Methodology Used to Produce an Encoded 1:100,000-Scale Digital Hydrographic Data Layer for the Pacific Northwest

By BRUCE J. FISHER

U.S. Geological Survey
Water-Resources Investigations Report 94-4043

Portland, Oregon
1996

U. S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
10615 S.E. Cherry Blossom Drive
Portland, Oregon 97216

Copies of this report can be
purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286, Federal Center
Denver, CO 80225

CONTENTS

FIGURES

Methodology Used to Produce an Encoded 1:100,000-Scale Digital Hydrographic Data Layer for the Pacific Northwest

By Bruce J. Fisher

Abstract

The U.S. Geological Survey (USGS) has produced a River Reach File data layer for the Pacific Northwest for use in water-resource management applications. The Pacific Northwest (PNW) River Reach Files, a geo-referenced river reach data layer at 1:100,000-scale, are encoded with the U.S. Environmental Protection Agency's (EPA) reach numbers. The encoding was a primary task of the River Reach project, because EPA's reach identifiers are also an integral hydrologic component in a regional Northwest Environmental Data Base—an ongoing effort by Federal and State agencies to compile information on reach-specific resources on rivers in Oregon, Idaho, Washington, and western Montana. A unique conflation algorithm was developed by the USGS to transfer the EPA reach codes and other meaningful attributes from the 1:250,000-scale EPA TRACE graphic files to the PNW Reach Files. The PNW Reach Files also were designed so that reach-specific information upstream or downstream from a point in the stream network could be extracted from feature attribute tables or from a Geographic Information System. This report documents the methodology used to create this 1:100,000-scale hydrologic data layer.

INTRODUCTION

In 1984, the States of Oregon, Idaho, Washington, and Montana, in conjunction with Northwest Indian Tribes and other State and Federal agencies, established a multi-State rivers resource program called the Pacific Northwest Rivers Study. This study, in cooperation with the Bonneville Power Administration (BPA), gathered reach-specific data relating to resident fish, recreation, wildlife, institutional constraints, and natural and cultural features along river systems in the region. Concurrently, the Northwest Power Planning Council (NPPC), by Congressional mandate, began collecting data on the effect of Columbia River Basin hydroelectric dams on anadromous fish resources, as part of a Pacific Northwest Hydropower Assessment Study.

The NPPC chose the U.S. Environmental Protection Agency (EPA) Reach File as the hydrologic structure to reference, organize, and manage the large anadromous fish data base. The Reach File, developed in 1982 to be a national data base for surface-water features, consisted of tabular Reach Structure Files and digital graphic (TRACE) files composed of representations of the reaches produced from scanned 1:500,000-scale National Oceanic and Atmospheric Administration aeronautical charts. Each Reach File contains a unified surface-water classification system whose basic element was the river reach (R. C. Horn, U.S. Environmental Protection Agency, Draft, 1986).

Each reach, defined as a distinct lineal segment, was assigned a unique identifier that consists of the U.S. Geological Survey (USGS) eight-digit hydrologic unit code (HUC), a three-digit unique segment number (later expanded to four digits in order to accommodate the higher resolution hydrography), and a four-digit fixed-decimal number to represent river mile. An example of an EPA reach identifier might be:

1706010204000.01

where
17060102 is the hydrologic unit code,
040 the unique reach-segment number, and
00.01 is the river mile.

From the beginning of the Pacific Northwest Rivers Study, State agencies referenced their river-reach data to individual State-level reach-code systems. To consolidate these separate data systems and make them accessible to all participating agencies, the NPPC subsequently developed cross-reference tables, associated with the EPA Enhanced Reach File (RF2) code system that linked the four individual State data bases to their system. This combined regional data base, called the Northwest Environmental Data Base (NED) has been managed jointly by the NPPC and the BPA. The NPPC managed the tabular reach data base; the BPA Geographic Information System (GIS) section and State agencies used the RF2 graphic files to produce maps and perform GIS analysis. Subsequent enhancements to NED included a personal computer (PC)-menu-driven interface system that provided access and data retrieval from the entire regional data base.

According to NPPC, the EPA's RF2 files were adequate for tagging anadromous fish data to larger basin streams, but the files lacked the resolution to inventory and display data collected on small streams in coastal basins. The inadequate resolution eventually led the NPPC to begin expanding their tabular Reach data base to include named reaches found on 1:100,000-scale USGS quad sheets. The NPPC and State agencies added more than 40,000 reaches to the NPPC data base.

In 1985, both the BPA and the NPPC recommended to a regional GIS committee that the resolution of the hydrologic structure for NED should be increased to 1:100,000-scale. A technical subcommittee of the Northwest Land Information System Network (on which the USGS, BPA, and NPPC were represented) submitted a proposal in which the USGS would produce a new digital River Reach data base at 1:100,000-scale. The proposal described the USGS plans to encode the National Mapping Division 1:100,000-scale digital hydrography with the EPA RF2 reach codes and the NPPC codes for the four-State area.

Purpose and Scope

This report documents the approach and methodology developed to encode digital River Reach Files at 1:100,000-scale resolution for the Pacific Northwest. Specifically, the report describes how (using the utilities of ARC/INFO, a geographic information system) digital map data were compiled, edited, and manipulated in order to transfer attribute data from one digital map layer at 1:250,000-scale to another layer at 1:100,000-scale. The report explains how ARC/INFO utilities were used to establish a single transport-linkage system within the stream network of each Reach File and the manner in which additional items were added to make the Reach Files compatible with the NED. The report contains a glossary of GIS terms, a schematic of the process steps, a diagram of the directory organization, pertinent programs written in ARC Macro Language (AML) to automate the development of the Reach Files, and a data dictionary of the Attribute Tables (AT).

Project Area

The 1986 Statement of Work agreement between the BPA and the USGS stipulated that the USGS would produce 1:100,000-scale Reach Files for the States of Oregon, Idaho, Washington, and Montana. In 1990, the agreement was modified so the geographic extent would include all of the Columbia River Basin within the conterminous United States, the Puget Sound, the Oregon and Washington coast, the Klamath Basin within Oregon, and the Bear River Basin in southeast Idaho. Excluded from the agreement were waters that flowed eastward in Montana from the Continental Divide into the Missouri River Basin.

Approach

The basic approach used was the transfer of meaningful reach attributes (reach code, stream name, and other items) from the TRACE files developed by the EPA to a hydrographic layer of greater detail and spatial accuracy at 1:100,000-scale. Figure 1 shows a generalized schematic outline of the process steps taken to produce a 1:100,000-scale Reach File. The general protocol was:

1. The USGS constructed PNW River Reach Files, by USGS hydrologic unit code (HUC), for the described project area.
2. The EPA RF2 reach codes were transferred to corresponding 1:100,000-scale reaches.
3. Uncoded 1:100,000-scale reaches would be assigned a unique provisionary number.
4. A downstream-pointing reach linkage structure was developed.
5. Base river miles for each transferred EPA segment were recomputed.
6. Spatial reference to State, County, 1:100,000 and 1:24,000-scale quad names were assigned to the 1:100,000-scale reaches.
7. Sinuosity was computed for each reach.
8. NPPC reach codes, stream names, and river miles were added.
9. Compatibility to the NED data base was included by adding many of the same items found in NED.
10. The completed Reach Files were distributed to regional agencies.

DIGITAL MAP PROCESSING

Three digital map sets were required to develop the new 1:100,000-scale Reach Files. The sets were obtained from different sources: the USGS 1:100,000-scale Digital Line Graph (DLG) for hydrography came from the National Mapping Division (NMD) of the USGS; an enhanced version of the Reach File (RF2), including the graphic line (TRACE) files provided by an EPA contractor; and a copy of a 1:2.5 million-scale USGS Hydrologic Unit map was provided by the USGS, Water Resources Division headquarters in Reston, Virginia.

The 1:100,000-Scale Hydrography

The NMD provided more than 7,000 DLG's for hydrography on 13 nine-track magnetic tapes. The 1:100,000-scale (100K) hydrography, with feature codes, was written to tape in 30 × 30 minute area blocks. An AML program STANDARDPANEL.AML (Appendix A) converted each 100K DLG piece into an ARC/INFO coverage (also described here as a panel). Area and line topology for each panel were computed using the ARC:CLEAN command on each. Blocks of panels were appended together to construct the 100K quads. The command STANDARDPANEL.AML also removed the straight-line edges from around each panel and appended them into a separate coverage. The edge coverages were useful as a check to determine if the paneling process was completed properly.

STANDARDPANEL also performed an automated edgematching of the features along the internal seams between panels. A node-snapping distance of 30 meters was used to close any line gaps that were present after the paneling process.

Once the 100K quads were created, the line and polygon features along the map boundaries were edited to produce a seamless connection between maps. The amount of adjustment of features had to be kept to a minimum to avoid corruption of the original DLG data. For this reason, it was decided that only the north and west edges of each quad would be edgematched. The south and east edges of each 100K-scale quad were left unaltered. This method seemed more appropriate than following a checkerboard approach, where all four sides of one quad might be adjusted. When evaluating edgematching methods for efficiency, it was found that the existing automated edgematching programs were slow, unreliable, and required extensive manual checking. In addition, the automated method required a user-given snap distance, often the maximum gap distance between adjacent features along the boundaries. The snap distance was usually obtained by measuring the gap with the graphic cursor, a method that added one more time-consuming step to the process. Manual edgematching of the features worked best, especially to resolve cartographic inconsistences that frequently existed between maps. These cartographic inconsistencies may have been introduced because the source materials were compiled at different times, from maps of two different scales, or by different cartographers.

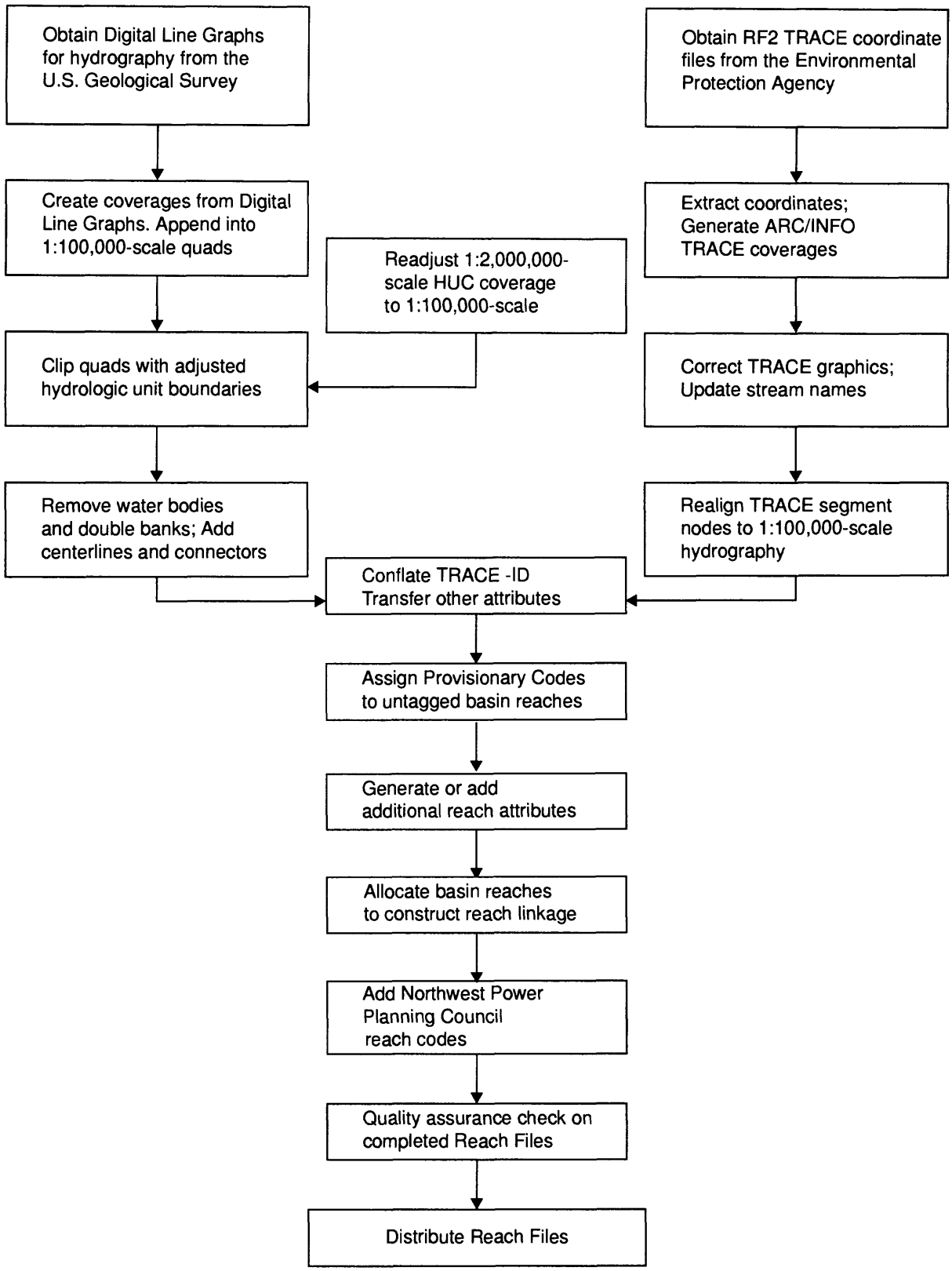

Figure 1. Generalized schematic of the River Reach encoding process.

To manually edgematch the 100K-scale quads, each was brought into ARCEDIT and graphically drawn at the terminal. A part of the edge of the adjacent quad was drawn in the background for reference. The pan and zoom functions of the graphics terminal were used to move along the edges of the quad, thereby selecting and moving end nodes of lines to spatially align them on top of the corresponding end nodes of its neighbor. This method affected only the adjustment of the arc from the end node to the last vertex, thereby minimizing or eliminating the need to shift the entire arc. When necessary, artificial segments were added to correct line inconsistencies and provide continuity along the borders. These artificial segments were assigned a MINOR1 feature code of 999.

A USGS Open-File Report summarized many of the procedures used by the USGS to edgematch the 100K-scale quads (Nebert, 1989).

Once edgematched, the 100K-scale quads were converted from Universal Transverse Mercator coordinates (the map projection for distributed DLG data) to Albers Equal Area coordinates (the projection used in the PNW River Reach project). The following projection parameters were used:

PROJECTION	Albers Equal Area
UNITS	Meters
1ST PARALLEL	43 30 00
2ND PARALLEL	47 30 00
CENTRAL MERIDIAN	-114 00 00
LATITUDE OF ORIGIN	41 45 00
EASTING	0.0
NORTHING	0.0

U.S. Environmental Protection Agency TRACE File

The RF2 Files for hydrologic Regions 16, 17, and 18 were provided on nine-track tape by an EPA contractor. An ARC/INFO program, EPATOARC .AML (Appendix A) was written to extract the longitude-latitude line coordinates for a selected HUC. The program produced an output file of coordinates in a format readable by the ARC/INFO: GENERATE command. This procedure created a geo-referenced line coverage named TRACE. The extended attributes of each TRACE line segment were subsequently joined to their matching segments in the TRACE Arc Attribute Table (AAT). Each TRACE coverage was then projected into Albers Equal Area coordinates.

Paper plots of the TRACE coverages were made and compared with Hydrologic Segment Plot indexes of the RF2 TRACE Files provided by the BPA and with available 1:100,000 and 1:24,000-scale paper manuscripts. Any graphic errors with the TRACE coverages were identified and marked on the paper plots for reference, then corrected manually in ARCEDIT. The kinds of errors discovered included duplicate, knotted, or incorrectly joined line segments and attribute errors such as misspelled, misplaced, or unnamed streams. The paper plots were retained in the event that questions might arise later regarding the TRACE coverage editing.

1:2,000,000-Scale Hydrologic Unit Map

The national hydrologic unit coverage obtained from the USGS was first reduced in areal extent to include only hydrologic units within the project area. The coverage was then converted into the Albers projection coordinates and renamed HUCSALB. The coverage was brought into ARCEDIT, and the boundaries were reshaped to capture all of the headwater and lower reaches of the 1:100,000-scale hydrography. Hydrologic unit boundaries are water-management boundaries and are not necessarily coincident with a watershed boundary determined from basin ridge lines; therefore, contours or elevation information were not required. The USGS 1:500,000-scale hydrologic unit map series was used as a primary source of reference when editing the boundaries. The edgematched 100K quads were graphically displayed in the background for additional reference. In certain areas, where the topographic relief was low or poorly defined (such as in the Craters of the Moon area of southeast Idaho), positioning the boundary line was difficult. A "best-guess" approach was used. Paper plots were made of the edited work and distributed to some State agencies for review.

CLIPBASIN.AML (Appendix A) used the ARC:RESELECT COMMAND to extract each redelineated boundary from HUCSALB, and it was used to individually "cookie cutter" those 100K-scale quads situated within its geographic extent.

The clipped quad pieces were appended to make 100K-scale basin coverages. Each basin coverage was named STR100. CLIPBASIN.AML invoked UNSPLITDLG.AML, which in turn removed any unnecessary pseudo nodes that may have been created from the earlier processes.

PROJECT ORGANIZATION

For the River Reach project, production-line procedures were incorporated to handle the assembling and processing of the hundreds of Reach Files and other associated coverages. ARC/INFO AMLs were extensively used to systematically create, process, edit, and move coverages from one directory to another. Other AML programs accessed the coverages to add, manipulate, update or manage attribute data. The AML programs were written to call for specifically named coverages. During the project, there were hundreds of coverages on-line; therefore, the standardization of coverage names, in conjunction with developing and maintaining an organized and homogenous directory structure, was an essential component of the project.

The project directories had to be structured to accommodate multiple use by several staff personnel, which required that directories be organized in a manner designed to minimize the possibility of users accessing the same coverages or data files at the same time. The design prevented accidental interference between personnel, which could have led to processes failing, corrupted coverages and data files, or both. The directory structure also had to be organized so that partly completed Reach Files could be easily stored on media when hard-disk space became limited. For example, the component pieces for an entire subbasin would be assembled, then archived, until work on them would proceed.

The River Reach project was organized in a tiered structure. The major subbasin directories (corresponding to the Willamette or Yakima Basins, for example) were located beneath the top-level directory, BPA-WORKING. Beneath each subbasin directory there were ARC/INFO workspaces for each HUC within the subbasin. Each workspace was named by HUC preceded by a letter: I for "in progress" or F for "final" or "complete." Each workspace contained an INFO directory, the Reach File for that particular HUC, and (in most cases) a water-body coverage. At various times, the workspace also may have contained the original 100K-scale basin coverage, the boundary polygon CLIPCOV, and the TRACE coverages. These particular coverages were eventually deleted or archived separately. Check plots arising from the editing and conflation processes also were kept temporarily in the workspace. This type of directory organization, illustrated in figure 2, worked well during production and when the entire River Reach File data base was subsequently managed in a digital map-library system.

Once completed, the coverages residing in each HUC directory were converted into ARC/INFO interchange files and copied to PNWFINAL, a depository directory structured similar to the BPA-WORKING directory. This process was done as a batch process with PNWARCHIVE.AML (Appendix A). From PNWFINAL the data sets were archived onto digital storage media, such as nine-track magnetic tape, optical disk, or eight-millimeter video cassette, and were distributed to participating or cooperating agencies. PNWARCHIVE.AML also updated items added to the HUCSALB polygon coverage to track the progress of each Reach File. These items were useful when producing reports or status plots.

CONSTRUCTION OF STREAM NETWORK CONNECTIVITY

Each Reach File was designed with the capability to accumulate reach-specific data while traversing the stream network in either an upstream or downstream direction. To make this functionality possible, it was imperative that all main-stem and tributary reaches were connected. As an aid in determining the connectedness of the Reach File (at this point in the production the Reach File was called STR100), each STR100 coverage was read into the NETWORK module of ARC/INFO. The ALLOCATE:GROW command in NETWORK was used to allocate the STR100 coverage, using previously selected starting points (centers). As each reach was allocated from a center, it was graphically drawn on the screen with a specified line symbol assigned to that particular center. When the allocation was finished, any disconnected (nonallocated) reaches were displayed in white. This process provided a visual means for evaluating the connectedness of the stream segments and, more importantly, for locating where gaps existed.

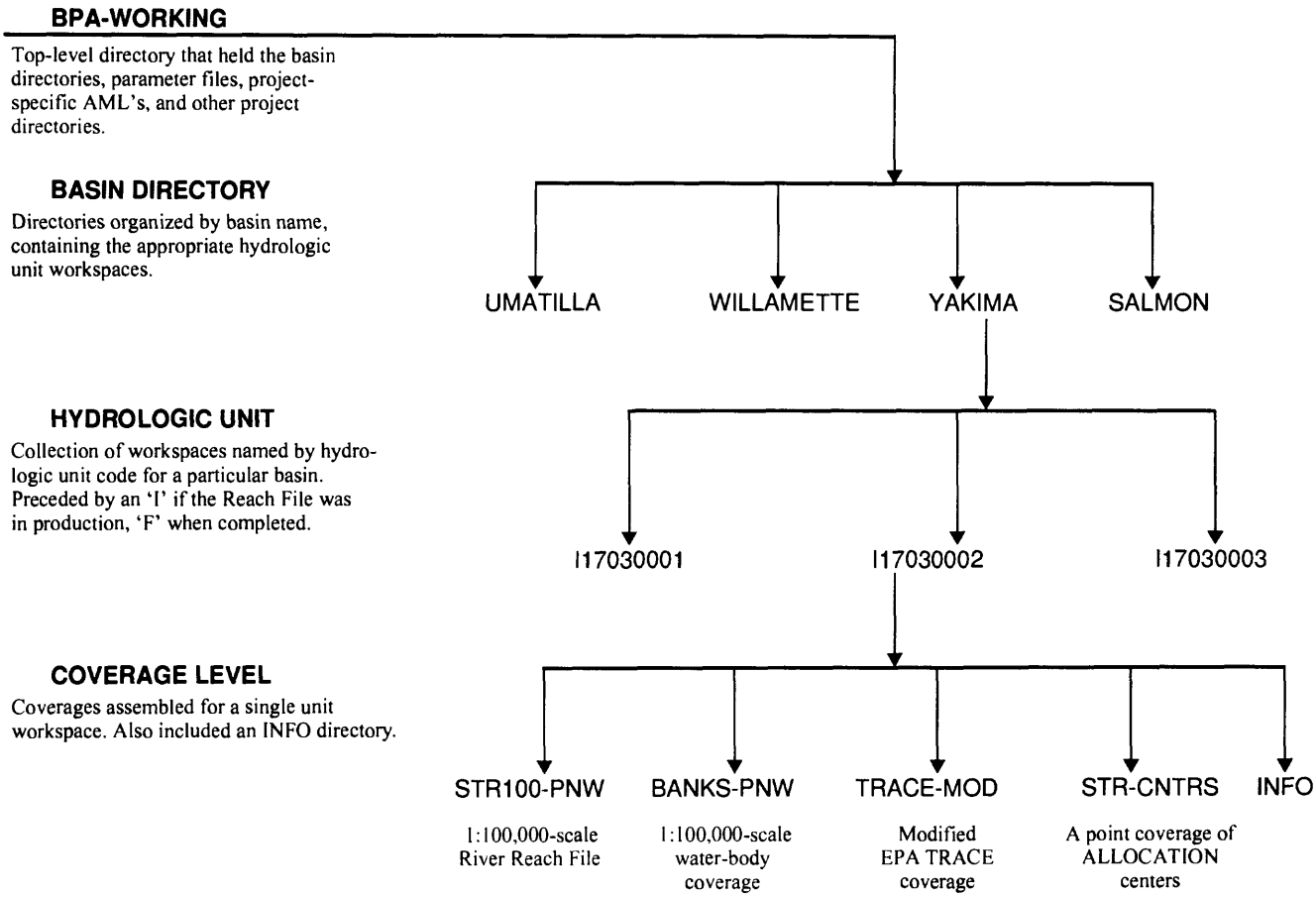

Figure 2. Schematic of the working directory structure.

If a large number of gaps required closing, then ARC.MATCHNODE was then run on the coverage. MATCHNODE.AML performed automated node snapping using a snap distance of 30 meters. The alternative method used was to manually edit the coverage and interactively repair the gaps. This process generally took more time than the automated method, but the process allowed for better feature control when repositioning the nodes before they were snapped. When needed, vertices in the line segment were added or deleted to help minimize the positional shifting of the nodes. This process of checking for gaps in the line features was repeated until the arcs in the STR00 coverage were satisfactorily connected. Using the ALLOCATE:SAVECENTER command, the centers were saved to a separate point coverage. The placement of allocation centers was based primarily on the line structure of the TRACE coverage for that particular hydrologic unit. Other factors, such as the drainage pattern of the basin, had to be taken into consideration. Allocation centers typically were the lowest node in the basin; however, for stream networks with more than one drainage, such as coastal basins or basins in areas with parallel drainage, the basin would be allocated from more than one center. Additionally, centers were sometimes placed on disconnected tributaries, if the tributary was significant enough to warrant routing.

For the final step, UNSPLIT.AML was run on the STR100 coverage to remove unneeded pseudo nodes. The program summed the MINOR descriptive codes for each arc; if the total equaled that of an adjoining arc, the pseudo node between them was removed. This method prevented the removal of legitimate pseudo nodes that appear in the hydrography, such as when a stream changes from perennial to ephemeral. The MINOR2 descriptive code changes from 0 to 610.

Creation of the Water-Body Coverage

The decision to remove nontransport reaches (such as lake and reservoir shorelines, marsh boundaries, ponds, glaciers, and all double stream banks of wide rivers) from the STR100 coverages and to replace them with a single transport path was partly a result of a 1989 technical evaluation of the PNW Reach File data structure by the Washington Department of Wildlife (WDOW) (Knutson, Lea, Washington Department of Wildlife, written commun., 1989). The WDOW was concerned that if the water-body features were left in the Reach Files, no single path would exist that properly connected all main-stem reaches. This situation would create problems for users of the Reach Files if they attempted to use the linkage items in the attribute tables to traverse the stream network in both directions. The WDOW suggested that leaving the water-body features in the Reach Files could lead to potential analysis errors. First, any reach above a water body would have more than one downstream or shoreline reach. When directional models were used, the downstream shoreline arc traversed by the model might be different from the arc the model might select if the direction were reversed. In addition, the shoreline reach chosen by the directional model on one side of an open water body would not be physically connected to shoreline reaches or tributaries on the opposite shore. The WDOW felt this occurrence might generate data-analysis errors when coding a stream network with anadromous fish presence data Another concern of less importance was expressed by regional data-base managers, who possessed limited computer resources and were reluctant to store and manage hundreds of additional and possibly redundant reach data.

The most efficient way to remove the nontransport features from the STR100 coverage was to employ the ARCEDIT:PUT command. The features were selected interactively or on the basis of a NMD feature code and were then copied into a separate water-body coverage. The features were then deleted from the STR100 coverage. This process worked well; however, the PUT command would retain only the complete set of attributes for the first feature type copied. Subsequent features types PUT into the water-body coverage were stripped of all attributes other than their default attributes. Additional steps for recoding these features had to be included. A second method for removing the nontransport features was the ARC:RESELECT command. Polygons in the basin coverage were extracted and placed into the water-body coverage on the basis of feature codes. The difficulty with ARC:RESELECT was that miscoded features (for example, a lake miscoded as a stream) were omitted from the ARC:RESELECT operation. This omission required additional editing time to locate and transfer the missing features. Once the features were copied to the respective water-body coverage (subsequently named BANKS-PNW), the STR100 coverage was then brought into ARCEDIT, and the polygon and double-banked features were deleted. The BANKS-PNW coverage was edited to close all open polygons, verify or add labels, and code the line features. Connector arcs were added, if needed. Polygon and line topology were then recomputed. The BANKS-PNW coverage also became a depository for areal and superfluous line features removed from the STR100 coverage. Small islands, heavily braided sections of streams, and submerged channels were examples of features that were removed from the STR100 coverage and moved to the water-body coverage.

Creation of Centerlines for the 1:100,000-Scale Hydrography

Centerline arcs were inserted into the STR100 coverage, instead of the water-body features, to ensure that a single transport path was created through the stream network. The centerlining was done within ARCEDIT. For double-banked rivers, centerline arcs were added in an attempt to maintain a logical flow between the two banks of the channel. The features placed in the BANKS-PNW coverage was drawn in the edit background to serve as a useful visual guide. Connector arcs were added to link every tributary that intersected a shoreline to the centerline. To retain the proper hydrologic sequence, straight connector arcs were added from the tributary to the centerline. Project staff chose to add short connector arcs from all tributaries, regardless of the distance to the centerline. The general rule for centerlining reaches rivers with large islands was to direct the centerline around the islands. In certain situations (for example, when tributaries entered opposite shorelines with an island in between them), the centerline was placed over the island to ensure that both tributaries were connected. This situation occurred in the lower Columbia River, where many islands in the river channel are several miles long.

Reservoirs typically had long, narrow, sinuous bays. Placing centerlines in these bays meant creating connector arcs that snaked from the point where the tributary intersected the reservoir shoreline to some appropriate point along the centerline. Sometimes, several connector arcs would converge at the centerline near or at the same point. The centerlining of reservoirs often was not cartographically pleasing but, nevertheless, served the purpose of properly linking the stream network.

Marshes were centerlined even though no channel existed, provided an outlet was present. Stream reaches with extensive interlacing braids also were centerlined. As a general rule, for heavily braided reaches, if the main course of flow was impossible to determine, the entire section was pulled out and placed in the water-body coverage; the reach was centerlined and, if needed, connector arcs were added. Otherwise, the braids were left intact and a single path through the section was determined in a later process. Whenever a disconnected branch was considered significant to the basin drainage (or if the TRACE coverage assigned segment codes to some or all of the disconnected branch), connector arcs were added to join the branch to the main stem. The connector arc would receive the attributes of its connecting stream. When a stream flowed into a lake (shaded blue on quad map sheets) and exited, the lake polygon was moved to the water-body coverage and replaced by a centerline segment.

The MINOR1 code feature for both centerline and connector arcs was set to 999 to signify that each was an artificial segment. The MINOR2 feature was sometimes coded to identify the feature that the artificial segment replaced.

Preparation of the TRACE Coverage

The RF2 TRACE coverages were edited extensively to prepare them for the conflation procedure, which is discussed in greater detail in the next section. The upper and lower nodes of every TRACE segment were adjusted to align them with the corresponding upper and lower nodes in the STR100 coverage. Before any editing was actually begun, working plots of the TRACE and STR100 coverages were made. Planned edits to the TRACE coverage were marked in red on the paper plots to serve as a hard-copy record of all TRACE coverages modifications. These plots were useful during the edit session and were archived for future reference. The repositioning of the TRACE nodes was done in ARCEDIT. This process was time-consuming because of the constant panning, zooming, and redrawing of features that was required. Determining the position of the upper TRACE segment node was a difficult task, because the 100K-scale hydrography often had multiple headwater reaches flowing into a single branch. Despite referencing of the topographic quads, the choice of headwater reach often was arbitrary. The lower TRACE segment node usually was at a point of confluence and had to be accurately positioned over the corresponding STR100 node. Any errors found with the lines in the TRACE coverage also were corrected. It was common to find line segments "twisted into knots" or incorrectly joined. For some TRACE coverages, the entire linework was pulled apart and then reconstructed. Nontransport reaches, such as water-body shorelines or partial centerlines, were either deleted or, when left in the TRACE coverage, moved to the outer edge of the coverage (out of the way of any future processes). When the graphic editing was completed, line topology for each TRACE coverage was rebuilt and the coverage renamed TRACE-MOD.

Conflation of the TRACE Attributes

CONFLATION.AML (Appendix A) was developed by the USGS as a method to perform a transfer of attributes from a simple line coverage to a more complex one. For the River Reach project, we wanted to transfer the RF2 attributes from one line segment in the TRACE-MOD coverage to many corresponding line segments in the STR100 coverage. Many different methods were attempted to accomplish this, but the following approach had the highest success rate. The CONFLATION program used the ARC:NODEPOINT command to create a point coverage, TRACE-MOD-P, from the nodes in the TRACE-MOD coverage. The ARC:NEAR command used TRACE-MOD-P as an input coverage to locate, within a specified search distance, the corresponding nodes in the STR100 coverage. When an STR100 node was found, its internal number was written into the TRACE-MOD-P Point Attribute Table (PAT). This established a topographic link between features in the TRACE-MOD-P and the STR100 coverage. It also created a link between the nodes in TRACE-MOD-P and the arcs in TRACE-

MOD.AAT. The next step was to redefine items in the TRACE-MOD-P.PAT and theTRACE-MOD.AAT to make it possible to relate the two attribute tables. Once the two files were related, it was possible to output a file that contained the TRACE-MOD-ID (from the TRACE-MOD.AAT) matched to the internal node numbers of the STR100 coverage in the TRACE-MOD-P.PAT. CONFLATION.AML calls up the NETWORK:ROUTE program, reads in the TRACE-MOD-ID, and matches STR100 node pairs from the output file; CONFLATION.AML then used NETWORK:ROUTE algorithms to compute the shortest path between the same node pairs in the STR100 stream network. The ARC: WRITEROUTE command transferred the TRACE-MOD-ID value to each STR100 reach along the ROUTE path. This process would be repeated for every line segment in the TRACE-MOD coverage.

Some TRACE coverage contained centerlines; if so, then the corresponding centerlines in the STR100 coverage would receive the same -ID values. If no TRACE centerline existed (which sometimes was the case), then one of the two shorelines was arbitrarily chosen. The -ID value from the chosen shoreline arc was transferred to the centerline. Connector arcs were given the -ID value of the tributary. Check plots were made to evaluate the success of the conflation program. If CONFLATION failed to locate an STR100 node within the specified search distance from a TRACE-MOD node, the STR100 node number and the -ID value of the arc in the TRACE-MOD coverage were output to an errors file for review. If a large number of failures occurred, this usually indicated that the search distance used by ARC:NEAR in the CONFLATION program was set too small—or the nodes in the TRACE-MOD coverage were not aligned closely enough to their corresponding STR100 nodes to find a match. After re-editing the TRACE-MOD coverage or selecting a larger search distance, the program was rerun until CONFLATION results were either all correct or showed only a few errors that could easily be corrected manually in ARCEDIT.

Once the TRACE-MOD-ID had been encoded onto the correct arcs in the STR100 coverage, GETATTS.AML (Appendix A) was run to complete the transfer of the remaining RF2 attributes. These RF2 items included SEG, SEQNUM, FLAGS, LEVEL, and STR-NAME. The TRACE-MOD -ID was used as the relate item.

Because of differences in resolution between the TRACE-MOD and STR100 coverages, only about one-third of the STR100 reaches were encoded with an RF2 segment number (SEG). CALCPSEG.AML (Appendix A) selected all uncoded STR100 reaches and assigned them a unique provisional reach code. The numbering began with 500, to segregate them from the EPA and NPPC segment numbers.

Addition of Quad Names and Political Boundaries

A composite overlay coverage was assembled from 1:100,000-scale and 1:24,000-scale quad index coverages, a 1:500,000-scale county map, and a 1:100,000-scale State outline map of the project area; the composite overlay coverage provided boundary attributes to each STR100 reach. This polygon coverage (PNW124C-ALB) was overlaid onto a copy of the STR100 coverage by using the ARC:IDENTITY command. After sorting by arc segment number and length and relating back to the original STR100 coverage, STATE, COUNTY, QUAD100, and QUAD75 names that were held by the most predominant arc (by length) were moved to all original reaches for that particular segment number. The second most predominant arc was then selected, and if the boundary names were different from those of the longest arc, these names were moved to STATE-2,COUNTY-2, QUAD100-2, QUAD75-2. Otherwise, these fields were left blank. The output coverage from the identity process was named STR100-PNW.

Development of a Stream Linkage System

The development of a linked stream network provides users with the ability to retrieve data from any reach and to accumulate information in either an upstream or downstream direction along the stream network. Two criteria were important when constructing the linkage system: (1) all naturally flowing reaches connected to the main-stem river(s) must be oriented to flow in a downstream direction, and (2) all upstream reaches must successfully end at a headwater reach. This meant that any manmade flowing-water features, such as canals, aqueducts, flumes, and penstocks, whose direction of flow were impossible to know or determine, were excluded from the network linkage system.

Some RF2's did have a reach code for large canals. In those instances, the canals were included as part of the stream network. Some natural features, such as braided reaches, glaciers, some coastal shorelines, dredging channels, marsh boundaries, and other features also were not incorporated into the linkage structure.

Blocking Features from Routing

To flag those features to be excluded from the stream network, item SAVENEG was added to the STR100-PNW.AAT. The features were selected interactively from the terminal or by feature code, by using the ARC:RESELECT command. Once selected, the value for SAVENEG was set to 1. When the selection process was complete, the STR100-PNW coverage was brought back into ARCEDIT and the LENGTH values for these features were multiplied by -1. The default impedance item for the NETWORK:ROUTE command was the item LENGTH. Any feature with a negative impedance (LENGTH) would be blocked from routing and, thus, removed as part of the stream network.

The next process was to read the STR100-PNW coverage back into the ARC: NETWORK utility for rerouting. Allocation centers again were selected, either interactively from the terminal or 'read-in' from a previously created STR-CNTRS coverage. The NETWORK:ROUTE command then assigned arcs in the stream network to each center along the path to the center. As each arc in the network was routed, its length was added to the cumulative demand value from the center. When the stream allocation was completed, the NETWORK:WRITEALLOCATION command wrote the results to the items CEN, CUMLENGTH, DNARC, and DIRECTION into the STR100-PNW.AAT. The item CEN contained the internal number of each node used as an allocation center. Reaches that were not allocated retained a CEN value of 0. CUMLENGTH contained the summed lengths of arcs along the path from each allocation center. The cumulative length values were later used to calculate river miles for those reaches with an RF2 segment number. The item DNARC preserved the internal record number of the previously traversed reach and was a key item in computing the network linkage. For the first reach allocated from a center, WRITEALLOCATION gave a DNARC value equal to the negative node number of the allocation center. DIRECTION was set to 1 or -1 to indicate the flow orientation of routed stream reaches. A value of 1 meant the direction of the arc was upstream. The program FLIPPER.AML (Appendix A) selected upstream flowing reaches and reversed their direction using the ARCEDIT:FLIP command. Any reach that was not routed retained a DIRECTION value of 0. FLIPPER.AML also added an item PNTR# to the AAT. The values in PNTR# were calculated equal to the values in STR100-PNW#, to preserve a record of the order of the AAT at the time the coverage was allocated. The final step to completing the linking of the stream network was to run UPLINK.AML. This program included an INFO program that used the DNARC and PNTR# items to fill in three upstream identifiers above a given reach (UPLINK1, UPLINK2 and UPLINK3); a flag item (UFLAG) to indicate, with a value of 1, whether there are more than three upstream reaches; and the downstream reach identifier (DOWNLINK). The headwater reach and the outlet reach were given a special MINOR3 code for interconnecting HUC's, making them easy to identify. A MINOR3 of 888888 was added to the headwater reach in the Reach File and for the outlet reach the MINOR3 code was set to 111111.

COMPUTATION OF RIVER MILES

The conflation process assigned multiple reaches in the STR100-PNW with the same RF2 reach code. To complete the requirement that every reach identifier in the STR100-PNW coverage be unique, river miles for these reaches required computing. CALCRMI.AML (Appendix A) used the arc length, the (RF2) SEG item, and items from the allocation process to compute the value for river mile. The items STR100-PNW#, SEG, LENGTH, ANDCUMLENGTH were pulled from the STR100-PNW.AAT to create a new INFO file named RMIFILE. An additional item, BASERMI, also was added. In an INFO program, the nonallocated reaches were selected from the RMIFILE and purged; next, CUMLENGTH and SEG (with values less than 500) were sorted in ascending order. Sorting RMIFILE in this manner placed all reaches with a common SEG number in upstream order. The BASERMI value for the lowest reach was set to 00.00, and its length (in meters) was placed in the BASERMI field of the first upstream reach.

For the next upstream reach, the sum of the lengths of the first two reaches was moved to BASERMI, and so on, until a BASERMI value was summed for each reach. Relating the RMIFILE with the STR100-PNW.AAT, BASERMI was moved into the item RMI in the STR100-PNW.AAT. River miles were then computed by dividing RMI by 1609.2. River miles for nonallocated reaches (CEN = 0) and SEG values 500 and greater were left set at 00.00.

COMPUTATION OF SINUOSITY

A sinuosity value was computed for each reach in the STR100-PNW coverage, by using SINUOSITY .AML (Appendix A), an AML program that computed the ratio of the actual lengths of arcs in the STR100-PNW coverage to straight-line arcs in a copy coverage. The arcs in the copy coverage were generalized into straight lines by taking the length of the longest arc in the coverage as the value for the ARCEDIT:GRAIN command. GRAIN removes vertices in an arc based on a specified distance.

TRANSFER OF NORTHWEST POWER PLANNING COUNCIL REACH CODES

Another important task was to transfer the NPPC's NED reach codes to the completed STR100-PNW coverages. This particular process was vital to the NPPC and to NED users who had a wealth of rivers information already tagged to these codes. The NPPC provided the USGS with photoreduced, quad index maps, marked with their specific reach codes, stream names, and river miles. The USGS first transferred the codes and stream names shown on the index maps onto 1:100,000-scale paper map sheets. Project personnel registered the quad map sheets on the digitizer; by using an ARCEDIT menu interface program, they transferred the NPPC reach codes and stream names from the quad sheets to STR100-PNW coverages brought into the edit session. The NPPC codes also were transferred interactively. Three new items, CSEG, CNAME, and CRMI, were added to the STR100-PNW.AAT to hold the NPPC data.

QUALITY ASSURANCE

To produce a Reach File, several different ARC/INFO processes and hundreds of detailed graphic edits were performed. AML programs were extensively used and became an integral component of the project. AMLs maintained production consistency from one process to the next, verified results, and served as a quality assurance tool. AML programs also set editing environments and tolerances, and automated editing procedures. Many AMLs included code to continually monitor the status of the Reach File topology. When topology had to be rebuilt, the tolerances used were within the accuracy standards warranted for maps at 1:100,000-scale resolution. This practice minimized the possibility that the features in Reach Files might become spatially displaced. AMLs standardized production tasks to ensure that each Reach File moved from one process to another in a systematic manner and maintained consistency with the names of coverages and associated file names. AMLs were written that updated, dropped, and ordered items in the attribute tables of final coverages. ORDER.AML (Appendix A) extracted and then reordered items from both the Reach File and the water-body coverage attribute tables to maintain item consistency. The provisionary (PSEG) reach-code values were moved into the item SEG. The field width for SEG was expanded from the three-digit EPA format to four digits for the River Reach Project. Items no longer needed, such as MAJOR2, MAJOR3, DIRECTION, and PSEG, were deleted. The items in the STR-CNTRS attribute tables were default ARC/INFO items and, therefore, did not require verification.

The organization of the item definitions, and examples of the tables when listed, are shown in Appendix B. The standardization and organization of items in the attribute tables is important when Reach Files and other associated coverages will be managed in a digital map library system.

CHECKIT.AML (Appendix A), a menu-based program, provided a quick quality assurance check of each completed Reach File. CHECKIT.AML contained menu options to verify reach coding, names of the quadrangle and political boundaries, networking items, results from conflation, and the integrity of the linkage structure.

USES FOR THE RIVER REACH FILES

The increased resolution of the Reach Files, nearly a fifteenfold increase over the original EPA Reach Files, provides regional agencies with a more accurate, geo-referenced data set for many types of

geographic and analytical applications. When interfaced to the Northwest Environmental Data Base, an advanced and comprehensive hydrographic information system will be available. During the past few years, Federal and State agencies have used the Reach Files for various specific applications. State agencies in Washington have used the Reach Files for the Puget Sound Basin for studies that determined the migratory extent of resident and anadromous fish, for a Hydropower Development /Resource Protection Plan, and to produce a series of maps showing the effects of hydroelectric facilities on anadromous fish habitat. The U.S. Forest Service has used the Reach Files to determine long-term effects of logging within the Salmon River Basin in Idaho, by comparing current data collected along the main stem and major tributaries with historic data collected along those same reaches in the 1940's by the BPA. The Reach Files are being used by the Spotted Owl Recovery Team for evaluating riparian corridors and by the U.S. Army Corps of Engineers for flood plain analysis of the Lower Willamette and Columbia Rivers. A private conservation organization recently used the Reach Files in a study to inventory the extent and status of temperate rain forests along the Oregon and Washington coasts. Successful implementation of the PNW Reach Files will eventually require a structure that extends far beyond the existing structure. Advances in GIS software may result in the applications of the Reach File system being expanded into such areas as dynamic segmentation (an ARC/INFO tool), which provides the ability to associate multiple layers of attribute data onto any river segment; real-time watershed modeling; or water availability forecasting.

RIVER REACH CLEARINGHOUSE

The River Reach Clearinghouse, a cooperative project between the USGS and the BPA, provides interim management of the Reach Files until a more permanent management agency, or system, is established. The major objective for the USGS and the River Reach Clearinghouse is to prevent the disintegration of the integral structure of the Reach Files as agencies incorporate these data sets for their own specialized applications. The USGS will oversee the development of protocols as the Reach Files are updated and errors are corrected, and will provide training to users regarding the design and capabilities of those Reach Files. The USGS also will provide additional support through the River Reach Task Force Committee, a group of regional Reach File users that would meet periodically to discuss issues concerning the current status and future directions of the Reach Files. Other tasks the USGS has assumed are the conversion of the PNW Reach Files to DLG Option -3 format, the organization of those files in a transportable ARC/INFO map LIBRARIAN system, and being the primary center for distribution of those files.

SUMMARY

The River Reach Project was one of the more ambitious GIS projects attempted by the U.S. Geological Survey during the mid-1980's. The project was of great regional importance and the resulting products in high demand. River Reach Files were completed for the Columbia River Basin within the conterminous United States, Oregon, Washington, and the Bear Lake Basin in southeast Idaho. Each Reach File was constructed by following a protocol developed by the U.S. Geological Survey with concurrence from regional Federal and State agencies. The project used ARC/INFO GIS software for compiling, manipulating, processing, and managing the Reach Files and their associated coverages. Individual coverages used to construct the Reach File underwent extensive editing by project staff. AML programming proved vital to the project and was used extensively to control the order of processes, set editing environments and tolerance values, maintain the integrity of the Reach Files and other coverages, and perform data base management functions. A separate water-body coverage was created to contain all areal features and shorelines removed from the Reach File; when needed, centerlines were inserted in their place. The insertion of centerlines provides users with the capability to move upsteam or downstream in the Reach File, by using items found in the tabular attribute files or with a GIS, and to accumulate reach-specific data. Additional Items also were included that allows a large regional rivers data base to be interfaced with the Reach Files.

Successful implementation of the River Reach File has potential utility beyond that for rivers and streams. While presently confined to flowing water, the methodology that has been developed for managing and storing river information could be expanded to include lakes, wetland areas, and other types of surface water bodies.

SELECTED REFERENCES

Environmental Systems Research Institute, 1987, ARC/INFO User's Guide, Vol. 1: Redlands, California.

———1987, ARC/INFO User's Guide—NETWORK: Redlands, California.

Horn, C. Robert, 1986, Reach File Manual [draft]: Washington, D.C., U.S. Environmental Protection Agency.

Nebert, Douglas D., 1989, Review of Edgematching Procedures for Digital Cartographic Data Used in Geographic Information Systems (GIS): U.S. Geological Survey, Open File Report 89–597, 12 p.

U.S. Geological Survey, 1983, Digital Cartographic Data Standards, Digital Line Graph Attribute Coding Standards: U.S. Geological Survey Circular 895–G, 31 p.

———1985, Digital Line Graphs from 1:100,000-scale maps: U.S. Geodata Data User's Guide 2, 74 p.

GLOSSARY OF COMMON TERMS AND ABBREVIATIONS USED IN THIS REPORT

AAT ---------- Arc Attribute Table. A table that contains the attribute data for a line coverage.

AML ---------- ARC/INFO Macro Language.

Arc ---------- A line feature defined by a from-node (endpoint) and a to-node and additional vertices in between. Arcs are topologically linked at their nodes. Arcs have tabular information that is stored in the AAT.

ARCEDIT --- The graphics and data base editor for ARC/INFO.

ARC/INFO -- The GIS software used for the River Reach Project. Geographic Information Systems are used to manage, manipulate, analyze and display geographic data. ARC is the spatial management environment of ARC/INFO while INFO is the relational data base manager for the attribute data associated with the geographic features.

ARCPLOT -- The interactive cartographic and mapping subsystem for ARC/INFO.

BUILD ------- ARC/INFO command to construct topology for points, lines, and areas and create feature attribute tables.

CLEAN ------ ARC/INFO command used to construct topology for lines and areas. CLEAN also creates the feature attribute tables. Unlike BUILD, CLEAN also creates intersections where arcs overlap and removes dangling arcs. CLEAN sets a minimum distance between arc vertices (known as fuzzy tolerance) in the output coverage. The fuzzy tolerance for the Pacific Northwest River Reach Project was kept between 5 and 17 meters.

Conflation --- Concept of combining two components. In this project, conflation combined attributes from a simple line coverage with a complex line coverage.

Connectivity- Concept of line segments connected to each other at nodes.

Coverage----- A digital map layer. Coverages consists of topologically linked geographic features and their associated descriptive data

DLG ---------- Digital Line Graph. Line map information in digital form of planimetric base categories.

HUC ---------- USGS eight digit hydrologic unit code.

INFO --------- A data base management system used by ARC/INFO to store and manipulate feature attributes.

Item---------- In an feature attribute table, an item stores one type of information for all the features in the data base.

Label Point -- A marker used to represent the location of a point feature, such as a well, or to assign an identification to a polygon.

Layer --------- Map features separated or organized by theme.

NETWORK- Routing and allocation module of ARC/INFO.

NMD---------- National Mapping Division.

Node ---------- The endpoint of an arc.

NPPC--------- Northwest Power Planning Council.

Panel---------- A synonymous term to mean a 1:100,000-scale DLG piece.

PAT ---------- Point/Polygon Attribute Table that stores descriptive information about for a feature in an INFO data File

Projection---- A mathematical model that transforms the location of features in an X-Y coordinate system.

Pseudo node- The point at which an arc connects to only one other arc or connects to form a closed loop. In the hydrography layer some pseudo nodes signified a change in a feature attribute, for example, a perennial stream changing to ephemeral.

Quad---------- Refers in this report to coverage representing features found on a 1:100,000-scale map series.

Relate--------- An operation that establishes a temporary connection between corresponding records in two tables using an item common to both.

Snap ---------- To move (adjust) a feature coordinate to coincide exactly with coordinates of another feature.Most snapping involves the adjustment of endpoints of disconnected arcs.

Topology ----- A list of explicit relations between geographic features. Topology defines connections between features, identifies adjacent polygons and can define one feature, such as an area, as a set of lines. Topology also defines the relation between a mapping feature and a record in an attribute table.

User-ID------- A number, assignable by the user, to each feature in a coverage. In most applications this value is unique.

Vertex -------- An internal coordinate along an arc.

APPENDIXES

APPENDIX A: Project Arc Macro Language (AML) Programs

The initial development of the PNW River Reach Files was implemented in ARC/INFO 3.2. During the project, the vendor released two major and two minor upgrades to the ARC/INFO software. With each major release, modifications were made to project AMLs to incorporate the software changes and expanded the functionality of ALLOCATION-NETWORK-HUC-STR-Look Also for STR the programs. During the development of the PNW River Reach Files more than 50 ARC/INFOAML programs were written to reformat data, control processes, set editing and graphics environments, produce plots, correct undesirable results and check quality control. In some cases the AMLs were modified numerous times. The authors of the original AML code are acknowledged whenever possible. If the original code was revised, with input from many staff members, then authorship was credited to the entire River Reach staff.

Standardpanel.AML

```
/*-------------------------------------------------------------------------
/* Command Name: STANDARDPANEL
/* Language:     ARC/INFO AML
/*
/* Written for the River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     This program compiles the many adjacent pieces of a 1:100,000 DLG
/*     file into a single network coverage with topology and attributes, where
/*     available. Program accepts either STANDARD or OPTIONAL format DLG
/*     data, creates a coverage, builds topology, joins attribute tables,
/*     places the neatline in a separate file, then appends the coverages
/*     (1 through n with the same root name)
/*     Program also verifies the proper number of attribute pairs
/*     and adds or drops items if necessary.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,    Type,             Definition
/*-------------------------------------------------------------------------
/*     COVER          (Character)     Root name of coverage
/*     FORMAT         (Character)     Type of DLG, must be STANDARD or Optional
/*     PAIRS           (Integer)      Number of attribute pairs desired (Def=2)
/*     STARTNO         (Integer)      Beginning DLG piece number (Def=1)
/*     ENDNO           (Integer)      Ending DLG piece number (Default=32)
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,      Date,               Event
/*-------------------------------------------------------------------------
/*     Douglas Nebert    11/86        Original coding as STDPANEL.CPL at ARC
/*                                    Version 3.2
/*                       1/88         Re-coded to behave at ARC Version 4.0
/*                       4/88         Replace INFO with TABLES for logic checks
/*     Leonard Orzol and Bruce Fisher 6/89 modified for ARC 5.0
/*-------------------------------------------------------------------------
/* System dependent calls:
/*     cn file1 file2 = Change Name
/*     rm = Delete system-level ASCII file
/*-------------------------------------------------------------------------
&type ======================== DISCLAIMER ======================================
&type  Although this program has been used by the U.S.Geological Survey,
&type  no warranty, expressed or implied, is made by the USGS as to
&type  the accuracy and functioning of the program and related program
&type  material nor shall the fact of distribution constitute any such
&type  warranty, and no responsibility is assumed by the USGS in
&type  connection therewith.
```

```
&type ================================================================================
/*
&ARGS COVER FORMAT PAIRS STARTNO ENDNO
&IF [NULL%COVER%] &THEN &DO
&TYPE
   &TYPE Usage:
   &TYPE DLGPANEL <DLG name> {STANDARD | OPTIONAL} {#pairs} {start.cell} {end.cell}
   &TYPE Default value for panelling is for 32 cells per 1:100K-scale DLG.
   &TYPE Default number of pairs is 3.
   &RETURN
   &END
/*
&IF [NULL%STARTNO%] &THEN &S STARTNO:= 1
&IF ^ [EXISTS%COVER%%STARTNO% -FILE] &THEN &DO
   &TYPE Source file does not exist.
   &RETURN
   &END
&IF [EXISTS%COVER% -COVERAGE] &THEN &DO
   &TYPE Composite coverage %COVER% already exists.
   &RETURN
   &END
/*
/*.....set default variable values
/*
&IF [NULL %ENDNO%] &THEN &S ENDNO := 32
&IF [NULL %FORMAT%] &THEN &S FORMAT := STANDARD
&IF [NULL %PAIRS%] &THEN &S PAIRS := 3

/*.....capture session for review if it dies

&WATCH %COVER%.WATCH
&TYPE Saving session to %COVER%.WATCH...
/*.....turn messages off
/*&MESS &OFF &ALL

/*
/*.....start processing loop for each I-numbered piece from STARTNO to ENDNO
/*
&DO I := %STARTNO% &TO %ENDNO%
&MESS &ON &ALL
&TYPE Processing piece %I%...

/* CHECK FOR PIECE EXISTENCE
&LABEL EXCHECK
&IF ^ [EXISTS %COVER%%I% -FILE] &THEN &DO
&TYPE  File %COVER%%I% is not present, continuing...
&GOTO BOTTOM
&END
/*&MESS &OFF &ALL
```

```
/* -------CREATE COVERAGE FEATURES
&SYSTEM CN %COVER%%I% %COVER%%I%.DLG
/*
/*.....convert DLG to coverage and set topology
DLGARC STANDARD %COVER%%I%.DLG %COVER%%I%  /* Convert DLG's into ARC coverages
CLEAN %COVER%%I% # 12 3 LINE
BUILD %COVER%%I% POLY
CREATELABELS %COVER%%I% 0
BUILD %COVER%%I% POLY
/*&MESS &ON &ALL
&TYPE Joining attributes to feature attribute table...
/*&MESS &OFF &ALL
/*.....join feature attribute file to FAT on condition that file exists
/*
&IF  [EXISTS %COVER%%I%.PCODE -INFO] &THEN ~
JOINITEM %COVER%%I%.PAT %COVER%%I%.PCODE %COVER%%I%.PAT %COVER%%I%-ID
 %COVER%%I%-ID
&IF [EXISTS %COVER%%I%.ACODE -INFO] &THEN ~
JOINITEM %COVER%%I%.AAT %COVER%%I%.ACODE %COVER%%I%.AAT %COVER%%I%-ID ~
%COVER%%I%-ID
/*
ADDITEM %COVER%%I%.AAT %COVER%%I%.AAT EDGE 1 1 I
/*.....get rid of temporary INFO files and flag neatlines
/*
&IF [EXISTS %COVER%%I%.PCODE -INFO] &THEN ~
 &s deletestatus := [delete %COVER%%I%.PCODE -INFO]
/*
&select %deletestatus%
  &when 0
     &type %cover%%i%.PCODE deleted..\
  &otherwise
     &type %cover%%i%.PCODE can not be deleted...\\
&end
/*
&IF [EXISTS %COVER%%I%.ACODE -INFO] &THEN ~
 &s deletestatus := [delete %COVER%%I%.ACODE -INFO]
/*
&select %deletestatus%
  &when 0
     &type %cover%%i%.ACODE deleted...\
  &otherwise
     &type %cover%%i%.ACODE can not deleted...\\
&end
/*
TABLES
SEL %COVER%%I%.AAT
RES FOR RPOLY# = 1 OR LPOLY# = 1
CALC EDGE = 1
Q STOP
/*
```

```
/* .....routine to even up the number of arc attribute pairs
&S NAATTP = 0
/*
/* .....finding the number of major and minor pairs within AAT file
/*
&ROUTINE ITEMFINDING AAT
&s NAATTP  %itemcount%
/*
/* .....test AAT record length against desired length
/*
&SELECT %AFLAG%
 &WHEN 0
   &DO
     &IF %NAATTP% > %PAIRS% &THEN ~
       &DO
         &S START := %PAIRS% + 1
         &DO K := %START% &TO %NAATTP%
           DROPITEM %COVER%%I%.AAT %COVER%%I%.AAT MAJOR%K%
           DROPITEM %COVER%%I%.AAT %COVER%%I%.AAT MINOR%K%
         &END
      &END
     &IF %NAATTP% < %PAIRS% &THEN ~
      &DO
       &S COUNT := %NAATTP% + 1
       &DO K := %COUNT% &TO %PAIRS%
         &S L := %K% - 1
         ADDITEM %COVER%%I%.AAT %COVER%%I%.AAT MAJOR%K% 6 6 I # MINOR%L%
         ADDITEM %COVER%%I%.AAT %COVER%%I%.AAT MINOR%K% 6 6 I # MAJOR%K%
       &END
     &END
   &END
 &OTHERWISE
     &DO K := 1 &TO %PAIRS%
       &S L := %K% - 1
       &IF ( %K% = 1 ) &THEN &S ITEM1 := %COVER%%I%-ID
        &ELSE &S ITEM1 := MINOR%L%
       ADDITEM %COVER%%I%.AAT %COVER%%I%.AAT MAJOR%K% 6 6 I # %ITEM1%
       ADDITEM %COVER%%I%.AAT %COVER%%I%.AAT MINOR%K% 6 6 I # MAJOR%K%
     &END
&END     /* ----- SELECT BLOCK

&S NPATTP := 0
/* .....finding the number of major and minor pairs within PAT coverage
&ROUTINE ITEMFINDING               /*========Routine ITEMFINDING
&S NPATTP := %itemcount%
/*
/* .....test PAT record length against desired length
```

```
/*
&IF %NPATTP% > %PAIRS% &THEN &DO
  &S START := %PAIRS% + 1
  &DO M := %START% &TO %NPATTP%
    DROPITEM %COVER%%I%.PAT %COVER%%I%.PAT MAJOR%M%
    DROPITEM %COVER%%I%.PAT %COVER%%I%.PAT MINOR%M%
  &END
&END
&IF %NPATTP% < %PAIRS% &THEN &DO
  &S COUNT := %NPATTP% + 1
  &DO M := %COUNT% &TO %PAIRS%
    &S N := %M% - 1
    ADDITEM %COVER%%I%.PAT %COVER%%I%.PAT MAJOR%M% 6 6 I # MINOR%N%
    ADDITEM %COVER%%I%.PAT %COVER%%I%.PAT MINOR%M% 6 6 I # MAJOR%M%
  &END
&END
/*
&LABEL BOTTOM
&END
/* STOP HERE TEMPORARILY
/*&MESS &ON &ALL
&TYPE %ENDNO% pieces processed...
&TYPE Appending pieces together...
/*&MESS &OFF &ALL
&DATA ARC APPEND %COVER% NET ALL          /*---------------APPEND DLG's
 &DO J := %STARTNO% &TO %ENDNO%
%COVER%%J%
 &END
END
&END
/*.....add entry to coverage log
&DATA ARC LOG %COVER% ADD
DLGPANEL PIECES = %STARTNO% TO %ENDNO%
&END
&MESS &ON &ALL
&TYPE Sending neatlines to %cover%-E...
&MESS &OFF &ALL
&DATA ARC ARCEDIT
EDITC %COVER%
EDITF ARC
SEL ALL
RESELECT EDGE = 1
PUT %COVER%-E        /* create a coverage of the DLG boxes.
DELETE
SEL ALL
SAVE
Q
&END
/*&MESS &ON &ALL
&TYPE      ....Establishing polygon and line topology...
```

```
/*&MESS &OFF &ALL
CLEAN %COVER% # 0 0.1 POLY      /* ----CLEAN coverages...
MATCHNODE %COVER% # 30
CLEAN %COVER% # 7 3 POLY
CLEAN %COVER%-E # 30 10
CREATELABELS %COVER%-E
/*&MESS &ON &ALL
&TYPE Killing component "piece" coverages...
/*&MESS &OFF &ALL
/*  DELETE COMPONENT COVERAGES
&DO K := %STARTNO% &TO %ENDNO%
KILL %COVER%%K% ALL
&END
/* ..............................Go into INFO and remove those weird 9's
&DATA ARC INFO
ARC
SEL %COVER%.PAT
RES MAJOR1 = -99999
CALC MAJOR1 = 0
ASEL
RES MINOR1 = -99999
CALC MINOR1 = 0
ASEL
RES MAJOR2 = -99999
CALC MAJOR2 = 0
ASEL
RES MINOR2 = -99999
CALC MINOR2 = 0
ASEL
SEL %COVER%.AAT
RES MAJOR1 = -99999
CALC MAJOR1 = 0
ASEL
RES MINOR1 = -99999
CALC MINOR1 = 0
ASEL
RES MAJOR2 = -99999
CALC MAJOR2 = 0
ASEL
RES MINOR2 = -99999
CALC MINOR2 = 0
ASEL
Q STOP
&END
/*.............................................delete hangers-on
&SYSTEM rm  %COVER%**.DLG
&SYSTEM rm  %COVER%**.PRJ
/*&MESS &ON &ALL
&TYPE Process completed...
&WATCH &OFF
&RETURN
```

Epatoarc.AML

```
/*-------------------------------------------------------------------------
/* Command Name: EPATOARC
/* Language:     AML
/*
/*
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     Extracts TRACE information from a master EPA river reach trace
/*     coordinate file for line features, links attributes, adds tics, and
/*     projects cover to common coordinate system.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,        Definition
/*-------------------------------------------------------------------------
/*     infile          (character)    Name of EPA datafile
/*     outcov          (character)    Name of final EPA coverage
/*     hucno            (numeric)     8-digit integer hydrologic unit number
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,      Date,              Event
/*-------------------------------------------------------------------------
/*     Douglas Nebert  4/27/88        Original coding.
/*                     7/28/88        Revised to hardcode TRACE outcover.
/*-------------------------------------------------------------------------
&type ========================= DISCLAIMER ======================================
&type  Although this program has been used by the U.S.Geological Survey,
&type  no warranty, expressed or implied, is made by the USGS as to
&type  the accuracy and functioning of the program and related program
&type  material nor shall the fact of distribution constitute any such
&type  warranty, and no responsibility is assumed by the USGS in
&type  connection therewith.
```

```
&type ================================================================================
/*
&args hucno
&s .mpath = /var/big_disk/gis/bpa/epaq
&if [null %hucno%] &then &do
  &type Usage: EPATOARC <hyd.unit.no>
  &return
  &end
&s infile %.mpath%/epadata
&if [exists b%hucno%.watch] &then &do
  rm  b%hucno%.watch
  &end
&watch b%hucno%.watch
/* initialize some variables...
&s home = [dir [pathname b%hucno%.watch]]

/* run the extraction program...
&data %.mpath%/tracer
%infile%
f%hucno%
%hucno%
&end
/* generate line coverage...
&DATA ARC GENERATE TRACE-DD
INPUT f%hucno%.gen
LINES
QUIT
&END

/* clean house..
rm f%hucno%.gen
CLEAN TRACE-DD TRACE-DD.CL 0 0.001 LINE
KILL TRACE-DD
RENAME TRACE-DD.CL TRACE-DD
/* project into BPA "standard" coordinates...
PROJECT COVER TRACE-DD TRACE %.mpath%/geoalb.prj

/* reestablish topology and clean house...
BUILD TRACE LINE
KILL TRACE-DD ALL
```

```
/* define attribute template...
&DATA ARC INFO
ARC
DEFINE TRACE.ATT
TRACE-NUM,4,4,I
HUC,8,8,I
SEG,3,3,I
RMI,5,5,N,2
LEVEL,2,2,I
SEQNUM,11,11,C
FLAGS,5,5,C
STR-NAME,30,30,C
TRACE-ID,4,5,B

GET %HOME%/f%hucno%.att COPY
CALC TRACE-ID = TRACE-NUM
Q STOP
&END

/* link attributes to AAT...
JOINITEM TRACE.AAT TRACE.ATT TRACE.AAT TRACE-ID TRACE-ID
DROPITEM TRACE.AAT TRACE.AAT TRACE-NUM

/* delete expansion file in INFO...
&DATA ARC INFO
ARC
SEL TRACE.ATT
ERASE TRACE.ATT
Y
Q STOP
&END

&watch &off
rm b%hucno%.watch
rm f%hucno%.att
rm f%hucno%.ext
&return

LOG TRACE ADD
EPATOARC was run.

&type Your EPA 1:250,000 scale coverage is named TRACE.
```

Clipbasin.AML

```
/*-------------------------------------------------------------------------------
/*  Command Name: CLIPBASIN
/*  Language:     AML
/*
/*
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     To RESELECT the proper polygon CLIPCOV from the reshaped
/*     Hydrologic Unit coverage, then use it to cookie-cutter out,
/*     the 1:100,000 scale reaches that are within its boundary.
/*     The AML will read from a file_list of quads compiled in advance.
/*     All coverages must be in the project's Albers coordinates.
/*:::::::::::;:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,        Definition
/*     ---------------------------------------------------------------------
/*      hucno                          Hydrologic Unit polygon
/*      kflag                          Flag to either kill or leave clipped
/*                                     100K-scale quad coverages
/*      qfile                          List of quads which fall within
/*                                     extent of CLIPCOV.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,      Date,               Event
/*-------------------------------------------------------------------------------
/*                        5/2/88        Original coding.
/*     DOUGLAS NEBERT    7/13/88       Updated with subroutines.
/*-------------------------------------------------------------------------------
&type ========================= DISCLAIMER ======================================
&type  Although this program has been used by the U.S.Geological Survey,
&type  no warranty, expressed or implied, is made by the USGS as to
&type  the accuracy and functioning of the program and related program
&type  material nor shall the fact of distribution constitute any such
&type  warranty, and no responsibility is assumed by the USGS in
&type  connection therewith.
```

```
&type ================================================================--

&args hucno kflag qfile
&if [null %hucno%] &then &do
  &type Usage: CLIPBASIN <hydro.unit> {NOKILL | KILL} {quad.file}
  &return
  &end
&if ^ [exists CLIPCOV -cov] &then &do
&type Reselecting for %hucno%...
&mess &off
&s covdir /var/big_disk/gis/bpa/hucque     /*-------- set covdir path.
&DATA ARC RESELECT %covdir%/hucs-alb CLIPCOV POLY
RES HUC = %hucno%

N
N
&END

&mess &on
BUILD CLIPCOV POLY     /*.............builds clipcover
&end

/*.....begin prompting dialog for quads
&if [exists t$quad -file] &then &do
&sys rm t$quad
&end
&call readquads       /* ............call  readquads
 &if ^ [null %qfile%] &then &sys COPY %qfile% t$quad
&call clipquads

&type Appending huc pieces...
&s count = %count% - 1
&DATA ARC APPEND B%hucno% NET ALL     /*....APPEND coverages
&do j = 1 &to %count%
B%hucno%%j%
&end
END
&END
```

```
&if %kflag% = [unquote 'NOKILL'] or [null %kflag%] &then &goto delabel
&do j = 1 &to %count%
KILL B%hucno%%j%
&end
&label delabel
&SYS rm t$quad

/* ADD LOG entry
LOG B%hucno% ADD
CLIPBASIN %hucno% %kflag% %qfile%

/* Go to HUCS-ALB.. flag hucno as 'in-progress'
&s home = [dir [pathname log]]
&SYSTEM cd /var/big_disk/gis/bpa/hucque
&DATA ARC INFO
ARC
SEL HUCS-ALB.PAT
RESELECT HUC = %hucno%
MOVE 'Y' TO IN.PROG
MOVE 'N' TO NEXT.IN
Q STOP
&END

&SYSTEM cd %home%
/* rename coverages when successful
RENAME B%hucno% STR100
UNSPLITDLG STR100 STR100-U
&type Your appended stream coverage is now named STR100.
&type Your final basin boundary coverage is called CLIPCOV.
&type Your STR100-U is STR100 with the pseudonodes removed.
&type Ignore the next couple of lines of error message regarding
&type the &ROUTINE call. This is not a fatal error.
&type
```

```
/*-------------------------------------------------------------------------------
&routine readquads
&if [null %qfile%] &then &do
&type Enter any number of quadnames, type END when done.
&s fileunit = [open t$quad openstatus -w]
&s count = 0
&label top
&s quadname = [response 'Quadname']
&if %quadname% = [unquote 'END'] &then &goto bottom
&if ^ [exists %quadname% -cov] &then
  &do
   &type Coverage %quadname% does not exist.
   &goto top
  &end
&s flerr = [write %fileunit% [unquote %quadname%]]
&s count = %count% + 1
&goto top
&end
&label bottom
&return
/*======================ROUTINE CLIPQUADS====================================
&routine clipquads
&s fileunit = [open t$quad openstatus -r]
&s count = 1
&do &until %eof% = 102
 &s string1 = [read %fileunit% eof]
 &if ^ [exists %string1% -cov] &then &goto next
CLIP [unquote %string1%] CLIPCOV B%hucno%%count% NET
&s count = %count% + 1
&end
&label next
&s flerr = [close %fileunit%]
&return
&return
```

Conflation.AML

```
/*-------------------------------------------------------------------------
/* Command Name: CONFLATE
/* Language:     AML ARC 4.0 - 5.0
/*
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     This program transfers meaningful attributes from a simple line
/*     coverage to a more complex line coverage.For the River Reach
/*     project CONFLATE transfers the TRACE-MOD-ID from lines segments in
/*     the EPA 1:250,000 Trace files to corresponding arcs in the
/*     1:100,000 scale hydrography.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,             Type,          Definition
/*-------------------------------------------------------------------------
/*     simp-cov                   Char        TRACE - EPA line file
/*     comp-cov                   Char        STR100 - 100K-scale Hydrography
/*     outcov                     Char        STR100-LNKS
/*     searchd                   Integer      Search distance in meters.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,              Date,             Event
/*-------------------------------------------------------------------------
/*     Kyler Diershaw          03/12/87       Original coding
/*     River Reach Staff                      Cleaned up AML coding style
/*-------------------------------------------------------------------------
&type ======================== DISCLAIMER ==================================
&type  Although this program has been used by the U.S.Geological Survey,
&type  no warranty, expressed or implied, is made by the USGS as to
&type  the accuracy and functioning of the program and related program
&type  material nor shall the fact of distribution constitute any such
&type  warranty, and no responsibility is assumed by the USGS in
&type  connection therewith.
```

```
&type ================================================================================
&args .simp-cov .comp-cov .outcov searchd
/* ------ do argument check
&if [null %.simp-cov%] &then
 &return &warning Usage: CONFLATE <trace.cov> <str100.cov> <outcov>~
 {searchdist.in.mapunits}
&if [null %.comp-cov%] &then
 &return &warning You must specify the Trace, Str100 and outcover.
/* ------ do existence check for coverages
&if ^ [exists %.simp-cov% -cover] &then
 &return &warning %.simp-cov% does not exist.
&if ^ [exists %.comp-cov% -cover] &then
 &return &warning %.comp-cov% does not exist
&watch %.outcov%.watch     /* ------ start watch file
copy %.comp-cov% %.outcov% /* ------ copy coverage
/* set search distance if none was previously entered.
/*
&messages &off &info
&if [exists %.outcov%.errors.watch] &then rm %.outcov%.errors.watch
&if [null %searchd%] &then &do
 &describe %.simp-cov%
 &s x = ( %dsc$xmax% - %dsc$xmin% )
 &s y = ( %dsc$ymax% - %dsc$ymin% )
 &s searchd = ([value [max %x% %y%]] / 100)
 &end
&if [iteminfo %.simp-cov% -line tnode1 -exists] &then
 &do
  dropitem %.simp-cov%.aat %.simp-cov%.aat tnode1
  dropitem %.simp-cov%.aat %.simp-cov%.aat fnode1
 &end
&messages &on
/*
&type  Creating point coverage..
&messages &off &info
/*
/* Generating a point coverage from the nodes of the simple coverage and
/* finding the corresponding nodes in the complex coverage.
/*
&if [exists %.simp-cov%-p -coverage] &then kill %.simp-cov%-p all
nodepoint %.simp-cov% %.simp-cov%-p
build %.simp-cov%-p point
&messages &on
&type finding nodes in Trace coverage
&messages &off &info
near %.simp-cov%-p %.outcov% node %searchd%
/*
```

```
/*    Add items to the simple coverage (Trace) AAT that will hold the internal
/*    node ids of the corresponding nodes of the complex coverage

additem %.simp-cov%.aat  %.simp-cov%.aat fnode1 4 5 b
additem %.simp-cov%.aat  %.simp-cov%.aat tnode1 4 5 b
/*
/* set pathname showing where to store the node file being generated next
/*
&s path [dir [pathname %.simp-cov%]]
&if [exists %path%/%.outcov%.points] &then rm %path%/%.outcov%.points
&severity &error &ignore
&data arc info
ARC
SEL %.SIMP-COV%-P.PAT
REM
REM These redefines allow for a common relate item between the point cover
REM and the simple coverage.
REM
REDEFINE
13
FNODE#,4,5,B
13
TNODE#,4,5,B
[UNQUOTE ' ']
SEL %.SIMP-COV%.AAT
REM
REM     Now move the nodes from the complex coverage PAT to the simple coverage
REM
REM     There are two (fnode1 and tnode1) values calculated into the simple
REM     coverage AAT from a single item in the point coverage PAT.
REM
RELATE %.SIMP-COV%-P.PAT BY FNODE#
CALC FNODE1 = $1%.OUTCOV%#
REL %.SIMP-COV%-P.PAT BY TNODE#
CALC TNODE1 = $1%.OUTCOV%#
REL
REM
REM   Now generate the ASCII file containing the cover# of the simple
REM   coverage arcs and the two analogous node ids from the complex coverage
REM
OUTPUT %PATH%/%.OUTCOV%.POINTS
CALCULATE $COMMA-SWITCH = -1
RES FNODE# NE 0 OR TNODE# NE 0
PRINT %.SIMP-COV%-ID,TNODE1,FNODE1
ASEL
Q STOP
&END

&MESSAGES &ON
&TYPE Running routing program Conroute
&messages &off &info
```

```
/*==================Call CONROUTE=========================================================
/* Conroute will tag the str100 arcs with the -ID of the simple coverage.
&CALL CONROUTE
&TYPE Use Plotbasin to verify your results
&return
/*conroute routine to encode 1:100,000 scale reaches.
&ROUTINE CONROUTE
&echo &on
route
readnetwork %.outcov%
&type
&set unit [open %.outcov%.points stat -R]
&set count = 0
/*
/*
&do &until %eof% = 102
 &set count = %count% + 1
 &set line = [read %unit% eof]
&end
&set count = %count% - 1
&type There are %count% records in the point file
&messages &off &info
&if [close %unit%] ne 0 &then
 &severity &error &routine problem
```

```
/* Now open the file again for reading each record
/*
&set reset# = 0
&set unit [open %.outcov%.points stat -R]
&do index = 1 &repeat %index% + 1 &until %index% = %count%
 &set record%index% [unquote [read %unit% eof]]
 &set id [before [trim [quote [value record%index%]] -left] ' ']
 &set nodes [after [trim [quote [value record%index%]] -left] ' ']
 &set node1 [before [trim %nodes% -both] ' ']
 &set hold [after [trim %nodes% -both] ' ']
 &set node2 [trim %hold% -both]
 &if %index% in {100,200,300,400} &then &do
  &set reset# = %reset#% + 100
  &MESSAGES &ON
  &Type %reset#% routes calculated
  reset
  readnetwork %.outcov%
 &end
 &severity &error &routine route_error
  /*calculate route
 addroute %id%
 path %node1% %node2%
 writeroute %.simp-cov%-ID # # # all noinit
&end /* &do
&echo &off
&messages &on
&if [close %unit%] = 0 &then &type All done
 &else &call &routine problem
 &messages &off &info
kill %.simp-cov%-p
rm %.outcov%.points
&watch &off
rm %.outcov%.watch
&messages &on
&return
/*
/* ---- this routine writes to %.outcov%.errors file all unsuccessful attempts
/* at routing between two known nodes.
&routine route_error
&severity &error &ignore
&watch &off
&messages &on
&watch %.outcov%.errors.watch &append
&messages &off &info
/*
/* General error trapping routine
/*
&return      /* returning to Conflate program
&routine problem
&messages &on
&return ; &return &error &bailing out
```

Getatts.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: GETATTS
/* Language:     ARC AML 4.0 - 5.0
/*
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     Creates a .CODE file containing EPA RF2 extended attributes that
/*     will be joined to the 1:100,000 scale Reach File .AAT file after
/*     the CONFLATION program has been run and updated, if needed.
/*     GETATTS uses a PULLITEM to extract out the items to be joined
/*     to the Arc Attribute Table of the current Reach File.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     frombasin     TRACE-MOD coverage
/*     tobasin       STR100 or the current 100K-scale Reach File
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Routines:  None
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author                Date            Event
/*-------------------------------------------------------------------------------
/*     BPA River Reach Staff  2/90         Original coding.
/*-------------------------------------------------------------------------------
&type ========================== DISCLAIMER ======================================
&type  Although this program has been used by the U.S.Geological Survey,
&type  no warranty, expressed or implied, is made by the USGS as to
&type  the accuracy and functioning of the program and related program
&type  material nor shall the fact of distribution constitute any such
&type  warranty, and no responsibility is assumed by the USGS in
&type  connection therewith.
```

```
&type ================================================================================
&ARGS  frombasin tobasin
/* First do an argument check.
&if [null %frombasin%] &then
 &do   /* Check for existence of first coverage.
  &type Usage: GETATTS <trace.cover> <str100.cover>
  &return
 &end
&if ^ [exists %frombasin% -cov] &then
 &do      /* Check for existence of second coverage
  &type Coverage not found. Returning to ARC.
  &return
 &end
 PULLITEMS %frombasin%.AAT %tobasin%.CODE   /*  items from TRACE-MOD
%frombasin%-ID
HUC
SEG
RMI
LEVEL
SEQNUM
FLAGS
STR-NAME
END
 JOINITEM %tobasin%.AAT %tobasin%.CODE %tobasin%.AAT %frombasin%-ID EDGE
 DROPITEM %tobasin%.AAT %tobasin%.AAT %frombasin%-ID   /*drop out TRACE-ID
&TYPE GETATTS is complete, the next process step is to run SINUOSITY.
&return
```

Sinuosity.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: SINUOSITY
/* Language:     AML
/* Version:      ARC/INFO 5.0
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     To calculate the sinuosity for a line coverage.
/*     For the River Project, Sinuosity was computed as the ratio between
/*     actual path distance and a straight-line distance from the two end
/*     nodes.
/*     The line coverage is first copied, then the copy coverage is
/*     GENERALIZED into straight line segments
/*     The straight line length and the original length are then
/*     compared.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,        Definition
/*-------------------------------------------------------------------------------
/*     COVER  (INPUT)     char        Name of coverage to process
/*     GRANE  (INPUT)   numeric       Value of maximum arc length in coverage
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,       Date,             Event
/*-------------------------------------------------------------------------------
/*     Douglas Nebert    2/24/88      Original coding.
/*-------------------------------------------------------------------------------
&type  ======================== DISCLAIMER ======================================
&type  |  Although this program has been used by the U.S. Geological Survey,      |
&type  |  no warranty, expressed or implied, is made by the USGS as to the        |
&type  |  accuracy and functioning of the program and related program             |
&type  |  material nor shall the fact of distribution constitute any such         |
&type  |  warranty, and no responsibility is assumed by the USGS in               |
&type  |  connection therewith.                                                   |
```

```
&type  ================================================================================
/*
&args cover grane
&echo &on
/*
&if [null %cover%] &then
 &do
  &type Usage: SINUOSITY <cover> <max.arc.length>
  &return
 &end
&if ^ [exists %cover% -cov] &then
 &do
  &type  Coverage does not exist.
  &return
 &end
&s cover [translate %cover%]
&if [exists T$%cover%.CODE -info] &then
 &do
  tables                    /* Use ARC/INFO TABLES
  $KILL T$%cover%.CODE
  Y
  Q STOP
 &end
&if [null grane] &then
 &do
  &type Maximum arc length in coverage must be entered. Use INFO
  &type to do a sort (D) on length, list the first few records,
  &type then sort back on coverage#. Example in INFO:
  &type      SORT ON LENGTH (D)
  &type      SORT ON STR100#
  &return
 &end
```

```
&type ......Generalizing coverage arcs into temporary coverage...
COPY %cover% T$%cover%
&DATA ARC ARCEDIT
EDITC T$%cover%
EDITF ARC
SEL ALL
GRAIN %grane%
SNAPDISTANCE 0.1
SPLINE
SAVE
Q
Y
&END
BUILD T$%cover% LINE
ADDITEM %cover%.AAT %cover%.AAT LENGTH2 4 12 F 3
ADDITEM %cover%.AAT %cover%.AAT SINUOUS 5 5 N 2
&mess &on
&type Calculating sinuosity...
&mess &off &all
&DATA ARC INFO
ARC
SEL %cover%.AAT
REDEFINE
25
T$%cover%-ID,4,5,B

RELATE T$%cover%.AAT BY T$%cover%-ID
CALC LENGTH2 = $1LENGTH
RELATE
RES LENGTH2 GT 0
CALC SINUOUS = LENGTH / LENGTH2      /* compute reach sinuosity
Q STOP
LOG %cover% ADD
SINUOSITY Completed.
&END    /* data block
&type Killing temporary coverage...
KILL T$%cover% ALL
&echo &off
&return
```

Calcpseg.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: CALCPSEG
/* Language:     AML IN ARC
/*
/* Written for the River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     To assign provisional segment (reach) numbers to arcs not coded
/*     with EPA codes.
/*     The program checks to see if CALCSEG or CALCPSEG has been run
/*     previously. If PSEG exists in the .AAT file then it skips to the
/*     second program which will update those arcs added after adding
/*     centerlines and connector arcs beginning with the next highest
/*     PSEG. If neither CALCSEG nor CALCPSEG have been run, then an item
/*     is added to the .AAT called PSEG. (format 4,4,I) and is calculated
/*     sequentially from 500. CALCSEG has been replaced by CALCPSEG.
/*     DUPPSEG checks for duplicate SEG numbers.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,        I/O,   Type,      Definition
/*-------------------------------------------------------------------------------
/*     cov                                     Coverage name
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,             Date,             Event
/*-------------------------------------------------------------------------------
/*     DDNEBERT                8/2/88          Original coding.
/*     BPA RR staff           4/15/90          Additional coding.
/*-------------------------------------------------------------------------------
&type  ======================== DISCLAIMER ====================================
&type  |  Although this program has been used by the U.S. Geological Survey,      |
&type  |  no warranty, expressed or implied, is made by the USGS as to the        |
&type  |  accuracy and functioning of the program and related program             |
&type  |  material nor shall the fact of distribution constitute any such         |
&type  |  warranty, and no responsibility is assumed by the USGS in               |
&type  |  connection therewith.                                                   |
```

```
&type  ================================================================================
/* ------- do argument check
&args cov
&if [null %cov%] &then
 &do
  &type    USAGE: CALCPSEG <coverage - River Reach File>
  &type    INPUT coverage must be STR100-LNKS or program will fail.
  &return
 &end
/*
/* ------ do existence checks..
&if ^ [exists STR100-LNKS -cov] &then &do
  &type STR100-LNKS does not exist.
  &return
  &end
&IF [ITEMINFO STR100-LNKS -LINE PSEG -EXISTS] &THEN
   &GOTO PSEGGER
ADDITEM STR100-LNKS.AAT STR100-LNKS.AAT PSEG 4 4 I 0 SEG
&DATA ARC INFO
ARC
ERASE CALCPSEG.PG
Y
SEL RMIFILE
SORT ON SEG (D)
RES BY $RECNO = 1
CALC $NUM1 = SEG
PROGRAM CALCPSEG.PG
SEL STR100-LNKS.AAT
RES SEG = 0
CALC $NUM2 = 0
PROGRAM SECTION
  CALC $NUM2 = $NUM2 + 1
  CALC PSEG = 499 + $NUM2
PROGRAM SECTION
END
[UNQUOTE ' ']
RUN CALCPSEG.PG
ERASE CALCPSEG.PG
Y
Q STOP
LOG STR100-LNKS ADD
CALCPSEG Completed.
&END
&RETURN
```

```
/* Here is where we only add to centerlined arcs a PSEG value.
/*
&LABEL PSEGGER
&DATA ARC INFO
ARC
ERASE CALCSEG.PG
Y
ERASE CALCPSEG.PG
Y
CA $NUM1 = 0
CA $NUM2 = 0
SEL STR100-LNKS.AAT
SORT ON PSEG (D)
RES BY $RECNO = 1
CALC $NUM1 = PSEG
ASEL
PROGRAM CALCPSEG.PG
RES SEG = 0 AND PSEG = 0
IF $NOSEL = 0
SORT ON STR100-LNKS#
END
ENDIF
PROGRAM SECTION 2
  CALC $NUM2 = $NUM2 + 1
  CALC PSEG = $NUM1 + $NUM2
PROGRAM SECTION 3
END
[UNQUOTE ' ']
RUN CALCPSEG.PG
Q STOP
&END
&DATA ARC INFO
ARC
SEL STR100-LNKS.AAT
SORT STR100-LNKS#
Q STOP
&END
DUPPSEG
LOG STR100-LNKS ADD
CALCPSEG Completed.
&RETURN
```

Iditems.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: IDITEMS
/* Language:     AML AT ARC 5.0
/*
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     Performs an IDENTITY overlay using the political and quad
/*     boundary coverage PNW124C-ALB on a copy of the 1:100,000 scale
/*     River Reach File.A copy coverage is used to prevent the actual
/*     splitting of reaches to the original A RELATE environment is
/*     set between the overlayed copy and the original and the identity
/*     information is moved across the to correct 1:100,000 scale reach.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,             Definition
/* ------------------------------------------------------------------------------
/*     cov                    Char           River Reach File
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,           Date,              Event
/* ------------------------------------------------------------------------------
/*     MEDarling              4/90           Original Coding
/*     BPA River Reach staff                 Revised
/* ------------------------------------------------------------------------------
&type  ======================== DISCLAIMER ========================================
&type  | Although this program has been used by the U.S. Geological Survey,       |
&type  | no warranty, expressed or implied, is made by the USGS as to the         |
&type  | accuracy and functioning of the program and related program              |
&type  | material nor shall the fact of distribution constitute any such          |
&type  | warranty, and no responsibility is assumed by the USGS in                |
&type  | connection therewith.                                                    |
```

```
&type  ================================================================================
&args cov
/*
&if [null %cov%] &then
 &do
  &return USAGE: IDITEMS  <coverage - River Reach File>
  &TYPE INPUT coverage must be STR100-LNKS or program will fail.
  &return
 &end
&if ^ [exists STR100-LNKS -cov] &then
 &do &type The STR100-LNKS coverage does not exist.
 &end
 &return

&SEVERITY &ERROR &IGNORE
COPY %cov% STR100-PNW
&DATA ARC INFO
ARC
SEL STR100-PNW.AAT
CA STR100-PNW-ID = STR100-PNW#     /* make sure the -ID = #
Q STOP
&END
IDEDIT STR100-PNW LINE             /* Update arc files with IDEDIT
/*
&TYPE RUNNING IDENTITY ...
/*&S icov  /var/big_disk/gis/bpa/quadq/ident-dir
IDENTITY STR100-PNW /var/small_disk/tmp/PNW124C-ALB STR-IDENT LINE 5 JOIN
/*
/*
ADDITEM STR100-PNW.AAT STR100-PNW.AAT STATE 4 4 C
ADDITEM STR100-PNW.AAT STR100-PNW.AAT COUNTY 15 15 C
ADDITEM STR100-PNW.AAT STR100-PNW.AAT QUAD100 26 26 C
ADDITEM STR100-PNW.AAT STR100-PNW.AAT QUAD75 25 25 C
ADDITEM STR100-PNW.AAT STR100-PNW.AAT STATE-2 4 4 C # STATE
ADDITEM STR100-PNW.AAT STR100-PNW.AAT COUNTY-2 15 15 C # COUNTY
ADDITEM STR100-PNW.AAT STR100-PNW.AAT QUAD100-2 26 26 C # QUAD100
ADDITEM STR100-PNW.AAT STR100-PNW.AAT QUAD75-2 25 25 C # QUAD75
/*
```

```
/* -----  TRANSFER identity items back to unsplit STR100-LNK coverage
&DATA ARC INFO
ARC
SEL STR100-PNW.AAT
RED
25,IDS,4,5,B
[UNQUOTE ' ']
SORT ON IDS
SEL STR-IDENT.AAT
RED
25,IDS,4,5,B
[UNQUOTE ' ']
SORT ON IDS,LENGTH (D)      /* Sort on IDS and length.
PROGRAM MV_ID_IT
CA $NM = 1
RELATE STR100-PNW.AAT IDS ORDERED NUMERIC
CA $NUM1 = 0
PROGRAM 2
IF IDS NE $NUM1
MOVE STATE TO $1STATE
MOVE COUNTY TO $1COUNTY
MOVE QUAD100 TO $1QUAD100
MOVE QUAD75 TO $1QUAD75
ENDIF
CA $NUM1 = IDS
IF $1STATE-2 CN '    ' AND $1STATE NE STATE
MOVE STATE TO $1STATE-2
ENDIF
IF $1COUNTY-2 CN '               ' AND $1COUNTY NE COUNTY
MOVE COUNTY TO $1COUNTY-2
ENDIF
IF $1QUAD100-2 CN '                          ' AND $1QUAD100 NE QUAD100
MOVE QUAD100 TO $1QUAD100-2
ENDIF
IF $1QUAD75-2 CN '                         ' AND $1QUAD75 NE QUAD75
MOVE QUAD75 TO $1QUAD75-2
ENDIF
PROGRAM 3
SORT ON STR-IDENT#
SEL STR100-PNW.AAT
SORT ON STR100-PNW#
END

RUN MV_ID_IT
ERASE MV_ID_IT
Y
Q STOP
&END

&TYPE NOW ALLOCATE COVERAGE ...
&RETURN
```

Flipper.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: FLIPPER
/* Language:     AML AT ARC 5.0
/*
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     Selects upstream flowing arcs in a coverage - direction = 1 and
/*     recalculates direction = -1. Also invokes the FLIP command to reverse
/*     the arc direction to flow downstream.
/*     Item PNTR# is added and calculated to the current value of the
/*     coverage. Item SAVENEG is also added and calculated to 1 for
/*     those arcs with a length < 0.Preserves a record of which arcs were
/*     blocked prior to the basin being routed.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,                Definition
/* ------------------------------------------------------------------------------
/*     cov                    Char                 Arc Coverage
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,            Date,                 Event
/* ------------------------------------------------------------------------------
/*     Mark Uhrich            4-28-89              Original Coding
/*     BPA River Reach staff                       Revised
/*-------------------------------------------------------------------------------
&type  ======================== DISCLAIMER ========================================
&type  |  Although this program has been used by the U.S. Geological Survey,       |
&type  |  no warranty, expressed or implied, is made by the USGS as to the         |
&type  |  accuracy and functioning of the program and related program              |
&type  |  material nor shall the fact of distribution constitute any such          |
&type  |  warranty, and no responsibility is assumed by the USGS in                |
&type  |  connection therewith.                                                    |
```

```
&type  ================================================================================
/*
/* ----------- do an argument check.
&args cov
&SEVERITY &ERROR &ROUTINE GET_OUT
&if [null %cov%] &then
 &do
   &type Usage FLIPPER <coverage>
   &return
 &end
/* ----------- do an existence check.
&if ^ [exists %cov% -cov] &then
 &do
   &type %cov% is not a valid coverage, try again!
   &return
  &end
&type  This AML will only execute after you have successfully run allocate.
&return

&IF ^ [ITEMINFO %COV% -LINE PNTR# -EXISTS] &THEN   /* Check if PNTR# exists
 ADDITEM %cov%.AAT %cov%.AAT PNTR# 4 5 B # DIRECTION
&IF ^ [ITEMINFO %COV% -LINE SAVENEG -EXISTS] &THEN
 ADDITEM %cov%.AAT %cov%.AAT SAVENEG 1 1 I # PNTR#
/* Go into ARCEDIT to FLIP upstream pointing arcs...
ARCEDIT
EDITC %cov%
EDITF ARC
SEL LENGTH < 0
&S NUM = [SHOW NUMBER SELECT]
&IF %NUM% = 0 &THEN &GOTO B
CALC SAVENEG = 1
&LABEL B
SELECT ALL
CALC PNTR# = %cov%#     /* capture an image of the AAT
RESELECT DIRECTION = 1
&S NUM = [SHOW NUMBER SELECT]
&IF %NUM% = 0 &THEN &GOTO BOTTOM
CALC DIRECTION = -1
FLIP              /* flip arcs
SAVE
QUIT
```

```
/* .....check to see if topology needs rebuilt.
&DESCRIBE %cov%
&IF %DSC$QEDIT% = .FALSE. &THEN
BUILD %cov% LINE
&MESS &ON
&TYPE Flipper is done.
LOG %cov% ADD
DIRECTION of arcs were flipped.  Items PNTR# and SAVENEG added.
&return
&label BOTTOM
 &do
  QUIT
  N
  &return
 &end
/*====================ROUTINE GET_OUT=============================================
&ROUTINE GET_OUT
&type FLIPPER.AML has failed ...
&stop
```

Calcrmi.AML

```
/*-------------------------------------------------------------------------------
/* Command Name:           CALCRMI
/*
/* Arc Version/Platform:   AML at 4.0
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     Program calculates the base river mile for same numbered EPA trace
/*     reach-segments (SEG).Requires that item CUMLENGTH be determined
/*     via ALLOCATE from outlet reach of system. Line topology must be
/*     must be present and no gaps should exist with numbered segments.
/*     Unallocated reaches were given a negative (-) RMI.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name        Type     Definition
/*-------------------------------------------------------------------------------
/*     cov                  char     River Reach File
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Programs or menus called:
/*     CALCRMI INFO program.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site          Date     Version   Event
/*-------------------------------------------------------------------------------
/*     River Reach Staff    12/89              Original coding
/*-------------------------------------------------------------------------------
&type  ======================= DISCLAIMER ========================================
&type  |  Although this program has been used by the U.S. Geological Survey,      |
&type  |  no warranty, expressed or implied, is made by the USGS as to the        |
&type  |  accuracy and functioning of the program and related program             |
&type  |  material nor shall the fact of distribution constitute any such         |
&type  |  warranty, and no responsibility is assumed by the USGS in               |
&type  |  connection therewith.                                                   |
```

```
&type  ================================================================================
/*
/*--------------------------------------------------------------------------------
/*
&args cov
&severity &error &routine get_out
/* -------- do argument check..
&if [null %cov%] &then &do
  &type Usage: CALCRMI <cover>
  &return
  &end
/* ------- do existence check of RMIFILE.
&if [exists RMIFILE -INFO] &then
&do
&DATA ARC INFO
ARC
SEL RMIFILE
ERASE RMIFILE
Y
Q STOP
&END
&end   /* &do
/* --------- Pull out items needed to compute RMI
PULLITEMS %cov%.AAT RMIFILE
%cov%#
SEG
CUMLENGTH
LENGTH
END

ADDITEM RMIFILE RMIFILE BASERMI 4 12 F 3 LENGTH

&DATA ARC INFO
ARC
SEL RMIFILE
RES CUMLENGTH = 0
PURGE
Y
SORT ON CUMLENGTH
SORT ON SEG

ERASE CALCRMI.PG
Y
```

```
PROGRAM CALCRMI.PG
CALC $NUM1 = 1
CALC $NUM2 = 0
DO UNTIL $NUM1 GT $NOREC
  ASEL
  RES BY $RECNO = $NUM1
  IF SEG NE $NUM2
    FO $NUM3,4,12,F,3
    FO $NUM5,4,12,F,3
    CALC $NUM3 = 0
    CALC $NUM5 = 0
  ENDIF
  CALC BASERMI = $NUM3 + $NUM5
  CALC $NUM3 = BASERMI
  CALC $NUM5 = LENGTH
  CALC $NUM2 = SEG
  CALC $NUM1 = $NUM1 + 1
DOEND

RUN CALCRMI.PG
SEL RMIFILE
SORT ON %cov%#
RELATE %cov%.AAT BY %cov%# LINK
CALC $1RMI = BASERMI / 1609.2  /*---compute river miles.
SEL %cov%.AAT
RES CEN = 0
CALC RMI = -1   /* give unallocated reaches a negative rmi.
Q STOP
/*====================ROUTINE GET OUT=============================================
&ROUTINE GET_OUT
&type Calcrmi.AML has failed ...
&stop
/*-----------------------------------------------------------------------------
LOG %cov% ADD
CALCRMI Completed.
&watch &off
&TYPE CALCRMI COMPLETE... NOW RUN UPLINK
LOG %cov% ADD
Calculated RMI.
&RETURN
```

Uplink.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: UPLINK
/* Language:     AML AT ARC 5.0
/*
/* Written for BPA River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/*  Purpose:
/*     This AML links the allocated reaches in the STR100-PNW
/*     coverage. The program uses the item PNTR# which has first been
/*     sequentially sorted.
/*     Program determines three upstream reaches above each a given reach
/*     then writes the values for HUC and PNTR# to UHUC1-UHUC3,
/*     and UPNTR1-UPNTR3 in AAT file. If there are more than three upstream
/*     reaches program indicates so by calculating item UFLAG = 1.
/*     UHUC + UPNTR items are redefined into UPLINK items.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,     Definition
/*-------------------------------------------------------------------------------
/*     cover                character  coverage name
/*-------------------------------------------------------------------------------
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,      Date,        Event
/*-------------------------------------------------------------------------------
/*     Mike Darling
/*     Bruce Fisher      11/89      Original Coding
/*     BPA RR staff       5/90      revised and enhanced.
/*-------------------------------------------------------------------------------
&type  ========================= DISCLAIMER ====================================
&type  |  Although this program has been used by the U.S. Geological Survey,      |
&type  |  no warranty, expressed or implied, is made by the USGS as to the        |
&type  |  accuracy and functioning of the program and related program             |
&type  |  material nor shall the fact of distribution constitute any such         |
&type  |  warranty, and no responsibility is assumed by the USGS in               |
&type  |  connection therewith.                                                   |
```

```
&type  ================================================================================
/*
&args cover
/*---------------------------- do existence of watch file check.
&if [exists uplink.watch -file] &then &do
   &sys close uplink.watch
   delete uplink.watch
   &end
&severity &warning &routine error_warning
&severity &error &routine error_failure
/*---------------------------- do existence of coverage check.
&if [null %cover%] &then
  &do
   &type Usage: UPLINK <coverage name>
   &return
  &end

&if ^ [exists %cover% -line] &then
 &do
   &type \The coverage %cover% does not exists in this directory.\
   &type These are the current coverages in this directory...\\\
   lc     /* -----list coverages
   &pause
   &return
  &end
/* ---------------------------- check if UPLINK has been run before.
&if ^ [iteminfo %cover% -line UHUC1 -exists] &then ~
 &do
   &S HOME = [DIR [PATHNAME LOG]]
   ADDITEM %cover%.AAT %cover%.AAT UHUC1 8 8 I
   ADDITEM %cover%.AAT %cover%.AAT UPNTR1 5 5 I
   ADDITEM %cover%.AAT %cover%.AAT UHUC2 8 8 I
   ADDITEM %cover%.AAT %cover%.AAT UPNTR2 5 5 I
   ADDITEM %cover%.AAT %cover%.AAT UHUC3 8 8 I
   ADDITEM %cover%.AAT %cover%.AAT UPNTR3 5 5 I
   ADDITEM %cover%.AAT %cover%.AAT UFLAG 1 1 I
   ADDITEM %cover%.AAT %cover%.AAT DHUC 8 8 I
   ADDITEM %cover%.AAT %cover%.AAT DPNTR 5 5 I
 &end

&if [exists uplink -info] &then ~
 &do
   &s deletestatus [delete uplink -info]
   &if ( %deletestatus% = 0 ) &then &call uplinking
    &else ~
      &do
       type Could not delete Info Program Uplink...\\\
       &return
      &end
 &end
```

```
&if ^ [exists uplink -info] &then &call uplinking    /* call UPLINKING

&if [exists uplink -info] &then ~
 &do
   &s deletestatus [delete uplink -info]
   &if ( %deletestatus% = 0 ) &then &return
   &else ~
      &do
       type Could not delete Info Program Uplink...\\\
       &return
      &end
 &end
&return
/*
/*======================ROUTINE UPLINKING=========================================
&routine uplinking
 &DATA ARC INFO
 ARC
 PROGRAM UPLINK
 REMARK THIS PROGRAM FINDS FOUR REACHES ABOVE ANY GIVEN REACH
 FORMAT $NUM3,8,I
 FORMAT $NUM5,4,I
 FORMAT $NUM6,5,N,2
 FORMAT $CHR7,30,C
 DISPLAY '    '
 DISPLAY 'Running Info Program Uplink'
 DISPLAY '    '
 SEL %cover%.AAT
 DISPLAY '    '
 DISPLAY 'Sorting on pntr#'
 DISPLAY '    '
 SORT PNTR#
 CA UHUC1 = 0
 CA UHUC2 = 0
 CA UHUC3 = 0
 CA UPNTR1 = 0
 CA UPNTR2 = 0
 CA UPNTR3 = 0
 CA UFLAG = 0
 CA $NUM1 = 0
 CA $NUM2 = 0
 CA $NUM3 = 0
 CA $NUM4 = $NOREC + 1
 CA $NUM5 = 0
 DO U $NUM1 = $NUM4
 RES BY $RECNO = 1
 CA $NUM1 = $NUM1 + 1
 ASEL
 RES BY $RECNO = $NUM1
 IF DNARC LE 0
 DISPLAY '1'
```

```
DISPLAY 'ARC#',$NUM1,'DNARC',DNARC
GOTO BOTTOM
ENDIF
CA $NUM2 = DNARC
CA $NUM3 = HUC
CA $NUM5 = PNTR#
MOVE [TRANSLATE STR-NAME] TO $CHR7
ASEL
RES BY PNTR# = $NUM2
DISPLAY '2'
DISPLAY 'ARC#',$NUM1,'DNARC',DNARC
IF UHUC1 = 0 AND STR-NAME EQ $CHR7
CA UHUC1 = $NUM3
CA UPNTR1 = $NUM5
DISPLAY 'ADDING TO UP1'
GOTO BOTTOM
ENDIF
IF UHUC2 = 0
DISPLAY 'ADDING TO UP2'
CA UHUC2 = $NUM3
CA UPNTR2 = $NUM5
GOTO BOTTOM
ENDIF
IF UHUC3 = 0
DISPLAY 'ADDING TO UP3'
CA UHUC3 = $NUM3
CA UPNTR3 = $NUM5
GOTO BOTTOM
ENDIF
CA UFLAG = 1
LABEL BOTTOM
ASEL
DOEND
SORT %COVER%#
CA DPNTR = DNARC
CA DHUC = HUC
END

RUN UPLINK
Q STOP
&END            /* -----End of UPLINKING ROUTINE
```

```
/* --------------add NPPC items to Reach File.AAT
&IF ^ [ITEMINFO %cover% -ARC CSEG -EXISTS] &THEN ADDITEM %cover%.AAT ~
%cover%.AAT CSEG 3 3 I # UFLAG
&IF ^ [ITEMINFO %cover% -ARC CRMI -EXISTS] &THEN ADDITEM %cover%.AAT ~
%cover%.AAT CRMI 5 5 N 2 CSEG
&IF ^ [ITEMINFO %cover% -ARC CNAME -EXISTS] &THEN ADDITEM %cover%.AAT ~
%cover%.AAT CNAME 30 30 C # CRMI
LOG %cover% add
UPLINK SUCCESSFUL
&TYPE UPLINK SUCCESSFUL ...
&TYPE NOW MANUALLLY IDENTIFY-
&TYPE    1. DHUC AND DPNTR FOR FIRST ARC IN BASIN
&TYPE    2. UHUC AND UPNTR FOR LAST ARC IN BASIN IF NOT HEADWATERS
&return

&routine error_failure
 &type \\\\\.....Uplink has failed.....\\\\\
 &stop
&return

&routine error_warning
 &type \\\\.... Warning nonfatal errors!!!....\\\\
&return
```

Order.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: Order.AML
/* Language:     ARC Macro Language
/*
/* Written for BPA River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:  Checks BANKS-PNW.PAT to insure items are in proper order
/*           Checks STR100-PNW.AAT to insure items are in proper order
/*           Redefines items in AAT to create River Reach Number (RRN)
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name,  I/O,   Type,     Definition
/*      none
/*-------------------------------------------------------------------------------
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     Author/Site,      Date,        Event
/*-------------------------------------------------------------------------------
/*     BPA RR staff       5/90        revised and enhanced.
/*-------------------------------------------------------------------------------
&type  ======================== DISCLAIMER ======================================
&type  |  Although this program has been used by the U.S. Geological Survey,      |
&type  |  no warranty, expressed or implied, is made by the USGS as to the        |
&type  |  accuracy and functioning of the program and related program             |
&type  |  material nor shall the fact of distribution constitute any such         |
&type  |  warranty, and no responsibility is assumed by the USGS in               |
&type  |  connection therewith.                                                   |
```

```
&type  ================================================================================
/*
/*
&S I = 0
&DO ITEM &LIST AREA PERIMETER BANKS-PNW# BANKS-PNW-ID MAJOR1 MINOR1 MINOR2 ~
  MINOR3 HUC
  &IF ^ [ITEMINFO BANKS-PNW -POLY %item% -EXISTS] &THEN
    &DO
     &S I = 1
     &TYPE %item% IS NOT PRESENT IN .PAT FILE
    &END
&END
&IF %I% = 1 &THEN &GOTO SKIP
PULLITEMS BANKS-PNW.PAT BANKS-PNW.PAT
  AREA
  PERIMETER
  BANKS-PNW#
  BANKS-PNW-ID
  MAJOR1
  MINOR1
  MINOR2
  MINOR3
  HUC
  END
&TYPE BANKS-PNW.PAT is ordered ...
LOG BANKS-PNW ADD
ORDERing of PAT completed.
&LABEL SKIP
&TYPE ......Now attempting to order STR100-PNW.AAT ...
&S N = 0
&DO ITEM &LIST FNODE# TNODE# LPOLY# RPOLY# LENGTH STR100-PNW# STR100-PNW-ID~
  MAJOR1 MINOR1 MINOR2 MINOR3 HUC SEG RMI LEVEL SEQNUM FLAGS STR-NAME CEN
  &IF ^ [ITEMINFO STR100-PNW -ARC %item% -EXISTS] &THEN
    &DO
     &S N = 1
     &TYPE %item% IS NOT PRESENT IN .AAT FILE
    &END
&END
&DO ITEM &LIST CUMLENGTH DNARC PNTR# SAVENEG SINUOUS~
  UHUC1 UPNTR1 UHUC2 UPNTR2 UHUC3 UPNTR3 DHUC DPNTR CSEG CNAME
  &IF ^ [ITEMINFO STR100-PNW -ARC %item% -EXISTS] &THEN
    &DO
     &S N = 1
     &TYPE %item% IS NOT PRESENT IN .AAT FILE
    &END
&END
```

```
&DO ITEM &LIST CSEG CNAME CRMI STATE STATE-2 COUNTY COUNTY-2 QUAD100~
  QUAD100-2 QUAD75 QUAD75-2
  &IF ^ [ITEMINFO STR100-PNW -ARC %item% -EXISTS] &THEN
    &DO
      &S N = 1
      &TYPE %item% IS NOT PRESENT IN .AAT FILE
    &END
&END
&IF %N% = 1 &THEN
  &DO
   &TYPE BAILING OUT...
   &IF %I% = 0 &THEN
    &DO
      &TYPE STR100-PNW.AAT not ordered
      &TYPE Add missing items and run ORDERAAT.AML
    &END
  &IF %I% = 1 &THEN
    &DO
     &TYPE Neither BANKS-PNW.PAT nor STR100-PNW.AAT ordered ...
     &TYPE Add missing items and rerun ORDER.AML
    &END
  &RETURN
&END
PULLITEMS STR100-PNW.AAT STR100-PNW.AAT
  FNODE#
  TNODE#
  LPOLY#
  RPOLY#
  LENGTH
  STR100-PNW#
  STR100-PNW-ID
  MAJOR1
  MINOR1
  MINOR2
  MINOR3
  HUC
  SEG
  RMI
  LEVEL
  SEQNUM
  FLAGS
  STR-NAME
  STATE
  STATE-2
  COUNTY
  COUNTY-2
  QUAD100
  QUAD100-2
  QUAD75
  QUAD75-2
```

```
  CEN
  CUMLENGTH
  DNARC
  PNTR#
  SAVENEG
  SINUOUS
  UHUC1
  UPNTR1
  UHUC2
  UPNTR2
  UHUC3
  UPNTR3
  UFLAG
  DHUC
  DPNTR
  CSEG
  CRMI
  CNAME
  END
&TYPE STR100-PNW.AAT is ordered ...
LOG STR100-PNW ADD
ORDER completed
&DATA ARC INFO
ARC
SEL STR100-PNW.AAT
REDEFINE
53,RRN,17,17,C
280,UPLINK1,13,13,I
293,UPLINK2,13,13,I
306,UPLINK3,13,13,I
320,DOWNLINK,13,13,I
[UNQUOTE ' ']
Q STOP
&END        /*--------ends &data block
LOG STR100-PNW ADD
RRN Redefined
&TYPE RIVER REACH NUMBERS ASSIGNED
&IF %I% = 0 &THEN &TYPE Ordering successful...  Now archive basin
&IF %I% = 1 &THEN
  &DO
    &TYPE BANKS-PNW.PAT not ordered ...
    &TYPE Add missing items and run ORDERPAT.AML
  &END
&RETURN
```

Checkit.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: CHECKIT.AML
/* Language:     AML
/* Version:      5.0.1 Unix
/* Written for River Reach Project
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     This AML performs a verification check of various process
/*     steps which went into constructing the River Reach files.
/*     It allows the user to check results from CONFLATION, UPLINK,IDENTITY
/*     and verify the connectedness of the reaches in the basin network.
/*     The user can also tag the inflowing and outflowing reaches of the
/*     subbasin and stay in ARCEDIT to add NPPC reach codes.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:
/*     Variable name  I/O   Type   Definition
/*     cov                         PNW River Reach.file
/*-------------------------------------------------------------------------------
/* History:
/*     Author/site   Site   Date
/*
/*     MODIFIED VERSION OF CHECK.AML
/*     B FISHER      PDX    10/30/90
/*-------------------------------------------------------------------------------
&type  ======================== DISCLAIMER ========================================
&type  |  Although this program has been used by the U.S. Geological Survey,       |
&type  |  no warranty, expressed or implied, is made by the USGS as to the         |
&type  |  accuracy and functioning of the program and related program              |
&type  |  material nor shall the fact of distribution constitute any such          |
&type  |  warranty, and no responsibility is assumed by the USGS in                |
&type  |  connection therewith.                                                    |
```

```
&type  ================================================================================
/*
/*&ARGS .COV

&SEVERITY &WARNING &ROUTINE ERROR_WARNING
&SEVERITY &ERROR &ROUTINE ERROR_FAIL
/*  --------do argument check
&IF [NULL %.COV%] &THEN
  &DO
   &TYPE USAGE: CHECKIT <Reach.file>
   &RETURN
  &END
/*  -------- do existence check.
&IF ^ [EXISTS %.COV% -COV] &THEN
  &DO
   &TYPE %.COV% does not exist is this directory.
   &TYPE These are the current coverages.
   LC
   &PAUSE
   &RETURN
  &END
&s .WORK [SHOW &WORKSPACE]
&S .COV [TRANSLATE %.COV%]
/* ------check coverage topology
describe %.cov%
&if %dsc$qedit% = .true. &then
 &do
  &type The coverage has an edit mask..reBUILDING with LINE..
  BUILD %.cov% LINE
 &end
&label termlabel
```

```
/* ------find out what the user is using as a graphics terminal.
&s tube [RESPONSE 'What terminal type are you using.. 4207,9999 etc']
&select %tube%
 &when 4107,
  &do
   &terminal 4107 &cursor
   display 4107
  &end
&when 4207
  &do
   &terminal 4207 &cursor
   display 4207
  &end
&when 9999
  &do
   &terminal 9999 &mouse
   display 9999 3
  &end
&otherwise
 &do
  &type 'The terminal type is an invalid one, try again'
  &goto termlabel
 &end
&end
ARCEDIT
MAPE %.COV%
EDITC %.COV%
EDITF ARC
EDITD 750
&LABEL DISPLAYMENU
&TYPE
&TYPE
```

```
&TYPE  ********************************************************************************
&TYPE  *                          ***MENU***                                          *
&type  ********************************************************************************
&TYPE  *  1. ALLOCATION         2. UPLINK              3. CONFLATION                  *
&TYPE  *  4. IDENTITY           5. DOWNSTREAM          6. TAG OUTFLOW REACH           *
&TYPE  *                        9.QUIT                                                *
&TYPE  ********************************************************************************
&TYPE
&SET CHOICE = [GETCHAR ' Make a selection from the menu']
```

```
/*--------------------------CHOICE 1-----------------------------------------
&IF %CHOICE% = 1 &THEN   /* Matches last ELSE statement
 &DO
  &TYPE CHECKING ALLOCATION ...
  &TYPE ALLOCATED REACHES ARE RED, UNALLOCATED REACHES ARE WHITE ...
  SEL CEN GT 0
  SDS 2
  DS
  NSEL
  SDS 1
  DS
  &PAUSE
  CLEAR
 &END
/*--------------------------CHOICE 2-----------------------------------------
&ELSE &IF %CHOICE% = 2 &THEN
 &DO
  &TYPE CHECKING UPLINK ...
  &TYPE PURPLE REACHES HAVE MORE THAN ONE REACH UPSTREAM ...
  &TYPE YELLOW REACHES WERE NOT ALLOCATED AND HAVE NO UPLINK VALUES ...
  SEL UPNTR2 GT 0 OR UPNTR3 GT 0 OR UFLAG GT 0
  SDS 6
  DS
  NSEL
  SDS 5
  DS
  SEL UPNTR1 = 0 AND CEN = 0
  SDS 7
  DS
  &PAUSE
  CLEAR
 &END
/*--------------------------CHOICE 3-----------------------------------------
&ELSE &IF %CHOICE% = 3 &THEN
 &DO
  &TYPE NOW HERE ARE THE ORIGINAL EPA-TRACE SEGMENTS (DARK BLUE)
  &TYPE AND PROVISIONAL SEGS (LIGHT BLUE)
  SEL SEG LT 500
  SDS 4
  DS
  NSEL
  SDS 5
  DS
  &PAUSE
  CLEAR
 &END
```

```
/*-------------------------CHOICE 4-----------------------------------------
&ELSE &IF %CHOICE% = 4 &THEN
 &DO
  &LABEL Q100K
  &S Q100 [GETUNIQUE %.COV% -ARC QUAD100 'Use mouse to select a 100k quad']
  &IF [INDEX %Q100% ' '] = 0 &THEN &S Q100 [QUOTE %Q100%]
  SEL ALL
  SEL QUAD100 CN  %Q100%
  &IF [SHOW NUMBER SELECT] EQ 0 &THEN
   &DO
    &TYPE No reaches were selected for %Q100% quad..
    &S A1 [RESPONSE 'Pick another from the list? Y/N']
    &IF [TRANSLATE %A1%] = Y &THEN &GOTO Q100K
   &END
  SDS 3
  &TYPE ..Drawing %Q100% 100K reaches now..displayed in GREEN...
  DS
  &PAUSE
  &LABEL Q24K
  &S Q75  [GETUNIQUE %.COV% -ARC QUAD75  'Use mouse to select a 24K quad']
  &IF [INDEX %Q75% ' '] = 0 &THEN &S Q75 [QUOTE %Q75%]
  SEL ALL
  SEL QUAD75 CN %Q75%
  &IF [SHOW NUMBER SELECT] EQ 0 &THEN
   &DO
    &TYPE No reaches were selected for %Q75% quad..
    &S A2 [RESPONSE ' Pick another from the list? Y/N']
    &IF [TRANSLATE %A2%] = Y &THEN &GOTO Q24K
   &END
  SDS 6
  &TYPE ..Drawing %Q75% 24K quad reaches now..displayed in PURPLE..
  DS
  &PAUSE
  &LABEL CNTY
  &S CTY  [GETUNIQUE %.COV% -ARC COUNTY  'Use mouse to select a COUNTY']
  &IF [INDEX %CTY% ' '] = 0 &THEN &S CTY [QUOTE %CTY%]
  SEL ALL
  SEL COUNTY CN %CTY%
  &IF [SHOW NUMBER SELECT] EQ 0 &THEN
   &DO
    &TYPE No reaches were selected for %CTY% county..
    &S A3 [RESPONSE 'Pick another from the list? Y/N']
    &IF [TRANSLATE %A3%] = Y &THEN &GOTO CNTY
   &END
  SDS 2
  &type ..Drawing %CTY% county reaches now..displayed in RED...
  DS
  &PAUSE
  CLEAR
 &END
```

```
/*--------------------------CHOICE 5-------------------------------------------
&ELSE &IF %CHOICE% = 5 &THEN
 &DO
  EDITFEA ARC
  &LABEL UP
  CLEAR
  SEL ALL
  SEL MINOR1 = 412
  SETDRAWSYM 5
  DRAWSEL
  SEL MINOR1 = 414 OR MINOR1 = 416
  &s NUM1 [SHOW NUMBER SELECT]
  &IF %NUM1% = 0 &THEN &GOTO CONT
  SETDRAWSYM 8
  DRAWSEL
  &LABEL CONT
  SEL ALL
  SEL MINOR1 = 999
  SDS 6
  DS
  &LABEL UP1
  SEL MINOR3 = 1
  &S NUM2 [SHOW NUMBER SELECT]
   &IF %NUM2% = 0 &THEN &GOTO PROCEED
  CALC MINOR3 = 0
  &LABEL PROCEED
  SEL ALL
  SEL MANY
  &S NUM [SHOW NUMBER SELECT]
  &IF %NUM% = 1 &THEN CALC MINOR3 = 1
  &ELSE
   &DO
    &S TRYAGAIN [RESPONSE 'Do you want to try again Y/N?']
    &IF [TRANSLATE %TRYAGAIN%] EQ N &THEN &GOTO DISPLAYMENU
    &ELSE &GOTO UP1
   &END
  SAVE
  &CALL DOWNSTREAM2
  SEL ALL
  SEL MINOR3 = 1
  SETDRAWSYM 9
  DRAWSEL
  &S QT [RESPONSE 'DO YOU WANT TO QUIT Y/N']
  &IF [TRANSLATE %QT%] NE Y &THEN &GOTO UP1
   &ELSE
     &CALL RESET
 &END
```

```
/*-------------------------------CHOICE 6----------------------------------------
&ELSE &IF %CHOICE% = 6 &THEN
 &DO
  editf arc
  CLEAR
  SEL SEG GE 500
  SDS 5
  DS
  NSEL
  SDS 4
  DS
  &TYPE Select all Outflowing reaches..
  sel many
  sds 6
  ds
  &type Tagging MINOR3 = 111111
  CALC MINOR3 = 111111
  &s ans [RESPONSE 'Do you need to tag inflow arc(s)? Y/N']
   &if [TRANSLATE %ans%] = Y &then
    &do
     sel many
     sds 2
     ds
     &TYPE Tagging MINOR3 = 888888
     CALC MINOR3 = 888888
    &end
  &else &goto displaymenu
  &END
```

```
/*------------------------CHOICE 9-------------------------------------------------
&ELSE &IF %CHOICE% = 9 &THEN
 &DO
  &TYPE Quitting session...
  CLEAR
  Q Y
  &STOP
 &END
&ELSE               /* goes with first IF statement.
 &DO
  &TYPE You have made an invalid choice.. try again
  &goto displaymenu
 &END
&S ANSW [RESPONSE 'Do you want to return to menu? Y/N?']
&IF [TRANSLATE %ANSW%] = Y &THEN &GOTO DISPLAYMENU
 &ELSE
  &DO
   &S A5 [RESPONSE 'Do you want to stay in ARCEDIT? Y/N']
   &IF [TRANSLATE %A5%] = Y &THEN &RETURN
   &ELSE
    &DO
     &TYPE CHECKING OF BASIN COMPLETE... RUN PNWARCHIVE.AML ...
     CLEAR
     Q Y
    &END
   &END
  &END
   &RETURN
```

```
/* ***************** Downstream2 Routine ****************************************
&ROUTINE DOWNSTREAM2
&IF [EXISTS %.COV%.KEY -INFO] &THEN
&S delete_status [DELETE %.COV%.KEY -INFO]
&DATA ARC INFO
ARC
DEFINE %.COV%.KEY
PNTR#,4,5,B
RECNO,4,5,B

SEL [TRANSLATE %.COV%.AAT]
REL %.COV%.KEY PNTR# APPEND
RES $RECNO > 0
SEL %.COV%.KEY
CALC RECNO = $RECNO
SORT ON PNTR#
PROG DS
SEL %.COV%.KEY
RELATE %.COV%.AAT RECNO LINK
RES $1MINOR3 = 1
LABEL TOP
CA $NUM1 = $1DNARC
DISPLAY 'DNARC =',$1DNARC
IF $1DNARC LE 0
GOTO BOTTOM
ENDIF
ASEL
RES BY PNTR# = $NUM1
CA $1MINOR3 = 1
GOTO TOP
LABEL BOTTOM
SEL %.COV%.AAT
ASEL
SORT ON %.COV%#
END

RUN DS
ERASE DS
Y
Q STOP
&END
&RETURN
```

```
/********* ERROR ROUTINES ************************************************************
&ROUTINE ERROR_WARNING
&type Warning.. returning to program.
&return
&ROUTINE ERROR_FAIL
&TYPE \\BAILING OUT OF CHECKIT..... FAILURE....\\
&STOP

&ROUTINE RESET
/*
&type
&type !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
&type   You must recalculate any reach with a MINOR3 set for OUTFLOW
&type   or INFLOW if they were previously set..MENU option 6.
&type !!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
&return
```

Pnwarchive.AML

```
/*-------------------------------------------------------------------------------
/* Command Name: PNWARCHIVE.AML
/* Language:     AML AT ARC 5.0.1 (PRIME)
/*
/*
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Purpose:
/*     To transfer completed River Reach Files and other coverages
/*     as export files to PNWFINAL directory.
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* Arguments:  AML PROMPTS FOR INPUTS OF BASIN AND HYDROLOGIC UNIT NUMBER
/*:::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::::
/* History:
/*     AUTHOR                 DATE         EVENT
/*-------------------------------------------------------------------------------
/*     BPA RIVER REACH STAFF  02-14-90     ORIGINAL CODING
/*-------------------------------------------------------------------------------
&type  ========================DISCLAIMER=======================================
&type  |  Although this program has been used by the U.S. Geological Survey,      |
&type  |  no warranty, expressed or implied, is made by the USGS as to the        |
&type  |  accuracy and functioning of the program and related program             |
&type  |  material nor shall the fact of distribution constitute any such         |
&type  |  warranty, and no responsibility is assumed by the USGS in               |
&type  |  connection therewith.                                                   |
```

```
&type  ================================================================================
/*
&type Are export files STR100-PNW.E00, BANKS-PNW.E00, STR-CNTRS.E00,
&s resp = [response 'STR-IDENT.E00, CLIPCOV.E00, TRACE-MOD.E00 ? Y/N']
&if %resp% = [unquote 'N'] &then
  &do
    &type Change name of export files and rerun ...
    &return
  &end
&type Coverage Archiving Subsystem \ \
&s home = [dir [pathname LOG]]
&type Valid basins are:
&type ================= \
&sys LD BPA>PNWFINAL>@@ -NHE -DIR
&s basin = [response 'Enter the name of the basin']
&if ^ [EXISTS BPA>PNWFINAL>%basin% -dir] &then &do
      &type Basin %basin% does not exist
      &type Bailing out of PNWARCHIVE...
      &return
      &end
&type Valid subbasin designators are:
&type ==============================
&sys LD BPA>PNWFINAL>%basin%>@@ -NHE -DIR      /* PRIMOS dependent command.
&s subb = [response 'Enter the name of the subbasin']
&if ^ [EXISTS BPA>PNWFINAL>%basin%>%subb% -dir] &then &do
      &type Subbasin %subb% does not exist
      &type Bailing out of PNWARCHIVE ...
      &return
      &end
&type
&type Your source directory is %home%.
&type The pathname you have selected is   BPA>PNWFINAL>%basin%>%subb%
&type
&s ans = [response 'IS THIS THE CORRECT PATHNAME? Y/N']
&if %ans% = [unquote 'N'] &then &do
  &type bailing out of PNWARCHIVE ...
  &return
  &end
&s hucno [substr %subb% 2 8]
&s init [response 'ENTER YOUR INITIALS (ABC)']
&if ^ [exists %home%>STR100-PNW.E00 -file] &then &do
  &type Coverage %home%>STR100-PNW.E00 not found.
  &type  Bailing out of PNWARCHIVE...
  &return
  &end
```

```
&type Copying Links export file ...
&SYS COPY %home%>STR100-PNW.E00 BPA>PNWFINAL>%basin%>%subb%>STR100-PNW.E00
&if ^ [exists %home%>STR-CNTRS.E00 -file] &then &do
  &type Coverage %home%>STR-CNTRS.E00 not found.
  &type Bailing out of PNWARCHIVE...
  &return
  &end
&type Copying Centers export file ...
&SYS COPY %home%>STR-CNTRS.E00 BPA>PNWFINAL>%basin%>%subb%>STR-CNTRS.E00
&if ^ [exists %home%>STR-IDENT.E00 -file] &then &do
  &type Coverage %home%>STR-IDENT.E00 not found
  &type Bailing out of PNWARCHIVE ...
  &return
  &end
&type Copying Identity export file ...
&SYS COPY %home%>STR-IDENT.E00 BPA>PNWFINAL>%basin%>%subb%>STR-IDENT.E00
&if [exists %home%>BANKS-PNW.E00 -file] &then &do
 &type Copying Banks export file...
  &SYS COPY %home%>BANKS-PNW.E00 BPA>PNWFINAL>%basin%>%subb%>BANKS-PNW.E00
  &end
&else &do
  &type Export file %home%>BANKS-PNW.E00 not found
  &end
&if [exists %home%>CLIPCOV.E00 -file] &then &do
  &type Copying Clip export file ...
  &SYS COPY %home%>CLIPCOV.E00 BPA>PNWFINAL>%basin%>%subb%>CLIPCOV.E00
  &end
&else &do
  &type Export file %home%>CLIPCOV.E00 not found
  &end
&if [exists %home%>TRACE-MOD.E00 -file] &then &do
  &type Copying EPA Trace export file ...
  &SYS COPY %home%>TRACE-MOD.E00 BPA>PNWFINAL>%basin%>%subb%>TRACE-MOD.E00
  &end
&else &do
  &type Export file %home%>TRACE-MOD.E00 not found
  &end
&TYPE %hucno% BEING UPDATED IN HUCSALB AS COMPLETE
&SYSTEM A BPA>HUCQUE
&DATA ARC INFO
SELECT HUCSALB.PAT
RES HUC = %hucno%
MOVE 'Y' TO CLIPPED
MOVE 'Y' TO CONFLATED
MOVE 'Y' TO IDENTITY
MOVE 'Y' TO COMPLETE
MOVE [QUOTE %INIT%] TO INITIALS
Q STOP
&END
&SYS A %home%
&RETURN
```

APPENDIX B: Data Dictionary

Following are item descriptions of attributes in the Reach File Arc Attribute Table

File Name: STR100-PNW.AAT

Attribute Name	Description
FNODE#	ARC attribute - downstream node number
TNODE#	ARC attribute - upstream node number
LPOLY#	ARC attribute - identifies polygon number to the left of the arc when polygon topology has been computed.
RPOLY#	ARC attribute - identifies polygon number to the right of the arc when polygon topology has been computed.
LENGTH	Arc length in map units. (meters)
STR100-PNW#	ARC attribute - internal record number.
STR100-PNW-ID	ARC attribute - assignable User-ID number
MAJOR1	NMD DLG base category identifier. Code of 50 identifies feature as hydrography.
MINOR1	NMD feature classifier. Code of 412 identifies the feature as a stream. Code of 999 was used to indicate artificial features such as centerlines and connector arcs.
MINOR2	NMD feature classifier. Descriptive code of 610 identifies the feature, stream, (412) as intermittent.
MINOR3	NMD feature classifier. Rarely used. A code of 111111 was used by project staff to indicate outlet reach for the basin, 888888 indicated headwater reach.
HUC	8-digit USGS Catalog Unit Code number.
SEG	Segment number. SEG numbers less than 500 were reach codes from EPA or NPPC. SEG numbers 500 and greater were computer generated and are provisional.
RMI	River Mile. Reach distance converted to miles. Lowest reach for a particular SEG number has a RMI of 00.00.
LEVEL	EPA assigned stream level. A reverse Strahler order. LEVEL was not supported in the development of the River Reach Project.
SEQNUM	EPA hydrologic sequence number. SEQNUM was key item for modeling EPA Reach File. SEQNUM was not supported in the River Reach Project.
FLAGS	EPA item used for routing. FLAGS was not supported in the PNW River Reach Project.
STR-NAME	Stream name. Obtained primarily from EPA TRACE attributes. Some additional names have been manually added.
STATE	Predominant state that a particular reach falls within.
STATE-2	Second most predominant state a particular arc falls within.
COUNTY	Predominant county a particular reach falls within.
COUNTY-2	Second most predominant county a particular reach falls within.

Following are item descriptions of attributes in the Reach File Arc Attribute Table—Continued

File Name: STR100-PNW.AAT—Continued

QUAD100	Predominant 1:100,000 scale quad a particular reach falls within.
QUAD100-2	Second most predominant 100K-scale quad a particular reach falls within.
QUAD75	Predominant 1:24,000 scale quad a particular reach falls within.
QUAD75-2	Second most predominant 24K- scale quad a particular reach falls within.
CEN	CEN is node number of allocation centers.
CUMLENGTH	Cumulative length of arcs traversed from an allocation center.
DNARC	Down arc. The internal record number (cover#) of the previously allocated arc.
PNTR#	PNTR# is a record of the order of the Arc Attribute Table at the time of ALLOCATION. PNTR# is a copy of STR100-PNW#.
SAVENEG	Flag item that preserves a record of the arcs that blocked prior to allocation. A value of 1 means the arc was blocked.
SINUOUS	Sinuosity of a reach. Ratio of the true distance over straight line distance.
UHUC1	Hydrologic Unit Code number of the first upstream reach for a particular reach.
UPNTR1	Pointer number (PNTR#) of first upstream reach
UHUC2	Hydrologic Unit Code number of second upstream reach for a particular reach.
UPNTR2	PNTR# of second upstream reach.
UHUC3	Hydrologic Unit Code number of third upstream reach for a particular reach.
UPNTR3	PNTR# of third upstream reach
UFLAG	Flag item to indicate the presence of a fourth upstream reach for a particular reach. If true, UFLAG is set to 1.
DHUC	Hydrologic Unit Code number of downstream reach.
DPNTR	PNTR# of downstream reach.
CSEG	NPPC added reach-code.
CRMI	River mile designation assigned to NPPC reaches.
CNAME	Stream name given to NPPC reaches.

ReDefined Items	**Description**
RRN	HUC + SEG + RMI (River Reach Number)
UPLINK1	UHUC1 + UPNTR1
UPLINK2	UHUC2 + UPNTR2
UPLINK3	UHUC3 + UPNTR3
DOWNLINK	DHUC + DPNTR

Following is a list of items contained in the water-body Polygon Attribute Table:

File Name: BANKS-PNW.PAT

Item	Description
AREA	ARC attribute. Area of a polygon in map units.
PERIMETER	ARC attribute. Perimeter of a polygon in map units.
BANKS-PNW#	ARC attribute. Polygon internal number.
BANKS-PNW_ID	ARC attribute. Assignable polygon User-ID.
MAJOR1	NMD category code. 50 is code for hydrography.
MINOR1	NMD feature identifier. 421 is code for lake or pond.
MINOR2	NMD feature identifier
MINOR3	NMD feature identifier.
HUC	8 digit Hydrologic Unit Code

File Name: BANKS-PNW.AAT

Item	Description
FNODE#	ARC attribute - downstream node number
TNODE#	ARC attribute - upstream node number
LPOLY#	ARC attribute - identifies polygon number to the left of the arc when polygon topology has been computed.
RPOLY#	ARC attribute - identifies polygon number to the right of the arc when polygon topology has been computed.
LENGTH	Arc length in map units. (meters)
STR100-PNW#	ARC attribute - internal record number.
STR100-PNW-ID	ARC attribute - assignable User-ID number
MAJOR1	NMD DLG base category identifier. 50 identifies feature as hydrography.
MINOR1	NMD feature classifier. 200 identifies the feature as a shoreline. 999 was used to indicate artificial connector arcs used to close polygons.
MINOR2	NMD feature classifier. Could have been used to describe right or left bank of shoreline.
MINOR3	NMD feature classifier. Rarely used for hydrography.

APPENDIX C: Item Format Tables and Map Projection Parameter

DataFile Name: STR100-PNW.AAT

44 Items: Starting In Position 1

Col	Item Name	Wdth	Oput	Typ	N.Dec	Alternate Name
1	FNODE#	4	5	B	-	
5	TNODE#	4	5	B	-	
9	LPOLY#	4	5	B	-	
13	RPOLY#	4	5	B	-	
17	LENGTH	4	12	F	3	
21	STR100-PNW#	4	5	B	-	
25	STR100-PNW-ID	4	5	B	-	
29	MAJOR1	6	6	I	-	
35	MINOR1	6	6	I	-	
41	MINOR2	6	6	I	-	
47	MINOR3	6	6	I	-	
53	HUC	8	8	I	-	
61	SEG	4	4	I	-	
65	RMI	5	5	N	2	
70	LEVEL	2	2	I	-	
72	SEQNUM	11	11	C	-	
83	FLAGS	5	5	C	-	
88	STR-NAME	30	30	C	-	
118	STATE	4	4	C	-	
122	STATE-2	4	4	C	-	
126	COUNTY	15	15	C	-	
141	COUNTY-2	15	15	C	-	
156	QUAD100	26	26	C	-	
182	QUAD100-2	26	26	C	-	
208	QUAD75	25	25	C	-	
233	QUAD75-2	25	25	C	-	
258	CEN	4	5	B	-	
262	CUMLENGTH	4	12	F	2	
266	DNARC	4	5	B	-	
270	PNTR#	4	5	B	-	
274	SAVENEG	1	1	I	-	
275	SINUOUS	5	5	N	2	
280	UHUC1	8	8	I	-	
288	UPNTR1	5	5	I	-	

DataFile Name: STR100-PNW.AAT

44 Items: Starting in Position 1

Col	Item Name	Wdth	Oput	Typ	N.Dec	Alternate Name
293	UHUC2	8	8	I	-	
301	UPNTR2	5	5	I	-	
306	UHUC3	8	8	I	-	
314	UPNTR3	5	5	I	-	
319	UFLAG	1	1	I	-	
320	DHUC	8	8	I	-	
328	DPNTR	5	5	I	-	
333	CSEG	3	3	I	-	
336	CRMI	5	5	N	2	
341	CNAME	30	30	C	-	
	** Redefined Items **					
53	RRN	17	17	C	-	
280	UPLINK1	13	13	I	-	
293	UPLINK2	13	13	I	-	
306	UPLINK3	13	13	I	-	
320	DOWNLINK	13	13	I	-	

DataFile Name: BANKS-PNW.PAT

8 Items: Starting in Position 1

Col	Item Name	Wdth	Oput	Typ	N.Dec	Alternate Name
1	AREA	4	12	F	3	
5	PERIMETER	4	12	F	3	
9	BANKS-PNW#	4	5	B	-	
13	BANKS-PNW-ID	4	5	B	-	
17	MAJOR1	6	6	I	-	
23	MINOR1	6	6	I	-	
29	MINOR2	6	6	I	-	
35	MINOR3	6	6	I	-	
40	HUC	8	8	I	-	

DataFile Name: BANKS-PNW.AAT

11 Items: Starting in Position 1

Col	Item Name	Wdth	Oput	Typ	N.Dec	Alternate Name
1	FNODE#	4	5	B	-	
5	TNODE#	4	5	B	-	
9	LPOLY#	4	5	B	-	
13	RPOLY#	4	5	B	-	
17	LENGTH	4	12	F	3	
21	BANKS-PNW#	4	5	B	-	
25	BANKS-PNW-ID	4	5	B	-	
29	MAJOR1	6	6	I	-	
35	MINOR1	6	6	I	-	
41	MINOR2	6	6	I	-	
47	MINOR3	6	6	I	-	

DataFile Name: TRACE-MOD.AAT

14 Items: Starting in Position 1

Col	Item Name	Wdth	Oput	Typ	N.Dec	Alternate Name
1	FNODE#	4	5	B	-	
5	TNODE#	4	5	B	-	
9	LPOLY#	4	5	B	-	
13	RPOLY#	4	5	B	-	
17	LENGTH	4	12	F	3	
21	TRACE#	4	5	B	-	
25	TRACE-ID	4	5	B	-	
29	HUC	8	8	I	-	
37	SEG	3	3	I	-	
40	RMI	5	5	N	2	
45	LEVEL	2	2	I	-	
47	SEQNUM	11	11	C	-	
58	FLAGS	5	5	C	-	
63	STR-NAME	30	30	C	-	

DataFile Name: STR-CNTRS.PAT

15 Items: Starting in Position 1

Col	Item Name	Wdth	Oput	Typ	N.Dec	Alternate Name
1	AREA	4	12	F	3	
5	PERIMETER	4	12	F	3	
9	STR-CNTRS#	4	5	B	-	
13	STR-CNTRS-ID	4	5	B	-	
17	NODE#	4	5	B	-	
21	CAPACITY	4	12	F	2	
25	IMPED-LIMIT	4	12	F	2	
29	IMPED-DELAY	4	12	F	2	
33	LINE-SYMBOL	4	5	B	-	
37	MAXIMUM-IMPED	4	12	F	2	
41	AVERAGE-IMPED	4	12	F	2	
45	ARCS-ALLOCATED	4	5	B	-	
49	UTILIZED	4	12	F	2	
53	ALLOCATED	4	12	F	2	
57	POINT-SYMBOL	4	5	B	-	

MAP PROJECTION PARAMETERS FOR PNW RIVER REACH FILES

PROJECTION ALBERS

UNITS METERS

1st lat	43 30 00
2nd lat	47 30 00
cm	-114 00 00
lat org	41 45 00
easting	0.0
northing	0.0

☆ U.S. GOVERNMENT PRINTING OFFICE: 1996 - 790-123 / 41707 REGION NO. 10