National Hydro Network, Canada, Level 1 Product Specifications

Edition 1.0

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REVISION HISTORY

Date	Version	Description
September 2002	Draft 01	First draft for discussion with Nova Scotia
January 2003	Draft 02	Second draft after discussion with Nova Scotia and major review of the hydro network model through: • Proposal of options
March 2003	Draft 02	Draft version after discussion and decisions made concerning NHNC1 scope and content with Nova Scotia and British Columbia. Meeting in Halifax, February 2003.
July 2003	Draft 02	Draft version after discussion and decisions made concerning the detailed NHNC1 model and content with Nova Scotia, British Columbia, and the Yukon. Meeting in Victoria, May 2003.
February 2004	Draft 02	English review.
August 2004	1.0	Adjustment of coordinate type notations that could cause confusion for readers in sections 3.2 and 6.2.

FUTURE WORK

Key word	Description

TABLE OF CONTENTS

ABBREVIATIONS

CTIS	Centre for Topographic Information in Sherbrooke
GML	Geography Markup Language
ID	Identifier
LRS	Linear Referencing System
MBR	Minimum-Bounding Rectangle
NHD	National Hydrography Dataset
NHNC1	National Hydro Network, Canada, Level 1
NID	National Identifier
NRCan	Natural Resources Canada
NTDB	National Topographic Data Base
NTS	National Topographic System
OGC	Open GIS Consortium
SFS	Simple Features Specification defined by the OGC
UML	Unified Modeling Language
UUID	Universal Unique Identifier

TERMS AND DEFINITIONS

Attribute

Characteristic of a feature, such as the type of water region.

Class

Description of a set of objects that share the same attributes, operations, methods, relationships, and semantics. A class does not always have an associated geometry (e.g., the metadata class).

Event

Characteristic of a feature measured along a hydro network object without modifying the associated geometry.

Feature

A digital representation of an object. For example, the digital representation of the St. Lawrence River is a feature. ”Features are digitally coded abstractions of real-world objects and phenomena that have a geometric representation and space/time and other attribution associated with them.”[1]

Object

An object is an instance of a class.

Packages

Grouping of a set of classes, relationships, and even other packages with a view to organizing the model into more abstract structures.

Linear Referencing System

A means of identifying a location by reference to a segment of a linear geographic feature (such as rapids) and distance from some point along that segment.

1 Overview

The term *Hydro* in reference to the National Hydro Network, Canada, Level 1 (NHNC1) product expresses the idea that the data model synthesizes the key concepts in hydrography and hydrology. Indeed, the common meeting ground of hydrography and hydrology lies with the description of surface water systems.

The NHNC1 concentrates on building a network path through naturally occurring and constructed bodies of water. These paths through which water flows will contain related entities. We will strive with our partners to keep this information as current as possible. There is currently no official data model for inland hydrographical information. Background research was done to develop a standardized vocabulary and relational model for the NHNC1. Unfortunately, since there are several models internationally, a common vocabulary and standardized national model must be agreed upon. The national model will include the identification of a set of basic features and attribute.

The modeling work of the NHNC1 was primarily based on Linear Reference System (LRS) concepts. This approach allows the management of geometric representation separately from attribute information (referred to as “event” in LRS). Unique Identifiers (IDs) are associated with each geometric and event object. These IDs (called National Identifiers - NIDs) will lead to more efficient management of updates between data producers and data users.

The Centre for Topographic Information in Sherbrooke (CTIS), part of Natural Resources Canada (NRCan), produced the NHNC1 model in collaboration with Nova Scotia and British Columbia. CTIS continues to pursue its goal of capturing and managing NHNC1 data within a network of partners. These partner organizations are selected for their specific interests or for their ease in offering adequate, up-to-date representations of NHNC1 phenomena. These data must be the product of a homogenous, standardized view of the entire Canadian landmass. Consequently, the NHNC1 is the culmination of cooperative efforts by federal and provincial government agencies.

The data model can (and must) extend beyond the smallest common denominator obtained with the partners. The model must therefore contain two levels of information: mandatory data and optional data. Data homogeneity will thereby be ensured by a minimum set of data. Beyond the minimum level, the model serves as a target for all partners. Over the years, we will therefore work towards raising the minimum and redefining new targets.

2 Data Identification

2.1 Spatial resolution

NHNC1 data will be acquired by using several sources (provincial and federal data, National Topographic Data Base database). As a result, it is difficult to provide a specific scale that describes the data. Nevertheless, we can qualify the data according to available information and potential partnerships for different parts of the country. As described in Figure 1, the southern part of the country as well as the Yukon, Nunavut, and Labrador are covered by NTDB data at the 1:50 000 scale (represented in dark and light grey). The remainder of the Canadian landmass is covered by NTDB data at the 1:250 000 scale. Lastly, the scales for provincial data sources vary from 1:50 000 to 1:10 000.

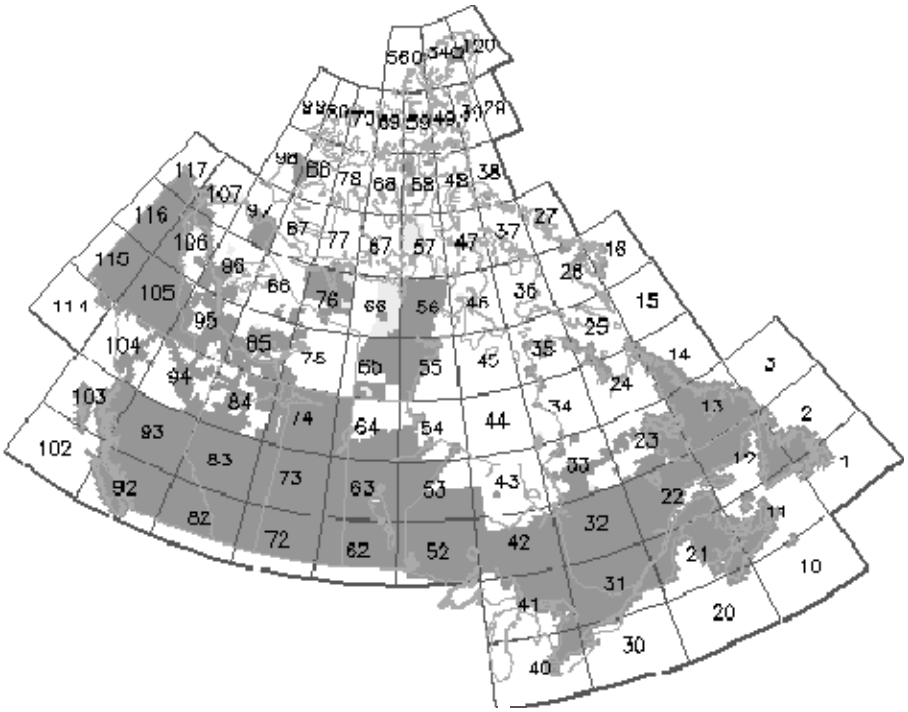

Figure 1 – Index of NTDB files at the 1:50 000 scale available

2.2 Language

All NHNC1 associated products and documentation will be available in French and English.

2.3 Character set

The character-coding standard used for the data expressed in Geography Markup Language (GML) is UTF8.

2.4 Topic category

NHNC1 data is related mainly to the *Inland Waters*, *Oceans*, and *Vector* data category. It may contain a few items of the *Structure* category related to water.

According to the GCMD[1] (Global Change Master Directory) thesauri, NHNC1 data can be classified into Science keywords structured using a four-level hierarchy: **CATEGORY > TOPIC > TERM > VARIABLE**.

The NHNC1 includes:

- EARTH SCIENCE > HYDROSPHERE > SURFACE WATER > DRAINAGE
- EARTH SCIENCE > HYDROSPHERE > SURFACE WATER > RIVERS/STREAMS
- EARTH SCIENCE > HYDROSPHERE > SURFACE WATER > WETLANDS
- EARTH SCIENCE > OCEAN > COASTAL PROCESSES > MARSHES
- EARTH SCIENCE > OCEAN > COASTAL PROCESSES > SHORELINES

2.5 Geographic box

The geographic box or Minimum-Bounding Rectangle (MBR) delineating the coverage of National Hydro Network in Canada is:

- West Bounding Coordinate: 150˚ West
- East Bounding Coordinate: -40˚ West
- North Bounding Coordinate: +90˚North
- South Bounding Coordinate: 40˚North

2.6 Geographic description

The first version of the NHNC1 will be a set of continuous and isolated water networks covering the entire Canadian landmass. Isolated water networks are considered unrelated network features.

2.7 Extent

The temporal extent of the NHNC1 is bounded by the beginning of the initial capture process and will continue to evolve over time.

[1] Information about the NASA Global Change Master Directory (GCMD) can be found at: http://gcmd.nasa.gov/.

3 Geospatial Characteristics

3.1 Spatial representation type

The NHNC1 is feature-based (or vector) data. Geometric representation details can be found in "*National Vector Data – Geometric Representation and Integrity Constraints* "[2].

3.2 Spatial representation

While the NHNC1 has no explicit topology, it does ensure that the network data are free from any spatial inconsistencies such as overshoots and undershoots. To ensure compliance with the Open GIS Consortium (OGC) specifications concerning spatial relationships for all Simple Features Specifications (SFS), the NHNC1 will comprise two-dimensional planimetric (x,y) data. When available, the height information will be provided without changing the geometry types and associated rules. Therefore, the NHNC1 2D planimetric data (x,y) and optionally a 1D height component (H) with all spatial relationships defined in two-dimensional space.

3.3 Coverage and continuity

NHNC1 data are seamless within datasets and form a continuous network over the Canadian landmass. Segmentation only occurs at National, Provincial, and Territorial limits (called Data Set Boundaries).

3.4 Data segmentation

Network Linear Elements form the geometric structure of the Hydro Network. In accordance with the LRS model, these elements may be segmented for two reasons only:

- Intersection at the same level[3] with another Network Linear Element
- Intersection at National, Provincial, or Territorial boundaries

[2] This document can be found at http://www.geobase.ca/ in the Data Description section.
[3] Hydro network linear elements that do not intersect at the same spatial level are not segmented.

4 Data Model

4.1 Data modeling schema used

The Unified Modeling Language (UML)[2] is used to model the NHNC1.

4.2 Application / spatial schema (Conceptual model)

The NHNC1 data model is based on an LRS approach. Four packages (see Figure 2 – NHNC1 Packages) have been defined: the *Hydro Network* package contains the basic network geometric information. The *Events* package contains attributive information. The *Hydro Graphy* package contains the geometric representations of hydrographical phenomena. The *Metadata* package contains information that describes the data itself (date, accuracy, and so on).

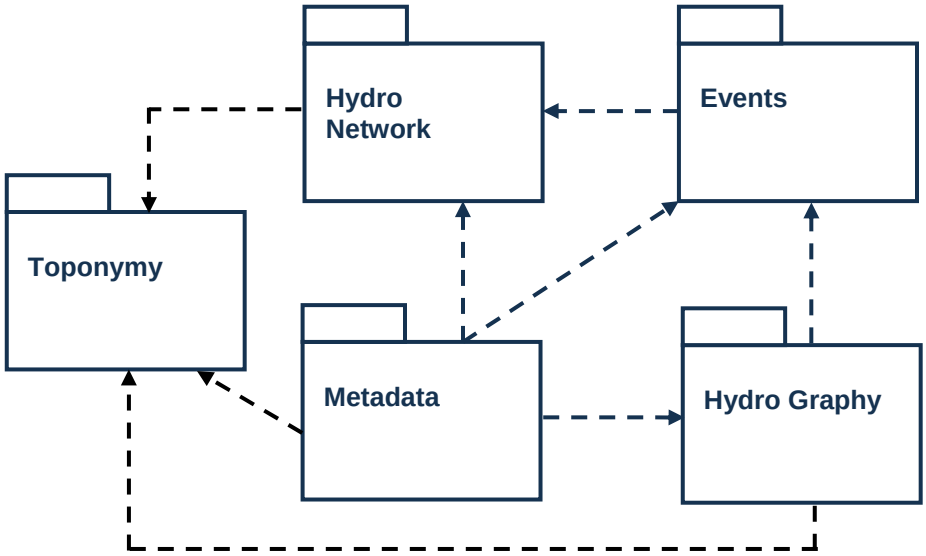

Figure 2 – NHNC1 Packages

Model details can be found in "*National Hydro Network – Data Models*"[4].

[4] This document can be found at http://www.geobase.ca/ in the Data Description section.

5 Data Dictionary / Feature Catalogue

The expanded NHNC1 feature and attribute catalogue can be found in "*National Hydro Network – Data Model.*"[5]

[5] This document can be found at http://www.geobase.ca/ in the Data Description section.

6 Coordinate Reference System

6.1 Horizontal reference system

NHNC1 spatial data are expressed in reference to the North American Datum 1983 / Canadian Spatial Reference System (NAD83CSRS).

6.1.1 Horizontal coordinate system

NHNC1 data are stored in latitude (ϕ) and longitude (λ) geographic coordinates.

6.1.2 Unit of measure (coordinate system axis units)

The measuring unit for storing horizontal spatial data is the degree, given to 7 significant digits. Coordinates are expressed as real values. The number of significant digits corresponds to the decimetre when the data are projected in UTM coordinates.

6.2 Vertical reference system

Optional elevations (H) are orthometric and expressed in reference to mean sea level (Canadian Geodetic Vertical Datum - CGVD28).

6.2.1 Unit of measure (coordinate system axis units)

The measuring unit for storing vertical spatial data is the metre (m).

7 Data Quality

7.1 Scope

The National Hydro Network focuses on providing a quality geometric description and a set of defined minimal standard requirement attributes of the Canadian Hydrographic Network.

7.2 Lineage

The NHNC1 will be created from several sources (provincial and federal data). During the initial acquisition of NHNC1 data, efforts will be made to try to recycle and update as close as possible to the source of the hydrographical data. Subsequently, each partner will be responsible for identifying their sources for the update process for datasets under their jurisdiction. Lineage information will be introduced into the metadata.

7.3 Completeness

The NHNC1 data content might differ slightly from one region to another. The NHNC1 data model allows this flexibility and ensures the registering of this type of metadata for all regions covered by NHNC1 data. Indeed, every region will be qualified by a set of metadata associated to a polygon defining the spatial extent of an area. Each of these polygons will also be associated with a list of NHNC1 features codes included in the content for the area.

7.4 Logical consistency

The logical consistency of the NHNC1 data can be evaluated in several ways.

- NHNC1 data are seamless and not segmented at any theoretical tile boundaries.

- NHNC1 data were acquired, as much as possible, from data closest to the source (such as provinces). When provincial data are used, the same geometry is used for the two levels of government: federal and provincial.

7.5 Positional accuracy

The accuracy of geometric representation data is given as the difference between the position of the geometric representation associated with an object and the real ground position of the corresponding topographic feature, as measured with respect to the geodetic network. Accuracy, which can vary from one occurrence of an object to the next, is provided as an attribute of each object. The NHNC1 aims at attaining a circular map accuracy standard (CMAS) of 30 m or better for data in all areas. This accuracy is based on Landsat 7 Orthoimages, Geobase Data Alignment Layer.

Standard circular error: $\sigma_c = 0.7071 (\sigma_x^2 + \sigma_y^2)^{½}$

σ_x : standard deviation in the X-axis

σ_y : standard deviation in the Y-axis

Circular map accuracy standard: $CMAS = 2.1460\ \sigma_c$

7.6 Temporal accuracy

Temporal information is needed for NHNC1 data. Two time stamps are required.

- The source material date (or capture date). This date can be found in the metadata information under the label “Acquisition or Revision Date.” It refers to the year and month of the source material or data capture process.

The database transactional date. This time stamp refers to the date that the data were recorded in the database. *National Vector Data – Change Management*[6] provides a detailed description of the change management mechanism. This date can be of nanosecond granularity, if needed.

7.7 Thematic (attribute) accuracy

NHNC1 data is acquired from several sources (provincial data, and NTDB data, in some cases). The methods to validate the data differ according to the initial acquisition method. The sources available at the time might be for example: orthophotos, orthoimages and fieldwork. Various other sources made available by different organizations can also be used. Regardless of the method of validation used, all errors detected will be flagged and resubmitted with the proper corrections.

[6] This document can be found in the Data section at http://www.geobase.ca/..

8 Metadata

Two levels of metadata to describe National Hydro Network, as shown in the following figure: collection and product/dataset. The higher level of metadata covers the entire data collection: it applies to the series of available datasets (group of features), database, etc. Product level metadata give specific information about each dataset.

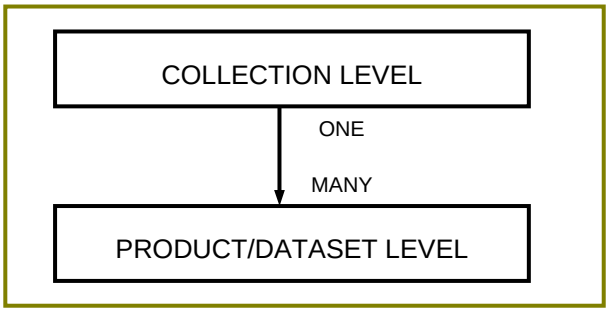

Figure 3 – Metadata Levels

In addition to these two levels of metadata, NHNC1 has "object metadata" associated with each geometry. These object metadata are described in the following documents[7]: "*National Hydro Network - Data Models"* and "*National Hydro Network - Data Catalogues*." More details can also be found in "*National Vector Data – Metadata Specifications."*

[7] These documents can be found at http://www.geobase.ca/ in the Data Description section.

9 Data Portrayal / Data Transfer Format / Physical Model

9.1 Conversion process

NHNC1 data are stored in an Oracle database using the LRS approach. The data can be converted in different method of LRS and also in a segmented view of the NHNC1 either to GML or SHAPE formats.

9.2 Files

NOT APPLICABLE

9.3 Directories

NOT APPLICABLE

9.4 Point entities

NOT APPLICABLE

9.5 Linear entities

NOT APPLICABLE

9.6 Surficial entities

NOT APPLICABLE

10 Data Delivery

10.1 Format information

The output file formats for the product are GML (Geography Markup Language) in ASCII and SHAPE (ESRI™). Detail for all different views of the NHNC1 on the name and the data type for each attribute in both formats are to be defined.

10.2 Medium information

The datasets will be available online via an FTP site. An e-mail will be sent to the customer when the process is complete and the file is available for transfer.

10.3 Constraints information

The constraints information for data access and data use are defined in the GeoBase Unrestricted Use Licence Agreement (in the Data section at http://www.geobase.ca/).

11 Data Capture and Maintenance

The initial targeted for the NHNC1 product is to create a first data framework in respect with this data model. Subsequently, each partner will be responsible for identifying their sources and cycle for the update process for datasets under their jurisdiction. One of the mechanisms is establishing change management principles. Two basic concepts are needed: identification rules and definition / classification of change.

On the Identification side, objects that depict real-world phenomena vary over time, either by their descriptive business case use or by the precision of the instruments and methods involved in their initial acquisition. One or more representation of the same phenomena may therefore exist. As part of this initiative, we want to build and maintain a ***single*** representation of the National Hydro Network. Identifiers play a fundamental role in ensuring the proper exchange and circulation of the Objects modified at the source and already provided to users. The implementation of a standard for the permanent identification of a phenomenon and its application are to achieve two primary objectives:

- Facilitate the management and distribution of object changes in an incremental manner;
- Facilitate the conflation or the proximity process of objects, if necessary.

Every occurrence of NHNC1 basic features must be uniquely identified. Moreover, each event in the LRS model that describes specific characteristics of *Hydro Network Element* must also be uniquely identified. *National Vector Data – Identification Rules*[8] provides details about ID definition.

In terms of change management, NHNC1 doesn't attempt to track the evolution of phenomena in the real world (features), but rather of the objects that represent them. In other words, the NHNC1 does not monitor real changes in the territory; only the *effects* they have on the data. *National Vector Data – Change Management*[9] defines change management as precisely as possible.

[8] This document can be found in the Data section at http://www.geobase.ca/.
[9] This document can be found in the Data section at http://www.geobase.ca/.

References

1 Buehler, K. and McKee, L., The OpenGIS Guide, Third Edition, June 1998. http://www.opengis.org/techno/guide.htm

2 Muller, P.A**.** "Modélisation objet avec UML," Éditions Eyrolles, 1997, 421 p.