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National Geospatial Program
The National Map

US Topo Product Standard

Chapter 2 of
Section B, U.S. Geological Survey Standards
Book 11, Collection and Delineation of Spatial Data

Techniques and Methods 11–B2
Version 2.0, February 2019

U.S. Department of the Interior
U.S. Geological Survey

Cover. Selected layers from the 2017 Arch Mesa Quadrangle US Topo map.

US Topo Product Standard

By Larry R. Davis, Kristin A. Fishburn, Helmut Lestinsky, Laurence R. Moore, and Jennifer L. Walter

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U.S. Department of the Interior
DAVID BERNHARDT, Acting Secretary

U.S. Geological Survey
James F. Reilly II, Director

U.S. Geological Survey, Reston, Virginia
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Conversion Factors

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch (in.)	2.54	centimeter (cm)
inch (in.)	25.4	millimeter (mm)

International System of Units to U.S. customary units

Multiply	By	To obtain
	Length	
meter (m)	1.094	yard (yd)

Datum

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Abbreviations

BGN	U.S. Board on Geographic Names
BIH	Bureau International de l'Heure
DEM	digital elevation model
DLA	Defense Logistics Agency
DLG	digital line graph
DMA	Defense Mapping Agency
DOD	U.S. Department of Defense
FGDC	Federal Geographic Data Committee
FGCS	Federal Geodetic Control Subcommittee
GCNDB	geographic cell names database (part of GNIS)
GIS	geographic information system
GNIS	Geographic Names Information System
GRS 80	Geodetic Reference System of 1980
GSD	ground sample distance
ISO	International Organization for Standardization
ITRF	International Terrestrial Reference Frame
MB	megabyte
MXD	Esri ArcGIS map document format
NAD 83	North American Datum of 1983
NAIP	National Agriculture Imagery Program
NAVD 88	North American Vertical Datum of 1988
NGP	National Geospatial Program
NOAA	National Oceanic and Atmospheric Administration
NWI	National Wetlands Inventory
OGC	Open Geospatial Consortium
PDF	Portable Document Format
PLSS	Public Land Survey System
PPI	pixels per inch
RGB	red green blue (image color channels)
SPCS	State Plane Coordinate System
URL	Uniform Resource Locator (or internet address)
USGS	U.S. Geological Survey
USNG	United States National Grid
UTM	Universal Transverse Mercator
WGS 84	World Geodetic System of 1984
XML	Extensible Markup Language

US Topo Product Standard

By Larry R. Davis, Kristin A. Fishburn, Helmut Lestinsky, Laurence R. Moore, and Jennifer L. Walter

Introduction

Purpose and Scope

This document defines a U.S. Geological Survey (USGS) digital topographic map. This map product series, named "US Topo," is modeled on the now historical USGS 7.5-minute (1:24,000 scale) topographic map series produced and printed by the USGS from 1947 to 2006. US Topo maps have the same extent, scale, and general layout as the historical topographic maps. US Topo maps incorporate an orthorectified image (hereinafter referred to as "orthoimage") and shaded relief image along with a selection of data that were included in the historical 7.5-minute topographic maps. Between June and September of 2017, the USGS transitioned the format of US Topo maps to be published, by using a geospatial extension, in an International Organization for Standardization (ISO) 32000-compliant Adobe® portable document format (PDF) that is called a "geospatial PDF." Previously, US Topo maps were published, by using geospatial extensions patented by TerraGo® Technologies, in PDF in a format called a "GeoPDF®." The geospatial PDF design allows a user to zoom in and out in a georeferenced environment, turn layers on and off, view or print any combination of layers, and print any portion of the map at the published scale.

US Topo maps are intended to serve conventional map users by providing geographic information system (GIS) information in symbolized form in the customary topographic map layout. The maps are not intended for advanced GIS analysis applications. These products are built on standard coordinate systems and include full U.S. National Grid (USNG) lines, making US Topo maps particularly useful for emergency first-response operations. These maps are also used by traditional topographic map users, such as resource managers, planners, and recreational users who continue to have a need for the symbolized feature data contained in the 7.5-minute quadrangle maps.

Full-size style sheet templates in PDF defining the placement of map elements, marginalia, and font sizes and styles accompany this standard. US Topo maps published as geospatial PDFs are fashioned to conform to these style sheets so that a user can print out a map at the 1:24,000, 1:25,000, or 1:20,000 scale using the dimensions of the traditional standard 7.5-minute quadrangle. Symbology and type specifications for feature content and detailed requirements for geospatial content will be published separately.

Applicability

This document is an update of the US Topo Product Standard published in 2011 (Cooley and others, 2011). It is applicable to all US Topo maps. Updates in this version include

- the introduction of an ISO 32000-compliant geospatial PDF as a new file format for published maps;
- new style sheet templates for 1:24,000-scale maps (conterminous United States and Hawaii), 1:25,000-scale maps (Alaska), and 1:20,000-scale maps (Puerto Rico and U.S. Virgin Islands);
- an updated US Topo Map Symbol attachment;
- minor updates to text, including changes to the features and layers included in the US Topo product and the sheet size of the US Topo maps;
- updated figures demonstrating the US Topo product; and
- an updated metadata file containing map-specific information.

Maintenance

The National Geospatial Program (NGP) of the USGS maintains standards for The National Map (TNM; https://nationalmap.gov/), including map standards for US Topo products, and Historical Topographic Map Collection products. Submit questions and comments concerning this document to the U.S. Geological Survey National Geospatial Program Standards group at nmpstds@usgs.gov.

Background

When the USGS topographic mapping program (https://nationalmap.gov/ustopo/) was redefined in late 2008, the end product, the US Topo, was specifically defined as a GeoPDF, a PDF with geospatial extensions patented by TerraGo Technologies. The PDF was chosen as the electronic format because it is accessible to computer users who are not GIS specialists and because it is relatively easy to print. The geospatial PDF provides the end user with a PDF map that is georeferenced (tied to a known Earth coordinate system) and that is built with multiple data layers that can be turned on and off to support different views of the map. Publishing topographic maps in an electronic format also supports a faster and wider public distribution than publishing topographic maps in a print format.

The first maps under the new US Topo program were created by the USGS in 2009. About 13,000 maps were created, consisting of a map collar; projection line and grids; orthoimage; and limited cartographic feature detail that includes roads, geographic names, and limited annotation. Contour lines, hydrography, and other standard topographic-map content were not included on those first maps. These early map products are branded as "Digital Map – Beta" (always specified with quotes).

Later in 2009, the USGS added contours and hydrographic features to the maps and the product was rebranded as "US Topo." US Topo map content is composed of an orthoimage and significant features and layers from the following geographic themes: transportation, geographic names, elevation, hydrography, boundaries, structures, and land cover. It is the objective of the USGS to expand the content of the US Topo maps over time to include additional features and layers from these themes. This will result in a product that becomes progressively more robust to support emerging consumer requirements.

In 2013, the US Topo map was redesigned to improve the readability of map features displayed on top of an orthoimage and shaded-relief background. Additionally, the US Topo redesign adopted a widely distributed typeface for feature labels and for text in the map margin.

Between June and September of 2017, the USGS transitioned the production of US Topo maps to a cloud-based production system, enabling the change in format to an ISO 32000-compliant geospatial PDF.

The US Topo maps are updated on a three-year production cycle. Newly published maps as well as previously published, noncurrent, US Topo maps are freely available for download from The National Map (https://www.usgs.gov/faqs/how-do-i-find-and-download-us-topo-maps-and-historical-topographic-maps).

Product Overview

The philosophy guiding the US Topo product design is as follows:

- The basic layout of the traditional USGS 7.5-minute topographic maps has value. Maps with standard cell extent, full map collars, and standard grids are useful, in part, because of their standardized format and layout. For these advantages to persist, the layout and design of the US Topo products must conform to editorial standards that echo the traditional USGS 7.5-minute maps.
- In the emergency response and national security communities, there is a need for general purpose maps that can be easily printed at a standard map scale.
- Similarly, there is need for a national map series that can be used without specialized GIS software and expertise.
- A topographic line map with the addition of an orthoimage and shaded relief is a valuable tool, particularly when provided in a digital format that allows the user to turn features and layers on and off, zoom in and out, and print the entire map or portions of the map at a standard map scale.

The utility of turning layers on and off is demonstrated by figures 1 through 4.

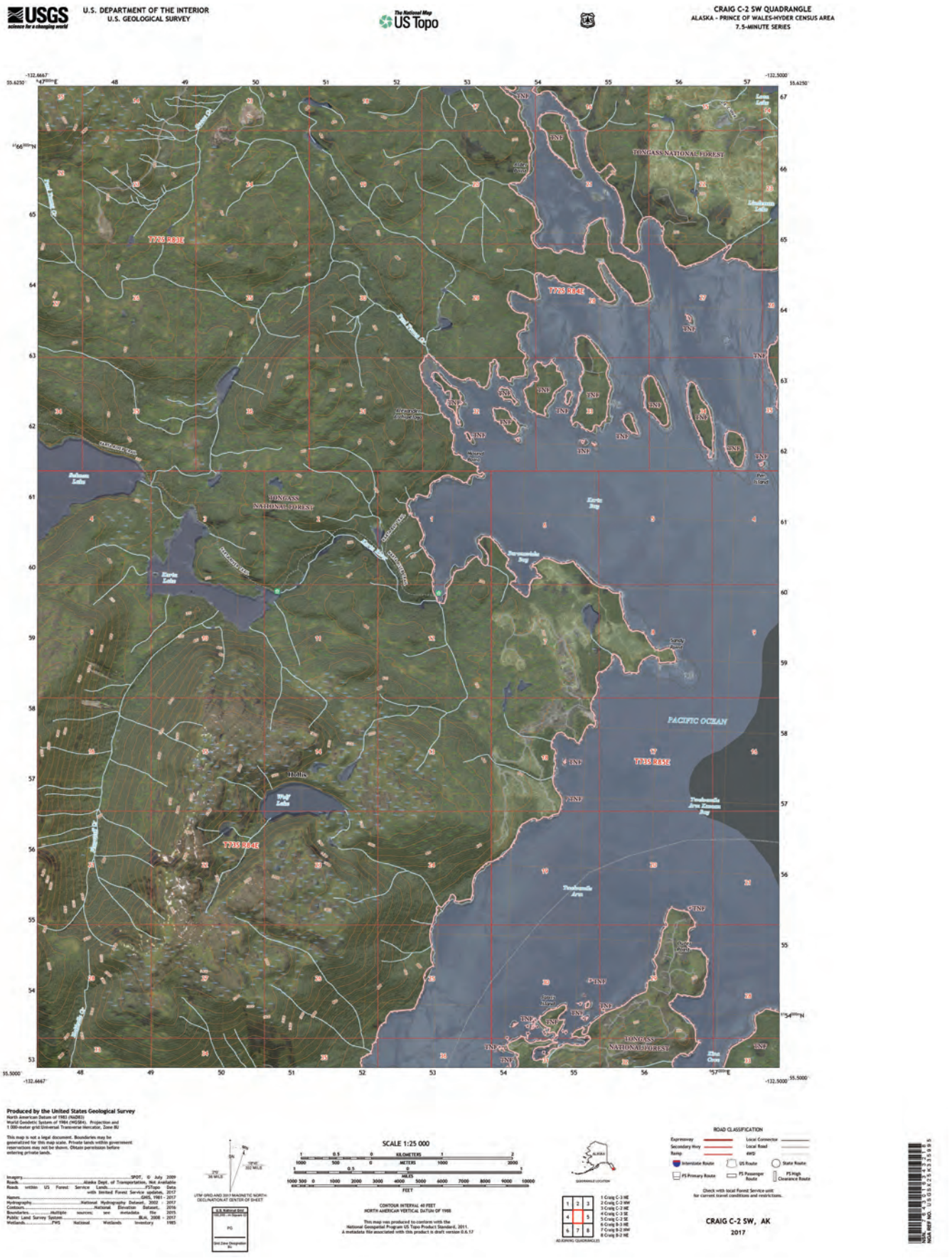


Figure 1. Image of a US Topo geospatial PDF with all layers on.

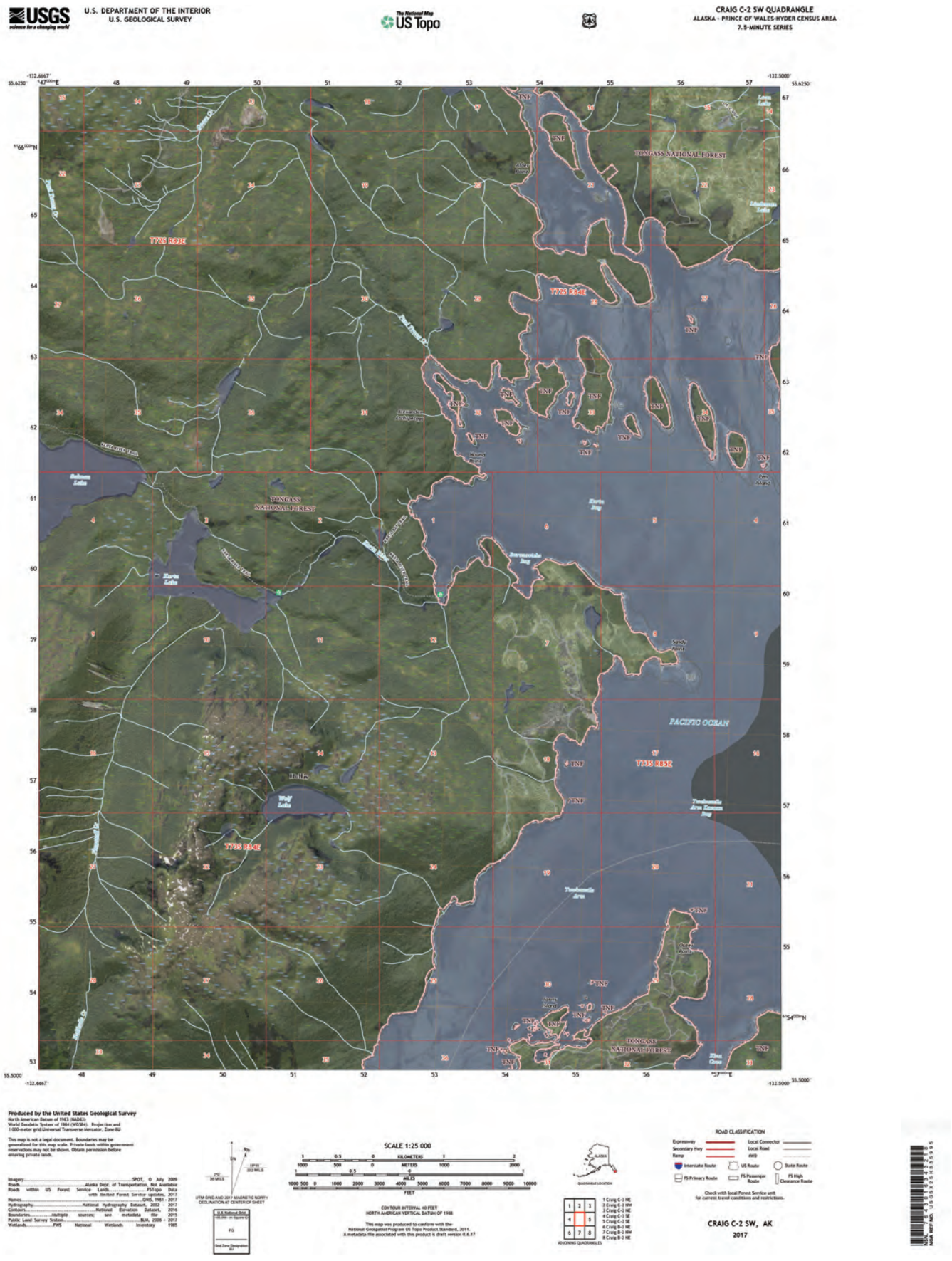


Figure 2. Image of a US Topo geospatial PDF with the contour layer off.

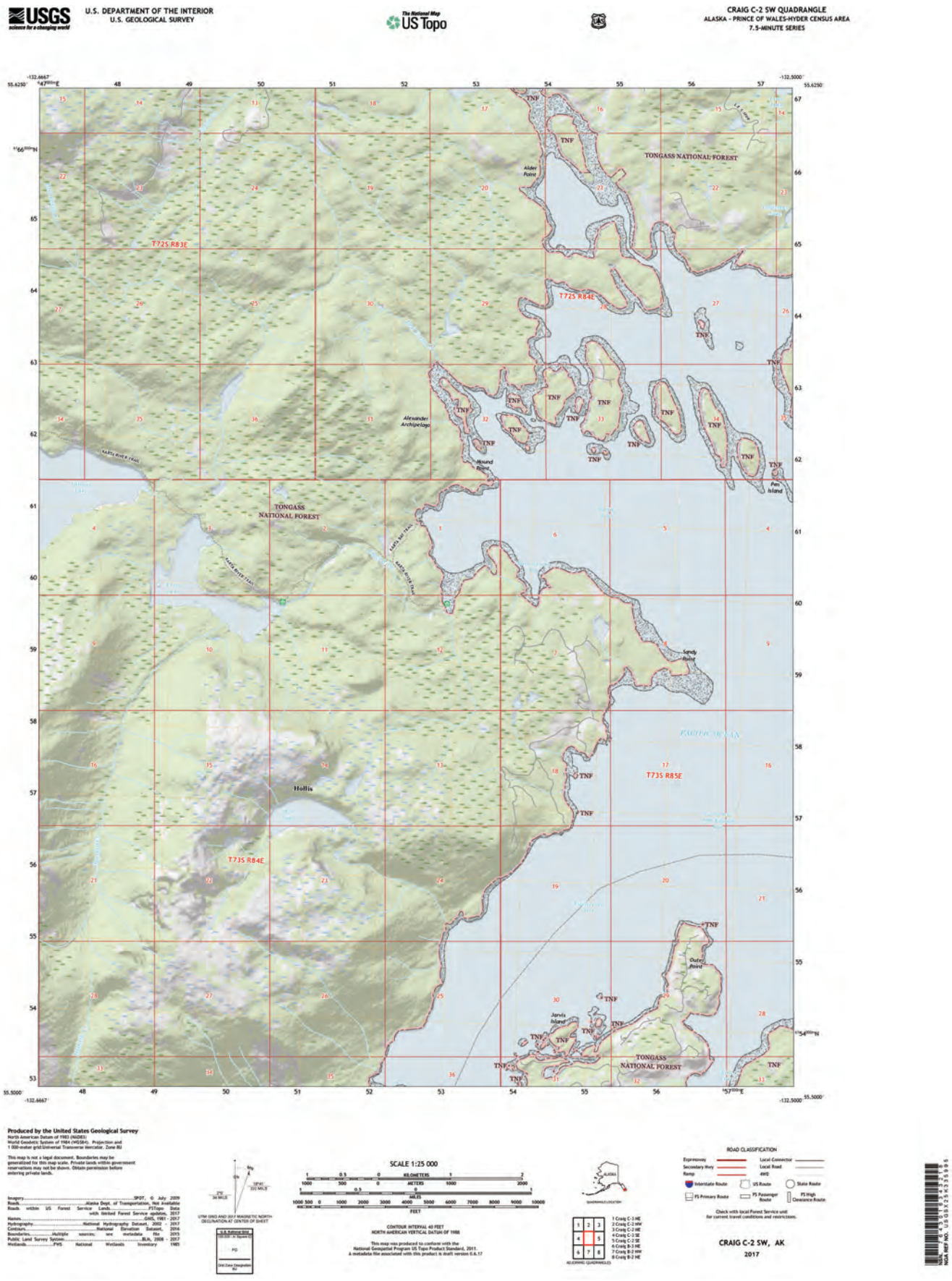


Figure 3. Image of a US Topo geospatial PDF with the contour and orthoimage layers off.

Figure 4. Image of a US Topo geospatial PDF with the orthoimage and shaded relief layers off.

Files and Formats

The product defined by this standard contains a layered geospatial PDF, an associated metadata file in Extensible Markup Language (XML) format conforming to the Federal Geographic Data Committee (FGDC) Content Standard for Digital Geospatial Metadata (FGDC, 1998) and a map symbol key (legend) file in PDF. Metadata and symbol key files are bundled with the geospatial PDF as file attachments.

Full-sized style sheets in PDF accompany this standard and define the placement of map elements, marginalia, and font sizes and styles for the 1:24,000-, 1:25,000- and 1:20,000-scale 7.5-minute series topographic maps.

From 2009 through as late as September 2017, the US Topo map file format was a GeoPDF; a PDF with TerraGo Technologies' patented georeferencing extension. The Open Geospatial Consortium (OGC) published a best practices specification, "PDF Geo-registration Encoding Best Practice Version 2.2" (Demmy and Reed, 2011) that documents the PDF geo-registration technique. Between June and September of 2017, the USGS transitioned the file format of the US Topo product to a geospatial PDF, an ISO 32000-compliant Adobe PDF file with a geospatial extension. Adobe released the PDF specifications to be published by the International Organization for Standardization (ISO). The document is now available as "ISO 32000-1" (ISO, 2008a).

To take advantage of the geospatial extensions, TerraGo provides a plug-in (TerraGo Toolbar®) for either Adobe Reader® or Adobe Acrobat® software. This plug-in works only with GeoPDF files. The plug-in is available for free and may be downloaded from http://info.terragotech.com/download/terrago-toolbar. There is not a free plug-in analogous to the TerraGo Toolbar for the geospatial PDF. However, Adobe Reader and Adobe Acrobat have a few built-in geospatial functions that work with the new geospatial PDF format, which are explained in the US Topo Map Users Guide (USGS, 2017).

Both GeoPDF and geospatial PDF US Topo maps can be viewed and printed with Adobe Reader, Adobe Acrobat, or any comparable PDF viewing software.

Scale, Extent, Projection, Datum, Coordinate System, and Grids

This standard defines the US Topo product at scales of 1:24,000, 1:25,000, and 1:20,000. The USGS has in the past produced maps at other scales (for example, 1:48,000, 1:50,000 1:62,500, 1:63,360, and 1:100,000). This standard does not prohibit other scales, but it does not completely define maps at other scales.

All maps are georeferenced to the North American Datum of 1983 (NAD 83) or to the World Geodetic System of 1984 (WGS 84). The two datums are virtually equivalent at US Topo map scales. See appendix 1 for further discussion of the relationship between NAD 83 and WGS 84. Vertical control used for elevation data is the North American Vertical Datum of 1988 (NAVD 88). All US Topo maps are projected to the Universal Transverse Mercator (UTM) projection and coordinate system.

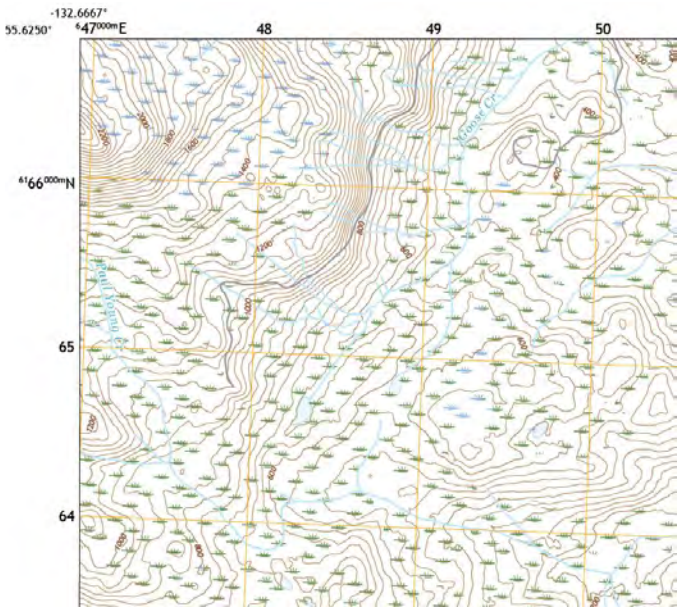


Figure 5. Northwest corner of a US Topo geospatial PDF showing correct style for geographic and U.S. National Grid (USNG) coordinate values.

Geographic coordinate labels are shown outside the projection line. The full latitude and longitude values in decimal degree format are shown at the corners of the projection. Fonts, type sizes, and placement guidelines are defined in detail in the style sheets (appendixes 2, 3, and 4).

All maps include a 1,000-meter UTM grid drawn and labeled in conformance with the U.S. National Grid standard (FGDC, 2001), including a USNG grid reference box in the map collar. As specified by the USNG standard, full UTM values are shown for the grid lines nearest the northwest and southeast corners of the projection and principal digits are shown for all remaining grid lines. The USNG standard has several options for representing the 1,000-meter grid labels. US Topo maps use the following options:

- Except for the corner coordinates that show full UTM values, grid lines are labeled with the USNG principal digits in Trebuchet MS 12-point font (for example, $^{2}63$ or $^{39}02$) (see figure 5 and the style sheet appendixes 2, 3, and 4).
- If the map includes more than one 100,000-meter National Grid zones, the zone letters are printed in the margins.

State Plane Coordinate System (SPCS) tic marks and labels, though shown on most historic maps and on the first 6 years of US Topo maps, were phased out of US Topo maps beginning in 2014.

Data Quality

Components of data quality include currency, consistency, completeness, and accuracy. The US Topo program uses interpreted cartographic point, line, and area features taken from databases maintained or approved by the USGS. These source databases are multipurpose GIS databases and are not necessarily complete or consistent in the same sense that is represented on historical topographic map series. The databases are often compiled from multiple primary and secondary sources and have no single currency date. US Topo maps therefore have different characteristics regarding currency, consistency, and completeness compared to historical USGS topographic maps. The data tend to be more current than on a legacy map but may be less consistent between maps and between regions because of variations in data collection between different sources.

Accuracy, both positional accuracy and attribute accuracy, of the data is the responsibility of the organization that produced the source data. The overall quality of the cartographic data depends directly on the quality of the source GIS databases. US Topo maps produced to date do not include a traditional accuracy statement in the map collar because of the variety of data sources used in creating them. The USGS cartographically adjusts and generalizes the data used in US Topo maps where necessary. The XML metadata file attached to each map includes data-quality statements in the Data Quality, Accuracy Information, Data Source, and Process Information sections for each individual data layer.

Projection-Line Orientation and Page Size

The orientation of the projection line to the internal coordinate system of the US Topo image space is equivalent to those traditionally used on traditional USGS topographic maps. The central meridian of the quadrangle (not to be confused with the central meridian of the projection zone) is set parallel to the left and right edges of the image file (or to the edges of the paper on a rectangular paper plot).

The page sizes for US Topo maps at various scales are detailed in table 1.

For two reasons, this standard does not define a constant page size for trimming US Topo maps printed at their full size. First, the width of 7.5-minute quadrangles vary with latitude. Second, while quadrangle height does not vary with latitude, the text in the map collar may vary in content. The geospatial PDF is constructed so that the width of the margins is always nearly equal. Because the geospatial PDF provides for custom printing, the user may trim the printed map as required.

Table 1. US Topo map page size, by scale.

[US Topo map page sizes have varied throughout the course of the project. The page sizes in this table represent the US Topo map page sizes at the time of the 2018 US Topo Standard publication]

Map scale	US Topo page size (inches)
1:24,000	24×29
1:25,000	24×29
1:20,000	29×33.5

Off-Grid and Oversized Maps

Approximately 400 of the historical USGS 7.5-minute topographic maps do not precisely match the domain of a standard 7.5-minute cell. For example, for some maps the projection line was extended to show all of a land mass or water feature or to match a state boundary. In a few cases, the entire projection line was shifted to center the map over an island.

USGS cell-based digital products, such as digital line graphs (DLG) and digital elevation models (DEM), did not allow for such exceptions. These products are restricted to the geographic domain of an on-grid 7.5-minute cell.

US Topo maps conform to the latter convention, and all maps precisely fit the standard 7.5-minute cell grid. See appendix 1 for further discussion of oversized and off-grid maps.

Map Collar

The map collar (or map margin) is defined as the area outside the projection line, including all text, diagrams, and other information that appears in this area, except for data related to cartographic coordinate systems, which are logically associated with the projection line and grids.

The general layout of the US Topo map collar is similar to that of historical 7.5-minute topographic maps. Precise content, positions, colors, fonts, and line weights for the US Topo map collar information are defined by the style sheets that accompany this standard (appendixes 2, 3, and 4). The information in table 2 is shown in the US Topo map collar (see appendixes 2, 3, and 4):

Map Interior—Data Sources, File Size, and Resolution

All geospatial content on US Topo products is derived from national geospatial databases under the stewardship of USGS data programs. Normally, these datasets are owned and hosted by the USGS, but they also include data sources owned and hosted by other organizations, provided that these sources

have been approved for use by the USGS. The US Topo product is freely distributable, but this does not necessarily mean that all the data in the product are in the public domain, as this standard does not preclude the use of licensed data. All source information and any relevant license information is documented in the product metadata and listed in the map collar.

Geospatial PDFs produced by the US Topo map program must support high-quality printing yet have a manageable file size for storage, viewing, and manipulation in their native digital format. These requirements have to take into account the size of the data sources that are integrated, ground sample distance (GSD), image bit depth, spatial resolution, and file compression. See appendix 1 for a more detailed discussion of these concepts. The following sections discuss the goals and requirements for the data sources used in the US Topo product and for the file size and resolution of the geospatial PDF.

Interpreted Cartographic Features

Each US Topo map is assembled as a layered geospatial PDF and includes significant features and layers that were included in the historical USGS 7.5-minute maps, such as transportation, geographic names, elevation, hydrography, boundaries, land cover, and structures. The USGS intends to continue to expand the content of the US Topo products in the future. The following list provides examples of features that are included in the US Topo maps, though it is a sample and is not intended to be all inclusive:

- Roads
- Airports
- National, State, and county boundaries
- Contours
- Coastlines
- Lakes and ponds
- Streams and rivers
- Schools
- Woodlands
- Geographic names
- Public Land Survey System (PLSS) boundaries
- Railroads
- Trails
- Hospitals
- Wetlands (from the National Wetlands Inventory [NWI])

The details of content, symbology, and labeling are outside the scope of this standard and will be published separately.

The United States Board on Geographic Names (BGN, https://geonames.usgs.gov/) is the official Federal Government body established in 1947 by Public Law 80-242 to maintain uniform geographic name usage throughout the Federal Government. In support of the BGS, the USGS developed the Geographic Names Information System (GNIS, https://geonames.usgs.gov/domestic/index.html) as the official repository of domestic geographic names data. GNIS is the primary source for applying geographic names to Federal electronic and printed products. Because not all features on US Topo maps are included in GNIS (for example, roads and highways are not in GNIS), GNIS names comprise a subset of all feature names that might be shown on the US Topo maps. See appendix 1 for further discussion of geographic names.

Orthoimage and Shaded Relief

Each US Topo map includes an orthoimage layer and, beginning in 2013, a shaded relief layer, two layers that were not included in the historical USGS 7.5-minute maps. Both the orthoimage and shaded relief are required layers in every US Topo product. Details of the content of these layers will be published separately.

File Size and Resolution

The National Geospatial Program's objective is to produce each US Topo product as a geospatial PDF with a file size of approximately 30 megabytes (MB). This is an ideal rather than a hard requirement because the data sources and orthoimage character vary between quadrangles. A file size of 30 MB is small enough for optimal performance and large enough to maintain visual quality. For example, at 1:24,000 scale, an orthoimage ground sample distance (GSD) of 1.5 meters and a spatial resolution of 400 pixels per inch (PPI) typically result in a file size of 30 MB.

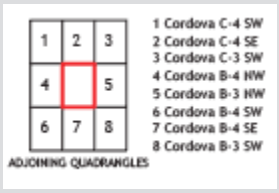
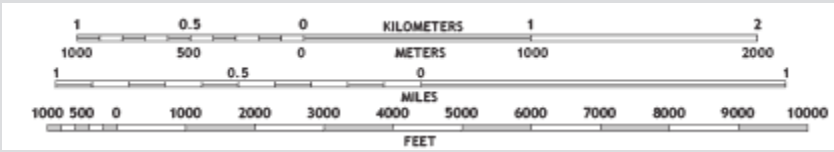
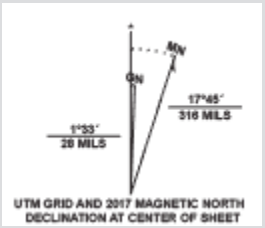
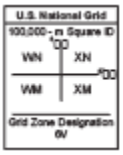
Digital File Organization

Historical 7.5-minute topographic maps were designed for ease of use by a person viewing a paper map. US Topo maps are still intended primarily for viewing (not for advanced GIS analysis), but the geospatial PDF allows the user to view a map in softcopy and to print it out at the default scales of 1:24,000, 1:25,000, or 1:20,000 as well as any desired scale for viewing on paper.

Table 2. Description and image of information included in the US Topo map collar.

Description of US Topo map collar information	Image of US Topo map collar information
USGS visual identity logo	USGS science for a changing world
U.S. Department of the Interior and bureau identifier	U.S. DEPARTMENT OF THE INTERIOR U.S. GEOLOGICAL SURVEY
The National Map visual identity logo	The National Map US Topo
U.S. Forest Service logo, for maps containing national forest land	
Title block, upper right	CORDOVA B-4 NE QUADRANGLE ALASKA - VALDEZ-CORDOVA CENSUS AREA 7.5-MINUTE SERIES
Title block, lower right	CORDOVA B-4 NE, AK
Map generation date, lower right (This is the year the map product was created, not the date of any source material.)	2017
Road symbology legend	ROAD CLASSIFICATION Expressway Secondary Hwy Ramp Local Connector Local Road 4WD Interstate Route US Route State Route FS Primary Route FS Passenger Route FS High Clearance Route Check with local Forest Service unit for current travel conditions and restrictions.
Map credit legend, consisting of the following: The note "Produced by the United States Geological Survey."	Produced by the United States Geological Survey
Map projection, horizontal datum, Universal Transverse Mercator (UTM) grid spacing, and UTM zone	North American Datum of 1983 (NAD83) World Geodetic System of 1984 (WGS84). Projection and 1 000-meter grid:Universal Transverse Mercator, Zone 6V
A list of the core data layers with sources and currency dates	Imagery.....SPOT, © July 2011 Roads.....Alaska Dept. of Transportation, Not Available Roads within US Forest Service Lands.....FSTopo Data with limited Forest Service updates, 2017 Names.....GNIS, 1981 - 2014 Hydrography.....National Hydrography Dataset, 2001 - 2013 Contours.....National Elevation Dataset, 2013 Boundaries.....Multiple sources; see metadata file 2017 Public Land Survey System.....BLM, 2008 - 2017 Wetlands.....FWS National Wetlands Inventory 1978 - 1982
Quadrangle location diagram	ALASKA QUADRANGLE LOCATION

Table 2. Description and image of information included in the US Topo map collar.—Continued

Description of US Topo map collar information	Image of US Topo map collar information
Adjoining quadrangle diagram	
Map scale note, with scale expressed as a representative fraction	SCALE 1:25 000
Bar scales	
Contour interval and vertical datum notes	CONTOUR INTERVAL 40 FEET NORTH AMERICAN VERTICAL DATUM OF 1988
US Topo standard version statement	This map was produced to conform with the National Geospatial Program US Topo Product Standard, 2011.
Metadata version statement	A metadata file associated with this product is draft version 0.6.17
North arrow and declination diagram	
U.S. National Grid reference box	
Defense Logistics Agency (DLA) bar code (The DLA bar code is a Department of Defense (DOD) inventory number for use within the DOD)	

Startup Conditions

Specifying software behavior is unusual for a USGS product standard but is necessary in this case because of the tight coupling between the geospatial PDF file format, the commercial software tools that can read a geospatial PDF, and this product standard. The following startup behaviors depend on viewing software that correctly implements the PDF specification, including PDF layers.

When the geospatial PDF file opens in a current version of Adobe Reader or Acrobat, the following actions are displayed:

- Only the map is displayed upon opening the PDF.
- The folder structure is hidden.
- The images folder, shaded relief layer, and PLSS layer (if applicable) are turned off.

Layers

The geospatial PDF file contains, at a minimum, the following folders and layers:

- Map Collar
  - Map Elements (this layer includes all information outside of the map neatline, except for data related to cartographic coordinate systems, including the map title, scale bar, map credit notes, USGS and cooperator logos, and more)
- Map Frame
  - Projection and Grids (this layer includes projection coordinate values, geographic and grid ticks, and grid lines)
  - Terrain
  - Images
  - Orthoimage
- Barcode

"Map Collar," "Map Frame," and "Images" must be folders and must minimally contain the listed subfolders and layers. The folders and layers listed above are present in every geospatial PDF file and use the precise names given in the preceding list.

The "Map Frame" folder also contains other folders and layers for the cartographic features included in the US Topo map, as depicted in figure 6. These other folders and layers are only shown if the cartographic features are present in the particular US Topo map. For example, the "Trails" layer is present in the "Transportation" folder for the map shown in figure 6.

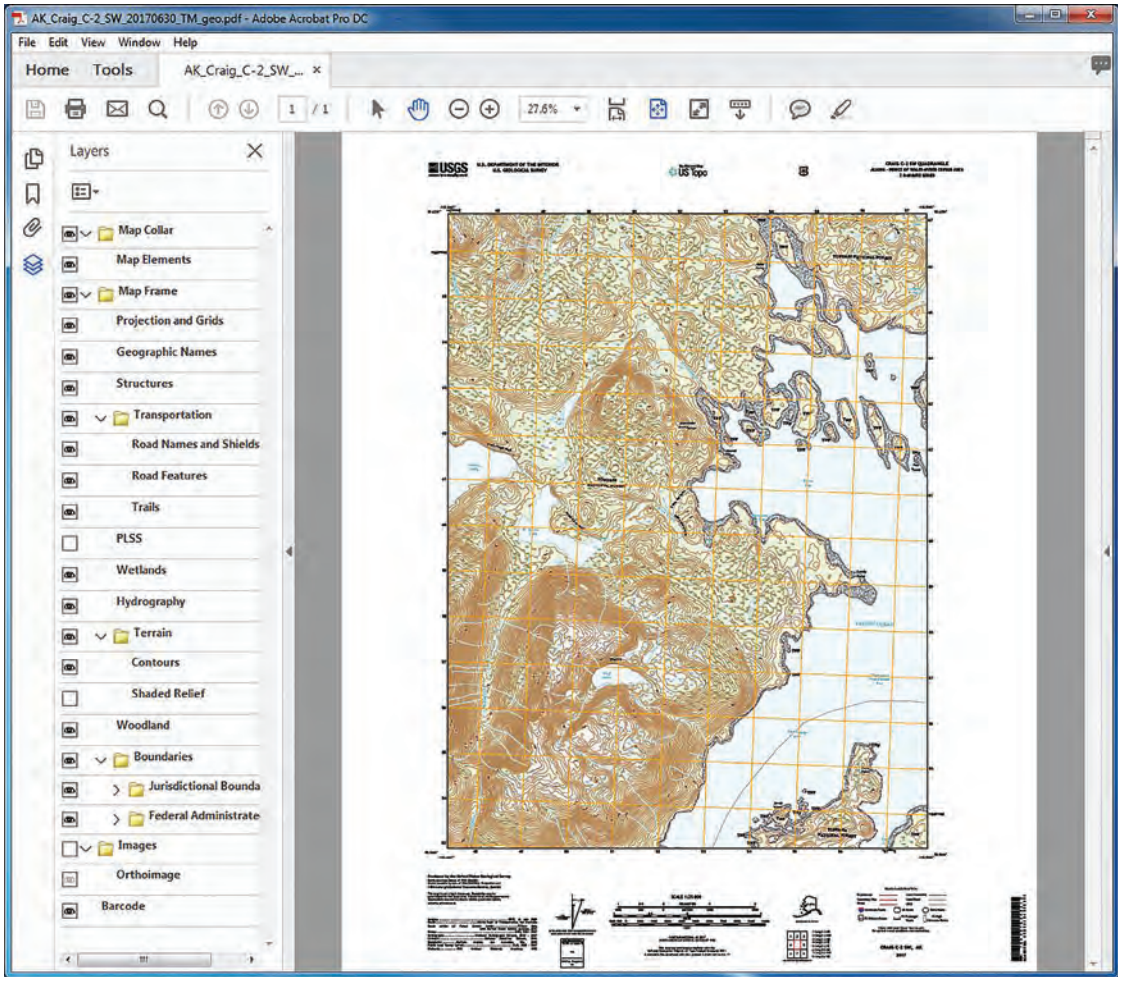


Figure 6. Image of a US Topo map depicting folders and layers. Images folder, Shaded Relief layer, and PLSS (Public Land Survey System) layer off by default.

Compliant with this standard, other data folders and layers may be added as the product develops. Each type of cartographic data in the geospatial PDF file is assigned to a folder or layer. Each folder or layer may be turned on or off by the user.

Open File Format

The geospatial PDF is an open file format, a PDF conforming to ISO 32000-1 (ISO, 2008b) encoded with Adobe's geospatial extensions to ISO 32000-1, which are published as ISO 32000-2 (ISO, 2017).

Metadata Files

An FGDC-compliant metadata file in XML format is attached to each US Topo product (fig. 7). The XML metadata file attached to each geospatial PDF contains standardized language that is determined by the source data used. Beginning in June 2017, the content of the XML metadata file is specifically tailored to each map.

The metadata file contains the same information as the map collar, plus additional information as required by the FGDC metadata content standard. The benefit of duplicating collar information is that the XML file can be parsed by a web-based search engine, making the map and its contents more widely discoverable. (See Data Quality section for US Topo map collar content.)

Metadata file versions are maintained for internal USGS use and the content of these files is not defined by this standard.

Map Symbol Key

A map symbol key (legend) is attached to each individual US Topo map as a PDF (fig. 7). The symbol key is not tailored to the individual content of each map, but rather includes the graphic representation of all features that could potentially be included in a US Topo map (fig. 8). The symbol key also includes a page of text that describes the US Topo product and the general background of the program.

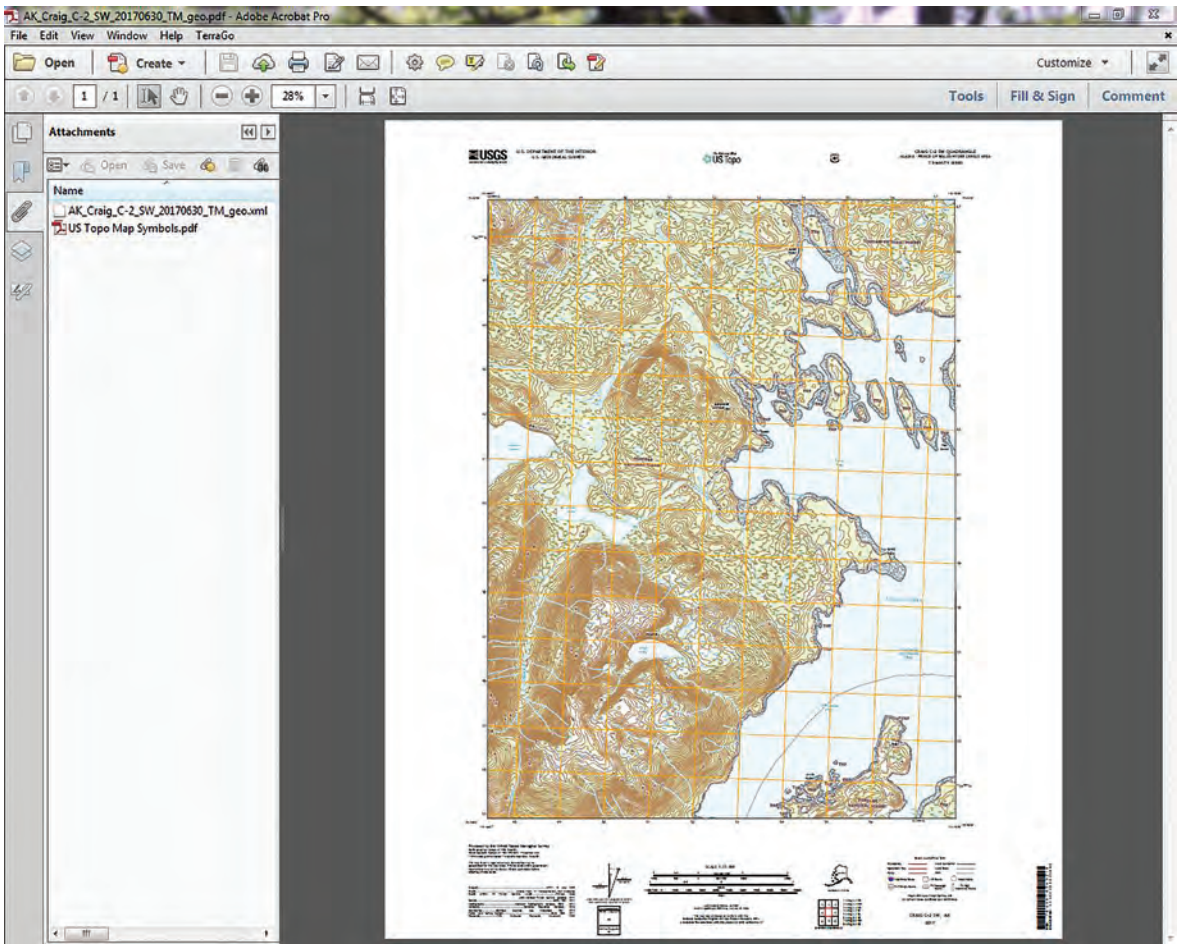


Figure 7. Metadata and map symbol key attachments to the Craig C-2 SW, Alaska US Topo map.

File Names

Geospatial PDF Files

There are no file-naming-convention requirements for US Topo geospatial PDF files. File names are determined by the respective download websites.

Transfer or Distribution Files

A naming convention is also not dictated for transfer or distribution files. For example, a *.zip file of one or more US Topo files need not conform to any particular naming convention.

Metadata Files

US Topo metadata files are named using the following convention:

state_cellname_datestamp_XX_geo.yyy (for example, *CO_Golden_20101005_TM_geo.xml)*.

- ***state*** is the two-letter abbreviation, in capital letters, of the primary U.S. State or U.S. Territory where the map is located.
- ***cellname*** is the name for this standard cell. If the cell name consists of multiple words, words are delimited with the underbar (_) character, not spaces, and the first letter of each word is capitalized.
- ***datestamp*** is the system-generated date of PDF file creation. Its primary purpose is to make each file name unique, regardless of how many instances of the same product are created for one cell. The timestamp string is a concatena-

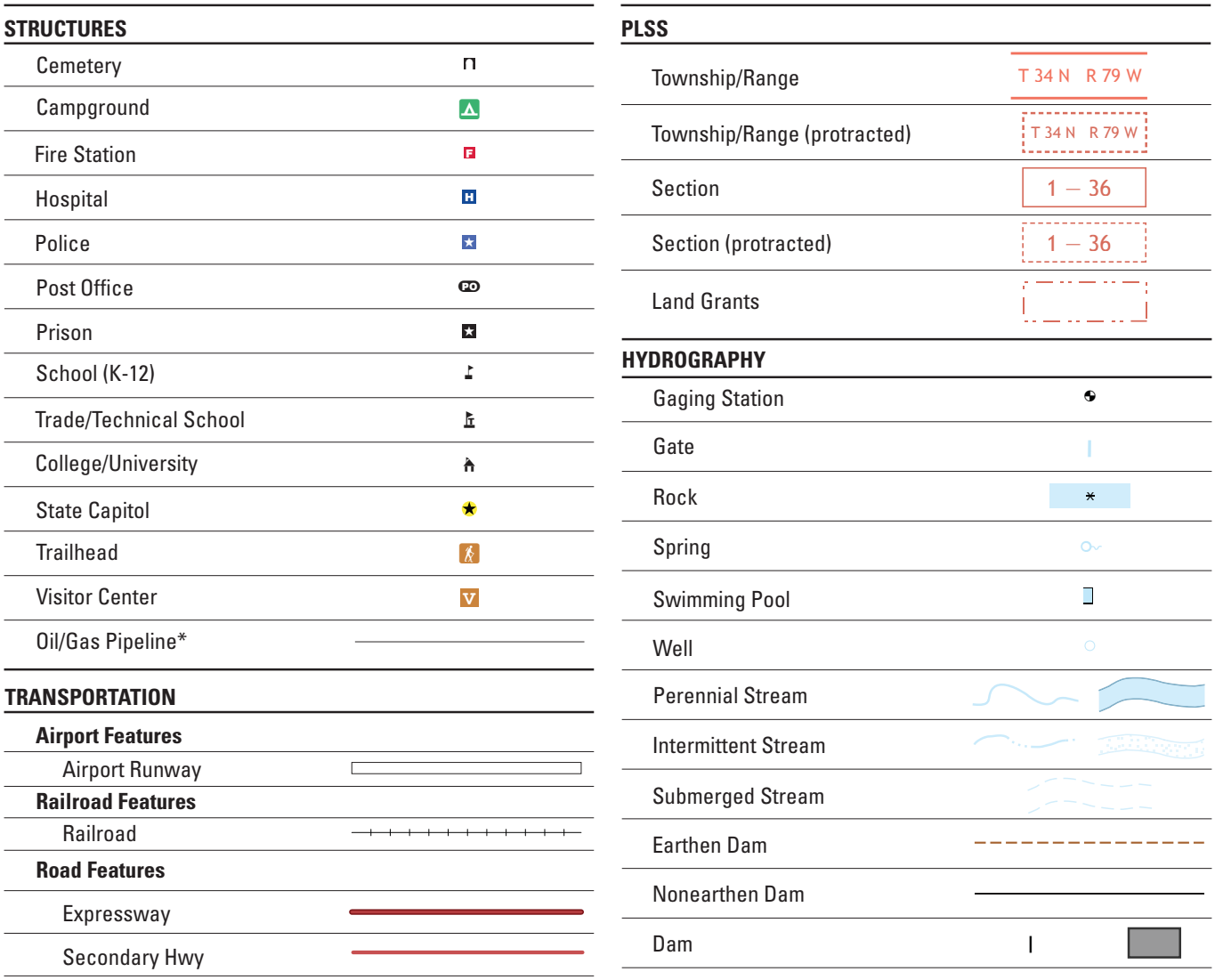


Figure 8. Subset of content included in the US Topo map symbol key attachment

tion of year-month-day, where year has four digits and the other two fields have exactly two digits (padded with zeros as necessary). No delimiters are used in the timestamp. For example, December 4, 2009, is expressed as 20091204.

- ***XX*** is a text string that indicates the map type. OM (Ortho Map) was used for maps published without contours in 2009. Publication of maps with contours began in 2010, and the type was changed to TM (Topographic Map). No domain of values for this string is specified by this standard.
- **geo** is a text string that indicates the PDF is georeferenced.
- ***yyy*** is the filename extension associated with the file type. A text string of "xml" indicates an Extensible Markup Language (XML) file and a text string of "pdf" indicates a Portable Document Format (PDF).

No requirements are specified for letter case; file names may use any combination of uppercase and lowercase letters.

Map Symbol Key File

Because the map symbol key file is the same file for all US Topo maps, a naming convention for the map symbol key file is not dictated. At the time of this publication, the map symbol key file is named "*US Topo Map Symbols.pdf*."

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Glossary

GeoPDF® Portable Document Format (PDF) with TerraGo Technologies' patented georeferencing extension.

geospatial PDF Portable Document Format (PDF) with a non-patented georeferencing extension.

National Geospatial Program (NGP, https://www2.usgs.gov/ngpo/) An administrative unit of the U.S. Geological Survey responsible for mapping and geographic information system (GIS) activities. The NGP is under the USGS Core Science Systems Mission Area.

Metadata information (https://geology.usgs.gov/tools/metadata/) An information set about a map or other geospatial product that describes how the product was made and gives the sources of data and other relevant information. The Federal Geographic Data Committee's (FGDC) Content Standard for Digital Geospatial Metadata (version 2.0), FGDC–STD–001–1998, defines content and organization of metadata files.

USGS Mapping Program An umbrella term that encompasses most of the activities of the NGP, including all aspects of The National Map, US Topo, and the Historical Topgraphic Map Collection.

U.S. National Grid (USNG) The official grid coordinate system of the U.S. Government. See https://www.fgdc.gov/usng/ for information and specifications.

7.5-minute standard cell Geographic quadrangle that aligns with 7.5-minute increments of latitude and longitude. These cells, their official names, and other attributes are stored in the geographic cell names database (GCNDB), a part of the Geographic Names Information System (GNIS).

Useful Websites

https://geology.usgs.gov/tools/metadata/ This site provides useful information about how to implement the FGDC metadata standard.
https://geonames.usgs.gov/ The USGS home page for the U.S. Board on Geographic Names.
https://get.adobe.com/reader/ Free Adobe Reader software may be downloaded from this site.
https://nationalmap.gov/ USGS home page for The National Map.
https://nationalmap.gov/ustopo/ USGS home page for the US Topo maps.
https://nationalmap.gov/ustopo/ustopo_feedback.html Submit feedback for the US Topo project at this site.
https://store.usgs.gov/ USGS products may be downloaded from this site.
http://info.terragotech.com/download/terrago-toolbar Free TerraGo toolbar extension may be downloaded from this site.
https://www.fsa.usda.gov/ Home page for the U.S. Department of Agriculture's Farm Service Agency.
https://www.fgdc.gov/ Home page for the Federal Geographic Data Committee.
https://www.fgdc.gov/standards/projects/FGDC-standards-projects/metadata/ The FGDC Content Standard for Digital Geospatial Metadata may be downloaded from this site.
https://www.fgdc.gov/usng/ FGDC site for the United States National Grid standard.
https://www.iso.org/ Home page for the International Organization for Standardization.
https://www.ngs.noaa.gov/ Home page for the U.S. National Oceanic and Atmospheric Administration National Geodetic Survey.
http://www.opengeospatial.org/ Home page for the Open Geospatial Consortium.
http://www2.usgs.gov/ngpo/ Home page for the USGS National Geospatial Program.
https://archive.usgs.gov/archive/sites/www.usgs.gov/pubprod/index.html Home page for USGS Maps, Imagery, and Publications.
http://communities.usgs.gov/blogs/vis/usgs-identifier/ Home page for USGS Identifier information.
https://internal.usgs.gov/ngp/branding/artwork.html The National Map logo library.

Appendix 1. Notes and Discussion Issues

This appendix contains additional discussion about several of the design decisions for the US Topo product.

Datums—North American Datum 1983 and World Geodetic System of 1984

The following is from the Federal Register: August 15, 1995 (v. 60, no.157), "Use of the NAD 83/WGS 84 Datum Tag on Mapping Products" (Federal Register, 1995).

> "SUMMARY: The Office of National Geodetic Survey, redefined and readjusted the North American Datum of 1927 (NAD 27), creating the North American Datum of 1983 (NAD 83). The World Geodetic System of 1984 (WGS 84) was defined by the Defense Mapping Agency (DMA). The interagency Federal Geodetic Control Subcommittee (FGCS) at its meeting on December 7, 1994, recommended that
>
> 'All maps and charts produced for North America, at scales of 1:5,000 or smaller, that are based on either the North American Datum of 1983 (NAD 83) or the World Geodetic System of 1984 (WGS 84), should have the horizontal datum labeled as NAD 83/WGS 84.'
>
> SUPPLEMENTARY INFORMATION: The following supplementary information was reviewed by FGCS membership. A Federal Register notice published on June 29, 1979 (44 FR 37969), by the National Oceanic and Atmospheric Administration (NOAA) provided notification of the establishment of a new Datum (NAD 83) to which the geographic and plane coordinate values for the National Network of Horizontal Geodetic Control would be referenced. A Federal Register notice published on June 14, 1989 (54 FR 25318), by NOAA affirmed NAD 83 as the official horizontal datum for all future U.S. surveying and mapping activities performed or financed by the Federal Government. Furthermore, this notice said that to the extent practicable and feasible, all Federal agencies using coordinate information should provide for an orderly transition to NAD 83. Both NAD 83 and WGS 84 were originally defined (in words) to be geocentric and oriented as the Bureau International de l'Heure (BIH) Terrestrial System. In principle, the three-dimensional coordinates of a single physical point should therefore be the same in both NAD 83 and WGS 84 systems; in practice, small differences are sometimes found. The original intent was that both systems would use the Geodetic Reference System of 1980 (GRS 80) as a reference ellipsoid. As it happened, the WGS84 ellipsoid differs very slightly from GRS 80. The difference is 0.0001 meters in the semi-minor axis. Effective January 2, 1994, the WGS 84 reference system was realigned to be compatible with the International Earth Rotation Service's International Terrestrial Reference Frame (ITRF)."

Off-Grid and Oversized Maps

The National Geospatial Program policy of not allowing oversize or off-grid maps has several implications:

- The development and maintenance of map-production software and procedures is simpler. This is the primary reason the current standard dictates only on-grid, standard-size products. Building production systems to accommodate the special cases of off-grid products is difficult and the number of cells involved is small.
- Softcopy map users will probably not be significantly inconvenienced by this policy and may consider the higher level of regularity and standardization to be a benefit.
- The primary effect of this policy is to users who rely on paper maps. There will be some instances of maps that are covered almost completely by water and instances of small island chains broken up into several pieces. In these cases, users who print their own maps will use more ink and paper to print very little additional information.

Image Ground Sample Distance, Bit Depth, Resolution, and Compression

The goal in US Topo map production is to construct a geospatial PDF that strikes a balance between manageable file size and visual quality.

The orthoimage has the greatest effect on file size. Government-procured orthoimagery is typically collected at a ground sample distance (GSD) between 6 inches and 1 meter. Though source orthoimagery may be collected at higher resolution, the US Topo product calls for an orthoimage with a GSD of approximately 1.5 meters. This imagery resolution was chosen for the US Topo product because a 1.5-meter GSD at 1:24,000 scale corresponds to a file size of approximately 30 MB, the target file size for US Topo maps. This imagery resolution also results in a map resolution of 400 pixels per inch (PPI), which is an appropriate resolution for visual quality and printing at scales as large as 1:10,000.

Bit depth represents the precision with which colors are specified in an image. For example, a RGB (red green blue) image is a 3-band image, with each band an 8-bit image, stores a total of 24 bits of color intensity values per pixel. An 24-bit true-color image is deemed to be of appropriate visual quality for viewing and printing.

A 7.5-minute orthoimage cell at 300 PPI contains approximately 35 million pixels, equating to over 100 megabytes (MB) of RGB image data. The same tile at 400 PPI (1.5 meter GSD) is almost twice as large. Given this hefty potential file size, lossy compression (elimination of data) is required to produce a 7.5-minute geospatial PDF containing 1.5-meter orthoimagery with a file size of approximately 30 MB. Compression is a tradeoff between quality and file size, as higher compression ratios result in smaller file sizes but lower quality images. The 30 MB file size is considered optimal for maintaining high quality for printing and is a manageable file size for storage, viewing, and manipulation of the geospatial PDF.

Note that compression is achieved with built-in features of commercial software for which precise algorithms are proprietary. The geospatial PDF compression settings for US Topo products are a quality setting of 75 percent and an adaptive image compression setting. Displaying and printing requires decompressing the data, which is done automatically by the Adobe Reader software, but the memory management of decompression is implementation dependent.

Geographic and Cultural Features and Their Names and Labels

The United States Board on Geographic Names (BGN) publication "Principles, Policies, and Procedures—Domestic Geographic Names" (U.S. Board on Geographic Names, 2016), states (page 4):

> "In accordance with Public Law 80-242, only official geographic names are to be used on Federal maps, publications, and other conventional and digital products, including websites. An official name is one in which the written form of that name and its application to the appropriate place, feature, or area are approved by the BGN or the appropriate administrative agency. By law, the BGN is responsible for all geographic names except those applying to offices or establishments of Federal agencies *** As a practical matter, the Board of Geographic Names (BGN) focuses on the names of natural features, as well as canals, channels and reservoirs, in the United States, and its territories and outlying areas ***"

Principle IV (p. 8–9) explains that names falling within the scope of other authorities (Federal agencies, State and local governments and associated entities, Native American Tribes, and structures on private property) are only the subject of BGN decisions when the Board decides that it is necessary to settle a conflict between the different authorities.

The document continues on page 4:

> "The Geographic Names Information System (GNIS) represents the Federal Government's only official repository for identifying official place-names *** All names in GNIS other than variant names are considered official for Federal use ***"

Appendix 2. 1:24,000-Scale US Topo Style Sheet

The US Topo style sheet for 1:24,000-scale maps is part of this US Topo Product Standard, and is published as an oversized map sheet included with this publication.

Appendix 3. 1:25,000-Scale US Topo Style Sheet

The US Topo style sheet for 1:25,000-scale maps is part of this US Topo Product Standard, and is published as an oversized map sheet included with this publication.

Appendix 4. 1:20,000-Scale US Topo Style Sheet

The US Topo style sheet for 1:20,000-scale maps is part of this US Topo Product Standard, and is published as an oversized map sheet included with this publication.

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Or visit the National Geospatial Technical Operations Center website at
https://ngtoc.usgs.gov/

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