Ministry of Transportation

Ministère des Transports

Ontario

MINISTRY DIRECTIVE

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TO: Assistant Deputy Ministers, Executive Directors, Regional Directors, Directors, District Engineers, Regional Managers, Office Managers

SUBJECT: The Use of Surface Course Types on Provincial Highways.

ALTERNATIVE INDEX LISTING (S): Highway Surfaces
Bituminous Mix Types
Alternative Bid

REFERENCE: This directive supersedes Directive C-16 dated 78-11-23; revised 84-5-23 and 88-05-03; OPSS 1150; and special provisions 311, 310 and 321.

PURPOSE: To establish policy to ensure consistent application of standards for selecting surface course types for all highway improvement projects in Ontario. These standards consider the present state of knowledge and experience in North America.

BACKGROUND: The previous Directive used Annual Average Daily Traffic divided by the number of lanes (AADT/lane) as the sole criterion for selecting the pavement surface course type. A document was published designating the highways in each region that would have HL3/HL4, HL1, and DFC as the surface course bituminous mix type [1].

According to the previous directive, HL3/HL4 was recommended for low volume roads with less than 2500 AADT/lane, HL1 for highways with 2500 to 5000 AADT/lane, and DFC for highways with 5000 or more AADT/lane. MTO no longer uses HL3 mix for Freeways and King's Highways. Superpave mixes and Stone Mastic Asphalt (SMA) have only recently been introduced into Ontario and were not included in the previous directive.

It was recognized that in addition to AADT, there are other factors which must be considered in selecting surface course types as part of highway construction, rehabilitation and maintenance projects. They include:

- Alternative Bid criteria for freeway paving contracts;
- Continuity within a specific origin/destination corridor;
- Rut resistant mixes (e.g. Dense Friction Course, DFC or Stone Mastic Asphalt, SMA) to withstand heavy truck loads based on Equivalent Single-Axle Load (ESAL);
- Satisfactory pavement surface friction characteristics; and
- Need for special mix types (e.g. HL1 modified, HL3 modified, HL4 modified, Superpave mixes and SMA).

POLICY: Considering the above factors and following consultation with the regions and other jurisdictions, the existing standards for selecting pavement surface course types for Freeways and King's Highways have been updated. The new standards for the selection of surface course types, which are provided in Table 1, are based on either ESAL or AADT criteria. Maps indicating the surface course types required for provincial highways for all regions are attached (Appendices 1-6) for use in conjunction with this directive. For additional information or clarification, the appropriate Geotechnical Section should be contacted.

TABLE 1: Selection of Surface Course Types

ESALS /design lane /year (or AADT/lane)				
AADT<500	AADT 500 - 2500	AADT 2500-5000	1<ESAL<3 Million or AADT>5000	ESAL> 3 Million
HL4 or Surface Treatment [a]	HL4 or Superpave 12.5	HL1 [b] or Superpave 12.5FC 1	DFC [c, d] or Superpave 12.5FC 2	SMA [d]

[a] Surface treatment type should be selected according to the guidelines given in the Pavement Design and Rehabilitation Manual [3].
[b] HL4 modified or HL3 modified (meeting the polishing and wear requirements of HL1) may be substituted for HL1 upon recommendation by the Heads of Geotechnical Sections.
[c] During the EA process, the use of Open Friction Course (OFC) may be considered for the purpose of noise reduction in urban residential areas where significant noise issues have been identified.
[d] Alternative Bid freeway paving contracts requiring the preparation of one concrete and one asphalt pavement design are to be used for all new construction and full depth reconstruction projects in the order of five 2-lane kilometres in length or longer, where close to one million or more ESALs are anticipated in the design lanes within 5 years of construction.

In general, the current ESAL or AADT value is considered for the selection. However, if the current value is close to the maximum threshold value, then an anticipated increase in traffic volume should be considered. In some cases, the criteria given in Table 1 may identify two possible surface course types, in which case the mix type satisfying the higher threshold value should be selected, as illustrated in the example given below.

Example A highway with less than one million ESALs/design lane/year and greater than 5000 AADT/lane would require either HL1 or DFC, based on ESAL or AADT criteria respectively. In this case, DFC mix should be selected as it satisfies the higher AADT threshold value. The ESAL (or AADT) threshold values for different mixes are based on research and experience of different agencies including MTO [2].

MAJOR CONTRIBUTORY FACTORS TO SURFACE COURSE SELECTION

Equivalent Single-Axle Load

The concept of ESALs was originally developed by AASHTO for converting mixed mode traffic to an equivalent number of 80 kN single-axle loads for use in pavement design. The process of collecting mixed traffic data and converting it to ESALs for Ontario road conditions is described in an MTO report [4].

In this directive, different surface course types are identified for each traffic category. It is important to note that the ESAL or AADT criteria in Table 1 should be used in conjunction with other factors, as described below, to match the unique features and requirements of different highways.

Alternative Bid Criteria

On December 3, 2001, MTO initiated an Alternative Bid (AB) process for freeway paving contracts. Under the AB process, bidders determine their "Construction Bid" for a concrete or asphalt pavement design option. The bidder then adds a "Bid Adjustment Factor" to their Construction Bid. Bid Adjustment Factors for the concrete and asphalt pavement options are calculated by MTO in advance based on life cycle costing information and are included in the tender documents. The lowest "Total Adjusted Bid" wins.

AB freeway paving contracts are to be used for all new and full depth reconstruction projects in the order of five 2-lane kilometres or longer in length, where close to one million or more ESALs are anticipated in the design lanes within 5 years of construction.

Projects that do not meet the AB criteria should not be automatically discounted, but with the approval of the Regional Director, an assessment should be made on the merits of awarding them as AB contracts. The advice of the Estimating Office and Materials Engineering and Research Office is available to assist the region in these situations.

Continuity Within A Specific Origin/Destination Corridor

Adjacent sections within a specific corridor should be considered when selecting a surface course type on a highway to ensure continuity.

Examples

1. If a highway between two communities meets HL1 criteria except for a short section, HL1 should be used for the entire length to ensure frictional continuity.

2. Continuity is also important in terms of winter maintenance requirements. The choice of surface course type should be consistent with the winter maintenance activities required for the adjacent or existing surface course types.

Rutting Resistance

Table 1 requires HL4 mix for highways between 500-2500 AADT/lane. However, in some cases, HL4 mix may require higher percent crushed particles for both coarse and fine aggregates to resist rutting due to large volumes of trucks, even if traffic volume is less than 2500 AADT/lane. In addition, highways with slow moving trucks particularly on steeper upgrades and at major intersections may require high stability mixes to resist rutting. The percent crushed particle requirement for high stability HL4 mix shall be determined in consultation with the Regional Geotechnical Section.

Surface Friction Characteristics

Bituminous mix consists of about 95 % aggregates, which have a great influence on the skid resistance or the frictional characteristics of the pavement. The skid resistance of wet pavements depends not only on the mix type but also on the physical properties of the aggregates used in the mix and the traffic volume and speed [5]. Thus, highways with AADT greater than 5000 vehicles/lane require high stone content in stable mixes with high wear and polish resistant aggregates.

On highways with 500-2500 AADT/lane, the designated HL4 mix may require good quality aggregates to resist polishing and wear due to large volumes of trucks, even if traffic volume is less than 2500 AADT/lane. In this case, HL4 may be modified to include aggregates meeting the physical property requirements of HL1.

Use of Special Mix Types

There are special mix types such as HL1 modified, HL3 modified and HL4 modified mixes that are being used in some regions to address specific local problems. The potential applications of these mixes in certain circumstances are discussed below. Superpave mixes and SMA have only recently been introduced into Ontario and a brief summary of these mix types follows.

HL1 modified

In some locations in Eastern Region, HL1 modified mix (maximum of 10% natural blending sand in a DFC mix) is being used in lieu of DFC for the surface course on a trial basis to improve durability and workability of the mix.

HL3 modified and HL4 modified

HL3 modified and HL4 modified mixtures are being used in some areas of Northern Ontario as the surface course mix in lieu of HL1 mix. The aggregates used are not included in the Designated Sources of Materials (DSM) list but shown on regional aggregate sources lists. The use of these mixes is permitted to keep costs to a reasonable level until sufficient local suppliers, if any, meet the DSM requirements for HL1. HL3 modified aggregates meet the physical property and gradation requirements of HL1 aggregates. HL4 modified aggregates meet the requirements of HL4 aggregates in addition to meeting the frictional property requirements of HL1 aggregates.

If a Superpave 12.5FC 1 mix is selected for a contract where an HL3 modified and/or HL4 modified mix has been historically used, the Superpave aggregates should be selected from the regional aggregate sources list specifically identified for this purpose to ensure that the required physical properties are met.

Superpave Mix

Superpave mix is a hot mix asphalt designed according to Superpave criteria. Superpave, which stands for Superior Performing Asphalt Pavements, was introduced in 1992 by the Strategic Highway Research Program (SHRP) under the sponsorship of the Federal Highway Administration of the U.S. The Superpave methodology incorporates a performance-based asphalt materials characterization system to improve the long-term pavement performance under diverse environmental conditions. It presently consists of the following elements:

- Asphalt cement specifications (now fully adopted in Ontario as Performance Grade Asphalt Cements (PGAC)).
- Revised aggregate specifications which include gradation control points, "consensus" properties such as fractured faces and clay content, as well as "agency" properties which are properties specified at the discretion of the agency; and
- A new mix design method using the Superpave Gyratory Compactor.

Superpave designates hot mix types by the Nominal Maximum Aggregate Size, which represents the sieve size, in mm, through which at least 90 % of the aggregate passes. Under this system, the most common surface course type on Ontario highways is expected to be Superpave 12.5. The Ministry has added two mix types to the Superpave suite of mixes: Superpave 12.5FC 1 and Superpave 12.5FC 2. The "FC" stands for friction course. The "1" requires that the coarse aggregate fraction for this mix type must be obtained from a Designated Sources for Materials (DSM) list. The "2" requires that the coarse and fine aggregates for this mix type must be obtained from a source listed on the DSM.

Stone Mastic Asphalt

Stone Mastic Asphalt (SMA) is a heavy duty gap graded hot mix asphalt with a relatively large proportion of stones and an additional amount of mastic-stabilized asphalt cement. The SMA mixture has an aggregate skeleton with coarse aggregate stone-on-stone contact to withstand damage due to heavy truck loads.

The additional amount of asphalt cement binder is required primarily to provide increased durability and resistance to aging and cracking to a mix, which by choice of aggregates and gradation, is already quite resistant to rutting. The stabilization of the extra asphalt cement and in particular, prevention of binder run-off during construction are achieved by: 1) an increase in fines and filler, 2) addition of organic or mineral fibre, 3) polymer-modification, or 4) a combination of all three.

DEVIATIONS FROM THE RECOMMENDED PLAN FOR SURFACE COURSE TYPES

It is recommended that the need for the use of special mixes not identified in Table 1 or on the attached maps be documented in the Pavement Design Report and submitted to the Geotechnical Committee for review and endorsement. In the event that deviations are required in the form of upgrading or downgrading the mix types identified in this directive to address local rutting problems and/or to ensure continuity, the Regional Heads of Geotechnical Sections would determine the need, if any, to request a review by the Geotechnical Committee. While implementing this directive, caution must be exercised so as not to create short, isolated sections, which may result in different maintenance requirements and varying pavement performance characteristics.

IMPLEMENTATION:

Implementation of this directive is effective immediately. In northern Ontario, implementation shall coincide with the establishment of regional aggregate sources lists for HL3 modified and HL4 modified aggregates not included in the Designated Sources of Materials (DSM) list. If implementation of this directive would result in a change in the surface course type in a contract requiring revision of contract documents, the Regional Director, at their discretion may opt to not implement the directive for that particular project.

REFERENCES

1. "HL1 and DFC Surface-Course Hot Mix Types for Designated Freeways and Other King's Highways (Excluding Secondary Highways)", Highway Design Office, Highway Engineering Division, April, 1984, revised May 1988.

2. The Benefits of New Technologies and Their Impact on Life-Cycle Models, ERES Consultants, and Report prepared for MTO, October 26, 2000.

3. Pavement Design and Rehabilitation Manual, Ministry of Transportation, SDO-90-01, January 1990.

4. Hajek, J., "Procedures for Estimating Traffic Loads for Pavement Design", Pavements and Foundations Section, MTO, January 1995.

5. Rogers C., Gorman, B., Lane, B. "Skid Resistant Aggregates in Ontario', Proceedings, 46th Canadian, Technical Asphalt Association Conference, Toronto, November 19-21, 2001.

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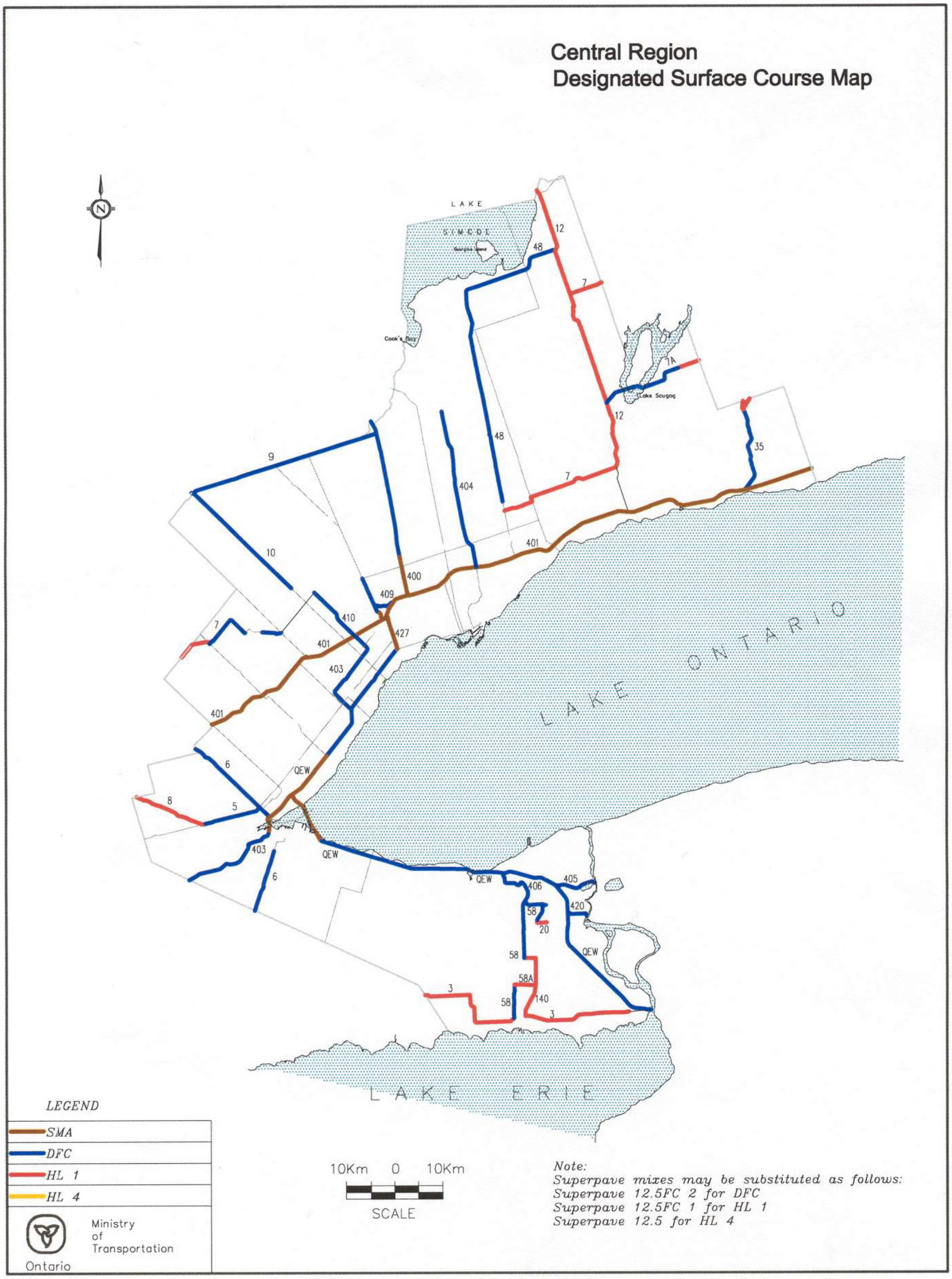
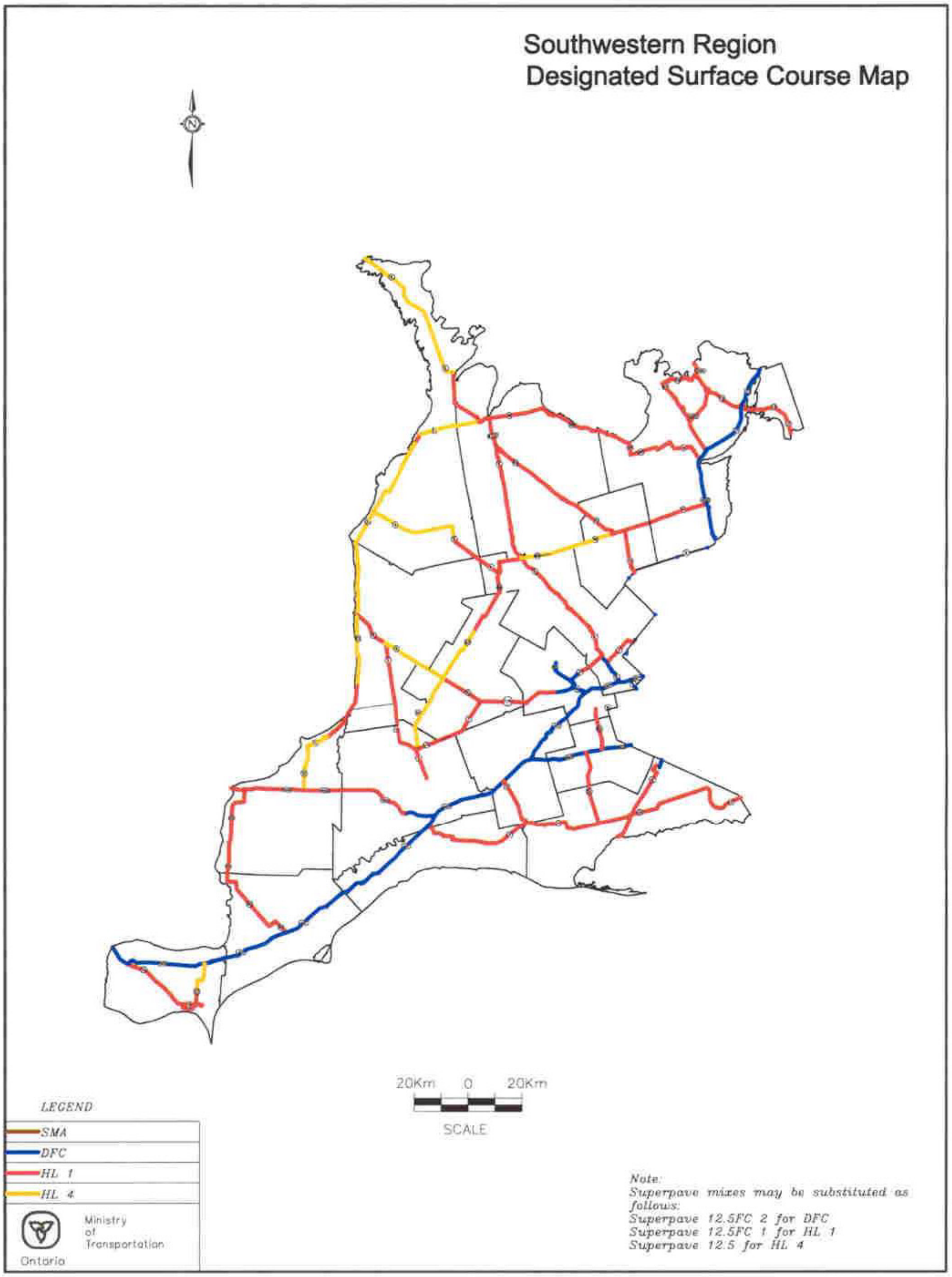
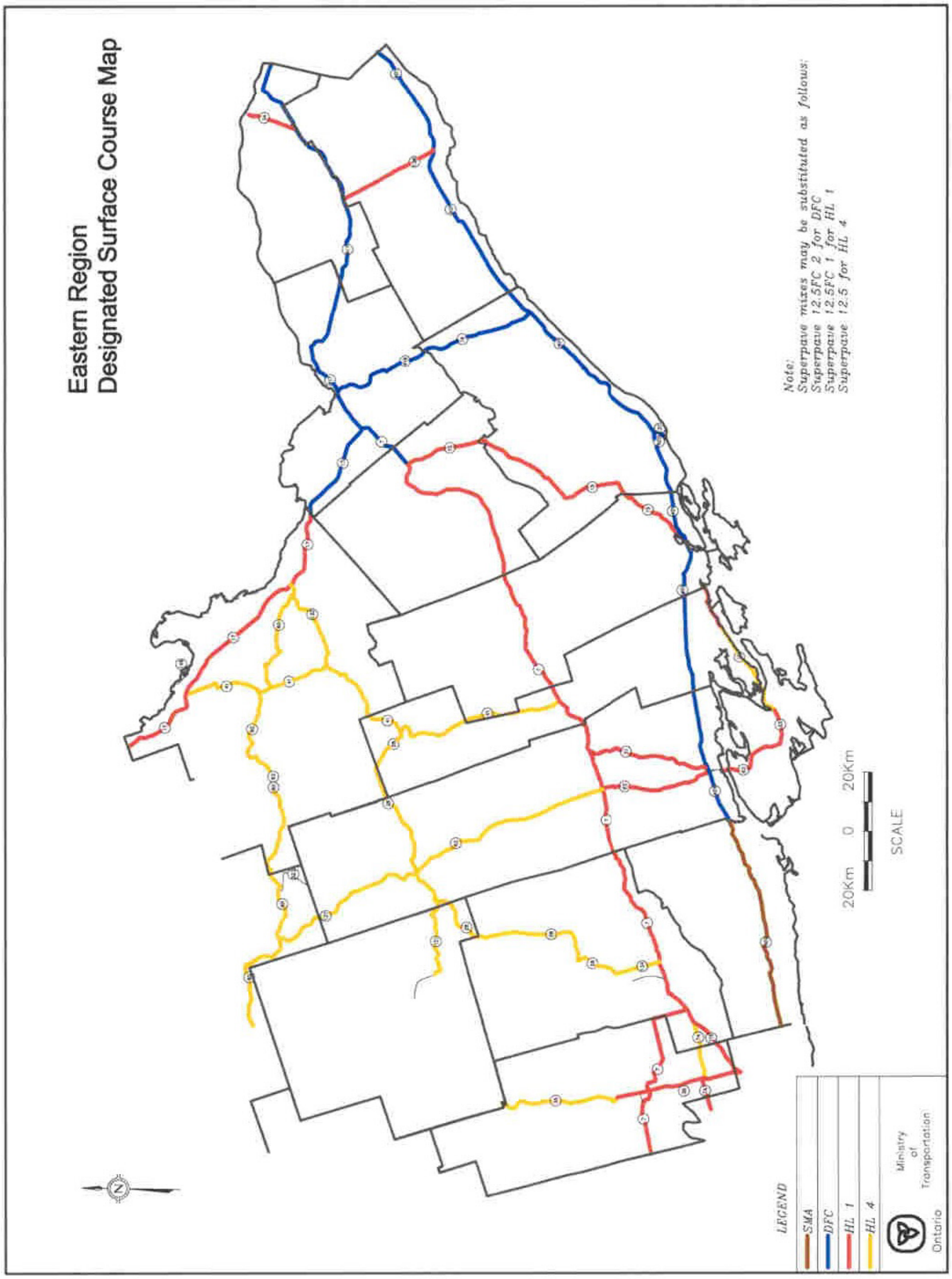
Appendix 1


Central Region
Designated Surface Course Map
LAKE SIMCOE
Cook's Bay
Lake Scugog
LAKE ONTARIO
LAKE ERIE
401
400
409
410
427
403
404
48
12
7
7A
35
9
10
6
5
8
QEW
405
406
420
58
58A
20
140
3
LEGEND
SMA
DFC
HL 1
HL 4
Ministry of Transportation
Ontario
10Km 0 10Km
SCALE
Note:
Superpave mixes may be substituted as follows:
Superpave 12.5FC 2 for DFC
Superpave 12.5FC 1 for HL 1
Superpave 12.5 for HL 4

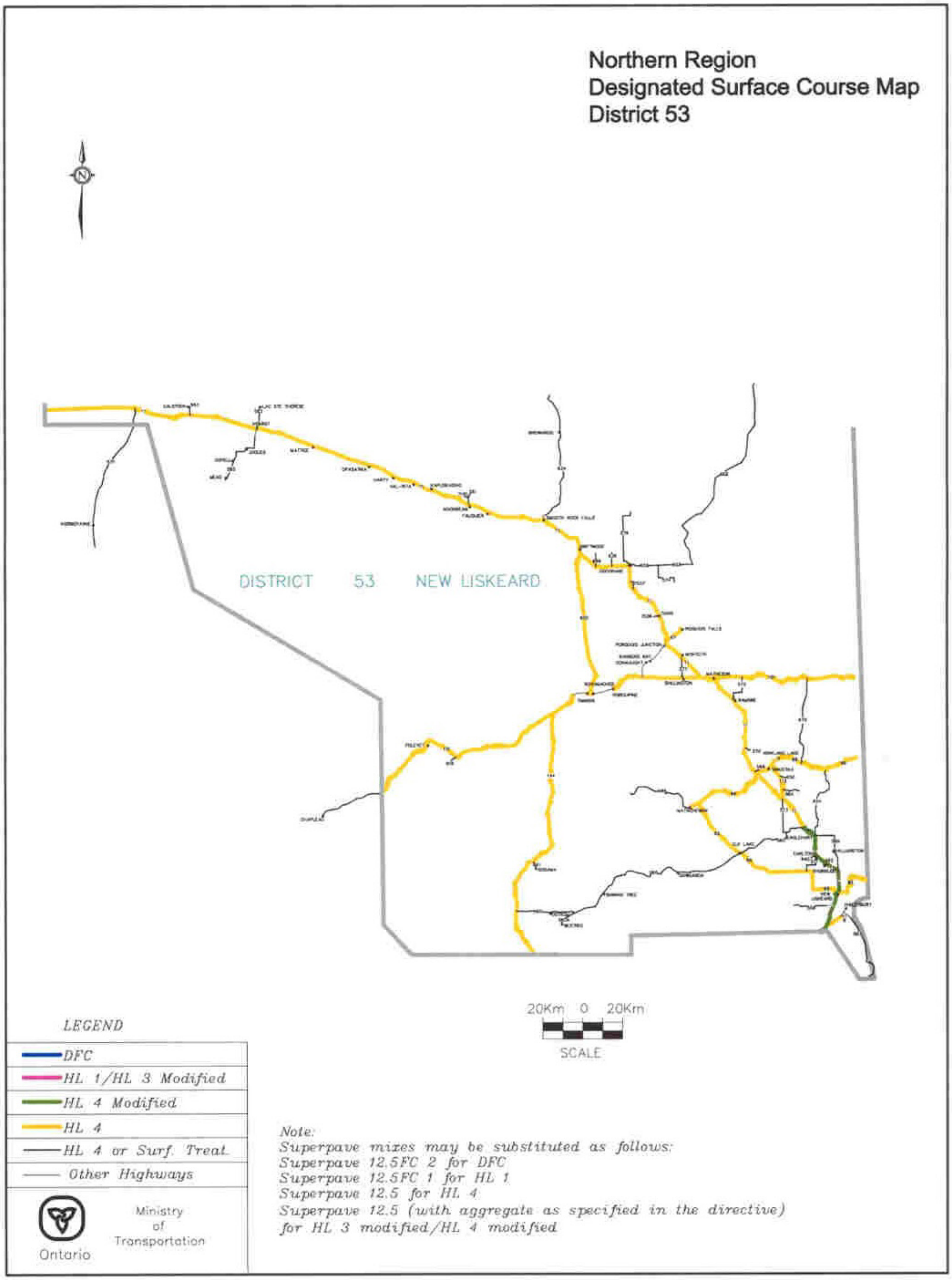
Appendix 2


Southwestern Region
Designated Surface Course Map
N
20Km 0 20Km
SCALE
LEGEND
SMA
DFC
HL 1
HL 4
Ministry of Transportation
Ontario
Note:
Superpave mixes may be substituted as follows:
Superpave 12.5FC 2 for DFC
Superpave 12.5FC 1 for HL 1
Superpave 12.5 for HL 4



Eastern Region
Designated Surface Course Map
Note:
Superpave mixes may be substituted as follows:
Superpave 12.5FC 2 for DFC
Superpave 12.5FC 1 for HL 1
Superpave 12.5 for HL 4
20Km 0 20Km
SCALE
LEGEND
SMA
DFC
HL 1
HL 4
Ministry of Transportation
Ontario

Appendix 4


Northern Region
Designated Surface Course Map
District 53
DISTRICT 53 NEW LISKEARD
20Km 0 20Km
SCALE
LEGEND
DFC
HL 1/HL 3 Modified
HL 4 Modified
HL 4
HL 4 or Surf. Treat.
Other Highways
Ministry of Transportation
Ontario
Note:
Superpave mixes may be substituted as follows:
Superpave 12.5FC 2 for DFC
Superpave 12.5FC 1 for HL 1
Superpave 12.5 for HL 4
Superpave 12.5 (with aggregate as specified in the directive)
for HL 3 modified/HL 4 modified

Appendix 5

Northern Region
Designated Surface Course Map
District 54

LEGEND

- *DFC*
- *HL 1/HL 3 Modified*
- *HL 4 Modified*
- *HL 4*
- *HL 4 or Surf. Treat.*
- *Other Highways*

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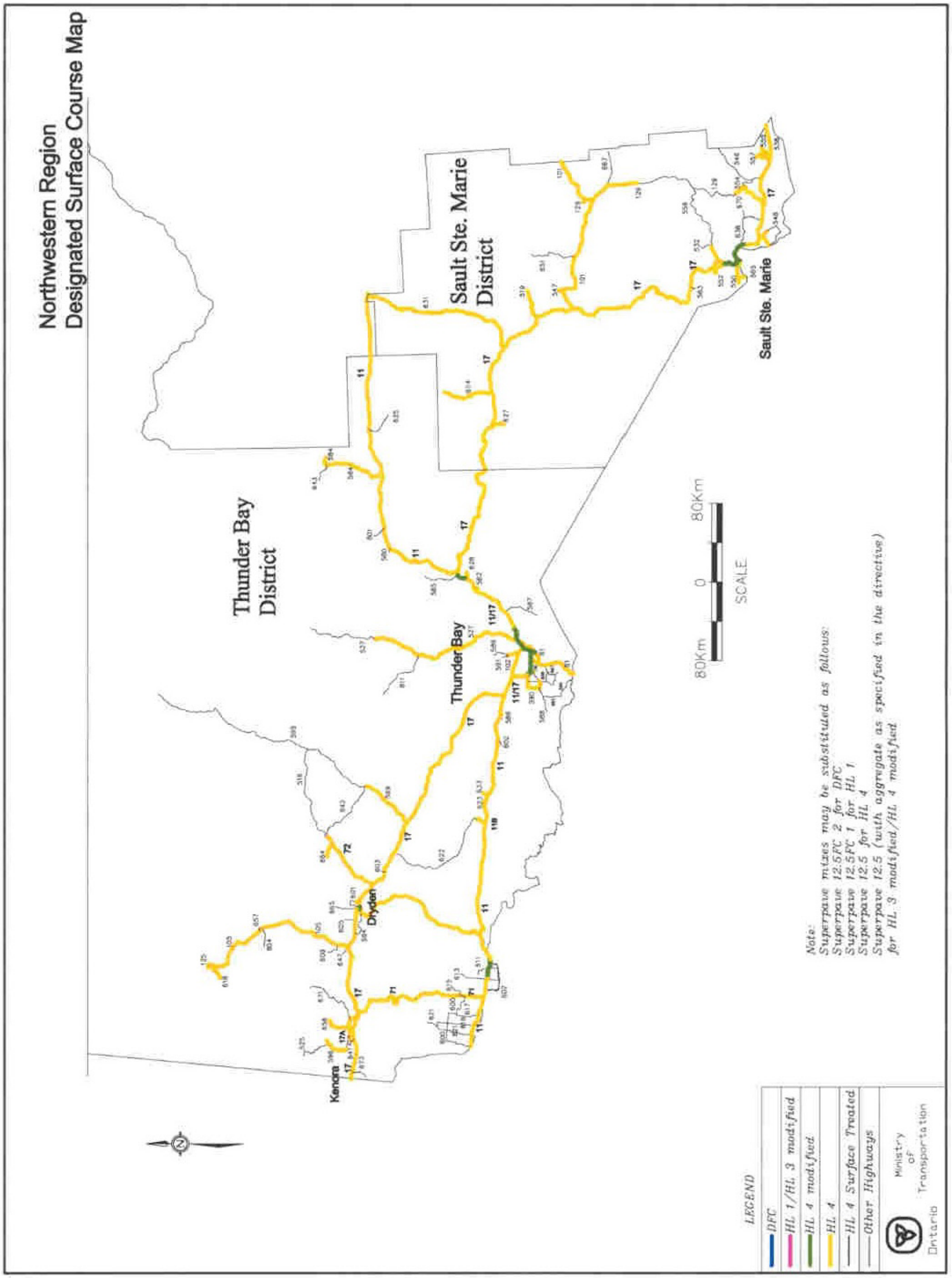
Note:
Superpave mixes may be substituted as follows:
Superpave 12.5FC 2 for DFC
Superpave 12.5FC 1 for HL 1
Superpave 12.5 for HL 4
Superpave 12.5 (with aggregate as specified in the directive) for HL 3 modified/HL 4 modified

Appendix 6


Northwestern Region
Designated Surface Course Map
Thunder Bay
District
Sault Ste. Marie
District
Kenora
Dryden
Thunder Bay
Sault Ste. Marie
80Km 0 80Km
SCALE
Note:
Superpave mixes may be substituted as follows:
Superpave 12.5FC 2 for DFC
Superpave 12.5FC 1 for HL 1
Superpave 12.5 for HL 4
Superpave 12.5 (with aggregate as specified in the directive)
for HL 3 modified/HL 4 modified
LEGEND
DFC
HL 1/HL 3 modified
HL 4 modified
HL 4
HL 4 Surface Treated
Other Highways
Ministry of Transportation
Ontario