

# **Completeness of the Digital Chart of the World (DCW) database**

Sindre Langaas

**Project Report No. 2/1995**

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DCW & Data Quality



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## ABSTRACT

The first version of the Digital Chart of the World was released in 1992 in the Vector Product Format. Since then this unique public domain global GIS database of 1.7 GB has been translated into most major GIS formats, and distributed to several thousand GIS users world-wide.

Despite its usefulness, many users have discovered various types of imperfections in several of the coverages in the 16 different thematic layers included in the DCW database.

This report deals with the completeness quality aspect of the DCW. First, the meaning of this data quality characteristic is discussed from the perspectives of the US Spatial Data Transfer Standard (SDTS) and the European spatial data standard, the former under implementation and the latter currently under development.

The major part of the report summarises completeness information found in a 'grey' military report :

*Defense Mapping Agency. 1987. Product specifications for Operational Navigation Charts (Code: ONC) Scale 1:1,000,000. First edition 1981 and changes and amendments thereto. Product Specifications PS/1AB/120.*

using the SDTS definition of the completeness,

The completeness information is structured in tables, usually two for each DCW coverage. One table presents additional definition information, the other includes selection criteria and other mapping rules. The selection criteria elaborated in various degrees of detail reflect the initial purposes of the Operational Navigation Charts, which are the basis for the DCW. These were produced to support "medium altitude enroute navigation by dead reckoning visual pilotage, celestial, radar, and other electronic techniques" and "for operational planning, intelligence briefings, and preparation of visual cock-pit displays/ film strips essential to aerospace navigation of high-performance weapon systems."



# 1. INTRODUCTION

The Digital Chart of the World (DCW) was released in 1992. It has since become an invaluable data source for GIS users world-wide concerned with regional, continental and global applications, and in many cases also on the national level. There are mainly two factors explaining this:

- The DCW is a public domain database, readily available at a very low cost.  
In a period of increasing commercialisation and copy-right confinement in the use of GIS data the DCW has become a provocative exclamation mark!
- The DCW is the most comprehensive and consistent cartographic database at the global scale at a scale of 1:1,000,000

However, to many users' disappointments, the quality of the DCW data has not always met expectations. These, often vague, expectations have to a large extent been based upon limited and insufficient data quality information available for the DCW database. Complaints about the DCW data quality have often been centred upon positional accuracy, logical consistency and completeness issues. Please, refer to Smith (1995) on user experiences of the DCW.

This report addresses the issue of the data quality of the DCW. More specifically, the report will focus upon the data quality characteristic *completeness*. The decision to focus upon this data quality indicator is mainly determined by the considerable resource demands required to perform quantitative assessments of positional accuracy and logical consistency tests for huge GIS databases, such as the DCW. Completeness can also be evaluated quantitatively, however, qualitative reports are also allowed (and recommended) in some standards. With the availability of a truly 'grey' document providing highly relevant completeness information, this focus becomes logical.

First, a very brief introduction to the Digital Chart of the World is given. Then, a small chapter deals with spatial data standards and their data quality components. The comprehension of completeness as defined and applied in the data quality portions of the US Spatial Data Transfer Standard (SDTS) and the European Standard under development under the framework of the European Committee of Standardisation (CEN) Technical Committee

287 are briefly reviewed. The two standards apply the same concept. Yet, it is argued that the two standards have different understanding of what this quality characteristic means and how to report or measure it.

The major part of the report provides extensive completeness information on the DCW data. In this report we apply the definitions and recommendations for quality reporting of completeness taken from SDTS. We consider these more suited for (thematic) cartographic databases such as the DCW. The completeness information is taken from the *Defense Mapping Agency. 1987. Product specifications for Operational Navigation Charts (Code: ONC) Scale 1:1,000,000. First edition 1981 and changes and amendments thereto. Product Specifications PS/1AB/120*. As the title announces, this document specifies how the Operational Navigation Charts shall be elaborated. Of particular interest for users of the DCW are the parts elaborating selection criteria, density requirements, detailed definitions and other mapping rules.

## 2. THE DIGITAL CHART OF THE WORLD

### 2.1 DCW Development

The development of the Digital Chart of the World is thoroughly described in DMA (1992a). For the sake of completeness a brief summary will be given here.

The DCW was developed by Environmental Systems Research Institute (ESRI) on commission for the United States Defense Mapping Agency to support global scientific and military analysis. To indicate the size of the DCW project, it can be noted that around 200 ESRI staff took part in the project, although several of these were only part-time involved. During the production peak fifty personnel worked full time. It should be noted also, that the main aim of the DCW project was to develop a generic, machine-independent format for GIS data that allows data prepared in accordance with it to be used by diverse software systems. This format, the Vector Product Format, will be used for the vector data products developed by DMA in the future. The VPF format is documented in DMA (1992b). With the simultaneous release of the unique global DCW database in the developed VPF format, the intent by DMA was to get as many commercial software vendors to develop conversion utilities to this specific format.

The agencies that produce the Operational Navigation Charts (ONC) map series: the United States Defense Mapping Agency, the Australian Army Survey Directorate, the Canadian Directorate of Geographic Operations, and the United Kingdom Military Survey all participated in the DCW development besides the ESRI staff. They were supported in the DCW design process by more than forty participating agencies.

The production procedures for the DCW database automation were developed during the design and prototyping phase. There some variation in the DCW production between layers, but in general the production process consisted of twelve steps:

1. Photographic reproduction of negative separates
2. Map preparation
3. Scanning and digitising
4. Basic processing and initial corrections
5. Attribute assignment
6. Annotation automation and final corrections
7. Transformations and edge matching

8. Tiling
9. Conversion to VPF
10. Premastering
11. Mastering
12. Packaging

## **2.2 Data Organisation**

The Digital Chart of the World (DCW) is a comprehensive 1:1,000,000-scale vector basemap of the world. The database contains more than 1,500 megabytes of vector data and is organised into 17 thematic layers including one Data Quality layer. These layers are found in chapter 6. The source data were 276 charts in the Operational Navigation Charts (ONC) and (for Antarctica) the Jet Navigation Chart (JNC) series (in scale 1:2,000,000). The Data Quality layer mainly comprise information on compilation and revision dates of the various charts.

The Digital Chart of the World (DCW) data are organised on a set of four CD-ROMs by geographic region. Each region is further geographically sub-divided into 5 deg. x 5 deg. tiles for each of the 17 layers and their coverages.

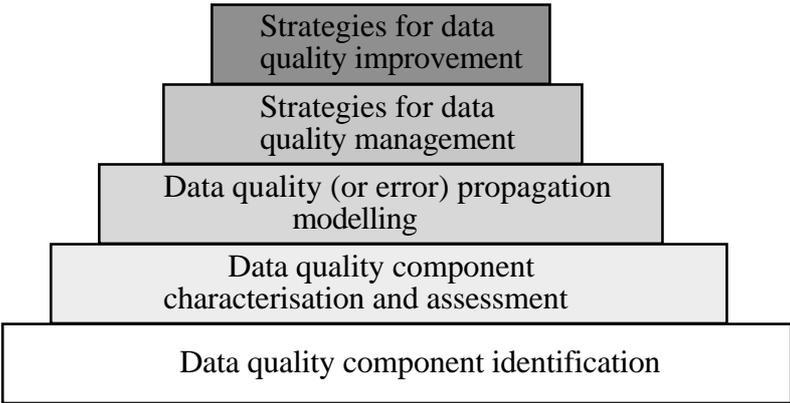
Besides the DCW as public domain data in the Vector Product Format (VPF), the DCW DB has now been released by a large number of GIS software vendors in their own propriety formats, such as ARC/INFO, MapInfo, Atlas and Intergraph formats.

# 3. SPATIAL DATA STANDARDS AND DATA QUALITY COMPONENTS

## 3.1 Spatial data standards

The need for data quality descriptions to be associated with digital georeferenced data has steadily grown over the past decades. The reason for this increasingly recognised need can be explained by the possibilities to readily use digital spatial data initially created for one specific purpose (by means of one or more types of primary data, specific methods and rules) for completely different applications and also for combing several layers into quite complex spatial models. Therefore, to apply spatial data sets, frequently received from other data producers such as mapping agencies, with confidence, there has been an increasing demand from the users to have data quality measures and reports attached to the georeferenced data. The producers themselves have also understood the advantage of having an active relationship to the quality issues of the data being produced to be able to reduce the error sources in the entire production process. Actually, the separation between spatial data producers and users are becoming more and more fuzzy as most users of spatial digital data also are producers,. For instance, those users who apply their input data in some analytical approach to derive a new GIS data set have inevitably become producers.

Figure 1, initially developed by Veregin (1989), provides a graphical overview of the hierarchy of needs for spatial data quality management.



*Figure 1. A hierarchy of needs for handling of spatial data quality. The caption text and concepts in this figure, based upon Veregin (1989), is modified according to more recent terminology.*

The identification of data quality component constitute the basis for all further actions within this hierarchy. The identification of data quality components have stayed central in the several developments of standards to facilitate transfer and use of spatial (i.e. cartographic and geographic) data (Moellering 1992). Most of these standards include data quality components. Some major standardisation efforts are DIGEST, the transfer format including conceptual schema, transfer schemas and encodings, developed under the framework of the NATO defence co-operation, the US Spatial Data Transfer Standard (SDTS, Fegeas *et al.* 1992) and the European standard currently under the development by the European Committee for Standardisation (CEN) Technical Committee 287 (CEN/TC287/WG02 1995). These standards, although quite similar in many respects, have significant differences. This can be explained by the fact that they have had their origin within different GIS producer and user communities. DIGEST obviously have had a bias towards military applications, SDTS have had the wider US GIS data community as its starting point and the European standard likewise.

Generic issues concerning geographic information and spatial data handling have a global nature. Therefore, an international effort co-ordinated by the International Organisation of Standardisation (ISO) started in 1994 (Østensen 1995). The scope is defined as:

*This work aims to establish a structured set of standards for information concerning objects or phenomena that are directly or indirectly associated with a location relative to the Earth....*

This work has just recently started. We will therefore probably have to wait until sometime into the next millennia before this more universal standard with a data quality part, enters into force.

### **3.2 Data quality components**

The data quality components defined by the various existing and planned standards vary. The current major standards, such as those mentioned earlier, have most quality components in common. Still, the definitions of the common quality components may vary, as well as the suggested means of reporting and measuring. Table 2.1 shows the data quality components in the US Spatial Data Transfer Standard (SDTS) and the European Standard

(CEN/TC287). Completeness is one such data quality component included in both the SDTS and the ongoing development of a European standard.

*Table 3.1 An overview of the data quality structure and characteristics for the US Spatial Data Transfer Standard (SDTS) and the European Standard (CEN/TC287)*

US Spatial Data Transfer Standard (SDTS)	European Standard (CEN/TC287)
<ul style="list-style-type: none"> <li>● Lineage</li> <li>● Positional accuracy</li> <li>● Attribute accuracy</li> <li>● Logical consistency</li> <li>● Completeness</li> </ul>	<ul style="list-style-type: none"> <li>● Lineage</li> <li>● Usage</li> <li>● Quality parameters                             <ul style="list-style-type: none"> <li>▪ Primary Parameters                                     <ul style="list-style-type: none"> <li>□ Positional Accuracy</li> <li>□ Thematic Accuracy</li> <li>□ Temporal Accuracy</li> <li>□ Completeness</li> <li>□ Logical Consistency</li> </ul> </li> <li>▪ Secondary Parameters                                     <ul style="list-style-type: none"> <li>□ Textual Fidelity</li> </ul> </li> </ul> </li> </ul>

The SDTS is currently being implemented by US federal spatial data producers. One main concern reported for those implementing SDTS is the question: What is a data set ? I.e. What shall be reported? Distinctions between 'databases', 'data sets', and 'data set members or extracts' are obscure. The judgement about reporting level in most cases will be determined by the priorities and resources available by the data producer.



## 4. COMPLETENESS REPORTING AND MEASURING - TWO DIFFERENT PERSPECTIVES

### 4.1 The SDTS perspective on completeness

The section in the SDTS that outlines the completeness reporting specifies that information on the following issues shall be given (NIST 1992) :

- Selection criteria
- Definitions used
- Other relevant mapping rules
- Deviations from standard geocoding of spatial entities

SDTS further states:

*"The report shall describe the relationship between the objects represented and the abstract universe of all such objects. In particular, the report shall describe the exhaustiveness of a set of features. Exhaustiveness concerns spatial and taxonomic (attribute) properties, both of which can be tested."*

Here the concept "abstract universe of all such objects" is a key concept which in each case needs an accurate definition to give the necessary information about the various completeness aspects.

The completeness quality aspect is of particular relevance for DCW. The deduction of the digital DCW was done from two analogue map series, the Operational Navigation Charts (ONC) and the Jet Navigational Charts (JNC); both with very specific thematic purposes, and both with a large number of rules for the making of the paper maps. In more general terms one can say that in the conventional production process for the making of most thematic analogue maps there exist a wide range of selection criteria, specific definitions and other mapping rules that convey information about the suitability of the digitised version also for other purposes than the initial thematic one.

Completeness reporting is of great value to potential users since it permits evaluation of the actual contents of the spatial database in question. It further allows for determination of the suitability of the data set, or any of its themes, features or objects for a given application. The quality reporting ideally therefore should be assigned to various levels of the data set.

SDTS distinguishes between the following levels:

- Data set
- Theme
- Map
- Feature/object
- Element

To clarify the difference between these levels, an example will be given.

An environmental researcher would like to use the DCW to quantify potential annual increase in methane (CH<sub>4</sub>) releases from *cranberry bogs* in Northern Finland under doubled atmospheric CO<sub>2</sub> levels and associated temperature rise. *Cranberry bog* is one class or feature under the layer Land Cover in the DCW.

Completeness descriptions on the entire data set level might be of limited relevance. However, the knowledge on the specific purposes of the ONC and JNC map series the analogue basis for the DCW; (i) aerial navigation and military strategic planning obviously indicates that the information contained on cranberry bogs might be unsatisfactory.

The next level of reporting is the theme level. Cranberry bog constitutes one class or features out of many in the theme (or layer) Land Cover of the DCW. A completeness description on the theme level, supposedly valid for the spatial extent of the entire data sets, then will provide more detailed information about the suitability for annual methane emissions.

The next level of reporting might be the feature/object level. If specific completeness information is available on the cranberry bogs *per se*, then the researcher would be even better prepared to evaluate the suitability of the DCW for its planned application.

Although not so relevant in this case, one might also find that completeness reporting down to the element level can be provided.

Depending upon the spatial coverage of the data set in question, the completeness reporting on the four levels; (i) data set, (ii) theme, (iii) feature/object and (iv) element ideally should be provided for specific regions. Individual map sheets in the ONC or JNC charts are an obvious sub-division of the entire data set region into smaller specific regions for reporting. Evidently, completeness reporting on cranberry bogs on the feature/object level for those map sheets that cover northern Finland would be the most specific and useful completeness reporting that could be provided.

## 4.2 The CEN/TC 287/WG02 perspective on completeness

In CEN/TC287/WG02 (1995) a quantitative approach is taken. Completeness is defined as

*'the difference between an actual data set and its specifications.'*

It is further stated that completeness measures indicate how well the information reflects the content defined by the specification. The specification is of the so-called nominal ground (or abstract view of universe) which is defined as an idealised abstraction of reality forming the basis for specifications defining how a geographic data set or extract relates to reality. This means that 'completeness' is differently defined compared to the SDTS definition since the European standard then presumes that the selection criteria, definitions used and other relevant mapping rules already are incorporated in the specification.

Three possible measures are suggested to quantify completeness. These are omission, commission and coverage ratio, represented by the following metrics:

- Percentage of data missing relative to specification,
- Percentage of data present that is not in current specification of data set or extract, and
- Occurrences of one variable per unit of another.

The CEN/TC287/WG02 assessment approach is more concise compared to SDTS. However, given its definition and recommended approaches of assessments, being solely quantitative, the precise specifications of the geographic data set examined or an extract of it defined as a subset of a geographic data set, limited by some criterion such as spatial extent, feature class, time given in quantitative terms are crucial for implementation. Furthermore, while the recommended approaches appear well suited for geographical data sets (or databases), they are more difficult to implement for cartographical data sets.

### **4.3 Choice of completeness reporting approach**

The DCW is a cartographical database derived (mainly) from the ONC charts. Due to this fact we find the SDTS recommended ways of completeness reporting more appropriate for the DCW. Further, as stated in the Introduction chapter, the considerable resource demands required to perform quantitative assessments of positional accuracy and logical consistency tests for huge GIS databases, such as the DCW, effectively prevents comprehensive quantitative assessments.

## 5. SOURCE ON COMPLETENESS INFORMATION ABOUT THE ONC/DCW

The major source for information on completeness aspects of the DCW is the "Product Specifications for Operational Navigation Charts (Code: ONC) Scale 1:1,000,000, third edition December 1981 and amendments and changes thereto" (DMA 1987). As specified under its foreword:

*"The specifications are the basic instructions for the compilation, color separation and reproduction of One's over major land masses of the world except conterminous USA, Alaska and Hawaii."*

*"Conformance to these specifications will ensure uniformity of treatment among all mapping and charting elements engaged in a coordinated production and maintenance program for these charts."*

In the tables 6.1 - 6.32 we have structured and summarised the information on feature/object definitions, selection criteria and other mapping rules provided in DMA (1987). This information is much more comprehensive than the limited information provided in ESRI (1992) or DMA (1992b), at the hands of most DCW users. The tables follow the organisation of the themes (layers) in the DCW. This organisation is in many ways similar to the organisation found in DMA (1987). Still, several significant differences occur since the ONC is an analogue map (chart) series and the DCW is a digital representation of the ONC (and JNC). The DCW data model is tailored to other needs and therefore structured differently.

In the tables we have chosen to follow the structure of the ARC/INFO DCW documentation as given in Part 3, layer descriptions, in ESRI (1992). This is very similar to the data dictionary appendix provided in DMA (1992b)

For each coverage under each layer generally two tables are provided; one giving additional definition information and another giving selection and density criteria and other mapping rules.



## 6. DCW DATA LAYER COMPLETENESS REPORTS

### 6.1 General introduction

This chapter includes information extracted from *Defense Mapping Agency. 1987. Product specifications for Operational Navigation Charts (Code: ONC) Scale 1:1,000,000. First edition January 1981 and changes and amendments thereto. PS/1AB/120.*

We had great difficulties in tracking this truly grey document, which definitively includes much useful information for DCW users. Furthermore, the differences in the ways that the product specification for the ONC and the DCW are structured justify the extraction and structuring of relevant completeness information according to the DCW data model structure.

### 6.2 ONC Usage

DMA (1987) includes some information on the intended usage of the ONC charts. We therefore include the most relevant sections describing these:

*“Purpose and Scope.*

*The 1:1,000,000 scale Operational Navigation Charts (ONC) Program provides aeronautical charts to support medium altitude enroute navigation by dead reckoning visual pilotage, celestial, radar, and other electronic techniques. In the absence of Tactical Pilot Charts (TPC’s), these charts should also satisfy the enroute visual/radar navigation requirements of pilots/navigators flying low altitude operations (500 feet to 2000 feet above ground level). The ONC is also used for operational planning, intelligence briefings, and preparation of visual cock-pit displays/ film strips essential to aerospace navigation of high-performance weapon systems.”*

### 6.3 ONC Overall Quality Standards, Detail Selection and Density

DMA (1987) include both general and more feature specific guidelines regarding quality standards, detail selection and density. The two most relevant sections for the overall information on these issues are included in their entirety.

*“103. Quality Standards*

*A. Although specifications tend to be a concrete expression of design, there are certain design features (particularly the selection and density of detail) which are sufficiently abstract as to preclude mathematical analysis. In these instances when a specification cannot be measured, certain criteria or design guidelines have been included to supplement the judgement of the cartographer. An attempt has been made, however, to minimize the amount of interpretation necessary in following these specifications.*

*B. The compilation is the foundation of the chart. The published chart can be no more accurate than the compilation, nor can it contain more information than is incorporated in*

*the compilation. A large part of the responsibility in preparing a satisfactory chart, therefore, rests squarely upon the compiler.*

*..”*

#### *“105. Detail selection and Density*

##### *A. General*

*Rigid rules to satisfy requirements in the selection and density of chart detail cannot be formulated in view of the multiple requirements. For this reason, the finished product may not necessarily represent optimum presentation of each chart feature; however, the selection criteria detailed in this section should serve as general guidance in achieving the best overall balance and relativity of the chart features portrayed. The compiler should bear in mind that aeronautical and vertical data are the most important information on this series of charts.*

##### *B. Basic Selection Criteria*

*1. The following basic rules governing the selection of detail should be kept in mind by the compiler.*

*a. A firm requirement exists to provide maximum density of ground features significant in VISUAL and RADAR low altitude-high speed navigation without impairing chart legibility.*

*b. Features validly selected for portrayal in one area may well be inappropriate in another area. In areas of sparse or moderate culture the lesser chart features assume extreme importance because of their checkpoint value. In congested areas these same features would not be seen by the low altitude-high speed pilot and normally should not be shown.*

*c. Cultural features that are so unique and outstanding that they serve as a medium for instantaneous orientation of the chart to the ground shall be shown as landmark features.*

*d. The visual outline of a populated place, in itself, is not necessarily landmark significant. Checkpoint features in the near vicinity are required to assure positive identification.*

*e. Roads and railroads by themselves are not necessarily significant to the low altitude-high speed pilot. Their identification value can be assured only by the inclusion of related features in the immediate vicinity which distinguish one from the other.*

*f. When the maximum feasible density is exceeded, the order of elimination will be as follows:*

*(1) Canal names, minor geographic names and small town names*

*(2) Tracks and trails symbolized as secondary roads*

*(3) Fingerling Streams*

*(4) Single line streams*

*(5) Other secondary roads lacking identifying characteristics*

*(6) Miscellaneous cultural features lacking visual or radar return value*

*(7) Descriptive words used to clarify symbols*

*...”*

## 6.4 Completeness information on individual DCW layers

### 6.4.1 Political and Oceans layer

Table 1. Coverage: PONENT, Feature class: Line, Item: POLNTYPE - Additional definition information

Code	Item class / Definitions in ESRI (1992)	Additional definition information in DMA (1987)
1	International boundary, Dejure	"De jure international boundaries separate sovereign states and are formally recognized by the producing nation."
2	International boundary, Defacto	"De facto boundaries are those which exist in fact but are not recognized by the producing nation."
3	Both 1 and 2	"In cases where a boundary is recognized by the producing nation insofar as one country is concerned (de jure) but is de facto insofar as the adjoining country is concerned, this boundary shall be portrayed by both the de jure and de facto boundary symbols."
4	Administrative boundary, first order	"Primary administrative boundaries demarcate states, provinces, or similar first-order administrative entities."
5	Administrative boundary, second order	No reference to "second order boundaries" is found. It is probably what is called Major administrative boundaries. "Major administrative boundaries are boundaries such as those dividing the territorial units of the United Kingdom"
6	Treaty or occupancy line (demilitarised zones)	"These boundaries designate treaty areas, divide administrative areas of occupation, show demilitarized zones and similar areas, and represent military demarcation lines."
7	Coastal closure line (used to connect ocean shoreline across river mouths and glacier)	
8	Ocean demarcation line (used to separate oceanic sub-areas)	
9	Ice line (used to separate types of ice - see Figure 3-2 in ESRI (1992))	
10	Coastline	Shorelines: "In tidal waters, shorelines shall be delineated as the outline of natural coastal features at mean high water except for mangrove, nipa and coastal marsh. In inland waters, shorelines shall be mapped to correspond to the normal stage of the water. This may differ from shorelines appearing on aerial photography which may have been taken during periods of flood or drought. The shoreline at normal state is usually marked by a line of permanent land vegetation"

11	Ice/Water line	
12	Seawall	
13	International Date Line	
88	Connector (if needed)	
99	None or unknown ( used for module border)	

Table 2. Coverage: PONENT, Feature class: Line, Item: POLNTYPE - Selection criteria and other mapping rules

Code	Item class / Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	International boundary, Dejure	
2	International boundary, Defacto	
3	Both 1 and 2	
4	Administrative boundary, first order	"They shall be used only in Australia, Brazil, Canada, United States and the USSR." "Boundaries of small entities may be omitted if they become confusing or tend to congest the chart."
5	Administrative boundary, second order	"Major administrative boundaries are boundaries such as those dividing the territorial units of United Kingdom"
6	Treaty or occupancy line (demilitarised zones)	
7	Coastal closure line (used to connect ocean shoreline across river mouths and glacier)	
8	Ocean demarcation line (used to separate oceanic sub-areas)	
9	Ice line (used to separate types of ice - see Figure 3-2 in ESRI (1992))	
10	Coastline	
11	Ice/Water line	"..Where the glacier extends into ice or open water areas, the delineating line shall replace the shoreline."
12	Seawall	"The coast line shall be omitted where it coincides with the sea wall symbol."
13	International Date Line	
88	Connector (if needed)	
99	None or unknown ( used for module border)	

## 6.4.2 Populated Place layer

Table 3. Coverage: PPPOLY, Feature class: Polygon, Item: PPPYTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Built-up area	The term Populated Place is used throughout DMA (1987). "The term POPULATED PLACE is interpreted to include: cities, towns, villages, settlements, industrial and military areas, resort areas and communal farms. Populated places may vary in size from an extensive megalopolis to a small hamlet." "Classification of a city by population is of little significance in itself. The significance lies in a cities vertical build-up, mass, shape etc., and its association with related features in close proximity."
2	Kampongs (Small villages or group of houses, especially in South-East Asia)	
9	None (Non-built up areas within built-up areas)	

Table 4. Coverage: PPPOLY, Feature class: Polygon, Item: PPPYTYPE - Selection criteria and other mapping rules

Code	Item class / Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Built-up area	<p>"It must be emphasized that small towns and villages assume extreme importance in this series of charts. A pre-flight course is plotted along the route of least habitation in order to avoid detection. Therefore, omission of towns and villages in sparse cultural areas could conceivably compromise the mission through ground observer detection, and could disorient the pilot or navigator."</p> <p>"702. Density and Selection</p> <p>A. The following general rules are formulated to govern the selection of populated places.</p> <ol style="list-style-type: none"> <li>1. In areas where populated places are very numerous, a selection of cities, towns and villages shall be shown to a density commensurate with scale.</li> <li>2. In areas where populated places are generally sparse, cities, towns and villages shall be shown to a density comparable to the density on a standard 1:500,000 scale map of the area.</li> </ol> <p>B. The compiler shall be guided by the following considerations when it is necessary to omit populated places in order to improve legibility or avoid congestion.</p> <ol style="list-style-type: none"> <li>1. Cities symbolized by an outline shall be portrayed short of over congestion.</li> <li>2. The smaller populated places, shown by symbol, shall be omitted in local areas when it tend to confuse, congest or de-emphasize checkpoints of radar and visual significance based on the following concepts. <ol style="list-style-type: none"> <li>a. The general outline of a concentrated area of villages and towns shall be retained. The "cluster" is significant. Individual villages within the cluster (unless distinctive) are not readily identified by a high speed pilot.</li> <li>b. Villages which, in the opinion of the compiler, have the least radar and visual significance in low altitude-high speed navigation may be omitted. I.e.: lack of building concentration, buildings obscured by vegetation, etc.</li> <li>c. In areas where the majority of cities are of sufficient size to warrant portrayal by their actual outline, the need for portrayal of villages is considerably lessened. Conversely, where few outlined cities occur, the need to portray smaller populated places increases proportionally.</li> </ol> </li> </ol>
1	Built-up area (cont'd)	<p>703. Classification</p> <p>A. The relative importance of populated places shall be determined from a regional aspect."</p> <p>"When adequate source material is available, all populated places which cover an area equivalent to a 1.5mm square or larger shall be shown by visual outline. " "Populated places smaller than an area equivalent to a 1.5mm should be shown by outline when the outlined area, because of unique shape, has checkpoint value. In these instances the outlined area may be enlarged slightly in order to portray the feature adequately."</p> <p>"Certain areas of the world, such as portions of India, contain a dense rural population living in small villages or on individual farms in close proximity to one another. When portrayal as cities, town or villages is not appropriate (due to poorly defined limits), these populated places shall be labeled: "continuous habitations", "scattered buildings". etc."</p>

2	Kampongs (Small villages or group of houses, especially in South-East Asia)	"Kampongs portrayed on source material shall be shown on the chart when they exceed 2.0mm minimum width and 5.0mm minimum length or equivalent area at the scale of the chart.
9	None (Non-built up areas within built-up areas)	"Openings within city area shall be shown when they are equivalent to a square 2.5mm at 1:1,000,000 scale."

Table 5. Coverage: PPPOINT, Feature class: Point, Item: PPPTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Populated places (no sub-categories)	"The term Populated Place is interpreted to include: cities, towns, villages, settlements, industrial and military areas, resort areas and communal farms. Populated places may vary in size from an extensive megalopolis to a small hamlet." "Classification of a city by population is of little significance in itself. The significance lies in a cities vertical build-up, mass, shape etc., and its association with related features in close proximity."
2	Populated places (associated with place names in city tints)	
3	Villages, strategic, or landmark places in conjunction with marginal note.	
4	Kampongs (Small villages or group of houses, especially in South-East Asia)	
5	Circular village	Not in ONC Product specifications, but found on ONC sheet G-4

*Table 6. Coverage: PPOINT, Feature class: Point, Item: PPTTYPE - Selection criteria and other mapping rules*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Selection criteria and other mapping rules in DMA (1987)</b>
1	Populated places (no sub-categories)	See Item class Built-up area under Coverage PPPOLY
2	Populated places (associated with place names in city tints)	
3	Villages, strategic, or landmark places in conjunction with marginal note.	
4	Kampongs (Small villages or group of houses, especially in South-East Asia)	See Item class Kampong under Coverage PPPOLY
5	Circular village	

### 6.4.3 Railroad layer

Table 7. Coverage: RRLINE, Feature class: Line, Item: RRLNTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Single railroad lines*.	"..a railroad is any type of reasonably permanent road or way having rails which provide a track for trains of rolling stock, either passenger or freight."
2	Multiple railroad lines* *All railroads shown on the ONCs are included in these categories, including lines annotated or symbolized as electric, in-street; in juxtaposition, non-operating, approximate alignment. existence doubtful, sidings and short spurs, overpass, and underpass	"Double Track - Two parallel tracks of the same line, designed to carry trains in opposite directions." "Multiple tracks - Three or more parallel tracks of the same line."
3	Light railroads, including carlines, tramways and similar light-load-bearing railways	"Any type of permanent road or way which carries rails serving as a light passenger car track and connecting two or more urban areas. The cars, which can travel as single units, are self-propelled by electricity."
8	Connectors	

Table 8. Coverage: RRLINE, Feature class: Line, Item: RRLNTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Single railroad lines*.	"All main line railroads shall be shown except where elimination is necessary in congested areas. All other railroads shall be portrayed to the maximum extent compatible with the scale of the chart and operational legibility requirements. In areas of congestion, preference should be given to display multiple track railroads over single lines and spurs. All railroads shall be shown in areas of sparse detail. In areas of very dense cultural detail, those operating railroads which would cause undue congestion, and thus negate operational requirements for a legible chart, shall not be shown. This includes nonoperating railroads, dismantled railroads, railroads with approximate alignment or whose existence is doubtful and those which: a. Lend little or no visual significance to the overall pattern. b. Are considered unimportant in regard to visual prominence."
2	Multiple railroad lines*	See above.
3	Light railroads, including carlines, tramways and similar light-load-bearing railways	"Carlines (interurban and street), tramways and similar light-load-bearing railways shall not be shown except when considered significant as checkpoints in areas of sparse or moderate detail."
8	Connectors	

\*All railroads shown on the ONCs are included in these categories, including lines annotated or symbolized as electric, in-street; in juxtaposition, non-operating, approximate alignment. existence doubtful, sidings and short spurs, overpass, and underpass 6.4.4 Road layer

Table 9. Coverage: RDLINE, Feature class: Line, Item: RDLNTYPE - Additional definition information

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Additional definition information in DMA (1987)</b>
1	Dual lane (divided) roads*.	"Dual line (divided) highways. Hard surface, all weather (primary) roads separated by a parkway, median or barrier between the two directions of travel."
2	Primary or secondary roads* *Included in these categories are roads symbolized or annotated on the ONCs as the following: under construction, approximate alignment, existence doubtful, railroad in road, and cloverleaf	"Primary roads. Hard surface, all weather roads two or more lanes in width maintained for automobile traffic. Secondary roads. All other roads maintained for automobile traffic."
3	Tracks, trails or footpaths	Not in the ONC Product Specifications, but is present on some ONC sheets.
8	Connectors (inserted by ESRI to connect breaks on the source maps).	

Table 10. Coverage: RDLINE, Feature class: Line, Item: RDLNTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Dual lane (divided) roads*.	<p>Generally:                      "The number of roads to be shown in an area is dependent upon the number of significant checkpoints available. Roads are shown for their radar as well as their visual value.                      In heavily populated areas roads should be selected which, in conjunction with other cultural and natural features, form a distinct configuration providing significant checkpoint identification.                      In open areas containing few checkpoints, the road pattern assumes a greater importance and additional roads shall be selected when their relationship with other roads serve as a visual checkpoint or as an aid in identifying a checkpoint."                      "Dual lane (divided) highways shall always be shown."</p>
2	<p>Primary or secondary roads*                      *Included in these categories are roads symbolized or annotated on the ONCs as the following: under construction, approximate alignment, existence doubtful, railroad in road, and cloverleaf</p>	<p>"Primary roads shall be shown wherever space will permit, short of overcongestion."                      "When it is necessary to make a selection of primary roads in areas of dense cultural detail, those primary roads which form a distinct configuration, or provide a significant checkpoint in conjunction with distinctive natural or cultural detail in the immediate vicinity shall be retained." "Secondary shall be shown when they do not cause clutter. These roads assume significance in open areas containing few checkpoints or primary roads. Selection should be based on those which form a distinct configuration, or provide significant checkpoint in conjunction with distinctive natural or cultural detail in the immediate vicinity."</p>
3	Tracks, trails or footpaths	<p>"No routes will be classified as tracks or trails. Normally this category includes those routes that are not maintained for automobile traffic. If shown, they will be classified as secondary."                      "Trails should normally be shown only in areas where few roads exist."</p>
8	Connectors (inserted by ESRI to connect breaks on the source maps).	

### 6.4.5 Utility layer

Note: No additional definition information was found for Coverage: UTLINE, Feature class: Line, Item: UTLNTYPE

*Table 11. Coverage: UTLINE, Feature class: Line, Item: UTLNTYPE - Selection criteria and other mapping rules*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Selection criteria and other mapping rules in DMA (1987)</b>
1	Power transmission lines	"Power transmission lines, because of their excellent radar return value, shall be shown on the chart to a density short of over-congestion in open areas. (Do not show in populated places)."
2	Telephone or telegraph lines	"Telephone and telegraph lines shall be shown only when found in open country for their landmark value."
3	Above ground pipelines	"Pipelines for gas, oil, etc., whether above or below ground, shall be shown and appropriately labeled only when they serve as landmarks in areas of sparse or moderate culture. They shall be omitted in developed areas." "No effort should be made to show pipelines as continuous features; only landmark portions need be shown."
4	Underground pipelines	See above.

## 6.4.6 Drainage layer

Table 12. Coverage: DNNET, Feature class: Polygon, Item: DNPYTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Perennial inland water. Includes perennial lakes and streams, unsurveyed perennial streams, all reservoirs, and navigable canals.	“...The permanent or temporary nature of the water within the feature as lake, stream, swamp, well,, etc. dependent upon flow and depth, natural or man-made within the feature establishes its classification within its type as PERENNIAL OR NON-PERENNIAL. A feature is normally PERENNIAL when it contains water throughout the major part of the each year. If it contains water for a lesser period it is considered NON-PERENNIAL. This latter category includes all features that may normally be found classified on source material as either intermittent or dry.” “A navigable canal is one that is used by commercial craft operating in that specific area. “
2	Nonperennial inland water. Includes nonperennial and seasonally fluctuating lakes and streams, wadis, sabkhas, and abandoned navigable canals.	See above. "Non-Perennial Streams. This category includes all features normally classified on source material in such descriptive terms as "dry," "intermittent," "dry wash," "dry riverbed," "wadi," "gulch," and "arroyo." "Wadi. A wadi is a natural channel or bed of a watercourse which is dry except in the rainy season. It is similar in appearance to a dry wash or dry riverbed."
2	Nonperennial inland water. Includes nonperennial and seasonally fluctuating lakes and streams, wadis, sabkhas, and abandoned navigable canals.(cont'd)	"Sebkhas. A sebkha is a natural depression whose bed may be covered with sand or mud. It is often salt encrusted and marshy after a rain. Depending upon the degree of wetness, it may contain more or less scattered marshlike growths. In aerial photography, sebkhas show up very clearly as depressions (with a definite outline), darker than the surrounding sand."
3	Wet sand. Includes wet sand and sand deposits in and along riverbeds.	
4	Snowfields, glaciers, ice fields, or ice caps.	
9	None (used for background and for islands within inland water)	



Table 13. Coverage: DNNET, Feature class: Polygon, Item: DNPYTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Perennial inland water. Includes perennial lakes and streams, unsurveyed perennial streams, all reservoirs, and navigable canals.	<p>“All perennial lakes and reservoirs which can be shown by outline and tint at this scale shall normally be shown. In areas where lakes are a major characteristics of the landscape such as Finland, Canada and Northern Russia, it is permissible to omit the less prominent , provided a representative pattern of the principal drainage features is retained.”</p> <p>"Streams measuring more than 0.4mm in overall width shall be shown as double line streams."</p> <p>“Canals shall be shown where they will aid pilotage or are common to an area.”</p> <p>“In areas where the canals are too numerous to delineate, the symbol shall be omitted and the words “numerous canals” placed in the area.”</p>
2	Nonperennial inland water. Includes nonperennial and seasonally fluctuating lakes and streams, wadis, sabkhas, and abandoned navigable canals.	<p>“In arid countries non-perennial streams shall be shown wherever they exist insofar as scale permits. Wherever, the perennial drainage is heavy, their importance is minor and only those whose size or configuration makes them important landmarks shall be shown.”</p> <p>“Non-perennial streams which in flood measure 1.3mm or more in width shall be shown by the double line symbol and dot fill. “</p>
3	Wet sand. Includes wet sand and sand deposits in and along riverbeds.	<p>“Sand Deposits.</p> <p>Sand deposits in and along riverbeds shall be shown when information is available on source material.</p> <p>Wet Sand Areas.</p> <p>Areas of wet sand shall be shown when they are of landmark significance, or necessary to preserve the characteristic pattern of an area, especially within and adjacent to desert areas.”</p>
4	Snowfields, glaciers, ice fields, or ice caps.	
9	None (used for background and for islands within inland water)	

Table 14. Coverage: DNNET, Feature class: Line, Item: DNLNTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Streams, rivers, channelized rivers	"A navigable canal is one that is used by commercial craft operating in that specific area." "Non-perennial streams include all features normally classified on source material in such descriptive terms as "dry," "intermittent," "dry wash," "dry riverbed," "wadi," "gulch," and arroyo".
2	Inland shorelines	"302. Shorelines. ... F. Two tones of blue will be used to distinguish water areas identified as "Open Water" and "Inland Open Water". 1. "Open Water" is defined as the limits (shorelines) of all coastal features at mean high water for oceans, seas and associated waters such as bays, gulfs, sounds, fjords, large estuaries, etc. 2. "Inland Open Water is defined as all other bodies of open water".
3	Wet sand limits	
4	Canals, aqueducts, flumes, penstocks, kanats, or similar features (clearly identified by annotation).	"A conduit is an artificial channel carrying water for either supply, drainage, or industrial purposes. Conduits include aqueducts, pipelines, irrigation ditches or canals, drainage ditches or canals, flumes, penstocks and similar features. "Kanats (underground irrigation systems with air vents)"
5	Glacial limits	"Glaciers cannot be accurately contoured since they usually are slowly, but constantly, changing in shape. ... The delineating line shall be omitted at the heads of glaciers where they meet snow fields or ice fields. Where the glacier extends into ice or open water areas, the delineating line shall replace the shoreline
6	Snowfields, glaciers, or land ice to water ice or ocean limits	
7	Ice free limits (land/ice line)	
8	Connectors (used to separate inland water from open ocean or ocean ice). These lines were derived from the border between the shade for inland water (dark blue), and open ocean or ocean ice (light blue) on the ONC sheets.	"The open water tone will be extended inland as far as deemed necessary to achieve a butt-join to the "Inland Open Water" tone. (Generally where drainage line coalesce to a width of 2.5mm approximate.)"

9	Tile boundary	
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Table 15. Coverage: DNNET, Feature class: Line, Item: DNLNTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Streams, rivers, channelized rivers	<p>"Perennial streams shall be shown, scale permitting. In well watered areas, it shall be permissible to omit the shorter and less important branches. In arid areas, it is important to include as much as much of the drainage pattern as possible."</p> <p>"Streams measuring more than 0.4mm in overall width shall be shown as double line streams."</p> <p>"In arid countries non-perennial streams shall be shown wherever they exist insofar as scale permits. Wherever the perennial drainage is heavy, their importance is minor and only those whose size or configuration makes them important landmarks, shall be shown."</p> <p>"Non-perennial streams which in flood measure 1.3mm or more in width shall be shown by the double line symbol and dot fill."</p>
2	Inland shorelines	<p>"The shoreline of a perennial lake or pond shall be mapped to correspond to the normal stage of water as evidenced by reliable source data."</p> <p>"All perennial lakes and reservoirs which can be shown by outline and tint at this scale shall normally be shown. In areas where lakes are a major characteristics of the landscape such as in Finland, Canada and Northern Russia, it is permissible to omit the less prominent, provided a representative pattern of the principal drainage features is retained."</p> <p>"In areas where isolated groups of lakes or reservoirs occur which are significant because of their uniqueness in the area, as many as possible shall be shown including lakes or reservoirs symbolized as pin-points."</p>
3	Wet sand limits	

4	Canals, aqueducts, flumes, penstocks, kanats, or similar features (clearly identified by annotation).	<p>"Canals shall be shown where they will aid pilotage or are common to an area. ...In areas where the canals are too numerous to delineate, the symbol shall be omitted and the words "numerous canals" placed in the area."</p> <p>"The compiler shall show a representative pattern of main ditches and canals in an area, omitting the secondary ditches when not required to show the character of the area."</p> <p>"In areas where ditches and canals are too numerous to delineate, the symbol shall be omitted and words "numerous ditches" of "numerous canals and ditches" placed in the area."</p> <p>" Aqueducts and pipelines carrying water shall be symbolized alike. Only the important trunk lines shall be shown; small feeder lines to houses or small villages shall generally be omitted. Only the most important shall be named.</p> <p>..</p> <p>It is a common practice in aqueduct construction to build a conduit of brick or concrete on or near the surface of the ground and to cover the structure with an earth fill which resembles in cross section. The levee like feature shall not be indicated. The buried aqueduct shall be indicated by a dashed line."</p> <p>"Kanats shall be shown."</p> <p>"Flumes, penstocks and similar features shall be shown when they are significant as landmarks in low altitude-high speed flight."</p>
5	Glacial limits	
6	Snowfields, glaciers, or land ice to water ice or ocean limits	
7	Ice free limits (land/ice line)	
8	Connectors (used to separate inland water from open ocean or ocean ice). These lines were derived from the border between the shade for inland water (dark blue), and open ocean or ocean ice (light blue) on the ONC sheets.	
9	Tile boundary	

Note: No additional definition information was found for Coverage: DNPOINT, Feature class: Point, Item: DNPTYPE E

*Table 16. Coverage: DNPOINT, Feature class: Point, Item: DNPTYPE - Selection criteria and other mapping rules*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Selection criteria and other mapping rules in DMA (1987)</b>
1	Springs, wells, waterholes, or bores	“Areas will be encountered containing features which are either too numerous or too small to show to scale. Wells, springs and pin-point ponds fall in this category. No attempt should be made to show all these features. Instead, a representative pattern of the symbols shall be added to cover the area, augmented where appropriate by a descriptive note as: “numerous small ponds,” “numerous small lakes,” etc.
2	Small reservoir	“Reservoirs and pools which are too small to be shown by actual outline may be shown by the located object symbol and labeled “reservoir””.
3	Falls	“Falls and rapids shall be shown in uncongested areas when they have landmark value. Major falls and rapids shall always be shown. Label when necessary for clarity.”
4	Rapids	“Falls and rapids shall be shown in uncongested areas when they have landmark value. Major falls and rapids shall always be shown. Label when necessary for clarity.”
5	Locks	“Passable Locks, Sluice Gates and Small Locks. Important or landmark locks and sluice gates shall be shown.”
6	Dams	“ 1. All dams shall be shown except for the smaller dams in congested areas built across single line streams. 2. No distinction shall be made between masonry dams and earth dams or dams constructed of other material. 3. Where exaggeration in length is necessary to show a small dam, the symbol shall be drawn 1.3mm long...”
7	Sluice gate	“Passable Locks, Sluice Gates and Small Locks. Important or landmark locks and sluice gates shall be shown.”

### 6.4.7 Supplemental Drainage layer

Note: No additional definition information was found for Coverage: DSPOINT, Feature class: Point, Item: DSPTYPE

*Table 17. Coverage: DSPOINT, Feature class: Point, Item: DSPTYPE - Selection criteria and other mapping rules*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Selection criteria and other mapping rules in DMA (1987)</b>
1	Small lakes	<p>“In areas where isolated groups of lakes or reservoirs occur which are significant because of their uniqueness in the area, as many as possible shall be shown including lakes or reservoirs symbolized as pin-points.”</p> <p>“Isolated small lakes and ponds too small to plot to scale shall normally be omitted.”</p>
2	Small islands within inland water areas	<p>"When an island is too small to show actual shape, it shall be shown by a solid dot. Where islands tend to coalesce, only the most prominent shall be shown. The small (pin-point) islands which coalesce with other island or the coastline shall be omitted."</p>

### 6.4.8 Hypsography layer

Note: No particular definition information, selection criteria and other mapping rules were found that readily followed the DCW data organisation structure for:

- Coverage: HYPYTYPE, Feature class: Polygon, Item: HYPYTYPE
- Coverage: HYLNTYPE, Feature class: Line, Item: HYLNTYPE

*Table 18. Coverage: HYPOINT, Feature class: Point, Item: HYPTTYPE - Additional definition information*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Additional definition information in DMA (1987)</b>
1	Spot elevation	"A spot elevation is a designed location with a numerical value indicating the vertical distance of that location above or below mean sea level
2	Spot elevation, questionable elevation or doubtful location	
3	Elevation at the base of a tower	
4	Hydrographic elevation point	

Table 19. Coverage: HYPOINT, Feature class: Point, Item: HYPTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Spot elevation	<p>"An adequate pattern of spot elevations should be distributed throughout the various elevation levels including the highest points in each area and significant lower points. Both are required to allow for proper planning of low altitude mission"</p> <p>"Spot elevations shall not be shown indiscriminately on slopes, or in areas where they cannot be readily identified with a topographic or cultural feature."</p> <p>"B. Selection and Density.</p> <ol style="list-style-type: none"> <li>1. Relatively level areas (4° slope or less). Show a minimum of two spot elevations per 30 x 30 mile area. Depict all isolated changes in elevation greater than 500 feet.</li> <li>2. Rolling hills. Show a minimum of one spot elevation per 30 x 30 mile area. The highest (peak or top) elevations will always be shown.</li> <li>3. Mountainous areas. A network of spot elevations will be shown along mountain ridges. Spot elevations depicting peaks (highest elevations) shall be shown at not less than 30 mile intervals." </li></ol>
2	Spot elevation, questionable elevation or doubtful location	
3	Elevation at the base of a tower	
4	Hydrographic elevation point	<p>"Elevations of the larger lakes in the area shall be shown when this information is available. This should normally include all lakes that are 4 by 6 miles or larger and may include smaller lakes in order to retain a representative pattern of water surface elevations in an area devoid of large lakes.</p> <p>Stream elevations shall be shown in level areas that are inadequately portrayed by elevation or contour data. Elevations shall be shown only on the major drains in an area and these should be no closer than 50 mile intervals."</p>

#### **6.4.9 Hypsography Supplemental layer**

Note: No particular definition information, selection criteria and other mapping rules were found that readily followed the DCW data organisation structure for:

- Coverage: HSLINE, Feature class: Line, Item: HSLNTYPE

### 6.4.10 Land Cover layer

Table 20. Coverage: LCPOLY, Feature class: Polygon, Item: LCPYTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
	<i>Agriculture/Extraction Features</i>	
1	Rice fields *	
2	Cranberry bogs	
3	Cultivated areas, gardens	
4	Peat cuttings *	
5	Salt pans	
6	Fish ponds/hatcheries	
7	Quarries, strip mines, mine dumps, and blasting areas	
8	Oil/gas	
	<i>Surface cover features</i>	
10	Lava flows	
11	Distorted surface areas	"Distorted surface areas, i.e. rocky areas, stratified rock outcrop and lava"
12	Unconsolidated materials, include the following kinds of areas: Glacial moraines Foreshore flats Sand or gravel areas Sand ridges Sand dunes	Foreshore Flats: "Foreshore. The foreshore is defined as being that area between high water shoreline and the low water shoreline, or any area along the coast that covers at high tide and uncovers at low tide. The extent of the foreshore area will depend upon the amount of tidal fluctuation and the slope of the shore. In non-tidal waters, the horizontal extent of the foreshore area is too small to plot even on a large scale chart."
13	Natural landmark areas	
14	Inundated areas	
15	Undifferentiated wetlands, including the following kinds of areas: Swamps, marshes and bogs Hummocks and ridges Mangroves and nipa Peat bogs	
	<i>Applies to layer in general</i>	

99	None (Uncoded areas, e.g., areas within lava flows that are not assigned another land cover code)	
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Table 21. Coverage: LCPOLY, Feature class: Polygon, Item: LCPYTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
	<i>Agriculture/Extraction Features</i>	
1	Rice fields *	"Rice fields, cranberry bogs and "similar flooded areas" shall be shown only when they are very unique or distinctive features in areas devoid of landmark detail"
2	Cranberry bogs	See above
3	Cultivated areas, gardens	"Unusual Landmark Areas. Sometimes in regions of sparse culture, generally devoid of landmarks, an area may exist which is so different in appearance from the surrounding terrain that it serves as an outstanding landmark.....Examples of such unique areas are:.....; cultivated areas in located in extensive uncultivated areas."
4	Peat cuttings *	"Peat bogs shall be symbolized the same as swamps and marches except that they shall be labeled "peat bog". Peat cuttings shall be indicated by the outline and labeled "peat cuttings" if they are large enough to plot to scale."
5	Salt pans	"Features such as salt pans and salt evaporators, sewage disposal beds and filtration beds shall be shown where they are considered significant as landmarks."
6	Fish ponds/hatcheries	"Fish Ponds and Hatcheries The outlines and major separations of these features shall be drawn to scale or by a single line when too small to plot to scale. When all divisions cannot be shown, a selection shall be made of the major divisions to give a representative pattern of the area. These features shall be appropriately labeled when necessary for clarity."
7	Quarries, strip mines, mine dumps, and blasting areas	"The following "Area Relief Features", which are not indicated by contouring, shall be shown by appropriate symbolization wherever such area are considered important to area identification: .... 6. Quarries to scale 7. Strip mines, mine dumps, and tailings to scale."
8	Oil/gas	"Unusual Landmark Areas. Sometimes in regions of sparse culture, generally devoid of landmarks, an area may exist which is so different in appearance from the surrounding terrain that it serves as an outstanding landmark.."
	<i>Surface cover features</i>	

10	Lava flows	"The following "Area Relief Features", which are not indicated by contouring, shall be shown by appropriate symbolization wherever such area are considered important to area identification: .... 2. Lava flows."
11	Distorted surface areas	"The following "Area Relief Features", which are not indicated by contouring, shall be shown by appropriate symbolization wherever such area are considered important to area identification: .... 1. Distorted surface areas, i.e. rocky areas, stratified rock outcrop and lava"
12	Unconsolidated materials, include the following kinds of areas: Glacial moraines Foreshore flats Sand or gravel areas Sand ridges Sand dunes	Glacial moraines: "Glacial moraines shall be shown when they have landmark value". Foreshore flats: "Foreshore Flats. Tidal flats (flats that cover and uncover with the tide) shall be shown when they are large enough to plot to scale." Sand or gravel areas; Sand ridges; Sand dunes: "The following "Area Relief Features", which are not indicated by contouring, shall be shown by appropriate symbolization wherever such area are considered important to area identification: .... 3. Sand or gravel areas 4. Sand ridges 5. Sand dunes"
13	Natural landmark areas	"Unusual Landmark Areas. Sometimes in regions of sparse culture, generally devoid of landmarks, an area may exist which is so different in appearance from the surrounding terrain that it serves as an outstanding landmark.....Examples of such unique areas are: areas of stunted growth in deserts; areas of dark soil surrounded by light soil..."
14	Inundated areas	"Land Subject to Inundation. Areas that have become permanently and distinctively marked due to frequent inundation by floods shall be shown by the flood marked symbol without delineating boundaries. Areas of general floods and overflows or those that are so vast that they have no significance shall not be shown."
		"Swamps and Marshes A. The compiler shall normally show all marshes and swamps which are equivalent to or exceed an area of 7.6mm (.3inch) square. Conversely, clearings in such areas of less than equivalent size shall usually be omitted. B. Marsh and vegetation shall be mapped separately in accordance with instructions for each.

15	<p>Undifferentiated wetlands, including the following kinds of areas:          Swamps, marshes and bogs          Hummocks and ridges          Mangroves and nipa          Peat bogs</p>	<p>C. No distinction shall be made between fresh and salt marshes.          D. Land subject to inundation shall not be regarded as marshland.          E. Marshes occurring within the limits of inland bodies of water shall be shown by the marsh symbol in the open water.          F. Coastal marsh occurring in tidal waters differ from ordinary marsh in that it covers and uncovers with the tide. For purposes of mapping, it shall be regarded as a land feature rather than as a water feature even though it physically falls within the foreshore area. It shall be treated as ordinary marsh with the shoreline defining its seaside limits.          G. Mangrove and nipa shall be shown with the swamp symbol and appropriately labeled. The wooded area symbolization shall be added when woods occur within the mangrove and nipa in those areas of the world where vegetation is required.          H. Peat bogs shall be symbolized the same as swamps and marshes except that they shall be labeled "peat bog". Peat cuttings shall be indicated by outline and labeled "peat cuttings" if they are large enough to plot to scale..          I. Swamps and marshes occurring in the permafrost areas of the world shall not be shown with the swamp symbol. The nature of the terrain shall merely be indicated by labelling, i.e., "tundra".</p>
	<i>Applies to layer in general</i>	
99	None (Uncoded areas, e.g., areas within lava flows that are not assigned another land cover code)	

Note: No particular definition information were found that readily followed the DCW data organisation structure for:  
 Coverage: LCPOINT, Feature class: Polygon, Item: LCPTTYPE

*Table 22. Coverage: LCPOINT, Feature class: Polygon, Item: LCPTTYPE - Selection criteria and other mapping rules*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Selection criteria and other mapping rules in DMA (1987)</b>
1	Mines	"A. Mining features such as open pit mines, quarries, strip mines, tailings, etc., shall be shown in the absence of more prominent landmark features. Where two or three mines are situated close together a single symbol shall be sufficient to portray them. B. Small strip mines, mine dumps and tailings that cannot be portrayed to scale as illustrated in the symbols appendix shall be shown by the square located object symbol and appropriate label. C. Mining features considered too small for visual significance may be omitted."
2	Quarries, Strip mines, Mine dumps, and Blasting areas.	See above. Separation done by Annotation.
3	Miscellaneous land features (e.g., mountain names, caves, sink holes, basalt pinnacles)	

### 6.4.11 Ocean Features layer

Table 23. Coverage: OFLINE, Feature class: Line, Item: OFLNTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Miscellaneous ocean features	
2	Reefs	“316. F. Reefs, Coral and Rocky Ledges. Reefs are any area of coral or rock that is awash at low tide.....”
3	Maritime area limits	

Table 24. Coverage: OFLINE, Feature class: Line, Item: OFLNTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Miscellaneous ocean features	<p>“316. J. Unusual Hydrographic Features. As a rule, objects below the surface of the water shall not be shown. In exceptional cases, however, a dashed line shall be used to delineate unusual submerged features such as shoals and reefs which are visible from the air. The use of this symbol is recommended for large water expanses where they are often the only distinguishable features. Each feature shall be appropriately labeled. Extensive reefs below the low water datum may be shown for unusual under-water features.”</p> <p>“316. H. Sunken Rocks. A rock which is submerged at the sounding datum shall not be shown by the rock symbol. An isolated area of numerous submerged rocks which is visible from the air may be portrayed as an unusual under-water feature.”</p>
2	Reefs	<p>“...If the area of a reef or ledge is small or is generally submerged, the reef symbol shall be omitted and the rock symbol shall be used to symbolize actual protrusions.” <i>See also above.</i></p>
3	Maritime area limits	<p>“316. K. Maritime Limits. The maritime limits of features below the low water line such as cable areas, anchorages, swept areas, dredge dumps, etc., shall normally not be shown.”</p>

Note:

No particular definition information were found that readily followed the DCW data organisation structure for:

Coverage: OFPOINT, Feature class: Point, Item: OFPTTYPE

*Table 25. Coverage: OFPOINT, Feature class: Point, Item: OFPTTYPE - Selection criteria and other mapping rules*

<b>Code</b>	<b>Definition in ESRI (1992)</b>	<b>Selection criteria and other mapping rules in DMA (1987)</b>
1	Rocks, isolated or awash	“316. G. Rocks, Bare or Awash. Rocks, bare or awash shall be individually symbolized. In congested areas only the most prominent shall be shown. Very large rocks which are above mean water may be shown as islands. The elevation of prominent rocks shall be shown whenever this information is of sufficient importance.”
2	Exposed wrecks	“316. I. Wrecks Exposed or stranded wrecks having any portion of the hull exposed at the low water datum shall be shown if prominent enough to aid pilotage. The symbol shall be positioned to indicate direction and position of the wreck. Sunken wrecks shall not be shown.”

### 6.4.12 Physiography layer

Table 26. Coverage: PHLINE, Feature class: Line, Item: PHLNTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Levees*, dikes*, and eskers	
2	Rock strata outcrops	410. Area Relief Features. A. The following “Area Relief Features”, which are not indicated by contouring, shall be shown by appropriate symbolization wherever such areas are considered important to area identification: 1. Distorted surface areas, i.e.: rocky areas, stratified rock outcrop and lava.....”
3	Escarpments, bluffs, cliffs, etc. * <sup>1</sup>	
4	Faults	
5	Ice cliffs on land	
6	Crater	

\* May be coincident with railroads or roads

\*<sup>1</sup> Coincide with elevation contour lines. Annotation distinguishes types of features.

Table 27. Coverage: PHLINE, Feature class: Line, Item: PHLNTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Levees*, dikes*, and eskers	<p>“413. Levees. Prominent levees shall be shown by symbol. and shall be named or labeled when clarification is necessary.”</p> <p>“414. D. Eskers. Prominent eskers shall be shown in the same manner as levees and labeled “Esker” .”</p>
2	Rock strata outcrops	<p>“410. Area Relief Features. A. The following “Area Relief Features”, which are not indicated by contouring, shall be shown by appropriate symbolization wherever such areas are considered important to area identification: 1. Distorted surface areas, i.e.: rocky areas, stratified rock outcrop and lava.....”</p>
3	Escarpments, bluffs, cliffs, etc. * <sup>1</sup>	<p>“412. Escarpments, Bluffs, Cliffs, Depressions, Etc. Prominent features of this type shall be shown whenever they occur because of their landmark significance.”</p>
4	Faults	<p>“414. Miscellaneous Relief Features. B. Fault Scarps. Fault Scarps shall be symbolized by a carrying contour, connecting contours on each side of the fault.”</p>
5	Ice cliffs on land	<p>“315.F. Ice Cliffs. Ice cliffs that are prominent landmark features shall be shown.”</p>
6	Crater	<p>“414. Miscellaneous Relief Features. A. Crater. Prominent volcanoes and craters shall be shown, especially in areas of sparse culture. In absence of lava flow, descriptive note “crater” shall be carried.”</p>

\* May be coincident with railroads or roads

\*<sup>1</sup> Coincide with elevation contour lines. Annotation distinguishes types of features.

### 6.4.13 Aeronautical layer

The information provided in this layer was compiled using a combination of the ONCs and the U.S. Defense Mapping Agency Digital Aeronautical Flight Information File (DAFIF) (DMA 1992a). The location of airports was retained from the ONCs. The information on the ONCs concerning air traffic control zones and vertical obstructions was not included in the final database except for airports in the former Eastern Bloc nations. Therefore, the completeness information found for the item types found in coverage AEPOINT, item AEPTTYPE, is derived from the DAFIFs. However, when it concerns the overall selection rules, the DMA (1987) provides some information:

#### “1103. Aerodromes (Airfields)

##### A. Selection.

1. Judgements and discretion should be applied in portraying airfields in congested areas based on:
  - a. The number and significance of airfields in the area.
  - b. Availability of other checkpoints in the area.
2. All major aerodromes (Civil, Army, Navy, Air Force) shall be shown.
3. If congestion results from plotting the position of all aerodromes, omissions may be made in the following order:
  - a. Abandoned, closed or unusable aerodromes.
  - b. Landing areas.
  - c. Minor aerodromes (other than military).
  - d. Minor aerodromes (military).
4. Sea plane stations / anchorages are not required to be shown on this series.”

#### 6.4.14 Cultural Landmark layer

This layer contains information pertaining to manmade or general cultural features, other than transportation features, populated places, and utilities which are also manmade (DMA 1992b). These features are not well described in DMA (1987), neither additional definition information or selection criteria and other mapping rules. Still, when it concerns selection criteria these features are mainly included for visual reference for air crews, and for their radar value. Due to this we have here chosen to limit ourselves to information related to the fairly limited items found in coverages CLPOLY and CLLINE. CLPOINT, includes a large number of features which, however, does not justify

Note:

No particular additional definition information were found that readily followed the DCW data organisation structure for:

Coverage: CLPOLY, Feature class: Polygon, Item: CLPYLABEL

*Table 28. Coverage: CLPOLY, Feature class: Polygon, Item: CLPYLABEL - Selection criteria and other mapping rules*

Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
<ul style="list-style-type: none"> <li>• Fort</li> </ul>	<p>“908. B. Forts. 1. Forts large enough to plot to scale (exceeding the equivalent 1.3mm .05 inch square) shall be shown with the wall symbol and properly identified.”</p>
<ul style="list-style-type: none"> <li>• Racetracks</li> </ul>	<p>“908. C. Stadiums, Outdoor Theatres, Race Tracks, Athletic Fields. The correct orientation of these features should be retained when they are plotted to chart scale.”</p>
<ul style="list-style-type: none"> <li>• Athletic field</li> </ul>	<p>“908. C. Stadiums, Outdoor Theatres, Race Tracks, Athletic Fields. The correct orientation of these features should be retained when they are plotted to chart scale.”</p>
<ul style="list-style-type: none"> <li>• Area delimiting lines (label)</li> </ul>	
<ul style="list-style-type: none"> <li>• Structure other than building (label)</li> </ul>	

Note:

No particular additional definition information were found that readily followed the DCW data organisation structure for:

Coverage: CLLINE, Feature class: Line, Item: CLLNLABEL

Table 29. Coverage: CLLINE, Feature class: Line, Item: CLLNLABEL - Selection criteria and other mapping rules

Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
<ul style="list-style-type: none"> <li>Weirs, jetties, and groynes</li> </ul>	<p>“905. Dams and Similar Features. D. Weirs and Jetties.. A weir, when used to dam water, shall be shown by the dam symbol. When used to trap fish in rivers or tidal waters or to divert water, a weir shall be symbolized similarly to a breakwater or jetty.”</p>
<ul style="list-style-type: none"> <li>Ramps</li> </ul>	<p>“906. Harbor Structures. A. Prominent piers, breakwaters, wharfs, quays, ramps, patent slips, marine railways, dry dock and floating docks which project into the open water from the shoreline shall be shown conforming as nearly as possible to the actual shape of the object and labeled appropriately.”</p>
<ul style="list-style-type: none"> <li>Prominent fences</li> </ul>	<p>“907. Prominent Walls, Trenches, Tank Traps, Fences These features shall be shown only when they serve as outstanding landmarks across great expanses of open country otherwise devoid of cultural features. Labeling identifying walls, trenches and tank traps shall be added parallel to the symbol. Fences shall not be labeled.”</p>
<ul style="list-style-type: none"> <li>Piers, wharfs, quays</li> </ul>	<p><i>See Ramps</i></p>
<ul style="list-style-type: none"> <li>Breakwaters</li> </ul>	<p><i>See Ramps</i></p>
<ul style="list-style-type: none"> <li>Aerial cableways</li> </ul>	<p>“908. G. Aerial Cableways, Ski Lifts, Conveyor Belts and Similar Features. Only those that have visual significance or that span valleys and canyons shall be shown.”</p>
<ul style="list-style-type: none"> <li>Walls, trenches, tank traps</li> </ul>	<p><i>See Prominent fences</i></p>
<ul style="list-style-type: none"> <li>Dams</li> </ul>	<p>“905. Dams and Similar Features. A. Dams. 1. All dams shall be shown except for the smaller dams in congested areas built across single line streams and without an impounded reservoir.” “905. Dams and Similar Features. D. Weirs and Jetties.. A weir, when used to dam water, shall be shown by the dam symbol...”</p>

### 6.4.15 Transportation Structure layer

Table 30. Coverage: TSLINE, Feature class: Line, Item: TSLNTYPE - Additional definition information

Code	Definition in ESRI (1992)	Additional definition information in DMA (1987)
1	Snowsheds	
2	Bridges	<p>“607. Bridges and Viaducts</p> <p>A. Definitions.</p> <p>1. Bridge - A structure erected over a river, stream or open body of water to serve as a crossing for railroad, vehicular or foot traffic. Except for such types as pontoon bridges, some free clearance usually exists between the bridge floor and the surface of the water.</p> <p>2. Viaduct - A structure erected over a depression, valley or over areas of heavy cultural density, as city streets, to serve as a crossing for railroad or vehicular traffic. Free clearance exists between the viaduct floor and the surface of the ground. A short viaduct passing over only one or two features -- such as roads or railroads -- shall be interpreted to be an overpass. “</p>
3	Causeways	<p>“609. Causeways</p> <p>A. Definition.</p> <p>A causeway is a fill of dirt, rock and /or masonry erected across open water to serve as a crossing for roads or railroads. The features area usually long and, except for occasional openings to permit cross-passage of boats, are usually continuous.”</p>
4	Tunnels	
5	Ferries	<p>“611. Ferries</p> <p>B. A ferry shall be regarded as such only where it is an established feature regularly in operation for transporting traffic between two points on opposite sides of a stream, river, bay, sound or lake. the landings need not necessarily be directly opposite one another.”</p>
6	Fords	

Table 31. Coverage: TSLINE, Feature class: Line, Item: TSLNTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Snowsheds	<p>“604. Snow Sheds.</p> <p>A. Prominent railroad snow sheds shall be shown.”</p>

2	Bridges	<p>607. Bridges and Viaducts  B. Items To Be Portrayed.  1. Where feasible, in uncongested areas, all bridges and viaducts 500 feet long and over shall be shown. Length may be slightly exaggerated in order to retain a minimum distance of 1.3mm (.05 inch) between abutment ticks.  ...  5. Footbridges shall be shown only in areas of very sparse detail.”</p>
3	Causeways	
4	Tunnels	<p>“610. Tunnels  A. If possible, tunnels for roads and railroads shall be shown wherever they exist.  B. Tunnels less than 1.3mm (.05inch) in length shall be exaggerated and shown with lines 1.3mm(.05inch) long between the tunnel entrance ticks. Longer tunnels shall be plotted to scale.”</p>
5	Ferries	<p>“611. Ferries  A. Ferries capable of accommodating vehicular or railroad traffic shall only be shown in areas of sparse detail (no congestion).”</p>
6	Fords	<p>“612. Fords.  A. Fords for roads shall be shown only in areas of sparse detail.  B. Fords across single line streams shall be indicated merely by labeling.  C. Fords across double line streams shall be indicated by labeling and breaking the symbol of the crossing feature at the shorelines.”</p>

Note:

No particular additional definition information were found for coverage: CLLINE, Feature class: Line, Item: CLLNLABEL except what has already been included in Table 30 for Coverage: TSLINE, Feature class: Line, Item: TSLNTYPE

Table 32. Coverage: TSPPOINT, Feature class: Point, Item: TSPTTYPE - Selection criteria and other mapping rules

Code	Definition in ESRI (1992)	Selection criteria and other mapping rules in DMA (1987)
1	Snowsheds	See Table 31
2	Bridges	See Table 31
3	Causeways	See Table 31
4	Tunnels	See Table 31
5	Ferries	See Table 31
6	Fords	See Table 31
7	Railroad yards	<p>“603. Railroad Yards</p> <p>A. Railroad yards are excellent radar checkpoints regardless of whether a roundhouse or other superstructure is present.</p> <p>B. All railroad yards shall be shown which exceed 2000 feet in length and 5 tracks in width. The correct shape of the yards shall be retained insofar as it is practical. No attempt should be made to show all tracks. Only the important switching lines shall be plotted. The remaining tracks shall be symbolized collectively but delineated in their correct direction.</p> <p>C. When necessary because of severe space limitations or other reasons, railroad yards may be shown by a solid square as indicated in Appendix 1, Symbolization.”</p>
8	Railroad stations	<p>“605. Railroad Stations</p> <p>A. Railroad stations shall be shown in areas of sparse culture. If a railroad station appears with a group of buildings, the buildings and station shall be indicated by the proper populated place symbol. In areas where railroads are the principal means of transportation, railroads stations assume a greater importance and consequently more shall be shown.”</p>

See Table 31

#### **6.4.16 Vegetation layer**

This layer is only available for North America. It is not derived from the ONC charts. This coverage contains vegetation data that were vectorized from Advanced Very High Resolution Radiometer (AVHRR) raster satellite data. No completeness information is available.





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