

## **QUICK REFERENCE FOR PRECAUTIONARY TREATMENT DECISION MAKING**

### **Decision making procedure preparation**

The following checklists are designed as a quick reference for the delivery of the Treatment Decision. Decision Making Checklist H1 “In advance of forecast” can be used to prepare for the winter season as well as be used in season to confirm that the data has not changed and take action where necessary outside of the individual treatment decision making process required for a weather event.

When this process is used and the results properly documented, when the treatment decision is made it is only necessary to confirm that certain parameters (the base data that may not change at each treatment decision) such as spreaders being in calibration and salt condition (is unchanged), need be confirmed. Furthermore, the number of treatment matrices and columns used within the matrix needed for a particular route can be identified possibly reducing to just one or two for most decisions (provided this base data has not changed).

Decision Making Checklist H2 “At forecast” is the part of the decision making process which is reliant on the forecast and other current conditions such as traffic level, road wetness at time of spreading and wind.

Please note this is an extract of Appendix H from Well-maintained Highways Code of Practice (published 18 September 2013) and although it should assist practitioners with their introduction to the new Appendix, the full Appendix in the Code should still be reviewed

<b>Decision Making Checklist H1 – In advance of forecast of frost</b>		
<b>Item</b>	<b>Parameters</b>	<b>Action</b>
The following conditions and parameters may be assessed/determined in advance of the treatment decision but must be confirmed within the treatment decision process for each forecast		
Spreader is allocated to route	Yes/No	Check spreader is able to spread de-icer allocated for the route – if not do not use or treat as poor spreading capability and increase spread rate to next largest rate in appropriate matrix. Monitor route during and after spreading – See Section H7.24
Spreader is in Calibration	Yes/No	Use Poor Spreading capability if No providing spreader is capable of spreading de-icer to the minimum level required <sup>*1</sup> . See Section H7.18
Is the same spreading technology used as when calibrated?	Yes/No	If No confirm spreader is capable of spreading de-icer to the minimum level required <sup>*1</sup> . Use spread rate matrix consistent with the actual technology to be used. See Section H10.22
Is de-icer the same type and grading as calibration (Normal and/or extreme cold alternatives need to be considered)	Yes/No	Is spreader capable and calibrated for de-icer if Yes OK – if No do not use or treat as poor spreading capability (poor coverage) and increase spread rate to next larger rate in appropriate matrix. Monitor route after during and spreading – See Section H7.24
Has de-icer been tested within allowable period (Table H5)	Yes/No	If No reduce spreading capability (coverage) to next lesser level of capability if above Poor Capability. Take remedial action (See H6.70) where salt exceeds maximum allowable m/c – See Section H6.8
Is de-icer within 1.5% of calibrated m/c and not above maximum allowable m/c	Yes/No	If No reduce spreading capability (coverage) to next lesser level of capability if above Poor Capability. Take remedial action (See H6.70) where salt exceeds maximum allowable m/c – See Section H6.8

<sup>\*1</sup> Note the minimum requirements for spreading capability when using the spreading matrices in this guidance are set out in Section H10.22. These must be met at all times for the rates to be valid.

<b>Decision Making Checklist H2 – At forecast of frost or ice</b>		
<b>Item</b>	<b>Parameters</b>	<b>Action</b>
The following conditions and parameters are assessed/determined when the treatment decision is being made for the forecast conditions		
Obtain forecast conditions (from forecast provider)	Temperature and precipitation	Use values to determine road surface wetness and appropriate row in spread rate matrix for salting technology for wetness and RST <sup>*1</sup>
Assess salt distribution	Good/Fair/Poor	Use results of distribution assessment if known and spreader is in calibration. Otherwise use Poor – See Flowchart H1
Assess traffic level	High/Medium	Use known traffic levels at time of/immediately after spreading. If traffic levels are not known carry out the full decision making process for both High and Medium/Low traffic levels and take higher spread rate. See Table H11
Assess road surface wetness at time of spreading	Dry/Damp/Wet  Or Very Wet	See Table H10 and use appropriate value to determine both losses and spread rate for combined RST and wetness in appropriate decision matrix for salting technology used. For a very wet road (in excess of Wet as defined in Table H10 refer to Table H13 for appropriate action
Assess loss after spreading	High/Normal	Use Flowchart H2
Assess road surface wetness at forecast point	Dry/Damp/Medium	Assess from forecast of precipitation See Table H10
Assess road surface temperature	°C (from forecast) <sup>*1</sup>	Use along with road surface wetness to determine appropriate row in spread rate matrix.
Determine spread rate from appropriate spread rate matrix for technology and de-icer used	Using information assessed above	Use Table H12 to identify appropriate Matrix column. For normal or extreme cold conditions.
Check special conditions which may require increase in treatment rate, etc.	Surfacing, wind, traffic.	See Table H13
Record of decision process		Record all information and communicate to appropriate parties for service delivery, management and audit of the service.

\*<sup>1</sup> – Forecast conditions may be modified by additional historical data, thermal mapping information, sensor information and other sources of local knowledge where these are available. This should only be done where well defined processes aligned with the Treatment Decision and understanding of the information along with its impact on the decision and associated risks are understood and risks mitigated.

<b>Table H2 – Optimum salt moisture content</b>		
<b>Salt type</b>	<b>Technology</b>	<b>Optimum range</b>
UK rock salt	Dry salting	2 to 3.5%
UK rock salt	Pre-wetted	Less than 3.5%
UK rock salt	Treated	2 to 3.5%
Marine salt* <sup>1</sup>	Dry salting	1.5 to 4%
High purity imported rock	Dry salting	2 to 3.5%

\*<sup>1</sup> Includes Vacuum and PAD salt.

<b>Table H5 – Salt testing frequency</b>	
<b>Storage type</b>	<b>Frequency of testing (per month)</b>
Outside unprotected	2
Outside covered * <sup>1</sup>	1
Barn or dome * <sup>1</sup>	1

\*<sup>1</sup> Use appropriate level for Fabric covered structures depending on specification

<b>Table H6 – Assessment of Uniformity of Salt distribution from stationary test</b>		
<b>Salt type</b>	<b>Uniformity</b>	<b>Minimum spread rate in a lane (% of the target amount)</b>
<b>Treated and pre-wetted</b>	Good	90
	Fair	70
	Poor	60
<b>Dry</b>	Good	80
	Fair	60
	Poor	50

<b>Table H7 – Assessment of Uniformity of Salt distribution from observed run</b>		
<b>Salt type</b>	<b>Uniformity</b>	<b>Observation of distribution to two lanes</b>
<b>Treated and pre-wetted</b>	Good	Distribution appears uniform between the lanes Wastage assessed to be less than 5%
	Fair	Up to 50% more salt assessed to be in one lane than the other Wastage assessed to be less than 10%
	Poor	Up to 75% more salt assessed to be in one lane than the other Wastage assessed to be less than 15%
<b>Dry</b>	Good	Up to 20% more salt assessed to be in one lane than the other Wastage assessed to be less than 10%
	Fair	Up to 75% more salt assessed to be in one lane than the other Wastage assessed to be less than 15%
	Poor	Up to 90% more salt assessed to be in one lane than the other Wastage assessed to be less than 20%

<b>Table H9 – Sample Precautionary Treatment Decision Guide</b>				
<b>Road Surface Temperature</b>	<b>Precipitation</b>	<b>Predicted Road Conditions</b>		
		<b>Wet</b>	<b>Wet Patches</b>	<b>Dry</b>
May fall below 1°C	<u>No</u> rain <u>No</u> hoar frost <u>No</u> fog		Salt before frost (see note a)	No action likely, monitor weather (see note a)
Expected to fall below 1°C	<u>No</u> rain <u>No</u> hoar frost <u>No</u> fog	Salt before frost		
	<u>Expected</u> hoar frost <u>Expected</u> fog		Salt before frost (see note b)	
	<u>Expected</u> rain <b>BEFORE</b> freezing	Salt after rain stops (see note c)		
	<u>Expected</u> rain <b>DURING</b> freezing	Salt before frost, as required during rain and after rain stops (see note d and H11.35)		
	<u>Possible</u> rain <u>Possible</u> hoar frost <u>Possible</u> fog	Salt before frost		Monitor weather conditions
	<u>Expected</u> snow (See H11.35)	Salt before snow fall		
<p>The decision to undertake precautionary treatments should be, if appropriate, adjusted to take account of residual salt.</p> <p>All decisions should be evidence based, recorded and require continuous monitoring and review.</p> <p>Decision on treatment timing should account for traffic and road surface wetness at time of treatment and after, as well as forecast conditions.</p>				

**Notes:**

- (h) Particular attention should be given to the possibility of water running across or ponding on carriageways and other running surfaces e.g. off adjacent fields after heavy rains, washing off or diluting salt previously deposited. Such locations should be closely monitored and may require treating in the evening and morning and possible other occasions. See Warning 6.
- (i) When a weather warning contains reference to expected hoarfrost, considerable deposits of frost may occur. Hoarfrost usually occurs in the early morning and is difficult to cater for because of the probability that any salt deposited on a dry road too soon before its onset, may be dispersed before it can become effective. Close monitoring is required under this forecast condition which should ideally be treated just as the hoarfrost is forming. Such action is usually not practicable and salt may have to be deposited on a dry road prior to and as close as possible to the

expected time of the condition. Hoarfrost may be forecast at other times in which case the timing of salting operations should be adjusted accordingly.

- (j) If, under these conditions, rain has not ceased by early morning, crews should be called out and action initiated as rain ceases.
- (k) Under these circumstances rain will freeze on contact with running surfaces and full pre-treatment should be provided even on dry roads. This is a most serious condition and should be monitored closely and continuously throughout the danger period. Service Providers should be aware of the health safety implications of ice forming during freezing rain events, both to the travelling public and winter maintenance personnel carrying out treatments. They should be prepared to make follow up treatments on any ice that has formed or to take suitable actions such as road closures.
- (l) By using domain-based forecasting, consideration can be given to differing actions from each depot.
- (m) Where there is any hint of moisture being present, a pessimistic view of the forecast should be taken when considering treatment to negatively textured surfaces. See Warning 6
- (n) Spreading salt alone at temperatures below about  $-7^{\circ}\text{C}$  (the lower of air or road surface at time of spreading) or below about  $-5^{\circ}\text{C}$  in low humidity conditions (relative humidity less than 80%) may not be practically effective. High spread rates will be required and even then salt may not enter solution quickly enough to prevent freezing or be able to melt ice or compacted snow. Consideration should be given to spreading at least 2 hours before the temperature reaches these values to allow salt to enter solution, or the use of alternative de-icers. See Section H12.

<b>Table H10 – Road Surface Wetness</b>		
<b>Definition</b>	<b>Description</b>	<b>Water film thickness (mm)</b>
Dry road	A road that shows no signs of water or dampness at the surface but may be just detectably darker (however it may have moisture contained in pores below the surface that is not 'pumped' to the surface by traffic)	0 to 0.03mm
Damp road	A road which is clearly dark but traffic does not generate any spray. This would be typical of a well-drained road when there has been no rainfall after 6 hours before the treatment time.	0.03 to 0.05mm
Wet road	A road on which traffic produces spray but not small water droplets. This would be typical of a well-drained road when there has been rainfall up to 3 hours before the treatment time.	0.05 to 0.1mm



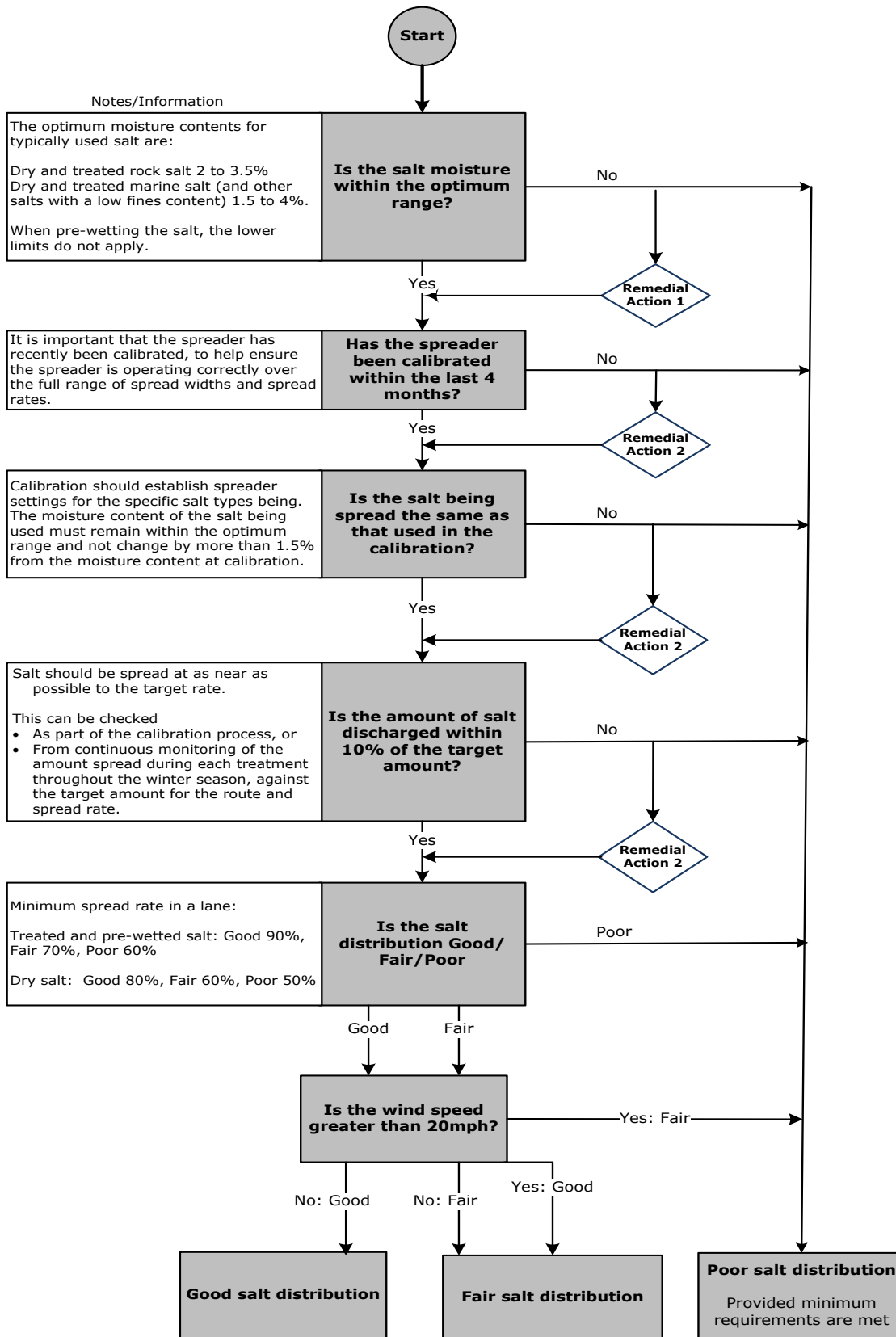
## Treatment decision making procedure

<b>Table H12 - Treatment matrix &amp; column for different non-forecast conditions</b>			
<b>Spreading Technology</b>		<b>Treatment Matrix</b>	
Dry Salting		Treatment Matrix A	
Pre-wet Salt Spreading		Treatment Matrix B	
Treated Salt Spreading		Treatment Matrix C	
<b>Salt distribution</b>	<b>Traffic level</b>	<b>Losses</b>	<b>Treatment matrix column</b>
Poor	High	Normal	<b>A</b>
Poor	High	High	<b>B</b>
Poor	Medium/Light	Normal	<b>C</b>
Poor	Medium/Light	High	<b>D</b>
Fair	High	Normal	<b>E</b>
Fair	High	High	<b>F</b>
Fair	Medium/Light	Normal	<b>G</b>
Fair	Medium/Light	High	<b>H</b>
Good	High	Normal	<b>I</b>
Good	High	High	<b>J</b>
Good	Medium/Light	Normal	<b>K</b>
Good	Medium/Light	High	<b>L</b>

<b>Table H13 - Change in spread rates</b>	
<b>Condition</b>	<b>Increase in spread rate or action</b>
Spreading when there is no or very little traffic	25%
Porous asphalt	25%
Dense surfacing after change from porous asphalt	25% for 1km
Areas prone to surface water	See Warning 6
Spreading in very heavy traffic (e.g. peak traffic times) if unavoidable	Consider treatment in 2 runs
Spreading in high winds (greater than 20 mph)	Consider continuous spreading or second treatment where spreader can be set (effectively) asymmetrically into the wind
Concrete roads after prolonged cold spell	25%
Spreading in low humidity (less than 80%)	Consider an additional precautionary treatment earlier in the day <sup>*1</sup>
Spreading in dry conditions in advance of heavy hoar frost	Consider an additional precautionary treatment earlier in the day <sup>*1</sup>

<sup>\*1</sup> The treatment should be timed to allow the maximum time for dissolution taking into account the likely losses due to traffic especially when using dry salt only.

### Assessing salt distribution



Flowchart H1 – Salt Distribution Flowchart

A Service Provider can improve its spreading capability by considering the remedial actions below.

Action1

Mix the salt with drier or wetter salt (as appropriate to decrease or increase the moisture content). Use salt from the stockpile or from new deliveries.

A simple test for moisture is outlined in H6.69

Action 2

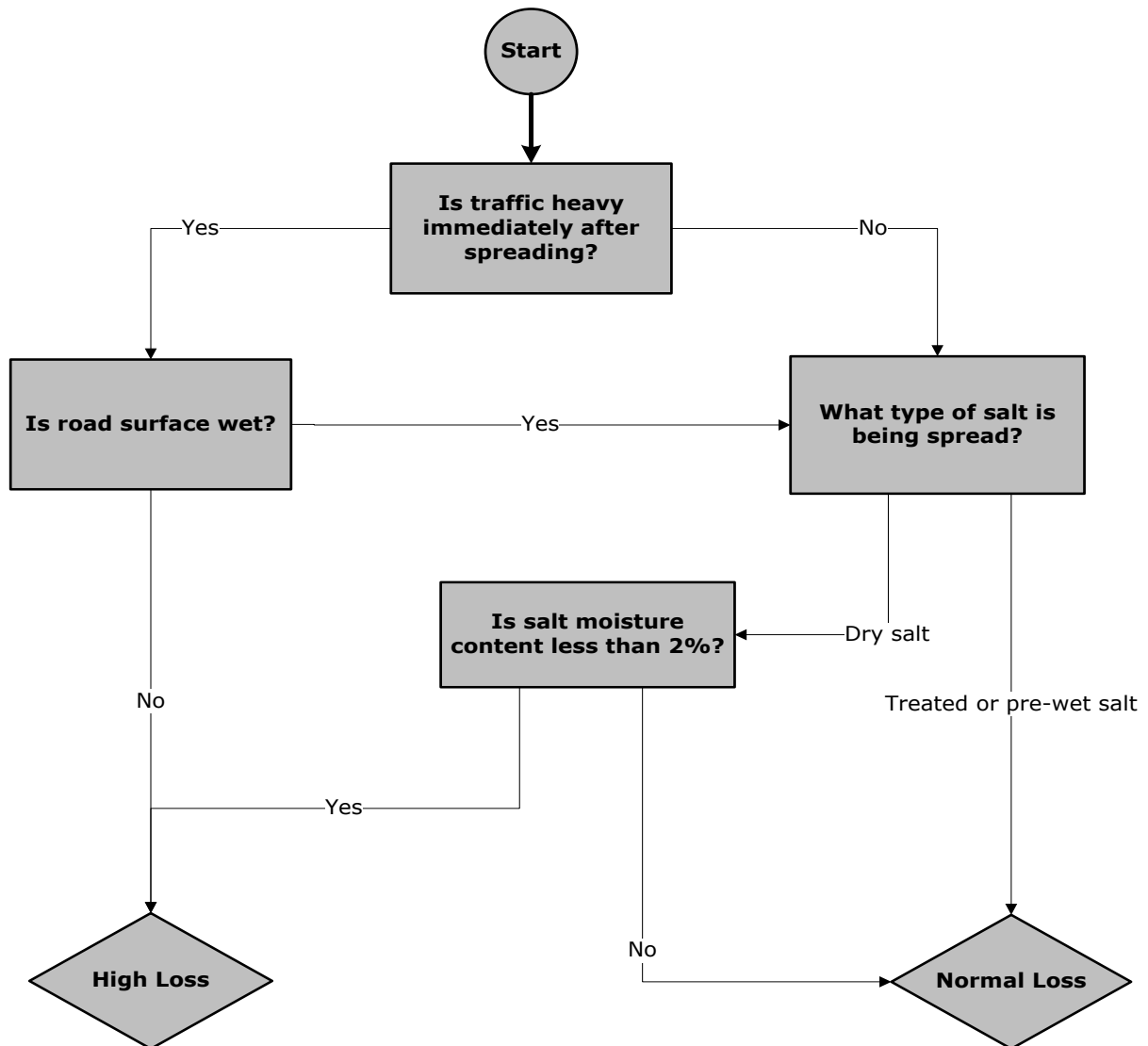
Calibrate the spreader using the salt being spread.

**Assessing traffic level**

<b>Table H11 – Traffic Level</b>	
<b>Level</b>	<b>Vehicles/hour/carriageway</b>
Heavy	250 or more
Low/Medium	Less than 250

<b>Table H8 – Effect of trafficking</b>		
<b>Traffic Level &amp; Timing</b>	<b>Pros</b>	<b>Cons</b>
Before treatment High	Removes water from wet road surfaces  Reduces water film thickness on damp roads	None
Before Treatment Low/Medium	None	Little water removed from a wet road surface  Higher water film thickness for damp and wet roads
At Treatment High	None	May deflect salt from target areas, vehicle draughts may remove salt from road, particularly in dry conditions. Operation of spreader may be less than optimal in slow moving or stop/start conditions
At Treatment Low/Medium	Little loss due to traffic  Salt spreading unhindered by vehicles adjacent to spreader	None
Shortly After Treatment High	Will help dissolution by crushing salt grains and reduce loss due to wind	Much salt may be removed from road by tyres and vehicle draughts before it enters solution
Shortly After Treatment Low/Medium	Less losses due to traffic	Dissolution may be slow particularly for dry roads and low humidity conditions. Some salt will be removed from the road before dissolution takes place.

### Assessing salt loss immediately after spreading



Flowchart H2 – Salt Loss Flowchart

<b>TREATMENT MATRIX A</b>													
<b>DRY SALTING (De-icer spread rates in g/m<sup>2</sup>)</b>													
Frost or forecast frost Road Surface Temperature (RST) and Road Surface Wetness	<b>Column Cvrg Traffic Loss</b>	<b>A PC HT NL</b>	<b>B PC HT HL</b>	<b>C PC MT NL</b>	<b>D PC MT HL</b>	<b>E FC HT NL</b>	<b>F FC HT HL</b>	<b>G FC MT NL</b>	<b>H FC MT HL</b>	<b>I GC HT NL</b>	<b>J GC HT HL</b>	<b>K GC MT NL</b>	<b>L GC MT HL</b>
RST at or above -2°C and dry or damp road conditions		8	8	8	8	8	8	8	8	8	8	8	8
RST at or above -2°C and wet road conditions		10	13	13	16	8	11	11	13	8	8	8	10
RST below -2°C and above -5°C and dry or damp road conditions		15	20	17	20	13	17	14	17	10	13	11	13
RST below -2°C and above -5°C and wet road conditions		25	2 x 17	2 x 17	2 x 20	21	28	28	2 x 17	16	21	21	25
RST at or below -5°C and above -10°C <sup>*1</sup> and dry or damp road conditions		29	2 x 19	2 x 16	2 x 19	24	32	27	2 x 16	18	24	20	24
RST at or below -5°C and above -10°C <sup>*1</sup> and wet road conditions°		2 x 24	2 x 32	2 x 32	2 x 39	2 x 20	2 x 27	2 x 27	2 x 32	30	2 x 20	2 x 20	2 x 24
Please see Table H13 for variations to the rates given above													

**Key:****Cvrg:** PC = Poor coverage, FC = Fair coverage, GC = Good coverage**Traffic:** HT = High level, MT = Medium Level**Loss:** NL = Normal loss, HL = High loss<sup>\*1</sup> Refer to Section H10.21 Notes 3, 4 & 5 when spreading at temperatures at or below -5°C

<b>TREATMENT MATRIX B</b>													
<b>PRE-WETTED SALTING (De-icer spread rates in g/m<sup>2</sup>)</b>													
Frost or forecast frost Road Surface Temperature (RST) and Road Surface Wetness	<b>Column Cvrg Traffic Loss</b>	<b>A PC HT NL</b>	<b>B PC HT HL</b>	<b>C PC MT NL</b>	<b>D PC MT HL</b>	<b>E FC HT NL</b>	<b>F FC HT HL</b>	<b>G FC MT NL</b>	<b>H FC MT HL</b>	<b>I GC HT NL</b>	<b>J GC HT HL</b>	<b>K GC MT NL</b>	<b>L GC MT HL</b>
RST at or above -2°C and dry or damp road conditions		8	8	8	8	8	8	8	8	8	8	8	8
RST at or above -2°C and wet road conditions		8	10	12	14	8	9	10	12	8	8	8	9
RST below -2°C and above -5°C and dry or damp road conditions		13	16	16	18	11	14	14	16	9	11	11	12
RST below -2°C and above -5°C and wet road conditions		21	26	2 x 16	2 x 18	18	22	27	31	14	17	21	24
RST at or below -5°C and above -10°C <sup>*1</sup> and dry or damp road conditions		26	2 x 16	2 x 16	2 x 18	22	27	27	31	17	21	21	24
RST at or below -5°C and above -10°C <sup>*1</sup> and wet road conditions <sup>o</sup>		2 x 21	2 x 26	2 x 31	2 x 36	2 x 18	2 x 22	2 x 27	2 x 31	28	2 x 17	2 x 21	2 x 24
Please see Table H13 for variations to the rates given above													

**Key:**

**Cvrg:** PC = Poor coverage, FC = Fair coverage, GC = Good coverage

**Traffic:** HT = High level, MT = Medium Level

**Loss:** NL = Normal loss, HL = High loss

<sup>\*1</sup> Refer to Section H10.21 Notes 3, 4 & 5 when spreading at temperatures at or below -5°C



<b>TREATMENT MATRIX C</b>													
<b>TREATED SALTING (De-icer spread rates in g/m<sup>2</sup>)</b>													
Frost or forecast frost Road Surface Temperature (RST) and Road Surface Wetness	<b>Column</b> <b>Cvrg</b> <b>Traffic</b> <b>Loss</b>	<b>A</b> <b>PC</b> <b>HT</b> <b>NL</b>	<b>B</b> <b>PC</b> <b>HT</b> <b>HL</b>	<b>C</b> <b>PC</b> <b>MT</b> <b>NL</b>	<b>D</b> <b>PC</b> <b>MT</b> <b>HL</b>	<b>E</b> <b>FC</b> <b>HT</b> <b>NL</b>	<b>F</b> <b>FC</b> <b>HT</b> <b>HL</b>	<b>G</b> <b>FC</b> <b>MT</b> <b>NL</b>	<b>H</b> <b>FC</b> <b>MT</b> <b>HL</b>	<b>I</b> <b>GC</b> <b>HT</b> <b>NL</b>	<b>J</b> <b>GC</b> <b>HT</b> <b>HL</b>	<b>K</b> <b>GC</b> <b>MT</b> <b>NL</b>	<b>L</b> <b>GC</b> <b>MT</b> <b>HL</b>
RST at or above -2°C and dry or damp road conditions		7	7	7	7	7	7	7	7	7	7	7	7
RST at or above -2°C and wet road conditions		7	8	10	11	7	7	8	10	7	7	7	7
RST below -2°C and above -5°C and dry or damp road conditions		10	13	12	14	9	11	11	12	7	9	8	10
RST below -2°C and above -5°C and wet road conditions		17	21	24	28	15	18	21	24	11	14	16	19
RST at or below -5°C and above -10°C <sup>*1</sup> and dry or damp road conditions		19	24	23	27	17	21	20	23	13	16	15	18
RST at or below -5°C and above -10°C <sup>*1</sup> and wet road conditions <sup>o</sup>		2 x 16	2 x 20	2 x 23	2 x 27	2 x 14	2 x 17	2 x 20	2 x 23	22	27	30	2 x 18
Please see Table H13 for variations to the rates given above													

**Key:****Cvrg:** PC = Poor coverage, FC = Fair coverage, GC = Good coverage**Traffic:** HT = High level, MT = Medium Level**Loss:** NL = Normal loss, HL = High loss<sup>\*1</sup> Refer to Section H10.21 Notes 3, 4 & 5 when spreading at temperatures at or below -5°C

<b>TREATMENT MATRIX D – Precautionary Treatments Before Snow Or Freezing Rain</b>		
<b>Weather conditions</b>	<b>Light or medium traffic</b>	<b>Heavy traffic</b>
<b>Light snow forecast</b>	Spread: <ul style="list-style-type: none"> <li>• 40g/m<sup>2</sup> of dry salt, or</li> <li>• 40g/m<sup>2</sup> of pre-wetted salt, or</li> <li>• 30g/m<sup>2</sup> of treated salt</li> </ul>	Spread: <ul style="list-style-type: none"> <li>• 20g/m<sup>2</sup> of dry salt, or</li> <li>• 20g/m<sup>2</sup> of pre-wetted salt, or</li> <li>• 15g/m<sup>2</sup> of treated salt</li> </ul>
<b>Moderate/Heavy snow forecast</b>	Spread: <ul style="list-style-type: none"> <li>• 20-40g/m<sup>2</sup> of dry salt</li> <li>• 20-40g/m<sup>2</sup> of pre-wetted salt</li> <li>• 15-30g/m<sup>2</sup> of treated salt (see Note 1)</li> </ul>	Spread: <ul style="list-style-type: none"> <li>• 40g/m<sup>2</sup> of dry salt, or</li> <li>• 40g/m<sup>2</sup> of pre-wetted salt, or</li> <li>• 30g/m<sup>2</sup> of treated salt</li> </ul>
<b>Freezing rain forecast</b>	<ul style="list-style-type: none"> <li>• 40 or 2x20g/m<sup>2</sup> of dry salt, or</li> <li>• 40 or 2x20g/m<sup>2</sup> of pre-wetted salt, or</li> <li>• 30 or 2x15g/m<sup>2</sup> of treated salt</li> </ul>	
<p>Note 1: The lower rates (e.g. 20g/m<sup>2</sup> for dry salt) can be used if the snow is likely to settle quickly, e.g. when the road surface temperature is below zero, the road surface is not wet and the snow is not wet, and/or there is little traffic after snowfall begins and settles.</p> <p>Note 2: Spreading salt before freezing rain can have a limited benefit and Service Providers should be prepared to make follow up treatments on any ice that has formed.</p>		