Ministry of Transportation

Ministère des Transports

Ontario

MINISTRY DIRECTIVE

Program: Provincial Highway Management

Directive: PHM-C-001

Issuing Authority: Director, Highway Standards Branch

Date of Issue: 78 11 23 **Effective Date:** Immediate **Revised:** 12 12 2014

TO: Assistant Deputy Ministers, Executive Directors, Regional Directors, Directors, 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

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.

REFERENCE: This directive supersedes Directive C-16 dated 78-11-23; revised 84-5-23 and 88-05-03; Directive PLNG-C-003 dated 03-08-06; and PHM-C-001 dated 2009-07-17.

BACKGROUND: Directive C-16, first implemented in 1978, used Annual Average Daily Traffic divided by the number of lanes (AADT/lane) as the sole criterion for selecting the pavement surface course type. In 1984, 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]. In 2003, MTO was no longer using HL3 mixes for Freeways and King's Highways, and with the introduction of Superpave mixes and Stone Mastic Asphalt (SMA), Directive PLNG-C-003 was implemented to update the surface course selection requirements. It was also recognized that in addition to AADT, there were other factors, which should be considered in selecting surface course types as part of highway construction, rehabilitation and maintenance projects. They included:

- 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

In 2005, MTO moved to full implementation of Superpave mixes, eliminating the use of DFC, Heavy Duty Binder Course (HDBC) and the standard Hot Laid (HL-) designated Marshall mixes. The Directive PLNG-C-003 dated 2003 was implemented to update Superpave and SMA mixes in place of HL mixes.

In 2009, MTO suspended the use of SMA to resolve technical concerns. This directive reinstates SMA as a premium surface course.

In 2012, revisions to the Alternative Bid Criteria to include arterials are also included in this directive.

POLICY: Considering the above factors and following consultation with the MTO 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 provided in Table 1 are based mainly on either design lane ESAL or AADT criteria generated from the latest Commercial Vehicle Survey (CVS) data. Design lane ESAL and/or AADT should be calculated by applying the lane distribution factors given in the MI-183 Report [2]. Maps highlighting the designated surface course types on provincial highways across all regions are attached for use in conjunction with this directive (Appendices 1-7). For additional information or clarification, the appropriate Regional Geotechnical Section should be contacted.

TABLE 1: Selection of Surface Course Type

ESALs /design lane /year (or AADT/lane)				
AADT<750	ESALs<1 Million		1 Million<ESALs<3 Million or AADT>5000	ESAL> 3 Million
	AADT 750 - 2500	AADT 2500-5000		
Surface Treatment[a)], Cold Mix, or Superpave 12.5	Superpave 12.5	Superpave 12.5 FC1	Superpave 12.5 FC2 [b,c)]	SMA [b,c,d)]

[a] Surface treatment type should be selected according to the guidelines given in the Pavement Design and Rehabilitation Manual [3].
[b] During the Environmental Assessment process, the use of an alternative surface course may be considered for the purpose of noise reduction in urban residential areas where significant noise issues have been identified.
[c] 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 500,000 or more ESALs are anticipated in the design lanes within 5 years of construction.
[d] When the pavement surface is temporary, e.g., traffic detour or holding strategy resurfacing, life cycle costing analysis (LCCA) should be carried out to determine if SMA is warranted.

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 may 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 Superpave 12.5 FC1 or 12.5 FC2, based on ESAL or AADT criteria respectively. In this case, Superpave 12.5 FC2 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 [4].

DESCRIPTION OF MIX TYPES:

Superpave Mix

Superpave mix is asphaltic concrete designed according to Superpave criteria. The Superpave methodology incorporates a performance-based asphalt materials characterization system to improve the long-term pavement performance under diverse environmental conditions.

Superpave designates asphaltic concrete 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 Superpave 12.5. The Ministry has added two mix types to the Superpave suite of mixes: Superpave 12.5 FC1 and Superpave 12.5FC2. The "FC" stands for friction course. The "1" requires that the coarse aggregate fraction for this mix type must be obtained from a pre-qualified supplier identified on the MTO Designated Sources for Materials (DSM) List # 3.05.25 [5]. The "2" requires that both the coarse and fine aggregates for this mix type must be obtained from a DSM source.

There are special mix types that are being used in some Regions to address specific local conditions. The potential applications of these mixes in certain circumstances are discussed below.

Stone Mastic Asphalt

Stone Mastic Asphalt (SMA) is a heavy-duty gap graded asphaltic concrete with a relatively large proportion of crushed stone 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 loading due to heavy truck loads. Both the coarse and fine aggregates for this mix type must be obtained from a pre-qualified product supplier listed in OPSS.PROV 1003.

An 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. 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 fibre, using either organic or mineral fibre or the addition of ground roof shingle tabs, 3) polymer-modification, or 4) a combination of all three. All SMA requires the application of a hot grit coated with asphalt cement (about 1%) during mix placement to increase early age friction.

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 [6].

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

MTO initiated an Alternative Bid (AB) process for freeway paving contracts in 2001. Under the AB process, bidders determine their "Construction Bid" for a rigid (concrete) or flexible (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 Criteria are applicable to all new and full depth reconstruction projects on freeways and arterials, in the order of five 2-lane kilometres or longer in length, where 500,000 ESALs or greater 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 Manager of Engineering, an assessment should be made on the merits of awarding them as AB contracts. The assessment should include advice from the Estimating Office and the Materials Engineering and Research Office.

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. Pavement friction and AB process should not be compromised for continuity.

Examples

1. If a highway between two communities meets Superpave 12.5 FC1 criteria except for a short section, Superpave 12.5 FC1 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

Highways with large volumes of trucks and/or slow moving trucks require enhanced resistance to rutting. These conditions should be considered as part of the Superpave design when selecting the Superpave Traffic Category and the Performance Graded Asphalt Cement (PGAC) grade. Further information on enhancing rut resistance of SMA and Superpave mixes can be found in the MTO Superpave and SMA Design Guide [7].

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 [8]. Thus, highways with high traffic require high wear and aggregates that are resistant to polishing.

On highways with traffic volumes less than 2500 AADT in design lane that have a high proportion of truck traffic the designated Superpave 12.5 hot mix may be modified to include aggregates that meet the requirements of SP 12.5 FC1. In this case, coarse aggregates would be required to be obtained from sources listed on the DSM.

The use of carbonate aggregates, e.g., limestone and dolostone, is restricted in surface courses as per the requirements of OPSS.PROV 1003.

Limitations on the Temporary Use of Binder Course Mixes in the Pavement Surface

For pavements with 1500-2500 AADT in the design lane, asphaltic concrete binder courses shall only remain exposed to traffic for a maximum period of 16 months prior to being overlaid with a surface course. For pavements with AADT greater than 2500 in the design lane, asphaltic concrete binder courses shall only remain exposed to traffic for a maximum period of 9 months prior to being overlaid with a surface course. The exposure time may be extended if friction testing indicates that adequate performance will be maintained during the longer exposure period.

Use of Thin Surfacing Treatments

Thin surfacing treatments such as micro-surfacing or chip seals may be used for preservation treatments to extend the service life of a pavement in accordance with current Ministry guidelines.

DEVIATIONS FROM THE RECOMMENDED SURFACE COURSE TYPES:

The need for the use of special mixes not identified in Table 1 or on the attached maps shall 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.

IMPLEMENTATION:

Implementation of this directive is effective immediately. If implementation of this directive would result in a change in the surface course type in a contract requiring revision of contract documents, the Manager of Engineering or the Manager of Contracts, 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. "Adaptation and Verification of AASHTO Pavement Design Guide for Ontario Conditions", Ministry of Transportation, MI-183, Final Updated Report March 2008.

3. Pavement Design and Rehabilitation Manual – Second Edition, Ministry of Transportation,, March 2013.

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

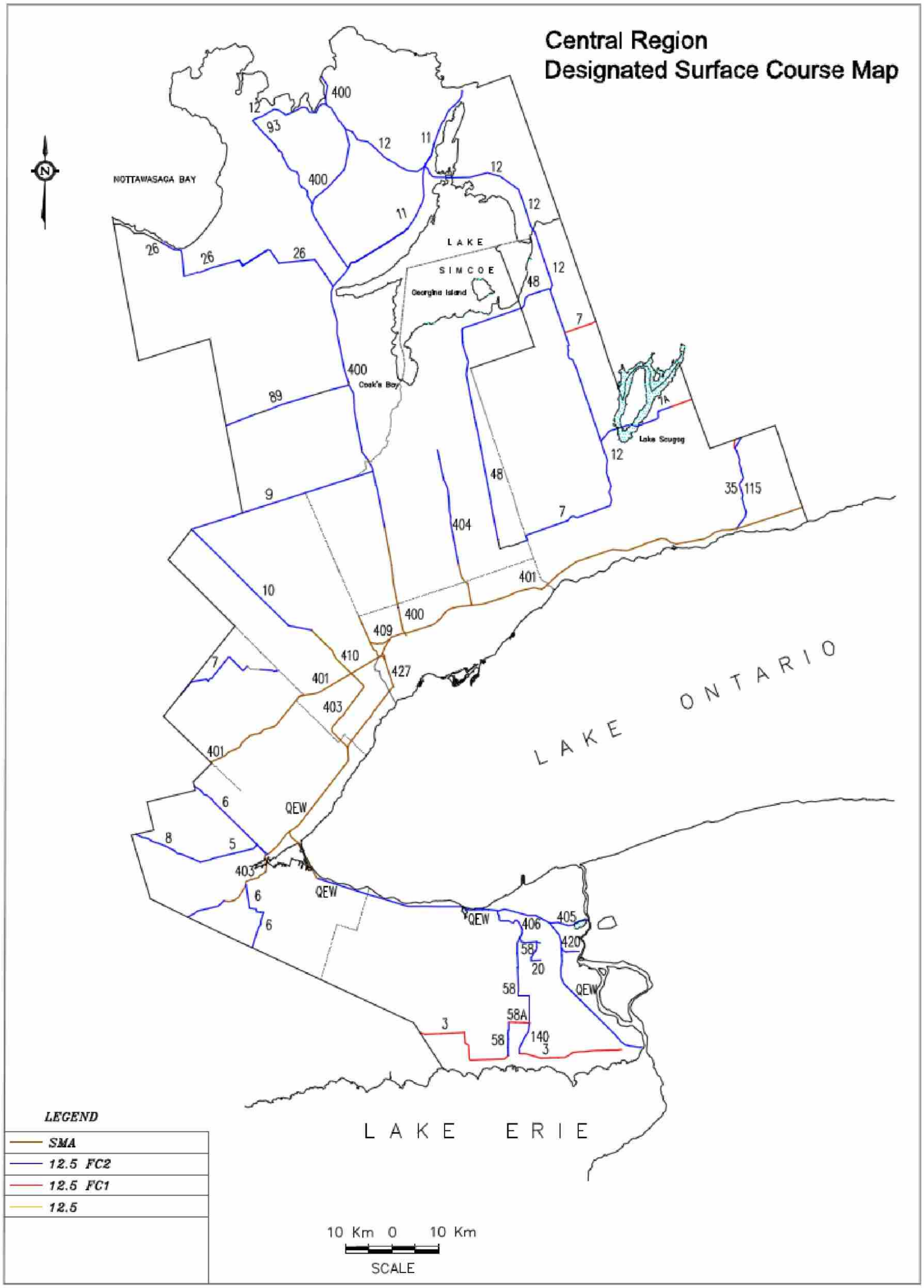
5. Designated Sources for Materials (DSM). "3.05.25 Aggregates: Coarse for Superpave 12.5 FC1, Superpave 12.5 FC2, HL1, DFC; Fine for Superpave 12.5 FC2, DFC", MERO, Soils & Aggregates Section.

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

7. MTO Superpave and SMA Guide, Ministry of Transportation, Bituminous Section, March 2008.

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

Appendix One



Appended to Directive PHM-C-001
Formerly PHY-C-016, PLNG-C-003
Revised December 12, 2014

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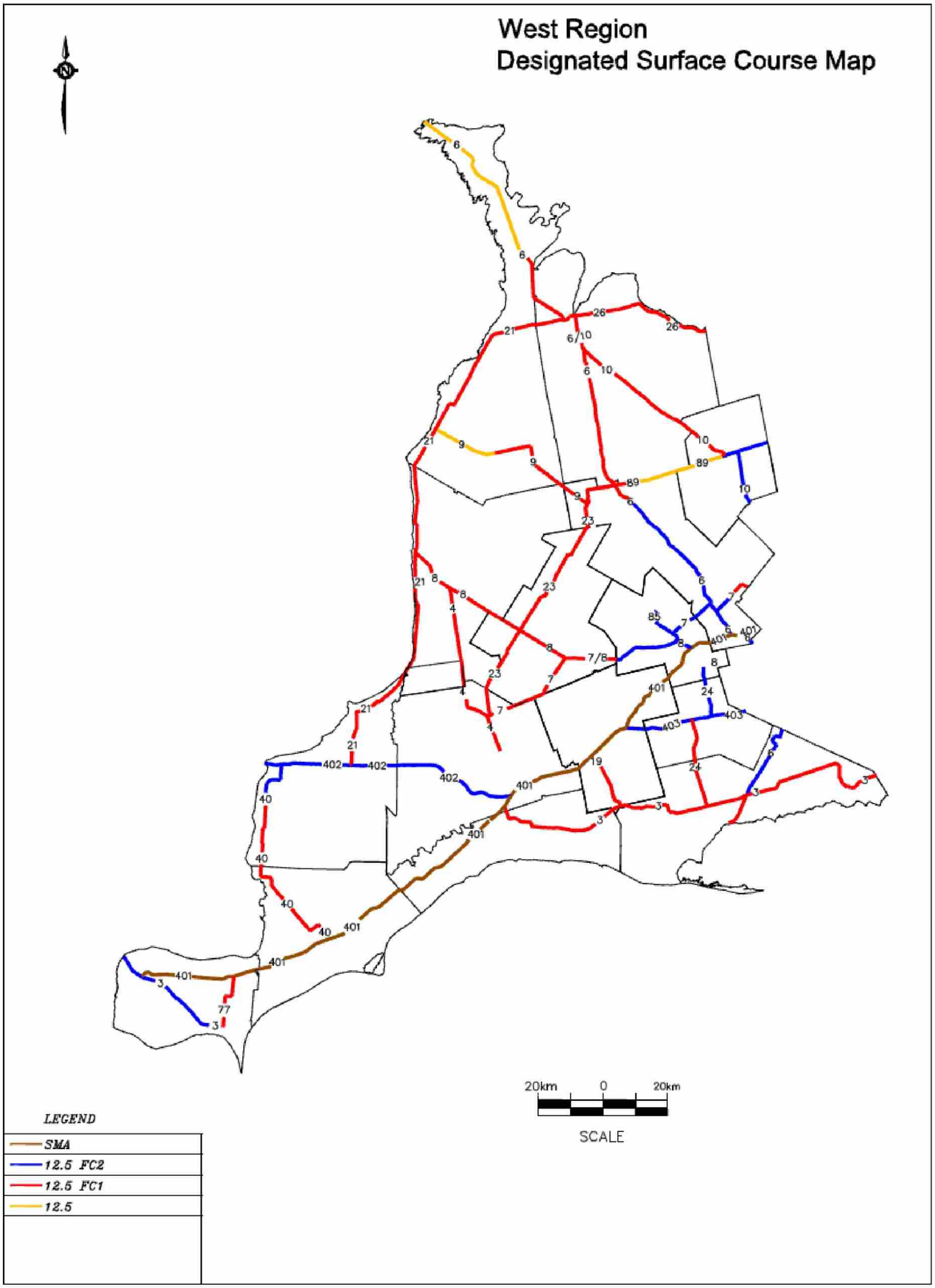
Appendix Two



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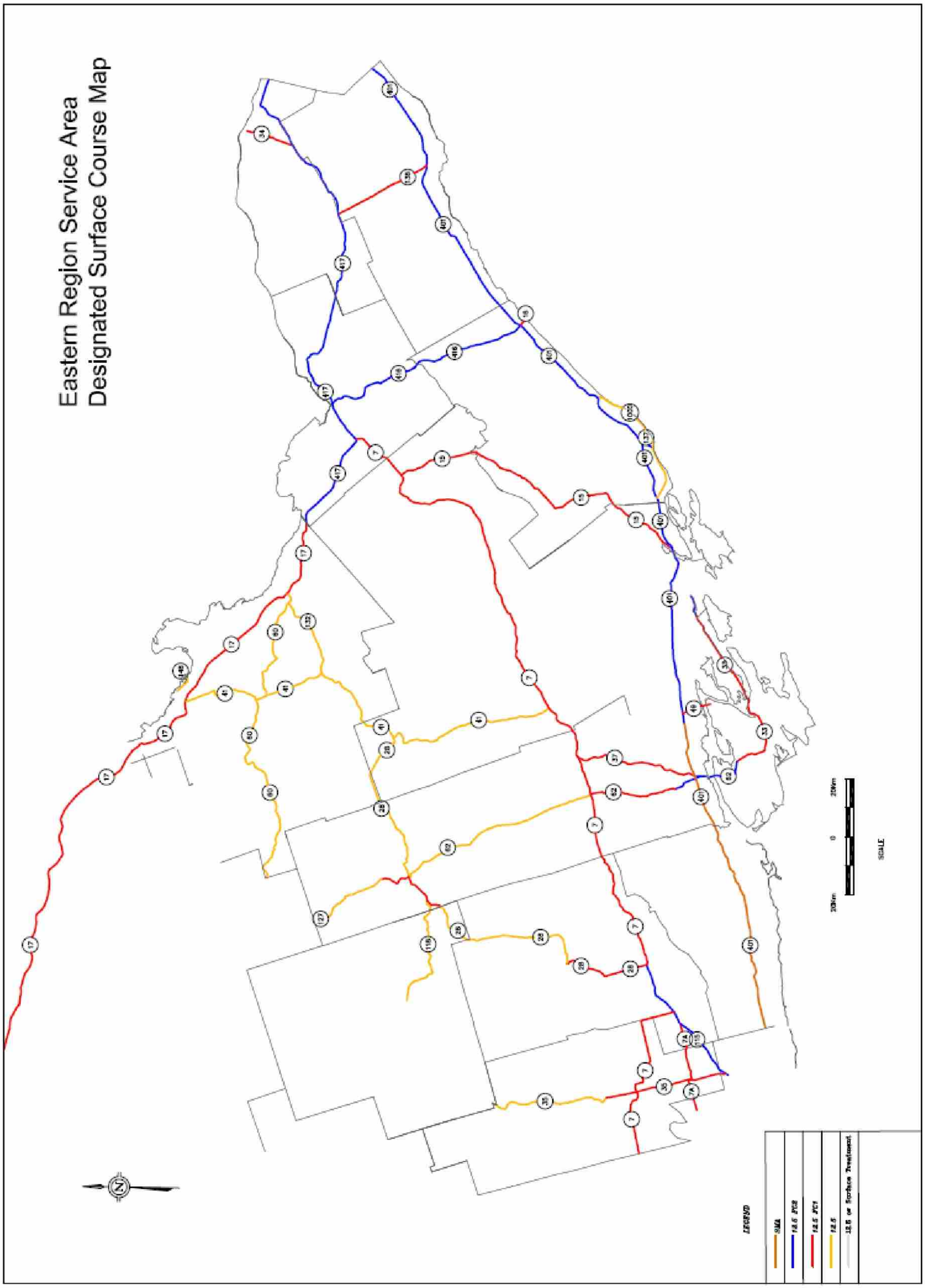
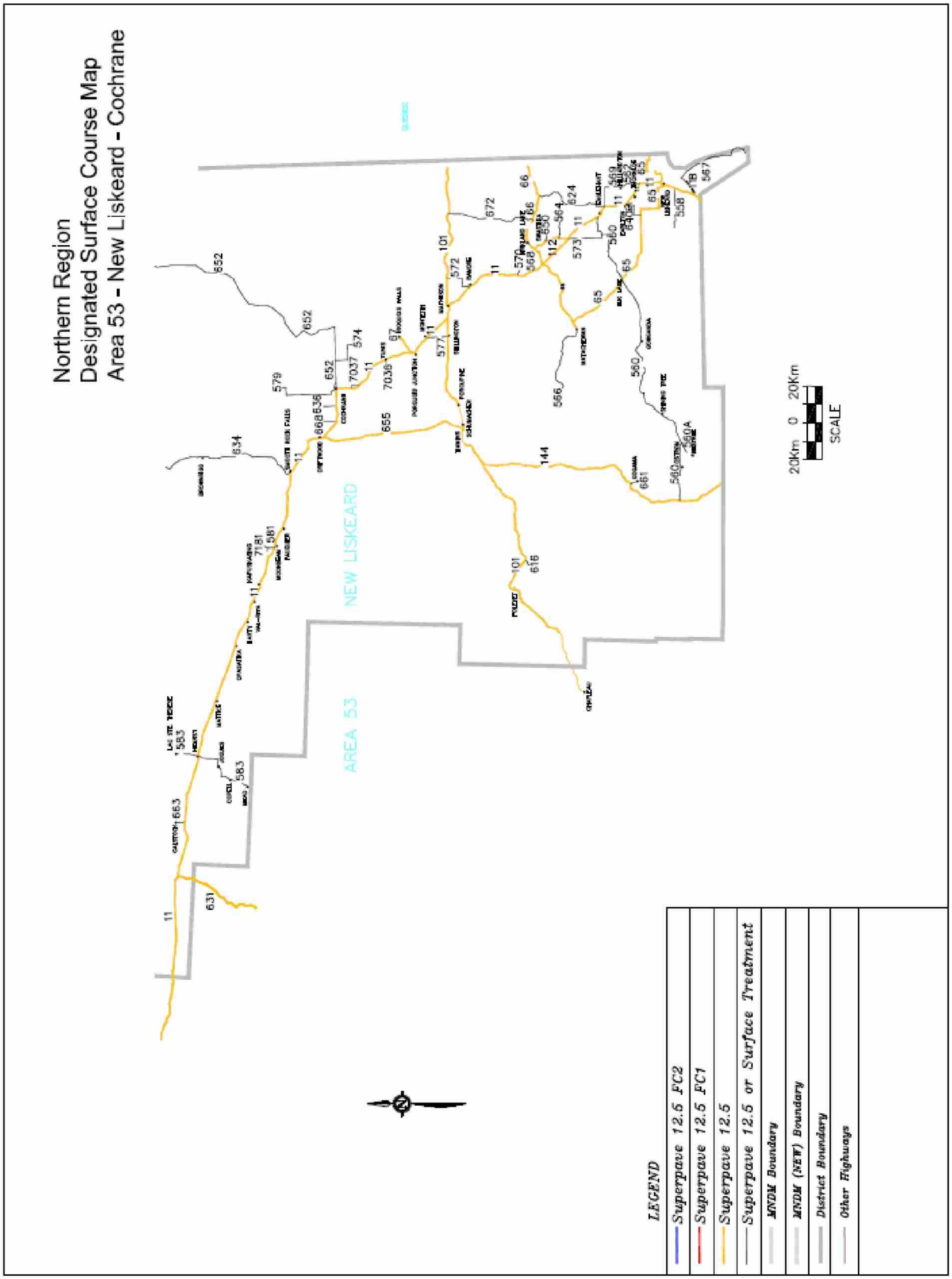
Appendix Three



Appendix Four



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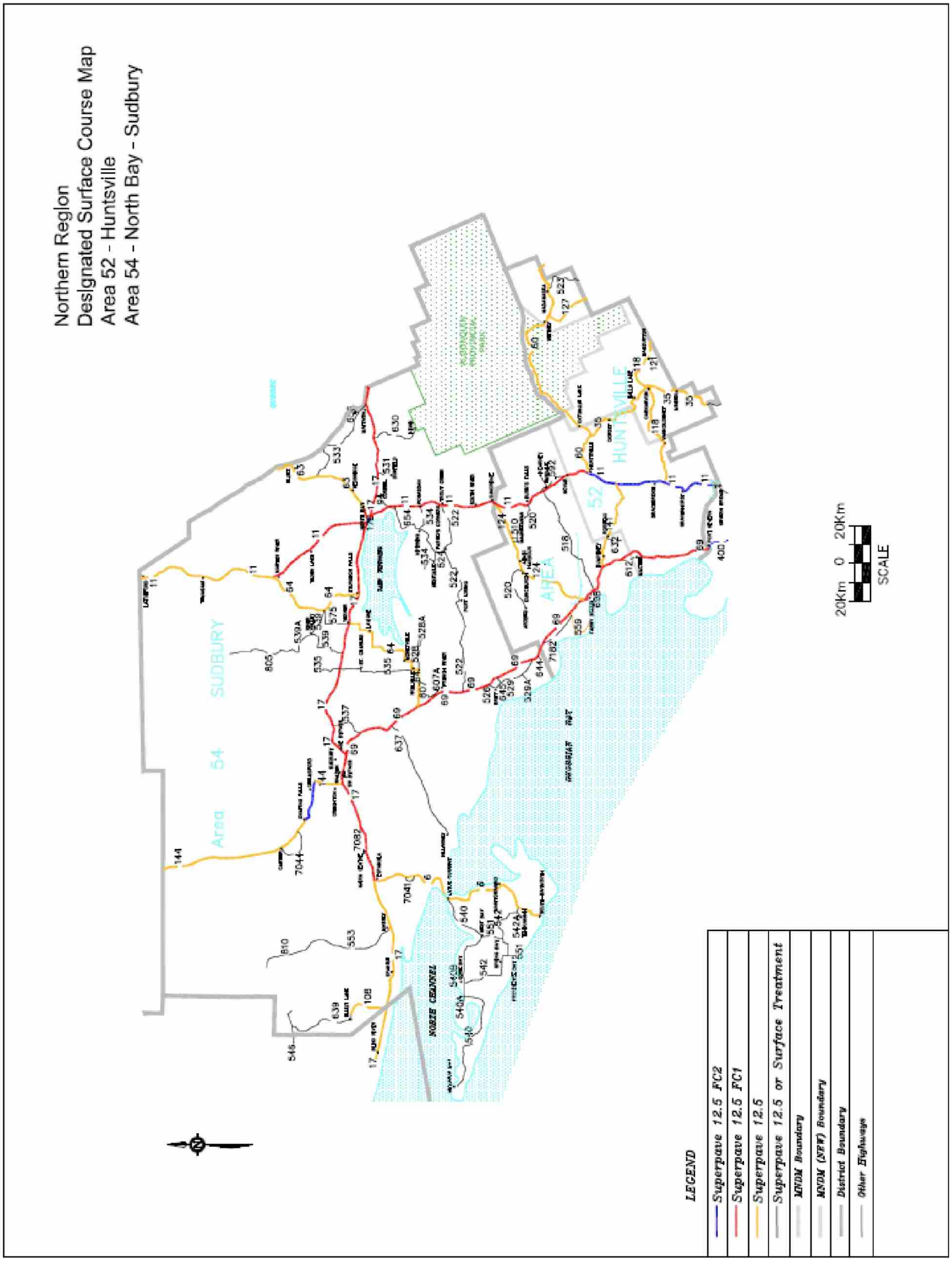
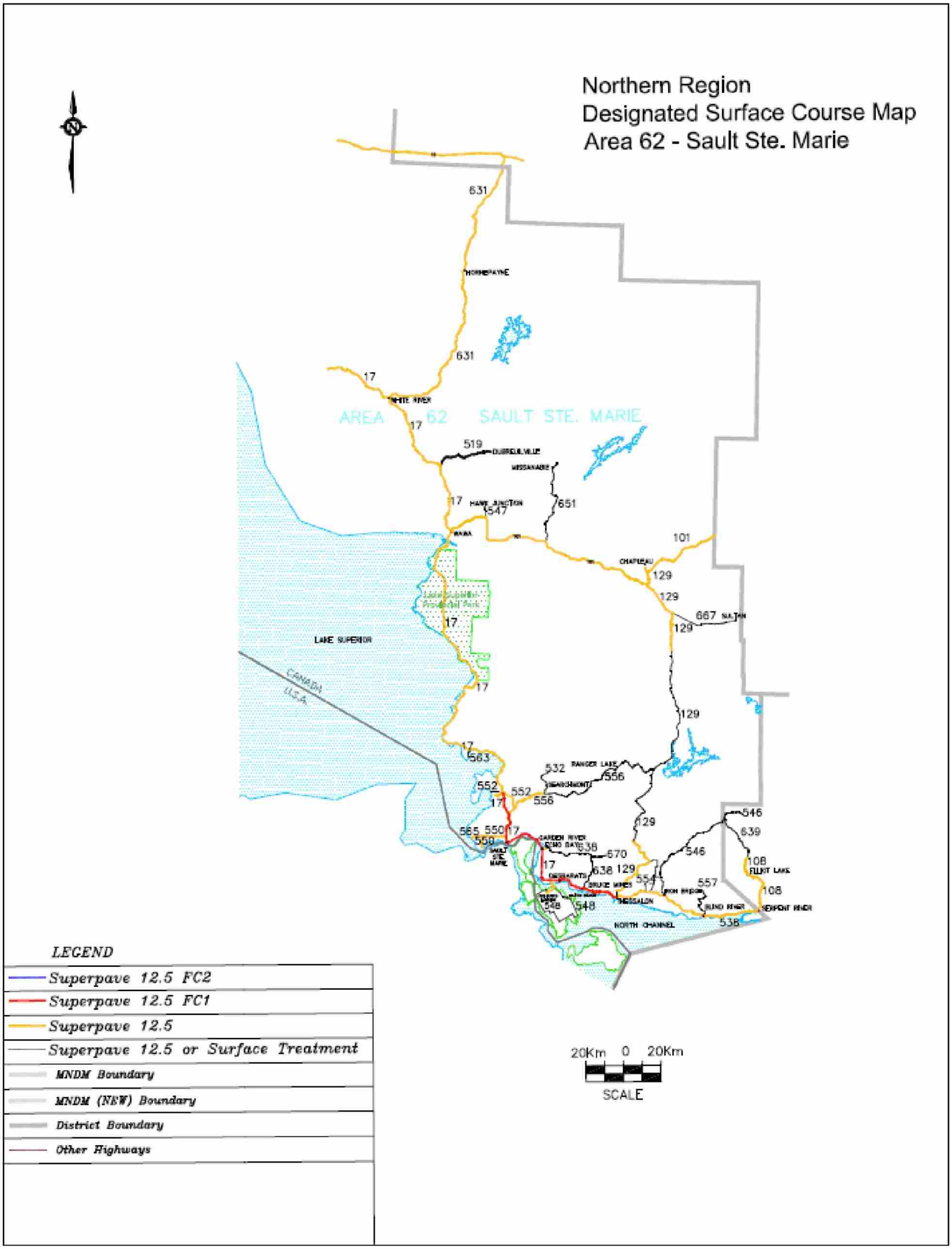
Revised December 12, 2014

Appendix Five



Appendix Six



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Revised December 12, 2014

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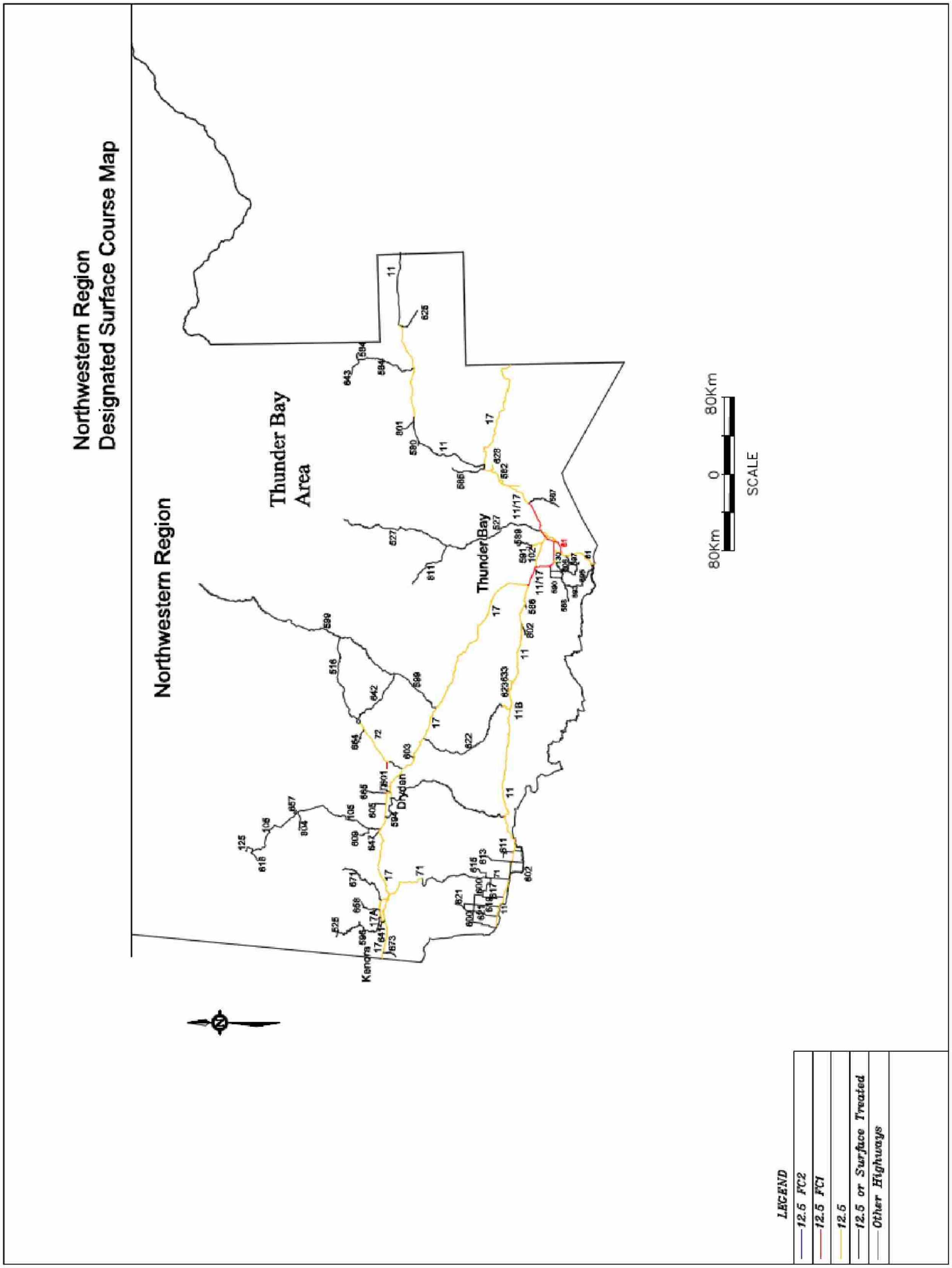
Appendix Seven



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