7.0 – DESIGN AND OPERATION OF MAINTENANCE YARDS

This is one in a series of Syntheses of Best Practices related to the effective management of road salt in winter maintenance operations. This Synthesis is provided as advice for preparing Salt Management Plans. The Synthesis is not intended to be used prescriptively but is to be used in concert with the legislation, manuals, directives and procedures of relevant jurisdictions and individual organizations. Syntheses of Best Practices have been produced on:

1. Salt Management Plans
2. Training
3. Road, Bridge and Facility Design
4. Drainage
5. Pavements and Salt Management
6. Vegetation Management
7. Design and Operation of Maintenance Yards
8. Snow Storage and Disposal
9. Winter Maintenance Equipment and Technologies
10. Salt Use on Private Roads, Parking Lots and Walkways
11. Successes in Road Salt Management: Case Studies

For more detailed information, please refer to TAC's Salt Management Guide - 2013.

INTRODUCTION

A Maintenance Yard is the location from which snowfighting agencies and companies stage their maintenance operations. Yards may be small, as in the case of a contractor facility or large and complex and as in the case of some road agencies. Agency yards may be dedicated to operating a single department like Roads or shared with other operating groups such as Sewer and Water, Waste and/or Parks Maintenance. They are referred to by a variety of other names including: patrol yards, camps, garages or depots. For the purposes of this document however we will refer to these facilities, either dedicated or shared, as Maintenance Yards. It is common that road maintenance work will be carried out from several road maintenance yards located throughout the area serviced by the snowfighting agencies and companies. Often in the past, these yards were located where land was in surplus or inexpensive for them to obtain. Little site engineering was used in determining the locations of the buildings on site and the functionality of the facilities simply evolved over time to match the needs of the department. Their impact in the local environment was not a major consideration in determining location or design and construction.

CONTENTS

This Chapter of the Syntheses of Best Practices is intended to present the salt management and environmental considerations that should be taken into account when locating, designing, operating and maintaining maintenance yards. There are many other considerations, particularly related to safety, that are unrelated to salt management that are not addressed in this document, but that should be taken into account when designing and operating maintenance yards.

The role of a maintenance yard can vary from being the central location for maintenance operations (including administration functions) to simply serving winter operations only. The practices described in this chapter apply to both.

This Synthesis of Best Practices includes:

- planning
- site selection
- designing a functional facility
- salt storage
- site drainage
- brine production
- site operation and maintenance
- monitoring
- record keeping, and
- training.

In general, maintenance yards are constructed for multiple purposes including the delivery of winter maintenance services.

For winter operations, there is a strong need to focus on salt loss, whether in the form of airborne salt dust, brine runoff, wastewater discharge from vehicle washing and surface drainage or simple loss of road salts through improper handling practices. Lost salt will dissolve and can infiltrate into the soils below and adjacent to the site. Components of road salt entering the environment can travel great distances and affect wells, vegetation, groundwater and surface water where the groundwater emerges as springs or discharges into streams.

There are cases where road authorities have had to replace salt impacted wells and the resultant corroded appliances of affected homeowners or install filtration systems (e.g. reverse osmosis systems) to remove contaminants.

In addition, salt impacted runoff can affect vegetation and agricultural operations, on and adjacent to yards, as well as any downstream aquatic habitats where the salt impacted water collects.

Good yard design and salt handling practices are essential to preventing unnecessary salt loss and the resultant environmental impacts.

The Yard In Action

The yard layout should be designed to be efficient in all activities. Considering the cycle of handling road salts in the yard may reveal potential enhancements that can be made to improve yard efficiency and reduce salt loss. It is assumed that a new maintenance yard would include some or all of the following:

- an office, lunch, wash and utility rooms
- parking areas for staff vehicles and maintenance equipment
- a vehicle maintenance garage
- winter materials storage facilities
- winter materials handling area
- indoor vehicle washing area
- a garage and/or shed for maintenance equipment and materials
- outside material storage area (e.g. gravel, posts, etc.)
- brine production and storage areas
- brine loading areas, and
- washwater and impacted surface water recycling system for brine production.

The typical salt handling cycle flows from delivery, to stockpiling, to loading onto the spreader and then to exiting the yard. Upon return, the spreader off-loads unspent salt (preferably indoors), and the equipment is then washed to remove remaining salt residue.

Each area affected by these activities can provide an opportunity for improvement.

Typically, a delivery transport trailer end dumps or off loads the salt via a longitudinal conveyor. Preferably, the storage facility has been designed and constructed to allow the salt to be unloaded directly inside. If unloaded outside, the salt must be moved into the storage facility.

Ideally, the salt should not be "double handled." In some cases salt is blown into storage facilities using a closed pipe system to eliminate double handling. Whether mechanically piled or blown, each handling can cause particle breakdown, segregation and loss. While handling can serve to break up any chunks that may be present, this double handling is inefficient. It also allows for a greater wind-blown loss of salt and the loss of salt fines that are remaining on the outdoor surface.

Loading and overloading spreader vehicles are potential sources of spillage. Improperly sized loaders and careless loading cause excessive spillage.

Where liquid melting agents are used, spillage of liquids can occur during production, delivery and transfer to spreaders.

It is not always necessary to spread the full load of material. Operators should be instructed to spread only what is needed to achieve the prescribed level of service. Unused materials must be returned and offloaded to the storage facility.

To minimize corrosion, spreaders are washed following a storm. The washwater is likely contaminated with dirt, oil, grease and salt (chlorides).

The washwater can be directed to a storage tank and used to make brine. Where washwater is used for brine production it is important that all reclaimed water be directed through a properly designed oil and grit separator (OGS) prior to use and that only detergents or de-greasers that are suitable for an OGS be used in the washing operations. Note: Local regulatory requirements may affect the ability to use washwater for brine production.

If not reclaimed for brine production the washwater should be directed to a sanitary sewer. If no sanitary sewer is available the washwater should be directed to a properly designed storm water management pond. Such ponds usually have designs which encourage the deposition of fines and heavy particles in a fore bay area and a secondary area where the salt impacted water can be diluted with surface drainage from the non-impacted areas of the yard to lower the salt component concentrations prior to discharge into a ditch or receiving body. The water that is collected should be periodically monitored/ checked to ensure compliance with release concentration requirements.

To summarize, salt is lost to the environment in a variety of ways during the salt handling process. These include:

- spillage of solid salt during delivery, mixing of sand/ salt blends, stockpiling and loading/ overloading of spreaders being carried away in the surface drainage of the yard
- salt being dissolved from uncovered stockpiles of salt and sand/salt blends
- spillage of liquid deicing chemicals during production, delivery, transfer to spreaders or tank/ line failures
- vehicle washing, and
- blowing salt dust from exposed piles.

Guiding Principles

When planning, designing and operating a winter maintenance yard, the following guiding principles should apply.

- Locate the yard(s) at strategically efficient location consistent with local land use plans and/or regulations.
- Locate and operate storage sites to minimize impacts to the natural environment and control nuisance effects, including noise, dust, litter and visual intrusion on adjacent landowners. Carry out Salt Vulnerability Mapping of the candidate areas and select areas that are less vulnerable to salt impacted drainage water.
- Place stockpiles inside storage structures.
- Use low permeable surfaces to minimize infiltration.
- Collect and reuse or properly manage salt impacted site drainage and vehicle washwater to comply with local water quality regulations and protect surface and groundwater resources.
- Promote indoor operations where possible.
- Handle materials and clean up spilled salt to minimize salt loss to the environment.
- Collect and dispose of onsite contaminants and wastes in accordance with local waste management legislation.
- Control emissions (drainage, noise, dust, litter, fumes) to prevent off-site environmental impacts.

SALT MANAGEMENT PRACTICES

Planning

While summer activities may dictate the core staffing needs, winter route times and service levels are the determining factors in establishing the numbers of staff and equipment that must be allocated and housed at each yard. Whether consolidating or constructing at new locations, there is more to consider than simply efficiency improvements. The re-evaluation of yard needs provides an opportunity to achieve the most functional design with positive economic and environmental returns.

A general yard location is dependent upon:

- control of emissions (drainage, noise, dust, litter, fumes) to prevent off-site environmental impacts
- the needs of the organization
- optimization of route times calculated to meet a required level of service, given equipment capabilities, and
- environmental considerations.

The supervisor of winter operations may not be able to make immediate changes to the winter equipment fleet. However, over time, as the winter fleet is improved, there will be more efficient use of resources. This will help to maximize the effectiveness of salt used, and to optimize the number of maintenance yards needed.

Site Selection

Next to the proximity and access to the road network to be serviced, it is important to assess site physiography and topography when choosing a new site. Ground conditions (soils or rock) and the lay-of-the-land complement the drainage management objectives.

For example, unlike granular bases, clay bases will prevent rapid infiltration of salt laden water. Conversely, highly permeable soils almost always allow the surface water to reach the ground water table. This may not be a serious concern if there is relatively quick outlet to a tolerant watercourse or the runoff is captured, contained and managed, but uncontrolled runoff can generate considerable liability if the groundwater impacted by salt becomes a well water source.

A site that has natural surface drainage will limit the impact on groundwater. Underlying soil and rock characteristics, groundwater use and characteristics, and proximity to, and sensitivity of surface water should be understood to evaluate potential impacts from the presence of salt. For example, a site with a deep groundwater table will limit the potential for groundwater contamination from salt and hydrocarbons.

It is also important when selecting a site for a maintenance yard to understand the long-term land use plans around the potential site. If a development based on groundwater sources for its water supply is to be located down gradient from the maintenance yard then the organization could face a future liability due to salt impacts to the groundwater.

A properly conducted environmental impact assessment, emphasizing the risks associated with salt loss pathways, will help to ensure that an appropriate site is selected and that proper considerations go into facility design.

When planning and designing maintenance facilities, salt vulnerable areas must be taken into consideration and avoided to the extent possible. Where they cannot be avoided, specific measures should be included in the design to protect vulnerable areas.

Salt vulnerable areas could include:

- bodies of water with low dilution, low volume or salt sensitive species
- salt sensitive vegetation and agricultural operations
- sources of drinking water (i.e. surface water and groundwater), and
- groundwater recharge zones or shallow water table, with medium to high permeability soils.

The assessment of alternative sites should consider the potential chloride loadings to salt vulnerable areas and whether or not these loadings could have any adverse effects. Sites that have the potential to adversely affect vulnerable areas even after applying best management practices should be eliminated from further consideration.

Design

Maintenance yards are often multi-functional facilities. A maintenance yard can be an evolving design. All functions conducted at the yard must be considered in designing the most suitable layout and features for the yard. The designers should consult with the people who will work at the facility when laying out the flow of the yard. The yard should be laid out to permit vehicles involved in the salt-cycle to move efficiently and safely about the site. The design should be flexible enough to allow the yard to be expanded as service delivery areas increase, or to be retrofitted to satisfy the latest method or policy change.

A Winter Maintenance Area (WMA) is a paved area of a maintenance yard where all salt materials will be handled and vehicles will operate. Its purpose is to isolate those activities in order to contain and manage salt-impacted drainage. As such, all activities that can lead to salt-impacted drainage should be located within the WMA. Such activities include:

- sand-salt mixing
- salt deliveries
- salt loading
- material storage
- access routes
- equipment washing, and
- snow storage (i.e. salt-impacted snow cleared from the yard).

Also designers should consider the following:

- The size of the WMA should be minimized to reduce the amount of salt-impacted run-off that needs to be managed.
- Avoid inclines that would require additional salting or sanding to gain traction during winter months.
- All activities not involving salt management should be located outside of the WMA.
- The WMA should be constructed on a pad with low permeability (e.g. 100 mm of high strength asphalt underlain with a low-permeability membrane) to limit infiltration of salt-impacted drainage. A small berm or curb (e.g., 150 mm asphalt curb) should be placed around the WMA to direct drainage.
- Drainage ditches conveying salt-impacted run-off should be of low permeability (e.g., asphalt lined).
- Drainage inside the WMA should be directed to containment where it can be tested and properly managed. Containment options include storage ponds and tanks. Testing will depend on management options which may include:
  - release to the environment
  - removal by licensed waste-hauler, or
  - directing the salt-impacted run-off to an oil/grit separator and then possibly to containment for brine production.
- Containment (e.g., storage ponds and tanks) must be designed to contain the drainage. Also, consideration should be given to the consequence of containment failure and back-up options to reduce deleterious impacts. Containment must be designed to contain the drainage from the WMA using annual precipitation data and pump-out frequency. Storage pond design considerations include:
  - sloping the bottom to allow for collection of water for disposal
  - lining the bottom to prevent infiltration of brine; constructing the pond with clay, a sand base, an UV stable 30-mil liner and sand top layer
  - providing a fore-bay area to settle out heavier suspended solids
  - allowing for sufficient freeboard to handle normal precipitation events
  - providing escape routes (e.g., tires roped together) for anyone falling into the pond
  - fencing the pond for security, and
  - pond agitator may be required to prevent mosquitos from breading (nuisance and disease prevention).
- Drainage from outside of the WMA (non-salt impacted) should be directed off-site in a way that minimizes off-site impacts (for example, to a storm water management pond).

A yard which has ample size and access, and which has managed drainage is a facility which:

- is safe from which to operate
- is cost effective to use
- facilitates the management of site drainage and vehicle wash water
- protects salt vulnerable areas
- generates limited liability
- provides indoor storage for all salt and sand/salt blends, preferably large enough to allow indoor delivery and spreader loading
- notes the prevailing winter wind direction and positions the building and doors with regard to sheltering loading operations; minimizing snow drifting around doorways, and keeping precipitation out of the storage areas
- provides proper lighting to help ensure safe and accurate salt loading operations when visibility is reduced during a storm event, especially at night
- properly spaces buildings and material storage facilities (e.g. liquid storage tanks) in order to maneuver vehicles properly and safely
- properly locating the office building with a viewing window suitable for observing the loading area (to confirm numbers of trucks, sizes of loads and general yard activity)
- constructs storage facilities on low permeability pads to limit infiltration of salt laden drainage
- constructs the loading pad of asphaltic concrete or other low permeability material at the entrance of the facility
- provides for the interception and management of salt impacted drainage
- locates parking, fuelling and loading/ unloading areas as well as paved pathways to permit efficient vehicle movements and limit backing operations
- locates catch basins properly, with hook-ups to avoid directing salt-laden runoff through storm sewers into salt vulnerable watercourses, or directly into the ground through poorly sealed sumps
- identifies snow storage around the yard perimeter to lessen the impacts of salt-laden melt water (see the Snow Storage and Disposal Synthesis of Best Practices)
- locates the potable water well for the maintenance yard up-gradient to prevent it from being impacted by site operations
- installs security fencing
- installs outlets for block heaters for vehicle readiness, and
- installs berms and screening to reduce nuisance omission such as dust and noise and reduce unsightliness of outdoor storage.

Storage

Solid salt stockpiles should not be exposed to wind, rain or snow. Dissolved salt does not "disappear", but rather enters the site drainage and creates problems off-site.

Therefore, proper storage of salt and sand/salt blends requires that they be covered to protect them from the elements. Salt and blended abrasives should be stored inside storage facilities located within the WMA.

The following should be considered when designing storage facilities:

STRUCTURAL

Structure designs range from the traditional dome, to rectangular sheds or barns, to high arch structures, to elevated silos. Storage structures can be made of different materials including wood, steel, aluminum, fiberglass or fabric.

Consideration should be given to the multiple function of storing sand with salt or other winter operations materials. Some structures provide a more efficient capacity than others depending on the intended methods of putting up the piles as well as in using the materials.

Consideration should also be given to the prevailing winter wind direction and channeling when siting and orienting the building. Where possible, position the building and doors to shelter loading operations, minimizing snow drifting around doorways and keeping precipitation out of the storage areas.

STORAGE CAPACITY

- The structure should be sized taking into account the seasonal needs, the reliability of the material source and the delivery frequency and timing possible during the winter season. The volume housed should include a contingency quantity to ensure that the supply will not run out in times of need or in the event of supply problems. This allows flexibility in the delivery of material to minimize potential environmental impacts caused by inclement weather.
- Structures should be sized so that materials are fully contained and do no extend outside the building. Likewise the capacity should not be exceeded.
- Where there is insufficient capacity to store all the materials inside the structure then tarps should be used to protect salt from the elements.

CONSIDERATIONS FOR INDOOR STOCKPILING AND SPREADER LOADING

- Indoor storage for all salt and sand/salt blends should be large enough to allow indoor delivery and spreader loading.
- Spillage during stockpiling and spreader loading is an important source of salt loss. The extent to which these activities can be carried out under cover will minimize salt loss.
- The design should accommodate the method of “putting up the pile”. There should be sufficient room to minimize material handling and the associated dust.
- Note: there are special considerations when selecting the storage facility design to permit indoor activities. The two most significant ones are ventilation and roof and door clearances.

Ventilation

- Ventilation is required for vehicle exhaust and dust.
- Carbon monoxide (CO) monitors/alarm systems are required.

Roof and Door Clearances

- The door and roof structure should be high enough to allow a transport trailer to end dump inside the structure. On rectangular structures, end doors are advantageous.
- The entrance to the storage structure may have a door, curtain or a sufficient overhang to minimize precipitation entering the structure.
- Operational access and egress to the structure should be considered in entranceway layout.

BASE

- To maximize storage capacity on the smallest footprint, the trend is to enclose the base of the pile and support the structure on a concrete wall, with or without a footing. These walls need to be designed to withstand the strain of materials and loaders pushing against them. They should be free of gaps that would allow salt or salt-impacted drainage to escape. Any gaps that could permit the release of salt from the storage structure or the entrance of water into the structure should be sealed.

ROOF AND EXTERIOR

- The roof and exterior of the storage structures shall be constructed of waterproof material such that precipitation and moisture are prevented from entering the building.

LIGHTING

- Proper lighting should be provided to help ensure safe and accurate salt loading operations when visibility is reduced during a storm event, especially at night. Emergency power backup may be required so that operations can continue during periods of power outages.

FLOOR

- The floor of the structure provides both the operating surface and the barrier to infiltration of salt-impacted water into the ground. Since indoor operations will place significant stresses on the floor, the floor must be designed properly. The floors of all structures should be constructed of low permeability material such as high strength asphalt or concrete. Both asphalt and concrete are somewhat permeable and should be sealed to minimize infiltration. Floors can also be underlain with a low-permeability membrane to limit salt loss.

ALLOWING FOR SALT/SAND BLENDING

- One possible design is to have salt at one end of the structure and blended sand at the other end with space to allow a pug mill and conveyor for creating the blend. This configuration warrants side doors to allow spreaders to drive through the structure and be loaded with different materials from either end.

COSTING

- In evaluating the costs of the various storage alternatives, of special note is the comparison of the actual, realistic in-use capacity that is expected in service, rather than simply the theoretical capacity. For example, a conical structure with a given design capacity will be greatly underutilized if the material stored is in two piles, one on either side. In addition, larger storage capacity allows agencies / companies the flexibility to buy salt during dips in market price (with the added benefit of having extra supplies in the event of back-to-back storms (there is a real “cost” to not providing adequate winter maintenance).
- Consideration of life cycle costs for repairs and intermittent refurbishing may show that a more functional yet costly facility to build is less costly in the long run because of lower operating costs.

LIQUID STORAGE FACILITIES

- Designers should consult with local environmental regulatory authorities regarding siting and containment requirements for liquid storage facilities.
- The required storage capacity will depend on the security of supply, production/delivery times and rate of use.
- Storage capacity can be reduced by using an “on demand” system.
- Where supplier-owned storage containers are used, arrangements need to be made for the delivery of full containers and removal of empties during yard operations.
- Supplier-owned storage containers should be treated the same as other brine storage containers (i.e. protected from vehicle impacts and provided with spill containment around both the storage tank and liquid transfer point where appropriate).
- Where practical, secondary containment should be provided through double walled tanks and/or containment dykes. Typically, containment capacity is 110-125% of the capacity of the largest tank.
- Crash protection should be provided to prevent vehicles from impacting the production and storage facilities.
- Sufficient water supply is often a constraint when designing a brine production facility. The designer must ensure that sufficient water capacity is available to produce brine at the required rate for the maintenance operation.
- Water supply lines may need to be heat traced to prevent them from freezing.
- The freeze point of the liquid being stored and the lowest possible winter temperatures must be taken into account when determining the need to heat the production and storage tanks and piping.
- Emergency power supplies may be needed to ensure that liquid supplies are available in the event of a power failure.
- Designers must take into account the desired fill time for spreaders when selecting pump and line sizes. Pumps and lines that are too small will prolong the time it takes to refill onboard tanks.
- Production and storage tanks must be designed with a clean-out or flushing capability to remove settled impurities.
- Some liquids may require periodic circulation to prevent settlement of impurities, additives or product separation.
- Site Drainage:
    - The site should be graded to direct drainage away from any down gradient groundwater well locations or salt vulnerable areas to a storage and/or treatment area.

- Snow plowed from the site should be directed to areas where the melt water will be directed away from groundwater wells, storage area and salt vulnerable areas.
- Salt-laden water should be collected and properly managed. The water can either be used in brine production or sent for disposal at sewage treatment facilities where permitted.

■ Indoors:

- Indoor material storage and vehicle loading is preferred. A drive-through facility is beneficial.

■ Underground Storage:

- Some highway agencies have buried the storage vessels and used the earth heat to maintain the temperature above freezing. Buried vessels have a high potential for undetected or large loss of material and costs for remediation or mitigation of contaminated soil and groundwater. It is suggested that great care be taken in the selection of this option and that local regulatory agencies and a professional engineer familiar with underground containment systems be consulted.

Operations and Maintenance

In addition to proper design, good operating practices are essential to minimizing material wastage and environmental impacts. Organizations must review all aspects of their operations (delivery, storage, handing, site drainage, brine operations, vehicle washing etc.) to determine where salt loss is occurring and to develop procedures to minimize or eliminate these losses. The following practices should be followed.

SALT HANDLING:

■ Where practical to do so, spreaders should be loaded inside the storage structure. Where inside loading is not possible, other systems are needed to recover salt spills that occur during loading.

■ When loading spreaders outside of the storage structure, care should be taken to minimize spillage of salt onto the loading pad and sweeping the pad of such spillage as soon as possible.

■ Overloaded spreaders are prone to spilling salt during operations. Therefore, spreaders should not be loaded beyond their capacity and, where feasible, should be covered with tarps when loaded with salt or sand.

■ Stockpiles frequently have portions that have become frozen. These frozen blocks need to be properly managed and should not be placed into spreaders. These blocks should be pushed into the corner of the storage facility and allowed to thaw and dry. Once they have thawed and dried, the material should be broken up and reintroduced to the pile. Where brine production is ongoing, blocks of pure salt can be put into the brine production tank.

■ Deliveries of salt should be arranged such that material is placed within the covered storage facility as soon as possible upon delivery. Deliveries should be scheduled for periods of good weather.

■ All deliveries should be covered when being transported to the maintenance yard.

■ Spreaders should be properly calibrated and periodically checked to ensure continued calibration. They should be recalibrated following any servicing of the salt delivery system.

■ Some organizations benchmark their service areas to establish the amount of material that would be placed under specified application rates. At the end of a run, the total material placed can be compared to the benchmark to see if the projected amount was put down. If there is a discrepancy then the reasons can be investigated.

■ Excess salt and sand remaining in the spreader following a storm should be returned to the storage facility and deposited within or as close to the entrance of the storage facility as possible. Where materials are off-loaded outside of the storage facility, they must be placed into the storage facility as soon as possible.

VEHICLE WASHING

■ Prior to washing, the spreaders should be swept to remove as much of the residual solids as possible and thereby minimize the amount of dissolved salt and solids in the wash water.

■ Where possible, vehicles should be washed indoors rather than outdoors to contain the wash water.

- Where only outdoor washing is possible, it should be done where all washwater can be contained and directed through positive drainage to a water management system.
- It is preferable to direct washwater to a storage facility where it can be reclaimed and used for brine production or sent for disposal.
- If a washwater reclaim system is not available spreaders should be washed at a location where the washwater can be properly diluted, disposed or treated. When sending for disposal, careful consideration must be given to the ultimate receiver of the washwater.
- All vehicle washwater should be directed through an oil/grit separator. Note, oil/grit separators do not remove dissolved contaminates like the sodium and chloride from salt-impacted water. Where discharge is to a municipal system, salt-impacted water can exceed municipal chloride limits.

SAND/SALT MIXING

- Sand and salt mixtures should be mixed inside, or on low permeable pad located as close to the storage area as possible.
- Mixing should be done during good weather. This will reduce salt loss due to precipitation and wind, and minimize the moisture content of the sand/ salt mix.
- Mixing should be done using a pug mill or some other method to achieve a homogeneous engineered blend. This reduces the amount of salt needed to prevent freezing of the pile.
- Sand should be as dry as possible, thereby reducing the amount of salt required to prevent freezing.
- After the sand and salt have been mixed, the mix should be loaded into a storage facility as soon as possible. The mixing area should then be swept and the sweepings placed into the storage facility.
- Organizations that purchase manufactured sand/ salt mixes should check deliveries to validate that the percentage mix is as specified. Too high a percentage of salt is wasteful and too low a percentage may result in the pile freezing.

SALT BRINE PRODUCTION & STORAGE

Brine production units require significant water supplies. Where well water is the intended supply source there may be insufficient supply to meet brine production requirements. Therefore, water supply must be carefully planned. A designer should identify all potential water requirements, both current and future needs, and plan the water source and taking requirements accordingly as follows:

- Water wells for human consumption should be located up-gradient of the Winter Maintenance Area to prevent the well from being impacted by site operations. Wells need to be drilled and installed with due regard for protecting groundwater resources from surface contamination, preventing aquifer cross connection and maintaining the function of groundwater such as baseflow and availability for water supply.
- Depending on local requirements, a licensed well driller may be required. Necessary permits must be obtained.
- Wells providing water for brine production should be located down gradient of the Winter Maintenance Area.
- Cisterns should be used in rural settings to stockpile water. Drawing from a cistern allows the well and underground pump to be better maintained with a consistent lower draw. The cistern can also handle water deliveries during times of drought or high water use.
- Where regulations permit, consideration should be given to using washwater or salt laden drainage and stormwater for brine production. Since relatively clean water is required to ensure a proper brine solution is produced, any salt-impacted water collected for recycling should be directed through an oil/grit separator prior to being used in brine production.
- Where possible, clumps of salt or wet salt can be placed into the brine production plant rather than placing this material in the salt storage facility.
- Where salt brine storage tanks are used, these tanks should be placed above ground, and protected from potential impacts by vehicles. Secondary containment should be provided where a tank failure could result in environmental

damage. Containment may be provided by double-walled tanks and/or dyking systems. Provincial regulatory agencies should be consulted to determine the containment and handling requirements.

- Periodic inspection of tanks, pumps and pipes/ hoses should be carried out and any leaks and damage should be repaired immediately.
- Brine production and storage facilities may need to be flushed periodically to remove sediments. The materials produced from this flushing activity are mostly sand and gravel and can be screened and mixed with the abrasive pile.

SOLID MATERIAL STORAGE FACILITIES

- Allow for indoor loading and unloading of winter maintenance materials.
- Allow sufficient area for material storage and include room to load and unload to reduce the need to double handle material.
- Any roof leaks, tears or damage should be temporarily repaired during winter to reduce entry of precipitation, with permanent repairs being completed prior to the next winter season. At no time should leaks be allowed to persist when materials are being stored inside.
- The floors should be inspected annually for cracks and repaired/resealed as required.
- If an agency/company lacks a building sufficiently sized for its inventory, a tarped outside storage pile would be used until sufficient space is cleared in the structure (i.e. use the inside storage first, not the outside storage). In that way, the movement of the salt inside can be done between storms, reducing the potential for environmental losses. Outside storage should be on the Winter Maintenance Area.

MONITORING

It is important to understand how much salt is being used, where it is going and the resultant environmental impacts. Monitoring will aid in the determination of the extent of the impacts and effectiveness of the mitigation measures taken. Most activities should be focused on preventing, minimizing or mitigating the impacts. Attachment 1 provides a checklist for inspecting maintenance yards. In addition monitoring may include the following:

- Baseline condition (benchmarking) of the site and surrounding area for future monitoring comparisons. For new facilities, this should be completed prior to the site being commissioned.
- The amount of material used during the year which can be reconciled at year-end.
- The use of weigh-in-motion (WIM) sensors at the entrance and exit to the site to confirm recorded amounts and track dispatches.
- WIM sensors would work well in conjunction with a loader scale sensor so the operator is in control of the load and his good judgment can be confirmed.
- Road authorities should also monitor compliance with good housekeeping policies.
- Providing for an activity code in maintenance management systems specifically for yard housekeeping to maintain a focus on this important activity and not unnecessarily burden other activities.
- Most storage facilities have salt contamination in the ground below the site and can migrate offsite. By establishing permanent monitoring wells and implementing a regular groundwater monitoring program, road salt plumes may be detected early (prior to off-site migration) allowing organizations to mitigate through improvements to road salt storage and handling procedures.

RECORD KEEPING

The performance measures that should be tracked and monitored include:

- percentage of salt and sand/salt blends stored under cover
- percentage of storage sites with collection and treatment of washwater and drainage
- inspection, housekeeping and repair records
- stockpiling records
- quality control records for brine concentrations, and
- levels of environmental indicators (e.g. chloride levels).

TRAINING

Training should focus on ensuring that those handling salt at the yard minimize the potential to waste salt and impact the environment. Prior to each winter all staff that are handling winter sand and deicing chemicals should receive training. The training program should focus on the following learning goals with respect to maintenance yards:

- understand that all salt and sand/salt blends should be covered to minimize salt loss
- understand that salt spillage is wasteful and harmful to the environment
- understand the salt-handling activities that result in wasteful releases of salt to the environment
- understand how these salt-handling activities should be carried out to prevent the wasteful release of salt to the environment
- understand the maintenance yard salt cleanup procedures that must be followed
- understand that timely yard maintenance and repairs are necessary to control salt loss, and
- understand the importance of proper record keeping and how to complete the required documentation on yard maintenance and salt use.

Training should be carried out through the following methods:

- pre-winter briefings
- observation and corrective action, and
- informal briefings during the season.

SUMMARY AND RECOMMENDATIONS

Most winter operators have an understanding of what works well in a maintenance yard setting. The practitioner's advice should be sought in planning changes to facilities or in locating and designing new ones. This consultation can also provide a complementary benefit of having the workers better understand why the facility is constructed the way it is and how it is expected to meet the needs of the winter service to be delivered. In designing a new maintenance yard or designing a major refurbishing of an existing yard, many of the above ideas are worthy of consideration. Information is also available from the Salt Institute and from storage structure suppliers for further guidance.

MAINTENANCE YARD INSPECTION CHECKLIST

Yard:	Date:	Inspector:

SOLID SALT STORAGE AND HANDLING	YES	NO
Has a review of current storage practices for salt and sand/salt blends been done?	☐	☐
Is there a defined Winter Maintenance Area (WMA)?	☐	☐
If yes, is it on a pad with low permeability (e.g. 100 mm of high strength asphalt underlain with a low-permeability membrane)?	☐	☐
If yes, is there a small berm or curb (e.g., 150 mm asphalt curb) surrounding WMA to direct drainage?	☐	☐
Is salt stored inside permanent roofed structures?	☐	☐
Is regular preventative maintenance performed on facilities?	☐	☐
Has the roof been inspected for leaks?	☐	☐
Were leaks found?	☐	☐
If found, were leaks repaired?	☐	☐
Has the floor been inspected for cracks?	☐	☐
Were cracks found?	☐	☐
If found, were cracks repaired?	☐	☐
Has the walls been inspected for leaks?	☐	☐
Were leaks found?	☐	☐
If found, were leaks repaired?	☐	☐
Is salt stored on an impermeable pad?	☐	☐
Does it have impermeable loading pads?	☐	☐
Is the site graded to ensure that water runs away from the storage structure?	☐	☐
Is salt delivered during dry weather only?	☐	☐
Are delivery trucks covered/tarped when being transported to the maintenance yard?	☐	☐
Is salt delivered directly into the storage facility?	☐	☐
Is delivered salt placed into storage immediately?	☐	☐
Is there indoor loading of spreaders?	☐	☐
Are spreaders calibrated and periodically check to ensure continued calibration?	☐	☐
Are there practices used to minimize spillage during loading?	☐	☐
Are there practices used to minimize outside salt spills?	☐	☐
Are there practices used to clean up salt spills quickly?	☐	☐
Is excess salt returned to storage?	☐	☐
Is salt-laden runoff directed to catch basins?	☐	☐
Have strategies for cleaning up existing sites and minimizing salt loss to the environment been developed and implemented?	☐	☐
Has a guide to best practices related to storage, handling and application of road salt and winter sand been developed and implemented?	☐	☐
Has training been implemented for supervisors and operators?	☐	☐

LIQUID STORAGE AND HANDLING	YES	NO
Are personnel trained in proper handling of liquids?	☐	☐
Has regulator been consulted regarding sitting and containment requirements for storage facilities?	☐	☐
Do liquid storage facilities have secondary containment?	☐	☐
Is secondary containment provided in the form of double walled tanks and/or containment dikes?	☐	☐
Is crash protection provided to prevent vehicles from impacting the production and storage facilities?	☐	☐
Are periodic inspections of tanks, pumps and pipes/hoses carried out?	☐	☐
Has consideration been given to using washwater or salt impacted drainage water for brine production?	☐	☐

BLENDED ABRASIVE HANDLING	YES	NO
Are blended abrasives stored under cover?	☐	☐
Are they delivered during dry weather?	☐	☐
Are salt and abrasives mixed indoors?	☐	☐
Does outdoor mixing only occurs during good weather?	☐	☐
Is the percentage of salt in the mixtures known?	☐	☐
Is only enough salt mixed in to keep the pile from freezing?	☐	☐
Are spreaders loaded inside?	☐	☐
Are there practices to minimize spillage when loading spreaders?	☐	☐
Are there practices to ensure spreaders are not overloaded?	☐	☐
Are spilled blended abrasives cleaned up quickly?	☐	☐
Are excess blended abrasives returned to storage?	☐	☐

LIQUID BRINE PRODUCTION FACILITIES	YES	NO
Are water wells located up-gradient of the WMA?	☐	☐
Are cisterns necessary/in place?	☐	☐

SITE DRAINAGE	YES	NO
Is drainage directed away from storage area and into containment where it can be properly managed?	☐	☐
Is the salt impacted water tested?	☐	☐
Are the drainage ditches conveying salt-impacted runoff of low permeability (e.g., asphalt lined)?	☐	☐
Where collection and treatment is not practical, is salt impacted drainage is directed away from salt vulnerable areas?	☐	☐
Is salt impacted water:	☐	☐
Released to the environment?	☐	☐
Removed by a licensed waste-hauler?	☐	☐
Directed to an Oil/Water Separator and then to containment for brine production?	☐	☐
Is drainage from outside of the WMA directed off-site in a way that minimizes off-site impacts?	☐	☐

VEHICLE WASHWATER	YES	NO
Is vehicle washwater collected, treated and sent for proper disposal?	☐	☐
Are vehicles swept prior to being washed?	☐	☐

GENERAL	YES	NO
Are you aware of the salt management plan (SMP)?	☐	☐
Have you provided / had training on the SMP?	☐	☐
Have you measured the performance of the SMP?	☐	☐
Have you reported performance through appropriate public reporting methods?	☐	☐
Have you identified salt vulnerable areas (SVA)?	☐	☐
Have you developed strategies for reducing salt impacts to SVAs?	☐	☐

ACKNOWLEDGEMENTS

The development of this *Salt Management Synthesis of Best Practices* was undertaken with funding provided by several agencies. TAC gratefully acknowledges the following funding partners for their contribution to the project.

- Alberta Transportation
- British Columbia Ministry of Transportation
- City of Burlington
- City of Edmonton
- City of Moncton
- City of Ottawa
- City of Toronto
- City of Winnipeg
- Manitoba Infrastructure and Transportation
- Ministère des transports du Québec
- Ministry of Transportation Ontario
- Newfoundland Transportation
- Nova Scotia Transportation and Infrastructure Renewal
- New Brunswick Transportation and Infrastructure
- Regional Municipality of Halifax
- Regional Municipality of Waterloo
- Salt Institute
- Saskatchewan Highways
- Transport Canada

Principle Consultant for update was Ecoplans, a member of the MMM Group Limited and Bob Hodgins (previously with Ecoplans, now an independent consultant).

This document is the product of a project conducted on behalf of the Chief Engineers Council under the supervision of a project steering committee. TAC thanks all the committee members who contributed their time and effort to this project.

Transportation Association of Canada
2323 St. Blvd., Ottawa, Canada K1G 4J8
Tel: (613) 736-1350 ~ Fax: (613) 736-1395
www.tac-atc.ca