National Mapping Program
Technical Instructions

USGeoData

Digital Line Graphs from 1:100,000-Scale Maps

Data Users Guide 2

Department of the Interior
U.S. Geological Survey
National Mapping Division

DATA USERS GUIDES

1: Digital Line Graphs from 1:24,000-Scale Maps
2: Digital Line Graphs from 1:100,000-Scale Maps
3: Digital Line Graphs from 1:2,000,000-Scale Maps
4: Land Use and Land Cover Digital Data from 1:250,000- and 1:100,000-Scale Maps
5: Digital Elevation Models
6: Geographic Names Information System
7: Alaska Interim Land Cover Mapping Program

Data Users Guides generally replace the Geological Survey Circular 895.

Questions regarding availability and ordering of US GeoData (all types of digital cartographic and geographic data produced and distributed by the U.S. Geological Survey) should be addressed to:

User Services Branch
National Cartographic Information Center
U.S. Geological Survey
507 National Center
Reston, Virginia 22092
(703)860-6045

Technical questions and comments should be addressed to:

Office of Technical Management
U.S. Geological Survey
510 National Center
Reston, Virginia 22092

UNITED STATES
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

DIGITAL LINE GRAPHS FROM 1:100,000-SCALE MAPS

Data Users Guide 2

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DIGITAL LINE GRAPHS FROM 1:100,000-SCALE MAPS

INTRODUCTION

The National Cartographic Information Center (NCIC) distributes digital cartographic/geographic data files produced by the U.S. Geological Survey (USGS) as part of the National Mapping Program. Digital cartographic data files may be grouped into four basic types. The first of these, called a Digital Line Graph (DLG), is line map information in digital form. These data files include information on planimetric base categories, such as transportation, hydrography, and boundaries. The second form, called a Digital Elevation Model (DEM), consists of a sampled array of elevations for ground positions that are usually, but not always, at regularly spaced intervals. The third type is Land Use and Land Cover digital data, which provides information on nine major classes of land use such as urban, agricultural, or forest as well as associated map data such as political units and Federal land ownership. The fourth type, the Geographic Names Information System, provides primary information for known places, features, and areas in the United States identified by a proper name.

The digital cartographic data files from selected quadrangles currently available from NCIC include the following:

- Digital Line Graphs (DLG's)
  --1:2,000,000-scale maps
  --7.5- and 15-minute topographic quadrangle series
  --1:100,000-scale quadrangle series

- Digital Elevation Models (DEM's)
  --7.5-minute quadrangle coverage
  --1.0-degree quadrangle coverage

- Land Use and Land Cover digital data
  --1:250,000- and 1:100,000-scale land use and land cover and associated maps
  --1:250,000-scale Alaska Interim Land Cover Maps

- Geographic names

This document describes the Digital Line Graphs (DLG's) prepared from the 1:100,000-scale materials associated with the USGS Topographic Map Series. The series will eventually provide complete national coverage.

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The digital data are useful for the production of cartographic products, such as base maps, and the data are structured to support the analytical functions of geographic information systems. A typical use of base category digital cartographic data is to combine them with other geographically referenced data, enabling various automated spatial analyses to be conducted.

DATA COLLECTION

The following is a general overview of DLG data collection methods currently in use at the USGS. Individual Mapping Centers may vary the details of data collection, but the basic method and resultant DLG-3 files remain standard.

The USGS collects DLG data files using manual, semiautomatic, and automatic digitizing systems.

The manual digitizing method is accomplished primarily on Altek and Intergraph digitizing systems. Stable-base manuscripts of the relevant data categories are prepared from the original map separates. The operator initiates digitizing by fixing the manuscript to the digitizing table, and collecting registration points for the corners of the quad. Features and their corresponding attributes are digitized as lines, nodes, or areas. Both systems are capable of collecting the topological elements and their associated codes concurrently; in addition, the DLG processing software, PROSYS, is able to automatically place area pointings for areas which carry no attribute codes. The Altek digitizing systems currently in use by the USGS are basically "blind" systems. In order to view the captured data the operator must generate plots or utilize a separate graphics display terminal. The Intergraph systems at the USGS allow for the visual display of the digitizing in progress, interactive editing, and for access to commonly used attribute codes. When all positional and attribute coding is complete, the digitized data file is processed through PROSYS software, which builds the topology and identifies structural errors. On the Altek systems, coding and positional accuracy are verified using plots. The Intergraph system allows for visual confirmation of most codes, but plots are used for accuracy checks and for quality control in more complex areas. After the file has been corrected and reprocessed through PROSYS, it is entered into the National Digital Cartographic Data Base (NDCDB) as a DLG-3 file.

The semiautomatic line-following method of collecting data is accomplished on Laser-Scan systems. This is an interactive line-following digitizing and editing system. Graphic data are captured in vector format and the line strings interactively coded. The primary application of the Laser-Scan equipment at the USGS is to collect hypsography data. The Lasertrak digitizer uses a film negative that is a photographic reduction of the original source material. The reduction factor is dependent on the latitude of the quadrangle, the density of the data, and photographic line reduction limitations. Prior to each digitizing session, the operator performs calibration and registration procedures to ensure that digitizing accuracy is maintained. The reduced film negative is projected onto a large format display screen. The operator selects and codes the feature to be digitized, monitors the progress of the Lasertrak as the feature is

automatically collected in vector format, and intervenes when an error occurs or when automatic line following is interrupted due to graphic ambiguities. The resulting vector file is processed to correct distortions and to detect errors, and plots are produced to facilitate quality control and editing. The Laser-Scan interactive Edit System allows for correction of digitizing errors, paneling of adjacent sections, and for manual collection and coding of categories of data which do not lend themselves to efficient line following. When editing is complete, the data are converted from Laser-Scan's Internal Feature Format into PROSYS input format and processed through PROSYS to build topology and identify structural errors. After the data file has been edited and reprocessed to correct errors, the DLG-3 file is entered into the NDCDB.

The automatic method of collecting data is accomplished using Scitex raster scanning and editing systems. Graphic data are captured in raster format from composites of selected map features, then edited, and reformatted into vector data. In preparation for scanning, a stable-base composite of the map separates is prepared representing the data category to be collected. Prior to scanning, the manuscript is annotated in a prescan editing process to identify features or locations which will require inspection by the Scitex operator. The scanned raster data file is manipulated interactively and in batch mode on the Scitex Response color edit station. The first editing operation (postscan edit) is a general cleanup. The interactive editing is facilitated by automatic search routines which present the operator with the problem areas identified in the prescan edit. The linework is then skeletonized (thinned to a centerline of one-pixel width). A one-pixel gap is made in the linework at the locations of attribute change annotated during the prescan edit. These breaks in the linework mark the positions for node placement during structuring. Linear features symbolized by dots or dashes are changed to a continuous line, and point features, such as wells and rocks, are changed to single points through interactive edit and batch procedures. When line editing is complete, the raster files are vectorized. Complete or partial feature coding is accomplished using the manual and semi-automatic coding capabilities of the Scitex edit stations. The files are then processed through PROSYS to build topology and to identify structural errors. Files which were only partially coded on the Scitex are sent in DLG format to Intergraph stations for coding completion. Quality control plots are generated to check positional and coding accuracy; the corrected files are then reprocessed through PROSYS and entered into the NDCDB as DLG-3 files.

DATA CONTENT

The DLG data files derived from the 1:100,000-scale maps contain selected base categories of cartographic data in digital form; these data categories do not necessarily correspond to the traditional feature separates associated with the maps. The following categories are included in current 1:100,000 DLG files:

- Hydrography -- This category of data describes combined hydrography consisting of all flowing water, standing water, and wetlands.

- Transportation -- This category of data includes major transportation systems collected in three separate subcategories labeled: (1) roads and trails, (2) railroads, and (3) pipelines, transmission lines, and miscellaneous transportation.

- Hypsography -- This category of data consists of information on topographic relief (primarily contour data), and supplementary spot elevations.

- Boundaries -- This category of data consists of (1) political boundaries that identify States, counties, cities, and other municipalities, and (2) administrative boundaries that identify areas such as National and State forests. Political and administrative boundaries are always collected as a single data set.

- Public Land Survey System (PLSS) -- This category of data describes the rectangular system of land surveys that is administered by the U.S. Bureau of Land Management. PLSS data are only collected for areas falling solely, or in part, within the States that were formed from the public domain. The PLSS subdivides the public domain and represents property boundaries or references to property boundaries. These DLG data are not intended to be official or authoritative. They are presented as cartographic reference information. The only legal basis for determining land boundaries remains the original survey.

The hypsography, boundary, and PLSS categories were authorized for production in late 1987. Currently there is very little data available in these categories.

The remaining categories: manmade features, survey control, vegetative surface cover, and nonvegetative features are projected to enter the production phase in 1990.

DATA STRUCTURE

Levels of Structuring

The term Digital Line Graph (DLG) is used by the USGS to describe a digital map data set in vector form. Originally, three levels of DLG data (DLG-1, DLG-2, and DLG-3) were envisioned; these levels were differentiated by their positional accuracy, level of attribute coding, and relational spatial information. It was found, however, that the widest user community would by served by producing DLG-3 data, which have the full range of attribute codes and are fully topologically structured. These two properties are required by users whose work includes both graphic and analytic applications. Therefore, all DLG data in the National Digital Cartographic Data Base are level 3.

Topology

Current data collection from 1:100,000-scale maps is exclusively directed toward producing fully topologically structured level 3 DLG data referred to as DLG-3. The DLG-3 concept is based on graph theory in which a two-dimensional diagram is expressed as a set of nodes (topologically significant points), lines, and areas in a manner that explicitly expresses logical relationships. Applied to a map, this concept is used to encode the digital data with the spatial relationships between map elements which are obvious when the map is examined visually. The spatial relationships include such concepts as adjacency and connectivity between features on the map. The abstraction of the map data according to the rules of graph theory preserves the spatial relationships inherent in the map graphic and creates a logical and consistent data file structure for computer processing. A digital file of cartographic or geographic data that maintains the spatial relationships inherent in the map is called a topologically structured data file. A topologically structured data file can support simple graphic applications, such as plotting streams and roads for base maps, as well as more advanced applications, such as computations and analyses involving areas and lines and their spatial relationships.

Topological Elements

A DLG-3 file is composed of three separate, but related, elements: nodes, lines, and area identifiers. Nodes define the location of the endpoints of every line, and a single node may mark the start or end of one or more lines. Thus, nodes occur at intersections of linear features and other places on linear features where the feature is subdivided into separate line segments.

A line is an ordered set of points that describes the position and shape of a linear feature on the map. Each line starts at a node and ends at a node, and has an area to the left of its direction of travel, and has an area to the right of its direction of travel. The direction of travel is arbitrarily determined at the time of data capture. Lines connect to each other at nodes, and a line does not cross itself or any other line. A line may describe the boundary between two areal map features, such as counties, or may define a map feature by itself, such as a road. A special line, called a degenerate line, is used to define features symbolized as independent points on a map. A degenerate line starts and ends at the same node, has two identical coordinate pairs, has zero length, and has the same area to the left and right of the direction of travel; that is, it is totally enclosed inside one map area.

An area is a portion of the map bounded by lines. All portions of the map must be assigned some area point. Each area is identified in a DLG-3 data file by a point chosen to represent the characteristics of the area. Newer versions of the processing software, the DLG Production System or PROSYS, locate a given area point inside the area it represents, although this is not a structural requirement. Every DLG data file will have at least two areas identified: one representing the area covered by the file and the other representing the area outside the coverage of the file. Additional areas will be identified as necessary to subdivide the

area covered by the file. Polygons as unique features are not defined explicitly in a DLG file. However, polygons can be constructed using line-area linkages built into the DLG data structure.

ATTRIBUTE CODES

In addition to locational and topological information, DLG data elements may have explicitly encoded attributes. Attribute codes, also called feature codes or classification attributes, are used to describe the map information represented by a node, area, or line. For example, the attribute code for an area might identify a lake or a swamp; the attribute code for a line might identify a road, railroad, stream, or shoreline; the attribute code for a node might identify the upper origin of a stream (fig. 1). The codes are based on the cartographic features symbolized on the USGS Topographic Map Series. These maps are the basic source material used to digitize and to encode the data elements and therefore the map symbology has a strong influence on the overall classification strategy. A listing of all the attribute codes currently assigned and used in the 1:100,000- scale DLG files is given in Appendix D. Detailed information on how to apply and interpret the attribute coding system is given in Standards for Digital Line Graphs, Part 3: Attribute Coding. (This publication may be purchased from the U.S. Geological Survey. See the Ordering Information inside the front cover.)

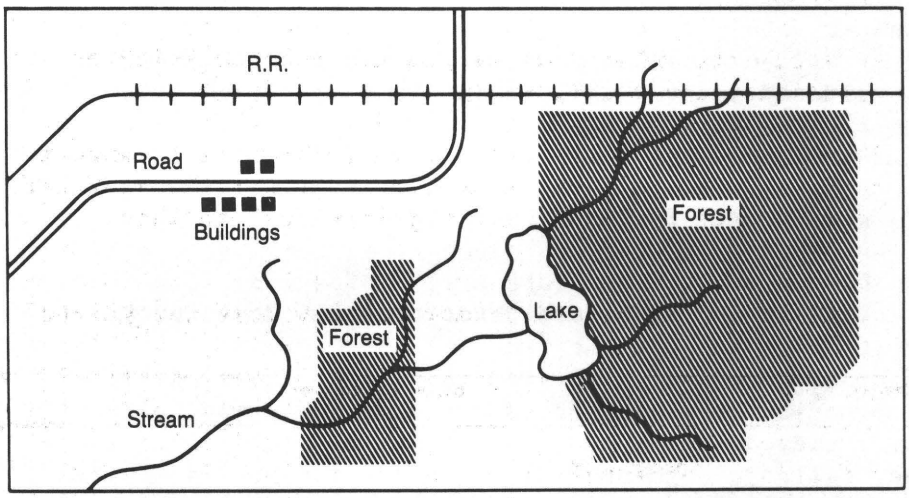

Figure 1.--Map elements showing roads, railroads, buildings, streams and lake and forest areas.

Each attribute code identifies the major category to which a data element belongs, as well as the specific nature of the element. Codes also may provide additional descriptive information. Most elements are uniquely described by a single attribute code. Others, however, may require two or more codes for a complete description. If multiple attributes are needed to describe an element, the order is not usually significant. Allowing for a variable number of attribute codes creates an open-ended structure to which information may be added at any time. It is not necessary for each element to have associated attributes; in general, attribute codes are not assigned to an element if the attributes can be

derived based on relationships to adjacent elements. For example, the mapped outline of an alkali flat is not assigned an attribute code because the line record carries a reference to the areas to the left and right. One area will be assigned an attribute code identifying the area as "alkali flat" and the other will have no attribute, signifying it is background or "nonhydrographic." The fact that the line defines an alkali flat is derivable.

A DLG attribute code is composed of two distinct numeric fields: a three-digit major code, which identifies the major category to which the element belongs, and a four-digit minor code, which specifically describes the element. In the digital file, the major and minor attributes are encoded in two integer fields of six digits, right justified with leading blanks (FORTRAN 2I6 format). In this document, major codes are presented as three digits, and minor codes are presented as four digits. Leading zeros are shown for clarity; for example: 050 0412.

Major Attribute Codes

A list of the major codes for the categories that are currently being collected is contained in table 1. The first two digits of the major code uniquely identify the category to which the described element belongs. The third digit of the major code is used to modify the minor code in two ways:

- If zero, the minor code represents a description or classification of the element.
- If nonzero, the minor code which follows is a parameter requiring special interpretation according to instructions given in the codes for each category (see next section).

Table 1.--Major codes used for DLG base categories

Major Code	Base Category
020	Hypsography
050	Combined hydrography--streams, water bodies, and wetlands
090	Boundaries
170*	Transportation systems--roads and trails
180*	Transportation systems--railroads
190*	Transportation systems--pipelines, transmission lines, and miscellaneous transportation
300	U.S. Public Land Survey System

* Transportation systems have been assigned more than one major code so that their components may be readily separated for analytical applications.

Minor Attribute Codes

The first digit of the minor code is normally zero. If nonzero, it is used as a modifier to provide additional information such as road access or railroad status.

The remaining three digits are normally used to indicate the cartographic interpretation to be applied to specific elements. The type of element described by a particular code usually can be determined from the range of value of the last three digits:

001 - 099 = nodes
100 - 199 = areas
200 - 299 = lines
300 - 399 = degenerate lines
400 - 499 = codes which may be applied to any element type (nodes, lines, areas, or points)
601 - 699 = general descriptive codes

The last three digits (and occasionally all four digits) also may be used as a parameter code. Parameters are used when a minor code can legitimately assume a range of values such as a water elevation or a highway route number. The meaning of a parameter code is indicated by the (nonzero) third digit of the major code.

Sample Attribute Codes

Three examples using the DLG attribute codes follow and should be interpreted with reference to Appendix D.

Example A:

050 0412 The major code 050 indicates the combined hydrography category. The minor code 0412 identifies the feature as a stream.

Example B:

170 0201 The major code 170 indicates the roads and trails subcategory in the transportation category. The minor code 0201 identifies the feature as a class 1 highway.

170 0603 The major code 170 indicates the roads and trails subcategory in the transportation category. The minor code identifies the feature as a road under construction. This code would be used in addition to the code describing the class of road, and would appear in the same record with the code 170 0201.

Example C:

055 0033 The major code 055 indicates a river mile mark for the hydrography category. Because the last digit of the major code is nonzero, the minor code is a parameter. The minor code 0033 indicates that the value of the river mile mark at that point is 33.

Example D:

306 0033 The major code 306 indicates an Origin of Survey code for the U.S. Public Land Survey System category. Because the last digit of the major code is nonzero, the minor code 0033 indicates that the area element is referenced to the Willamette Meridian.

SAMPLE LINE GRAPH STRUCTURE

Examples of a line graph and its corresponding digital records are given in figure 2 and table 2. These examples are simplified representations of the concepts used in the DLG-3 structure; they are not actual data files. The examples shown are composed of 13 nodes, 5 areas, and 15 lines. The 13 nodes are labeled N1 through N13, the 5 areas are labeled A1 through A5, and the 15 lines are labeled L1 through L15. Each element type is maintained as a separate list in the digital data.

The map represented by the example is divided into five distinct areas labeled A1 through A5. Area A1 represents all the area outside of the map border. There is one outside area for each DLG-3. It is always the first area encountered and has the attribute code 000 0000. In the example given in figure 2, the portion of the map inside the border is divided into four areas, each bounded (closed) by lines. Area A2 is bounded by lines L14, L1, L4, and L5. Area A3 is bounded by lines L3, L13, L4, L6, L7, L8, L15, and L9. Area A4 is bounded by lines L8, L15, and L9. Area A5 is bounded by lines L5, L6, L7, and L10 and L2.

As implemented in the standard DLG-3 data structure, line elements contain the only explicit topological references. Each line contains pointers to its bounding nodes (starting and ending) and the areas that it bounds (left and right of the line). This format minimizes redundant linkages to achieve efficient data encoding and storage.

The lines in figure 2 are labeled L1 through L15. The lines can be identified by their starting node number, ending node number, number of the area to the left of the direction of travel, number of the area to the right of the direction of travel, and string of coordinates describing the alignment of the line. In this example, only two pairs of coordinates are shown; however, in an actual file, an irregular line would have a variable number of coordinate pairs up to a limit of 3,000 coordinate pairs. The direction of travel of the line is arbitrarily determined during the digitizing operation. In this example, L1 is encoded as proceeding clockwise around area A2. Thus line L1 starts at node N1, ends at node N3, has area A1 to the left of the direction of travel, and has area A2 to the right of the direction of travel. The coordinate string

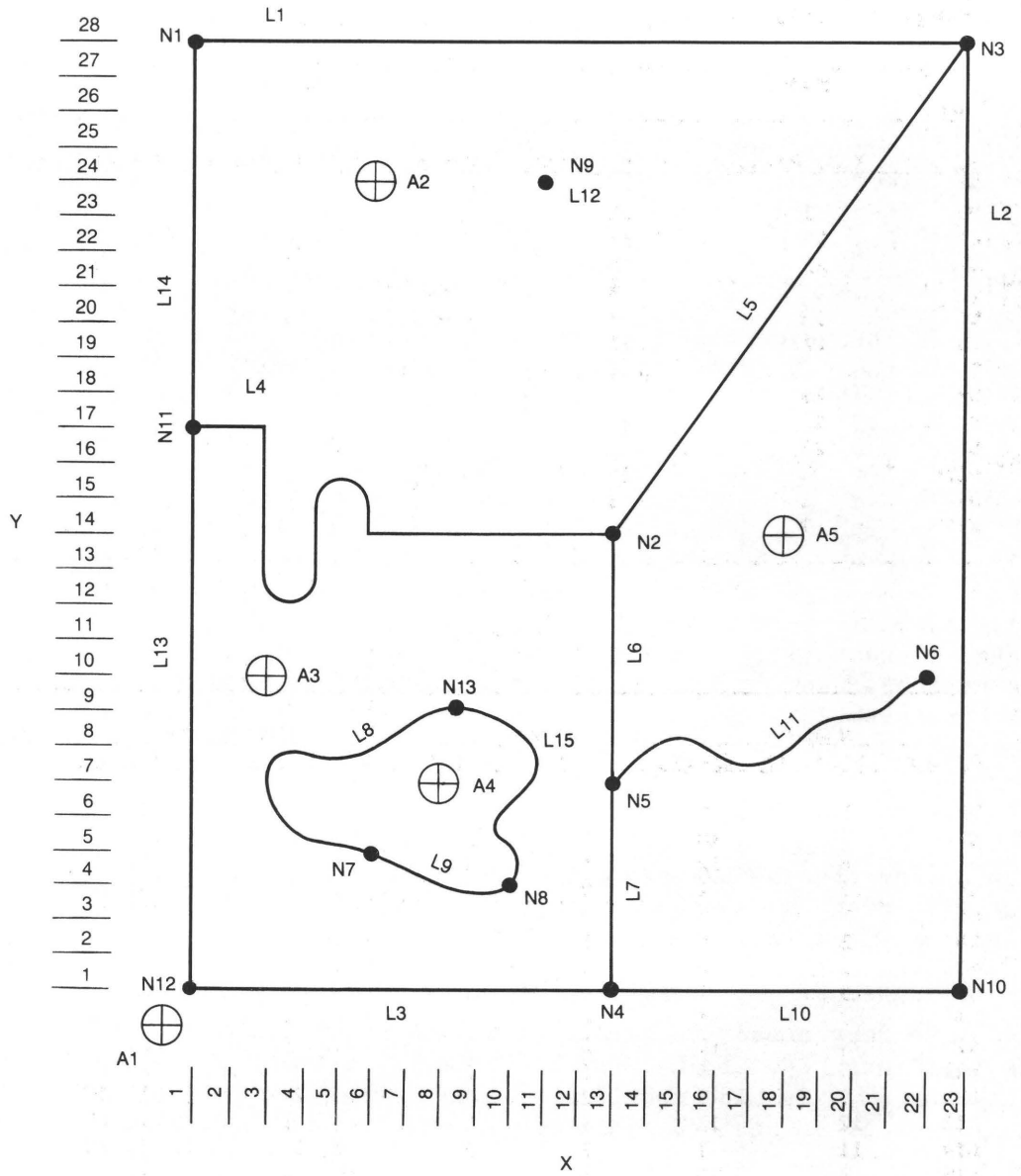

Figure 2.--Sample line graph.

describing the alignment of the line will start with the same coordinate values as that of node N1 and will end with the same coordinate values as that of node N3. Because the area to the left of its direction of travel, A1, is different from the area to the right of its direction of travel, A2, the line is known to be a boundary between the two areas.

Lines L11 and L12 are examples of lines that lie within one area. In this example, line L11 starts at node N5, ends at node N6, has area A5 to the left of the direction of travel, and again has area A5 to the right of the direction of travel. The coordinate string for the line will start with the same coordinate values as that of node N5 and will end with the same coordinate values as that of node N6. Line L12 is an example of a degenerate line. The line starts at node N9, ends at node N9, and has area A2 as both the area to its left and right. There are only two

Table 2.--Digital description of sample DLG-3 (see fig. 2)

Nodes			Areas		
Number	X Coordinate	Y Coordinate	Number	X Coordinate	Y Coordinate
N1	1	28	A1	0	0
N2	13	14	A2	6	24
N3	23	28	A3	3	10
N4	13	1	A4	8	7
N5	13	7	A5	18	14
N6	22	10			
N7	6	5			
N8	10	4			
N9	11	24			
N10	23	1			
N11	1	17			
N12	1	1			
N13	9	9			

Lines

	Nodes		Area		Coordinates		
Number	Starting	Ending	Left	Right	(first x y		last x y)
L1	1	3	1	2	1, 28		23, 28
L2	3	10	1	5	23, 28		23, 1
L3	4	12	1	3	13, 1		1, 1
L4	11	2	2	3	1, 17	....	13, 14
L5	2	3	2	5	13, 14		23, 28
L6	2	5	5	3	13, 14		13, 7
L7	5	4	5	3	13, 7		13, 1
L8	13	7	4	3	9 9	....	6, 5
L9	7	8	4	3	6, 5	....	10, 4
L10	4	10	5	1	13, 1		23, 1
L11	5	6	5	5	13, 7	....	22, 10
L12	9	9	2	2	11, 24		11, 24
L13	12	11	1	3	1, 1		1, 17
L14	11	1	1	2	1, 17		1, 28
L15	8	13	4	3	10, 4	....	9, 9

coordinate pairs in the string defining the line: both points have the same coordinate values as node N9; thus, the two points are the same and the line has zero length.

The line graph concept allows all of the points on the map to be described as a member of a line graph element (node, area, or line) with minimal redundancy. The relationships between the various elements are indicated by the structure. Note that in this example the x and y coordinates are numbered from the lower left corner to simplify the drawing. In an actual DLG-3 file, the origin is the center of the map and the internal file coordinates are numbered plus or minus 1 to 32,767 in thousandths of inches. See the section labeled "coordinate systems" for more detail.

GRAPH THEORY IN DLG DATA

The digital line graph concept is based on graph theory, in which a diagram can be expressed as a set of elements (nodes, areas, and lines) in a manner that shows logical spatial relationships with minimal redundancy. There are three ways to implement the line graph concept in DLG files: the area case, the network case, and the area-hybrid case. These cases are differentiated by the nature of the information contained in the category. Currently all NMD files are processed as area-hybrid case DLG's.

Area Case

Area line graphs can be used to represent area features such as political entities or the U.S. Public Land Survey System. In the pure area case, each line element bounds two different area elements, all closed circuits of lines form unique areas, and all areas are attribute coded. Line elements for area line graphs are not usually assigned primary attributes. The primary attribute characteristics of lines in these categories are derived by examining the attributes of the area elements on either side of the lines.

Network Case

Network line graphs can be used to represent linear features such as roads, railroads, or pipelines. The major topological relationship expressed by network data is that of connectivity. The network case differs from the area case in that, irrespective of the number of closed areas forming the graph, only two areas are encoded: (1) the area outside the graph, termed the outside area; and (2) the area within the graph, termed the background area. All lines except the graph boundary, or neatline, are considered to be contained within the background area. Lines may exist within the background area that are not part of closed line circuits. In the pure network case, the lines themselves have the identity and carry the appropriate attribute codes. Data encoded in network line graph form are suitable for various forms of network analysis, such as minimum path computations.

Area-Hybrid Case

In the area-hybrid case, network and area type information are gathered in a single DLG file. In this approach, all closed circuits of lines define unique areas. The unique areas which represent features for the overlay are given attribute codes. The remaining areas are recognized in processing as individual unattributed background areas. Linear features may exist which do not form boundaries between two areas. These lines may occupy a position in an unattributed background area, or in an attributed area. Lines that have significance in themselves are assigned attribute codes. For example, in the hydrography overlay, areal features such as lakes and swamps will be encoded with the appropriate attributes; surrounding nonhydrographic areas will be uncoded. Linear features such as

streams and aqueducts receive the appropriate line code; unattributed lines may also exist (e.g. around defined areal features such as an alkali flat).

Figure 3 shows a 7.5-minute window taken from the Cartersville, Ga., 1:100,000-scale quadrangle. Figure 4 shows the line graph encoded for the hydrography of the same area. Certain nodes, areas, and lines are labeled.

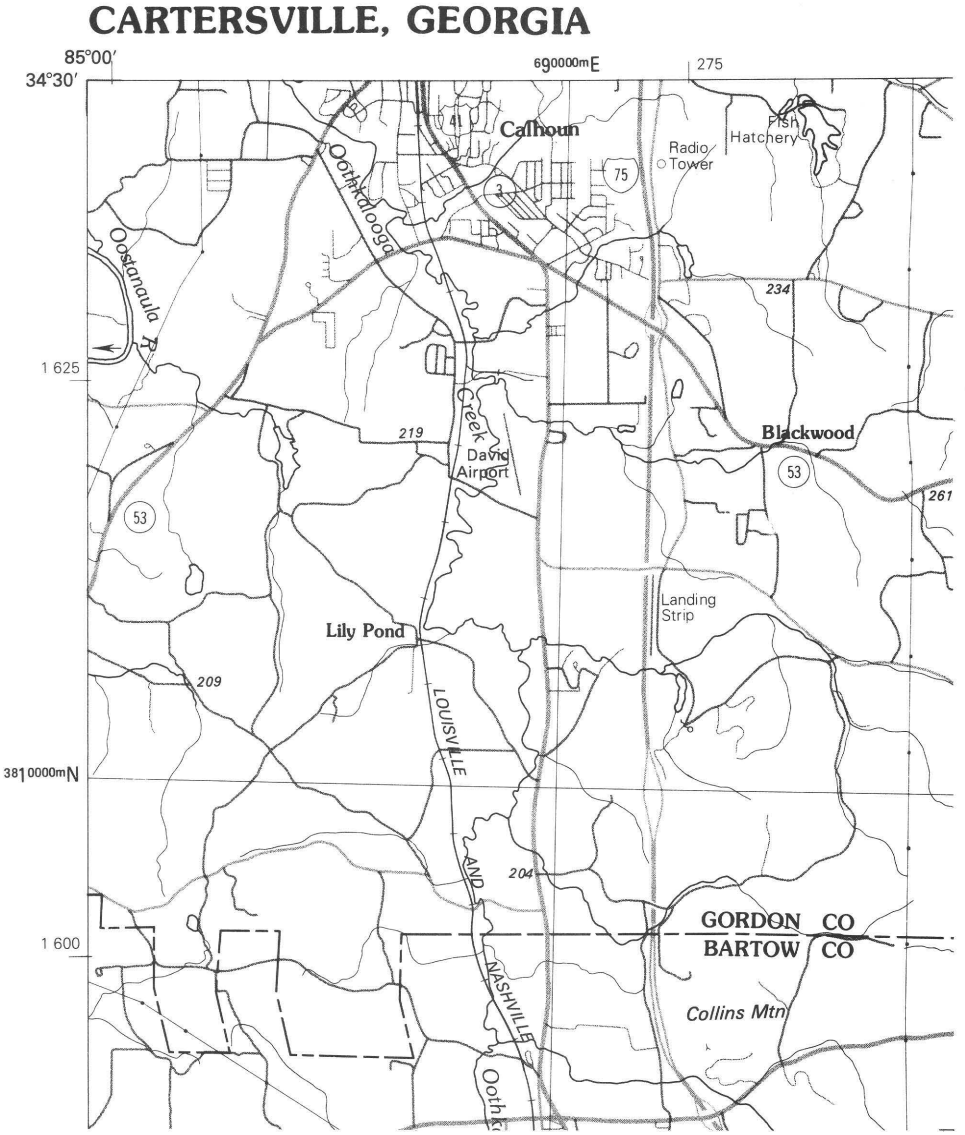

Figure 3.--Window from the Cartersville, Ga., 1:100,000-scale USGS quadrangle map.

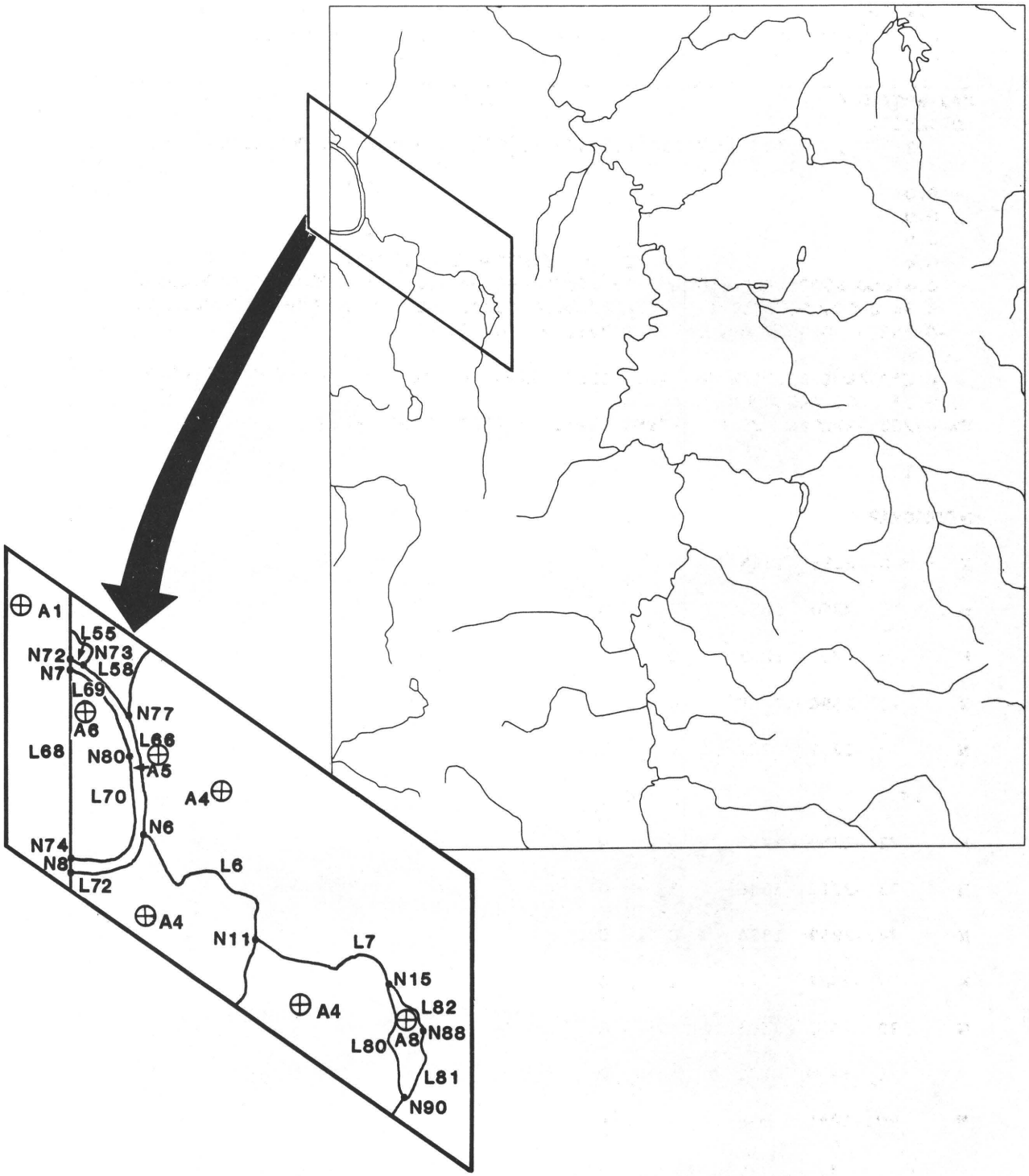

Figure 4.--Plot from line graph of hydrography, Cartersville, Ga., 7.5-minute section of quadrangle, with enlarged detail.

Table 3 contains some of the digital data records, extracted from the standard format DLG file, which describe this portion of the graph. The internal sequence identification numbers shown reflect the order of these features in the original file. (Note: Descriptions of DLG-3 formats are contained in Appendixes A and B, and a list of attribute codes is contained in Appendix D.)

Table 3.--Selected sample of standard format DLG-3 records of Cartersville, Ga., 7.5-minute section of quadrangle

```
CARTERSVILLE                    GA          1981,        100000.  S01
RO4.HYS01
     3     1    16  -0.840560150000038D+08   0.340260150000010D+08   0.0
                     0.0                      0.0
   0.0                     0.0                      0.0
   0.0                     0.0                      0.0
   0.0                     0.0                      0.0
   0.0                       2   0.254000000000000D+01     0     4
  -0.850000000000000D+02   0.343750000000000D+02  -0.850000000000000D+02
   0.345000000000000D+02  -0.848750000000000D+02   0.345000000000000D+02
  -0.848750000000000D+02   0.343750000000000D+02

   0.253948017060000D+01  -0.516359320290000D-01   0.689504506100000D+06
   0.381240214830000D+07      4
SW -2263 -2729NW -2260  2729NE  2259  2729SE  2263 -2729

     1

HYDROGRAPHY             795   118   795    22   530   138

N       6 -2034  1365      1     0

N       7 -2260  1285      0     0

N       8 -2261  1263      0     0

N      11 -1698  1059      0     0

N      15 -1292   929      1     0

     50     5

N      72 -2260  1855      0     0

N      73 -2217  1836      1     0

N      74 -2259  1824      0     0

N      77 -2087  1707      1     0

N      80 -2077  1584      0     0

N      88 -1200   821      0     0

N      90 -1244   608      1     0

     50     4

A       1     0     0     1     0

      0     0

A       4     0     0     0     0

A       5 -2057  1523      1     0

     50   412
```

Table 3.--Selected sample of standard format DLG-3 records of Cartersville, Ga., 7.5-minute section of quadrangle--continued

```
A       6      0      0      0      0

A       8  -1243    770      1      0

     50    421

L       6     11      6      4      4     21      1      0

 -1698  1059 -1699  1115 -1686  1140 -1686  1178 -1698  1193 -1718  1203
 -1777  1216 -1792  1238 -1838  1257 -1902  1243 -1910  1236 -1911  1212
 -1920  1208 -1929  1214 -1957  1249 -1957  1253 -1981  1281 -2010  1333
 -2009  1351 -2014  1361 -2034  1365
    50    412

L       7     15     11      4      4     17      1      0

 -1292   929 -1295   951 -1306   973 -1308   987 -1321  1000 -1359  1019
 -1416  1017 -1430  1008 -1434  1000 -1455   981 -1469   988 -1482  1000
 -1524   994 -1576  1002 -1644  1034 -1669  1050 -1698  1059

     50    412

L      55     73     72      5     18      2      1      0

 -2217  1836 -2260  1855

     50    606

L      58     77     73      5      4      5      1      0

 -2087  1707 -2116  1746 -2164  1801 -2213  1828 -2217  1836

     50    606

L      66      6     77      5      4      7      1      0

 -2034  1365 -2036  1520 -2052  1573 -2053  1586 -2065  1609 -2069  1643
 -2087  1707
    50    606

L      68     74      7      1      6      2      0      0

 -2260  1285 -2259  1824

L      70     74     80      6      5     10      1      0

 -2260  1285 -2207  1277 -2123  1284 -2103  1292 -2077  1315 -2063  1355
 -2058  1375 -2060  1472 -2063  1523 -2077  1584
    50    605

L      69     80      7      6      5     11      1      0

 -2077  1584 -2082  1616 -2085  1619 -2087  1637 -2094  1652 -2098  1675
 -2107  1695 -2161  1763 -2209  1801 -2244  1820 -2259  1824
    50    605
```

Table 3.--Selected sample of standard format DLG-3 records of Cartersville, Ga., 7.5-minute section of quadrangle--continued

```
L     72      8      6      5      4      7      1      0

 -2261  1263 -2192  1254 -2142  1256 -2106  1267 -2073  1283 -2044  1335
 -2034  1365
    50   606

L     80     90     15      4      8     14      1      0

 -1244   608 -1248   611 -1251   661 -1260   707 -1259   737 -1268   749
 -1292   765 -1289   779 -1268   824 -1268   843 -1276   858 -1281   883
 -1299   918 -1292   929

    50   200

L     81     90     88      8      4     12      1      0

 -1244   608 -1228   613 -1193   699 -1181   716 -1167   724 -1167   730
 -1180   743 -1198   769 -1196   787 -1179   802 -1177   810 -1200   821
    50   200

L     82     88     15      8      4      8      1      0

 -1200   821 -1200   848 -1200   854 -1202   864 -1202   875 -1260   898
 -1274   930 -1292   929
    50   200
```

In the Cartersville example, each node and area element is described by one or two logical records: (1) a type D.1 record that describes the element, and (2) an optional type F record that lists the attribute codes associated with the element. The first record (type D.1) for each node and area element contains the following fields:

1. Type of record indicator, N for node or A for area.
2. Internal sequence identification number.
3. X-coordinate of node or representative area point.
4. Y-coordinate of node or representative area point.
5. Number of attribute codes that describe the element.
6. Number of pairs of characters in the text string that describes the element.

The second record (type F) for each node and area element contains n attribute codes (expressed as major and minor code pairs), where n is the number specified in field 5 of the first (type D.1) record.

Each line element in the Cartersville example is described by two or three logical records: (1) a type D.2 line description record, and (2) a type E record that lists the x,y coordinate pairs that define the shape of the line, and, if appropriate, (3) a type F (attribute code) record. The first record (type D.2) for each line element contains the following fields:

1. Type of record indicator (L).
2. Internal sequence identification number.
3. Internal sequence number of starting node.

4. Internal sequence number of ending node.
5. Internal sequence number of the area to the left of the line.
6. Internal sequence number of the area to the right of the line.
7. Number of x,y coordinate pairs that locate the line on the map.
8. Number of attribute codes that describe the line.
9. Number of pairs of characters in the text string that describes the line.

The second logical record (type E) for each line element contains n coordinate pairs, where n is the number specified in field 7 of the first (type D.2) record. The type F record is as described above.

The specific records listed in table 3 completely describe several hydrographic features in the upper left section of figure 3, the Oostanaula River, a small irregularly shaped lake, and the single line stream flowing from the lake to the river. The records referred to in the following description have been extracted from a complete DLG. Therefore the internal sequence identifiers reflect the original order of the features in the file. The records are referred to by the internal sequence number, e.g., area 4, node 77, line 82.

The double line stream, Oostanaula River, is represented by area record 5 and identified by the attribute code 050 0412. Area records 4 and 6 are the background areas on either side of the river and as such have no attribute code assigned. The area outside of the map is represented by area record 1 and is identified by the attribute code 0 0.

Line records 55, 58, 66, and 72 form the left bank of the river, coded as though one were facing downstream. They are identified by the attribute code 050 0606. They can be chained by referring to the nodes. Line record 72 starts at node 8 and ends at node 6. Line record 66 starts at node 6 and ends at node 77. Line record 58 starts at node 77 and ends at node 73. Line record 55 starts at node 73 and ends at node 72.

The right bank of the river is formed in a similar fashion by line records 69 and 70, which are identified by the attribute code 050 0605. They are similarly linked through the nodes 7, 80, and 74. Note that the identity of the shoreline as either left or right bank, (coded as such to indicate downstream flow), is established by the attribute code without changing the identity of the feature. The given line segments making up the shore may be digitized in either direction. The segment of neatline represented by line record 68 stretches from node 7 to node 74, the two places where the right bank intersects the neatline. The neatline has no attribute code assigned but can be identified by the fact that the area on one side of it is the outside area, area 1.

Area record 8 is the irregularly shaped lake. It is identified by attribute code 050.0421. Its shoreline is formed by line records 80, 81, and 82, which are identified by attribute code 050.0200. These lines also can be identified as bounding area 8, by reference within the line record to area 8 being located either to the left or right of the line (depending on which way the digitizer traced each line). The lines can be chained by referring to the starting and ending nodes 90, 15, and 88.

The single-line stream that flows from the lake to the Oostanaula River is represented by line records 6 and 7 and identified by attribute code 050.0412. One stream segment connects to the lake at node 15 and one to the left river bank at node 6. The segments of the stream are themselves linked at node 11. Note that this stream has the same attribute code as the river. This is because both are streams, one of which is digitized as a line and one of which is digitized as an area and its delimiting banks. The direction of flow of this stream can be derived from the fact that node 15 is identified with attribute code 050.0005 (stream exiting hydrographic area). Background area 4 is located on both sides of the stream.

DISTRIBUTION FORMATS

The 1:100,000-scale DLG data are available in two distribution formats: (1) standard and (2) optional.

The standard distribution format is intended to minimize storage requirements. Explicit topological linkages are contained only in the line elements (starting node, ending node, area to the left of direction of travel, area to the right of direction of travel). A sample DLG in standard format is found in Appendix A.

The optional distribution format was designed to facilitate data usage. The topological relationships explicitly encoded include starting node, ending node, area to the left of direction of travel and area to the right of direction of travel for line elements, bounding lines for area elements, and bounding lines for node elements. These files are typically larger than those in the standard format but, for certain applications, can simplify processing requirements. For example, topological linkages are explicitly encoded for all line, node, and area elements, allowing a polygon data structure to be easily created. These linkages facilitate GIS applications of DLG data as well as generation of graphic products. A sample DLG in optional format is found in Appendix B.

The characteristics of the standard and optional DLG formats are summarized below in table 4.

SOURCE MATERIALS

The DLG data files described in this document are derived from USGS topographic maps published as 30- x 60-minute quadrangles at 1:100,000-scale. Where 1:100,000-scale coverage is not available, the following sources are used, in order of preference:

1. Bureau of Land Management editions of 1:100,000-scale maps,
2. Archival compilation materials, if available.

Table 4.--Standard and optional DLG format

	Standard	Optional
Character set	8-bit ASCII	8-bit ASCII
Logical record length	144 bytes	80 bytes
Physical record length (blocksize)	variable in multiples of 144 bytes	variable in multiples of 80 bytes
Coordinate system	internal file (thousandths of a map inch)	ground planimetric (UTM)
Topological linkages	contained only in line elements	contained in node, area, and line elements

These formats are described in detail in Appendixes A and B.

The scale of the source materials used to generate a DLG is contained in the file header. The scale is also reflected in the resolution field, which states the ground length in meters of the smallest data collection unit 0.001 inch (2.54 m).

CELL SIZE AND FILE EXTENT

The DLG's are distributed in groups of files that make up a 30- x 30-minute area of coverage representing the selected category of information in the east half or west half of a 1:100,000-scale source map. Each 30-minute area consists of a varying number of DLG files depending on the category and the feature density. The normal distribution group will be four 15-minute files per 30-minute area. If the feature density in an area is such that the file size would exceed the limitations of the processing programs, then that 30-minute area will be covered by sixteen 7.5-minute files. This seldom occurs except in the case of roads and trails in large cities.

For the categories currently available, the 30-minute area of coverage will comprise the following:

Category	Number of files	Size
Hydrography		
Normal	4	15 minute
Very Dense	16	7.5 minute
Transportation		
Normal		
Roads and trails	4	15 minute
Railroads	4	15 minute
Pipelines, Transmission Lines and Miscellaneous Transportation	4	15 minute
Very Dense		
Roads and trails	16	7.5 minute
Railroads	4	15 minute
Pipelines, etc.	4	15 minute
Hypsography		
Normal	4	15 minute
Very dense	16	7.5 minute
Boundary*		
Normal	4	15 minute
PLSS*		
Normal	4	15 minute

*Boundary and PLSS overlays are by nature less dense and will always be contained within four 15-minute files.

The quadrangle name field in the header record will contain the name of the 1:100,000-scale source map. However, the pieces or sections into which each is divided are identified within the header (A) record to the size and placement of each. In column 64-66, each section will be identified by a 3-character code XNN where:

X is a single letter indicating size
F = Fifteen (15) minute block
S = Seven and a half (7.5) minute block

NN is a two-digit number indicating the specific quad. Figure 5 illustrates this division with the sections labeled with the code that would appear in column 64-66 of the header record.

If data for a particular category exist only in a portion of a 30-minute area, the entire area will be digitized. The 7.5- or 15-minute sections which contain no feature in the given category will be digitized as "null" or empty files. This means they will contain the neatline records, inside

F01	F02	F03	F04
F05	F06	F07	F08

A 1;100,000-scale quad divided into eight 15-minute quads, 4 per 30-minute area.

S01	S02	S03	S04	S05	S06	S07	S08
S09	S010	S011	S012	S013	S014	S015	S016
S017	S018	S019	S020	S021	S022	S023	S024
S025	S026	S027	S028	S029	S030	S031	S032

A 1:100,000-scale quad divided into 32 7.5-minute quads, 16 per 30-minute area.

Figure 5.--Sectioning scheme for DLG data of a 1:100,000-scale quadrangle.

area record, and outside area records only in order to indicate the absence of any features in that category in that location. The remaining 7.5- or 15-minute sections which contain features in that category will be digitized as usual.

If no data for a particular category exist in an entire 30-minute area the entire 30-minute area will not be digitized. This occurs on coastal areas where an entire 30-minute area may be ocean, or along the national boundary where an entire 30-minute area may lie outside the United States. Data are not currently collected in Canada or Mexico. At some time in the future, the non-U.S. areas will be digitized and added to the NDCDB.

Nonstandard cells are not collected. In areas where map format is sometimes extended to conform to the shoreline or national boundary, the portion of the map that extends beyond the normal size is digitized as a separate file. Such cells are readily identified by examining the geographic coordinate limits contained in the file header. Such files may also be identified by the name which will be formed by adding descriptive information to the map name, such as "Mt. Baker O.E. N" (Mt. Baker over-edge North).

Preliminary Data

In mid-1986, the U.S. Geological Survey released a preliminary version of DLG's from 1:100,000-scale maps. These data differ in format from those previously described. Specific characteristics of these preliminary data are given below.

1. These data are topologically structured, attribute coded, and will be distributed in standard or optional DLG format.

2. The DLG's are distributed in groups of files that make up a 30- by 30-minute area of coverage representing a category of information in the east half or west half of a 1:100,000-scale source map. The distribution groups for both roads and trails, and hydrography will consist of sixteen 7.5-minute files (rather than four 15-minute files).

3. Railroad and miscellaneous transportation data consisting of a single 30-minute file will contain a 3-character TNN code in columns 64-66 of the header (A) record where:
   T = Thirty-minute (30) block
   NN = A two-digit number indicating the West (01) or East (02) half of a 1:100,000-scale graphic.

4. Preliminary data have not been processed through edge-matching software and will not include edge-join quality control flags.

The USGS is currently involved in a program to reformat data, originally available for distribution in preliminary format, to standard cell size. Data that have been processed through edge-matching software and reformatted to the standard cell size automatically supercede preliminary format data.

COORDINATE SYSTEMS

The positional descriptions for DLG data elements are expressed in one of two coordinate systems, dependent upon the distribution format selected. These are described as follows as the standard distribution format and the optional distribution format.

Standard Distribution Format

The DLG data in the standard distribution format are encoded using an internal file coordinate system to minimize storage requirements. The characteristics of this system are as follows:

1. The coordinate system is Cartesian.
2. The origin (x=0, y=0) is at the center of the cell.
3. The x-axis of the coordinate system is parallel to a theoretical straight line connecting the southwest and southeast corners of the cell, y-axis is perpendicular to that line.
4. One unit is equal to 0.001-inch at map scale.
5. The coordinate domain is limited to the range -32767 to +32767.

The file header contains the parameters of a transformation which can be used to convert the internal file coordinates to the ground coordinate system, which is the Universal Transverse Mercator (UTM) for 1:100,000-scale DLG's. An example of this transformation is given in Appendix E.

Optional Distribution Format

The DLG data in the optional distribution format are expressed in the units of the ground coordinate system, that is, meters in the UTM coordinate system.

DATA VALIDATION

The DLG data do not currently carry quantified accuracy statements. The following procedures, however, are used to validate the data files before they are released for distribution:

1. File fidelity and completeness -- The data are either manually digitized using equipment with a resolution of 0.001 inch and an absolute accuracy of from 0.003 to 0.005 inch, or are scanned on an automatic device with a resolution of 30 points per millimeter, or 0.0013 inch. The positional accuracy of the data and completeness of the file are checked by visually comparing proof plots with the original stable-base source material. These proof plots are generated using automated drafting machines with a resolution of 0.001 inch and an absolute accuracy of from 0.003 to 0.005 inch.

2. Attribute accuracy -- DLG attribute codes are checked by software against a table of valid codes to ensure that each attribute in a file is valid for the category and element type to which it is assigned. Validating the codes for correct application is currently a manual process involving the correlation of formatted listings with proof plots and graphic displays.

3. Topological fidelity -- The topological structure of each DLG file is fully validated by software. There are no extraneous intersections; that is, a line does not join or cross another line, or itself, except at a node. No line extends through a node. Polygon (area) adjacency is also validated; that is, area left and right topological attributes of lines are consistent throughout the file. The neatline is free of gaps. Validation of DLG data is performed for each category within a file.

Additional data validation is being implemented as follows:

1. Edge matching -- Validation software provides for checking the edges of each quadrangle against the edges of the four adjacent quadrangles. Each edge of a DLG-3 is checked for positional and attribute matching along the neatlines of the adjoining DLG-3 cells, providing that the surrounding data cells are available at the time the DLG-3 is entered into the NDCDB. There is currently no attempt, other than the coding of coincident features, to provide fully integrated data categories.

2. Quality Control Flags -- Information in the header of the DLG-3 indicates the status of the file with respect to the edge matching described above. Twelve bytes at the end of record A.1 in the standard distribution format and at the end of record 3 in the optional distribution format of the ASCII file are set aside for quality control flags (see Appendices A and B). The first three

of these flag positions are for future use. The fourth flag position contains a value encoded in the bit pattern that is used only by the data base manager to check the edge status. The remaining eight flags indicate to the user the edge status code and the status reason code. The four status flags contain the status of the West, North, East, and South edges of a DLG-3 as compared to the edges of the four adjoining DLG-3 files. Each of the four flags is followed by a status reason code that explains the status of the four edges respectively.

The possible status values for a DLG-3 entered into the NDCDB are:

(blank) = unchecked
0 = passed edge match check
1 = alignment discontinuity
2 = attribute discontinuity
3 = attribute and alignment discontinuity

The possible reason flags are:

(blank) = no reason code set ("unchecked" for some earlier data sets)
4 = adjacent data do not exist
5 = adjacent data unavailable
6 = graphic discontinuity
7 = mismatch valid
8 = paneling unauthorized

The following combinations of status flags and reason flags are currently valid for the processing software.

blank,blank	blank,4	blank,5	blank,8
	0,blank		
	1,6 1,7		
	2,6 2,7		
	3,6 3,7		

The following is a brief explanation of the reason flags.

4 = adjacent data do not exist -- This flag is used with a status flag of blank (unchecked). This combination exists primarily for file edges which are adjacent to areas unmapped within the series/scale of products being digitized, e.g. coastal and international boundary locations. These flags are also used for Public Land Survey System (PLSS) file edges which border areas of the country not having PLSS information.

5 = adjacent data unavailable -- This flag is used with a status flag of blank (unchecked). This flag is appropriate for edges adjacent to areas having similar source material and data categories, but which have not been digitized and archived. A reason code with the value of 5 may be reset as the adjoining data cell becomes available for edge match verification.

6 = graphic discontinuity -- This flag indicates a discontinuity in classification or alignment between features on adjacent graphics which were digitized as represented.

7 = mismatch valid -- This reason flag applies in the case of a linear graph element ending precisely on the neatline or having a reasonable attribute value change as it crosses the neatline, (e.g. a single line stream ending on the neatline, a road changing from third to fourth class at the neatline).

8 = panelling unauthorized -- This flag is used with the edge status flag of blank and indicates that no authorization was in place for edge matching at the time the data were archived.

This flag is to be used when adjoining quads do not match in cell size (e.g. the situation internal to a 1:100,000-scale project, where a standard 15-minute distribution file adjoins four 7.5-minute files, which cannot at this time be merged into standard 15-minute format because of the density of the data).

In the course of checking and aligning an edge, it is possible to encounter more than one reason for a mismatch status, such as both valid and graphic discontinuities. In such cases the reason flag is to be set to indicate the "worst case," i.e. the reason indicating the most serious problem with the edge and which in most cases would require some degree of correction in the future. For the above example, the graphic discontinuity reason flag would be set in preference to the mismatch valid flag.

> When an edge status code is other than "0", the DLG-3 file will be entered into the DCDB only when the reason code has also been set as a result of examination of the file.

APPENDIXES

APPENDIX A.--Standard DLG Distribution Format (Record Contents)

In the standard DLG format, the topological linkages are contained only in the line elements. The files are physically comprised of standard ASCII characters organized into fixed-length logical records of 144 characters. Nine distinct record types are defined.

Logical record type	Content
A	Header record containing DLG identification information.
B	Header record containing projection information and registration points.
C	Header record identifying data categories contained in this DLG and indicating the number of nodes, areas, and lines in each category.
D.1	A node or an area record.
D.2	A line record.
E	Record containing x,y coordinate strings.
F	Record containing attribute codes.
G	Record containing text string (not currently used).
H	Accuracy estimate (not currently used).

The actual sequence of records in a standard distribution DLG file is as follows:

1. Header records
   - Type A (one record)
   - Type B (one record)
   - Type C (one record)

2. Data records

Node records	Repeated
Node description (D.1)	for each
Attribute codes (F)	node within a
Text string (G)	data category
Area records	
Area description (D.1)	Repeated
Attribute codes (F)	for each
Text string (G)	area within a
	data category
Line records	
Line description (D.2)	Repeated
X,Y coordinates (E)	for each
Attribute codes (F)	line within a
Text string (G)	data category

3. Accuracy estimate
   - Type H (one record) (not currently used)

Descriptions of the contents of records A-F are contained in the following tables. The tables also reflect the relationship between these record types and 144-byte logical records.

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

[Integer fields with a value of zero will have leading zeros suppressed. [Any field with the format of D24.15 which has a value of zero will be represented as "bbb0.0bbbbbbbbbbbbbbbbbb", the last four positions of the fractional portion being reserved for a decimal exponent. (b=blank)]

Logical Record Type A

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
A.1	1	Name of digital cartographic unit	ALPHA	A40	1	40	The name of the digital data cell followed by the State two-character designators, separated by hyphens.
---	---	Filler	---	---	41	41	1 space
A.1	2	Date of original source materials	ALPHA	A10	42	51	Year of original source material, followed by latest revision date if applicable. For example, 1956, 1965.
A.1	3	Date qualifier	ALPHA	A1	52	52	Qualifier to discriminate revision date, if present. (P=photorevision, I=photo-inspected, L=limited revision, D=digital revision)
A.1	4	Scale of original source material	INTEGER*4	I8	53	60	Scale denominator of source material; for example, 24000, 100000, or 2000000.
(Data elements 5 through 23 of record A.1 apply to 1:24,000- and 1:100,000-scale files only. For 1:2,000,000-scale data files, bytes 61 - 144 of record A.1 are filler.)							
---	---	Filler	---		61	63	3 spaces
A.1	5	Sectional indicator (100K files)	ALPHA	A3	64	66	Codes S, F, or T for size of section, plus sequence number.

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type A--continued							
Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
---	---	Filler	---	---	67	113	47 spaces
A.1	6	Largest primary contour interval	ALPHA	A4	114	117	Largest primary contour interval, followed by the interval unit (1=feet, 2=meters). Present only if two or more primary intervals exist. (selected categories)
A.1	7	Comma	ALPHA	A1	118	118	comma separator
A.1	8	Largest primary bathymetric contour interval	ALPHA	A4	119	122	Largest primary bathymetric interval, followed by the interval unit (1=feet, 2=meters, 3=fathoms). Present only if two or more primary intervals exist. (selected categories)
---	---	Filler	---	---	123	123	1 space
A.1	9	Smallest primary contour interval	ALPHA	A4	124	127	Smallest or only primary interval, followed by the interval unit as shown above. (selected categories)
A.1	10	Comma	ALPHA	A1	128	128	comma separator
A.1	11	Smallest primary bathymetric contour interval	ALPHA	A4	129	132	Smallest or only primary bathymetric interval, followed by the interval unit as shown above. (selected categories)

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type A--continued

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
A.1	12-14	Coded flags	ALPHA	A1	133	135	3 flags for future use
A.1	15	Coded flag	ALPHA	A1	136	136	Database coded edge flag
A.1	16	EDGEWS	ALPHA	A1	137	137	Status flag for west edge, values are: b = unchecked, 0 = passed, 1 = alignment discontinuity, 2 = attribute discontinuity, 3 = attribute and alignment discontinuity.
A.1	17	EDGEWR	ALPHA	A1	138	138	Reason for EDGEWS, values are: b = no problem, 4 = adjacent data do not exist 5 = adjacent data unavailable, 6 = graphic discontinuity, 7 = attribute mismatch valid, 8 = paneling unauthorized
A.1	18	EDGENS	ALPHA	A1	139	139	Status flag for north edge, values = b,0,1,2, or 3 as above.
A.1	19	EDGENR	ALPHA	A1	140	140	Reason for EDGENS, values are b,4,5,6,7, or 8 as above.
A.1	20	EDGEES	ALPHA	A1	141	141	Status flag for east edge. Values are b,0,1,2, or 3 as above.
A.1	21	EDGEER	ALPHA	A1	142	142	Reason for EDGEES, values are b,4,5,6,7 or 8 as above.

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type A--continued

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
A.1	22	EDGESS	ALPHA	A1	143	143	Status flag for south edge, values are b,0,1,2, or 3 as above.
A.1	23	EDGESR	ALPHA	A1	144	144	Reason for EDGESS, values are b, 4, 5, 6, 7 or 8.
A.2	1	DLG level code	INTEGER*2	I6	1	6	Code=3, DLG-3
A.2	2	Code defining ground planimetric reference system	INTEGER*2	I6	7	12	Code=1, UTM (24K and 100K) Code=3, Albers Conical Equal Area (2M)
A.2	3	Code defining zone in ground planimetric reference system	INTEGER*2	I6	13	18	Code for appropriate UTM zone (24K and 100K files) Code=9999 (2M files)
A.2	4	Map projection parameters	REAL*8	5D24.15	19	138	This field contains the first 5 of 15 map projection parameters (see Appendix 2-4).
---	---	Filler	---	---	139	144	6 spaces
A.3	1	Map projection parameters	REAL*8	6D24.15	1	144	This record contains projection parameters 6 thru 11 (see Appendix 2-4).
A.4	1	Map projection parameters	REAL*8	4D24.15	1	96	This field contains the last 4 projection parameters (see Appendix 2-4).
A.4	2	Code defining units of measure for ground planimetric coordinates throughout the file	INTEGER*2	I6	97	102	Code=2, meters

Logical Record Type A--continued

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
A.4	3	Resolution	REAL*8	D24.15	103	126	The true ground distance corresponding to one unit (0.001 inch at map scale) in the file internal reference system.
							Scale / Resolution: 1:24,000 — 0.61 M; 1:25,000 — 0.635 M; 1:48,000 — 1.22 M; 1:62,500 — 1.587 M; 1:63,360 — 1.61 M; 1:100,000 — 2.54 M; 1:250,000 — 6.35 M; 1:2,000,000 — 50.80 M
A.4	4	Accuracy code of planimetric data	INTEGER*2	I6	127	132	Code=0, unknown accuracy
A.4	5	Number (n) of sides in the polygon which defines the coverage of the cell	INTEGER*2	I6	133	138	n=4
---	---	Filler	---	---	139	144	6 spaces
A.5	1	A (4,2) array containing geographic coordinates of the registration points for the DLG. In quadrangle-based mapping, these points form a geographic square/rectangle which contain the domain of the DLG.	REAL*8	3(2D24.15)	1	144	The four registration points usually coincide with an area defined by one of the standard map formats of the National Mapping Program. Coordinates are in geographic longitude and latitude in units of degrees and decimal degrees and are expressed in the order: SW, NW, NE, SE.
A.6				2D24.15	1	48	
---	---	Filler	---	---	49	144	96 spaces

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type B							
Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
B.1	1	Parameters (A1, A2, A3, A4) of file-to-ground projection transformation; the explicit form of the transformation is: X=A1x+A2y+A3 Y=A1y-A2x+A4 where: x,y are coordinates in file internal reference system; X,Y are coordinates in map projection reference system	REAL*8	4D24.15	1	96	X,Y coordinates resulting from this transformation will be in ground units in the appropriate projection defined by the data elements in records A.2 through A.4.
B.1	2	Number (m) of registration points	INTEGER*2	I6	97	102	m=4
---	---	Filler	---	---	103	144	42 spaces

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type B--continued							
Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
B.2	1	A (4,3) array containing identifications and coordinates of registration points. Coordinates are expressed in the file internal reference system.	ALPHA/ INTEGER*2	4(A2, 2I6)	1	56	The corners of a four-sided polygon are used as registration points. The identification sequence is SW, NW, NE, SE. The array is stored by row. Coordinates in the file internal reference system are expressed in units of thousandths of an inch and fall in the range -32768 to +32767. These coordinates correspond to the geographic coordinates contained in records A.5 and A.6.
---	---	Filler	---	---	57	144	88 spaces

Logical Record Type C

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
C.1	1	Number (q) of categories in the DLG file	INTEGER*4	I6	1	6	q=1
---	---	Filler	---	---	7	144	138 spaces
C.2[1] to C.N	1	A (q,7) array containing category name as well as maximum and actual number of node, area, and line elements in the category	ALPHA/ INTEGER*2	q (A20,6I6)	1 (57	56 112)	This array is stored by row. The first element is the category name consisting of 20 alphanumeric characters, the first four of which are unique. Elements 2 and 3 contain the maximum and actual number of nodes in the category, elements 4 and 5 the maximum and actual number of areas, and elements 6 and 7 the maximum and actual number of line segments. (Note: for 24K and 100K files, the maximum number of nodes or areas in a category is 25,960 and the maximum number of lines is 25,938. For 2M files, the maximum number of any element type within a category is 4,770. This field is used only during initial processing of data.
---	---	Filler	---	---	---	144	32 or 88 spaces

[1]The number of categories "q" is given in record C.1. There are 56 bytes of data per category, and thus a maximum of two categories can be described on a 144-character record. The space filler will vary in size depending on the value of "q".

Note that the actual number of elements will equal the highest ID number used because the files are packed and the element numbers are compressed.

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type D

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
D.1	1	Type of element code	ALPHA	A2	1	2	Code ='Nb' for Node element, 'Ab' for Area element.
D.1	2	Element's internal identification number	INTEGER*2	I6	3	8	Number is positive and sequential from 1-n within each element type.
D.1	3	X,Y file coordinate of node point or representative point for the area element	INTEGER*2	2I6	9	20	The representative area point is usually, but not always, contained within the area it represents.
D.1	4	Number (t) of attribute codes which are attached to the node or area element (t>=0)	INTEGER*2	I6	21	26	Absence of attribute codes is indicated by t=0.
D.1	5	Number (k) of pairs of text characters which are attached to the node or area element (k>=0)	INTEGER*2	I6	27	32	k=0. Not currently used.
---	---	Filler	---	---	33	144	112 spaces
D.2	1	Code indicating a line segment graph element	ALPHA	A2	1	2	Code='Lb' for line segment.
D.2	2	Line segment's internal identification number	INTEGER*2	I6	3	8	Number is positive and sequential from 1-n within each category and element type.

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type D--continued

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
D.2	3	Internal identification number of starting node	INTEGER*2	I6	9	14	Number refers to data element 2 in record D.1.
D.2	4	Internal identification number of ending node	INTEGER*2	I6	15	20	Number refers to data element 2 in record D.1.
D.2	5	Internal identification number of left area	INTEGER*2	I6	21	26	Number refers to data element 2 in record D.1.
D.2	6	Internal identification number of right area	INTEGER*2	I6	27	32	Number refers to data element 2 in record D.1.
D.2	7	Number (v) of coordinate pairs which define the line segment.	INTEGER*2	I6	33	38	The value of v is from 2 to 3000 (for 24K and 100K files) and from 2 to 1500 for 2M files.
D.2	8	Number (t) of attribute codes which are attached to the line segment (t>=0)	INTEGER*2	I6	39	44	Absence of classification attribute codes is indicated by t=0.
D.2	9	Number (k) of pairs of text characters which are attached to the line segment (k>=0)	INTEGER*2	I6	45	50	k=0. Not currently used.
	---	Filler	---	---	51	144	94 spaces

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type E

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
E.1 to[2] E.n	1	A (v,2) array containing an ordered sequence of coordinate pairs which define the image presentation of a line element	INTEGER*2	v(2I6)	1		Coordinates are expressed in internal file reference system, in units of thousandths of an inch. The array is stored by row.
---	---	Filler	---	---	---	144	0 to 132 spaces

[2]The number of coordinate pairs, "v", is given in record D.2. There will be v(2I6) coordinate pairs of which a maximum of 12 pairs will fit on a 144-character ASCII record. The space filler will vary in size depending on the value of "v." If "v" is an integer multiple of 12, there will be no spaces as filler at the end of the record.

APPENDIX A.--Standard DLG Distribution Format (Record Contents)--continued

Logical Record Type F

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
F.1[3] to F.n	1	A (t,2) array containing major and minor attribute codes for a graph element	INTEGER* 2	t(2I6)	1		The array is stored by row with the first column containing the major attribute code, and the second column containing the minor attribute code.
---	---	Filler	---	---	---	144	0 to 132 spaces

[3]The number of feature (attribute) codes, "t" is given in the D.1 and D.2 records. The F record is an array of t(2I6) codes of which a maximum of 12(2I6) will fit on a 144-character ASCII record. The space filler will vary depending on the value of "t". If "t" is an integer multiple of 12 there will be no spaces as filler at the end of the record.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)

In the optional DLG distribution format, topological linkages can be explicitly encoded for node and area elements as well as for line elements. The files are physically comprised of ASCII characters organized into fixed-length logical records of 80 characters (bytes). Bytes 1-72 of each record contain DLG data, and bytes 73-80 may be blank or contain a record sequence number.

The record types used in the optional DLG distribution format may be categorized as header and data records.

The following are considered header records:

- File identification and description records (variable record formats)
- Accuracy/miscellaneous records (not currently used)
- Control-point identification records
- Data-category identification records

The following are considered data records:

- Node and area identification records
- Node-to-area linkage records*
- Node-to-line linkage records
- Area-to-line linkage records
- Area-to-node linkage records*
- Line identification records
- Coordinate string records (lines)
- Coordinate string records (areas)*
- Attribute code records
- Text records (not currently used)

*Data distributed in optional format from the NDCDB will not contain these data records.

The actual sequence of records in an optional distribution format DLG file is as follows:

1. Header records
   - Ten file identification and description records
   - Accuracy records (not currently used)
   - Control point identification records (one per control-point)
   - Data category identification records (one per data category in the file)

2. Data records

Node identification record	
Node-to-area linkage record(s)*	Repeated
Node-to-line linkage record(s)	for each
Attribute code record(s)	node within a
Text record(s)	data category
Area identification record	
Area-to-node linkage record(s)*	Repeated
Area-to-line linkage record(s)	for each
Coordinate string record(s)*	area within a
Attribute code record(s)	data category
Text record(s)	
Line identification record	Repeated
Coordinate string record(s)	for each
Attribute code record(s)	line within a
Text record(s)	data category

*Data distributed in optional format from the NDCDB will not contain these records.

Descriptions of the contents of the various types of records in an optional distribution format DLG are contained in the following tables.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

FILE IDENTIFICATION AND DESCRIPTION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte*	Comment
1	1	Banner	ALPHA	A72	1	72	" *** DLG-OPTIONAL FORMAT PRODUCED BY USGS PROSYS RELEASE x.x.x *** "
2	1	Name of digital cartographic unit	ALPHA	A40	1	40	The name of the digital data cell followed by the State two-character designators, separated by hyphens.
---	---	Filler	---	--	41	41	1 space
2	2	Date of original source material	ALPHA	A10	42	51	Year of original source material followed by latest revision date if applicable; for example, 1956, 1965.
2	3	Date qualifier	ALPHA	A1	52	52	Qualifier to discriminate revision date if present. (P=photorevision, I=photo-inspection, L=limited revision, D=digital revision).
2	4	Scale of original source material	INTEGER*4	I8	53	60	Scale denominator of source material; for example, 24000, 100000, or 2000000.

(Record 2, data element 5 and Record 3, data elements 1 through 18 apply to 24K and 100K data files only. These fields contain filler in 2M data files.)

---	---	Filler	---	---	61	63	3 spaces

*The logical record length for the optional distribution format is 80 bytes, with 8 spaces of blank fill in bytes 73-80 of each record which may be used for a record sequence number.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

FILE IDENTIFICATION AND DESCRIPTION RECORDS-continued							
Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
2	5	Sectional indicator (100K files)	ALPHA	---	64	66	Codes S, F, or T for size of section, plus sequence number.
---	---	Filler	---	---	67	72	6 spaces
---	---	Filler	---	---	1	41	41 spaces
3	1	Largest primary contour interval	ALPHA	A4	42	45	Largest primary contour interval, followed by the interval unit (1=feet, 2=meters). Present only if two or more primary intervals exist. (selected categories)
3	2	Comma	ALPHA	A1	46	46	comma separator
3	3	Largest primary bathymetric contour interval	ALPHA	A4	47	50	Largest primary bathy-metric interval, followed by the interval unit (1=feet, 2=meters, 3=fathoms). Present only if two or more primary intervals exist. (selected categories)
---	---	Filler	---	--	51	51	1 space

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

FILE IDENTIFICATION AND DESCRIPTION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
3	4	Smallest primary contour interval	ALPHA	A4	52	55	Smallest or only primary contour interval, followed by the interval unit as described above (selected categories).
3	5	Comma	ALPHA	A1	56	56	comma separator
3	6	Smallest primary bathymetric contour interval	ALPHA	A4	57	60	Smallest or only primary bathymetric contour interval, followed by the interval unit as described above (selected categories).
3	7-9	Coded Flags	ALPHA	A1	61	63	3 flags for future use
3	10	Coded Flag	ALPHA	A1	64	64	Database coded edge flag for internal NMD use.
3	11	EDGEWS	ALPHA	A1	65	65	Status flag for west edge, values are: b=unchecked, 0=passed, 1=alignment discontinuity, 2=attribute discontinuity, 3=attribute and alignment discontinuity.
3	12	EDGEWR	ALPHA	A1	66	66	Reason for EDGEWS, values are: b=no problem, 4= adjacent data do not exist, 5=adjacent data unavailable, 6=graphic discontinuity, 7=graphic mismatch valid, 8=paneling unauthorized.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

FILE IDENTIFICATION AND DESCRIPTION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
3	13	EDGENS	ALPHA	A1	67	67	Status flag for north edge, values are b,0,1,2, or 3 as above.
3	14	EDGENR	ALPHA	A1	68	68	Reason for EDGENS, values are b,4,5,6,7 or 8 as above.
3	15	EDGEES	ALPHA	A1	69	69	Status flag for east edge, values are b,0,1,2, or 3 as above.
3	16	EDGEER	ALPHA	A1	70	70	Reason for EDGEES, values are b,4,5,6,7 or 8 as above.
3	17	EDGESS	ALPHA	A1	71	71	Statusflag forsouth edge, values are b,0,1,2, or 3 as above.
3	18	EDGESR	ALPHA	A1	72	72	Reason for EDGESS, values are b,4,5,6,7 or 8 as above.
4	1	DLG level code	INTEGER*2	I6	1	6	* Code=3, DLG-3
4	2	Code defining ground planimetric reference system	INTEGER*2	I6	7	12	* [1]Code=1 UTM (24K and 100K), Code=3 Albers Conical Equal Area (2M files)
4	3	Code defining zone in ground planimetric reference system	INTEGER*2	I6	13	18	* [1]Code for appropriate UTM zone (24K or 100K files), Code=9999 for 2M files

[1] See General Purpose Transformation Package software documentation for additional information.

* Listed values reflect current NMD standard.

FILE IDENTIFICATION AND DESCRIPTION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
4	4	Code defining units of measure for ground planimetric coordinates throughout the file	INTEGER*2	I6	19	24	* [1]Code=2, meters
4	5	Resolution	REAL*4	D18.11	25	42	The true ground distance corresponding to 0.001 inch at map scale. Scale / Resolutions: 1:24,000 — 0.61 M; 1:25,000 — 0.635 M; 1:48,000 — 1.22 M; 1:62,500 — 1.587 M; 1:63,360 — 1.61 M; 1:100,000 — 2.54 M; 1:250,000 — 6.35 M; 1:2,000,000 — 50.80 M
4	6	Number of file-to-map transformation parameters	INTEGER*2	I6	43	48	number=4
4	7	Number of accuracy/ miscellaneous records	INTEGER*2	I6	49	54	Currently=0, none included
4	8	Number (n) of control points	INTEGER*2	I6	55	60	n=4 These points are usually, but not always a definition of the file coverage.

[1]See General Purpose Transformation Package software documentation for additional information.

* Listed values reflect current NMD standard.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

FILE IDENTIFICATION AND DESCRIPTION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
4	9	Number (q) of categories in the DLG file	INTEGER*2	I6	61	66	* q=1
---	---	Filler	---	---	67	72	6 spaces
5-9	1	Projection parameters for map transformation	REAL*8	3D24.15	1	72	Three parameters on each of 5 records (see Appendix 2-4).
10	1	Internal file-to-map projection transformation parameters	REAL*4	4D18.11	1	72	X, Y coordinates resulting from this transformation will be expressed in the appropriate ground planimetric coordinate system. If the x, y coordinates are already in the ground coordinate system, the projection parameters will be: A1=1.0, A2=0.0, A3=0.0, and A4=0.0.

* Listed values reflect current NMD standard.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

CONTROL POINT IDENTIFICATION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
1-n	1	Control-point label	ALPHA	A6	1	6	"SW," "NW," "NE," or "SE" for four quadrangle corners. Field is padded with trailing blanks.
	2	Latitude	REAL*4	F12.6	7	18	In degrees and decimal degrees.
	3	Longitude	REAL*4	F12.6	19	30	In degrees and decimal degrees.
		Filler			31	36	6 spaces
	4	X coordinate	REAL*4	F12.2	37	48	In units in the appropriate zone of the ground planimetric coordinate system.
	5	Y coordinate	REAL*4	F12.2	49	60	In units in the appropriate zone of the ground planimetric coordinate system.
---	---	Filler	---	---	61	72	12 spaces

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

DATA CATEGORY IDENTIFICATION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
1-q	1	Category name	ALPHA	A20	1	20	The first 4 characters are unique to USGS/NMD data.
	2	Attribute format codes	INTEGER*2	I4	21	24	Blank or zero (0) indicates default (2I6) attribute formatting in major-minor pairs.
	3	Highest node identification number.	INTEGER*2	I6	25	30	Number of nodes referenced in the file.
	4	Actual number of nodes in file	INTEGER*2	I6	31	36	Only if the DCF is not packed, and the element ID numbers not compressed, will this number be different from data element 3.
	---	Filler	---	---	37	37	1 space
	5	Presence of node-to-area linkage records	INTEGER*2	I1	38	38	*0=node-area list not included, 1=node-area list included.
	6	Presence of node-to-line linkage records	INTEGER*2	I1	39	39	0=node-line list not included, *1=node-line list included.
	---	Filler	---	---	40	40	1 zero or space

*Values marked are values from data distributed from the NDCDB.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

DATA CATEGORY IDENTIFICATION RECORDS--continued

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
1-q	7	Highest area ID number.	INTEGER*2	I6	41	46	Number of areas referenced in the file.
	8	Actual number of areas in file	INTEGER*2	I6	47	52	Only if the DCF is not packed, and the element ID numbersnotcompressed, will this number be different from data element 7.
	---	Filler	---	---	53	53	1 space
	9	Presence of area-to-node linkage records	INTEGER*2	I1	54	54	*0=area-node list not included, 1=area-node list included.
	10	Presence of area-to-line linkage records	INTEGER*2	I1	55	55	0=area-line list not included, *1=area-line list included.
	11	Presence of area-coordinate lists	INTEGER*2	I1	56	56	*0=area coordinates not included, 1=area coordinates included
	12	Highest line identification number	INTEGER*2	I6	57	62	Number of lines referenced in the file.

*Values marked are values for data distributed from the NDCDB.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

DATA CATEGORY IDENTIFICATION RECORDS--continued							
Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
1-q	13	Actual number of lines in file	INTEGER*2	I6	63	68	Only if the DCF is not packed, and the element ID numbers not compressed, will this number be different from data element 12.
	---	Filler	---	---	69	71	3 spaces
	14	Presence of line-coordinate lists	INTEGER*2	I1	72	72	0=line coordinates not included, *1=line coordinate list included.

*Values marked are values for data distributed from the NDCDB.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

NODE AND AREA IDENTIFICATION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
	1	Record type	ALPHA	A1	1	1	"N" or "A"
	2	Element internal ID number	INTEGER*2	I5	2	6	Number is positive and sequential from 1-n within each element type, where n is the highest element ID number.
	3	Coordinates of node point or representative point for area	REAL*4	2F12.2	7	30	The area point is usually, but not always within the polygon it represents.
	4	Number of elements in an area list (for nodes), or a node list (for areas)	INTEGER*2	I6	31	36	
	5	Number of elements in line list	INTEGER*2	I6	37	42	Number of line segments that intersect at the node or, for areas, line segments plus number of islands.
	6	Number of x,y or lat-long points in area-coordinate list	INTEGER*2	I6	43	48	For area records only, blank for node records.
	7	Number of attribute code pairs listed	INTEGER*2	I6	49	54	
	8	Number of text characters listed	INTEGER*2	I6	55	60	Zero (0). There are no text attributes for DLG data.
	9	Number of islands within area	INTEGER*2	I6	61	66	For area records only, blank for node records.
---	---	Filler	---	---	67	72	6 spaces

NODE-TO-AREA LINKAGE RECORDS

FORTRAN FORMAT (12I6), for each node: The list consists of area internal ID numbers (which appear in bytes 2-6 of the area identification records) of all the areas that are adjacent to that node. There is no logical order to the list.

NODE-TO-LINE LINKAGE RECORDS

FORTRAN FORMAT (12I6), for each node: The list consists of line internal ID numbers (which appear in bytes 2-6 of the line identification records) of all the lines that connect to that node. The lines that begin at this node are included in the list as positive ID numbers. The lines which terminate at this node are included as negative ID numbers. There is no logical order to the list.

AREA-TO-NODE LINKAGE RECORDS

FORTRAN FORMAT (12I6) for each area: The list consists of node internal ID numbers (which appear in bytes 2-6 of the node identification records) of all nodes that are adjacent to that area. For those areas with islands, the number zero, used as a delimiter, marking the beginning of each island sublist. The format of this list is the same as the Area-Line list below.

AREA-TO-LINE LINKAGE RECORDS

FORTRAN format (12I6), for each area: The list consists of line internal ID numbers (which appear in bytes 2-6 of the line identification records) of all lines that bound that area. and lines which are adjacent to an area. For those areas with islands (indicated by bytes 61-66 of the area's first record), the number zero, used as a delimiter, marking the beginning of islands. Lines with this area to the right are included as positive ID numbers. Lines with this area to the left are included as negative ID numbers. The list is ordered clockwise around the perimeter of the area and counterclockwise around each island, if any (counterclockwise around an island of an area is still a clockwise direction in reference to the area itself). The number zero is inserted in the list before each island sublist. Lines that do not contribute to the effective boundary of the area (those having both their area left and area right assigned to the same area) are not considered bounding lines. Therefore, these lines, while still present in the file, will not be referenced in the area-to-line linkage records.

APPENDIX B.--Optional DLG Distribution Format (Record Contents)--continued

LINE IDENTIFICATION RECORDS

Record Number	Data Element	Contents	Type (Fortran Notation)	Format	Starting Byte	Ending Byte	Comment
	1	Record type		A1	1	1	"L"
	2	Element internal ID number		I5	2	6	Number is positive and sequential from 1-n within each element type, where n is the highest element ID number.
	3	Starting node		I6	7	12	Internal ID number. Refers to data element 2 of the node identification record.
	4	Ending node		I6	13	18	Internal ID number. Refers to data element 2 of the node identification record.
	5	Left area		I6	19	24	Internal ID number. Refers to data element 2 of the area identification record.
	6	Right area		I6	25	30	Internal ID number. Refers to data element 2 of the area identification record.
	---	Filler		---	31	42	12 spaces
	7	Number of x,y coordinate pairs listed		I6	43	48	Number of coordinate pairs listed.
	8	Number of attribute code pairs listed		I6	49	54	
	9	Number of text characters listed		I6	55	60	Zero (0). There are no text attributes for DLG data.

LINE COORDINATE STRING RECORDS

FORTRAN format (3(2F12.2)): The coordinates are in appropriate units in the designated ground planimetric coordinate system (usually meters in UTM), or in internal file units.

CODE RECORDS

As major-minor code attribute pairs, FORTRAN format (6(2I6)): Within each pair, the first integer is the major code and the second integer is the minor code. Each major and minor code is a one-to-four-digit integer, right justified within the six-byte field.

AREA COORDINATE STRING RECORDS

FORTRAN FORMAT (3(2F12.2)): The last data element in the area identification record contains the number of islands within the area. If this number is greater than zero, the following convention applies to the Area Coordinate list:

> The coordinates of the outside boundary of the area are listed first. The first coordinate of the outside boundary is repeated to signal the closure of this ring. Next, the coordinates of one of the islands are listed. The first coordinate of this boundary is repeated, again signaling the end of this ring. Next, the first coordinate of the outside boundary is listed as a ring delimiter. This process is repeated until the coordinates of the boundaries of all the islands are listed. The coordinates in this list are ordered so that the area being referenced is always to the right of the boundary described by the sequence of coordinates. Therefore, the list is ordered clockwise around the perimeter of the area and counterclockwise around each island, if any. The common coordinates between adjacent ring lines are only listed once, except for the beginning and ending of a ring.

EXAMPLE 1: (A diagram illustrating this example may be found following the text.)

Area line list (for area 41): 10, 11, -12, 0, 14, -15, 0, -18, 0, -82, -84, 21

Area node list (for area 41): 30, 31, 32, 0, 33, 34, 0, 35, 0, 36, 77, 76

Area coordinate list explanation:

- Outside ring coordinates:
  (20, 50), (40, 60), (60, 50), (70, 40), (60, 20), (40, 10), (30, 10), (20, 30), (10, 40), (20, 50) starting point
  [( ] [ )] of outside ring

  L10 L11 L12 separate rings)

- 1st island ring coordinates:
  (25, 45), (28, 39), (34, 43), (34, 48), (30, 50), (25, 45), (20, 50) ring closes itself; first coordinate in outside ring
  [( ]) delimiter

  L14 L15

- next island ring coordinates:
  (30, 30), (30, 20), (40, 20), (40, 30), (30, 30), (20, 50) ring delimiter
  [ ]

  L18

- last island ring coordinates:
  (50, 40), (50, 30), (48, 22), (58, 24) (60, 35), (55, 45), (50, 40), (20, 50) ring delimiter must be present at end of list if
  [( ] [ )] islands are present.

  L82 L84 L21

Note: Since lines 80, 85, and 86 have area 41 as both their area left and area right, they are not considered "boundaries" of area 41. Therefore, they are not used to build the area line list, area node list, or area coordinate list for this area.

Complete area coordinate list:
(20, 50), (40, 60), (60, 50), (70, 40), (60, 20), (40, 10), (30, 10), (20, 30), (10, 40), (20, 50),
(25, 45), (28, 39), (34, 43), (34, 48), (30, 50), (25, 45), (20, 50),
(30, 30), (30, 20), (40, 20), (40, 30), (30, 30), (20, 50),
(50, 40), (50, 30), (48, 22), (58, 24), (60, 35), (55, 45), (50, 40), (20, 50)

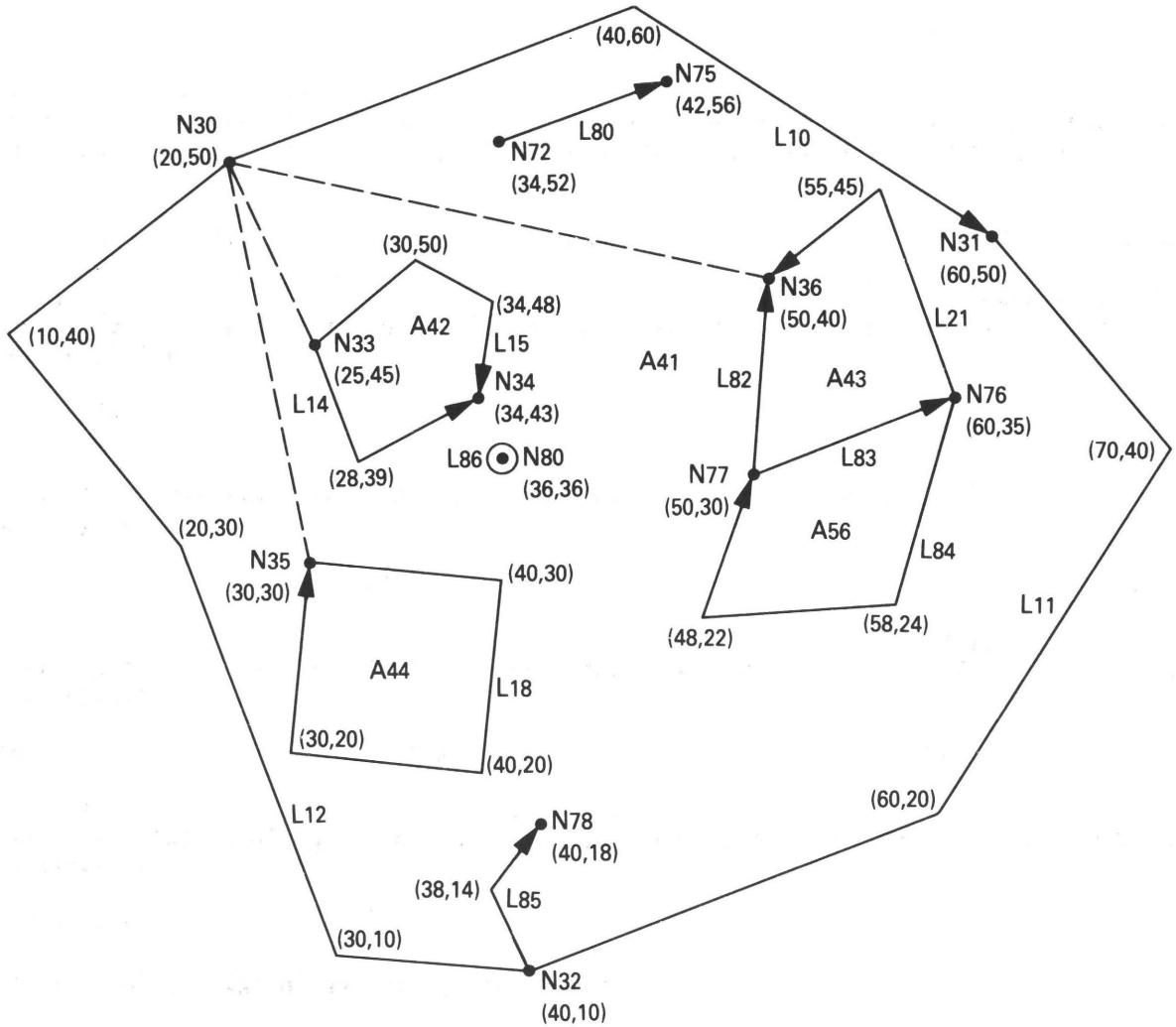

Diagram illustrating Example 1 on previous page.

APPENDIX C.--Map Projection Parameters
Universal Transverse Mercator (UTM)

The standard and optional DLG distribution formats include 15 fields reserved for map projection parameters. These parameters are typically used as input for a coordinate transformation package such as the USGS General Cartographic Transformation Package (GCTP).

When the ground coordinate system of a DLG is the Universal Transverse Mercator system, as in the case for all DLG's digitized from 1:100,000-scale maps, only the first two of the 15 parameter fields are used:

1.	Longitude of any point in UTM zone.	Normally placed at the
2.	Latitude of any point in UTM zone.	center of the DLG cell.

3-15. Not used (=0).

A transformation to or from UTM using GCTP can be controlled by specifying the UTM zone or by supplying the geographic coordinate in parameters 1 and 2, from which the UTM zone is computed by GCTP. In a DLG file, the parameters are encoded as packed, degrees-minutes-seconds (DMS) as follows:

```
degrees * 1000000 + minutes * 1000 + seconds
```

Example: If degrees = +50, minutes = 30, and seconds = 36.25, then the parameter value is 50030036.25 stored as a REAL*8 variable, and "bb0.500300362500000D 08" encoded in FORTRAN D24.15 format.

APPENDIX C.--Map Projection Parameters
Universal Transverse Mercator (UTM)--continued

Codes for UTM Coordinate Zones

West Longitude (degrees)	Zone
180-174	1
174-168	2
168-162	3
162-156	4
156-150	5
150-144	6
144-138	7
138-132	8
132-126	9
126-120	10
120-114	11
114-108	12
108-102	13
102- 96	14
96- 90	15
90- 84	16
84- 78	17
78- 72	18
72- 66	19
66- 60	20

Valid Minor Codes for the Coincident Feature Parameter

Code	Base Category
0002	Hypsography
0005	Hydrography
0007	Surface Cover
0009	Boundary
0015	Survey Control
	Transportation Systems
0017	Roads and Trails
0018	Railroads
0019	Pipelines, Transmission Lines, Miscellaneous Transportation
0020	Manmade Features

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Hypsography	Feature identification	Nodes	020	NONE	
		Areas	020	0100	Void area
		Lines	020	0200	Contour (index or intermediate)
				0201	Carrying contour
				0202	Supplementary contour
				0203	Continuation contour
				0204	Amended contour
				0205	Bathymetric contour
				*0206	Depth curve
				0207	Watershed divides
				0208	Closure line
		Points (degenerate lines)	020	0300	Spot elevation, less than third order
			020	0301	Spot elevation, less than third order, not at ground level.
		Multiple element types	020	NONE	
	Descriptive	Multiple element types	020	0600-0609	Decimal fractions of feet or meters
				0610	Approximate
				0611	Depression
				0612	Glacier or snow field
				0613	Underwater
				0614	Best estimate of contour elevation value
			020	0000	Photorevised feature

* denotes a code which is no longer being used to encode features, but which may appear in older files.

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Hypsography (cont'd.)	Parameter	Multiple element types	02N	----	Elevation in whole feet or meters, right-justified
			026	00--	Major category associated with a spot height, not at ground elevation.
			029	00--	Coincident feature
Hydrography	Feature identification	Nodes	050	0001	Upper origin of stream
				0002	Upper origin of stream at water body
				0003	Sink, channel no longer evident
				0004	Stream entering water body
				0005	Stream exiting water body
		Areas	050	0100	Alkali flat
				0101	Reservoir
				0102	Covered reservoir
				0103	Glacier or permanent snowfield
				0104	Salt evaporator
				0105	Inundation area
				0106	Fish hatchery or farm
				0107	Industrial water impoundment
				0108	Area to be submerged
				0109	Sewage disposal pond or filtration beds
				0110	Tailings pond
				0111	Marsh, wetland, swamp, bog
				0112	Mangrove area
				0113	Rice field
				0114	Cranberry bog
				0115	Flats (tidal, mud, sand, gravel)
				0116	Bays, estuaries, gulfs, oceans, seas
				0117	Shoal
				0118	Soda evaporator
				0119	Duck Pond
				0120	Void area

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Hydrography (cont'd.)	Feature identification (cont'd.)	Lines	050	0200	Shoreline
				0201	Manmade shoreline
				0202	Closure line
				0203	Indefinite shoreline
				0204	Apparent limit
				0205	Outline of a Carolina bay
				0206	Danger curve
				0207	Apparent shoreline
		Points	050	0300	Spring
				0301	Non-flowing well
				0302	Flowing well
				0303	Riser
				0304	Geyser
				0305	Windmill
				0306	Cistern
		Multiple element types	050	0400	Rapids
				0401	Falls
				0402	Gravel pit or quarry filled with water
				0403	Gaging station
				0404	Pumping station
				0405	Water intake
				0406	Dam or weir
				0407	Canal lock or sluice gate
				0408	Spillway
				0409	Gate (flood, tidal, head, check)
				0410	Rock
				0411	Crevasse
				0412	Stream
				0413	Braided stream
				0414	Ditch or canal
				0415	Aqueduct
				0416	Flume
				0417	Penstock
				0418	Siphon
				0419	Channel in water area

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Hydrography (cont'd.)	Feature identification (cont'd.)	Multiple element types (cont'd.)	050	0420	Wash or ephemeral drain
				0421	Lake or pond
				0422	Coral reef
				0423	Sand in open water
				0424	Spoil area
				0425	Fish ladders
				0426	Holiday area
	Descriptive	Multiple element types	050	0601	Underground
				0602	Overpassing
				0603	Elevated
				0604	Tunnel
				0605	Right bank
				0606	Left bank
				0607	Under construction
				0608	Salt
				0609	Unsurveyed
				0610	Intermittent
				0611	Abandoned or discontinued
				0612	Submerged or sunken
				*0613	Wooded
				0614	Dry
				0615	Mineral or hot (sulphur, alkali, etc.)
				0616	Navigable, transportation
				0617	Underpassing
				0618	Earthen construction
				0619	Interpolated elevation
				0621-0629	Decimal fractions of feet or meters
			050	0000	Photorevised feature
	Parameter	Multiple element types	05N	----	Water surface elevation, actual or interpolated, N=1 for feet, 2 for meters, 6 for feet below datum, and 7 for meters below datum. Elevation value in four spaces, right justified.

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Hydrography (cont'd.)	Parameter (cont'd.)	Multiple element types (cont'd.)	053	0---	Angle of clockwise rotation (nearest whole degree)
			055	----	River mile, value in four spaces, right justified
			058	0000	Best estimate of classification or position
			059	00--	Coincident feature
Boundaries	Feature identification	Nodes	090	0001	Monumented point on a boundary
		Areas	090	0100	Civil township, district, precinct, or barrio
				0101	Incorporated city, village, town, borough, or hamlet
				0103	National park, monument, lakeshore, seashore, parkway, battlefield, or recreation area
				0104	National forest or grassland
				0105	National wildlife refuge, game preserve, or fish hatchery
				0106	National scenic waterway, riverway, wild and scenic river, or wilderness area
				0107	Indian reservation
				0108	Military reservation
				0110	Federal prison
				0111	Miscellaneous Federal reservation
				0129	Miscellaneous State reservation
				0130	State park, recreation area, arboretum, or lake
				0131	State wildlife refuge, game preserve, or fish hatchery
				0132	State forest or grassland
				0133	State prison
				0134	County game preserve

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Boundaries (cont'd.)	Feature identification (cont'd.)	Areas (cont'd.)	090	0150	Large park (city, county, or private)
				0151	Small park (city, county, or private)
				0197	Canada
				0198	Mexico
				0199	Open water
		Lines	090	0201	Indefinite (or approximate) boundary
				0202	Disputed boundary
				0203	Historical line
				0204	Boundary closure line
		Points (degenerate lines)	090	0301	Reference monuments for boundary points
		Multiple element types	090	NONE	
	Descriptive	Multiple element types	090	0000	Photorevised feature
	Parameter	Multiple element types	091	00--	State FIPS code
			092	0---	County or county equivalent FIPS code
			095	----	Monument number
			096	XXYY	Alphabetic portion of any monument number substitute numeric equivalent of alphabetic for XX and for YY as follows: 00 blank, 01 = A, 02 = B, 03 = C, 04 = D, 05 = E, 06 = F, 07 = G, 08 = H, 09 = I, 10 = J, 11 = K, 12 = L, 13 = M, 14 = N, 15 = O, 16 = P, 17 = Q, 18 = R, 19 = S, 20 = T, 21 = U, 22 = V, 23 = W, 24 = X, 25 = Y, 26 = Z.
			098	0000	Best estimate of classification or position.
			099	00--	Coincident feature

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Transportation, Roads, and Trails	Feature identification	Nodes	170	0001	Bridge abutment
				0002	Tunnel portal
				0004	Gate
				0005	Cul-de-sac
				0006	Dead end
				0007	Drawbridge
			170	0100	Void area
		Lines	170	0201	Primary route, class 1, symbol undivided
				0202	Primary route, class 1, symbol divided by centerline
				0203	Primary route, class 1, divided, lanes separated
				0204	Primary route, class 1, one way, other than divided highway
				0205	Secondary route, class 2, symbol undivided
				0206	Secondary route, class 2, symbol divided by centerline
				0207	Secondary route, class 2, symbol divided, lanes separated
				0208	Secondary route, class 2, one way, other then divided highway
				0209	Road or street, class 3
				0210	Road or street, class 4
				0211	Trail, class 5, other than four-wheel-drive vehicle
				0212	Trail, class 5, four-wheel-drive vehicle
				0213	Footbridge
				0214	Ferry crossing
				0215	Perimeter of parking area
				0216	Arbitrary extension of line (join or closure)

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Transportation, Roads, and trails (cont'd.)	Feature identification (cont'd.)	Lines (cont'd.)		0217	Road or street, class 3, symbol divided by centerline
				0218	Road or street, class 3, divided lanes separated
				0221	Road in street, class 3, one way
				0222	Road in transition
		Points (degenerate lines)		NONE	
		Multiple element types	170	0401	Traffic circle
				0402	Cloverleaf or interchange
				0403	Toll gate, toll plaza or perimeter of toll plaza
				0404	Weigh station
				0405	Nonstandard section of road
			*170	0600	Historical
	Descriptive	Multiple element types	170	0601	In tunnel
				0602	Overpassing, on bridge
				0603	Under construction, classification known
				0604	Under construction, classification unknown
				0605	Labeled "old railroad grade"
				0606	Submerged or in ford
				0607	Underpassing
				*0608	Limited access
				0609	Toll road
				0610	Privately operated or controlled public access
				0611	Proposed
				0612	Double-decked
				0613	In service facility or rest area
				0614	Elevated
				0615	Bypass route
				0616	Alternate route

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Transportation, Roads, and trails (cont'd.)	Descriptive (cont'd.)	Multiple element types (cont'd.)	170	0617	Business route
				0618	On drawbridge
				0619	Spur
				0620	Loop
				0621	Connector
				0622	Truck route
				0650	Road width 46-55 feet, 0.025 inches at 1:24,000
				0651	Road width 56-65 feet, 0.030 inches at 1:24,000
				0652	Road width 66-75 feet, 0.035 inches at 1:24,000
				0653	Road width 76-85 feet, 0.040 inches at 1:24,000
				0654	Road width 86-95 feet, 0.045 inches at 1:24,000
				0655	Road width 96-105 feet, 0.050 inches at 1:24,000
				0656	Road width 106-115 feet, 0.055 inches at 1:24,000
				0657	Road width 116-125 feet, 0.060 inches at 1:24,000
				0658	Road width 126-135 feet, 0.065 inches at 1:24,000
				0659	Road width 136-145 feet, 0.070 inches at 1:24,000
			170	0000	Photorevised feature
	Parameter	Multiple element types	171	----	Number of lanes
			172	----	Interstate route number
			173	----	U.S. route number
			174	----	State route number
			175	----	Reservation, park, or military route number
			176	----	County route

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Transportation, Roads, and Trails (cont'd.)	Parameter (cont'd.)	Multiple element types (cont'd.)	177	XXYY	Alphabetic portion of any route number. Substitute numeric equivalent of alphabetic for XX and for YY as follows: 00 = blank, 01 = A, 02 = B, 03 = C, 04 = D, 05 = E, 06 = F, 07 = G, 08 = H, 09 = I, 10 = J, 11 = K, 12 = L, 13 = M, 14 = N, 15 = O, 16 = P, 17 = Q, 18 = R, 19 = S, 20 = T, 21 = U, 22 = V, 23 = W, 24 = X, 25 = Y, 26 = Z.
			178	0000	Best estimate of position or classification
			179	00--	Coincident feature
Transportation, Railroads	Feature identification	Nodes	180	0001	Bridge abutment
				0002	Tunnel portal
				0007	Drawbridge
		Areas	180	0100	Void area
		Lines	180	0201	Railroad
				0202	Railroad in street or road
				0204	Carline
				0205	Cog railroad, incline railway, logging tram
				0207	Ferry crossing
				0208	Railroad siding
				0209	Perimeter or limit of yard
				0210	Arbitrary line extension
				0211	Closure line
		Points (degenerate lines)	180	NONE	
		Multiple element types	180	0400	Railroad station, perimeter of station
				0401	Turntable
				0402	Roundhouse
			*180	0600	Historical

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Transportation, Railroads (cont'd.)	Descriptive	Multiple element types	180	0601	In tunnel
				0602	Overpassing, on bridge
				0603	Abandoned
				0604	Dismantled
				0605	Underpassing
				0606	Narrow gauge
				0607	In snowshed or under structure
				0608	Under construction
				0609	Elevated
				0610	Rapid transit
				0611	On drawbridge
				0612	Private
				0613	U.S. Government
				0614	Juxtaposition
			180	0000	Photorevised feature
	Parameter	Multiple element types	181	----	Number of tracks
			188	0000	Best estimate of position or classification
			189	00--	Coincident feature
Transportation, Pipelines, Transmission Lines, Miscellaneous Transportation Features	Feature identification	Nodes	190	0001	End of transmission line at power station, substation, or hydroelectric plant
				0002	End of pipeline at oil or gas field
				0003	End of pipeline at refinery, depot, or tank farm
		Areas	190	0100	Void area
		Lines	190	0201	Pipeline
				0202	Power transmission line
				0203	Telephone or telegraph line
				0204	Aerial tramway, monorail, ski lift
				0205	Arbitrary line extension
				0206	Closure line

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
Transportation, Pipelines, Transmission Lines, Miscellaneous Transportation Features (cont'd.)	Feature identification (cont'd.)	Points (degenerate lines)	190	0300	Seaplane anchorage
		Multiple element types	190	0400	Power station
				0401	Substation
				0402	Hydroelectric Plant
			190	0403	Landing strip, airport, perimeter of airport
				0404	Heliport, perimeter of heliport
				0405	Launch complex, perimeter of launch complex
				0406	Pumping station (other than water)
				0407	Seaplane ramp or landing area
				0408	Measuring station
	Descriptive	Multiple element types	190	0600	Underground
				0601	Under construction
				0602	Abandoned
				0603	Above ground
				0604	Labeled "closed"
				0605	Unimproved, loose surface
				0606	Submerged
				0607	Nuclear
			190	0000	Photorevised feature
	Parameters	Multiple element types	193	0---	Angle of clockwise rotation (nearest whole degree)
			198	0000	Best estimate of position or classification
			199	00--	Coincident feature

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
U.S. Public Land Survey System	Feature identification	Nodes	300	0001	U.S. Public Land Survey System section corner
				0002	Point on section line (no corner)
				0003	Closing corner
				0004	Meander corner
				0005	Auxiliary meander corner
				0006	Special meander corner
				0007	Witness corner
				0008	Witness point
				0009	Angle point
				0010	Location monument (includes amended monument and mineral monument)
				0011	Reference mark
				0012	Quarter-section corner
				0013	Tract corner
				0014	Land grant corner
				0015	Arbitrary section corner
		Nodes (identification procedures)	300	0040	Corner identified in field
				0041	Corner with horizontal coordinates
				0042	Corner with elevation value
	Parameters	Areas			Select one parameter code from each of the following A, B, C, and D lists and/or consult list E.
					A. Origin of Survey
			306	00--	Insert two-digit code from Appendix K.
					B. Township number(s)
			30-	----	Insert 2 for north of the baseline or 3 for south of the baseline in first space. In the second space, insert a 0 for full township, 2 for 1/4 township, 4 for 1/2 township, or 6 for 3/4 township. Insert township number in the last three spaces, right justified.

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
U.S. Public Land Survey System (cont'd.)	Parameters (cont'd.)	Areas (cont'd.)			C. Range number(s)
			30-	----	Insert 4 for east of the principal meridian or 5 for west of the principal meridian in the first space. In the second space, insert a 0 for a full range, 2 for 1/4 range, 4 for 1/2 range, 6 for 3/4 range, 8 for duplicate to the north or east of the original township, or 9 for triplicate to the north or east of the original township. Insert range number in last three spaces, right justified.
					D. Section number
			301	----	In the first space, insert 0 for numeric section identifier, 1 for numeric portion of alphanumeric identifier, or 2 for alphabetic part of alphanumeric identifier. In the last three spaces, insert section number or numeric representation of alphabetic character (01-26), right justified.
					E. Land grant identifier
			307	----	In the first space, insert the appropriate number:
				0	for numeric grant identifier
				1	for numeric portion of alphanumeric identifier
				2	for alphabetic portion of alphanumeric identifier
				3	for alphabetic identifier
				4	for identifier of named grant in Arizona

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
U.S. Public Land Survey System (cont'd.)	Parameters (cont'd.)	Areas (cont'd.)		5	for identifier of named grant in California
				6	for identifier of named grant in Colorado
				7	for identifier of named grant in New Mexico
				8	For identifier of named grant in other States
					In the last three spaces after 0-3 above, insert the grant number or numeric representation of the alphabetic character (01-26), right-justified. In the last three spaces after 4-7 above, insert the three-digit code of the named grant as designated in Appendix L.
					F. Excluded areas
			300	0100	Indian lands
				0101	Homestead entries
				0102	Donation land claims
				0103	Land grants; civil colonies
				0104	Private extension of public land survey
				0105	Area of public and private survey overlap
				0106	Overlapping land grants
				0107	Military reservation
				0198	Water
				0199	Unsurveyed area
	Feature identification	Lines	300	0201	Approximate position (within 200 feet)
				0202	Protracted position
				0203	Arbitrary closure line
				0204	Base line
				0205	Claim line, grant line
		Points (degenerate lines)	0300	0300	Location monument
				0301	Isolated found section corner
				0302	Witness corner (off surveyed line)

APPENDIX D.--DLG Attribute Codes--continued

DATA CATEGORY	TYPE OF CODE	APPLICATION	MAJOR CODE	MINOR CODE	DESCRIPTION
U.S. Public Land Survey System (cont'd.)	Parameter	Multiple element types	308	0000	Best estimate of classification and/or position
			309	00--	Coincident feature or symbol

* denotes a code which is no longer being used to encode features, but which may appear in older files.

APPENDIX E.--Coordinate Conversion

This appendix illustrates the procedure for converting the internal file coordinates of the standard DLG format to the ground planimetric UTM reference coordinates. The formulas for this conversion, representing a simple offset, rotation, and scale, are as follows:

$$X = A1x + A2y + A3, \text{ and}$$
$$Y = A1y - A2x + A4,$$

where X and Y are the ground planimetric coordinate values and x and y are the internal file coordinates.

The parameters for these formulas (A1, A2, A3, and A4) are contained in Header Record B, as double-precision floating-point numbers.

This example converts four coordinate pairs from internal file coordinates to ground planimetric UTM zone 10 coordinate values. The parameters are as follows:

A1 =.60959440759
A2 = -.0028817856942
A3 = 538248.79341
A4 = 4240374.4556

The internal file coordinates to be converted are as follows:

	x	y
1st pair	-8971	-11376
2nd pair	-8955	11375
3rd pair	8955	11376
4th pair	8971	-11376

The calculations to determine the ground planimetric coordinates for the first pair are as follows:

$$X = (0.60959440759)(-8971) + (-0.0028817856942)(-11376) + (538248.79341)$$
$$= 532812.91$$

$$Y = (0.60959440759)(-11376) - (-0.0028817856942)(-8971) + (4240374.4556)$$
$$= 4233413.86$$

The resulting X,Y coordinate values for the four pairs are as follows:

	X	Y
1st pair	532,812.91	4,233,413.86
2nd pair	532,757.10	4,247,282.79
3rd pair	543,674.93	4,247,335.01
4th pair	543,750.25	4,233,465.56

APPENDIX F.--Sample DLG Data File
(Standard Distribution Format)

```
CARTERSVILLE                    GA          1981,        100000.  S01
RO4.HYS01
    3     1    16  -0.840560150000038D+08   0.340260150000010D+08   0.0
                     0.0                      0.0
  0.0                    0.0                      0.0
  0.0                    0.0                      0.0
  0.0                    0.0                      0.0
  0.0                      2    0.254000000000000D+01    0     4
 -0.850000000000000D+02   0.343750000000000D+02  -0.850000000000000D+02
  0.345000000000000D+02  -0.848750000000000D+02   0.345000000000000D+02
 -0.848750000000000D+02   0.343750000000000D+02

  0.253948017060000D+01  -0.516359320290000D-01   0.689504506100000D+06
  0.381240214830000D+07     4
SW -2263 -2729NW -2260  2729NE  2259  2729SE  2263 -2729

     1

HYDROGRAPHY             795   118   795    22   530   138

N       1  2202  2571     1     0

    50     1

N       2   855  2522     1     0

    50     1

N       3  1003  2390     1     0

    50     1

N       4  1626  2381     0     0

N       5  -256  1394     0     0

N       6 -2034  1365     1     0

N       7 -2260  1285     0     0

N       8 -2261  1263     0     0

N       9  -151  1156     0     0

N      10   772  1079     1     0

    50     2
```

APPENDIX F.--Sample DLG Data File
(Standard Distribution Format)--continued

```
N      11 -1698  1059      0      0
N      12  1912  1028      1      0
     50      1
N      13  -828  1011      1      0
     50      1
N      14  -932   957      1      0
     50      1
N      15 -1292   929      1      0
     50      5
N      16 -2139   922      1      0
     50      1
N      17   489   919      1      0
     50      2
N      18  2162   697      1      0
     50      1
N      19 -1724   212      1      0
     50      2
 A      1     0     0     1     0
      0     0
 A      2     0     0     0     0
 A      3  1533  2471     1     0
     50   106
 A      4     0     0     0     0
 A      5 -2057  1523     1     0
     50   412
```

```
A      6      0      0      0      0
A      7    797   1119      1      0
     50    421
A      8  -1243    770      1      0
     50    421
A      9    530    916      1      0
     50    421
A     10  -1711    129      1      0
     50    421
A     11      0      0      0      0
A     12  -1726  -1658      1      0
     50    421
A     13      0      0      0      0
     50    106
A     17   1365   2584      1      0
     50    106
A     18      0      0      0      0
A     19    841   1803      1      0
     50    421
A     20      0      0      0      0
A     21    819   -440      1      0
     50    421
A     22      0      0      0      0
```

APPENDIX F.--Sample DLG Data File
(Standard Distribution Format)--continued

```
L      1    74    72     1     5     2     0     0

 -2259  1824 -2260  1855

L      2     8     7     1     5     2     0     0

 -2261  1263 -2260  1285

L      3     9     5     4     2    13     1     0

  -151  1156  -147  1180  -153  1189  -161  1193  -198  1181  -211  1184
  -253  1174  -263  1181  -268  1192  -264  1238  -264  1333  -250  1361
  -256  1394

    50   412

L      4   115     8     1     4     2     0     0

 -2260  1091 -2261  1263

L      5    10    10     2     7    10     1     0

   772  1079   773  1109   794  1161   803  1169   816  1169   823  1162
   824  1117   814  1081   810  1077   772  1079
    50   200

L      6    11     6     4     4    21     1     0

 -1698  1059 -1699  1115 -1686  1140 -1686  1178 -1698  1193 -1718  1203
 -1777  1216 -1792  1238 -1838  1257 -1902  1243 -1910  1236 -1911  1212
 -1920  1208 -1929  1214 -1957  1249 -1957  1253 -1981  1281 -2010  1333
 -2009  1351 -2014  1361 -2034  1365
    50   412

L      7    15    11     4     4    17     1     0

 -1292   929 -1295   951 -1306   973 -1308   987 -1321  1000 -1359  1019
 -1416  1017 -1430  1008 -1434  1000 -1455   981 -1469   988 -1482  1000
 -1524   994 -1576  1002 -1644  1034 -1669  1050 -1698  1059

    50   412

L      8    16   115     4     4    11     2     0

 -2139   922 -2154   961 -2160   970 -2167   989 -2179  1006 -2182  1017
 -2206  1041 -2207  1052 -2217  1065 -2250  1079 -2260  1091
    50   412    50   610
```

APPENDIX F.--Sample DLG Data File
(Standard Distribution Format)--continued

```
L      9    84     9     2     2    29     1     0

   444   923   413   928   370   922   360   904   321   886   267   921
   255   934   251   943   235   956   145   952   133   949    94   962
    71   955    44   957    12   981   -26   988   -37   997   -54  1027
   -74  1048   -80  1060   -87  1086   -85  1115   -94  1124   -96  1165
  -110  1179  -127  1175  -131  1158  -144  1153  -151  1156

    50   412

L     10    17    17     9     2    12     1     0

   489   919   489   908   498   900   510   900   524   906   570   902
   578   910   578   927   529   933   498   932   492   927   489   919
    50   200

L     11    17    84     2     2     3     2     0

   489   919   465   924   444   923

    50   412    50   610

L     12    87    84     2     2     3     1     0

   511   836   472   873   444   923

    50   412

L     13    89    87     2     2     3     1     0

   527   788   511   816   511   836

    50   412

L     14    21    20     2     1     2     0     0

  2262   172  2261   200

L     24    49    50    15     1     2     0     0

 -1188  2729 -1249  2729

L     25    51    49    14     1     2     0     0

 -1146  2729 -1188  2729
```

APPENDIX G.--Sample DLG Data File
(Optional Distribution Format)

```
CARTERSVILLE, GA 01                          1981,        100000.  S01
RO4.RDS01
     3     1    16     2 0.25400000000D+01     4     0     4     1
  -0.840560150000038D+08   0.340260150000010D+08   0.000000000000000D+00
   0.000000000000000D+00   0.000000000000000D+00   0.000000000000000D+00
   0.000000000000000D+00   0.000000000000000D+00   0.000000000000000D+00
   0.000000000000000D+00   0.000000000000000D+00   0.000000000000000D+00
   0.000000000000000D+00   0.000000000000000D+00   0.000000000000000D+00
 0.10000000000D+01 0.00000000000D+00 0.00000000000D+00 0.00000000000D+00
SW       34.375000  -85.000000          683898.58  3805355.05
NW       34.500000  -85.000000          683624.37  3819215.69
NE       34.500000  -84.875000          695100.28  3819449.04
SE       34.375000  -84.875000          695392.26  3805588.76
ROADS AND TRAILS       0   551   551 010   198   198 011   747   747   1
N    1   695392.26  3805588.76           2           0     0
  -724   725
N    2   685742.29  3819258.76           3           0     0
     1    -2   -87
N    3   684845.86  3819240.53           3           0     0
    -1   -23  -258
N    4   687098.38  3819286.33           3           0     0
     2    -3   -34
N    5   687347.30  3819288.85           3           0     0
     3    -4   -35
N    6   687509.77  3819294.70           3           0     0
     4    -5   -42
N    7   687735.78  3819299.29           3           0     0
     5    -6   -43
N    8   687842.44  3819301.46           3           0     0
     6    -7   -45
N    9   687969.42  3819304.04           3           0     0
     7    -8   -67
N   10   688042.96  3819310.62           3           0     0
     8    -9   -66
N   11   688129.40  3819307.29           3           0     0
     9   -10   -80
N   12   688462.08  3819314.06           3           0     0
    10   -11   -31
N   13   688632.22  3819317.52           3           0     0
    11   -12   -32
N   14   688837.92  3819321.70           3           0     0
    12   -13   -24
N   15   688947.12  3819323.92           3           0     0
    13   -14   -26
N   16   689490.57  3819334.97           3           0     0
    14   -15  -154
```

APPENDIX G.--Sample DLG Data File
(Optional Distribution Format)--continued

```
L   28    29    25     4     4                3     1     0
   685461.28  3819085.37   685414.90  3819117.45   684825.58  3819113.09
   170   209
L   29    30    24    24    22                2     1     0
   694605.90  3819273.85   694205.18  3819364.78
   170   205
L   30    30    23    22    23                4     1     0
   694605.90  3819273.85   694615.85  3819284.21   694851.82  3819423.66
   694914.90  3819445.27
   170   205
L   31    31    12    13    14                4     1     0
   688529.54  3819119.81   688480.67  3819149.30   688470.15  3819166.87
   688462.08  3819314.06
   170   210
L   32    31    13    14    15                4     1     0
   688529.54  3819119.81   688611.12  3819230.71   688637.82  3819292.23
   688632.22  3819317.52
   170   210
L   33    32    21    21    21                2     1     0
   693453.44  3819227.55   693447.02  3819417.96
   170   209
L   34    33     4     3     6                4     1     0
   687148.37  3819076.48   687139.15  3819155.05   687123.40  3819180.14
   687098.38  3819286.33
   170   210
L   35    33     5     6     7                4     1     0
   687148.37  3819076.48   687172.89  3819120.17   687342.68  3819265.89
   687347.30  3819288.85
   170   201
```