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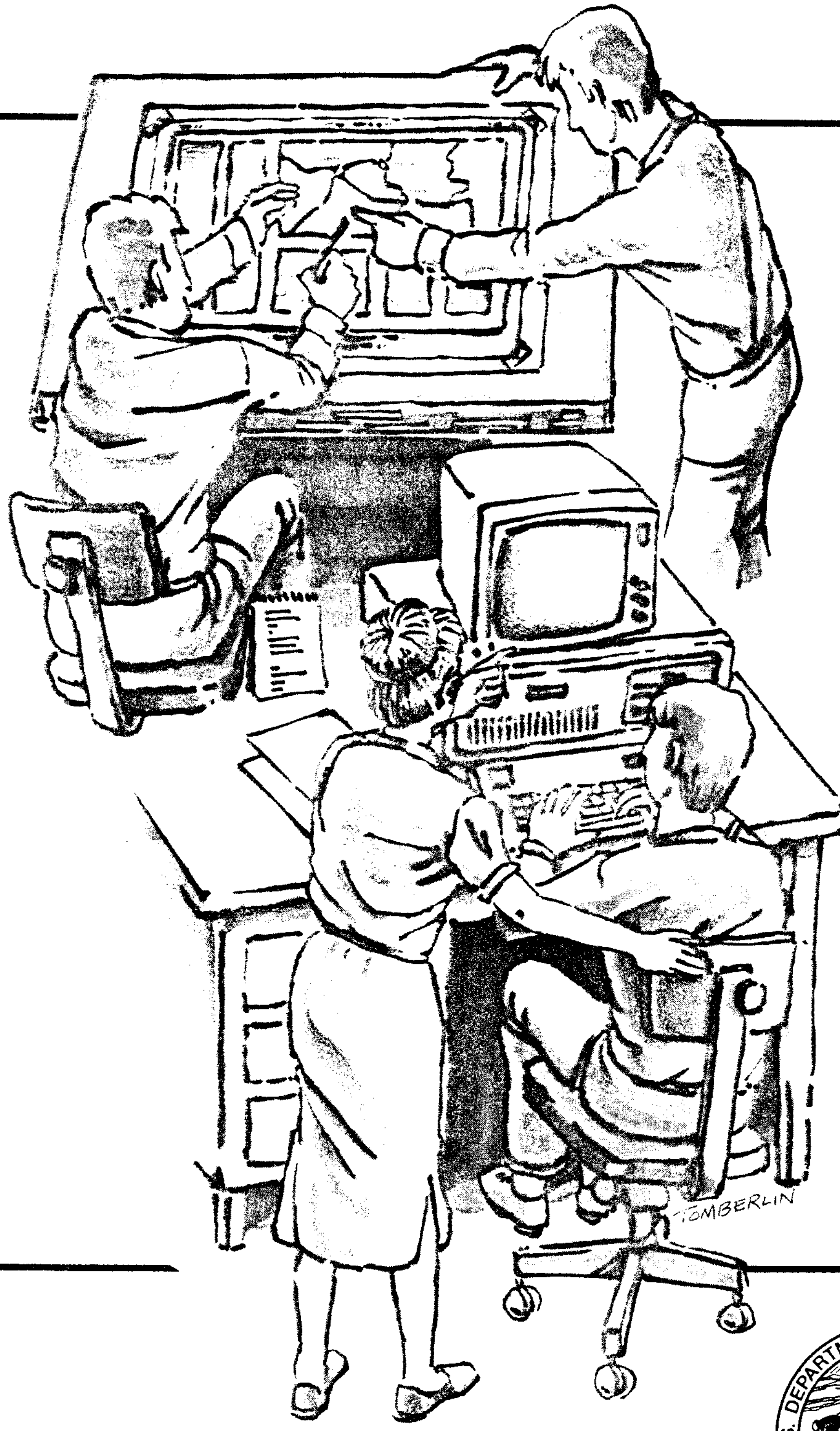

U.S. Geological Survey

Open-File Report 95-415

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849

Standards for Illustrations in Reports of the U.S. Geological Survey, Water Resources Division

Compiled by Robert A. Miller and Barbara H. Balthrop

U.S. GEOLOGICAL SURVEY

Open-File Report 95-415

1995

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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FOREWORD

This volume will provide a convenient and much-needed compilation of standards for the design of illustrations for authors of Survey reports produced in the Southeastern Region. While it presents very little that is new, it does draw material together under one cover for easy reference. Material is incorporated from the following sources:

WRD Publications Guide (blue cover)
Cartographic Technical Standards, Publications Division
Branch of Technical Standards, Technical Standards Section
Branch of Technical Standards, Instruction Series
Specimens of Type Faces for Maps, Branch of Printing, Publications Division
WRD Publications Guide, Volume 1, Publications Policy and Text Preparation, 1986 Edition (green cover)

The editors and several Regional and District people are to be commended for conceiving, compiling, and implementing this volume, which is designed to bridge the gap between obsolete or widely dispersed references and a new national standards guide for illustrations planned for the future. This volume itself will be obsolete when the new guide is issued, but until that time, I urge all authors, reviewers, and cartographers in the Southeastern Region to use the standards presented herein.

Illustrations as well as writing standards promulgated by the Geological Survey are, to many, voluminous, stringent, and laboriously detailed. Yet, familiarity with these standards brings the realization that they are the blueprint to good writing and the pathway to effective communications. I have made arrangements for a copy of this volume to be given to each hydrologist, editor, and cartographer in the Southeastern Region in an effort to maximize our communications skill. I request that each of you implement this thrust by becoming familiar with, and applying, these standards.

Jim
James L. Cook
Regional Hydrologist

CONTENTS

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

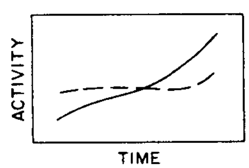
Replaces Article No.: | Effective Date: 10/25/73 | Article No.: 3.08.1

Subject: ILLUSTRATIONS -- Graphs and related diagrams - Types

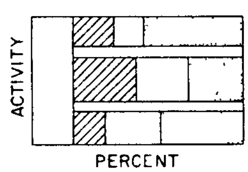
Illustrations can facilitate a reader's comprehension of the data and, if presented properly, can permit the author to omit from his text numerous descriptive details. It is not surprising therefore, that an almost-unlimited variety of graphs and diagrams has been published in reports of the Geological Survey. The following discussion categorizes the most commonly used graphs and diagrams to indicate to authors the general types of presentation available.

A. Graphs

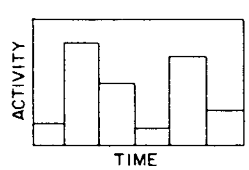
1. Curve or line graph -- emphasizes the trend or rate of activity of relatively continuous data. The graph is drawn by connecting, in sequence, plotted points that represent data. Differing line symbols are used to distinguish intersecting lines on the graph. If more than three intersecting lines are to be compared, multiple graphs may be necessary.



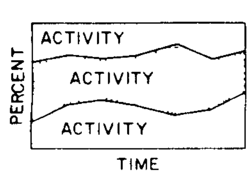
2. Bar or horizontal (bar) graph -- emphasizes the volume of data. The graph compares data for different items or activities at the same time; therefore, it needs only one numerical scale as no time scale is necessary. The bars representing plotted data should be arranged in order of magnitude, if possible. This type of graph best shows percentages.



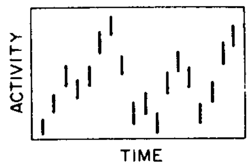
3. Column or vertical (bar) graph -- emphasizes sharply fluctuating magnitudes of data for one item or activity at different times. The bars may be subdivided, by color or patterns, so that component parts of the total are represented by the height of segments of the columns.



4. Surface or band graph -- emphasizes amount of data. On this graph, values of a number of parts are represented by layers placed one above the other, forming a cumulative total. The graph is especially effective for showing components, but should not be used when data fluctuate sharply, thereby distorting other component data.

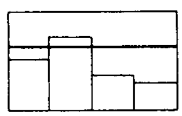


5. Symbol graph -- emphasizes the general trend or activity of data. Symbols, unconnected by lines, represent data. Example usage could be (1) symbols plotted as data points, where a trend line is not possible or desired, or (2) a series of vertical bars, each bar showing the maximum and minimum values of the data (such as monthly mean water level) for a period of time.

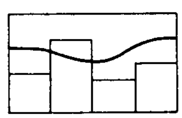


6. Combination graph -- combines two (or more) of the preceding forms into one graph.

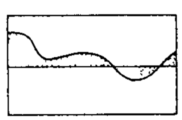
   a. A vertical bar and straight horizontal line combination is useful for measuring performance against a goal or standard, such as showing annual precipitation by bar and average annual precipitation by horizontal line.



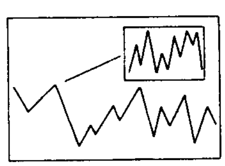
   b. A vertical bar and curve line combination is useful for relating variables such as water use and population, and precipitation and water levels in wells.



   c. A curve line and straight horizontal line combination can be used to compare monthly or annual precipitation with an average or cumulative departure from average.

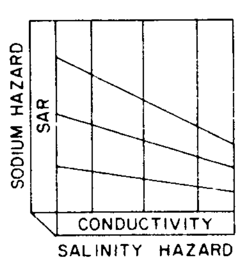


   d. An inset, which is a smaller graph superimposed on a larger one, magnifies part of the data lost in the range of the larger graph. The informative value of this presentation lies in a different or more comprehensive view of the data.

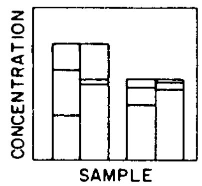


B. Diagrams

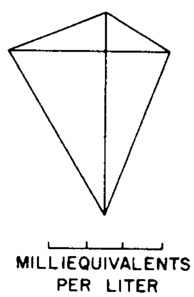
1. Classification of water for irrigation diagram -- permits an estimate to be made of the suitability of water for irrigation in terms of sodium and salinity hazards, once the sodium-adsorption ratio (SAR) and the electrical conductivity of the water are known. The diagram is divided into 16 areas that are used to rate the degree to which a particular water may be subject to salinity problems and undesirable ion-exchange effects.



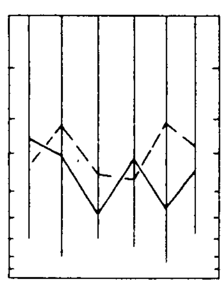
2. Collins diagram -- shows in a bar-graph form the total solute concentration and the proportions assigned to each principal ionic species. Each analysis is represented by a vertical bar graph whose total height is proportional to the total concentration of anions or cations, in milliequivalents per liter. The bar is divided into a left half representing cations and a right half representing anions. Each half is then divided by horizontal lines to show concentrations of the major ions, which are identified by distinctive patterns. The lengths of the cation and anion halves should be equal.



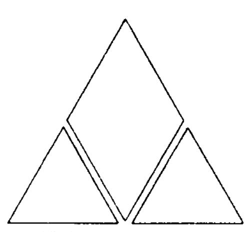
3. Kite diagram -- a pattern diagram in which concentrations of cations and anions are represented on rectangular coordinates. The length of each coordinate line from center corresponds to the concentration of constituents, in milliequivalents per liter. Once the ends of the four coordinate lines are connected, thereby forming a distinctive shape, the patterns for different water types can be easily and quickly compared visually.



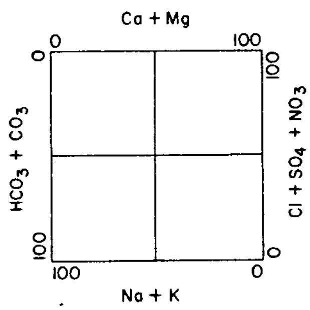
4. Nomograph -- can be used to depict one or a group of analyses. Lines connect points on the interior scales of the nomograph that represent concentration of ions, in milligrams per liter. Scales for milliequivalents per liter at the left and right sides of the nomograph give the advantage of showing the relationship to scales for milligrams per liter. Waters of similar composition plot as near-parallel lines.



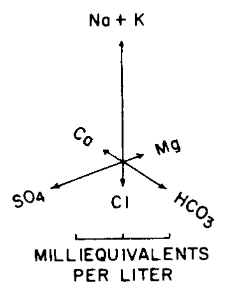
5. Piper diagram -- indicates the essential chemical character of a water by single-point plottings of cations and anions on trilinear coordinates. The proportions of cations and anions are plotted in each of the lower triangles; then the points are extended into the central diamond-shaped field. The intersection of the projections represents the composition of the water with respect to the combination of ions shown.



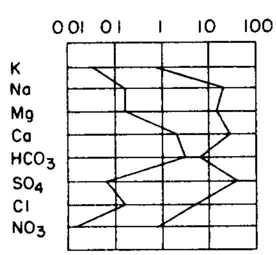
6. Modified Piper diagram -- indicates the essential chemical character of a water sample, or group of samples, by the location of plotted points within a square diagram. Concentrations of the ions for each water sample are in milliequivalents per liter; points are plotted in percentages of total anions. Thus, the sum of cations (Ca + Mg) + (Na + K) equals 100 percent and the sum of anions equals 100 percent.



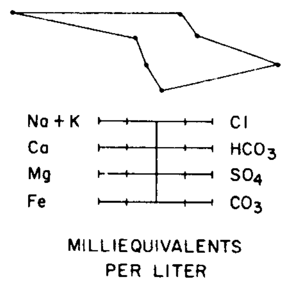
7. Radiating-vectors diagram -- Uses a system of plotting analyses by radiating vectors. The length of each of the six vectors from the center represents the concentration of principal ionic species, in milliequivalents per liter. A scale of units must be included with each diagram. A summation of the lengths of the arrows for cations should equal the lengths for the anions.



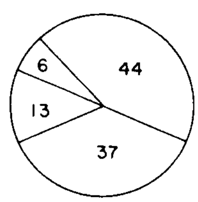
8. Semilog concentration graph (Ropes diagram) -- consists of a principal graph produced as line-printer output on which is a set of parallel horizontal log-scale axes, each corresponding to a selected constituent or variable. On each axis are plotted the distribution, minimum, mean, and maximum values for the variables selected. Straight lines are drawn to connect the low values and the high values for all variables, thereby giving a characteristic shape to the "distribution" of a selected group of data. An optional top-view graph contains a horizontal log scale corresponding to the principal graph; the vertical scale can be a time or space scale depending on the variable selected. Taken together, the principal graph and the top-view graph represent front and top orthographic projections of a three-dimensional array of data.



9. Stiff diagram -- forms a relatively distinctive pattern that can be used to show water composition differences or similarities. Four parallel horizontal lines extending on each side of a vertical line form a grid on which cations are plotted to the left and anions plotted to the right. The plotted points are connected by lines, forming a closed pattern that is characteristic of a certain water. The pattern tends to maintain its characteristic shape as the sample becomes dilute. The width of the pattern is an approximate indication of total ionic content.



10. Circular (pie) diagram -- emphasizes subdivisions of a whole by means of a circle, which is divided into sectors. This diagram is commonly used to show percentages, but it can also be drawn with a scale for the radii, which makes the area of the circle represent total ionic concentration and subdivisions of the area represent proportions of the different ions. Visual comparisons of subdivisions of bar graphs are clearer and more accurate than comparisons of sectors of circular diagrams, because the eye can measure linear distances easier than radial ones.



11. Well-numbering system diagram -- describes the system used in a report for numbering wells, test holes, and springs. The diagram generally shows, by means of one or more successively enlarged diagrams, the position of a location number within a township and range land-measurement grid. These diagrams can take many forms; published reports of the Survey are good references to the formats of numbering-system diagrams used by other authors.

References: Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water: U.S. Geol. Survey Water-Supply Paper 1473, 2d ed., 363 p.

Ropes, L. H., Morgan, C. O., and McNellis, J. M., 1969, FORTRAN IV program for synthesis and plotting of water-quality data: Kansas Geol. Survey Spec. Distrib. Pub. 39, 59 p.

GRAPH CONSTRUCTION

CASE– upper, lower, mixed

LINEWEIGHT– Technical pen/Jewel scribe
light (000 or 00/.006 or .008)
medium (0 or 1/.010 or .012)
heavy (2 or 2.5/.015 or .020)

CHARACTER SIZE– small (6–8 pt.), medium (10 pt.), large (12–14 pt.)

	PREPARATION		
	CASE	LINEWEIGHT	CHARACTER SIZE
① Frame[1]	——	light	——
② Data & curve[1]	——	heavy	large
③ Grid[1]	——	light	——
④ Axis captions[1]	upper	medium	medium
⑤ Axis numbers	——	medium	medium
⑥ Figure title[1]	mixed	medium	medium
⑦ Explanation[2]			
ⓐ Primary entry	upper	medium	small
ⓑ Secondary entry	mixed	medium	small
⑧ Primary interior label[1]	upper	medium	medium
⑨ Secondary interior label[1]	mixed	medium	small

	IMPORTANCE		
Data & curve	——	heavy	large
Primary interior label	upper	medium	medium
Axis captions	upper	medium	medium
Axis numbers	——	medium	medium
Explanation –			
(a) primary entry	upper	medium	small
(b) secondary entry	mixed	medium	small
Secondary interior label	mixed	medium	small
Frame	——	light	——
Grid	——	light	——

[1]See page 8 for examples.
[2]See page 82 for examples.

GRAPH CONSTRUCTION EXAMPLE

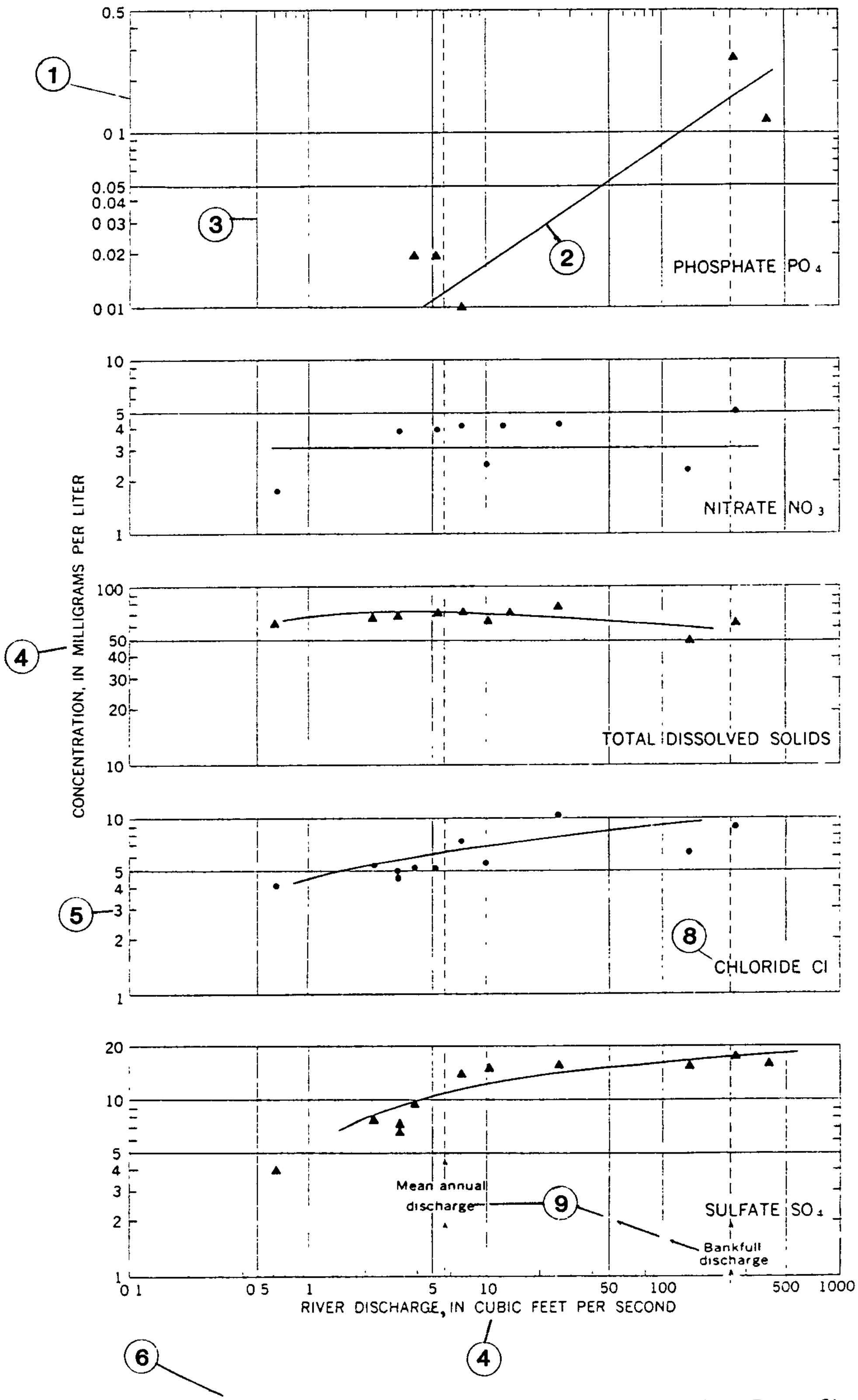


Figure 13.--Water-quality factors as functions of river discharge, Indian Run at Glenmore.

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

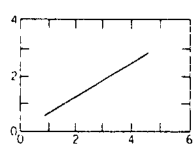
Replaces Article No.:	Effective Date: 10/25/73	Article No.: 3.08.2

Subject: ILLUSTRATIONS -- Graphs and related diagrams - Preparation

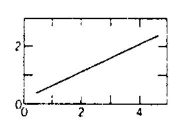
A. Grids

1. The grid may consist of a network of lines across the entire illustration or, more commonly, short lines (ticks) along the inside of all abscissa (horizontal) and ordinate (vertical) axes. The use of ticks to identify the grid is preferred on all simple illustrations in which the relationship shown is principally a visual one. Complicated illustrations that necessitate a detailed comparison of lines on a single graph or comparison of lines on one graph with those of another may require the use of a line grid. The grid of a graph generally consists of lines or ticks that are horizontal and vertical. The lines forming the grid of a diagram can be horizontal and vertical, horizontal and diagonal, vertical and diagonal, diagonal and diagonal, or radial.

2. The grid encompasses all data shown on the graph. Ideally, the grid should extend to the next numbered increment of the scale beyond the data lines or data points. When this is impractical because of size limitations, the grid should extend to the next increment (tick or line) beyond the data.



PREFERRED



PERMITTED

3. Logarithmic grids should be identified by lines or ticks at all points corresponding to whole numbers for each log cycle; for example, 10 lines or ticks for the cycle from 0.1 to 1, 10 lines or ticks for the cycle from 1 to 10, and so forth. Intermediate ticks can be added for clarity, where needed.

4. Arithmetic grids must be square to avoid skewing of data.

B. Scales[1]

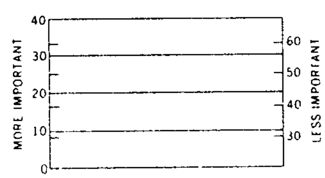
1. Scales of a graph generally are placed only along the left and bottom axes; ordinate-axis scales can be identified along both left and right axes if the graph is unusually wide. The grid along the right and top sides generally is not identified by a

[1]See page 18.

scale unless variables, differing from those on the left and bottom axes respectively, are plotted on the graph. Then, the left and bottom scales should identify the data of more importance and the right and top scales the data of less importance.

2. Scales for both English and metric units on the same graph should be located according to the following: if the report is intended primarily for scientific audiences and metric units precede English units (in parentheses) in the text, then metric units should be identified by the left and bottom scales, and English units by the right and top scales; if the report is intended primarily for the general public and English units are given first, then English-unit scales should be on the left and bottom, and metric scales on the right and top.

3. Differing scales used on both the left and the right sides of a graph wherein the grid on the left does not correspond with the grid on the right require the use of both lines and ticks to identify the grids. The grid for data of more importance, corresponding to the left scale, should consist of lines; the grid for data of less importance, corresponding to the right scale, should consist of ticks. The line grid should be drawn completely across the graph, and the ticks should be drawn at the left and right sides of the graph. An example will clarify the recommended usage:



4. Multiple scales on the ordinate or abscissa axes of a graph should be balanced, insofar as practical. The use of one scale on the left side and one on the right is preferred over the use of two scales on one side and none on the other.

5. Scales along the top, left, or right side of a graph indicate amount, whereas the scale along the bottom generally indicates time, if time is one of the variables shown on the graph.

6. Scales need to extend only to the nearest grid line or tick beyond the data extremes (maximum or minimum data points or data lines) shown; however, if alternate grid marks are identified, the scale and grid should be extended an additional increment to keep the numbering sequence uniform. Data lines can extend to, but not beyond, the outer grid lines of the graph or diagram. If data lines will not fit within the grid proposed, the scales and grid must be extended until they will. The numerical values used on arithmetic and similar scales should be such that the scale could be extended to the value of zero.[1]

[1]See page 16 for examples.

7. Numbers are added to all arithmetic grid lines or ticks or to every alternate line or tick for identification. Scale numbers for a logarithmic grid are generally needed only at selected lines or ticks.

8. Commas are used within numbers of 10,000 or more that identify points or lines on the grid of a graph. Commas are not used within numbers of 9999 or less.

9. The scale number "zero" consists of only zero without a decimal. Scale numbers less than one should consist of a zero, a decimal, and the number. Numbers of one or greater need a decimal and trailing zero only where significant figures dictate. Significant figures should be consistently used in scales of illustrations.

10. Scale numbers should increase from bottom to top along the ordinate axis and from left to right along the abscissa axis.

11. When both abscissa and ordinate scales begin with zero, both zeros should be shown at the lower left corner of the graph[2].

12. Months of the year along the bottom axis of a graph are identified by complete names, by abbreviated forms, or by only the first letter of each month where space dictates. Abbreviated forms are Jan., Feb., Mar., Apr., Aug., Sept., Oct., Nov., and Dec. The months of May, June, and July are not abbreviated.

13. Years should preferably be shown in the complete unabbreviated form; however, the abbreviated form (last two digits) can be used if the years are given in full at both ends of the scale. Years can be positioned to be read from the right if space is limited. Examples:

1959	1960	1961	1962	1963	Preferred
1959	60	61	62	1963	Permitted
1959	1960	1961	1962	1963	Permitted

14. Military or 24-hour time can be used for scales, provided the complete 4-digit number is used, such as 0600 and 1300. Do not use abbreviated forms, such as 06 or 13.

15. Avoid overlapping or coinciding scales where possible.

C. Abscissa- and ordinate-axis captions

1. All lettering in the captions must be capitals except for letter symbols.

2. All units of measure must be spelled in full (not abbreviated).

[2]Preferred numerical divisions on scales should be 1, 2, 5, or multiples of these basic numbers (for example 0.01, 0.1, 1, 10, 100, 1000). The number 25 and multiples thereof is also useful in special cases.

3. For an axis caption that includes a variable and a unit of measure, the variable must be followed by a comma, the word "in," then the unit of measure. For example:

DISCHARGE, IN CUBIC FEET PER SECOND

4. A unit of measure can separate or follow the description of a variable. If a unit of measure separates the description, a comma precedes the unit of measure but does not follow it. Examples:

TIME, IN HOURS AFTER TRACER INTRODUCED

TIME AFTER TRACER INTRODUCED, IN HOURS

5. The word "percent" is used in axis captions where preceded by the word "in." The word "percentage" is used where not preceded by the word "in." Examples:

DYE CONCENTRATION, IN PERCENT OF PEAK CONCENTRATION

PERCENTAGE OF TIME DISCHARGE WAS EQUALED OR EXCEEDED

6. Axis captions should indicate the datum for a variable shown on a graph when a datum exists, such as

WATER LEVEL, IN FEET BELOW LAND SURFACE

RIVER STAGE, IN FEET ABOVE SEA LEVEL

7. For an axis caption that contains an abbreviated letter symbol, the letter symbol should be enclosed in parentheses following the variable and preceding the unit of measure. For example:

OXIDATION POTENTIAL (Eh), IN MILLIVOLTS

8. The words "acre-feet" are always hyphenated -- in an axis caption and wherever else used.

9. The designation of the type of year needs to be added as the axis caption only when the year used is other than a calendar year, such as water year (October 1 through September 30) or climatic year (April 1 through March 31).

10. All vertical-axis captions should read from left to right when the illustration is turned clockwise for viewing.

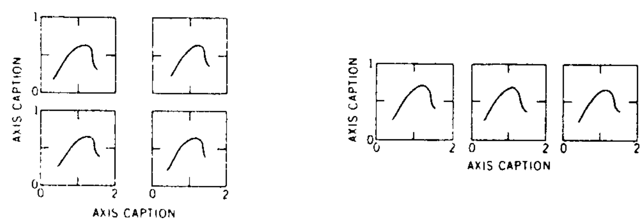
11. Use of scales for both English and metric units on the same graph requires repetition of the axis caption for each set of units. That is, if depth to water is shown in both units, the axis captions would read:

DEPTH TO WATER, IN METERS BELOW LAND SURFACE
and
DEPTH TO WATER, IN FEET BELOW LAND SURFACE

Each axis caption must be shown with its corresponding scale.

12. General relationships between parameters are sometimes shown on graphs without the use of a grid or scale, as in a time-versus-concentration graph. Arrows must be added to the axis captions of graphs of this type to show the general direction of increasing amount.

13. Repetition of parameters presented on several graphs sometimes permits them to be grouped or stacked in such a way that one ordinate-axis caption and one abscissa-axis caption apply to all graphs presented. Each graph must contain a complete grid, but the axis captions and some scales are shared by all graphs. For example:



D. Data points[1]

1. Data points may be included on graphs if necessary for coherence or special purpose.

2. If data points are widely scattered over the graph, an "envelope" may be drawn connecting the outermost points in a continuous line.

3. If data points are scattered but confined to a general direction, a line can be drawn through the average points. The line is useful for visualizing the trend.

4. If the diagram for classification of water for irrigation is to be used in a report, selected data points should be shown.

E. Data lines[1]

1. Lines connecting data points on graphs and diagrams must be straight between each pair of data points. If the lines are drawn as a "best fit" among data points and peaks and troughs of the line do not coincide with data points, then the author must explain to the reader why the extremes do not coincide with the data points.

2. Lines that intersect should be differentiated by symbol or line thickness to avoid confusion.

[1]See page 17 for examples for plotting data to the line or the space.

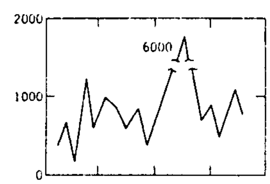
3. Dashed lines on a graph are used to indicate no available data or lack of adequate data. The dashed lines should be straight between points of known data. Where only one data point is known in an area of otherwise missing data, show the data point and connect the data point, by straight dashed lines, to the solid parts of the line. The reason for dashing lines must be explained adjacent to the dashed lines (most desirable), within the graph explanation, or in the figure caption (least desirable).

4. If two or more data lines are shown on a graph, the lines or data points corresponding to the lines must be identified by lettering placed along the data lines, in an explanation, or by description in the illustration caption.

5. Leaders are used to connect identification lettering or numbers with corresponding data points or data lines. Leaders consist of only straight lines. The leader should not be curved or in the shape normally used to represent lightning, nor should it have an arrowhead on the tip.

6. If a complete cycle of average annual or average monthly values is plotted on a graph, both ends of the data line must have the same value. For example, an average monthly value for the first of January should coincide with that for the last of December, provided the graph is prepared for the entire year.

7. The peak or trough in a data line can be "broken off" inside the outer scale line only where continuation of the scale to include the anomalous part of the line would result in a graph size that would be out of proportion to what is being shown. The extremity of the data line, accompanied by a numerical value, should be shown in the following manner:



8. Data lines can be broken (dashed) where continuation as a solid line would obscure data points plotted on the graph. The line should be discontinuous only at the data point.

9. Data lines should be checked for accuracy once they are drawn. A common failing of illustrations is the lack of agreement between what is shown on the graph or diagram and what is discussed in the text. On circular (pie) diagrams especially, check to see that all subdivisions add up to the whole.

F. Color

1. It is recommended that data lines on graphs in publications of the U.S. Geological Survey will be printed in black, because colored data lines can become misregistered during printing with respect to the black grid of the graph and introduce errors into the data presented. Therefore, data lines should be drawn on the same sheet as the rest of the graph.

2. Color may be used below data lines or within data bars and, in special cases, in data lines. Color on review prints may be applied directly to the graph or diagram.

G. Example usage

1. Examples illustrated on graphs are helpful in interpreting the data. Examples can be located within the graph (most desirable), figure caption, or accompanying text (least desirable).

2. Examples can be identified on the graph by a circle at the point of intersection of the abscissa and ordinate values selected for illustration; by straight solid, dashed, or dotted lines drawn from the data point to the scales; or by a combination of circle and lines.

3. The author should check and recheck the example presented to ensure that the example description and example circles or lines agree. Rechecking is especially important after review in which the example was revised.

4. A well-numbering system diagram should include an example location number. The number used on the diagram must correspond to a well, test hole, or spring actually located within the area described in the report.

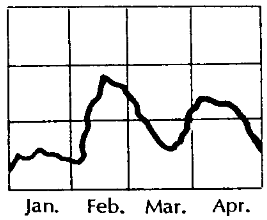
H. Drafting

1. The use of green or blue graph paper for plotting data is recommended. Orange graph paper with data plotted in pencil generally results in poor review prints.

2. After preliminary data are plotted in pencil, the entire graph or diagram (data points, data lines, grid, and axis captions) may have to be traced in ink (or typed) to obtain clear reproductions.

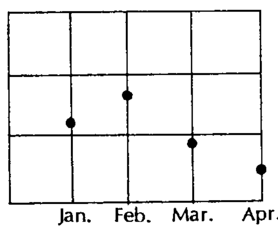
	SCALE	DATA
	Continuous	Continuous
	Discrete	Discrete

EXAMPLE 1



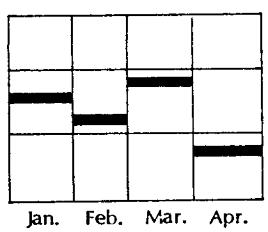
CONTINUOUS DATA ON CONTINUOUS SCALE

EXAMPLE 2



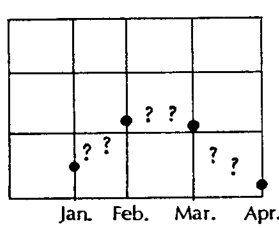
DISCRETE DATA ON DISCRETE SCALE

EXAMPLE 3



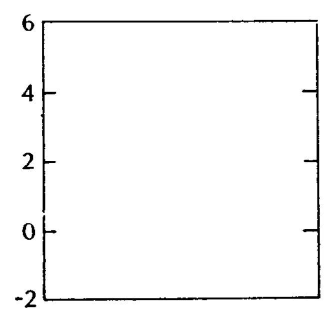
DISCRETE DATA ON CONTINUOUS SCALE

EXAMPLE 4



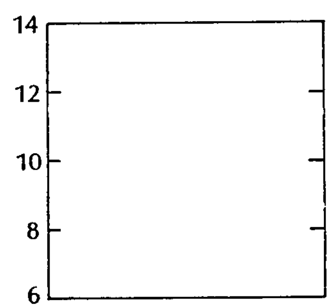
CONTINUOUS DATA ON DISCRETE SCALE
(not meaningful, do not use)

A scale can be continuous or discrete. Data can be continuous or discrete. Care should be taken when plotting one type of data to a different type of scale. The first example shows continuous data plotted on a continuous scale as for a daily hydrograph. Example 2 shows discrete data plotted on a discrete scale and example 3 shows discrete data plotted on a continuous scale. Either example could be used to plot mean monthly water levels. Example 4 shows continuous data plotted on a discrete scale which is mathematically impossible and should not be used.



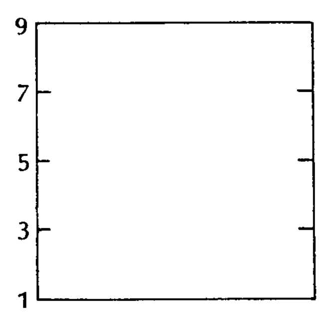
CORRECT

Zero shown on graph



CORRECT

Note: If scale were extended
zero would be on graph



INCORRECT

If scale is extended zero will not
appear on graph with this division

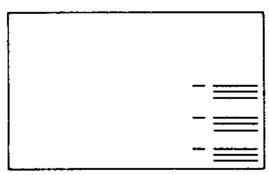
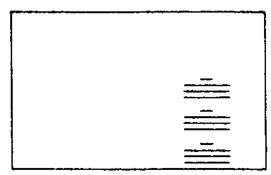
WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.:	Effective Date: 3/15/74	Article No.: 3.10.1

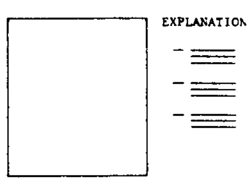
Subject: ILLUSTRATIONS -- Explanations - Graphs and diagrams[1]

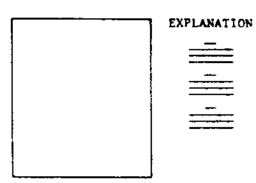
Generally on graphs and diagrams, every effort should be made to label the data lines, points, or areas directly on the graph or diagram. When space limitations prohibit the labeling of the data directly, explanations should be used.

The preferred placement of the explanation is within the graph or diagram. The preferred format is the same as for map explanations with the description to the right of the data sample. If space limitations prohibit the use of the preferred format, the description can be placed below the data sample. The word "EXPLANATION" should not be used with these formats.

If the explanation must be placed outside the graph or diagram, it should be placed to the right of the graph or diagram, the word "EXPLANATION" should be used, and the description should be to the right of the data sample, if possible. Placing the description below the data sample is acceptable.





Cross reference: 3.10.2 Explanations - Maps

[1]Computer graphics will follow the same standards as cited in this publication.

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

In Reply Refer To:
WGS-Mail Stop 445

March 9, 1987

WATER RESOURCES DIVISION MEMORANDUM NO. 87.36

Subject: PUBLICATIONS--Computer Graphics Publication Standards: X-Y Plots and Time-Series Plots

I am pleased to announce that additional publication-quality graphics are now available. Computer-generated x-y and time-series plots that meet publications standards have been developed by Alan Lumb of the Office of Surface Water, working with the Computer Graphics Publications Standards Workgroup. These plots are generated by the 1987 release of ANNIE--an interactive computer program for the management and analysis of hydrologic data. To obtain the computer program and documentation that produced these plots, please contact Kate Flynn at FTS 959-5313, or send E-MAIL to KMFLYNN@RVARES. Examples of the x-y and time-series plots are attached to this memorandum.

Previous to this announcement, a bar chart and geophysical log plot were distributed in WRD Memorandum No. 86.53 and 86.108, respectively. If further information about publication-quality computer graphics is needed, please call Gloria Stiltner at FTS 959-5616 or send E-MAIL to GJSTILTNER@QVARSA.

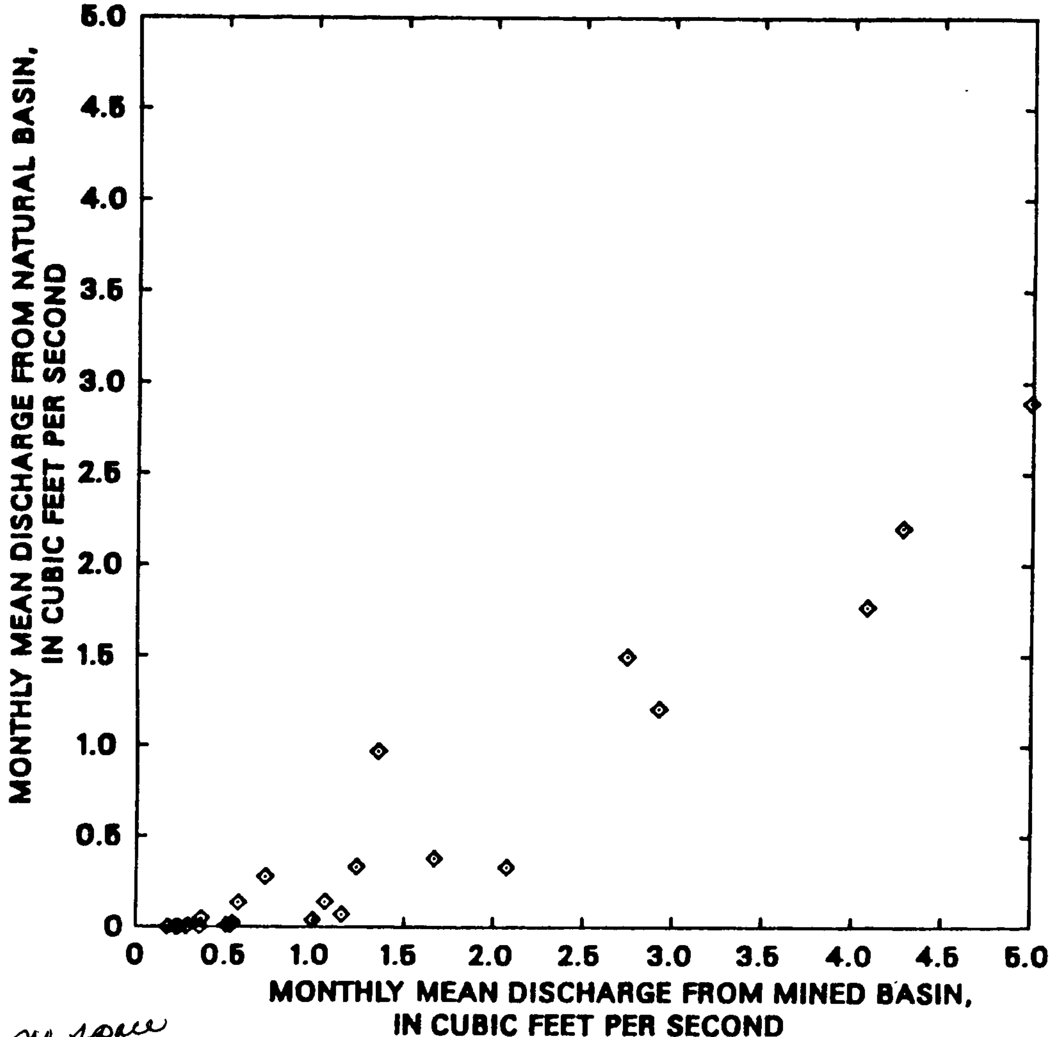
James F. Daniel

James F. Daniel
Assistant Chief Hydrologist
for Scientific Information Management

Attachments

WRD Distribution: A, B, S, FO, PO

This memorandum supersedes WRD Memorandum No. 86.108.



*Note: no space needed here or here

Figure 1. -- Relation between monthly mean discharges in natural and mined basins, Sandlick Creek, West Virginia, water years 1981-82.

3 line figure titles should show 2nd and successive lines indented 2 spaces with text beginning under "g" in the word figure

*Figure title should be centered under the baseline of the graph

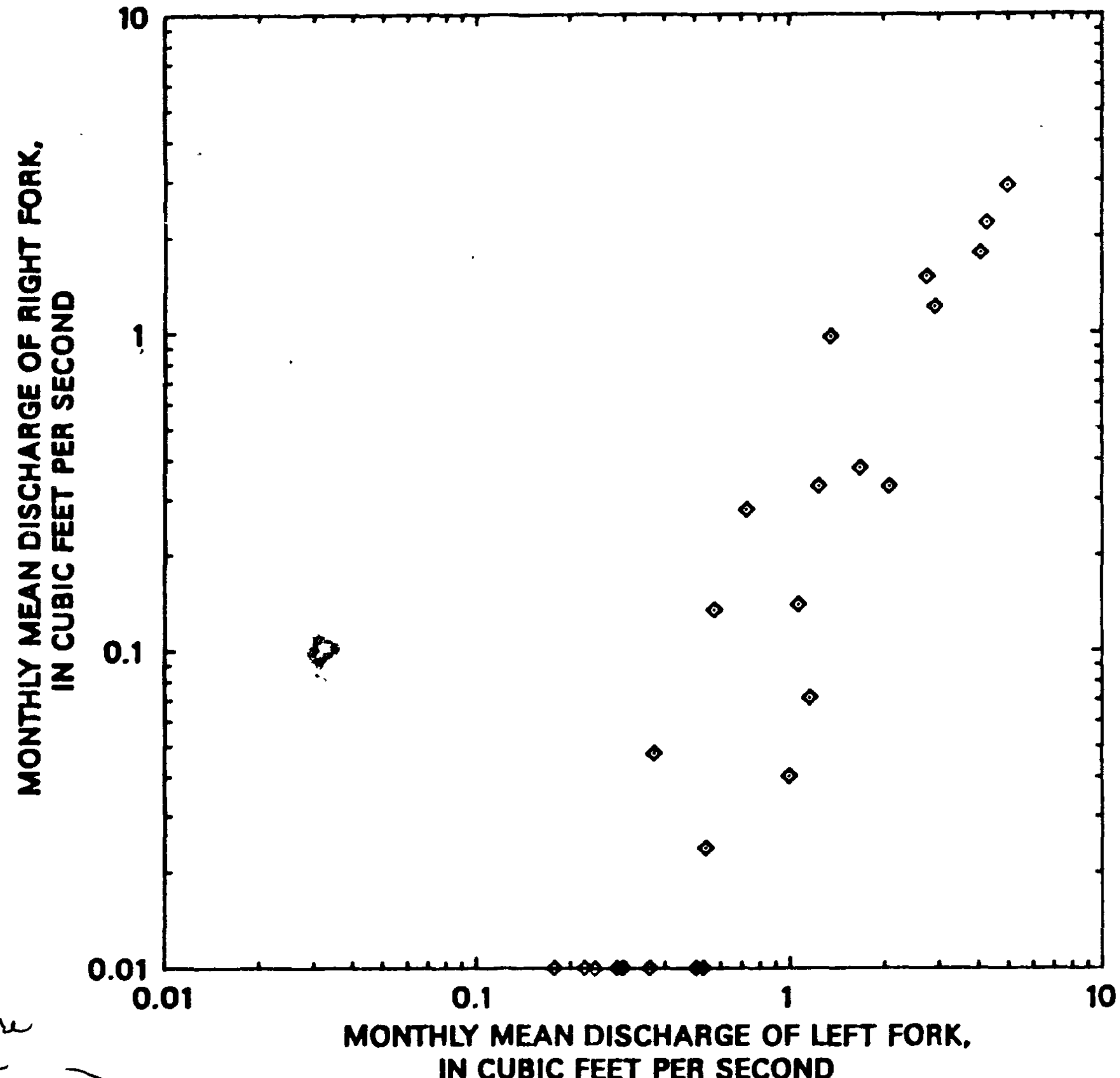
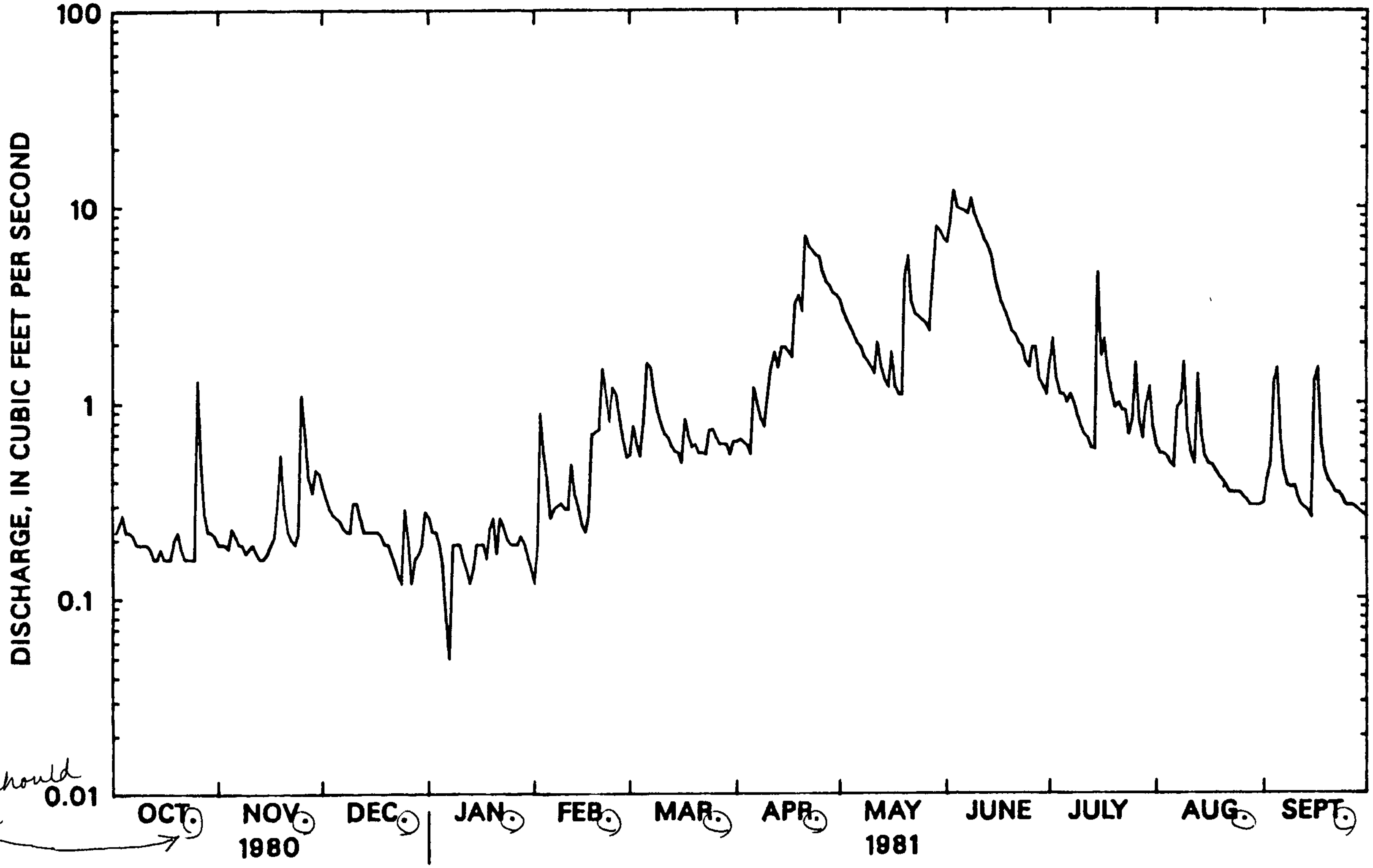


Figure 2. -- Relation between monthly mean discharges in Right and Left forks of Sandlick Creek, West Virginia, water years 1981-82.

* If Right and Left are capitalized the word forks should be also or all should be lower-case.

* See comments on figure 1.



* Period should be placed after an abbreviation

Figure 3. -- Discharge, Left Fork Sandlick Creek, West Virginia, water year 1981.

* No space needed here or here

* Center figure title beneath baseline of graph

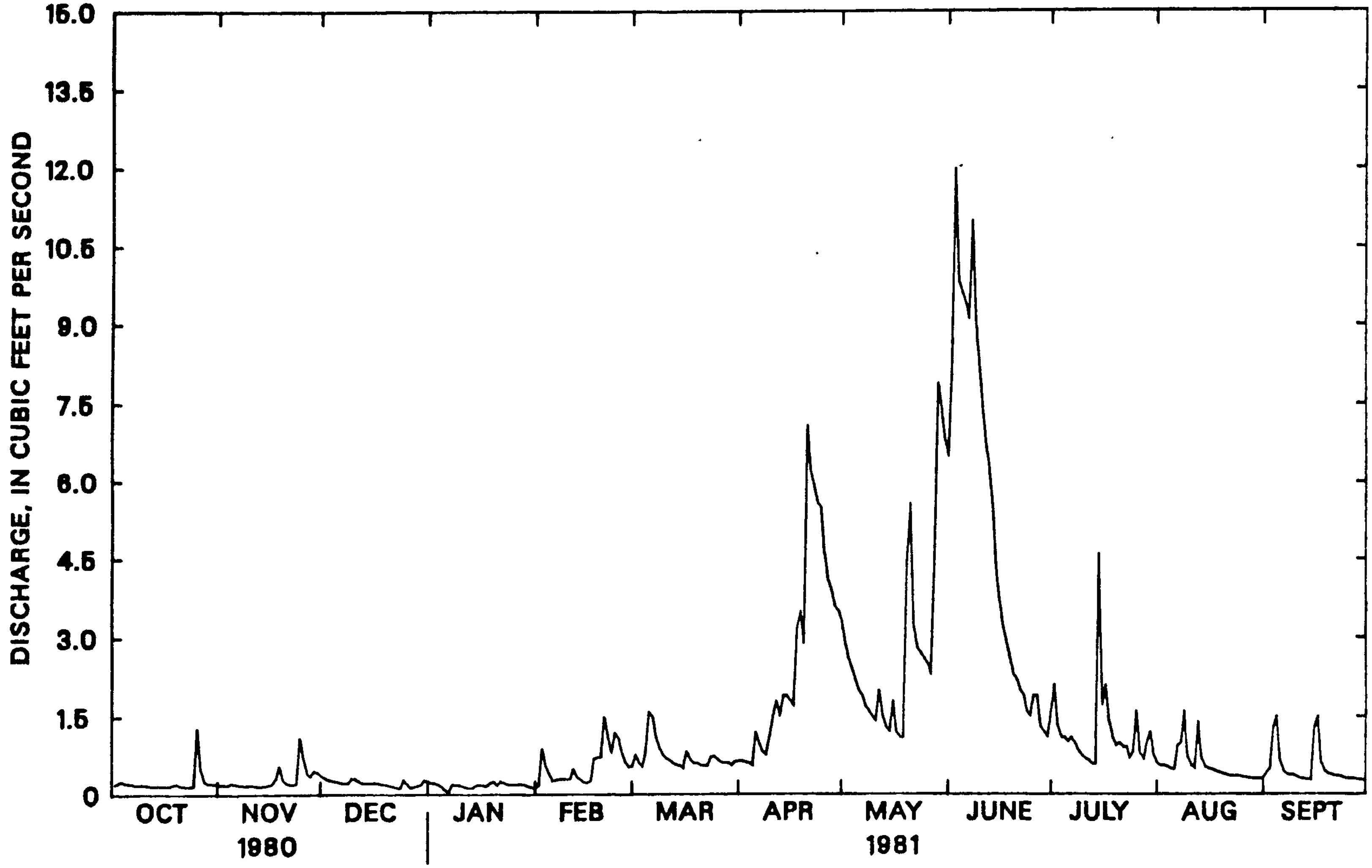
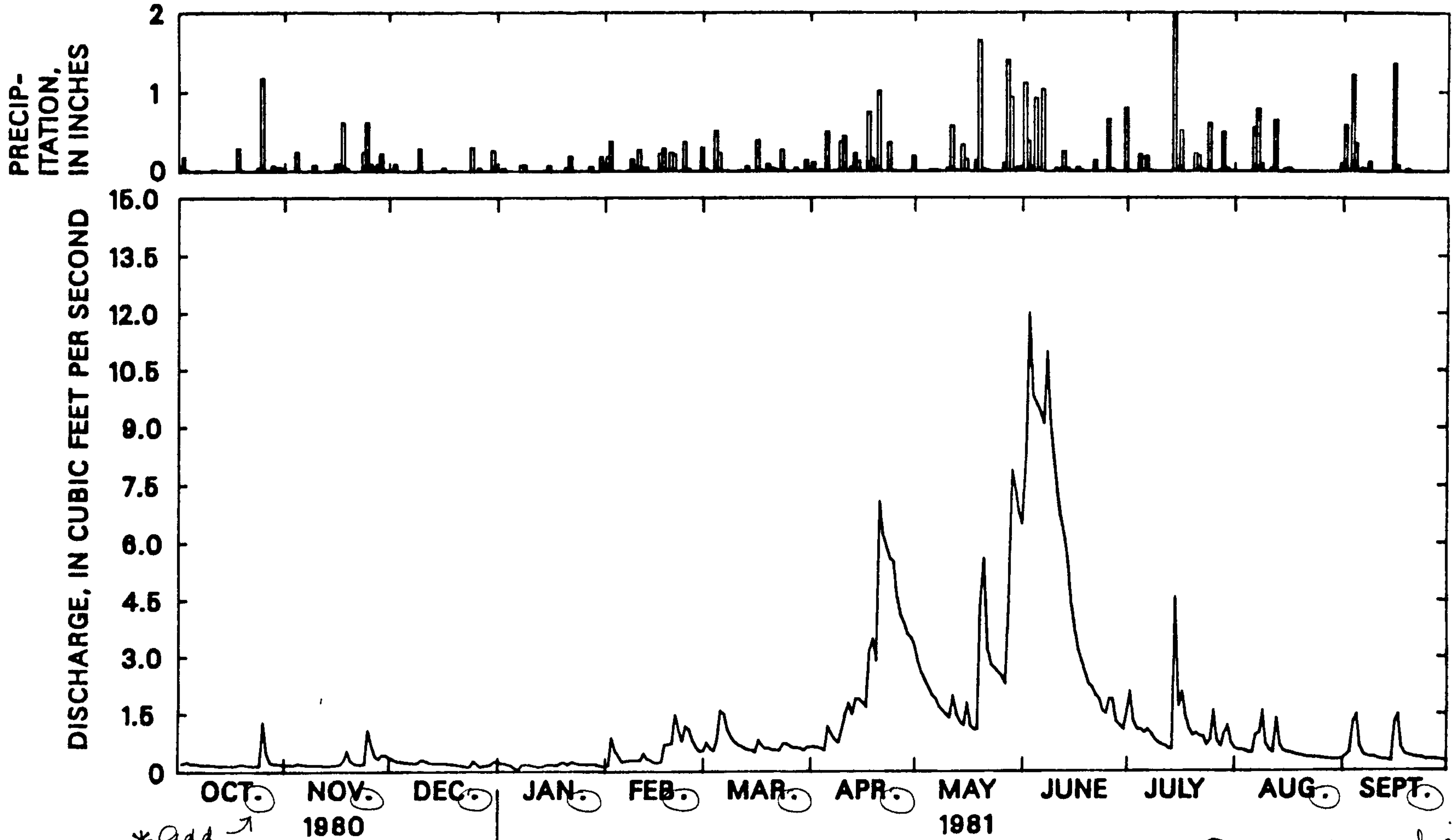


Figure 4. -- Discharge, Left Fork Sandlick Creek, West Virginia, water year 1981.

* See comments on figure 3.



*Add ↗

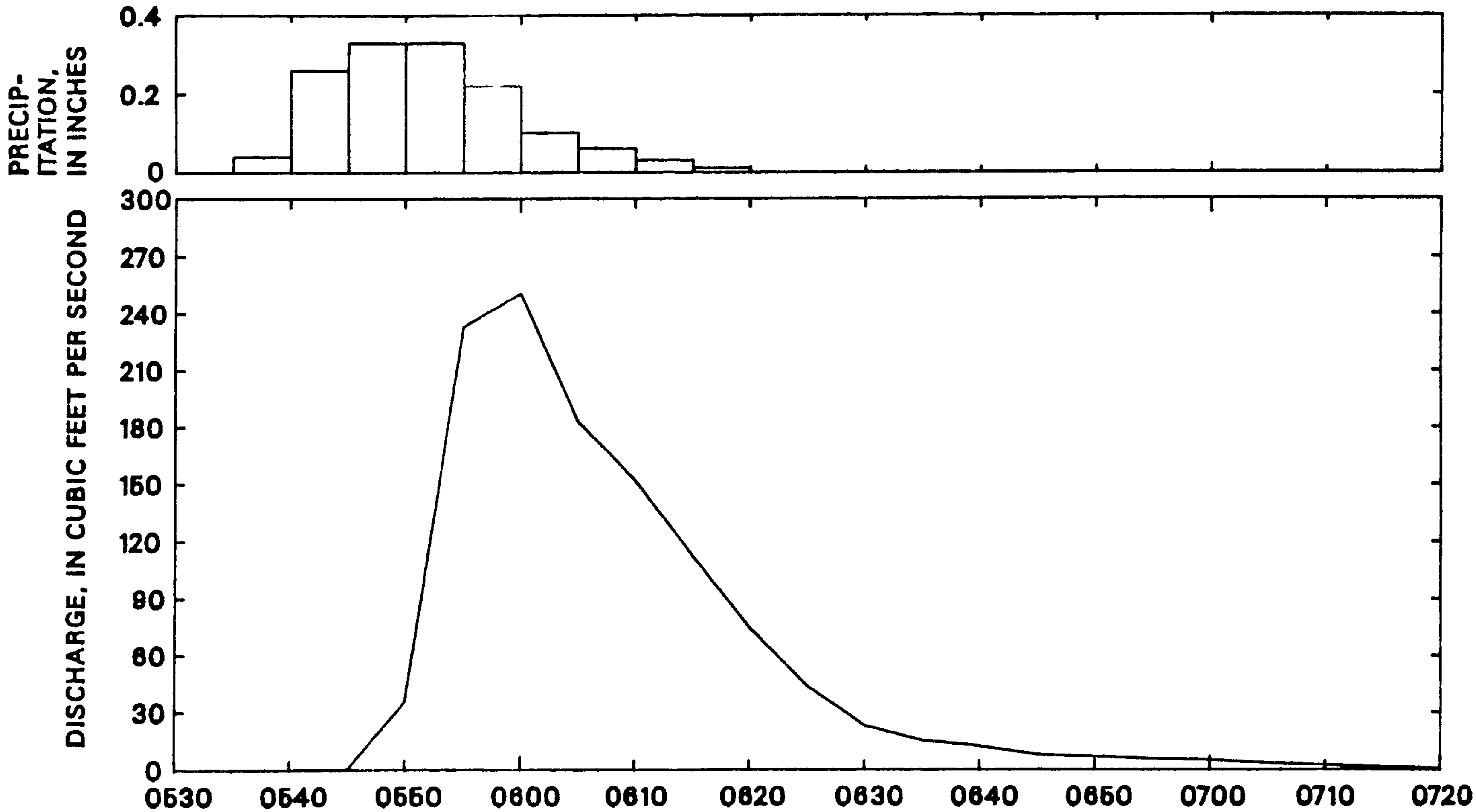
Figure 5. -- Discharge, Left Fork Sandlick Creek, and precipitation at
Left Fork Sandlick Creek, West Virginia, water year 1981.

2-line figure title

2nd line should be centered under 1st line

*No space needed here or here

*Center figure title under baseline of graph



JULY 30, 1974

& [TIME, IN HOURS] 24-HOUR TIME

Figure 6. -- Discharge of Sand Creek, and precipitation at Denver, Colorado, on July 30, 1974.

* See comments on figure 5.

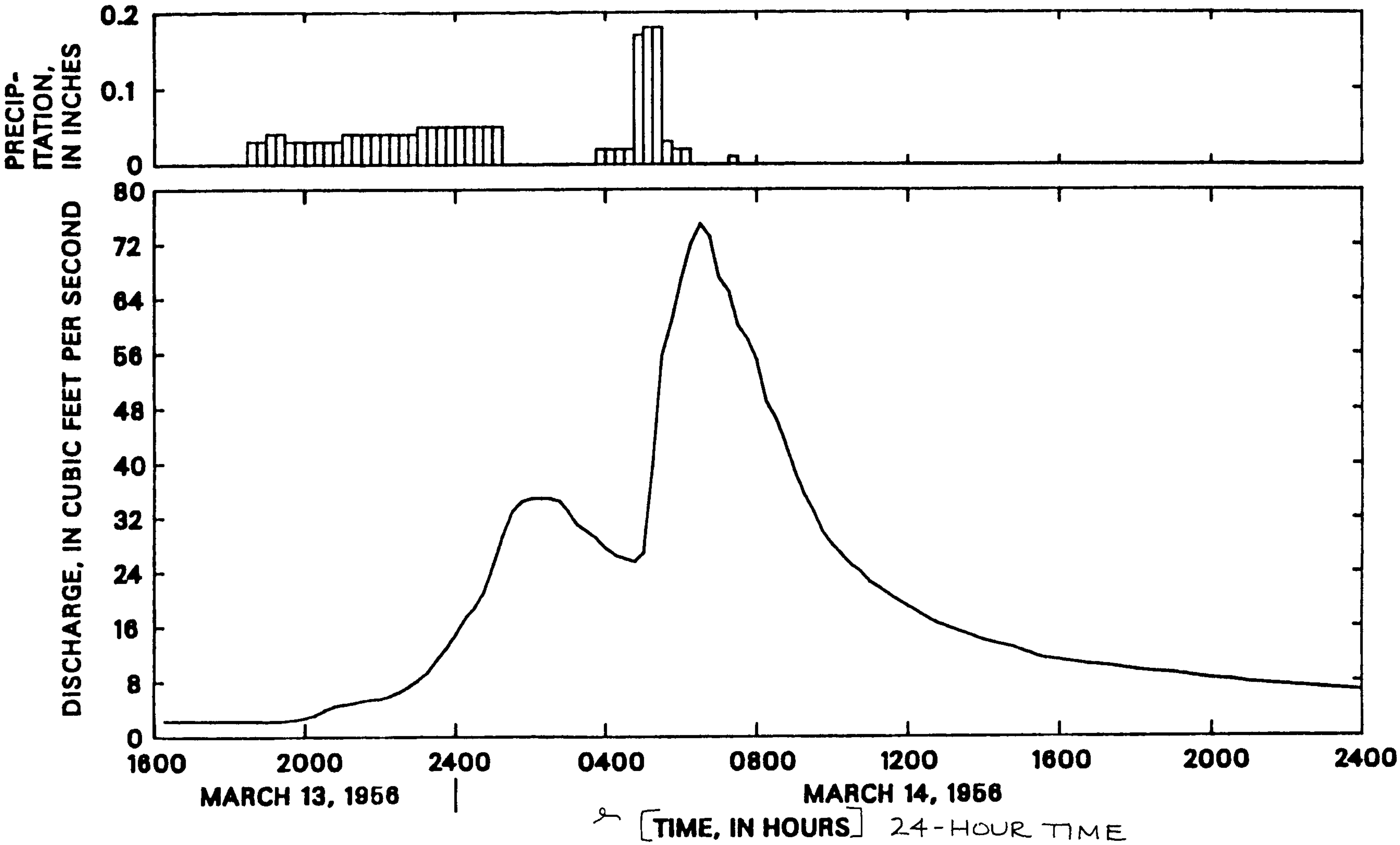


Figure 7. -- Discharge, Cane Branch, and precipitation at Cane Branch, Kentucky, March 13-14, 1956.

* See comments on figure 5.

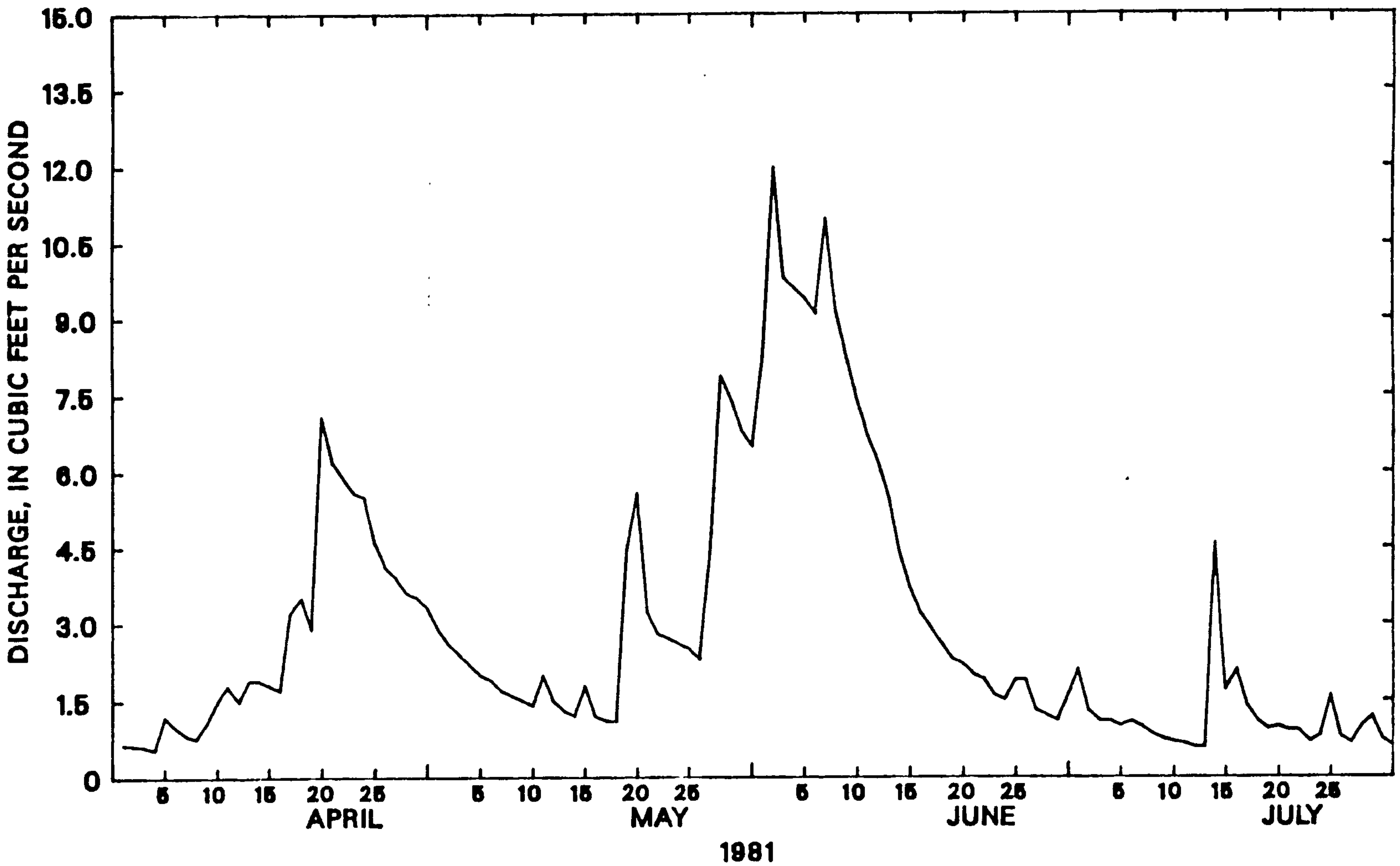


Figure 8. -- Discharge, Left Fork Sandlick Creek, West Virginia, April-July, 1981.

* See comments on figure 5.

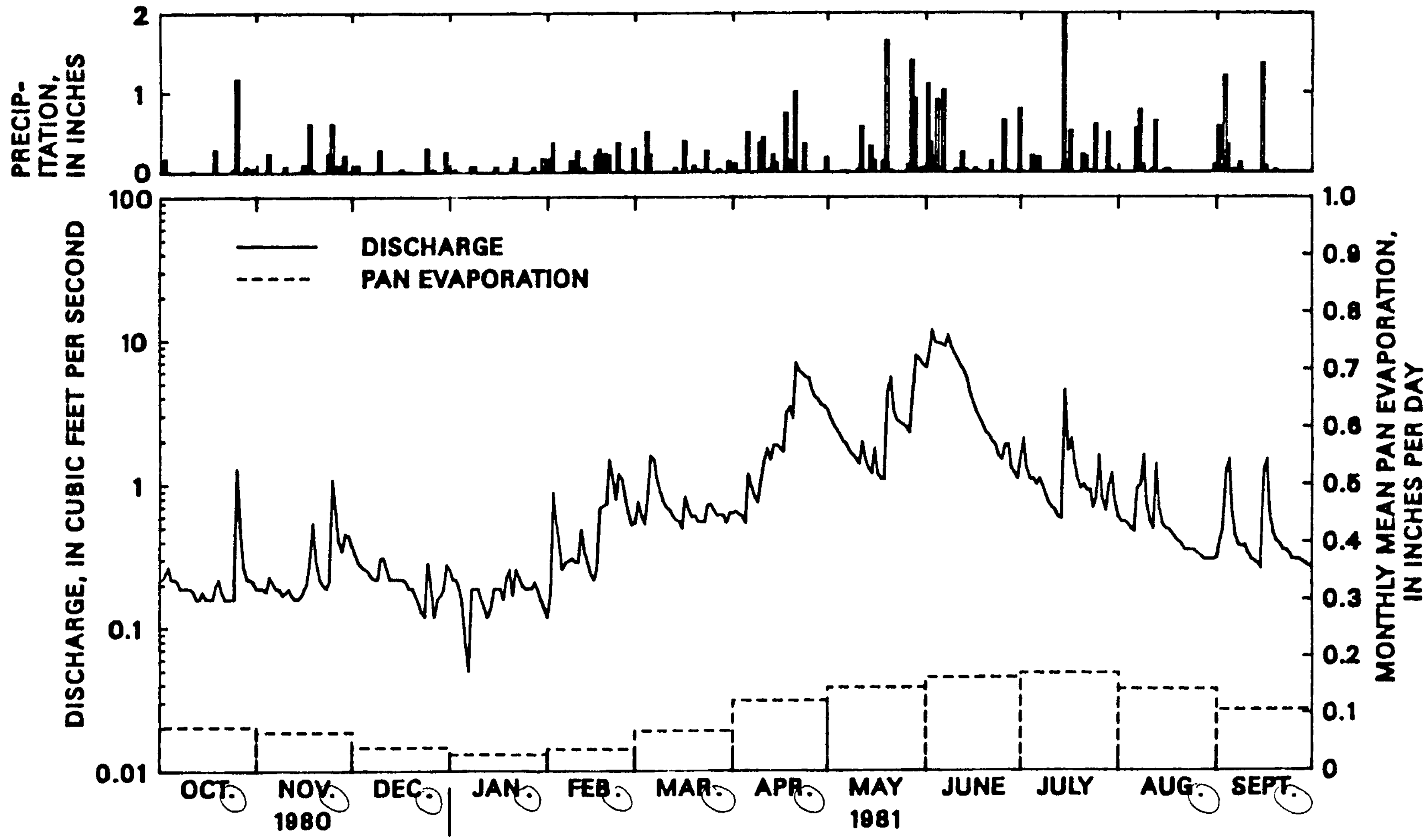


Figure 9. -- Discharge of Left Fork Sandlick Creek, and precipitation and pan evaporation at Bluestone Lake, West Virginia, for water year 1981.

* See comments on figure 1.

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

In Reply Refer To:
WGS-Mail Stop 445

September 15, 1986

WATER RESOURCES DIVISION MEMORANDUM NO. 86.108

Subject: PUBLICATIONS--Computer Graphics Publications Standards--
Geophysical Log Plot

This is the second plot which has been developed through the Computer Graphics Publications Standards Workgroup. This plot, which meets publications standards, was developed by Stan Leake of the Arizona District. A copy is attached to this memorandum, and the computer program that developed this plot and related documentation has been placed in the SOFTEX library on the Prime computer. The reference number is AZSAL00001, and the name is PLOT.GEO.PUB.

If further information about this plot or the workgroup is needed, please call Gloria Stiltner at FTS 959-5616, or send E-MAIL to GJSTILTNER@QVARSA.

James F. Daniel
James F. Daniel
Assistant Chief Hydrologist
Scientific Information Management

Attachment

Distribution: A, B, S, FO, PO

This memorandum supersedes no previous WRD Memorandum.

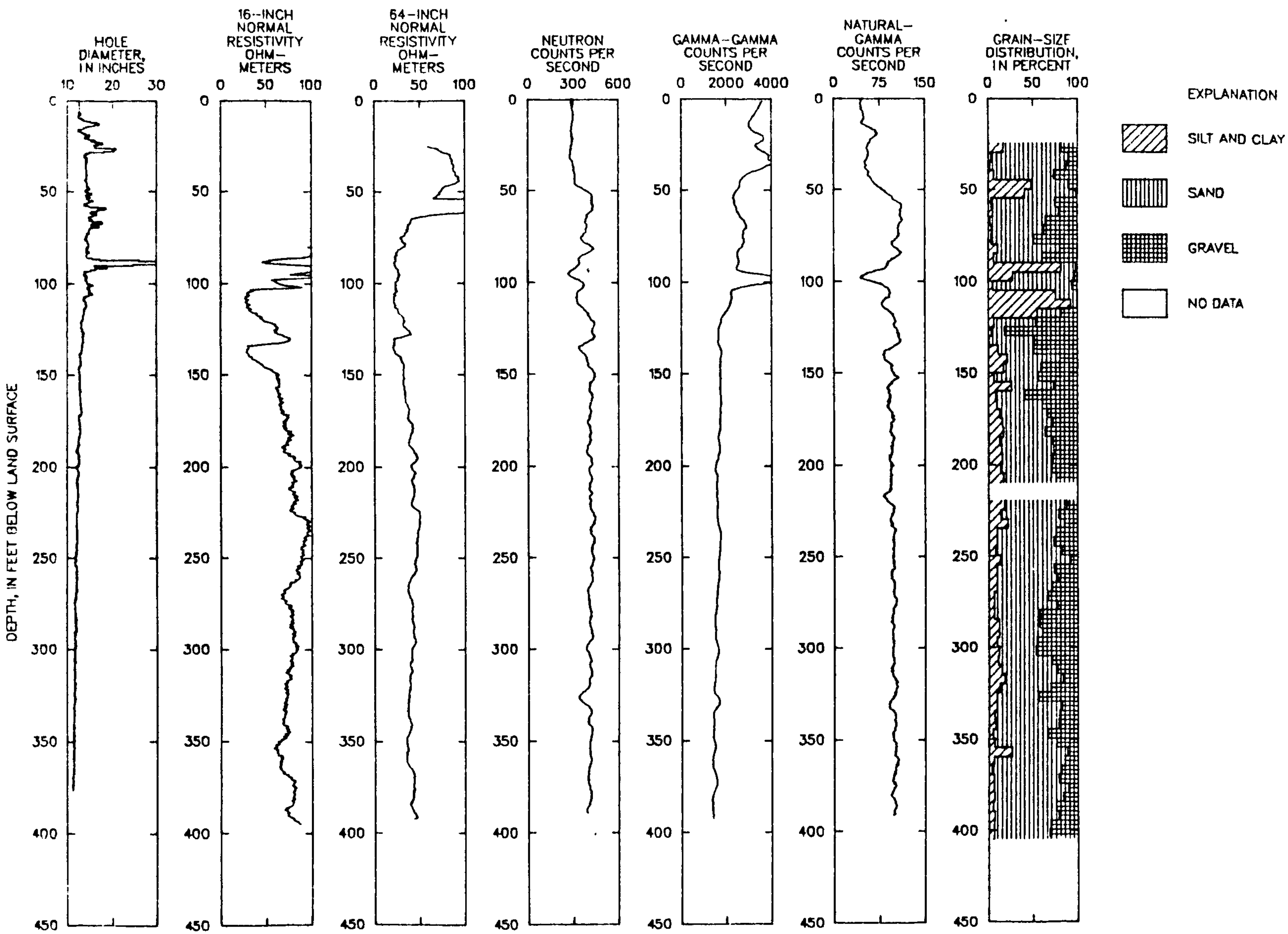


Figure 1.-- Geophysical logs for well SF-19.

*Center figure title

United States Department of the Interior

GEOLOGICAL SURVEY
RESTON, VA. 22092

In Reply Refer To:
WGS-Mail Stop 440

April 14, 1986

WATER RESOURCES DIVISION MEMORANDUM NO. 86.53

Subject: PUBLICATIONS--Computer Graphics Publications Standards Work Group

The subject work group has been formed to produce computer-generated graphics that will meet publications standards and then make the computer programs available to users.

The work group members have been addressing issues of publications standards such as (1) position of text and labels, (2) point size and style of type, and (3) acceptability of output for reproduction. The process has been to generate, critique, revise, and document examples.

The group is currently working on gathering and critiquing examples of the four most commonly used x-y plots in WRD. These are the arithmetic x-y, logarithmic, semi-logarithmic and probability plots. The group has generated, critiqued and produced examples of a bar chart that meets publication standards. A copy is attached to this memorandum and the computer program that developed this plot has been placed in the SOFTEX library on the PRIME computer. The reference number is VATCW00009 and the name is PLOT.BAR.PUB. Other programs will be made available as they are completed.

The work group feels that while we are successful using the graphics software TELLAGRAF and DISSPLA we do parallel testing using a Computer Aided Drafting (CAD) package for a microcomputer. This package would be directed toward graphic artists' needs.

If your unit is interested in this project and could commit time to do testing and experimentation, please call Gloria Stiltner at FTS 648-5616, or E-Mail GJSTILTNER@QVARSA.

Gary D Cobb

for James F. Daniel
Assistant Chief Hydrologist for
Scientific Information Management

Attachment

WRD Distribution: A, B, S, FO, PO

This memorandum does not supersede any previous WRD memorandum

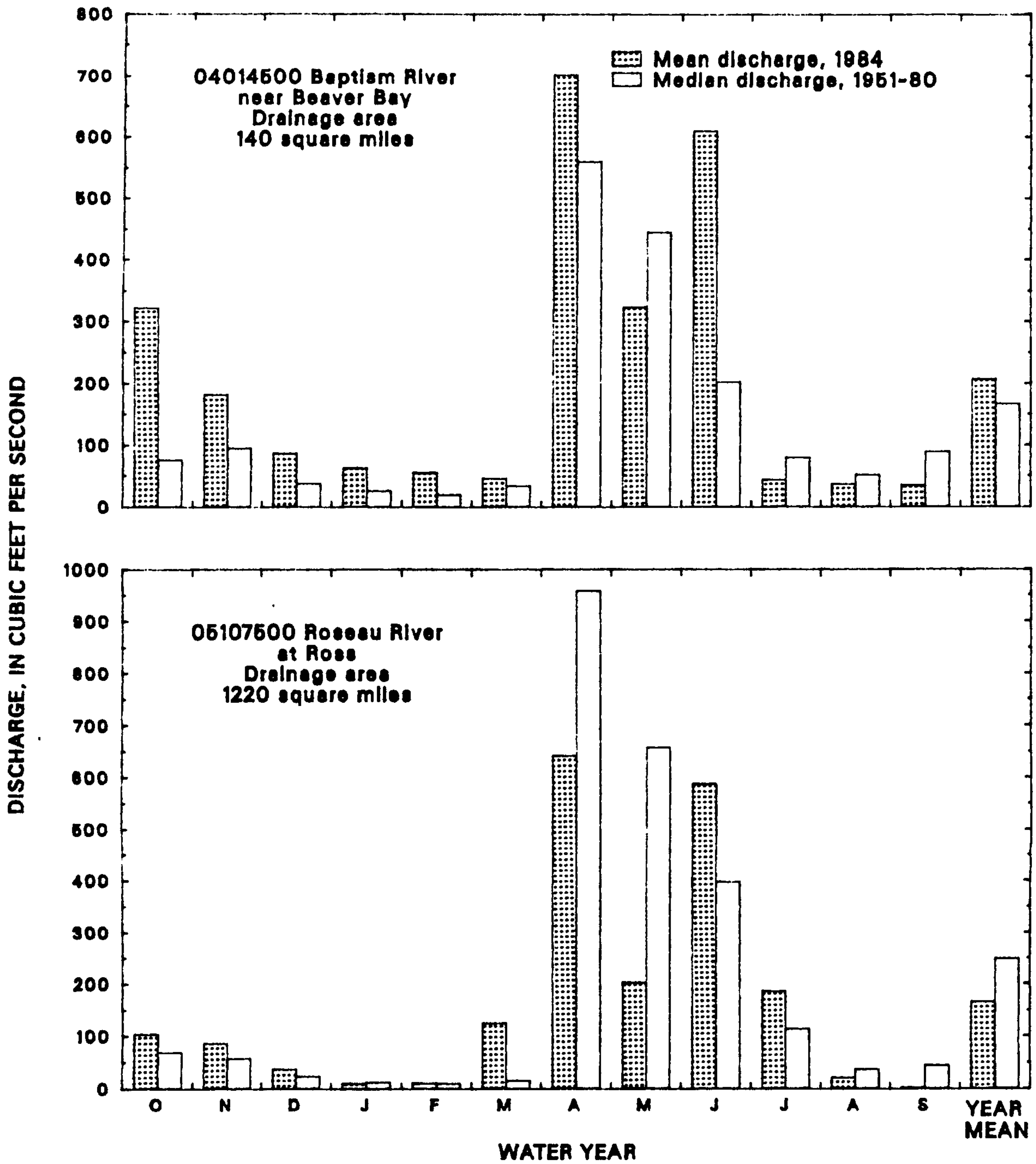


Figure 2.--Comparison of discharge at two long-term representative gaging stations for the 1984 water year with a median discharge for a 30-year base period.

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces 3.1 Article No. Dated 5/4/64 | Effective Date: 5/20/71 | Article No.: 4.01.1

Subject: BASE MAPS -- General information

"Base map" may be defined as a map upon which specialized data are placed to show relations or distribution. The Water Resources Division uses a wide variety of base maps, among which are the following:

Planimetric:	Shows culture, drainage, and land net.
Topographic:	Shows culture, drainage, land net, and <u>topographic</u> <u>contours</u>.
Drainage:	Shows drainage features and land net.
Orthophotograph:	A cartographically accurate "photomap" showing all physical and cultural features. It looks like an aerial photograph.
Aerial photomosaic:	Shows all physical features, but the scale is variable and measurements are not accurate.

Base maps may be from many sources, for example:

Standard Survey maps at various scales.[1]
Maps from other Federal agencies.
State maps. Some States have the best available maps of local areas.
County maps. Most States have County highway maps, usually planimetric. In some areas, these maps are the best available.
Copyrighted private maps are rarely used, but may be used if necessary. In such a case, permission to publish must be obtained from the author and (or) publisher.
Preparation of new maps from aerial photography to suit the project. This is costly, time consuming, and rare.

[1]If map has metric units and it is published in English, show metric units in parentheses.

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No. 4.02.1 Dated 5/20/71 | Effective Date: 9/12/74 | Article No.: 4.02.1

Subject: BASE MAPS -- Criteria for selecting base maps

The selection of a suitable base map is an important function of the Project Chief. Careful consideration in this selection may save much time and money both in the field office and in later preparation for printing. The Project Chief may get assistance from the District and Regional staffs as well as from State officials and the Geohydrologic Map Editor.

A map should be selected according to readability, accuracy, density of data (already on it and to be added), ease of compilation, and economy of preparation. In choosing the most suitable base, therefore, the Project Chief must weigh these factors:

1. Project area
2. Purpose of the project
3. Density of data
4. Degree of quantitative measurement planned
5. Breakdown of data
6. Scale of the map
7. Printing press sizes
8. Availability of maps

The project area is of prime concern. If the report deals with a river basin, the map must cover at least the entire basin. If the report deals with the geomorphology of an unnamed creek near a small town, a more detailed base map may be needed.

The purpose of the project commonly is the most important single factor in base-map selection. If the map is to show the location of gaging stations, a drainage map (showing streams, lakes, and land net or coordinates) will suffice. If the location of wells is of importance, a planimetric or topographic base will be more useful to both the compiler and the map user.

Commonly the map is designed to show the location of gages, wells, or other data points. Most of the time a planimetric map is sufficient, and indeed it is less cluttered than a topographic map of the same area. If a series of simple maps is contemplated, the maps will be printed in black and white. If it is necessary to compare various parameters such as the salt water-fresh water interface in relation to geologic formations, then several color separations should be planned. For some maps of high complexity, color-separated bases may be necessary. (*Permission is necessary from Pubs Management Unit to publish in color.)

The density of data will influence the selection of the scale for the map. If there are only widely scattered wells in a large county, a 1:24,000-scale map is scarcely needed; 1:250,000 might be more suitable.

The degree of quantitative measurement planned is not merely a consideration, it is an important factor. As the Division scientists and engineers investigate the "basin approach" to hydrology, they find that the configuration of the basin must be known and that the accuracy of water-budget determinations depends largely on the precision with which the configuration of the basin can be depicted. The type of map projection and the degree of topographic detail will affect the accuracy of measurement of areas and shapes. The location of topographic features will be facilitated by accurate topographic contours. Water-table mapping and subsurface measurements of key beds or bedrock are commonly dependent on the accuracy of the base map because the errors introduced by the plotting of data on poor base maps may be significant. If a generalized reconnaissance type of project is intended in an area of little potential development, the base map need not be elaborate or accurate in every detail. In summary, if the quantitative measurements are in any way dependent on the accuracy of the map, the base map should be the best available.

The breakdown of data can affect the type of base map desired and the total number of base maps needed. Planimetric one-color maps at 1:250,000 may be suitable for showing the location of principal physiographic features, or of scattered wells or sampling sites. Yet in one municipal area a nitrate-contamination problem may require that the scale be 1:24,000 and that topographic contours be added. In this instance the base map needed can be for the entire project area at 1:24,000, or can be 1:250,000 for the entire project with a supplemental base map of the municipal area at 1:24,000.

There are times when the advantage of compiling several water-table maps of the same area (for different time periods) on the same base far outweighs the slight saving in printing cost that would accrue by using a smaller map for one set of sparse data.

The scale of the map should be a standard Survey scale, when possible (following table). Exceptions must be justified.

Scales for typical base maps are given below; source is U.S. Geological Survey except as noted.

United States	1:2,500,000 1:3,168,000 1:5,000,000
States	1:500,000 1:1,000,000
Counties	Various scales (local agencies)
Quadrangles	1:250,000 1:62,500 1:63,360 (Alaska) 1:24,000 1:20,000 (Puerto Rico)

Maps are designed for readability at a certain scale; when we change the scale, many features become illegible (by reduction) or overpowering (by enlargement). Therefore, scale changes of more than a factor of 2 require redrafting or rescribing. The rescribing of bases is rare but is done chiefly where small-scale maps must be combined with larger scale mosaics to complete a map of the area of study.

Survey maps now carry the kilometre scale as well as the mile scale (article 3.09.1). The kilometre scale is added in final drafting; it need not be drafted in the field.

Printing press sizes are the ultimate determinant of the size of any illustration.

The availability of maps of the type needed for compilation and publication should be sought by the Project Chief during the initial phases of a project. Because the Project Chief may not know of specific maps that have been prepared but not yet published, preliminary inquiry should be made of the Geohydrologic Map Editor at the National Center, Reston, Va. or the Southeastern Region Cartographic Clearinghouse, Nashville, Tenn.

Cross reference: 3.09.1 Maps - Base credit

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 10/5/73 | Article No.: 3.09.3

Subject: ILLUSTRATIONS -- Maps - Base features

1. Symbols for base features of maps in publications of the U.S. Geological Survey must follow the Topographic Division's symbolism. Scribed bases should also follow the Topographic Division's established line weights.*

2. Maps that show topographic or bathymetric contours must have contour-interval and datum notes. These notes are placed below the map scale. Example:

   CONTOUR INTERVAL 50 FEET
   NATIONAL GEODETIC VERTICAL DATUM OF 1929

3. Contour intervals must be identified when more than one contour interval exists on the same base map. Sample contour-interval notes are:

   CONTOUR INTERVALS 25 AND 50 FEET

   CONTOUR INTERVALS 40, 50, AND 80 FEET

   CONTOUR INTERVAL 50 FEET

   DOTTED LINES REPRESENT 10-FOOT CONTOURS

   CONTOUR INTERVAL 10 FEET IN EASTERN PART
   OF MAP AND 20 FEET IN WESTERN PART

   If the base map contains more than three contour intervals and the contours are in feet, the contour-interval note should read:

   CONTOUR INTERVAL, IN FEET, IS VARIABLE

4. All geographic place names that are mentioned in the report and occur within the areas mapped in the report must be shown on the maps.

5. The size of the lettering used for place names should be proportional to the physical size of the features in relation to one another and to their importance in the report. For example, the principal river in a basin would have the largest lettering, tributary streams would have smaller lettering, and so forth.

6. All hydrologic features on a base map normally are identified by slant lettering and all other features are identified by upright lettering. Styles of lettering similar to that used by the Topographic Division should be followed if the base map will contain customized lettering.

*See pages 73, 74, and 75.

7. The words "railroad" and "railway" are not generally used on maps; the railroad name, such as Great Northern, is sufficient. However, the words are included where they are part of a descriptive label or proper (formal) name, such as Railroad of New Jersey, Logging Railroad, U.S. Government Railroad, and The Alaska Railroad.

8. Symbols for base features generally are not shown in the map explanation. However, any symbol for a base feature that might not be recognized should be labeled on the map.

References: Technical Standards Papers 2.05.1 and 3.09.1 of Publications Division.

Cross reference: 3.06.4 -- Symbols - Standard lineweights for scribing.

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.: | Effective Date: 10/5/73 | Article No.: 3.09.2

Subject: ILLUSTRATIONS -- Maps - Land grids

1. Types of grids -- All maps, except those covering very small areas such as plane-table maps, should have a land grid. Grids that can be used on maps are latitude-longitude, township and range, or State-developed grids. Maps should be oriented, when possible, so that north is at the top of the sheet.

2. Latitude-longitude grid -- Maps that are to be in reports of the U.S. Geological Survey, except as noted above, must have a latitude-longitude grid. It is recommended that maps to be used in non-Survey reports have a latitude-longitude grid.

   Latitude is the angular distance, measured in degrees, north or south from the equator. The equator is at zero degrees latitude and each pole is at 90 degrees latitude. Thus, latitude lines are horizontal and increase northward for maps of the United States.

   Longitude is the angular distance, measured in degrees, east or west of the standard or prime meridian, which passes through Greenwich, England. Longitude ranges from zero degrees at the prime meridian to 180 degrees in either direction from the prime meridian. Thus, longitude lines are vertical and increase westward for maps of the United States.

   A. When geographic projections are divided into multiples of full degrees, do not use zero-minute (00') values after the degree values.

   B. When geographic projections are divided into units of less than full degrees, use degree values on the coordinates at or nearest the corners of the maps and where the degree value changes. Degree values should be omitted from all other coordinates; however, see item 2F.

   C. Never use zero-second (00") values.

   D. When values for minutes or seconds are less than 10, use a zero before the number only when that number is preceded by degrees or minutes. Example: 7', 37°07', 42°07'05".

   E. If a map has a skewed projection (the north direction of the map is not toward the top of the sheet), the grid numbers should be aligned in the same direction as the grid lines unless a neatline intervenes. (A neatline is the line that encloses all illustrations, explanations, and text material on plates or on sheets of map reports; thus, a neatline is the border of a map.)

F. If a map has an irregular shape and the reader might have difficulty reading the grid-coordinate values, the degree values can be retained on all grid coordinates.

G. On maps that are small in physical size, such as index maps, the grid coordinates need be labeled on only two sides, preferably the top and left sides. Maps that are large in physical size should be labeled on all four sides.

H. Topographic Division practices should be followed when labeling the grids: $7\frac{1}{2}$-minute quadrangles should be labeled at each $2\frac{1}{2}$-minute division, and 15-minute quadrangles should be labeled at each 5-minute division. When a base is reduced to 50 percent of its original size, alternate grid numbers should be eliminated. If a base is enlarged to double its original size, intermediate grid numbers may be added.

3. Township and range grid -- This Federal land-measurement grid establishes townships of approximately 36 square miles, 6 miles to a side. Each township is identified numerically in a system of base lines and principal meridians. The tiers of townships are numbered consecutively north or south of the base line as "Township 1 North, Township 2 North, Township 1 South, and so forth." The rows of townships are numbered consecutive east or west of the principal meridian as "Range 1 East, Range 1 West, and so forth." Each section (approximately 1 square mile) within a township is labeled numerically from the northeast corner to the southeast corner:

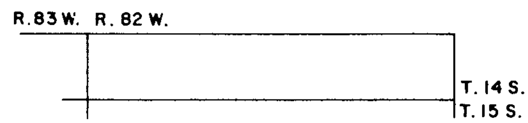
6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

The following States or Commonwealths do not have a township and range grid:

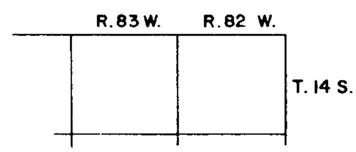
Connecticut
Delaware
Georgia
Hawaii
Kentucky
Maine
Massachusetts
New Hampshire
New Jersey
New York
North Carolina
Ohio (parts)
Pennsylvania
Rhode Island
Puerto Rico
South Carolina
Tennessee
Texas
Vermont
Virginia
West Virginia

The latitude-longitude grid used in conjunction with the township and range grid (where available) is recommended for both Survey and non-Survey reports.

A. On standard (7½- and 15-minute) topographic maps and other maps where the land grid is widely spaced, the township and range numbers should be set opposite each other at the boundaries. For example:



B. On maps where the land grid is narrowly spaced, the township and range numbers should be centered between the townships.



C. Township and range numbers appearing outside the body of the map should include periods after the letter designations (such as T.3 S. and R.1 W.); those appearing inside the body of the map should not include periods after the letter designations (such as T 3 S and R 1 W).

D. Township numbers should be stacked (number aligned vertically) only when used on small figures or on maps where space does not permit them to be placed horizontally.

4. State-developed grids -- These grids can be used on maps in any report if the grid is explained in the report text or in the base-credit note.

References: Technical Standards Papers 2.03.2 and 2.03.3 of Publications Division.

BRANCH OF TECHNICAL ILLUSTRATIONS
TECHNICAL STANDARDS SECTION

Replaces T.S. Paper	Dated 7/8/64	Effective Date	6/30/68	T.S. Paper No.	2.03.2
Subject:	BASE MAPS - Labeling Grid Coordinates on Base Maps*				

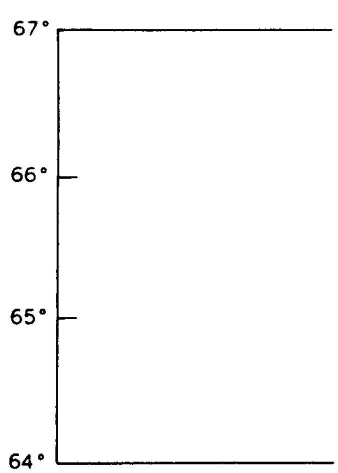
If grid coordinate type must be added to the base maps the following Topographic Division practices will be followed for labeling the grids: 7½ minute quadrangles should be labeled at each 2½ minute division, 15 minute quadrangles should be labeled at each 5 minute division. When the base is reduced to 50% original size the alternate grid numbers should be eliminated. If the base is enlarged to double the original size, intermediate grid numbers may be added.

The grid values will be added with the following rules kept in mind:

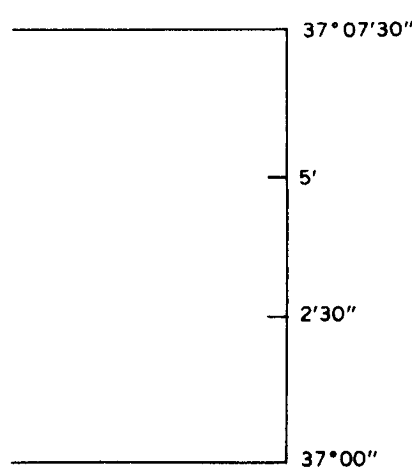
1. When geographic projections are divided into multiples of full degrees, do not use minute (00') values. (See example 1).
2. When geographic projections are divided into units of less than full degrees, use degree values on the coordinates at the corners and where there is a change in degree value. (See example 2).
3. Never use zero seconds (00").
4. When values for minutes or seconds are less than 10, use a zero before the number only when that number is preceded by degrees or minutes.

4°05' 5" 103°02'30" 27'30" 7'30"

EXAMPLE 1

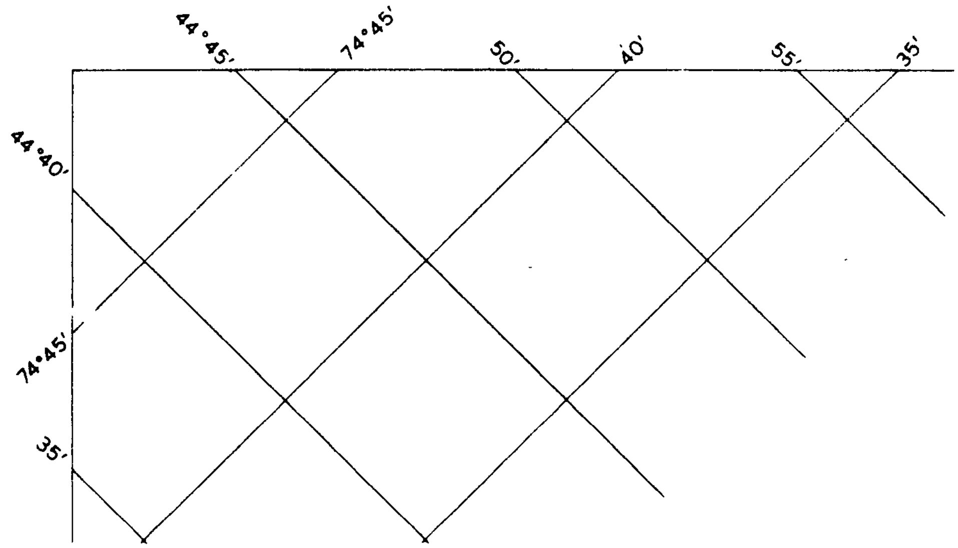


EXAMPLE 2

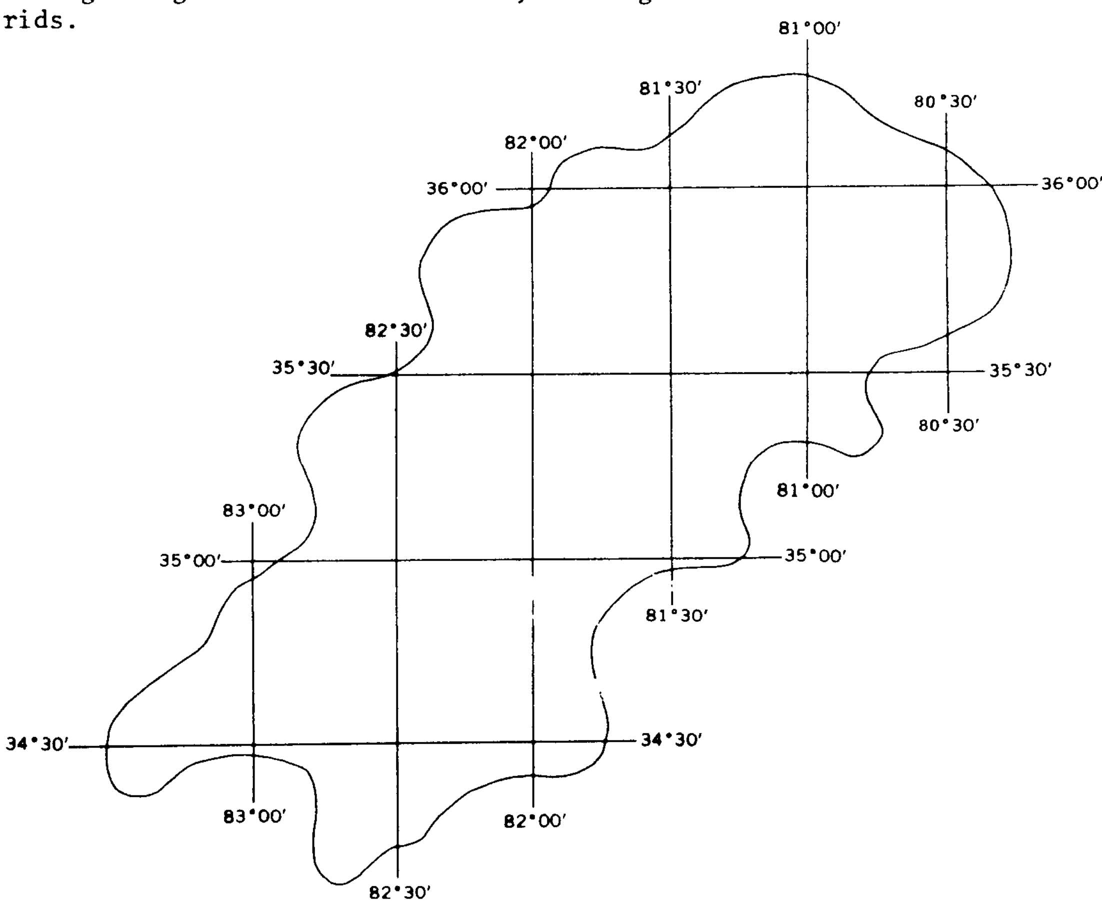


*See page 43.

5. When there is a skewed projection on a large-scale map the grid numbers should be aligned in the same direction as the grid line. It is emphasized that grid values for complete small-scale maps such as the 1:2,500,000 base map shall continue to be aligned with the map border and sheet edge.



6. When a map has an irregular shaped base and the viewer might have difficulty reading the grid coordinate values, the degree values can be retained on all grids.



WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.:

Effective Date: 10/5/73

Article No.: 3.09.6

Subject: ILLUSTRATIONS -- Maps - North arrow and magnetic declination

The addition of a north arrow and (or) magnetic declination to a map is not automatic but is dependent on the scale of the map and the information shown on the map.

A. Principal maps in map reports and plates in book reports

The standard north arrow with magnetic declination will be used on all quadrangle maps (maps having topographic contours) with scales from 1:20,000 through 1:125,000. The words "TRUE NORTH" and "MAGNETIC NORTH" should appear along the shafts of the respective arrows and the notation "APPROXIMATE MEAN DECLINATION, 19__" should be beneath the arrows. The magnetic declination is indicated by number, to the nearest whole degree, between the arrow tips.

The standard north arrow with magnetic declination should be centered between the base-credit note and the map scale below the south border of the map. On irregular-shaped maps or where proper placement is not possible, place the magnetic declination in the lower left area of the map or beneath the map explanation.

If the map covers more than 1 degree (30 minutes in Alaska) of latitude or longitude, the standard north arrow should not be used. On these maps, or on maps having scales between 1:125,000 and 1:500,000, a variable magnetic-declination note, of the same wording as on the base map, should be placed below the topographic contour datum note. A variable magnetic-declination note is not required on maps covering large areas where the scale number is 1:500,000 or greater.

B. Secondary maps in map reports and text figures in book reports

Maps having a latitude-longitude grid, wherein north is at the top of the page, do not need a magnetic or north arrow. Maps skewed so that north is not at the top of the page should have a north arrow in addition to a latitude-longitude grid. A north arrow should be added to maps having land grids other than latitude-longitude.

Reference: Technical Standards Paper 3.06.1 of Publications Division.

Cross reference: 3.09.2 -- Maps - Land grids

WATER RESOURCES DIVISION
PUBLICATIONS GUIDE

Replaces Article No.:	Effective Date: 10/5/73	Article No.: 3.09.1

Subject: ILLUSTRATIONS -- Maps - Scales

1. All maps must have a scale.

2. Standard publication scales used by the U.S. Geological Survey are:

1:20,000 (Puerto Rico only)	1:250,000
1:24,000	1:500,000
1:48,000	1:1,000,000
1:62,500	1:2,500,000
1:63,360 (Alaska only)	1:3,168,000
1:125,000	1:5,000,000

Other acceptable publication scales are:

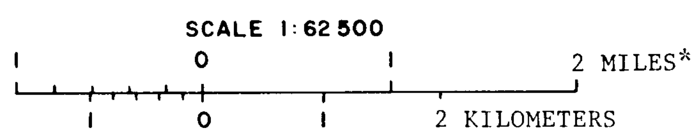
1:12,000	1:96,000
1:16,000	1:750,000
1:18,000	1:2,000,000
1:31,680	

3. Base maps for text figures designed to fit a fixed page size* in a book report or a column width in a book or map report need not be prepared at one of the scales listed above. However, if a scale listed above is compatible with the fixed page size or column width, the maps should be prepared at that scale.

4. Base maps that are prepared for plates in a book report or for principal maps in a map report should be prepared at one of the scales listed above.

5. Bar scales are used on all multicolor maps and on those monochrome (one color or shades of one color) maps that use topographic quadrangles as the source of the base map. Both the English (mile, foot) and the metric (kilometer, meter) scales are shown separately. The English scale is placed above the metric scale, except for maps of foreign countries and Puerto Rico where the order is reversed.

6. Rake scales are used on all monochrome maps that do not use topographic quadrangles as the source of the base map. Rake scales are also used on index maps and on maps designed for a fixed page size or text column width. All rake scales will combine English units with corresponding metric units onto one scale, with the English units placed above the metric units. An example of a combined English and metric scale follows:



*Scales should be divided in equal divisions of English and metric units.

*See page 52.

7. The fractional-scale notation (for example, SCALE 1:62 500) should be shown above the bar or rake scale only if the map is at one of the standard or acceptable scales listed above. A comma is not included in the number to the right of the colon when placed on the map.

8. The letters of the units of measure (for example, MILES) should be placed to the right of the largest number on the scale in all capital letters.

9. Bar or rake scales used for plates or principal maps should be subdivided to the left of zero into logical increments of the first unit of the right-hand measure. The length of the scale to the left of zero should be about 1 inch. The units to the right of zero are not subdivided.

10. Scales for index maps and maps fitted for a fixed page size or column width should start at zero. No divisions should occur to the left of zero.

11. The length of any scale should be proportional to the size of the map under which it appears. The scale length should be approximately a third the width of the map but not longer than 7 inches.

12. Map scales can be prepared from the following conversion table, which was compiled for plotting map scales and vertical scales on sections. Only one column was prepared for the metric information as 1 kilometer is equivalent to 1,000 meters.

FRACTIONAL SCALE	INCHES PER MILE	INCHES PER 1,000 FEET	INCHES PER KILOMETER
1:500	126.72	24.00	78.74
1:600	105.60	20.00	65.62
1:1,000	63.36	12.00	39.37
1:1,200	52.80	10.00	32.81
1:1,500	42.24	8.00	26.25
1:2,000	31.68	6.00	19.68
1:2,400	26.40	5.00	16.40
1:2,500	25.34	4.80	15.75
1:3,000	21.12	4.00	13.12
1:3,600	17.60	3.33	10.94
1:4,000	15.84	3.00	9.84
1:4,800	13.20	2.50	8.20
1:5,000	12.67	2.40	7.87
1:6,000	10.56	2.00	6.56
1:7,000	9.05	1.714	5.62
1:7,200	8.80	1.668	5.47
1:7,920	8.00	1.517	4.97
1:8,000	7.92	1.500	4.92
1:8,400	7.54	1.429	4.69
1:9,000	7.04	1.333	4.37
1:9,600	6.60	1.250	4.10
1:10,000	6.34	1.200	3.94
1:10,800	5.87	1.112	3.65
1:12,000	5.28	1.000	3.28
1:13,200	4.80	0.909	2.98
1:14,400	4.40	0.833	2.73
1:15,000	4.22	0.800	2.62

FRACTIONAL SCALE	INCHES PER MILE	INCHES PER 1,000 FEET	INCHES PER KILOMETER
1:15,600	4.06	0.769	2.52
1:15,840	4.00	0.757	2.48
1:16,000	3.96	0.750	2.46
1:16,800	3.77	0.714	2.34
1:18,000	3.52	0.667	2.19
1:19,200	3.30	0.625	2.05
1:20,000	3.17	0.600	1.97
1:20,400	3.11	0.588	1.93
1:21,120	3.00	0.568	1.86
1:21,600	2.93	0.556	1.82
1:22,800	2.78	0.527	1.73
1:24,000	2.64	0.500	1.64
1:25,000	2.53	0.480	1.57
1:31,680	2.00	0.379	1.24
1:48,000	1.319	0.250	0.82
1:50,000	1.267	0.240	0.79
1:62,500	1.013	0.1920	0.62
1:63,360	1.000	0.1895	0.62
1:75,000	0.844	0.1600	0.52
1:96,000	0.659	0.1250	0.41
1:100,000	0.634	0.1200	0.39
1:125,000	0.507	0.0960	0.32
1:126,720	0.500	0.0948	0.31
1:200,000	0.317	0.0600	0.19
1:250,000	0.253	0.0480	0.15
1:253,440	0.250	0.0473	0.15
1:400,000	0.1583	0.0300	0.10
1:500,000	0.1267	0.0240	0.08
1:506,880	0.1250	0.0237	
1:750,000	0.0844	0.01600	
1:1,000,000	0.0634	0.01200	
1:1,013,760	0.0625	0.01183	
1:1,500,000	0.0422	0.00800	
1:1,680,000	0.0377	0.00714	
1:2,000,000	0.0317	0.00600	
1:2,500,000	0.0253	0.00480	
1:3,000,000	0.0211	0.00400	
1:3,168,000	0.02000	0.00379	
1:3,500,000	0.01809	0.00343	
1:4,000,000	0.01583	0.00300	
1:4,500,000	0.01407	0.00267	
1:5,000,000	0.01267	0.00240	
1:6,000,000	0.01054	0.00200	
1:7,000,000	0.00904	0.001715	
1:8,000,000	0.00792	0.001500	
1:9,000,000	0.00703	0.001333	
1:10,000,000	0.00634	0.001200	
1:11,000,000	0.00577	0.001092	
1:12,000,000	0.00527	0.001000	
1:13,000,000	0.00487		
1:14,000,000	0.00452		
1:15,000,000	0.00422		
1:16,000,000	0.00396		
1:17,000,000	0.00372		
1:18,000,000	0.00352		
1:19,000,000	0.00333		
1:20,000,000	0.00317		
1:21,000,000	0.00302		
1:22,000,000	0.00288		
1:23,000,000	0.00276		
1:24,000,000	0.00264		
1:25,000,000	0.00254		

References: Technical Standards Papers 3.07.1, 3.07.2, and 3.08.2 of Publications Division.