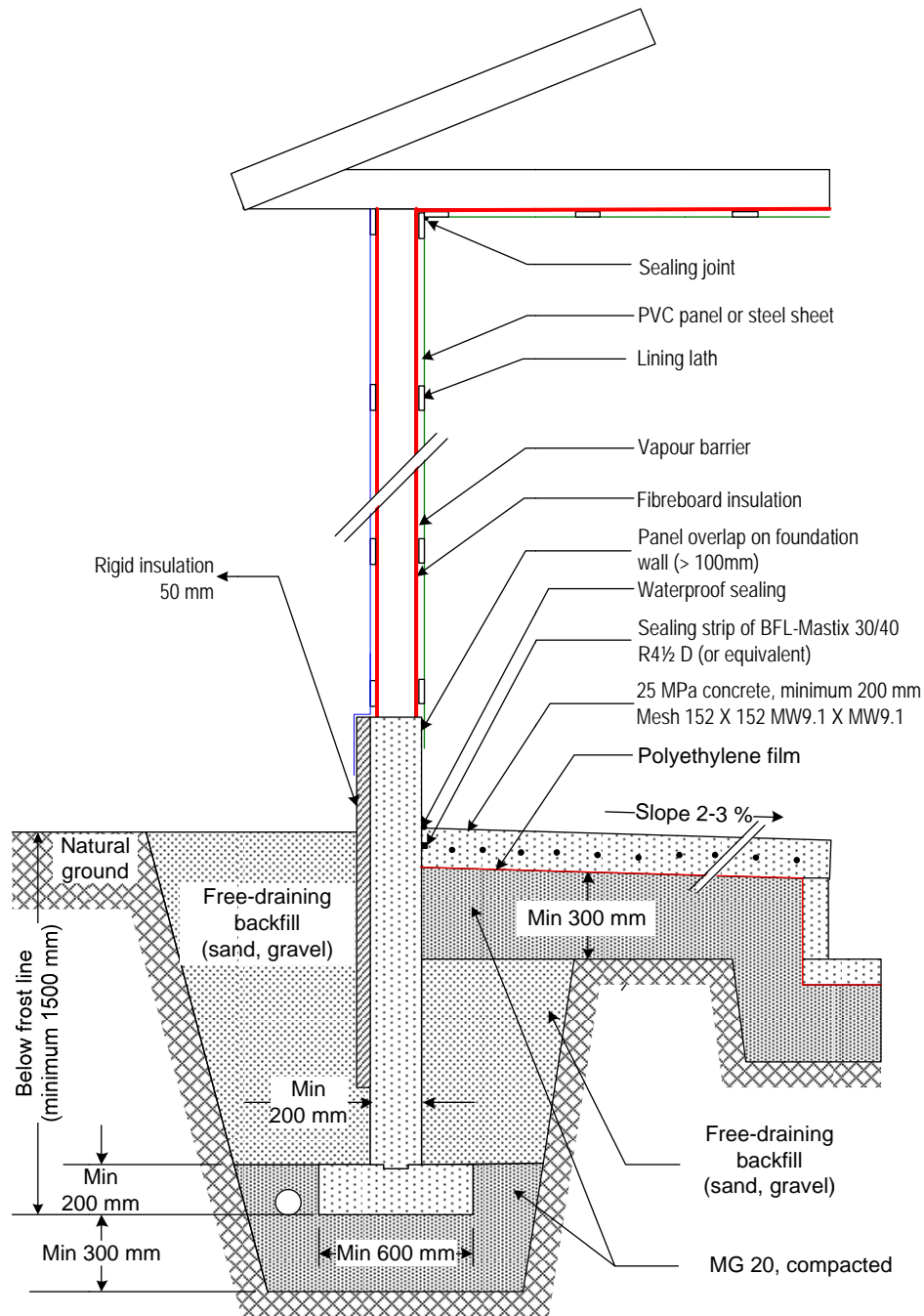


Figure 3-3
Cross-section of a wash room



a) Polyvinyl chloride (PVC)



b) Pre-painted steel



c) Galvanised steel

Figure 3-4
Different types of wall lining



a) Overlapping the foundation wall



b) Molding fixed to foundation wall

Figure 3-5
Different types of finishing for foundation wall lining



a) Longitudinal drain, center



b) Transversal drain in
back of vehicle



c) Longitudinal drain between
two adjacent wash tracks

Figure 3-6
Different locations for the floor drain

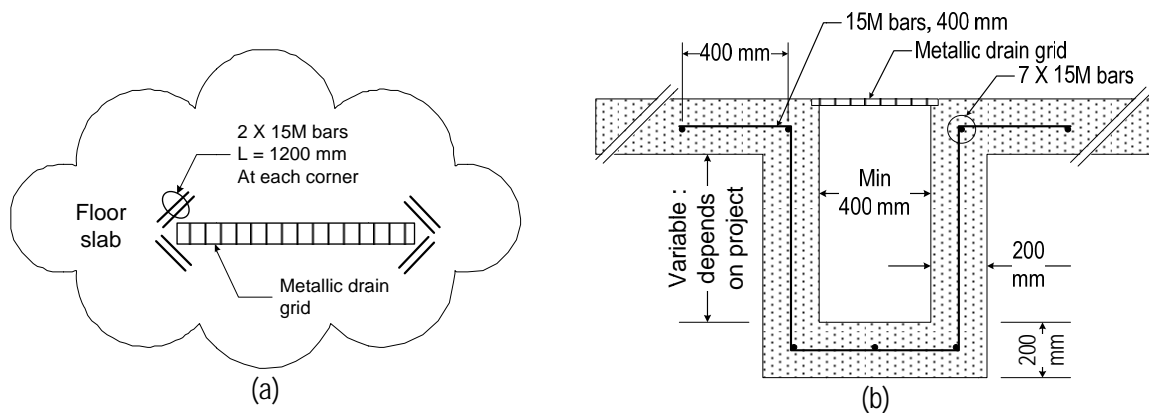


Figure 3-7
Reinforcement for floor drain: plan view (a) cross section view (b)

3.1.3 Doors

The washroom comprises two garage doors, depending on the chosen configuration. The door is preferably made of extruded aluminum with double polycarbonate panels; it is not insulated owing to the high level of humidity in the wash room during the winter and the difficulty of maintaining the insulation in good condition (Figure 3-8). This type of door provides a good amount of natural lighting and enhanced durability in such operating conditions. As it is more fragile, the panel on the bottom of the door may be replaced by an aluminum panel. However, considering its higher cost, an industrial-grade pre-painted galvanised steel door may be preferred, particularly for less frequent station usage periods (Figure 3-9). In that case, a window may be added for natural lighting.

The door dimensions must include a minimum clearance of 0.60 m above and on either side of the largest vehicles. The recommended door dimensions are usually 4.27 m wide (14 feet) and 4.90 m high (16 feet) for biggest vehicles

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authorised on Quebec roads (Table 3-1). Moreover, a recommended clearance of 60 cm (24 inches); minimum 40 cm (16 inches), must be planned between the room ceiling and the top of the door, for opening the latter.

In addition, the national building code (NBC 2010) requires that access doors (other than the garage doors) be included for the safety of the operators (Figure 3-9). Although two exit doors (not necessarily to the exterior of the building) are normally required, a single exit door is sufficient provided the following conditions are met:

- one exit door must open to the exterior of the building;
- the floor surface area must be less than 200 m²;
- the maximum distance to reach the access door must be no more than 15 m.

Protection posts must also be installed in front of the entrance door, particularly if vehicles can enter the station by backing up (Figure 3-8).



Figure 3-8
Polycarbonate door and protection posts



Figure 3-9
Steel doors and exit door

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3.1.4 Miscellaneous

Certain items of equipment must also be installed in the wash room, notably:

- Hose reels and / or hose carrier for pressure washer;
- Wall mounts to support removable floor panels when they are washed;
- Mounts for washing operator clothing (boots, raincoats);
- Mobile drying equipment (ventilator or unit dryer).

For small wash stations with only one wash room and a small room, most of the equipment (prewash lance, hoses, products, mask, etc.) can be stored in the wash room. In that case, store them in closable cabinets, whenever possible.

3.2 DRYING ROOM

Although vehicles can be dried in the wash room, a drying room may be necessary when there are too many users in the wash room and the vehicles cannot be fully dried before leaving the wash station. Generally, the construction of a drying room meets the same criteria as for the wash room, notably in the design of the walls, ceiling and floors. The main differences are given below (Figure 3-10):

- The drying room can be designed such with the back of the vehicle facing the drying facilities, it leans against a loading dock with a dock seal;
- Behind the dock seal, a room is equipped with heating and air ventilation for drying the vehicle;
- The clearance around the vehicle must be no more than 1.0 m on each side and 1.0 m at the front end;
- The slope of the floor can be greater than 2-3% (up to 5%) to ensure the best possible drainage of the vehicle. Mobile ramps can be used (Figure 5-11) if the slope cannot meet these requirements;
- As no operator is continually present in this room, fewer windows can be installed (e.g. garage doors made of steel without windows);
- It may be advantageous to install an air-air heat exchanger if there are many vehicles to be dried.

3.3 OTHER AREAS

Depending on the size and occupancy rate of the wash station, it may be worthwhile to have rooms dedicated to certain activities.

One room could be used as an office. Depending on the occupancy rate of the station, there should be at least workstation (a desk, telephone line and computer with internet access). The office should be accessible from the outside and be accessible directly or indirectly from other rooms in the wash station.

A second room could be used for cleaning equipment: pump, product reservoirs, lances, storage cabinet for protective equipment, etc. Considering the presence of chemical products, the room should be well ventilated and dry. To reduce the risks of contamination, this room must be accessible directly from the outside for product suppliers (delivery of inputs, calibration of dosing pump injectors, etc.).

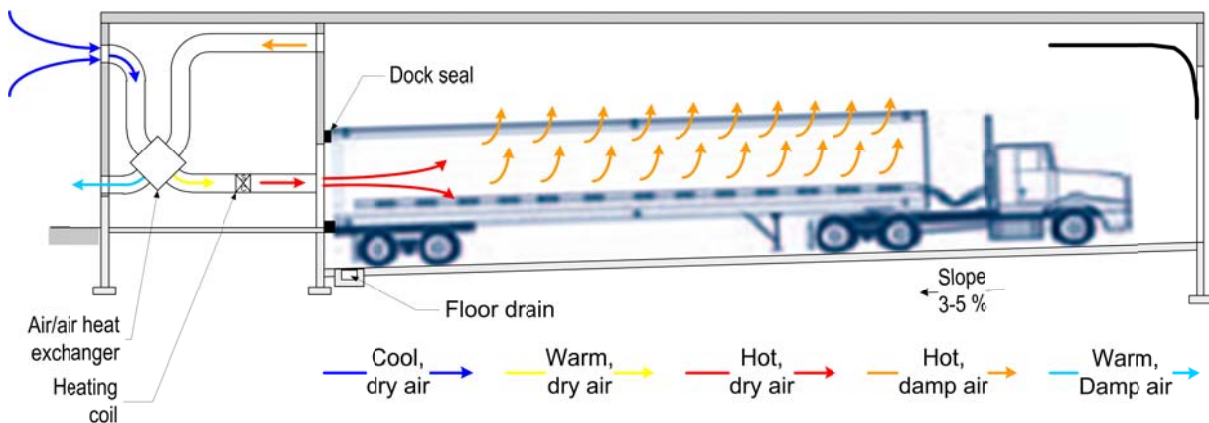


Figure 3-10
Schematic sectional view of a drying room

If the heating system is centralised, a mechanical room must be constructed. The boiler and water treatment, if required, would be located there.

Toilet facilities must also be provided with hot and cold potable running water, soap dispensers, sanitary hand drying equipment or supplies and cleanable waste receptacles. Signs must be posted in the appropriate areas reminding employees to wash their hands.

A separate laundry room for washing over-garments must be provided. It should be equipped with a sink, washer and dryer. A chute must be installed for soiled clothing and a counter for folding and storage of clean, dry clothing. Ideally, the garments used for washing operations must remain on site or removed only if cleaned by a specialised company. Garments must not be washed in a private home. If the wash station is designed to accommodate vehicles for different systems (slaughters versus breeding animals), two different chutes should be installed for soiled clothing.

Finally, large wash stations should install a special room for operators to put on their over-garments.

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3.4 WASH STATION CONFIGURATION

As for the site, several wash station configurations are possible to meet different needs. Figure 3-11 gives an example of a layout for a basic wash station without a laundry room and office area. The vehicles enter and exit from the same door; a pedestrian door is also included. Due to the smaller dimensions, this wash station cannot accommodate tractor-trailers. A storage cabinet is provided to store small washing equipment such as lances, injectors, masks, etc.

Figure 3-12 illustrates an intermediate-size wash station that can accommodate tractor-trailers. It has two garage doors for unidirectional vehicle flow, thereby ensuring a higher level of biosecurity. Special rooms are provided for washing equipment and products, an office, clothing and laundry room and toilet facilities.

Figure 3-13 gives an example of a layout for a comprehensive wash station with two wash rooms, a drying room and additional rooms for laundry and building mechanical room (boiler, water treatment, etc.).

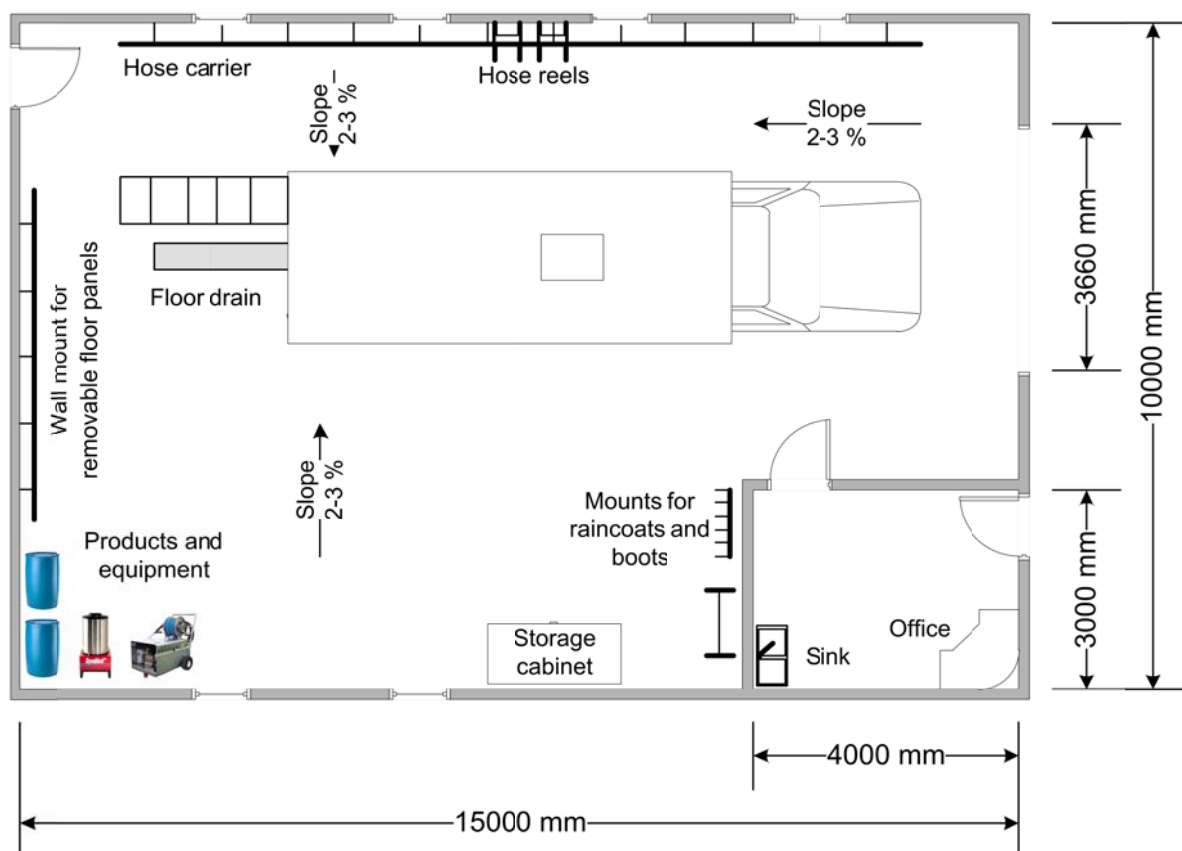


Figure 3-11
Example of a basic (small size) wash station layout

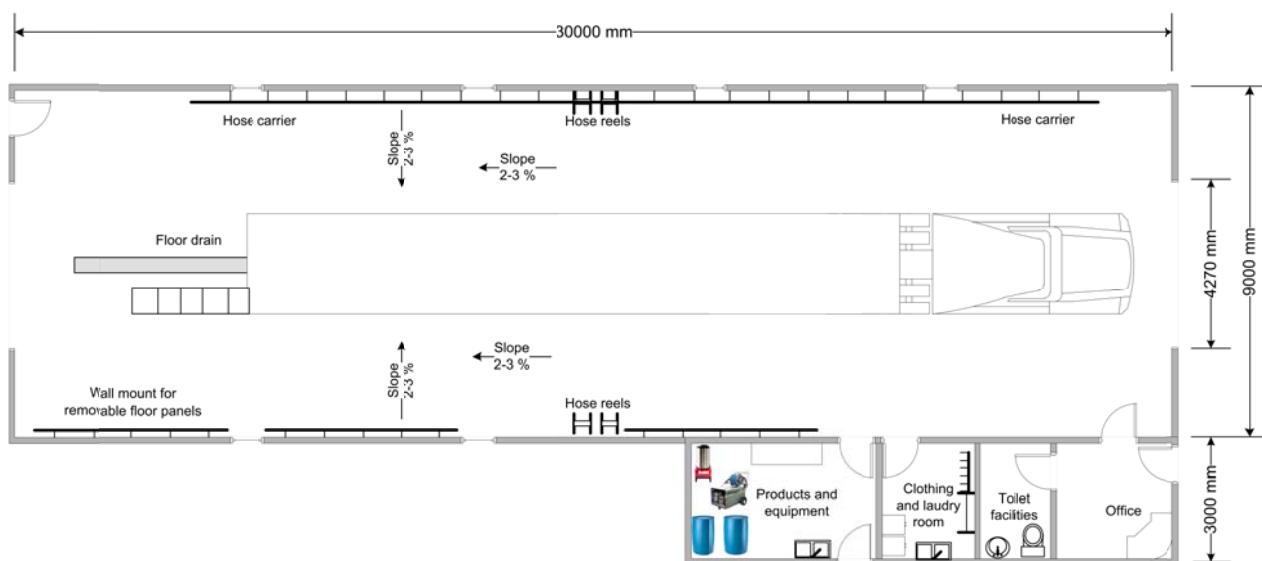


Figure 3-12
Example of an intermediate-size wash station layout

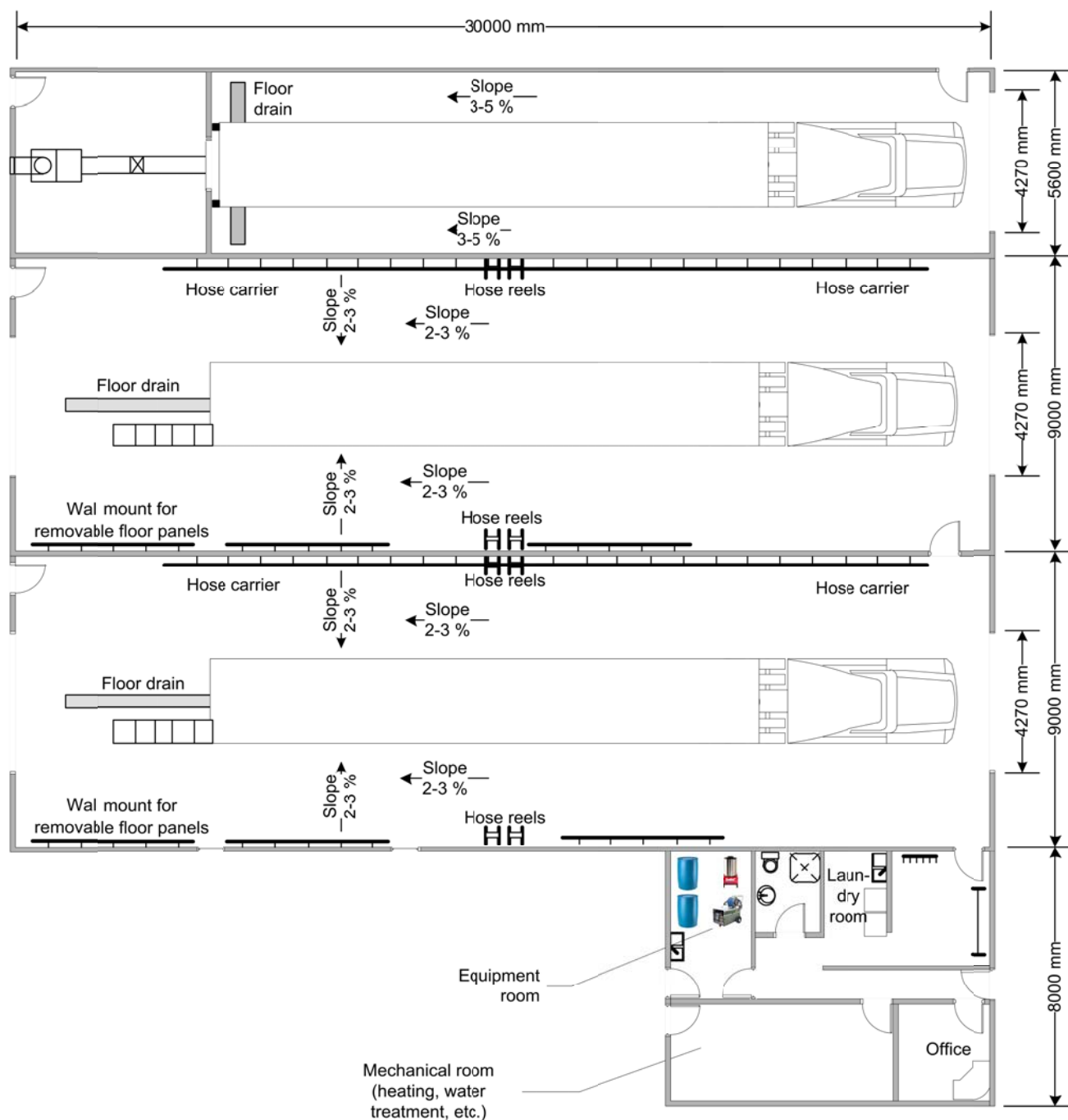


Figure 3-13
Example of a comprehensive wash station layout

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4. THE MECHANICAL SYSTEM OF THE BUILDING

Considering Quebec's climatic conditions, vehicles are washed in closed buildings for maximum effectiveness. Thus, a specially designed system must be provided to maintain the appropriate environmental conditions for the operators and, in most cases to dry the vehicles, even during the winter period.

4.1 REQUIREMENTS

The conditions to be maintained are stipulated by the National Building Code (NBC) ¹⁴ and by different standardisation bodies, including the CSST¹⁵ and the ASHRAE ¹⁶. In particular, they aim to ensure that the concentration of toxic gases is maintained below a certain threshold, notably for carbon monoxide (CO) and Nitrogen Oxides (NO_x), and that the temperature and relative humidity are maintained at an appropriate level.

The main NBC requirements during wash station operating hours are:

- Maximum carbon monoxide concentration (CO): 100 ppm;
- Maximum nitrogen dioxide concentration (NO₂): 3 ppm;
- Continuous supply of outside air: 0.75 ft³/min per square foot of floor area (3.9 L/s/m²).

For a given type of application, the CSST recommendations are:

- Renewal of air volume four (4) times per hour for a maintenance garage or three (3) times per hour for a garage with parking and permanent on-site personnel.

The ASHRAE recommends a minimum air flow rate at all times, independently of the purpose of the building, depending on the floor surface area and the number of persons present:

- Minimum air flow rate to be maintained at all times: 0.06 ft³/min/ft² + 5 ft³/min/person (0.3 L/s/m² + 2.5 L/s/person).

CSST requirements concerning the minimum **temperature** to be maintained during operating hours varies between 12°C à 20°C, depending on the type of work performed whereas the only requirement regarding **relative humidity** is 20% minimum, with no upper threshold.

4.2 DESIGN PARAMETERS

Considering these requirements and the expected dimensions of the wash room and number of persons potentially present, the requirements chosen for the ventilation system are:

- Minimum flow rate to be ensured at all times : 0.06 ft³/min/ft² (0.3 L/s/m²)
- Ventilation capacity in the case of detected CO or NO₂: 1.0 ft³/min/ft² (5 L/s/m²)

Moreover, the minimum **temperature** to maintain during operating hours is set at 15°C (59°F) and the minimum **relative humidity** is 20%, with no upper threshold (100%).

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4.3 EQUIPMENT

Several types of heating and ventilation systems are available for meeting the needs of a wash station. The capacity of the heating system depends on the regional climatic conditions, the building characteristics (dimensions, heat insulation factor, sealing efficiency of the building shell) and the presence and efficiency of the heat recovery equipment. Heating a building involves two mechanisms:

- Heating the building shell (heat loss through the ceiling, walls and floor, air infiltration);
- Heating the cool air incoming through the ventilation system.

Either a single mechanical system can fill both functions at a time or two separate systems can be installed. In both cases, it is strongly recommended to preheat the cool air intake to reduce the mist formed by condensation of the water vapour in the surrounding air when it comes in contact with the incoming cool air, particularly in the winter.

Figure 4-1 and Figure 4-2 illustrate equipment combinations for centralised and decentralised heating systems. Centralised systems are particularly adapted for wash stations with several rooms. In such cases, the heat is produced by a single heating appliance and then either delivered as hot air directly to each room through air ducts and air diffusers or carried by a heat-transfer fluid (water-glycol mixture) and then dissipated through heating coils (baseboard heaters), unit heaters (combined heating-coil and ventilator) or a radiating floor (under-floor heating system). The prime advantage of a centralised system is that the energy source can be modified at low cost (e.g. conversion of an electrical energy system to natural gas or biomass energy) by changing the type of boiler, without having to modify the heat transport mode (heat transfer fluid) and the heat diffuser. Moreover, the total installed capacity can be lower than for a decentralised system, particularly if the rooms' peak demands are not simultaneous.

In a decentralised system, the heat is produced locally in each room. Such a system requires a greater number of independent appliances but eliminates the need for a heat distribution network. The total installed capacity is usually greater than for a centralised system heating the entire building. This system is well-suited to small wash stations.

Moreover, a high occupancy rate for the station may economically justify the installation of additional (related) equipment to reduce energy consumption. This may include an air-air heat exchanger to recover the energy from exhaust air leaving the wash station, an air-air heat pump which draws energy from outside air, or a solar wall. Generally, an air-air heat exchanger is more efficient when the outdoor temperature is lower. Oppositely, the efficiency of an air-air heat pump decreases with decreasing outdoor temperature. As for the solar wall, it is only effective during daylight hours. Therefore, the efficiency of a solar wall is greatly reduced if the wash station must operate in the evening or at night. A solar wall must face southward to draw the maximum amount of energy from sunlight.

Le Table 4-1 shows some of the advantages and disadvantages of some of these systems and equipment.

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4.4 CONTROLS

Indoor conditions are controlled by the following equipment:

- Thermostat;
- Relative humidity probe;
- Carbon monoxide (CO) detector;
- Nitrogen oxide (NO_x) detector.

The amount of fresh air drawn into the building depends on the relative humidity in the building air which is monitored by a humidity probe. Despite this, CO and NO_x gas detectors will override the setpoint and activate the maximum ventilation rate if the threshold concentrations of these gases are reached.

The heating system is controlled only by the “on” and “off” temperatures set in the system, with an “on” temperature set to 15°C (59°F).

Note that several other systems can be envisaged and might be economically interesting alternatives, particularly if the station owner can do the construction or installation work himself.

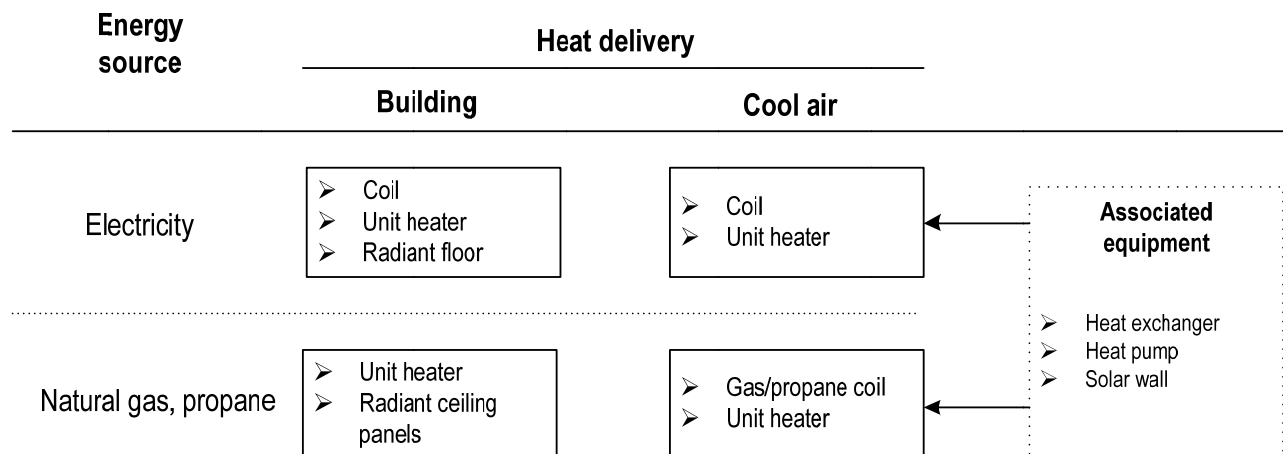
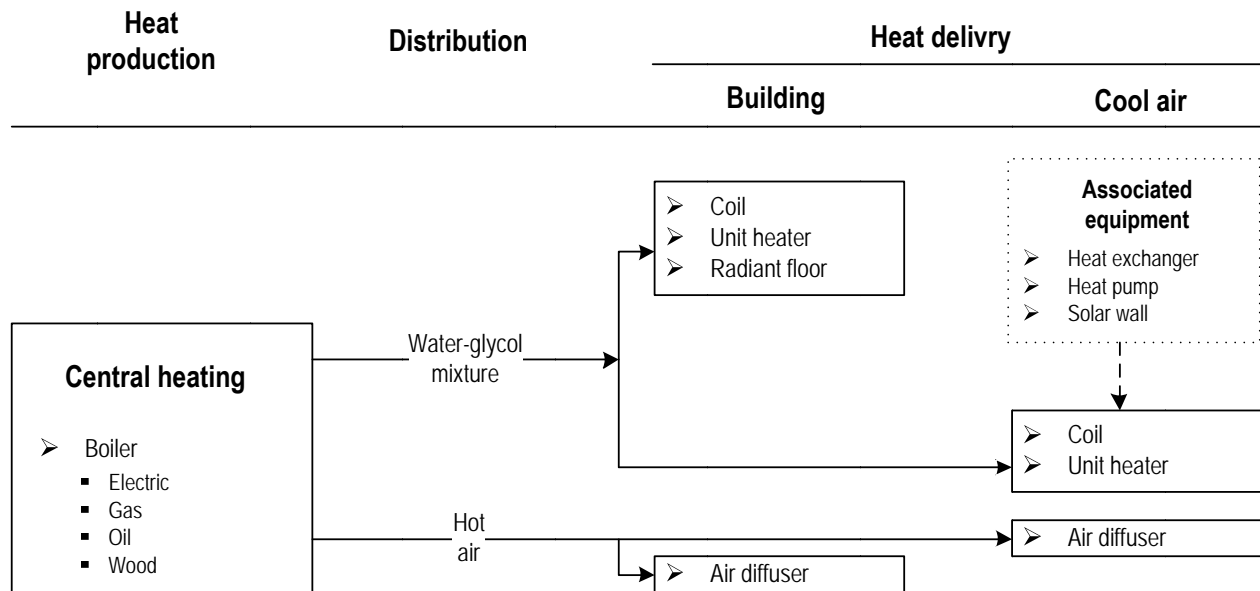
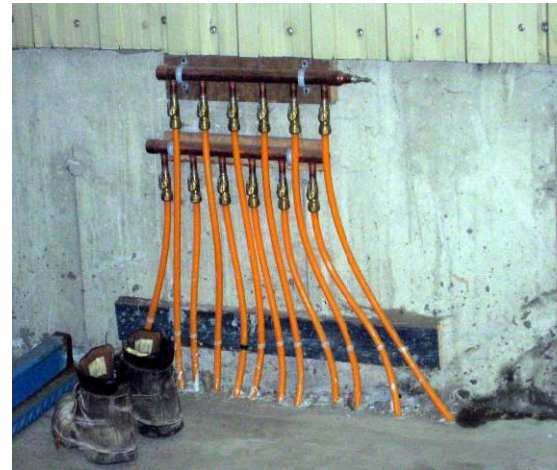


Table 4-1
Advantages and disadvantages of the different systems

System / equipment	Advantages	Disadvantages
Centralised system	Heat production by a single item of equipment for the entire station Energy source can be modified at low cost, according to energy costs Usually more energy-efficient More suitable for a wash station with several rooms	More complex Higher investment for a small wash station
Decentralised system	Simpler More suitable for a small station	Less energy-efficient than a centralised system
Glycol-based radiant floor (Figure 4-3) or electrical radiant floor	Improved room conditions for operators, especially in winter Rapid drying of floor and improved sanitary control More energy-efficient (lower heating costs) Provides the same comfort for operators while ensuring a room temperature 2 to 3°C lower than with other systems	Thermal inertia (takes longer to adjust room temperature) Economic rate of return difficult to achieve Requires the installation of insulation beneath the concrete floor slab
Radiant ceiling heating (Figure 4-4)	Provides the same comfort for operators while ensuring a room temperature 2 to 3°C lower than with other systems	
Air/air heat exchanger (Figure 4-5)	Fresh-air heating costs reduced by 70% Return on investment increases with increasing duration of wash station operation, energy cost and decrease of the mean outside temperature	Requires higher investments Involves a minimum operating period before return on investment
Solar wall	Variable reduction in heating costs (depending on orientation, operating time, sunlight, etc.) Passive system with zero operating costs	Efficient during daytime only Must be installed on a wall facing between south-east or south-west
Air-air heat pump	Sensitive reduction in energy consumption (about 50%)	High investment cost Economic rate of return difficult to achieve Efficiency decreases with decreasing outdoor temperature
Geothermal heat pump	Significant decrease in energy consumption (about 75%)	Very high investment costs Economic rate of return difficult to achieve



(a)



(b)

Figure 4-3

Radiant floor: (a) piping installation; (b) heat transfer fluid piping



Figure 4-4

Infrared radiant heating



Figure 4-5

Air/air heat exchanger

4.5 LIGHTING

The floor-level illuminance should be at least 400 lux, considering the requirements of washing activities, in particular the visual inspection following washing. Two types of lamp bulbs are recommended for rooms with high ceilings (more than 5m): low-pressure fluorescent light bulbs with high output (T5 HO) and high-pressure fluorescent bulbs, also called high intensity discharge bulbs (HID), containing sodium or metal halides. T5 HO fluorescent lamps comprise 4 or 6 light bulbs with a rated output of 54 W each. As for HID lamps, they generally comprise a single light bulb varying from 50W to 1000W. Table 4-2 gives the main advantages and disadvantages of both types of lamps.

Table 4-2
Advantages and disadvantages of the different lamp types

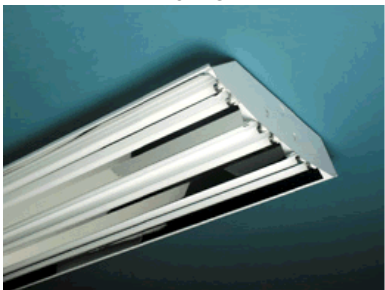

Lamp type	Advantages	Disadvantages
<p>Low-pressure fluorescent T5 HO</p> 	<p>Service life: 20 000 hours</p> <p>Good color rendering</p> <p>High output (lumen/W)</p> <p>Fast start-up (can be used with a motion detector)</p> <p>Can still be used if one light bulb is burned out (6 light bulbs per lamp).</p>	<p>Higher investment cost than for HID</p> <p>Slightly lower output than for HID</p>
<p>High-pressure fluorescent metal halide</p> 	<p>Service life: 20 000 hours</p> <p>Very high output (lumen/W)</p> <p>Lower investment cost than for T5 HO</p>	<p>Color rendering poorer than for T5 HO</p> <p>Slow start-up (5 to 10 minutes)</p> <p>Not recommended for discontinuous use</p>

Table 4-3 gives the characteristics of the lighting for a wash room 30 m long, 7.6 m large and 6.1 m high (100 ft X 25 ft X 20 ft) and for an average floor-level illuminance of 425 lux.

Table 4-4 gives the energy impact for these two lighting options.

Regarding lighting, the following points must be considered:

- The installation must be waterproof ;
- The lamps must be installed on either side of the area provided for the vehicle and not directly underneath;
- It must be kept in mind that the light bulbs' lighting capacity will decrease over time; install 10% more lighting capacity than desired;
- Lighting equipment and efficiency are constantly being improved (ballast, igniters, etc.). Consult a specialist when designing the wash station;
- Choose a light-colored, reflective wall coating to increase the luminance in the wash room;
- Consider adding portable lamps to inspect vehicles after washing;
- Ask the advice of an industrial lighting specialist before finalizing your project.

Table 4-3
Typical wash room lighting design

Type of light bulb	Ballast / Igniters	Power per light bulb		Number of light bulbs ²	Floor-level luminance (lux)
		Rated (W)	Consumed ¹ (W)		
T5 HO	Electronic	324	354	20 ³	430
HID Metal halide	Impulse	400	452	12	420

¹ Including power consumed by ballasts.

² For a wash room 30 m long, 7.6 m large and 6.1 m high.

³ Each lamp comprises 6 light bulbs, 54 W each.

Table 4-4
Energy consumption for lighting a wash room

Type of lamp	Total consumed power ¹ (W)	Energy density ² (W/m ²)	Yearly energy consumption ³ (kWh/yr)
T5 HO	7080	30,5	14 750
HID Metal halide	5425	23.3	11 300

¹ For a wash room 30 m long, 7.6 m large and 6.1 m high.

² Power consumed per unit floor surface area.

³ Considering 40 hours of operation per week.

4.6 MISCELLANEOUS

- Place a birdscreen in front of air ventilation inlets and outlets.
- Install a fresh-air intake filter to prevent the heating coils from getting fouled.
- Locate the air ventilation inlets upwind of the dominant winds (clean vehicles parking) and the outlets downwind of dominant winds (dirty vehicles parking area).
- If the air inlets and outlets must be located on the same side (heat exchanger), place them upwind of the dominant winds (clean vehicles parking area).

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5. EQUIPMENT

Efficient washing involves several consecutive steps, each with its own objective and each requiring specific equipment and operating conditions.

5.1 STEPS INVOLVED IN WASHING, DISINFECTION AND DRYING

Washing, disinfection and drying (WDD) covers several operations carried out in the usual sequence described below. The recommended operating parameters are presented in Table 5-1 (imperial units) and Table 5-2 (metric units).

Cleaning consists in removing organic matter (bedding) and mineral matter (sand, dirt) from the vehicle following transport (this operation is also called “dry cleaning” or “scraping”). It is done manually using scrapers, shovels and brushes. The residues are disposed of in a watertight structure on the station site or better yet evacuated to an external site (dedicated site, if possible).

Prewash consists in spraying a jet of water to remove and evacuate any solid debris that has remained in the vehicle after cleaning. The water flow rate must be high enough so that solid particles will float and/or be carried away from the vehicle. When bedding has been used in the vehicle, the prewash should be performed with a high-flow-rate, low pressure water spray. If no bedding was used, and to reduce water consumption, a medium-pressure water spray can be used at a lower flow rate. The efficiency of the prewash also depends on the slope of the vehicle floor, which should be at least 2% during the operation.

Detergence improves the water wettability and eliminates dirt and stains by emulsifying them in a solution or by dispersing them in water. Detergence is basically a chemical rather than mechanical action. Ordinary detergents have no bactericidal, virucidal or fungicidal characteristics, but do help remove the biofilm and grease which hide the bacteria on surfaces. Commercial detergents are concentrated and must be diluted before they are used. Instructions for use are given in terms of the amount of product to be used per surface area (ml of product / m² or g or product / m²) for either the undiluted product or at the recommended dilution ratio. Typical recommendations for use are given in Table 5-3. When possible, it is strongly recommended to foam the product for the following reasons:

- Foam improves the adhesion of the detergent on the surface to be washed and reduces streaming on vertical walls;
- Foam increases the effective contact period of the detergent on the walls;
- The detergent penetrates better in porous areas;
- Once applied, the product is more visible, resulting in more uniform application;
- Condensation mist is reduced, especially in winter;
- Water consumption is reduced by 50% (the concentrated product should therefore be diluted twice as much as the when the foamless product is used).

Table 5-1
Typical equipment operation settings (imperial units)

Operation	Hose diameter (in.)	Pressure (psi)	Solution flow rate (USGPM)	Temperature (°F)
Prewash				
▪ No bedding used	3/8	1000	4.0	Cold
▪ Bedding used	1 to 1.5	60 to 90	30 – 40 ³	
Detergence				
▪ Without foam gun	3/8	400 to 1000	2.1	85 to 105 ¹
▪ Foam at network pressure	1/2 to 3/4	60 to 90	1.5	
▪ Foam at medium pressure	1/2	400 to 1000	1.1	
Rinsing	3/8	1000 to 3000	4.0	Cold
Disinfection	Same as for Detergent use	Same as for Detergent use	Same as for Detergent use	70 ^{1, 2}

¹ Temperature at nozzle outlet (when no specific recommendations are given by supplier)

² According to Canadian General Standards Board requirements, the efficiency of disinfectants is given for a service temperature of 68°F and a maximum contact time period of 10 minutes. Use of colder water and a lower contact period could decrease the effectiveness of the disinfectant.

³ Flow rate obtained with a 3/8" diameter nozzle.

Table 5-2
Typical equipment operating parameters (metric units)

Operation	Hose diameter (in.)	Pressure (psi)	Solution flow rate (USGPM)	Temperature (°C)
Prewash				
▪ No bedding used	9.5	6 700	15	Cold
▪ Bedding used	25 to 38	400 to 600	115 to 150 ³	
Detergence				
▪ Without foam gun	9.5	2 600 to 6 700	8.0	30 to 40 ¹
▪ Foam at network pressure	12.7 to 19.0	400 to 600	5.7	
▪ Foam at medium pressure	12.7	2 600 to 6 700	4.0	
Rinsing	9.5	6 700 to 20 000	15	Cold
Disinfection	Same as for Detergent use	Same as for Detergent use	Same as for Detergent use	20 ^{1, 2}

¹ Temperature at nozzle outlet (when no specific recommendations are given by supplier)

² According to Canadian General Standards Board requirements, the efficiency of disinfectants is given for a service temperature of 68°F and a maximum contact time period of 10 minutes. Use of colder water and a lower contact period could decrease the effectiveness of the disinfectant.

³ Flow rate obtained with a 9.5 mm diameter nozzle.

Table 5-3
Typical application ratios of detergents and disinfectants and solution flow rate

Product	Dose of undiluted product (ml / m ²) or (g / m ²)	Dilution ratio ¹		Solution application concentration ¹ (L / m ²)	Solution flow rate ²	
		(%)	(mL / L)		(L / min)	(USGPM)
Detergent	2 to 5	0.5 to 2.0	5 to 20	0.2 to 0.4	4 to 8	1.1 to 2.1
Disinfectant	1 to 3	0.5 to 2.0	5 to 20	0.1 to 0.2	2 to 4	0.5 to 1.1

¹ The highest dilution ratio and lowest solution application concentration correspond to foam application.

² Takes into consideration a coverage rate of 20 m² / min (200 ft²/min). The lowest flow rate corresponds to foam application.

“Hot” water improves the efficiency of the detergent by increasing the wettability with water, the solubility of organic substances and reduces the duration of the operation. In absence of specific supplier recommendations, a temperature of 30°C to 40°C (85°F to 105°F) at the nozzle outlet should be sufficient. This requires a temperature of about 50°C (120°F) at the water-heater outlet.

In all situations, a minimum contact period must be observed for the detergent to work. In absence of supplier recommendations, a minimum contact period of 10 minutes, preferably 20 minutes, should be observed. It is important to make sure that the product does not dry on the surfaces before rinsing.

Occasional use of an acid detergent can help control the biofilm that develops on surfaces. However, systematic use of acid detergents combined with long contact periods can accelerate corrosion of the trailer and alter the concrete floor of the wash station. Efficient control of the biofilm can only be obtained by manually brushing the surfaces.

Rinsing is a mechanical action aimed at eliminating all traces of detergent and residues which could hinder the effectiveness of the disinfectant. Rinsing is performed using a high-pressure water spray, with no added product. A rotating nozzle can be used for encrusted solids. As rinsing essentially is a mechanical action, it is carried out using cold water.

Disinfection is usually performed following detergence. It aims to inactivate or destroy pathogens and reduce or eliminate their proliferation on treated surfaces. Disinfectants are applied basically in the same way as detergents. The amount of undiluted product applied is typically half that of a detergent whereas the dilution ratio in water is of the same order of magnitude (Table 5-3). It is also strongly recommended to foam the disinfectant, when possible. Ideally, disinfection is performed on dry surfaces. As this is often not possible in practice, make sure that excess water is eliminated to avoid diluting the disinfectant.

The *Food and Drugs Act* stipulates that the efficiency of a disinfectant must be approved for use at a temperature of 20°C and for a contact period of 10 minutes, respectively. Consequently, the effectiveness may be different than indicated if the water temperature is lower or contact period is briefer. In absence of supplier recommendations, a water temperature of 20°C at the nozzle outlet and a minimum contact period of 10 minutes should be observed

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when applying the disinfectant. During the contact period the surfaces should remain damp but well drained. Certain products available in Canada have been approved in other countries for lower operating temperatures.

Drying greatly enhances the efficiency of the disinfectant by reducing the survival of pathogens. Its purpose is to destroy pathogens that have not been eliminated by disinfection, by rendering the environment hostile through absence of water and organic matter. The drying operation can be passive, inside or outside of the wash station. Drying is best conducted inside the wash station and is combined with ventilation and/or heating to reduce its duration to a minimum. It must be carried out as soon immediately following the contact period with the disinfectant. The shorter the drying time, the more efficient it is. Three main factors affect drying time: room relative humidity, room temperature and air flow rate on the surface to be dried. Rapid drying involves:

- Fast, complete draining of vehicle surfaces;
- Fast, complete draining of wash station floor to floor drain;
- Extraction of humidity in the room air to the outside;
- Blowing of air on surfaces to be dried.

Drying is performed in the same room as washing in basic wash stations or in a specially-designed separate room in wash stations with a high occupancy rate.

5.2 BASIC EQUIPMENT

The recommended tools for **cleaning** are a scraper, a grain shovel and a brush with stiff bristles (Figure 5-1).

As most livestock is transported with bedding, the **prewash** operation requires water at a minimum pressure of 45 psi (300 kPa), but preferably 60 psi to 90 psi (400 to 600 kPa) at a flow rate of 45 USGPM (170 L/min). A semi-rigid hose, with a diameter of 1 to 1½ in. (25 to 38 mm) fitted with a 3/8 to 1/2 in (9.5 à 12.7 mm) diameter nozzle is adequate (Figure 5-2). The hose length depends on the station dimensions and the location of the supply line; it should vary between 10 and 30 m long. In this case the diameter of the supply line should be 1½ to 2 in (40 to 50 mm).

For **detergence**, **disinfection** and **rinsing** operations, several equipment configurations and operating settings are possible. These options take into account the points below.

5.2.1 High-pressure wash unit

A high-pressure wash unit is always required for rinsing and, depending on the system used, for prewash, detergence and disinfection. For a station with a low occupancy rate, a single mobile unit is sufficient (Figure 5-3). Units on the market are usually equipped with a positive displacement pump: they usually work at constant flow rate, regardless of the pressure. The pressure depends on the chosen nozzle diameter. A capacity of about 3 to 4 USGPM (11.5 to 15.0 L/min) at a pressure of 3000 psi (20 000 kPa) is adequate for a wash room.

If undiluted products are injected directly at the pump outlet, the wash unit must comprise at least a hose, dual-lance gun assembly with a rotating nozzle, all adapted to the capacity (pressure and flow rate) of the wash unit. The dual-lance assembly is fitted with two separate nozzles providing one high-pressure spray of 1000 psi, used in most

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cases for all operations (prewash, rinsing and product application) and a second spray of 3000 psi, used especially for rinsing.

If the products are injected from a portable container attached to the spray lance, then three separate lances should be used for: water (dual lance), detergent and disinfectant, to avoid errors and reduce product consumption.

If the occupancy rate of the station is higher or if the station comprises two or more wash rooms, then a fixed wash unit with as many spray pumps as there are wash rooms should be used (Figure 5-4). Product injection is best carried out at the outlet of each pump and there must be three hoses per wash room.

In all cases, the hoses used must have an inner diameter of 3/8 in., be designed for pressures of 3000 psi and have lengths varying from 10 to 30 m.

5.2.2 Product dilution

Detergent and disinfection products presently on the market are always undiluted: they must therefore be diluted before being used. The most widely-used dilution principle applied in wash stations is based on suction: the product in the detergent or disinfectant container is drawn by suction through a calibrated hole. In that case, a small container containing the undiluted product can be attached directly to the lance (Figure 5-7 and Figure 5-8) or the product can be injected from a larger container at the outlet of the high pressure pump (Figure 5-5). Different dilution ratios are obtained, orifices are available at various diameters, or variable-aperture orifices are available. The orifice must be calibrated for each product used as the varying viscosities of the products may affect their dilution ratio.

The product can also be diluted by injection using a proportional pump which delivers a quantity of product proportional to the water flow rate (Figure 5-6) or using a fixed displacement dosing pump. Such equipment must also be calibrated but they are seldom used in wash stations.

5.2.3 Foam production

Foam is produced by injecting air in the detergent or disinfectant solution while it is applied. Foam is produced according to one of two systems. The first involves a lance designed to draw in air by suction induced by the flow of solution through the lance (Figure 5-7 and Figure 5-8). Lances are available for different water pressures, from 30 psi to 1000 psi (200 kPa to 6700 kPa). They are therefore designed for supply through the water network or by a high-pressure wash unit. This system is economical but the foam is unstable as the volume of air drawn through is usually insufficient and the foam usually does not have enough holding power for the required contact period. This method is lower cost and simpler to use; it is therefore particularly well-suited to wash stations with low occupancy rates.

The second method is based on air injection and requires compressed air. The latter is injected after the product is diluted in water (Figure 5-9). This method makes it possible to inject a volume of air about 20 times (5 to 50) greater than the volume of solution to be applied. It also generates a more stable foam which will stay longer on the vehicle's vertical walls. Considering the significant increase in volume, a solution flow rate of about 1.0 to 2.0 USGPM (4 to 8 L/min) is sufficient. Application requires an air flow rate of about 85 to 140 L/min (3 to 5 ft³/min) for an air/solution ratio of about 20. Considering the significant volume increase of the air/solution mixture, a hose

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with a minimum diameter of ½ inch (12.7 mm) is required to apply the detergent or disinfectant product. This method is particularly well-suited to wash stations with a higher occupancy rate. Its efficiency lies in improved surface coverage and reduced product and water consumption.

5.2.4 Water heating unit

A wash station uses hot water for personnel sanitary requirements, WDD operations and, in some cases, for heating the building. The needs for WDD operations are intense, but of short duration. Taking into account the nature of these needs, an independent heating unit specifically for WDD operations is recommended. It is installed in line and requires no storage tank.

The required heating power depends on the desired flow rate and temperature. For a station that uses a single spray at a time, a minimum heating capacity of 200 000 BTU/h (60 kW) is needed to deliver a flow rate of 4 USGPM (15 L/min) at a temperature of 140°F (60°C) at the water heater outlet.

Water heaters using different energy sources are available on the market: electrical, propane, natural gas or oil. Table 5-4 gives some of the advantages and disadvantages of these different sources. They may be connected to the high-pressure wash system (Figure 5-3) or installed separately (Figure 5-10).

Table 5-4
Advantages and disadvantages of different energy sources for water heater

Energy source	Advantages	Disadvantages
Electricity	<ul style="list-style-type: none"> ▪ Continuous supply (no storage or resupply needed) ▪ Highly-compact system ▪ No combustion (no toxic gases or GHG emissions, no additional ventilation required, no flue required) ▪ No heat discharge (energy efficiency nearly 100%) ▪ Cost stability ▪ No maintenance 	<ul style="list-style-type: none"> ▪ Three-phase electric power supply strongly recommended ▪ Higher electric input ▪ Several seconds of lag time before the desired temperature is reached.
Propane	<ul style="list-style-type: none"> ▪ Largely available ▪ Rapid heating ▪ Little maintenance ▪ Few risks to the environment (volatilisation of propane to the event of leak) 	<ul style="list-style-type: none"> ▪ Requires a storage tank and resupply ▪ Fuel which generates combustion gases, including GHG ▪ Requires a flue or additional ventilation ▪ Instability of propane cost.
Natural gas	<ul style="list-style-type: none"> ▪ Continuous supply (no storage or resupply needed) ▪ Rapid heating ▪ Little maintenance ▪ The “cleanest” fossil fuel ▪ Little risk to the environment (volatilisation of methane to the event of leak) ▪ Relatively stable cost 	<ul style="list-style-type: none"> ▪ Limited availability ▪ Fuel which generates combustion gases, including GHG ▪ Requires a flue or additional ventilation
Oil	<ul style="list-style-type: none"> ▪ Widely available ▪ Rapid heating 	<ul style="list-style-type: none"> ▪ Requires a storage tank and resupply ▪ Environmental risk to be considered in the event of a leak (cautionary measures to be taken for storage) ▪ Combustion gas emission, flue absolutely necessary ▪ Cost variability ▪ The “least clean” fossil fuel ▪ Regular maintenance

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5.2.5 Drying

Drying the vehicles in room not specifically designed for drying requires elements that are part of the building construction itself and special equipment. The building elements are covered in more detail in chapters 3 and 4:

- Sloping wash station floor with a smooth, well drained surface;
- Wash-station heating system, with additional heat exchanger allowing high air renewal rate, therefore rapid moisture extraction, at lower cost;
- Floor heating, in some cases.

A minimum amount of equipment can be used to reduce vehicle drying time.

- 1- For stations with an inadequate floor slope, a ramp (Figure 5-11) or equivalent (Figure 5-12) can be used to raise the front wheels of the truck or the back wheels of the tractor (for a tractor trailer).
- 2- Ceiling fans increase the water evaporation rate of the walls by creating an air current and increase the relative humidity of the air by homogenising it (Figure 5-13).
- 3- Use of ventilators in the back of the vehicle significantly reduces the drying time (Figure 5-14). This type of system can be made more efficient by:
 - Adding a panel the size of the vehicle opening so that all of the air blown by the fans is forced in (principle used when there is a dedicated drying room);
 - Re-installation of winter panels in a slightly open position to help blown air reach the front of the vehicle;
 - Addition of a coil upstream of the ventilator or use of a unit heater to force hot air into the vehicle.
- 4- Use of a fan with or without a unit heater, fitted with a perforated polyethylene ventilation sleeve introduced inside the vehicle.

It must be mentioned that the equipment discussed in points 3 and 4 are not commercially available. They must be constructed by the owner. A fan with a minimum air flow rate of 10 000 m³/h (6 000 ft³/min) at a static pressure of 50 Pa (0.2 inches of water) should be used for a tractor-trailer – this is the equivalent of a 60 cm (24 inch) diameter fan.

5.3 RELATED EQUIPMENT

Several other types of equipment can supplement the washing equipment strictly speaking:

- Hose reels or hose carriers ;
- Storage tanks for undiluted products;
- Hangers for drying boots and rain gear (Figure 5-16);
- Wiper blade for eliminating surplus water on surfaces (if needed);
- Eye bath (Figure 5-15);
- Toilet facilities (toilet, washbasin, sink, water heater);
- Clothes washer and dryer;
- Water treatment unit (if required).



Figure 5-1
Cleaning equipment



Figure 5-2
Semi-rigid water hose and spray nozzle (not
proportional to hose)



Figure 5-3
Mobile high-pressure washing unit
fitted with an electric water heater



Figure 5-4
Fixed high-pressure washing
unit with two pumps



Figure 5-5
Suction-based dilution



Figure 5-6
Proportional pump



Figure 5-7
Foam generator



Figure 5-8
Foam production and application

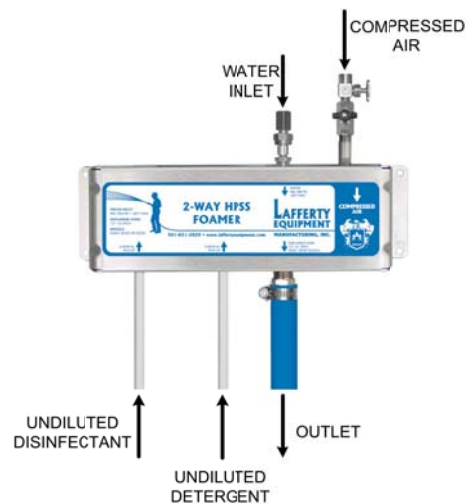


Figure 5-9
Unit for mixing water, undiluted products and
compressed air



Figure 5-10
Propane or natural gas fired water heater with a
heating capacity of 100 kW (345 000 BTU/h)



Figure 5-11
Metal ramp



Figure 5-12
Wheel rim used as a ramp for supporting a tractor-
trailer



Figure 5-13
Ceiling fan



Figure 5-14
Fans assembled for back of a vehicle



Figure 5-15
Eye bath



Figure 5-16
Hangers for boots and rain gear

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6. WATER SUPPLY

6.1 VOLUME AND FLOW RATE

Water supply, whether from the public water network or a private source (well or surface water) must be able to meet the station's needs in terms of volume and flow rate. The daily volume is determined by the number of each vehicle type to be washed and the equipment used. The instantaneous flow rate depends on the number of operators who can work simultaneously on the different washing operations.

An estimate of the water volume required for different WDD operations on different types of vehicles is given in Table 6-1, along with the conditions for which the estimate is made. The volume takes into account washing operations for the interior and exterior of the trailer, the two sides of the removable floors, the tires and the exterior of the truck cabin. The biggest water volumes are required for prewash and rinsing following detergence because they must carry the residues away from the trailer. For this reason it is important that the trailer floor be inclined at least 2 to 3% to optimise evacuation, especially during prewash as the particles to be carried away are bigger. A lower-angle slope would reduce the water flow velocity, thereby reducing the energy required to carry off the residues, whereas a slope higher than 5% would reduce the thickness of the water layer on the floor, leaving particles to be deposited on the floor.

A foam gun can be used with almost all detergent and disinfectant products, thereby helping to reduce by 50% the water volume required for the detergence and disinfection steps, all while significantly improving their effectiveness.

As for the required instantaneous flow rate, it is determined by the most demanding operation, i.e. prewash. Depending on the types of hose and nozzle used, and the pressure in the water system, the flow rate may vary from 0.75 L/s (12 USGPM) for a 9.5 mm (3/8 inch) diameter nozzle and a pressure of 270 kPa (40 psi) to 4.5 L/s (71 USGPM) for a 12.5 mm (½ inch) diameter nozzle and a pressure of 600 kPa (90 psi).

6.2 QUALITY

The microbial and chemical characteristics of water are important to ensure the long-term efficiency of the wash station's WDD operations. Table 6-2 gives the minimum parameters with which the wash water must comply.

Most of the pathogens (viruses, bacteria or protozoa which can cause illness and disease) that can be found in water come from human or animal faeces ⁹. As it is technically impossible to analyse all pathogens, microbiological indicators are used instead: total coliform bacteria, Enterococci bacteria and *E. Coli* bacteria. **Total coliforms** are a heterogeneous group of bacteria (they include *E. Coli* bacteria) found in faecal matter and in the environment. Actually, most species may be found naturally in the soil and vegetation. Their presence in water usually does not mean that there has been faecal contamination nor is it a sign of a health risk, but rather that there is a decrease in the bacterial quality of the water. This may be ascribed to, in particular, water infiltration in the well. The analysis of total coliforms provides information on the potential vulnerability of a well to surface pollution.

Table 6-1
Volume of water typically required for different types of vehicles and WDD operations

Type of vehicle	Volume (m ³)				
	Prewash ¹	Detergence ²	Rinsing ³	Disinfection ⁴	TOTAL ⁵
6-wheel truck	2.00	0.10	0.40	0.05	2.55
10-wheel truck	2.60	0.13	0.51	0.06	3.30
45' tractor trailer	3.80	0.19	0.76	0.10	4.85
53' tractor trailer	4.20	0.22	0.87	0.11	5.40
53' lowered tractor trailer	4.90	0.24	0.97	0.12	6.23

¹ Water spray with a 12.7 mm (½ in) nozzle at a pressure of 600 kPa (90 psi).

² Application of a solution at a concentration of 500 ml / m², without a foam lance.

³ Water spray using a 9.5 mm (3/8 in) supply hose at a pressure of 20 000 kPa (3000 psi).

⁴ Application of a solution at a concentration of 250 ml / m², without a foam gun.

⁵ If all WDD operations are conducted

Enterococci bacteria are less abundant in the intestinal flora of humans and animals than *E. Coli* bacteria, and certain species are not of faecal origin. The detection of Enterococci bacteria in well water may indicate faecal contamination or surface water infiltration. However, it is a good precautionary measure to consider Enterococci bacteria as an indicator of faecal contamination.

E. coli bacteria are part of the total coliforms group. This species is highly abundant in intestinal and animal flora and it is also the only species which is entirely of faecal origin. The presence of *E. Coli* in water signifies that the latter has been contaminated by faecal pollution and that it may contain pathogens. Also, even though a certain level of total coliforms contamination is acceptable, *E. Coli* should be tolerated under no circumstances in drinking water ^{9, 10} and in water used for WDD activities.

The presence of mineral salts such as calcium, magnesium, iron and sulphates in water may affect the equipment operation by causing either calcium deposits, scaling, particularly with hot water, clogging of small openings, nozzle openings in pressure units, and in some cases pipe corrosion. Water hardness is an indicator of the mineral content in the water. It expresses the concentration of these elements in the form of equivalent calcium carbonate (CaCO₃ eq), units of ppm (parts per million, w/v) or mg/L, the latter two being equivalent. Water hardness is ascribable to calcium and magnesium ions. Hard or very hard water (Table 6-3) contains many calcium and magnesium ions whereas soft or very soft water is deficient in terms of these ions and may be aggressive on materials which contain these elements, notably concrete.

Moreover, it is known that water hardness decreases the effectiveness of certain detergents and disinfectants. The expected effectiveness for the recommended concentrations is usually given for water with a hardness of 150 to 250 ppm of CaCO₃ eq. Also, product concentrations used must be increased with harder water (see appropriate concentrations recommended by the product manufacturer). The effect of hard water is generally seen by a decreased foaming effect, when foam application is recommended. Excessively hard water prevents foaming, thereby causing poor "coverage" of surfaces, particularly vehicle walls. The same applies to water acidity (pH). It is

recommended to meet the minimum water quality criteria given in Table 6-2. It is therefore important to know this water quality parameter so as to adjust the washing product concentrations or to treat the water, if necessary.

Table 6-2
Water quality parameters for WDD activities

Parameter	Value
Total Coliformes	10 / 100 ml
E. coli	0
Water hardness	Between 80 and 120 mg CaCO ₃ eq. / L
pH	6.5 to 7.5

Table 6-3
Water hardness classification (Health Canada)

Water quality	Hardness (mg CaCO ₃ eq. / L)
Soft	0 to 17
Slightly hard	17 to 60
Moderately hard	60 to 120
Hard	120 to 180
Very hard	> 180

6.3 MONITORING

Water quality is monitored by sampling and analysis. The monitoring frequency depends on the contamination risk of the water source (Table 6-4). Public and private networks are subject to Quebec's *Règlement sur la qualité de l'eau potable* and deliver suitable-quality drinking water. Artesian wells are practically protected from contamination by surface waters: yearly monitoring is therefore sufficient.

Surface waters (wells, streams, etc.) are usually vulnerable to contamination. They must therefore be monitored more frequently, preferably during critical periods, i.e. in autumn and in spring. If the surface water is sampled from a point located in an agricultural basin, monitoring may be synchronised with periods when organic fertilisers are spread, as this is when the bacteriological contamination risk of surface waters is at its highest. The risk is also high if the water is taken from a pond. In that case, it is strongly advised to implement a treatment system to eliminate bacteriological contamination from the water.

Table 6-4
Frequency of bacterial count monitoring in wash water

Source	Frequency (/ yr)
Public or private network	0
Artesian well	1
Surface well	4
Stream, lake, pond	4

Several laboratories are accredited by the *Ministère de Développement durable, de l'Environnement et des Parcs du Québec*¹² to perform chemical and bacteriological analyses on water. The cost of the analyses depends on the parameters to be analysed.

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6.4 CHOICE OF WATER TREATMENT

Water supply from a private well or surface waters can be contaminated in several ways. The water quality analyses of samples taken during critical periods helps determine the type of contamination. If the water is effectively contaminated, an inspection of the catchment facility, the well or surface water intake point and an identification of potential sources of contamination in the vicinity of these facilities (e.g. septic tank) must be conducted in order to take the appropriate corrective measures. If the contamination persists, the installation of a water treatment system must be considered.

Even though there are many different technologies for treating drinking water, each is designed for treating a specific type of contamination. There is no universal treatment technology and therefore it is important to ensure that the system is adapted to the company's specific situation. A complete guide has been published by the MDDEP¹³, covering the various available techniques and the typical configurations of these systems according to the operating conditions.

The design of the treatment system must first take into consideration the maximum instantaneous flow rate and the daily flow rate of the wash station (section 6.1). The maximum instantaneous flow rate is usually far greater than the maximum daily flow rate. Consequently, to reduce the treatment equipment sizing and therefore the treatment costs, a buffer tank and pump are required to supply water to the wash station equipment.

Two techniques are usually put forward for disinfection: chlorination and ultraviolet radiation (UV treatment) (Table 6-5). Chlorination kills microorganisms whereas UV treatment inactivates them and damages their genetic material, thereby causing their destruction. To be effective, disinfection must be carried out on water free of other contaminants, and therefore it is the last step in a more extensive water treatment process. The chlorine concentration must correspond to a residual concentration (chlorine which has not reacted) of 1.0 mg/L of total chlorine and 0.2 mg/L of free chlorine at the water utilisation point, without exceeding 4.0 mg/L of total chlorine. Special kits are available for analysing pool water. They provide an easy way of regularly checking the chlorine level of the water.

Treatment of hard water usually involves a water softener (or cation exchanger). This type of treatment is also effective for removing iron, manganese and barium. The technique requires periodic replacement of the softener salt, usually sodium chloride, and evacuation of water containing concentrated calcium and magnesium salts. Other techniques must be used to remove hydrogen sulphide, nitrates and organic compounds: sand filters, anion exchangers or activated charcoal.

Due to the complexity of physical and chemical reactions which can take place in such treatment systems, it is strongly recommended to consult a specialist to guarantee that the best possible treatment is chosen for the appropriate use. A specialist from the MDDEP can also direct you to the proper resources.

Table 6-5
Advantages and disadvantages of water disinfection techniques

Chlorination	UV Treatment
Advantages <ul style="list-style-type: none"> ▪ Residual disinfection capacity during storage and distribution ▪ Availability of cost-effective equipment ▪ Indirect verification of the effectiveness by measurement of the residual chlorine ▪ Very effective on bacteria and viruses 	Advantages <ul style="list-style-type: none"> ▪ No chemical products involved ▪ No chemical by-products generated ▪ System easy to install, use and maintain ▪ Low investment costs for a small capacity ▪ Low operating costs
Disadvantages <ul style="list-style-type: none"> ▪ Ineffective against certain parasites (e.g. <i>Giardia</i>, <i>Cryptosporidium</i>) ▪ Required minimum contact period of 20 minutes ▪ May generate by-products if water has not undergone prior treatment ▪ Requires manipulation of chemicals 	Disadvantages <ul style="list-style-type: none"> ▪ No residual disinfection capacity during storage and distribution ▪ Water quality can largely affect the effectiveness of the disinfection ▪ Very strong exposure required to inactivate viruses ▪ Investment costs increase rapidly with increasing treatment capacity.

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7. EFFLUENT MANAGEMENT

7.1 REGULATIONS

Due to the effluents that a wash station can generate, the station operator falls under the jurisdiction of the Quebec Environmental Quality Act (*Loi sur la qualité de l'environnement*)¹⁸, in particular section 22 which stipulates that:

22. No one may erect or alter a structure, undertake to operate an industry, carry on an activity or use an industrial process or increase the production of any goods or services if it seems likely that this will result in an emission, deposit, issuance or discharge of contaminants into the environment or a change in the quality of the environment, unless he first obtains from the Minister a certificate of authorization.

This article is general in application and no specific reference to wash stations is made. Therefore, requests put to the regional MDDRP office will be handled on a case-by-case basis. In theory, however, and taking into consideration the characteristics of the effluents (containing contaminants such as organic matter, nitrogen, phosphorus, suspended matter, detergents and disinfectants) they must be managed accordingly.

7.2 BEDDING

Soiled bedding must be stored in a watertight structure to avoid leakage of pathogens and contaminants on the site or to drainage ditches, or their infiltration into ground water. The storage capacity is estimated on the basis of the transport frequency, the type of vehicle, the quantity of bedding used and the storage period. For bedding used during transport, an optimal thickness of 1 to 3 cm of saw dust or shavings on the vehicle floor can be applied, depending on the climatic conditions²⁰. Table 7-1 gives the storage volume to be considered for a bedding thickness of 1.0 cm on the vehicle floor, and for different types of vehicles. For example, cleaning 10 x 53' "pot-belly" tractor-trailers and 5 x 28' trucks per week requires a storage capacity of 50 m³ per month of operation. Note that vehicles are not cleaned systematically after each transport, especially when the transporter does not use bedding.

Soiled bedding should be composted before it is disposed of in fields. Composting can reduce the risk of contamination from bedding for a certain number of viruses, bacteria and parasites¹. A typical composting facility comprising two or three units and a roof (Figure 7-1) meets storage requirements and reduces the risk of contaminating clean vehicles. If bedding cannot be composted, it is safer to spread at a distance of more than 3 kilometres from the wash station.

Table 7-1
Volume of bedding per cleaning operation

Vehicle	Volume per cleaning operation (m ³)
20' truck	0.3
28' truck	0.5
51' tractor-trailer	0.8
53' tractor-trailer (pot-belly)	1.0

¹ For a bedding thickness of 1.0 cm.



Figure 7-1
Composting facility

7.3 WASH WATER

In Quebec, wash water is dealt with according to four different means:

- Storage in a watertight structure and spreading
- Settling, municipal sewage system (agreement with municipality)
- Settling, septic tank, disposal field
- Discharge to natural environment without treatment.

Whereas the first three means are capable of meeting environmental requirements, discharge to the natural environment must be prohibited.

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Wash water storage in a watertight facility and spreading does not require any wash water treatment in the building. The wash water is channelled to a pumping well (Figure 7-2), through the floor drain and then pumped to the storage facility. High and low level sensors in the pumping well automate this operation. This effluent management mode requires a storage facility with a capacity that is determined by the washing station's level of activity. Moreover, and despite the low fertilising value of these waters which need to be characterised, the company must factor in a minimum cost of 2 \$/m³ for their spreading and inclusion in a fertilisation plan. From an economic standpoint, this type of management can be considered only if the company already has such a structure and if it can spread the wash water near the station, but this is undesirable considering the biosecurity risk.

If a municipal sewage system is accessible, it is best to settle or screen the water before evacuating it to the system. Thus, a settling tank with an inverted "U" pipe will allow the mineral particles (dirt, sand, etc.) to settle out and the organic particles to float, while maintaining a constant water level in the tank (Figure 7-3). The top of the tank must be at a higher elevation than the screen of the floor drain to avoid the tank's overspilling in the event of obstruction or backflow from the sewage system. If this were to occur, the backflow would rise directly to the wash room. A useful settling volume must be determined – about 2 to 3 m³ (measured from the bottom of the tank to the level of water in the tank). Settled matter and floating matter can be removed when necessary. This effluent management mode can generate treatment costs which may have to be paid to the municipality. This point must be ascertained with the relevant municipality.

If no municipal sewage system is available or if the company wishes to fully treat the wash water at the station, a ***septic tank*** and ***disposal field*** will complete the work of the settling tank. Although a septic tank can perform part of the settling operation, it is best to install a settling tank due to the low biodegradability of the organic matter (mostly saw dust and shavings) and of the mineral matter, both of which may clog the disposal field. It is best to consult professional specialists to determine the septic tank and disposal field sizing, considering the pollution load of wash water and the hydraulic flow rate. The specialists will also assess the characteristics of the natural ground and determine if it can be used for septic tank disposal or if material has to be added.



Figure 7-2
Pump for manure pre-pit

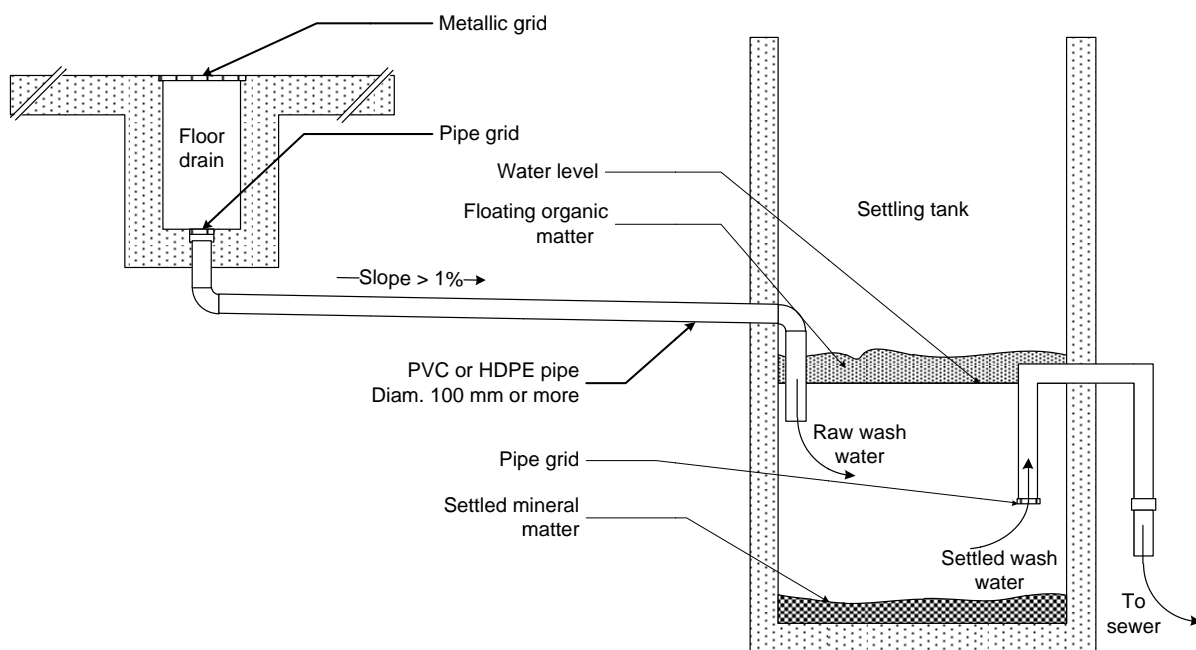


Figure 7-3
Wash water settling tank for evacuation to a sewage network

8. COST ESTIMATE

The cost of operating a wash station was estimated for two wash stations and three occupancy levels for each. Table 8-1 presents their main characteristics and levels of occupancy.

Table 8-1
Main characteristics of the wash stations and relevant cost estimates

Characteristics	Basic station (cf. Figure 3-11Figure 3-11)	Intermediate station (cf. Figure 3-12Figure 3-11)
Type of vehicle washed	10-wheel truck	Tractor-trailer
Occupancy level (Num. of vehicles per week)	5, 10 and 20	10, 20 and 30
Rooms	Single wash room (15 m X 10 m X 6.1 m) Other room: office	Single wash room (30 m X 9 m X 6.1 m) Other rooms: office, toilet room, products and equipment room, laundry room
Cool air heating and ventilation	Fuel-fired boiler, glycol coil	
Building heating energy	Electricity	
Water heater	Oil	
Lighting	T5 HO fluorescent lamps	
Floor	Untreated, steel-trowel finished concrete	
Doors	Single garage door	Two garage doors

8.1 CAPITAL INVESTMENT

The investment value is for a turnkey project, constructed by skilled workers with experience in building institutional or light industrial buildings, at new market-value for all materials and equipment. It also includes the preparation of the land prior to construction, connection to utilities (electricity, water, sewage system) and construction of the road surface and parking area. However, it excludes the value of the land owing to the significant price variability.

Table 8-2 presents the budgeted value of the investment for the two wash stations considered, including the required contingencies, construction site overhead costs, contractor profit, consultancy fees and applicable taxes. The cost estimate is fairly conservative. It may be lower if the workers are less skilled or if the design parameters are not the same as those put forward in the Guide, especially regarding the outdoor road and parking surfaces, the heating system type and capacity, the lighting intensity, etc. It is also important to note that the choice of an oil-fired boiler and water heater was motivated by the fact that electrical equipment would require a three-phase electrical supply. This type of service may not be available locally and involves a greater capital investment and specific costing. It is important to consult experts in this domain to make certain that the best possible option is chosen.

Table 8-2
Investments for both wash stations

		Basic wash station	Intermediate wash station
I Construction works		425 343 \$	727 952 \$
New building		239 606 \$	408 381 \$
Infrastructure	56 307 \$		107 446 \$
Superstructure and enclosure	120 970 \$		218 342 \$
Indoor facilities	5 159 \$		15 582 \$
Services	57 170 \$		67 011 \$
Outdoor facilities		49 362 \$	86 172 \$
Sub-total A : Cost of items		288 968 \$	494 553 \$
Design contingencies (15%)		43 345 \$	74 183 \$
Sub-total B : Cost of items including design contingencies		332 313 \$	568 736 \$
Construction site overheads (7 %)		23 262 \$	39 812 \$
General contractor administration and profits (5%)		17 779 \$	30 427 \$
Construction works costs excluding taxes		373 354 \$	638 975 \$
Taxes (TPS : 5.0 %; TVQ: 8.5%)		51 990 \$	88 977 \$
Construction works costs including taxes		425 343 \$	727 952 \$
II Construction contingencies		21 267 \$	36 398 \$
Cost of contingencies (5%)		21 267 \$	36 398 \$
III Consultancy fees		61 056 \$	104 494 \$
Cost of fees (architect, engineer, etc.) (12%)		53 593 \$	91 722 \$
Taxes (TPS : 5.0 %; TVQ: 8.5%)		7 463 \$	12 772 \$
IV Cost of project construction = I+II+III		507 667 \$	868 844 \$
V Furnishings and general equipment		14 241 \$	17 089 \$
Cost of washing equipment		12 500 \$	15 000 \$
Taxes (TPS : 5.0 %; TVQ: 8.5%)		1 741 \$	2 089 \$
VI Cost of capital investment project = I+II+III+V		521 907 \$	885 933 \$

8.2 OPERATING COSTS

8.2.1 Overhead costs

The fixed costs estimate is based on the budgeted capital investment costs and the parameters given in Table 8-3. Table 8-4 gives the yearly fixed costs for operating each of the wash stations.

Table 8-3
Parameters chosen for fixed costs estimate

Straight-line amortisation	30 years (3.33 %/an)
Financing	6 %
Maintenance	1.40 %
Property taxes	1.15 %
Insurance	0.40 %

Table 8-4
Yearly fixed costs

Overhead	Basic wash station	Intermediate wash station
Amortisation	15 800 \$	26 800 \$
Interests	22 100 \$	37 600 \$
Maintenance	7 300 \$	12 400 \$
Property taxes	6 000 \$	10 200 \$
Insurance	2 100 \$	3 500 \$
TOTAL	53 300 \$	90 500 \$

8.2.2 Variable costs

Variable costs depend mainly on the type of vehicles washed, independently of their number and of the wash station. Table 8-5 gives the parameters chosen for the variable costs estimate and Table 8-6 gives the yearly variable costs for both wash stations and three levels of occupancy.

Table 8-5
Parameters chosen for variable costs estimate

Labour	20 \$/h
Water supply	0.40 \$/m ³
Undiluted detergent	750 \$ / 205 L
Undiluted disinfectant	1500 \$ / 205 L
Energy costs	
Electricity	Tariff D – 0.075 \$/kWh
Oil	1.21 \$/L
Duration of washing operations	
10-wheel trucks	1.85 hours
Tractor-trailers	4 hours

Table 8-6
Yearly variable costs for operating a wash station

Type of variable cost	Basic station			Intermediate station		
	5 veh./week	10 veh./week	20 veh./week	10 veh./week	20 veh./week	30 veh./week
	(\$/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$/yr)	(\$/yr)
Labour	11 700	23 400	46 800	62 830	125 670	188 500
Detergent	750	1 510	3 020	3 210	6 430	9 640
Disinfectant	750	1 510	3 020	3 210	6 430	9 640
Water	260	520	1 040	1 110	2 210	3 320
Electricity	2 110	2 350	2 850	5 030	6 890	8 760
Oil	1 960	3 250	5 830	8 280	15 340	22 410
TOTAL	17 530	32 540	62 560	83 670	162 970	242 270

8.2.3 Total costs

Table 8-7 gives the cost estimate per year and per vehicle washed, for both wash stations and three levels of occupancy.

Table 8-7
Yearly operating costs for a wash station and unit cost per vehicle washed

Costs	Basic station ¹			Intermediate station ¹		
	5 veh./week	10 veh./week	20 veh./week	10 veh./week	20 veh./week	30 veh./week
Overhead costs (\$/yr)	53 300 \$	53 300 \$	53 300 \$	90 500 \$	90 500 \$	90 500 \$
Variable costs (\$/yr)	17 530 \$	32 540 \$	62 560 \$	83 670 \$	162 970 \$	242 270 \$
Total costs (\$/yr)	70 830 \$	85 840 \$	115 860 \$	174 170 \$	253 470 \$	332 770 \$
Unit cost (\$/veh.)	272 \$	165 \$	111 \$	335 \$	244 \$	213 \$

¹ For a basic wash station: 10-wheel trucks; for an intermediate wash station: tractor-trailer, 3 levels.



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9. EXISTING WASH STATIONS



Although this document is a guide essentially for designing and constructing new wash stations, most of it can be applied to existing wash stations. This chapter gives certain points covered in the present guide, which can be applied to existing stations in light of observations made when wash stations were characterized in 2008! An indicative cost estimate of these points is presented, knowing that they may vary sensitively from one company to another. As an indication, the actions are classified by order of decreasing priority (1 to 5) according to their potential impact on the quality of washing operations and their cost.

These various points are given in Table 9-1 in the same order as presented in the guide, and not according to their degree of effectiveness, or their cost. Obviously, certain points in this guide may not apply, particularly as regards the location of the wash station. The table also illustrates, where applicable, whether or not a situation is undesirable.



Table 9-1
Suggested actions for existing wash stations

ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Road surface</u></p> <p>The surface must be properly drained to allow access to the wash station at all times and to minimise the risk of cross-contamination.</p>	1	<p>The cost varies, depending on the original condition and surface area of the road surface.</p>	
<p><u>Parking</u></p> <p>The dirty-vehicles parking area is located near the floor slab of the soiled-bedding disposal area.</p>	3	<p>The cost is highly variable depending on the availability of land and its original condition.</p>	



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ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Materials</u></p> <p>Use of porous and putrescible materials inside the wash station should be avoided. Equipment and materials should be made of painted or galvanised metal or synthetic materials (PVC).</p>	<p>1 to 5</p> <p>Depending on the relevant equipment or structures.</p>	<p>Cost highly variable, depending on modifications needed.</p>	
<p><u>Maintenance</u></p> <p>Building maintenance is important, in particular in the wash room. Pathogens may be found in dust and soiling on the walls and ceiling.</p>	<p>2</p>	<p>Minimum cost</p> <p>Detergents, disinfectants and labour</p>	


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ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Floor drainage</u></p> <p>The floor must be smooth and inclined for faster drying. If the slope is insufficient, use ramps to raise the vehicle (Figure 5-11Figure 5-11). If the slope is sufficient but the floor surface is rough, resurface the concrete floor.</p>	<p>1 (insufficient slope)</p> <p>4 (roughness)</p>	Depending on work needed.	
<p><u>Floor surface</u></p> <p>The floor does not <i>have to</i> be covered, especially if the required biosecurity level is not very high. It must be considered if breeding animals are transported.</p>	5 in general (may be more important depending on the type of livestock transported)	<p>From 15 to 70 \$/m²</p> <p>From \$ 4 000 to \$ 20 000 for a 9 m X 30 m wash room as shown in Figure 3-12.</p>	

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ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Dividing the wash room into 2</u></p> <p>To reduce the width of a wash room which must accommodate more than one vehicle at a time: a curtain may be used instead of building a wall, to reduce the risks of cross-contamination between two vehicles.</p>	<p>1</p> <p>In applicable situations.</p>	<p>± \$ 200</p>	
<p><u>Air exchanger</u></p> <p>Mist is caused when humidity in the warm, damp air of the wash room condenses as it encounters cool intake air. To limit condensation, use an air exchanger. This reduces the temperature difference between the cool intake air and the warm room air. To eliminate condensation, heat the fresh air to room temperature.</p>	<p>3</p>	<p>The cost varies depending on the current installation of the wash station and the amount of condensation to be reduced.</p>	

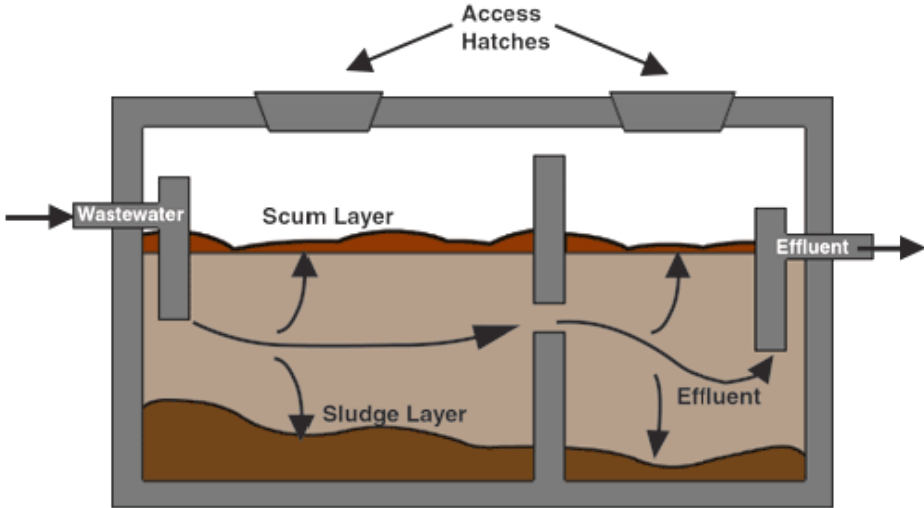
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ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Lighting</u></p> <p>A lighting level of 400 lux is required for a good washing operation and to inspect the result. A sufficient number of lights should be installed and burned-out light bulbs must be replaced.</p>	<p>1 to 5</p> <p>Depending on current situation</p>	<p>Cost variable depending on current situation.</p> <p>Negligible if only replacement of burned-out bulbs is required.</p>	
<p><u>Access forbidden to animals</u></p> <p>Domestic and wild animals are potential vectors for pathogens. They must not be allowed to access the interior of the wash station. A sign should be posted to warn users and visitors of this rule.</p>	<p>1</p>	<p>± 10 \$</p> <p>Only requires the purchase and installation of a sign and strict enforcement of its message.</p>	

ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Foam gun</u></p> <p>Applying detergent and disinfectant using a foam gun gives a more uniform result and extends the contact period between the product and the soiled areas. Various models are available with different characteristics, and at various prices.</p>	1	<p>\$ 200 to \$ 1000.</p> <p>Depending on the principle used to inject air: using a venturi mounted directly on the gun hear (illustration on the right) or by injection of compressed air.</p>	
<p><u>Water heater</u></p> <p>Use of hot water for detergence and disinfection operations has already proven its efficiency. Installing a water heater is a simple matter. Such equipment is adapted to high-pressure wash system. Models are available for various capacities and types of energy.</p>	2	<p>± \$ 1 000</p> <p>Depending on model, heating capacity and energy source</p>	

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ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p>Drying</p> <p>Rapid drying of vehicles improves the overall effectiveness of the washing and disinfection operations. Different systems of varying efficiency can be acquired at various costs:</p> <ul style="list-style-type: none"> ■ Portable fans (illustration to right) ■ Fan assemblies ■ Unit heater 	2	Starting at \$ 200, depending on the equipment design (mounted on a structure, heating element, air piped into the vehicle, etc.)	
<p>Bedding disposal</p> <p>Bedding must be disposed of in an impermeable structure, preferably with cover.</p>	1 (regulated situation)	Depending on volume to be disposed of	<div>  <p>Disposal on an impermeable platform with no wall or cover.</p> </div> <div>  <p>Disposal on an impermeable platform, with wall and without cover.</p> </div>

ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Disposal of wash water</u></p> <p>Even if wash water contains few contaminants with respect to bedding, they cannot be discharged to the natural environment without prior treatment.</p>	<p>1 depending on current situation</p>	<p>Cost may vary considerably, depending on the chosen option:</p> <ol style="list-style-type: none"> 1. Storage with bedding, in a watertight structure 2. Discharge to municipal sewage system with or without passing through a septic tank first 3. Treatment by septic tank and disposal field (± \$ 10 000) 	 <p>The diagram illustrates a cross-section of a rectangular wastewater treatment tank. At the top, two 'Access Hatches' are shown on the roof. On the left side, a vertical pipe labeled 'Wastewater' enters the tank. On the right side, a vertical pipe labeled 'Effluent' exits the tank. The interior of the tank is divided into two main sections by a central vertical partition. The top layer is labeled 'Scum Layer' and is depicted with a wavy, brown surface. The bottom layer is labeled 'Sludge Layer' and is shown as a darker, more solid brown area. Arrows indicate the flow of water from the input pipe, through the tank sections, and out through the effluent pipe. The tank is enclosed in a grey frame representing the structure.</p>

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ACTIONS	PRIORITY	ESTIMATED COST	REFERENCE
<p><u>Washing, disinfection and drying protocol</u></p> <p>A specific guide entitled “LIVE HOG TRANSPORT VEHICLES WASH/DISINFECT/ DRY PROTOCOLS” has been published and should be made available in all wash stations.</p>	1	<p>Negligible cost</p> <ol style="list-style-type: none"> 1. Get the guide from the Canadian Swine Health Board 2. Produce and post a sign describing the protocol to be observed. 	<div data-bbox="1060 316 1480 901">  <p>Guide describing how to perform washing, disinfecting and drying operations</p> </div> <div data-bbox="1501 308 1974 917">  <p>Washing protocol displayed for the benefit of operators</p> </div>

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