U.S. DEPARTMENT OF COMMERCE

WEATHER BUREAU

TECHNICAL PAPER NO. 52

TWO- TO TEN-DAY PRECIPITATION FOR RETURN PERIODS OF 2 TO 100 YEARS IN ALASKA

Weather Bureau Technical Papers

*No. 1. Ten-year normals of pressure tendencies and hourly station pressures for the United States. 1943.
*Supplement: Normal 3-hourly pressure changes for the United States at the intermediate synoptic hours. 1945.
No. 2. Maximum recorded United States point rainfall for 5 minutes to 24 hours at 207 first order stations. Rev. 1963. .40
*No. 3. Extreme temperatures in the upper air. 1947.
*No. 4. Topographically adjusted normal isohyetal maps for western Colorado. 1947.
*No. 5. Highest persisting dewpoints in western United States. 1948.
*No. 6. Upper air average values of temperature, pressure, and relative humidity over the United States and Alaska. 1945.
*No. 7. A report on thunderstorm conditions affecting flight operations. 1948.
*No. 8. The climatic handbook for Washington, D.C. 1949.
*No. 9. Temperature at selected stations in the United States, Alaska, Hawaii, and Puerto Rico. 1949.
No. 10. Mean precipitable water in the United States. 1949. .30
No. 11. Weekly mean values of daily total solar and sky radiation. 1949. .15. Supplement No. 1, 1955. .05.
*No. 12. Sunshine and cloudiness at selected stations in the United States, Alaska, Hawaii, and Puerto Rico. 1951.
No. 13. Mean monthly and annual evaporation data from free water surface for the United States, Alaska, Hawaii, and the West Indies. 1950. .15
*No. 14. Tables of precipitable water and other factors for a saturated pseudo-adiabatic atmosphere. 1951.
No. 15. Maximum station precipitation for 1, 2, 3, 6, 12, and 24 hours: Part I: Utah, Part II: Idaho, 1951, each .25; Part III: Florida, 1952, .45; Part IV: Maryland, Delaware, and District of Columbia; Part V: New Jersey, 1953, each .25; Part VI: New England, 1953, .60; Part VII: South Carolina, 1953, .25; Part VIII: Virginia, 1954, .50; Part IX: Georgia, 1954, .40; Part X: New York, 1954, 60; Part XI: North Carolina; Part XII: Oregon, 1955, each .55; Part XIII: Kentucky, 1955, .45; Part XIV: Louisiana; Part XV: Alabama, 1955, each .35, Part XVI: Pennsylvania, 1956, .65; Part XVII: Mississippi, 1956, .40; Part XVIII: West Virginia, 1956, .35; Part XIX: Tennessee, 1956, .45; Part XX: Indiana, 1956, .55; Part XXI: Illinois, 1958, .50; Part XXII: Ohio, 1958, .65; Part XXIII: California, 1959, $1.50; Part XXIV: Texas, 1959, $1.00; Part XXV: Arkansas, 1960, .50; Part XXVI: Oklahoma, 1961, .45.
*No. 16. Maximum 24-hour precipitation in the United States. 1952.
No. 17. Kansas-Missouri floods of June–July 1951. 1952. .60
*No. 18. Measurements of diffuse solar radiation at Blue Hill Observatory. 1952.
No. 19. Mean number of thunderstorm days in the United States. 1952. .15
No. 20. Tornado occurrences in the United States. Rev. 1960. .45
*No. 21. Normal weather charts for the Northern Hemisphere. 1952.
*No. 22. Wind patterns over lower Lake Mead. 1953.
No. 23. Floods of April 1952—Upper Mississippi, Missouri, Red River of the North. 1954. $1.00
No. 24. Rainfall intensities for local drainage design in the United States. For durations of 5 to 240 minutes and 2-, 5-, and 10-year return periods. Part I: West of 115th meridian. 1953, .20; Part II: Between 105° W. and 115° W. 1954. .15
*No. 25. Rainfall intensity-duration-frequency curves. For selected stations in the United States, Alaska, Hawaiian Islands, and Puerto Rico. 1955.
No. 26. Hurricane rains and floods of August 1955, Carolinas to New England. 1956. $1.00
*No. 27. The climate of the Matanuska Valley. 1956.
*No. 28. Rainfall intensities for local drainage design in western United States. For durations of 20 minutes to 24 hours and 1- to 100-year return periods. 1956.
No. 29. Rainfall intensity-frequency regime. Part 1—The Ohio Valley, 1957, .30; Part 2—Southeastern United States, 1958, $1.25; Part 3—The Middle Atlantic Region, 1958, .30; Part 4—Northeastern United States, 1959, $1.25; Part 5—Great Lakes Region, 1960, $1.50.
No. 30. Tornado deaths in the United States. 1957. .50
*No. 31. Monthly normal temperatures, precipitation, and degree days. 1956.
No. 32. Upper-air climatology of the United States. Part 1—Averages for isobaric surfaces, height, temperature, humidity, and density, 1957, $1.25; Part 2—Extremes and standard deviations of average heights and temperatures, 1958, .65; Part 3—Vector winds and shear, 1959. .50
No. 33. Rainfall and floods of April, May, and June 1957 in the South-Central States. 1958. $1.75
No. 34. Upper wind distribution statistical parameter estimates. 1958. .40
No. 35. Climatology and weather services of the St. Lawrence Seaway and Great Lakes. 1959. .45
No. 36. North Atlantic tropical cyclones. 1959. $1.00
No. 37. Evaporation maps for the United States. 1959. .65
*No. 38. Generalized estimates of probable maximum precipitation for the United States west of the 105th meridian for areas to 400 square miles and durations to 24 hours. 1960.
No. 39. Verification of the Weather Bureau's 30-day outlook. 1961. .40
No. 40. Rainfall frequency atlas of the United States for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. 1961. $1.25
No. 41. Meridional cross sections, upper winds over the Northern Hemisphere. 1961. $4.25
No. 42. Generalized estimates of probable maximum precipitation and rainfall-frequency data for Puerto Rico and Virgin Islands. 1961. .50
No. 43. Rainfall-frequency atlas of the Hawaiian Islands for areas to 200 square miles, durations to 24 hours, and return periods from 1 to 100 years. 1962. .40
No. 44. A catalog of 100 FCC-positioned transosonde flights. 1962. $2.00
No. 45. Snowmelt floods of March–April 1960, Missouri and Upper Mississippi Basins. 1962. $1.25
No. 46. Atmospheric electric measurement results at Mauna Loa Observatory. 1962. $1.25
No. 47. Probable maximum precipitation and rainfall-frequency data for Alaska for areas to 400 square miles, durations to 24 hours, and return periods from 1 to 100 years. 1963. $1.00
No. 48. Characteristics of the hurricane storm surge. 1963. .70
No. 49. Two- to ten-day precipitation for return periods of 2 to 100 years in the contiguous United States. 1964. $1.00
No. 50. Frequency of Maximum water equivalent of March snow cover in North-Central United States. 1964. .25
No. 51. Two- to ten-day rainfall for return periods of 2 to 100 years in the Hawaiian Islands. 1965. (In press)

*Out of print.

Weather Bureau Technical Papers are for sale by Superintendent of Documents
U.S. Government Printing Office, Washington, D.C. 20402

U.S. DEPARTMENT OF COMMERCE
JOHN T. CONNOR, Secretary

WEATHER BUREAU
ROBERT M. WHITE, Chief

TECHNICAL PAPER NO. 52

TWO- TO TEN-DAY PRECIPITATION FOR RETURN PERIODS OF 2 TO 100 YEARS IN ALASKA

Prepared by

JOHN F. MILLER

Special Studies Branch, Office of Hydrology, U.S. Weather Bureau
for
Engineering Division, Soil Conservation Service, U.S. Department of Agriculture

WASHINGTON, D.C.

1965

For Sale by the Superintendent of Documents, U.S. Government Printing Office, Washingon, D.C., 20402, Price 60 cents

U.S. DEPARTMENT OF COMMERCE
JOHN T. CONNOR, Secretary

WEATHER BUREAU
ROBERT M. WHITE, Chief

TECHNICAL PAPER NO. 52

TWO- TO TEN-DAY PRECIPITATION FOR RETURN PERIODS OF 2 TO 100 YEARS IN ALASKA

Prepared by

JOHN F. MILLER

Special Studies Branch, Office of Hydrology, U.S. Weather Bureau

for

Engineering Division, Soil Conservation Service, U.S. Department of Agriculture

WASHINGTON, D.C.

1965

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., 20402, Price 60 cents

PREFACE

Authority. This report was prepared for the Soil Conservation Service to provide generalized rainfall information for planning and design purposes in connection with its Watershed Protection and Flood Prevention Program (authorization: P.L. 566, 83rd Congress, and as amended).

Scope. Precipitation data for various hydrologic design problems involving areas up to 400 square miles and durations from 2 to 10 days are presented. The data consist of generalized estimates of rainfall-frequency data for return periods from 2 to 100 years.

Accuracy of results. The degree of accuracy of the generalized estimates depicted on the precipitation-frequency maps presented in this report is believed to be adequate for most engineering purposes. The accuracy of the results obtained is greater than might be expected from the approximately 100 stations used since the approach involved the use of the 24-hour rainfall-frequency maps of *Technical Paper No. 47* [1] as a base. The 24-hour maps were constructed using data from about 250 stations.

Acknowledgments. The project was under the general supervision of J. L. H. Paulhus, Manager, Water Management Information Division of the Office of Hydrology, W. E. Hiatt, Director. W. E. Miller and N. S. Foat supervised the collection and processing of the basic data. Coordination with the Soil Conservation Service was maintained through H. O. Ogrosky, Chief, Hydrology Branch, Engineering Division.

CONTENTS

LIST OF ILLUSTRATIONS

TWO- TO TEN-DAY PRECIPITATION FOR RETURN PERIODS OF 2 TO 100 YEARS IN ALASKA

1. INTRODUCTION

"Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska," [1] presents generalized estimates of rainfall-frequency data for durations from 30 minutes to 24 hours and return periods from 1 to 100 years. The present report is an extension of that work. In a series of maps and diagrams this report provides generalized estimates of the precipitation-frequency regime of Alaska for durations from 2 to 10 days and for return periods from 2 to 100 years.

A relation for obtaining 2-year 10-day precipitation from 24-hour data was developed. The 2-year 24-hour values of [1] were used in this relation to obtain the 2-year 10-day precipitation map (fig. 29). This map was used in combination with a 100-year to 2-year 10-day ratio map (fig. 7) to obtain the 100-year 10-day precipitation map (fig. 34). The 2-year and 100-year 10-day maps, together with the 24-hour maps from [1] were then used with generalized duration and return-period interpolation diagrams to provide estimates for a 1720-point grid for 22 additional maps.

2. BASIC DATA

Summarization of data. First, daily data from 36 stations were summarized into sequences from 1 to 10 days. The stations (solid square symbols in fig. 1) were so distributed geographically as to represent the various precipitation regimes. These data were the basis for testing the duration- and return-period—interpolation diagrams. One- and 10-day data were then summarized for 49 additional Alaskan and 8 Canadian stations. The locations of the Alaskan stations are shown as open squares in figure 1. The latter data were used to supplement the data from the first group of 36 stations to develop the relation between 1- and 10-day amounts.

Period and length of record. Data for the 36 stations in the first category were tabulated for the 43-year period, 1920–62. However, there were relatively few stations in operation during the entire period. The average length of record available from these stations was 29 years. Data for the 57

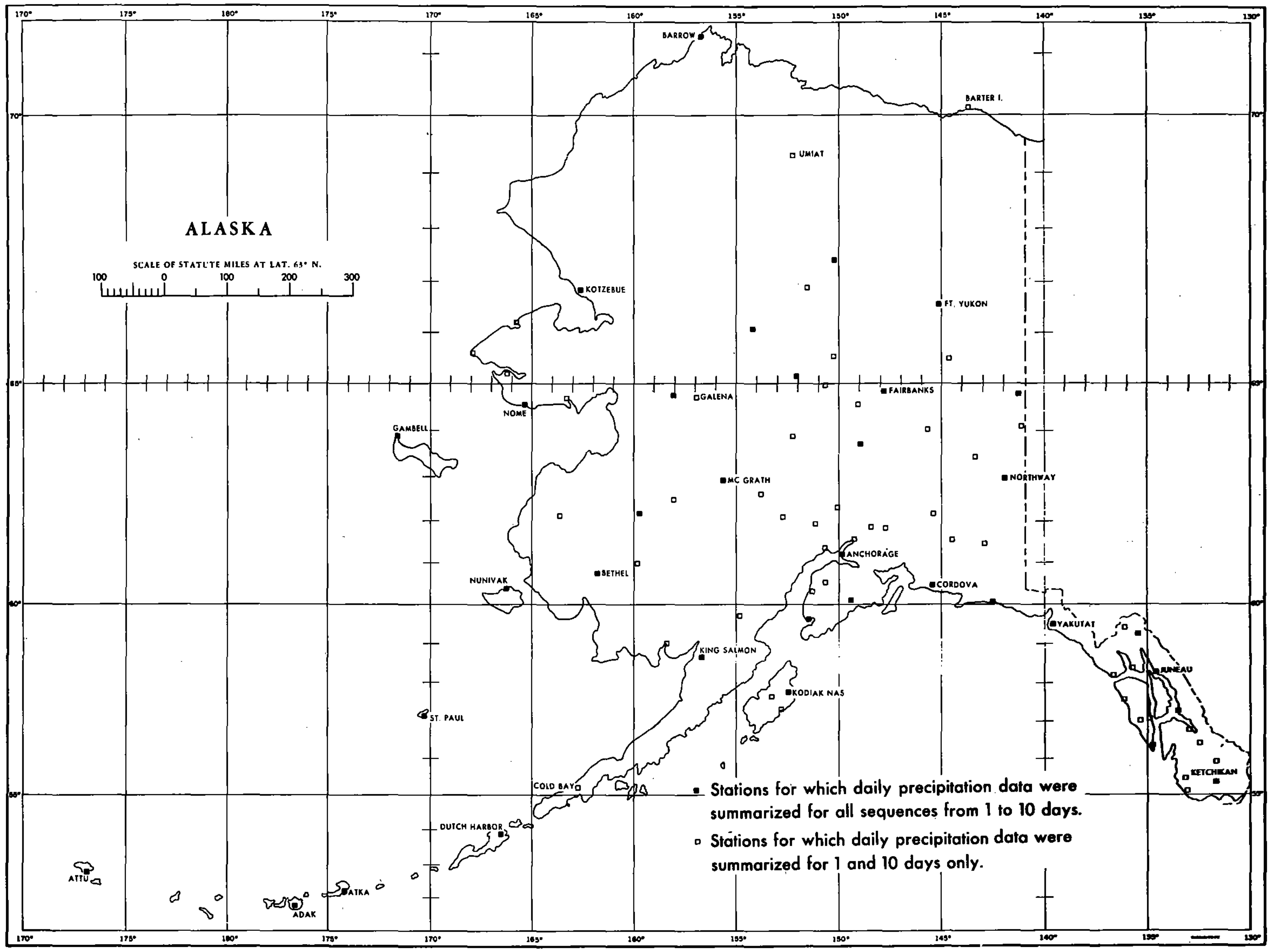

FIGURE 1.—Precipitation stations.

Table 1.—*Precipitation stations grouped by length of record*

Length of record (years)	Stations for which data were summarized for sequences from 1 to 10 days	Stations for which data were summarized for only 1 and 10 days
10–14	4	15
15–19	5	14
20–24	5	28
25–29	4	----------
30–34	3	----------
35–39	7	----------
40–44	8	----------
Total	36	57

stations in the second group were tabulated for the 20-year period, 1943–62. Breaks in record at some stations necessitated tabulation of data prior to 1943 to obtain a 20-year record. In order to obtain a better sampling of the various precipitation regimes, data for other periods of record at favorably located stations not in operation during the period 1943–62, were also used. In some cases, a 20-year record was not available. In no case, however, was less than 10 years of data used. The average length of record for all stations in the second group was 17 years. Table 1 groups the number of precipitation stations used by length of record.

Station exposure. In refined analysis of mean annual and mean seasonal precipitation data it is necessary to evaluate station exposures by methods such as double-mass-curve analysis [2]. Such methods are not appropriate for extreme values. Except for selection of stations that had consistent exposures during the period of record used, no attempt has been made to adjust precipitation values to a standard exposure.

3. DURATION ANALYSIS

n-*hour vs. observational-day precipitation.* Since the basic data consisted mostly of observational-day amounts, relations developed in an earlier rainfall-frequency study [3] between observational-day data and corresponding n-hour amounts, i.e., the 2-observational-day to 48-hour, the 3-observational-day to 72-hour, etc., were used. These relations were developed using hundreds of years of data from widely scattered stations, some of which had precipitation regimes similar to those of Alaska. These relations are ratios of the mean of the annual series (Sec. 4) of the n-hour precipitation to the mean of the annual series of the corresponding observational-day data. The adjustment factors are shown in table 2. The conversion factor between the observational-day and n-hour amounts is an average relationship.

Duration-interpolation diagram. A generalized relationship was developed for estimating precipitation for any duration between 2 and 10 days for a selected return period when the 2- and 10-day amounts for that return period are given (fig. 2). This generalization was obtained empirically from

Table 2.—*Empirical factors for converting observational-day amounts to the corresponding* n-*hour amounts*

Observational-day	Conversion factor to n-hour
2	1.04
3	1.03
4	1.03
5	1.02
6	1.02
7	1.02
8	1.02
9	1.01
10	1.01

data for the 36 stations (Sec. 2) and is the same as that used in [3]. Consideration of the meteorology of Alaska suggested that the region north of the major orographic barrier in southern Alaska might have a different duration relation than the southern and southeastern coastal regions. The stations were therefore grouped by geographic regions, and the data plotted separately. Since the boundary between the two regions is a diffuse transitional zone rather than a sharp line, stations near this zone were identified separately and checked against both diagrams. Comparison of the two diagrams showed only negligible differences so a single diagram was used.

The duration-interpolation diagram was developed using data for the 2-year return period, but tests with Alaskan data have shown the relationship to be appropriate for use within the range of return periods covered in this report. To use the diagram, a straightedge is laid across the values given for 2 and 10 days, and the amounts for other durations are read at the proper intersections.

4. FREQUENCY ANALYSIS

Two types of series. Frequency analyses of precipitation data are based on one of two types of data series. The annual series consists only of the highest value for each year. The partial-duration series recognizes that the second highest of some year occasionally exceeds the highest of some other year, and utilizes all items above a base value which is selected to yield n-items for n-years. The highest value of record, of course, is the top value of either series, but the lower values in the partial-duration series tend to be higher than those of the annual series.

The purposes served by this publication require that the results be expressed in terms of partial-duration frequencies. In order to avoid laborious processing of partial-duration data, the annual series were collected, analyzed, and the resulting statistics transformed to partial-duration statistics. Consequently, the maps of figures 11 to 34 are, in effect, based on partial-duration series data. These data may be converted to annual series data by multiplying by the factors given in table 3. These factors are the same as those de-

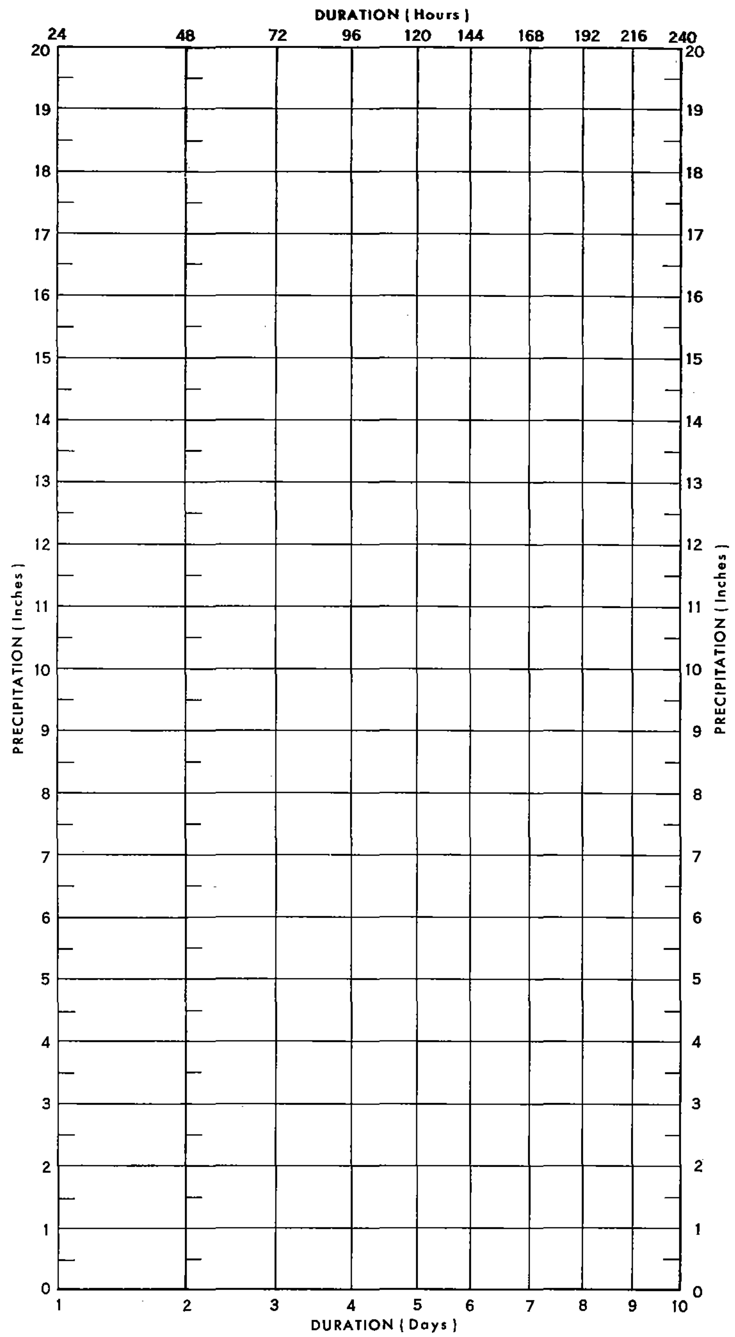

Figure 2.—Duration-interpolation diagram.

veloped in [3]. The two types of data series show no appreciable differences for return periods greater than 10 years.

Frequency considerations. Extreme values of precipitation depth form a frequency distribution which may be defined in terms of its statistical moments. Investigation of

TABLE 3.—*Empirical factors for converting partial-duration series to annual series*

Return period	Conversion factor
2-yr.	0.88
5-yr.	0.96
10-yr.	0.99

hundreds of precipitation distributions with lengths of record ordinarily encountered (usually less than 50 years) indicates that these records are too short to provide reliable statistics beyond the first and second moments. The distribution must therefore be regarded as a function of the first two moments. The 2-year value is a measure of the first moment—the central tendency of the distribution. The relationship of the 2-year to 100-year value is a measure of the second moment—the dispersion of the distribution.

Return-period diagram. The return-period diagram of figure 3 was obtained by the method described by Weiss [4] and is the same as that used in [3]. The two intercepts required are the 2-year and 100-year values obtained from the maps of this report. Tests have shown that within the range of the data and the purpose of this paper, the return-period relationship is independent of duration. Thus, given the 2- and 100-year return-period values for a particular duration, a straightedge is laid across these values on the diagram and the intermediate values determined. If values for return periods between 2 and 100 years are read from the return-period diagram, then converted to annual series values by applying the factors of table 3, and plotted on either extreme or log-normal probability paper, the points will very nearly define a straight line.

Secular trend. The use of short-record data introduces the question of possible secular trend and biased sample. Routine tests with subsamples of equal size from different periods of record for each of several stations showed no appreciable trend, indicating that the direct use of the short-record data is legitimate.

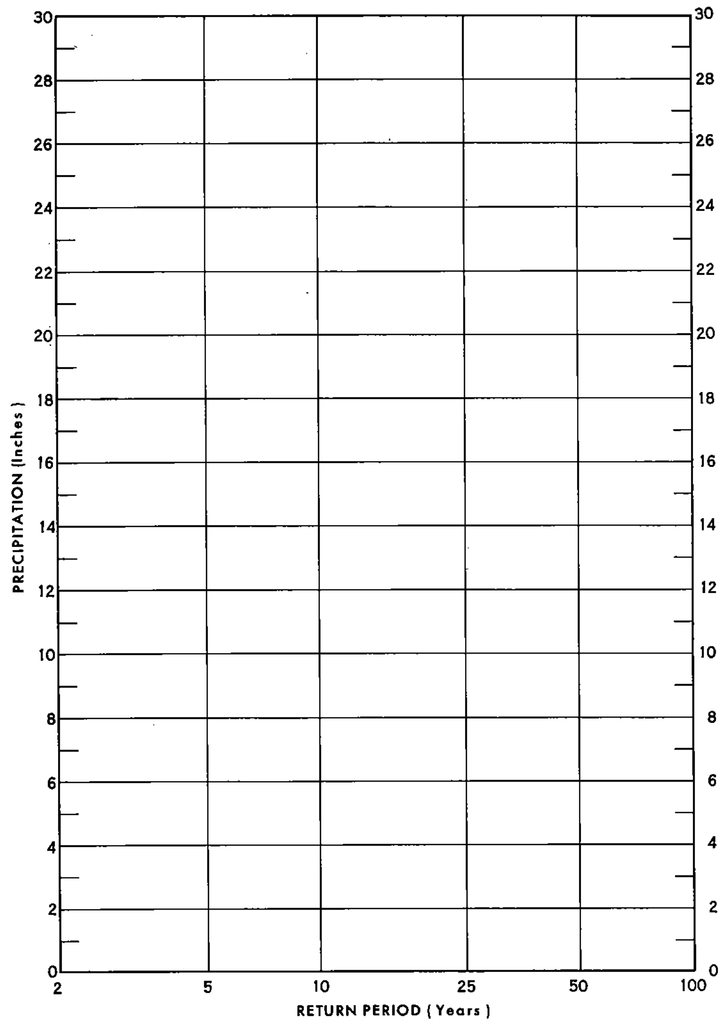

FIGURE 3.—Return-period—interpolation diagram.

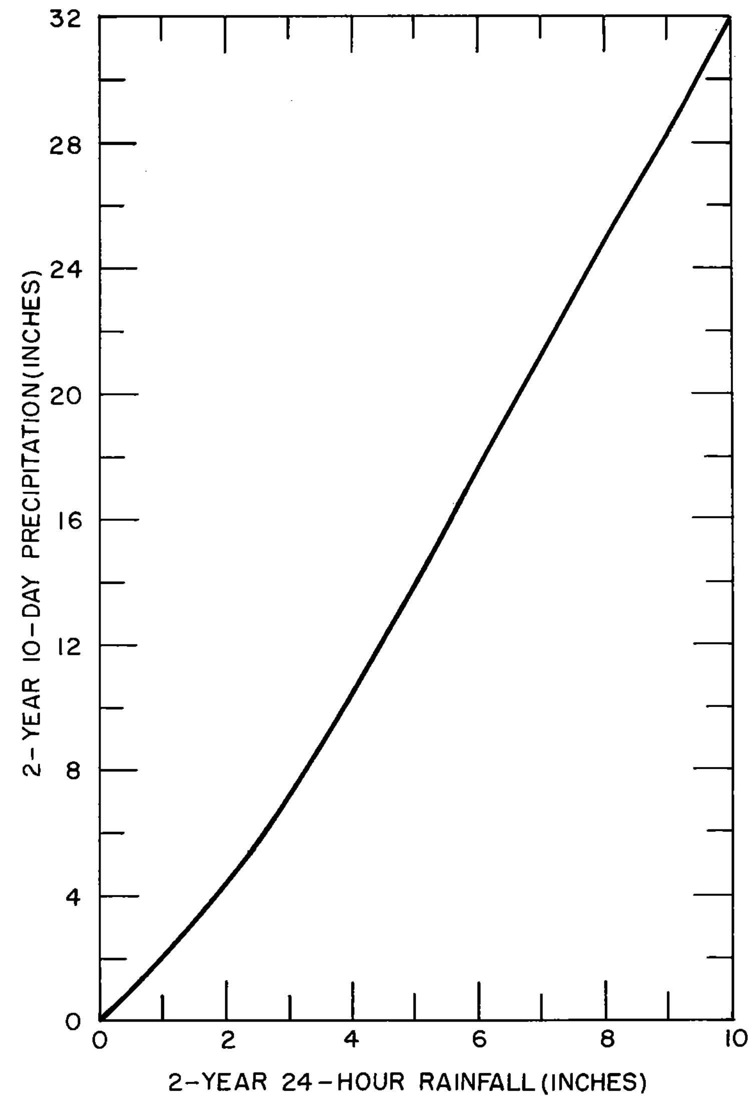

FIGURE 4.—Relation for estimating 2-year 10-day precipitation.

5. ISOPLUVIAL MAPS

Relation between 2-year 24- and 240-hour amounts. It was necessary to develop a relationship for estimating 10-day values for points in regions for which data were not available. Since a generalized chart of 2-year 24-hour precipitation was already available, values for this duration were used to develop a relation. A total of 93 stations (Sec. 2) provided the basic data. Meteorological considerations suggested that various regions of Alaska would have dissimilar relations. Attempts were made to separate the data on the basis of geographic factors but no consistent variation of the relationship could be determined. Studies of the meteorology associated with heavy rains in Alaska indicated that the Interior and Arctic regions receive a higher percentage of their precipitation in the form of showers than do the southern and southeastern coastal regions. The mean annual number of thunderstorm days is one climatological factor that indicates the degree of shower activity. Introduction of this as well as other climatological and physiographic parameters did not improve the relation. A single curve, therefore, provided the adopted relation (fig. 4).

In the development of the relationship (fig. 4) all 24-hour data were adjusted to the corresponding n-minute amounts. The 10-day values were adjusted to the corresponding 240-hour amounts. The correlation coefficient between the computed and estimated amounts was 0.99, with a standard error of estimate of 0.7 inch. The mean of the computed values was 5.5 inches. The scatter of estimated vs. computed values is shown in figure 5.

Smoothing of isopluvial maps. The analysis of a series of maps involves the question of how much to smooth the data. An understanding of the degree of smoothing in the analysis is necessary to the most effective use of the maps. The problem of drawing isopluvial lines through a field of data is

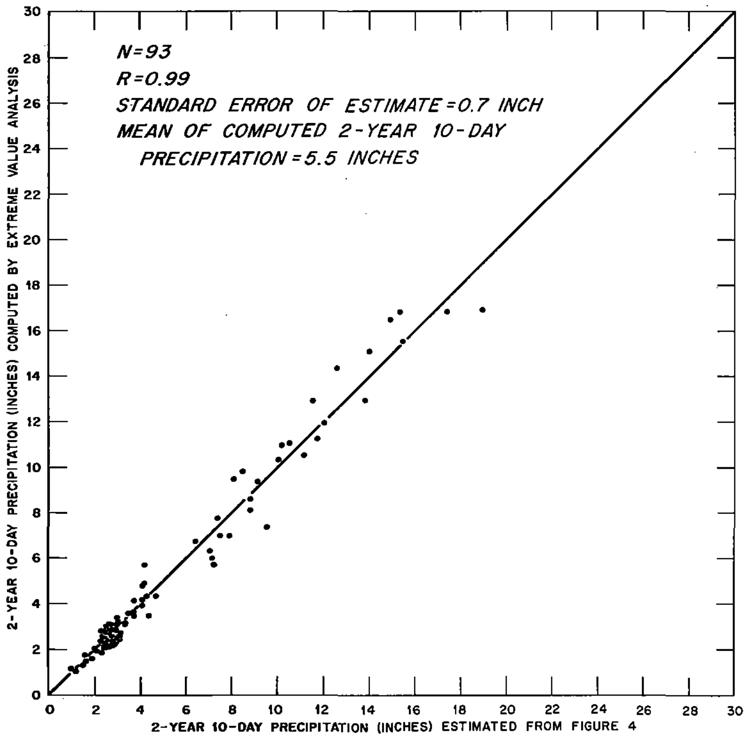

Figure 5.—Test of relation of figure 4.

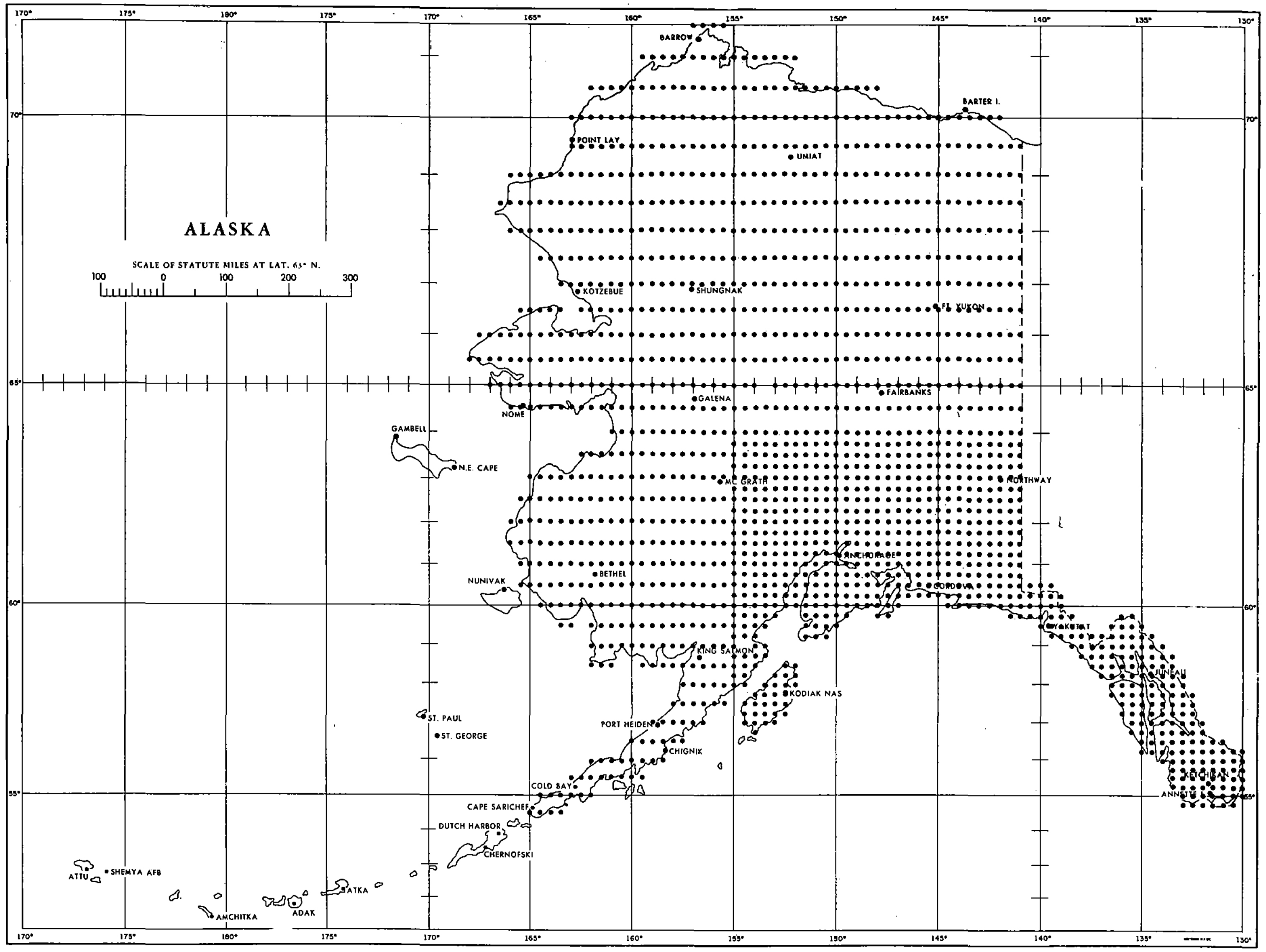

Figure 6.—Points for which precipitation-frequency data were computed.

analogous, in some important respects, to drawing regression lines on a scatter diagram. Just as an irregular regression line can be drawn to every point on a scatter diagram, the isolines may be drawn to fit every point. Such a complicated pattern of many small highs and lows would be unrealistic in most cases. There is a degree of inconsistency between smoothness and closeness of fit. Any analysis must strive for a balance between the two, sacrificing some closeness of fit for smoothness and vice versa. The maps of this report were drawn so that the standard error of estimate was commensurate with the sampling and other errors in the data and methods used.

2-year 10-day map (fig. 29). The relationship (fig. 4) described in the preceding paragraphs, and the 2-year 24-hour map of [1] were used to estimate the 2-year 10-day values for a grid of 1720 points (fig. 6). Also plotted on the map were the data for the 93 stations (fig. 1) for which 10-day data had been tabulated. On this and similar maps all precipitation data have been adjusted by the factors of table 2 to *n*-hour amounts, i.e., the 2-day map presents 48-hour amounts, the 4-day presents 96-hour amounts, etc.

Ratio of 100-year to 2-year values. A map (fig. 7) was prepared showing the 100-year to 2-year ratio for the 10-day amounts. A smooth geographical pattern was indicated. The ratio varied from about 1.6 to 2.5 with an average ratio about 2.2. The highest ratios were found in northeastern Alaska, just north of Fort Yukon, with the lowest ratios along the southern and southeastern coasts.

100-year 10-day map (fig. 34). The 100-year 10-day values were computed for the grid points of figure 6 by multiplying the values read from the 2-year 10-day map (fig. 29) by those from the 100- to 2-year ratio map (fig. 7). As a further aid in the analysis of the isopluvial pattern, the 100-year 10-day values computed for the 93 stations for which data had been processed were also plotted, in addition to the grid points.

22 additional maps. For the 22 intermediate maps required for this report, values were computed for the 1720 grid points (fig. 6). First, values were read from the 2-, 5-, 10-, 25-, 50-, and 100-year 24-hour maps of [1] and the 2-year and 100-year 10-day maps. Then, the duration-interpolation diagram (fig. 2) and the return-period diagram (fig. 3) were used to compute amounts for the grid points. The frequency values computed for stations for which data were processed were also plotted on each of the maps. Isolines were then drawn. Pronounced "highs" and "lows" are positioned in consistent locations on all the maps. The 24 precipitation-frequency maps are shown at the end of the text (figs. 11–34).

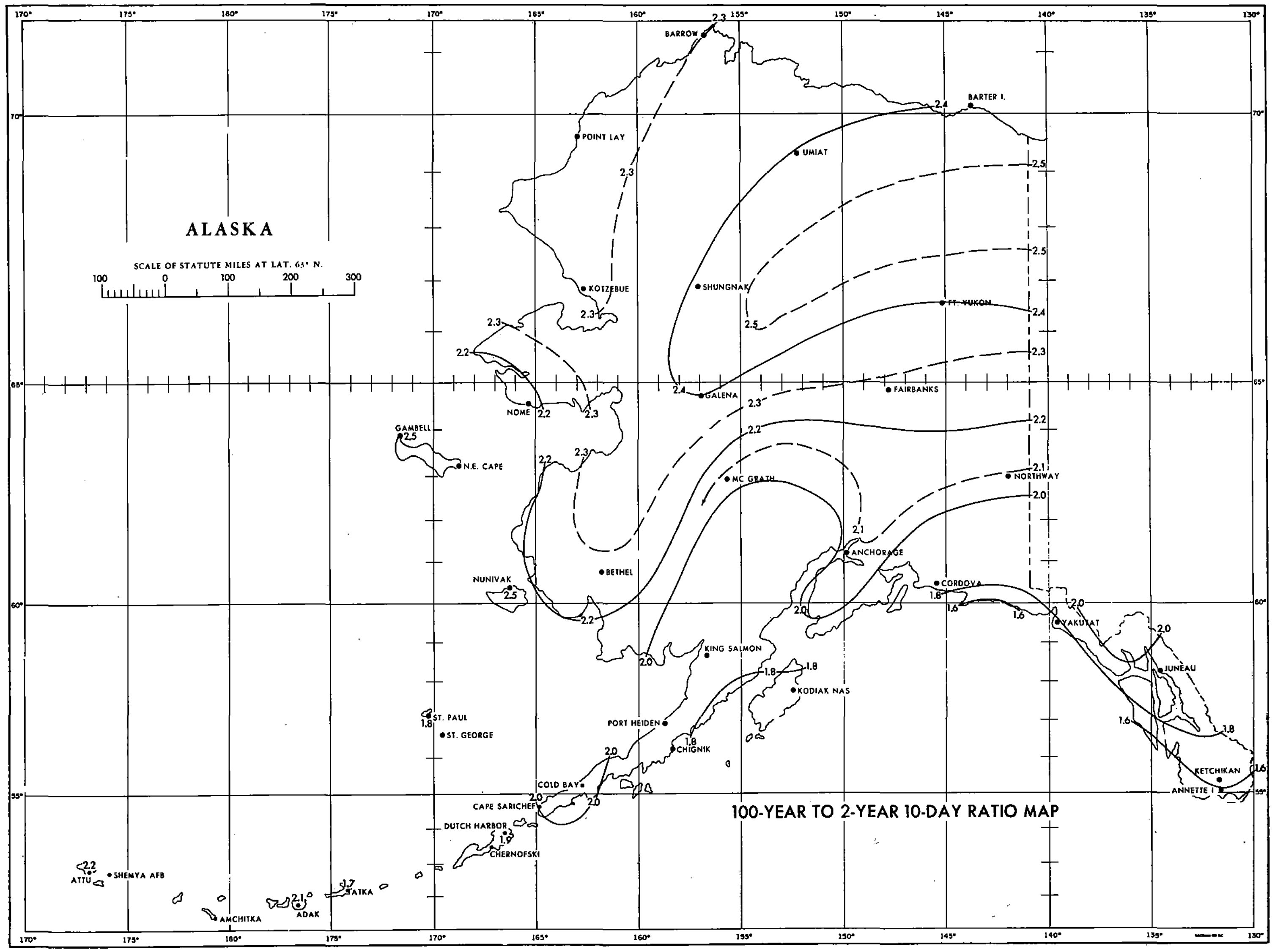

Figure 7.—100-year to 2-year 10-day ratio map.

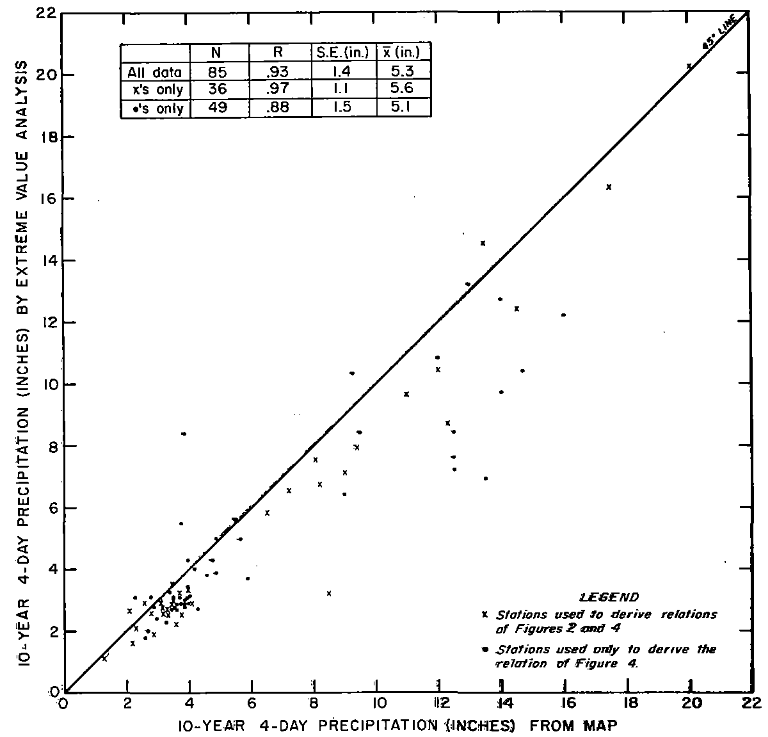

Figure 8.—Comparison of estimated vs. computed 10-year 4-day precipitation.

Reliability of results. The term is used here in the statistical sense to refer to the degree of confidence that can be placed in the accuracy of the results. The reliability is influenced by the accuracy of [1] and the accuracy of the relationships developed for this report. The accuracy of the results presented in [1] was discussed in that report. The reliability of the relationships developed for the present study may be assessed by reference to scatter diagrams of observed vs. estimated values like that of figure 5. The scatter of points in these diagrams may be largely the result of sampling error in time and space. Sampling error in space is a result of: (1) the chance occurrence of an anomalous storm which has a disproportionate effect on the record at a station as compared with that of a nearby station, and (2) the use of station data that are not representative of the precipitation regime of the surrounding area. Similarly, sampling error in time results from the use of data for a given period that is not representative for a longer period. Elimination of all sampling error, however, would still leave some scatter, indicative of the geographic variation unexplained by the graphical relation.

Tests of the relationships used to estimate point precipitation amounts for various durations and return periods do not indicate the accuracy of the final generalized maps. The reliability of these maps can be partially assessed by comparison of the values indicated for various precipitation stations with those computed directly from their records. Figure 8 shows such a comparison for the 10-year 4-day amounts. Similar comparisons were made for other durations and return periods.

The data of figure 8 show a tendency for the maps to indicate higher values than those computed from station records. The bias suggests that the analysts tended to give greater weight to the higher of adjacent values. This practice may be considered conservative.

The major part of the bias in figure 8 comes from the envelopment of the precipitation-frequency values of low elevation stations in the generalization necessary to represent the precipitation-frequency values on the more exposed steeper slopes. It would be nearly impossible to show on any chart of reasonable scale sufficient detail to eliminate all bias resulting from this type envelopment in a region with as rugged orography as Alaska. However, as can be seen from figure 8, the standard errors of estimates do not greatly exceed the 20-percent limitation considered acceptable for this type of data. Of course, such tests do not eliminate possible errors of larger magnitude in those areas where lack of observed data preclude comparisons with estimated values.

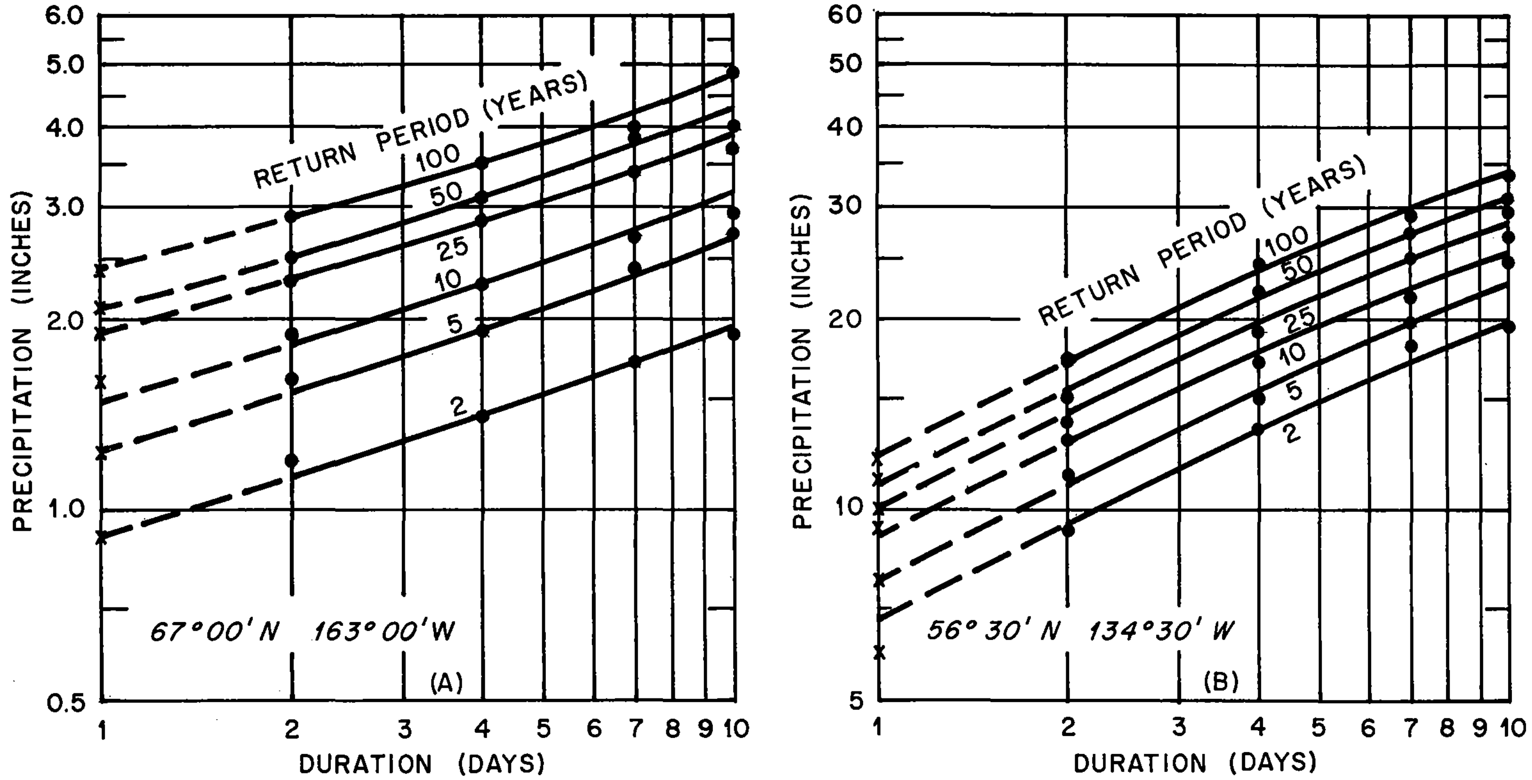

FIGURE 9.—Smoothing values read from isopluvial maps.

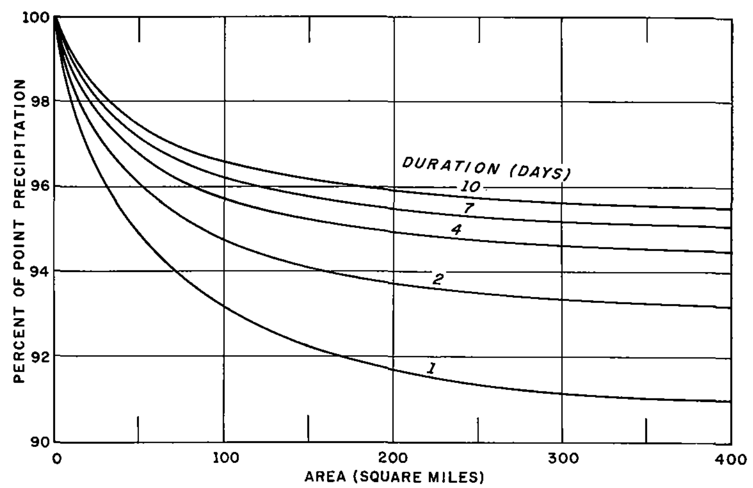

FIGURE 10.—Depth-area curves.

Smoothing values read from the maps. The complex patterns and steep gradients of the isopluvials combined with the difficulties of interpolation and accurate location of a specific point on a series of maps might result in inconsistencies in data read from the maps. Such inconsistencies can be minimized by fitting smooth curves to a plot of the data obtained from the maps. Figure 9 illustrates two sets of curves on logarithmic paper, one for a point (a) 67°00′ N., 163°00′ W., and the other (b) at 56°30′ N., 134°30′ W. Data for the 24-hour values for these curves have been taken from [1]. An alternative procedure would be to read these values from the duration-interpolation diagrams (fig. 2).

In regions where the isopluvial pattern is relatively simple and exhibits flat gradients, minor differences in locating points have less effect on the interpolated values, and the plotted points will more clearly define a smooth set of curves. In mountainous regions complex patterns and steep gradients complicate interpolation, and the curves will be more poorly defined.

Interpolated values for a particular duration should define an almost straight line on the return-period diagram of figure 3. Also, the interpolated values for a particular return period should very nearly define a straight line on the duration-interpolation diagram of figure 2.

6. DEPTH-AREA RELATIONSHIPS

Any value read from an isopluvial map for a point is an average depth for the location, for a given return period and duration. The depth-area curve attempts to relate this average point value, for a given duration and frequency within a given area, to the average depth over that area for the same duration and frequency. The curves of figure 10 depict the relationship for durations of 1 to 10 days and for areas up to 400 square miles, and are to be used in reducing the point values of precipitation shown on the maps of figures 11 to 34 to areal values. The curves are based on data from 27 dense rainage networks in the contiguous United States, and are identical with those of [3]. A survey failed to reveal any dense network data for Alaska that could be used to test the relationship. Some of the networks used to develop the curves, however, were from meteorologically similar regions. Examination of the data from these networks suggested that the adopted area-reduction curves were reasonable.

7. SEASONAL VARIATION

The basic data for the precipitation-frequency maps of figures 11 to 34 show seasonal trends. Some months may contribute most of the annual series or partial-series data used in the frequency analyses, while other months may contribute little or nothing. Also, the months contributing most of the series data for the shorter durations, say, one or two days, may not be the same as those contributing most of the data for the longer durations, say, nine or ten days. Seasonal probability charts for 24-hour precipitation for various climatic regions of Alaska were presented in [1].

Seasonal probability curves were not derived for this report because it appeared that their usefulness was not commensurate with the costs of collecting and processing the additional data required for their construction.

REFERENCES

1. U.S. Weather Bureau, "Probable Maximum Precipitation and Rainfall-Frequency Data for Alaska," *Technical Paper No. 47*, 1963, 69 pp.

2. M. A. Kohler, "Double-Mass Analysis for Testing the Consistency of Records and for Making Required Adjustments," *Bulletin of the American Meteorological Society*, vol. 30, No. 5, May 1949, pp. 188–189.

3. U.S. Weather Bureau, "Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States," *Technical Paper No. 49*, 1964, 29 pp.

4. L. L. Weiss, "A General Relation between Frequency and Duration of Precipitation," *Monthly Weather Review*, vol. 90, No. 3, Mar. 1962 pp. 87–88.

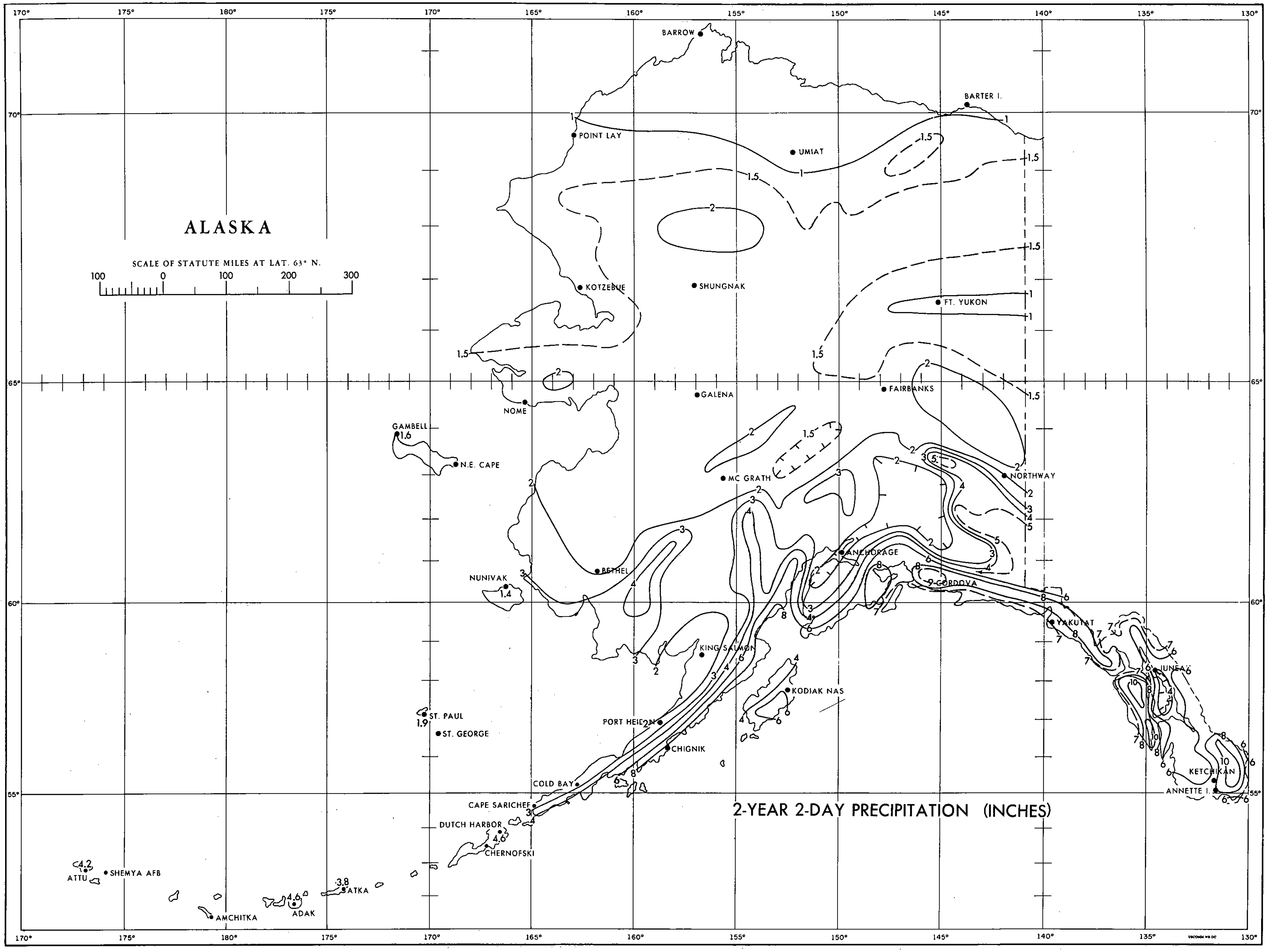

FIGURE 11.—2-year 2-day precipitation (in.).

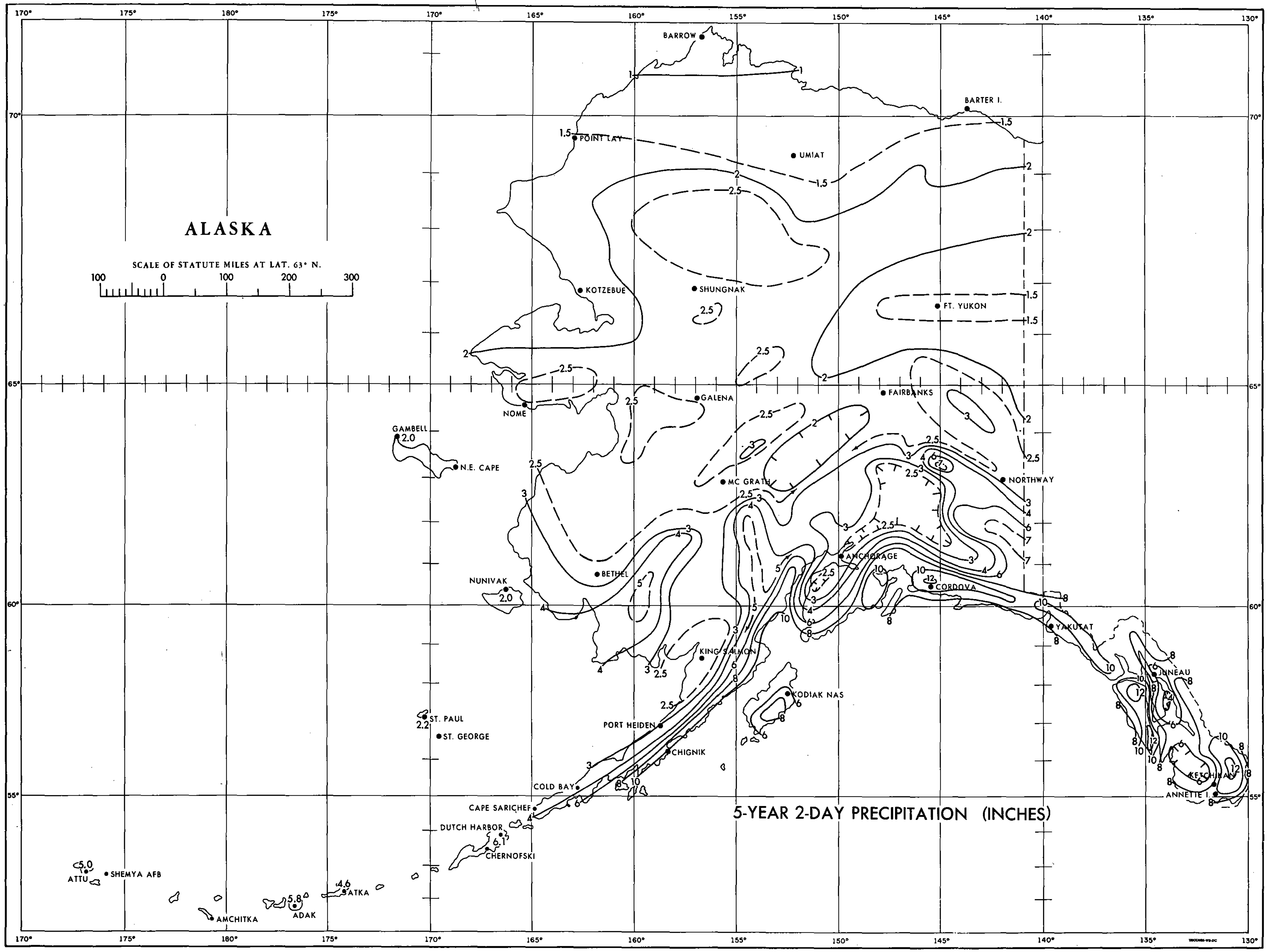

FIGURE 12.—5-year 2-day precipitation (in.).

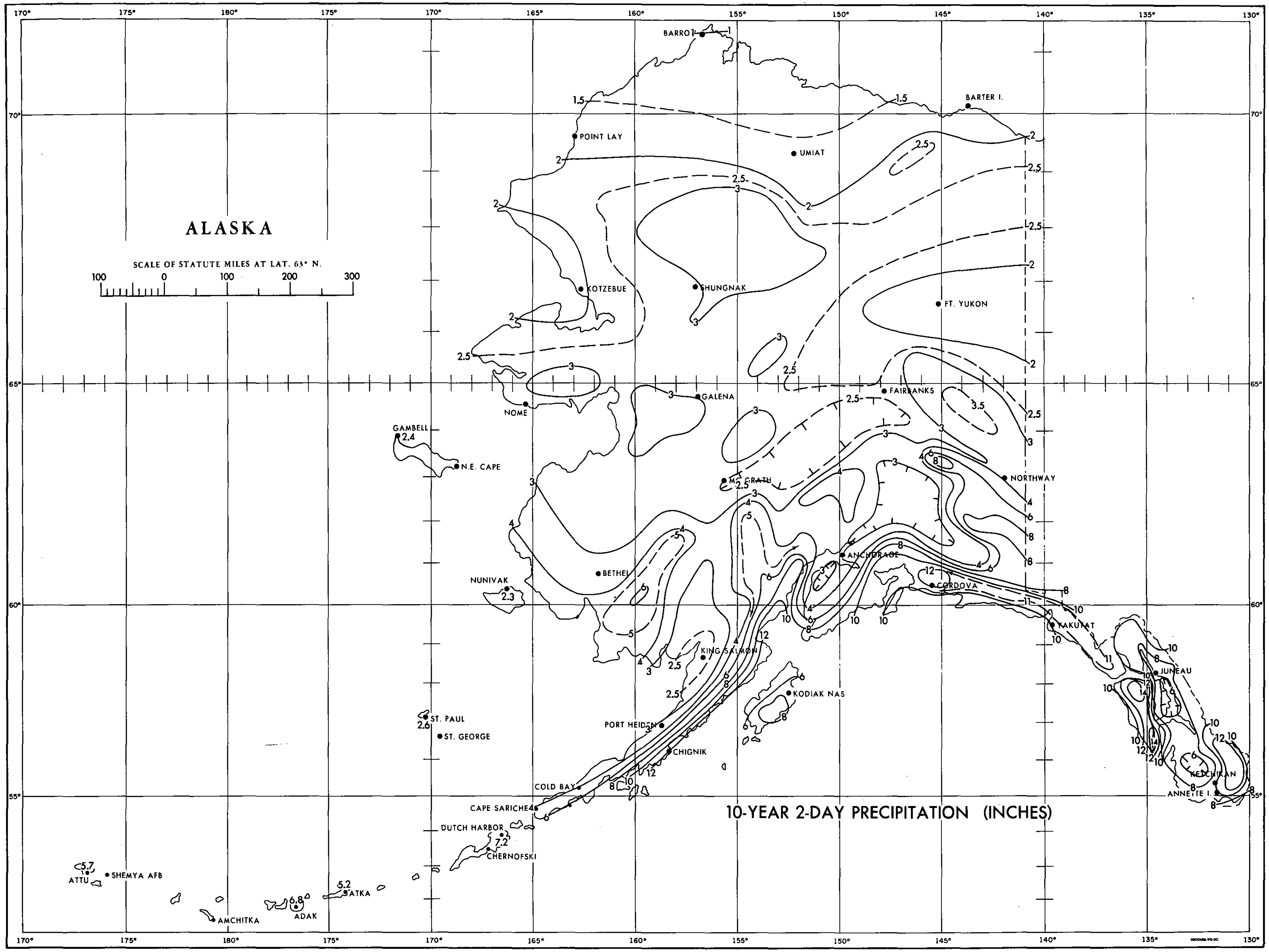

FIGURE 13.—10-year 2-day precipitation (in.).

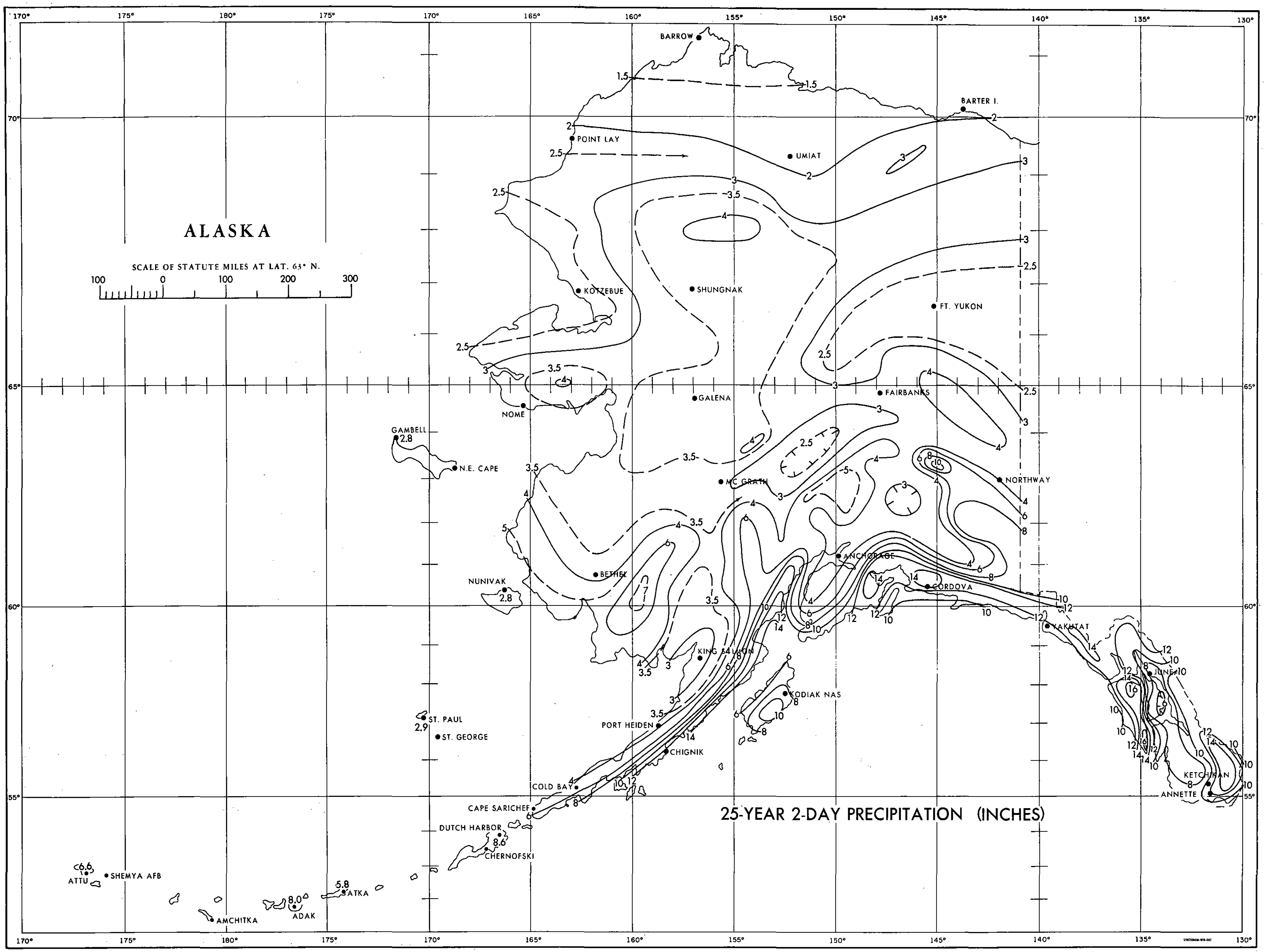

FIGURE 14.—25-year 2-day precipitation (in.).

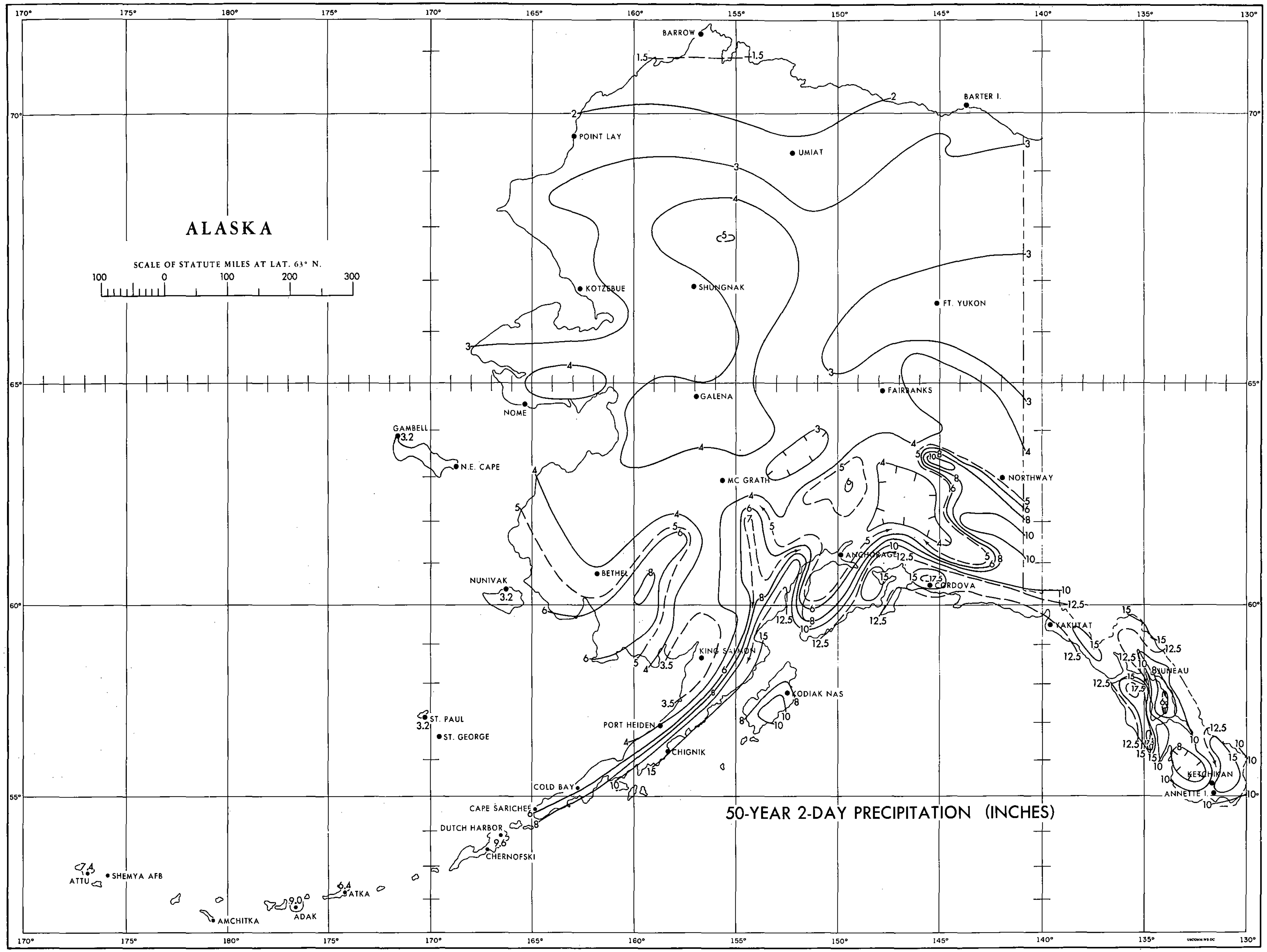

FIGURE 15.—50-year 2-day precipitation (in.).

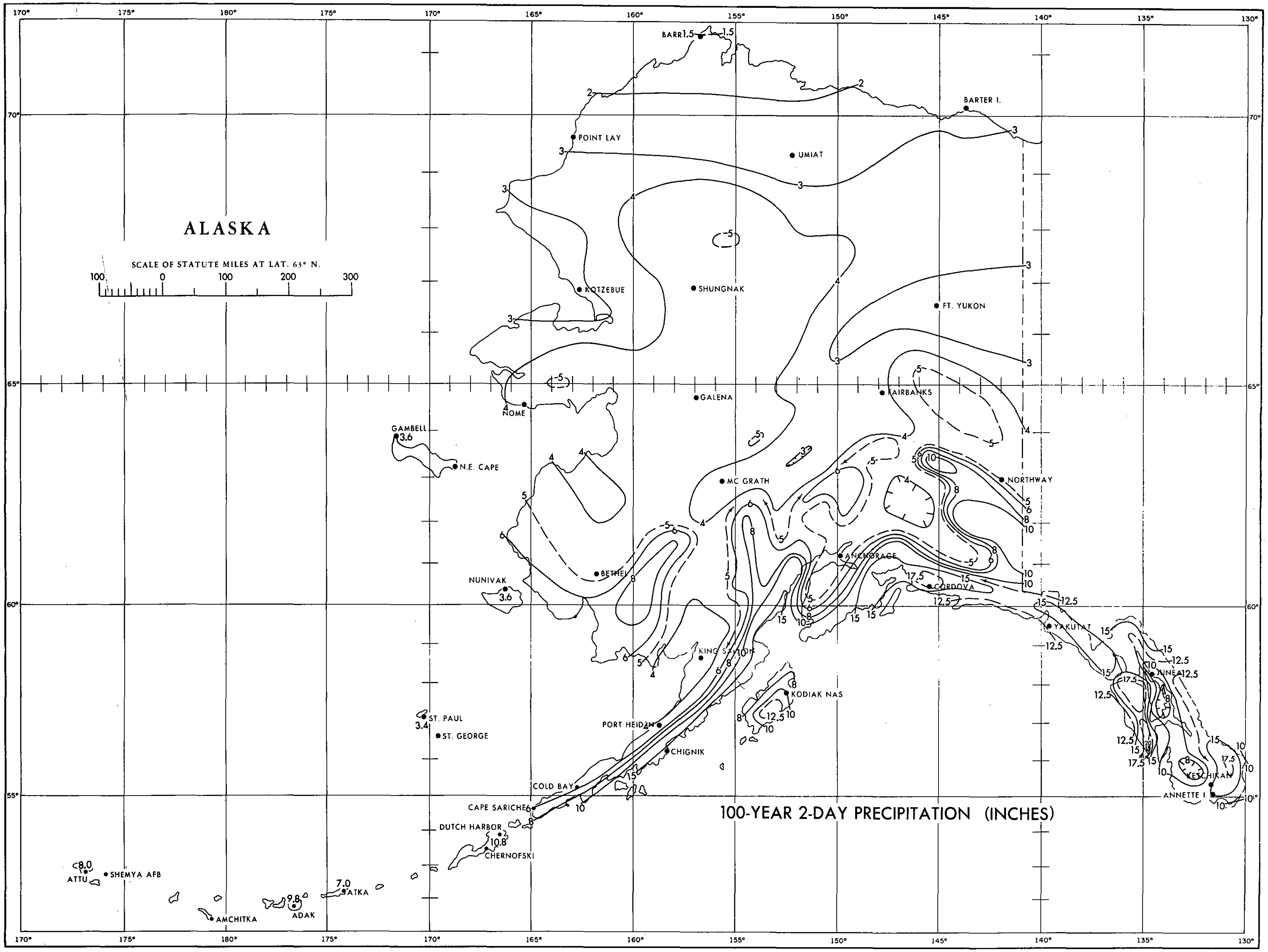

FIGURE 16.—100-year 2-day precipitation (in.).

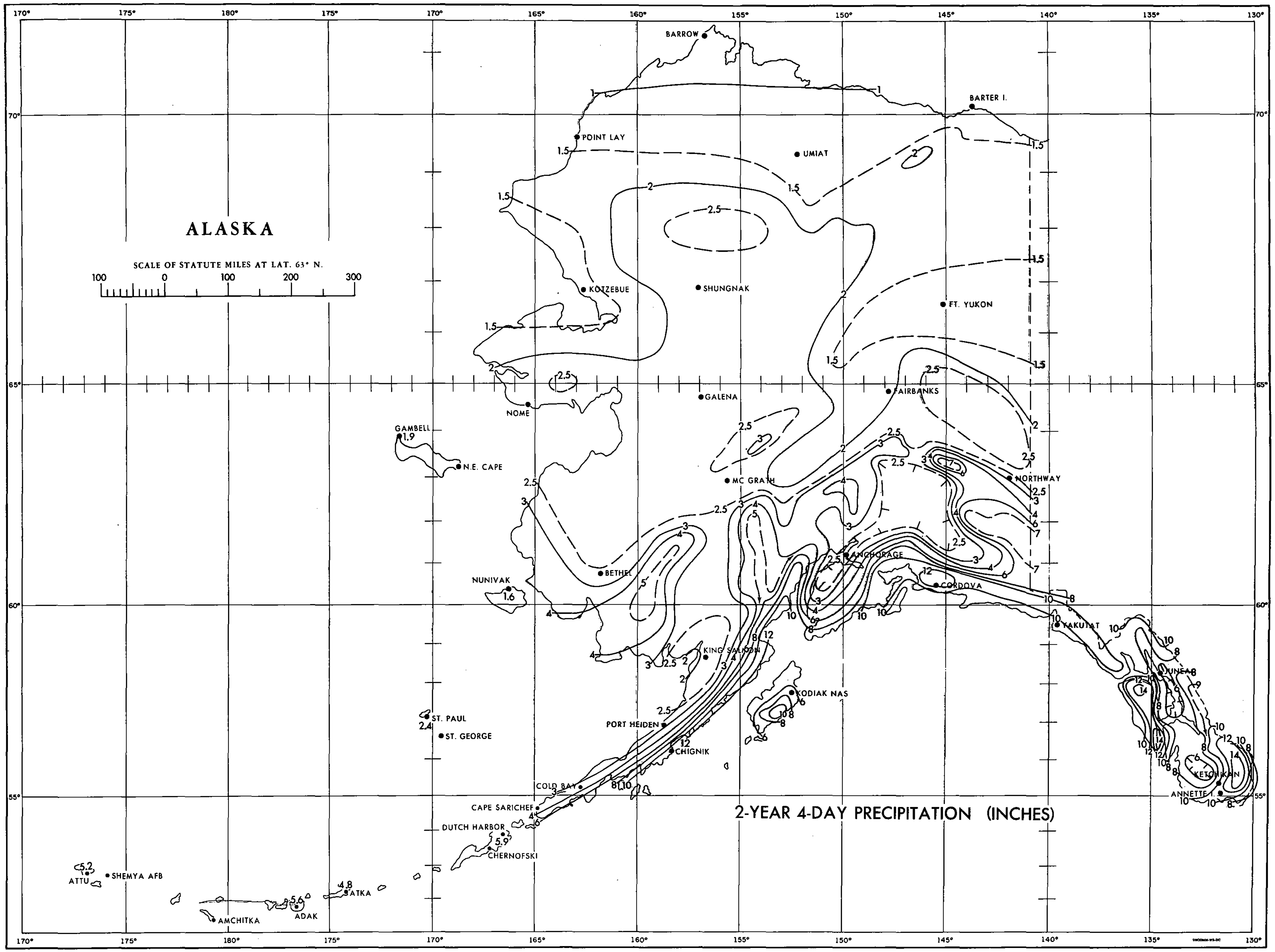

FIGURE 17.—2-year 4-day precipitation (in.).

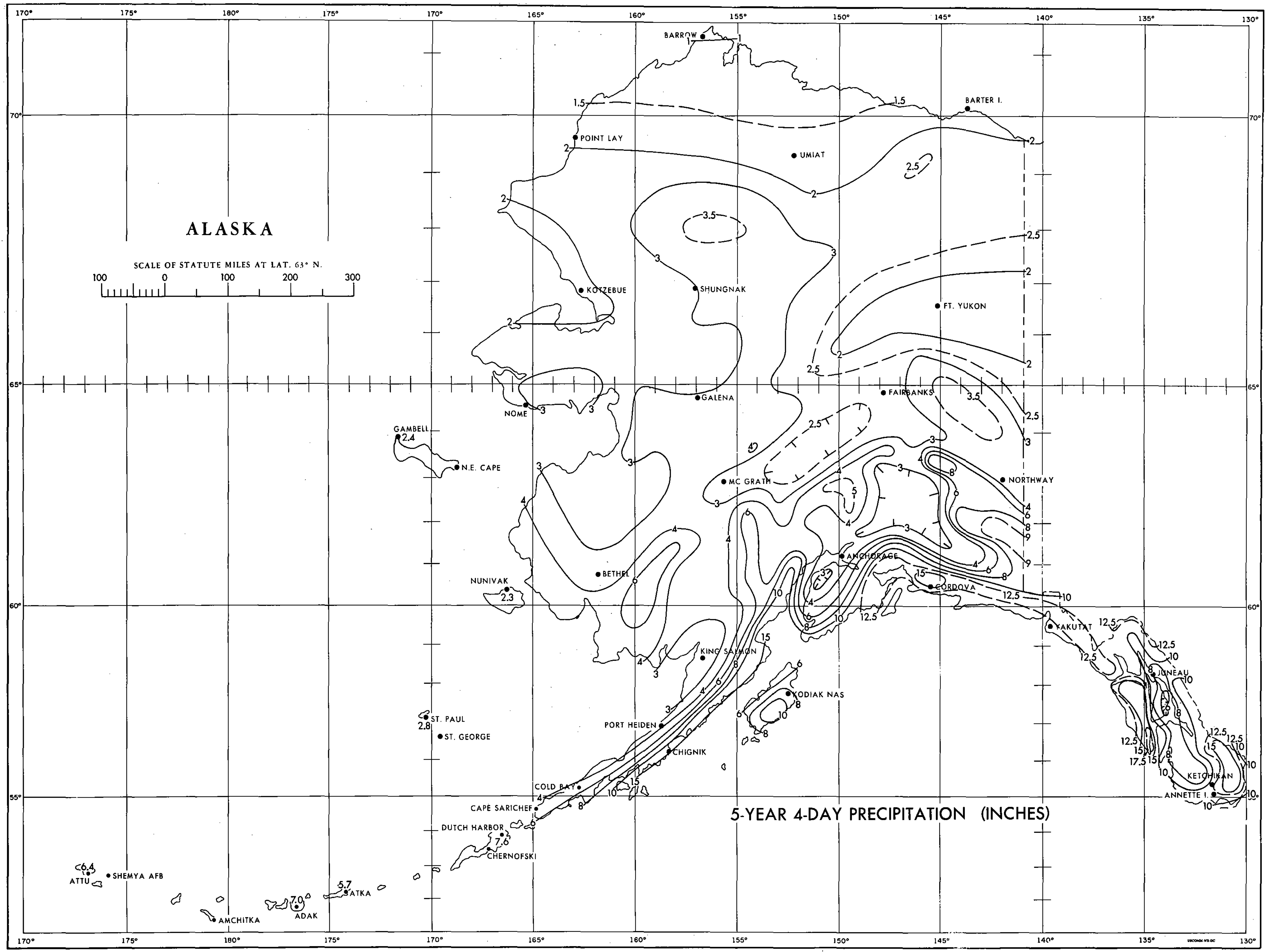

FIGURE 18.—5-year 4-day precipitation (in.).

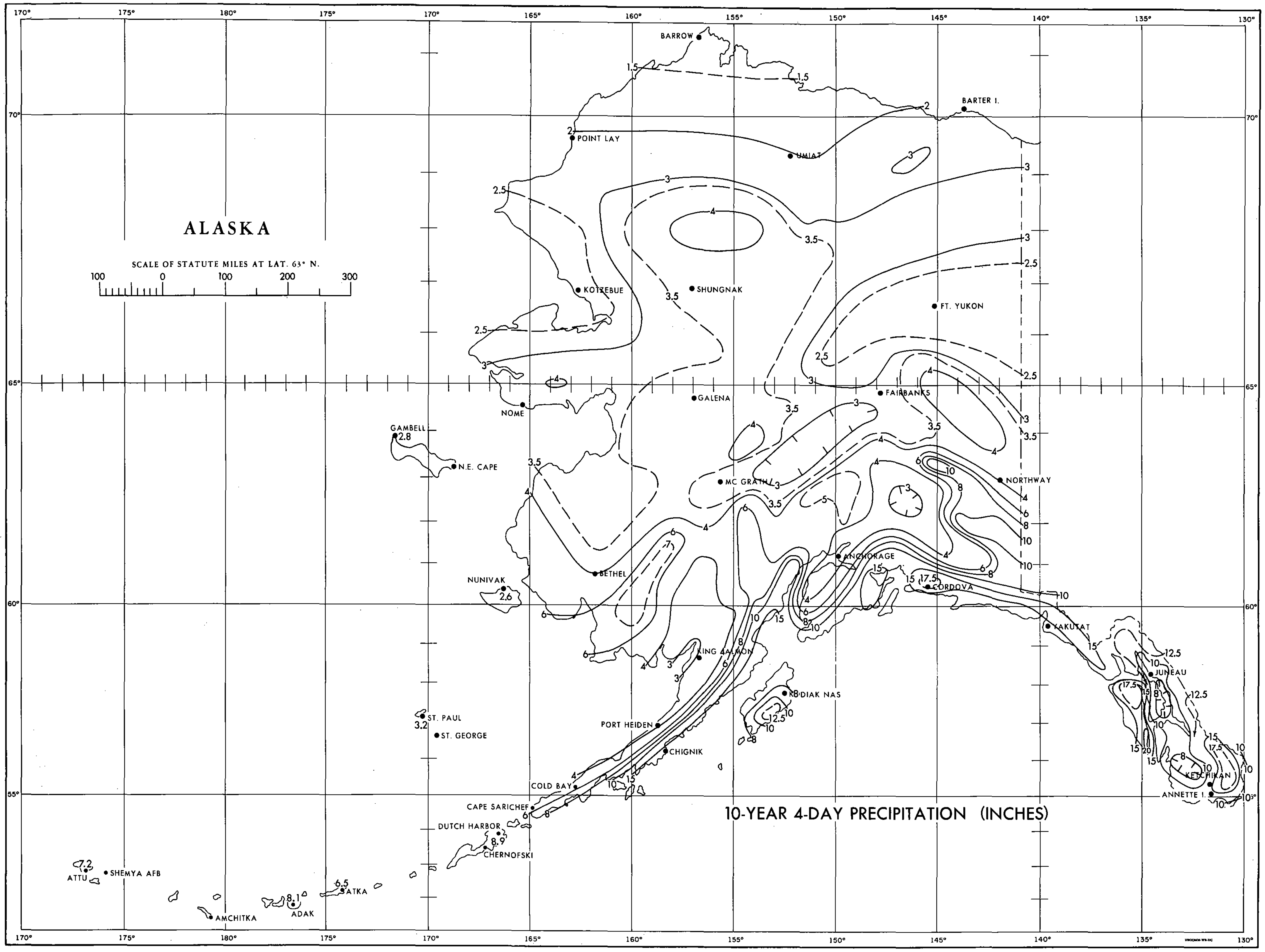

Figure 19.—10-year 4-day precipitation (in.).

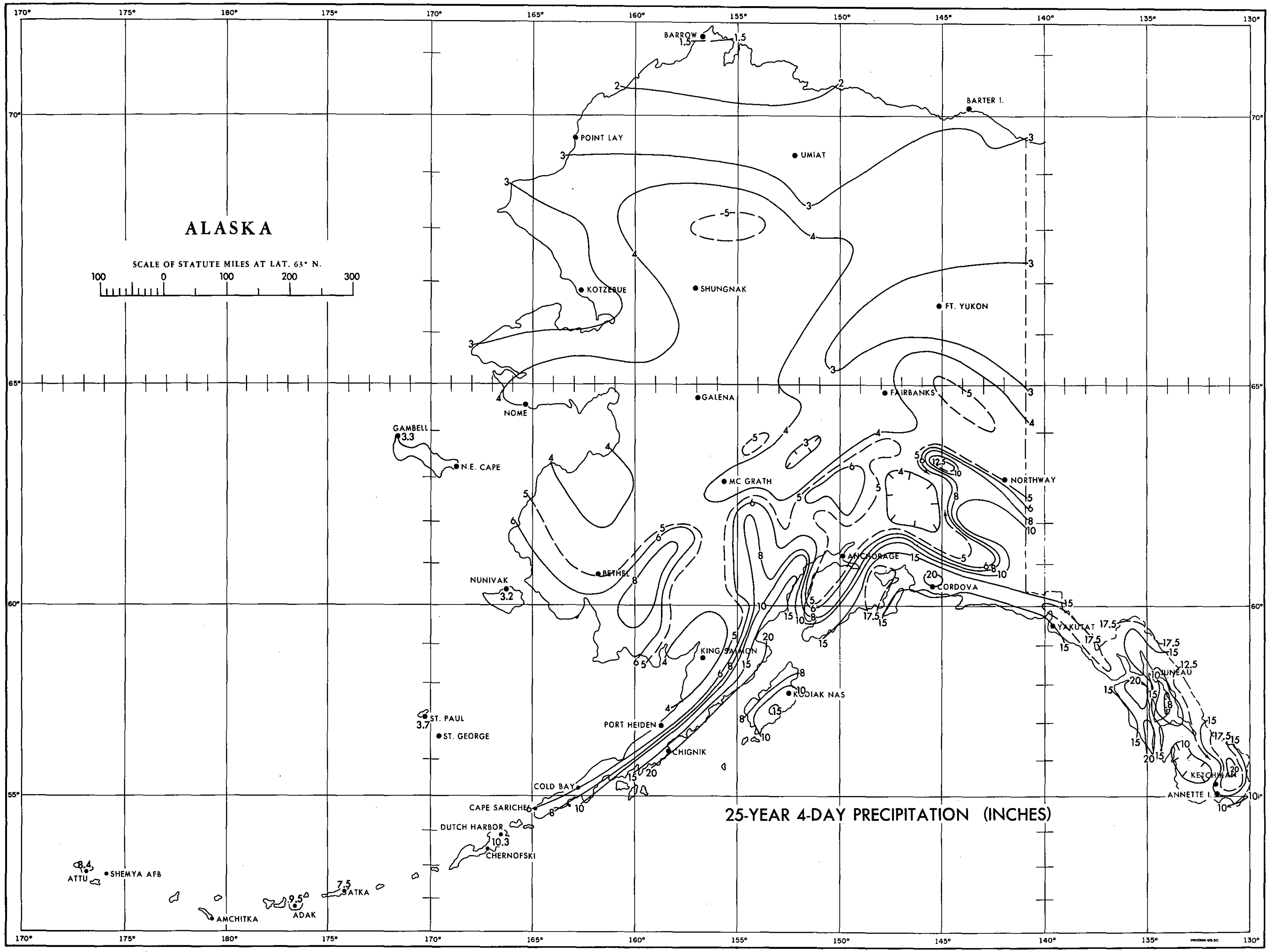

FIGURE 20.—25-year 4-day precipitation (in.).

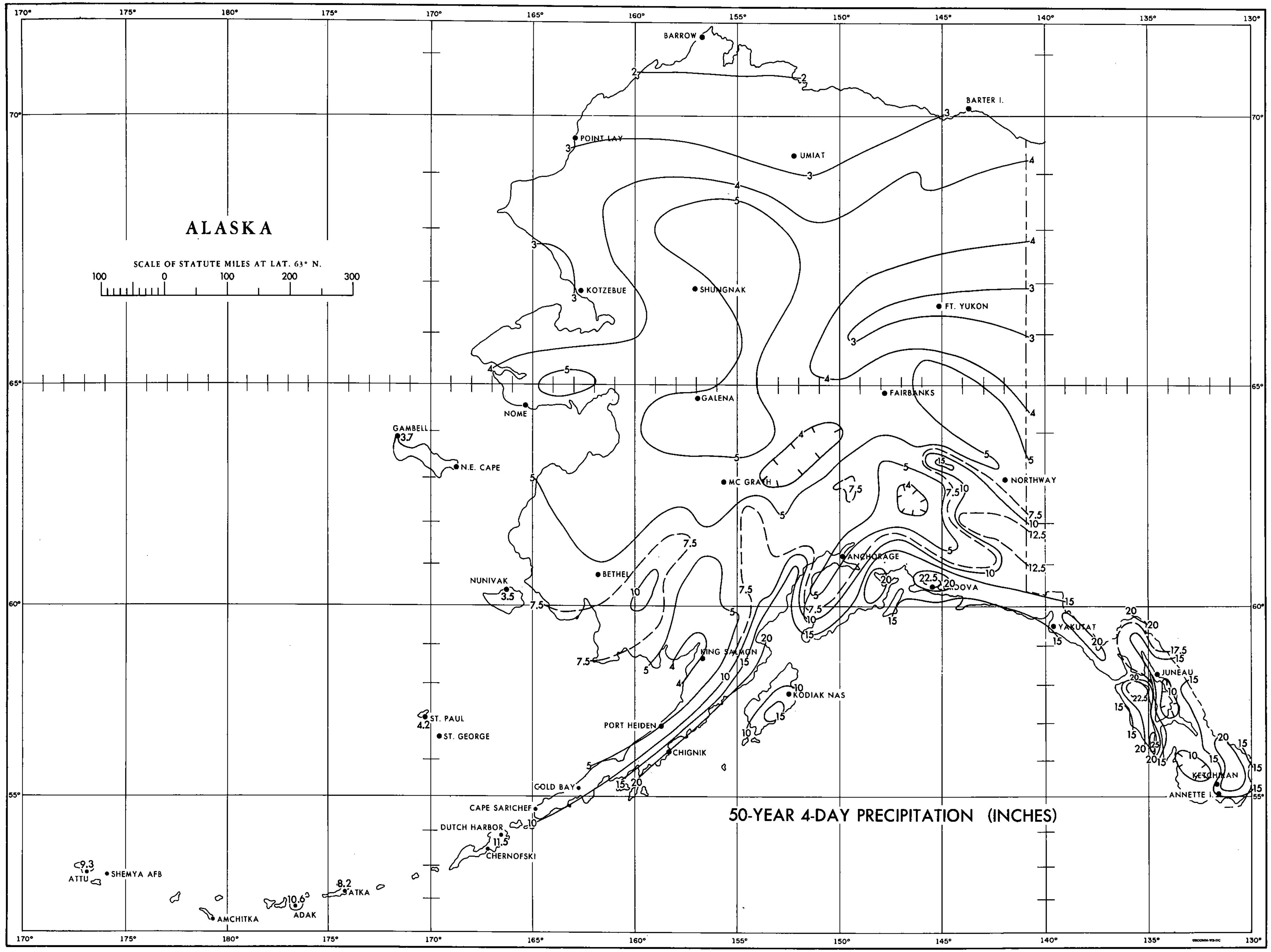

FIGURE 21.—50-year 4-day precipitation (in.).

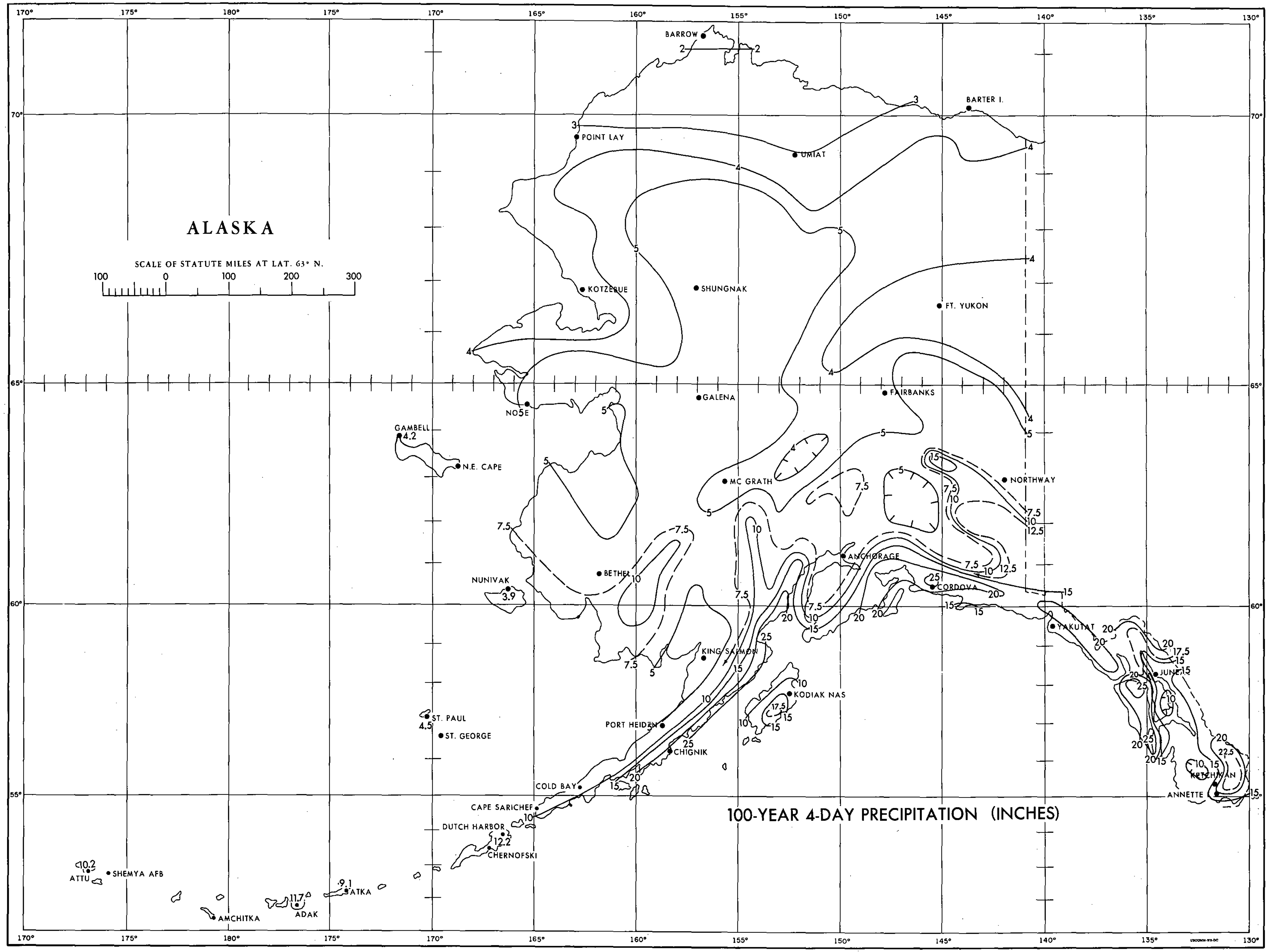

FIGURE 22.—100-year 4-day precipitation (in.).

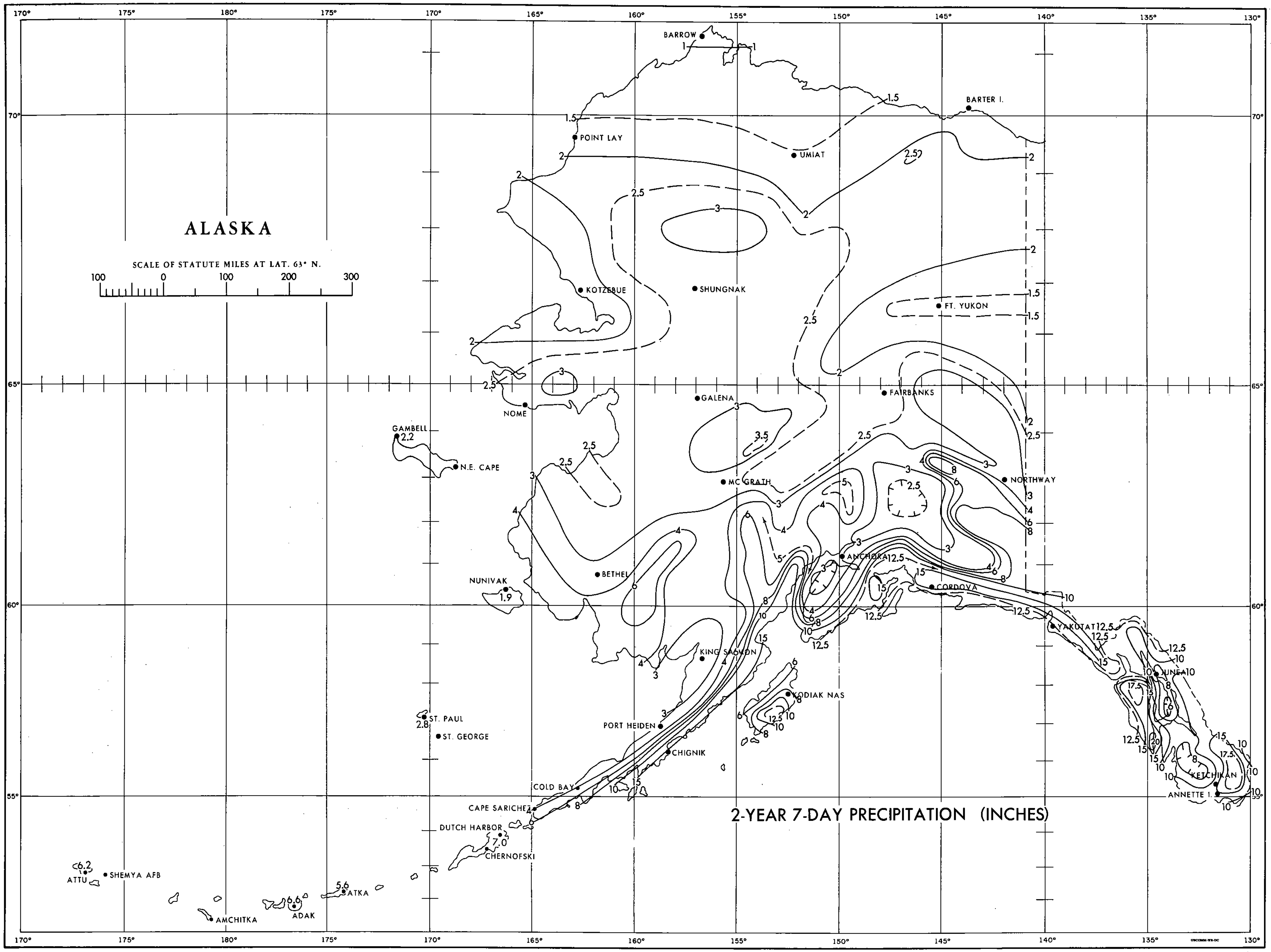

FIGURE 23.—2-year 7-day precipitation (in.).

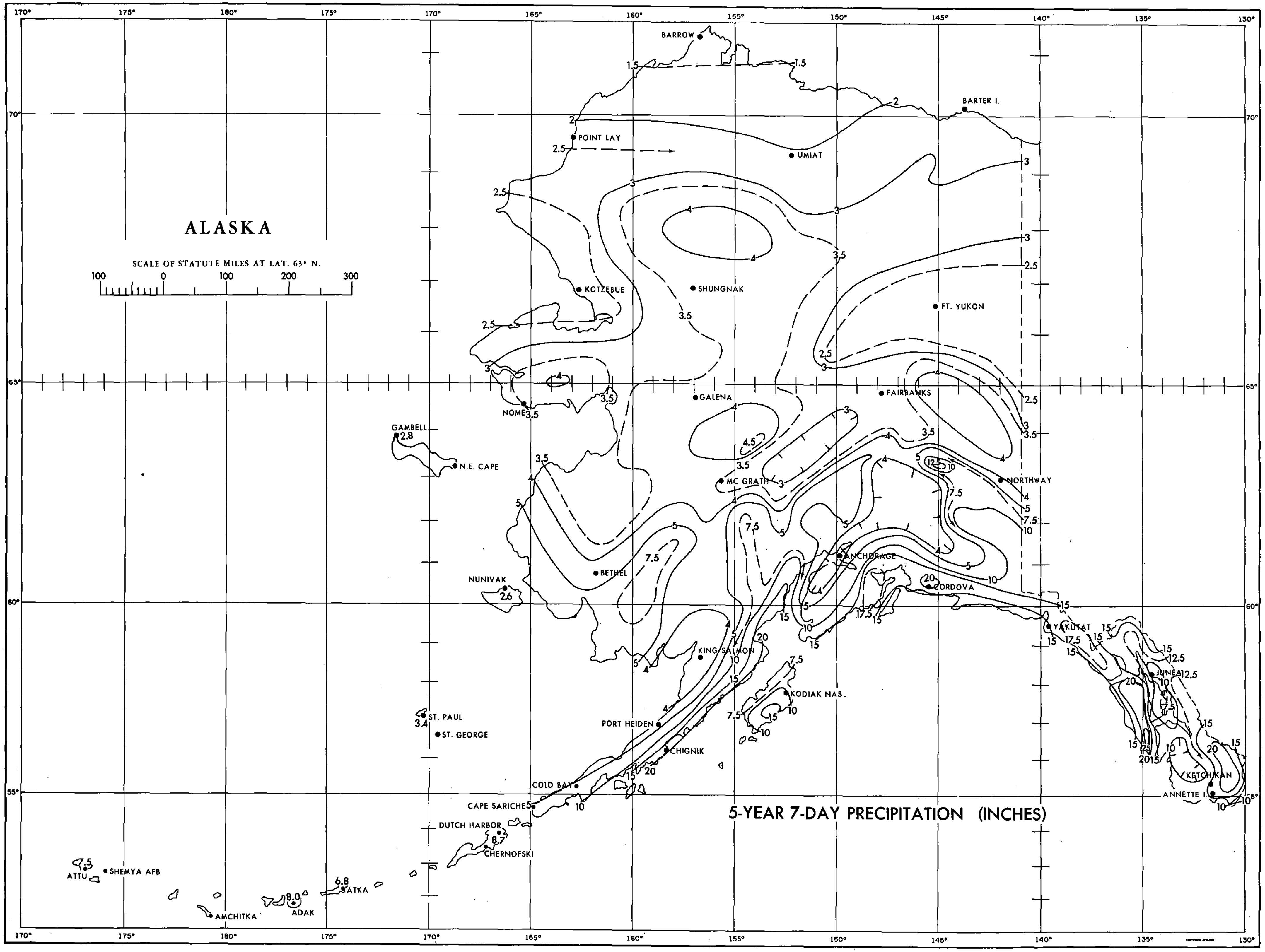

FIGURE 24.—5-year 7-day precipitation (in.).

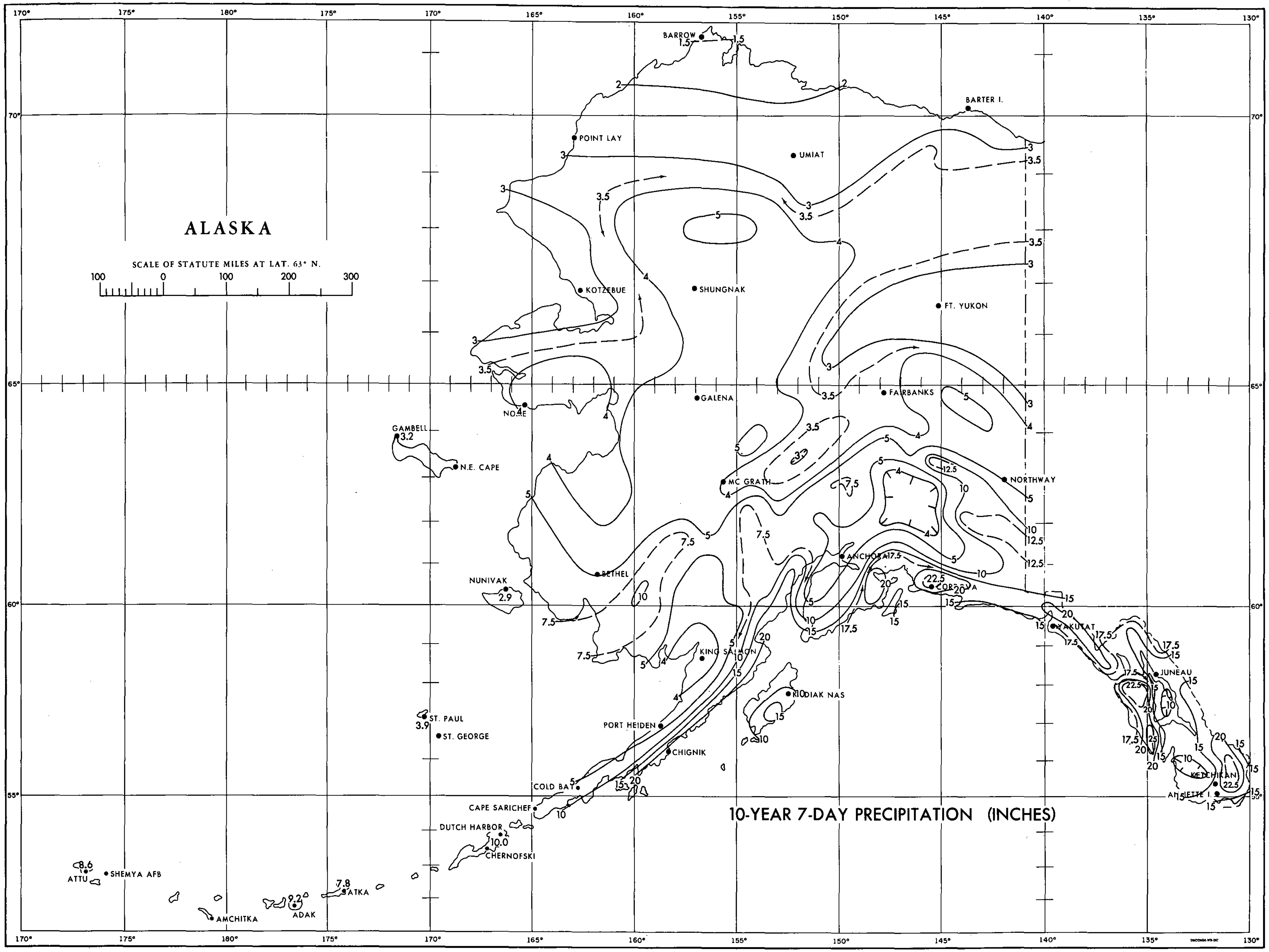

FIGURE 25.—10-year 7-day precipitation (in.).

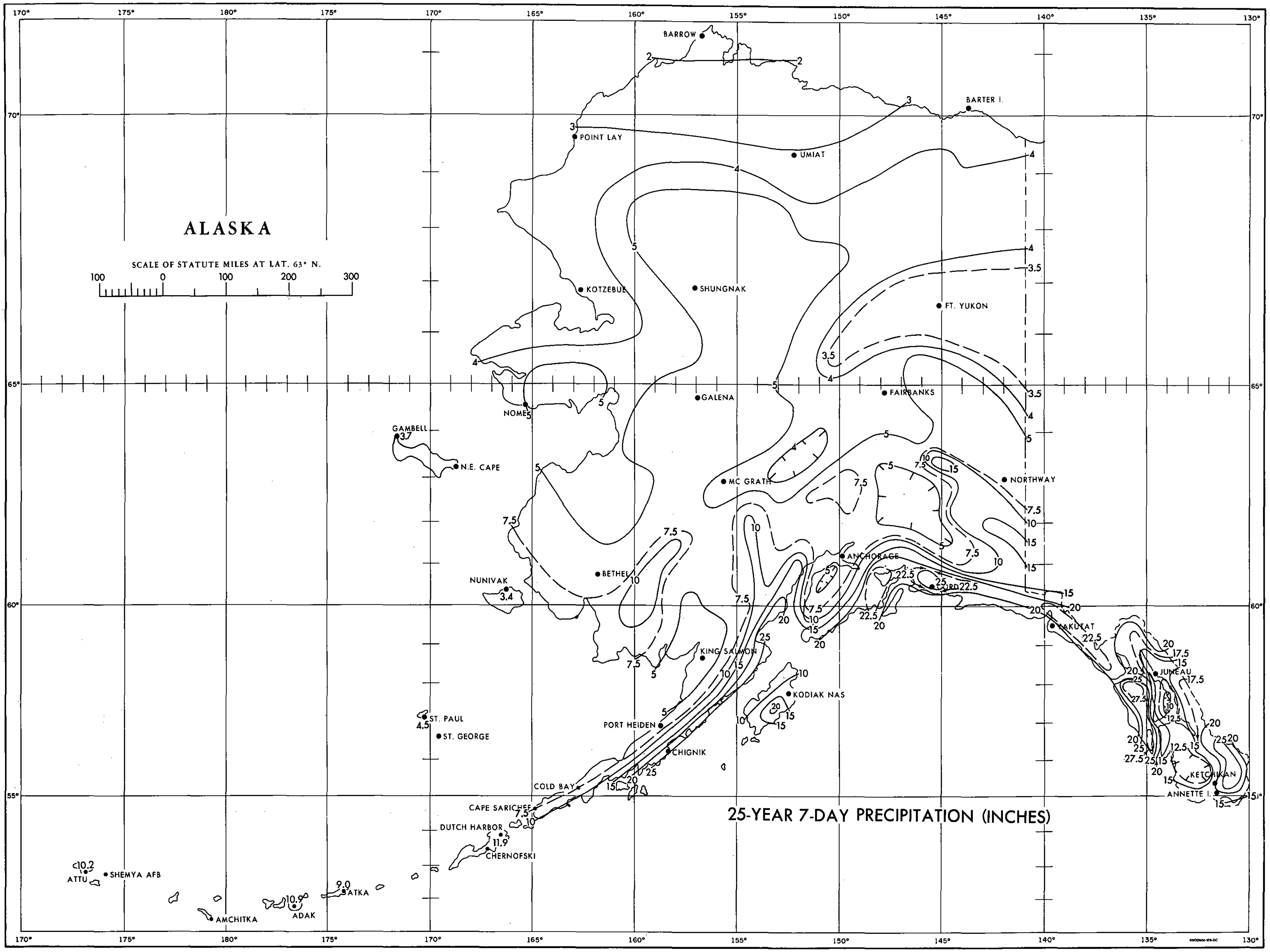

FIGURE 26.—25-year 7-day precipitation (in.).

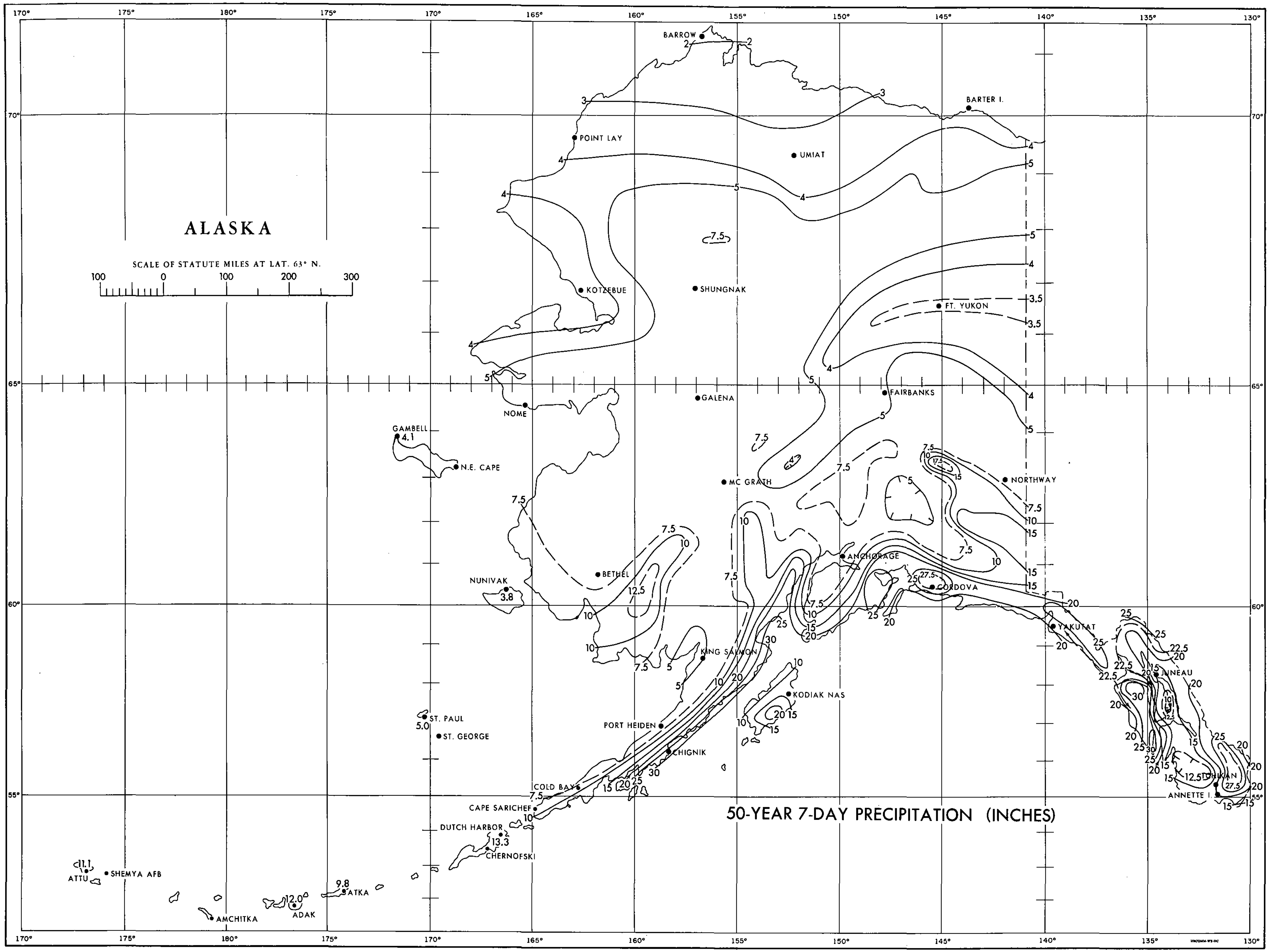

FIGURE 27.—50-year 7-day precipitation (in.).

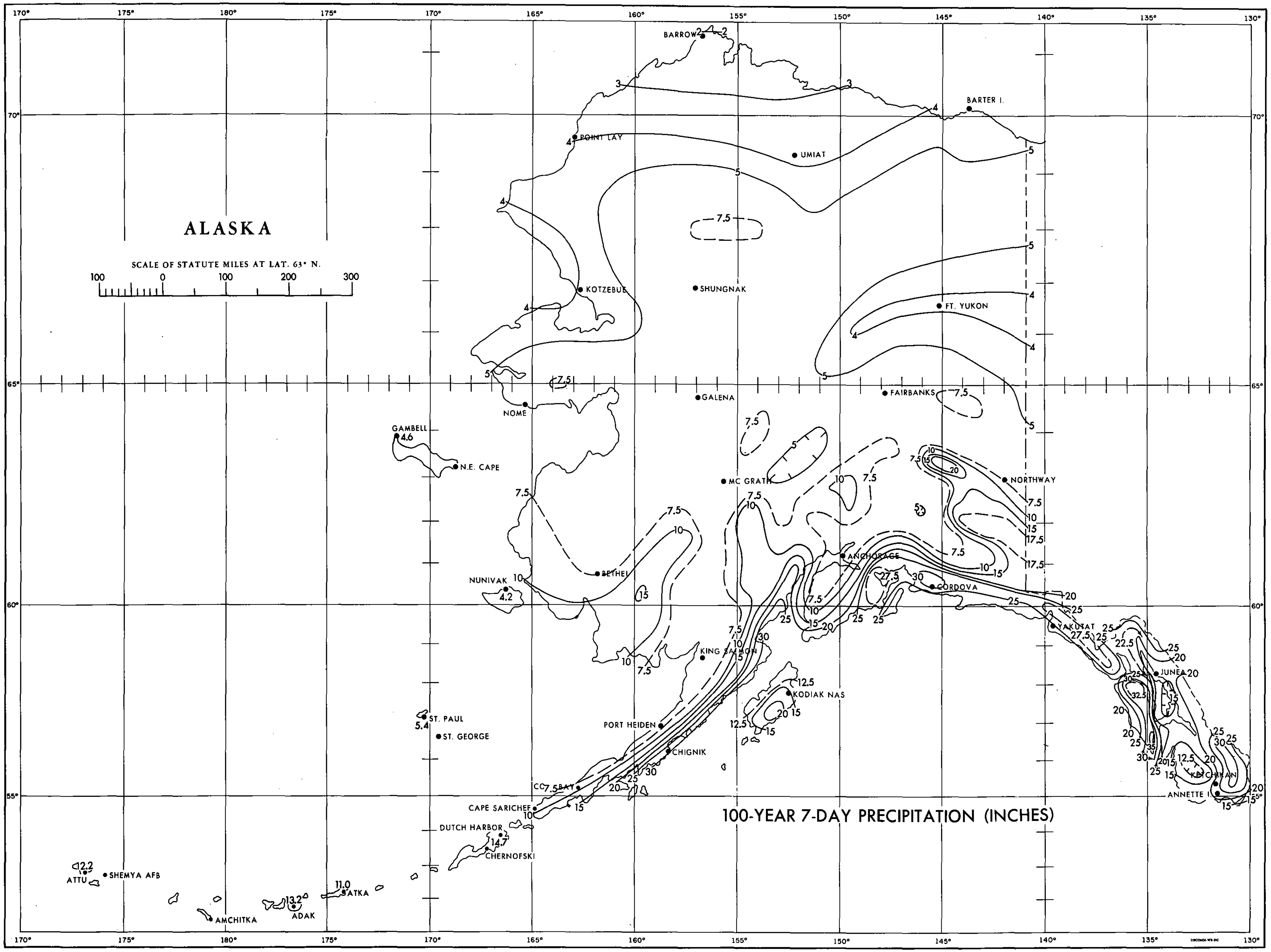

FIGURE 28.—100-year 7-day precipitation (in.).

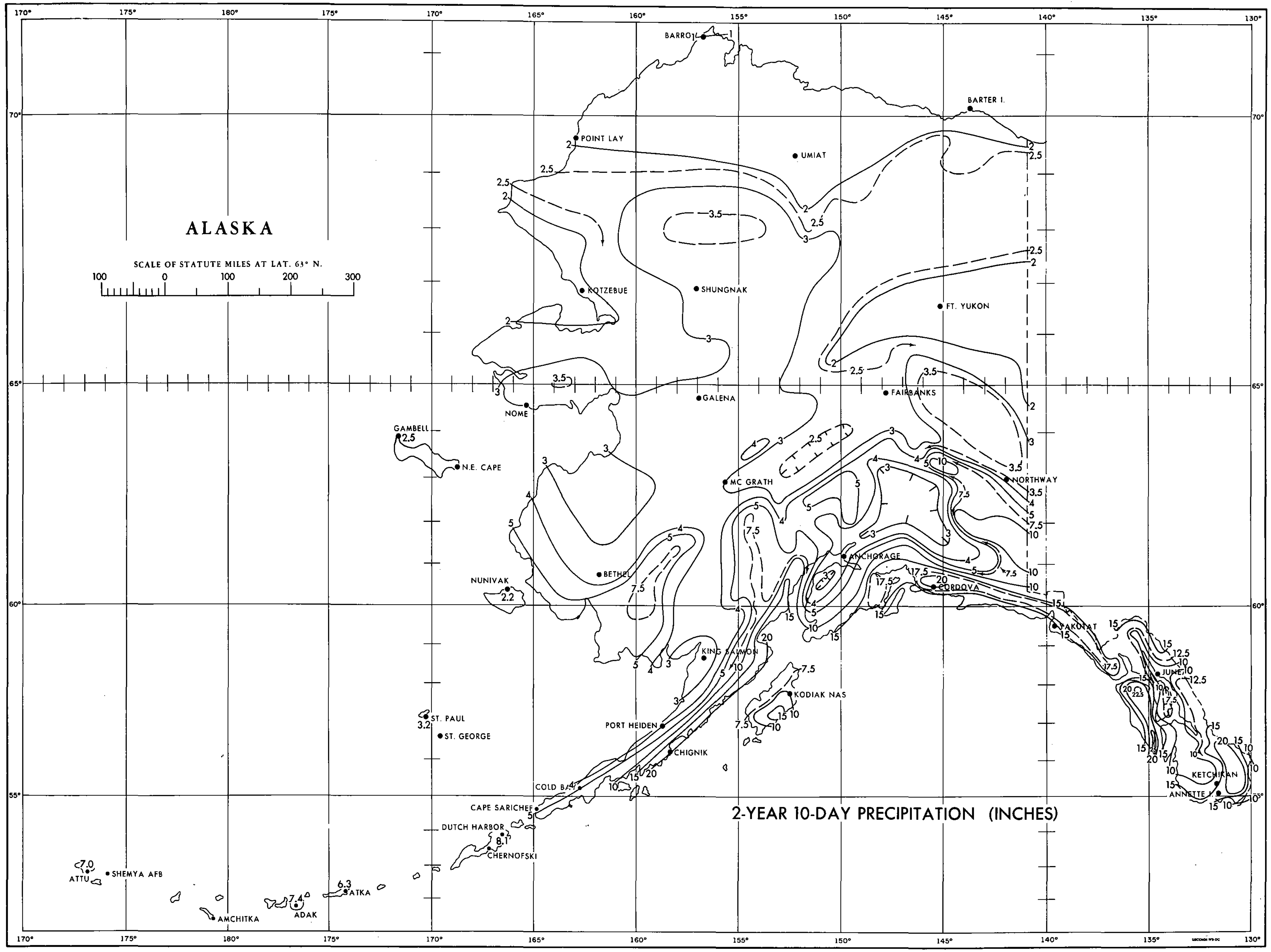

FIGURE 29.—2-year 10-day precipitation (in.).

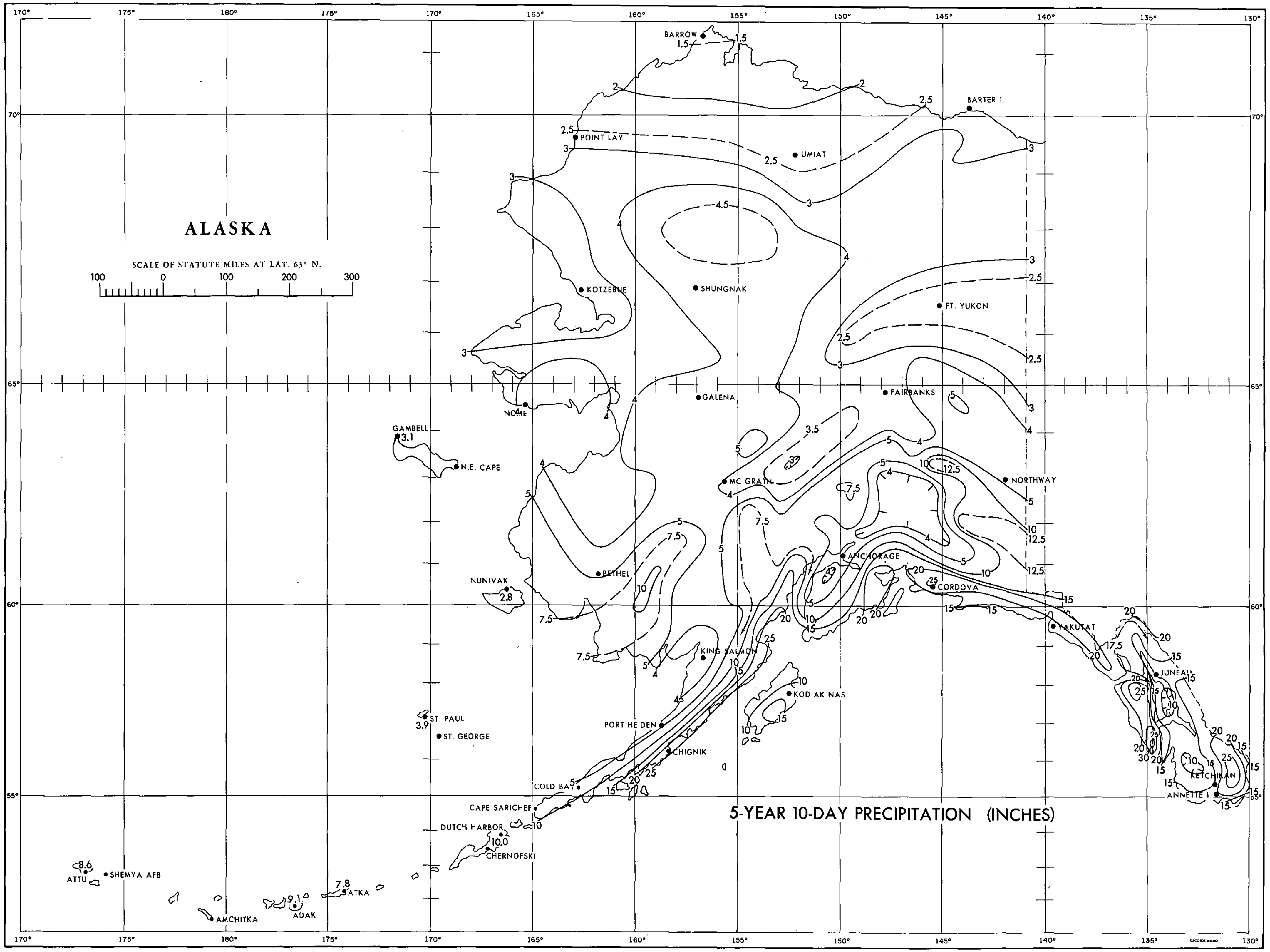

FIGURE 30.—5-year 10-day precipitation (in.).

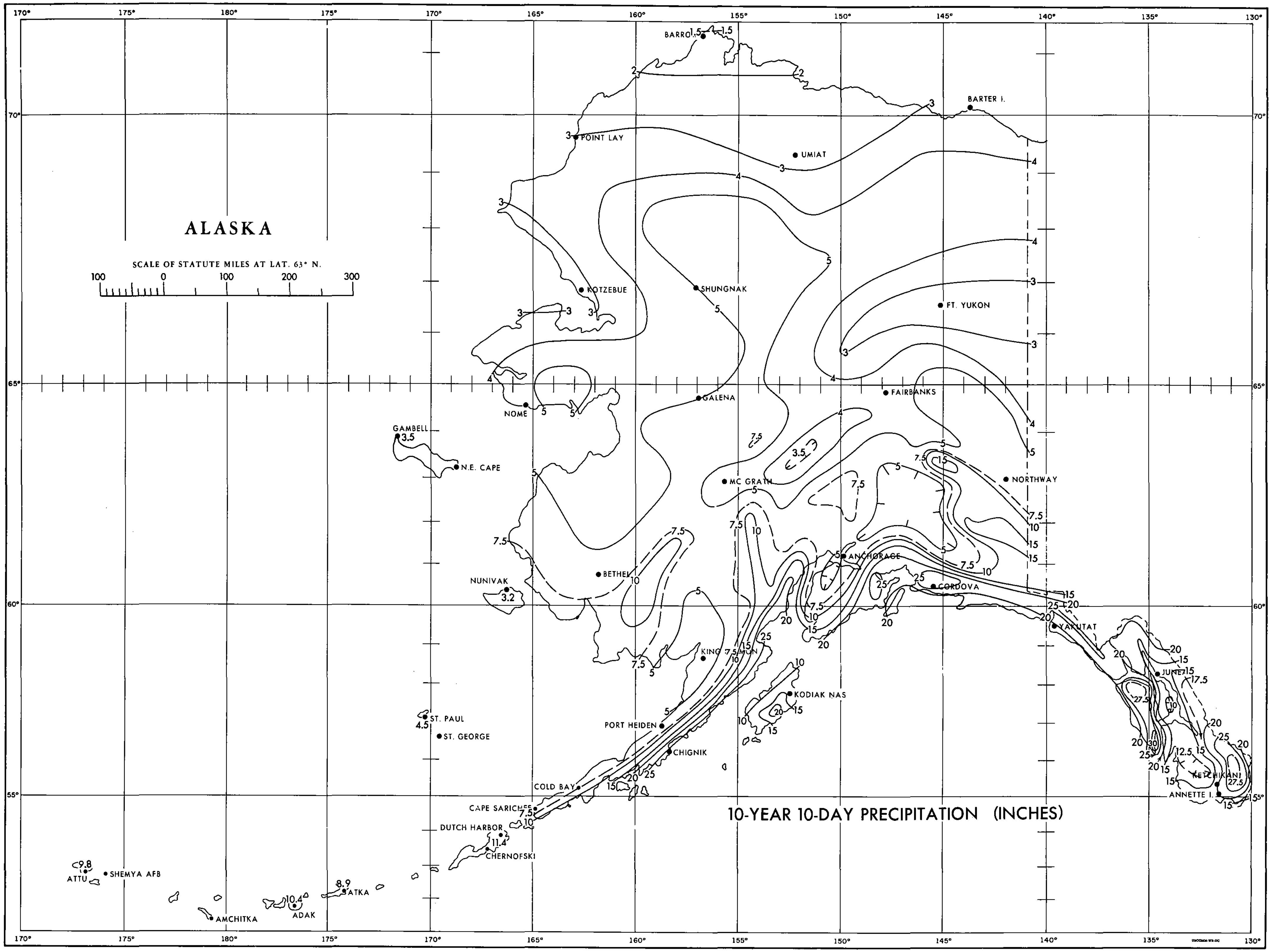

FIGURE 31.—10-year 10-day precipitation (in.).

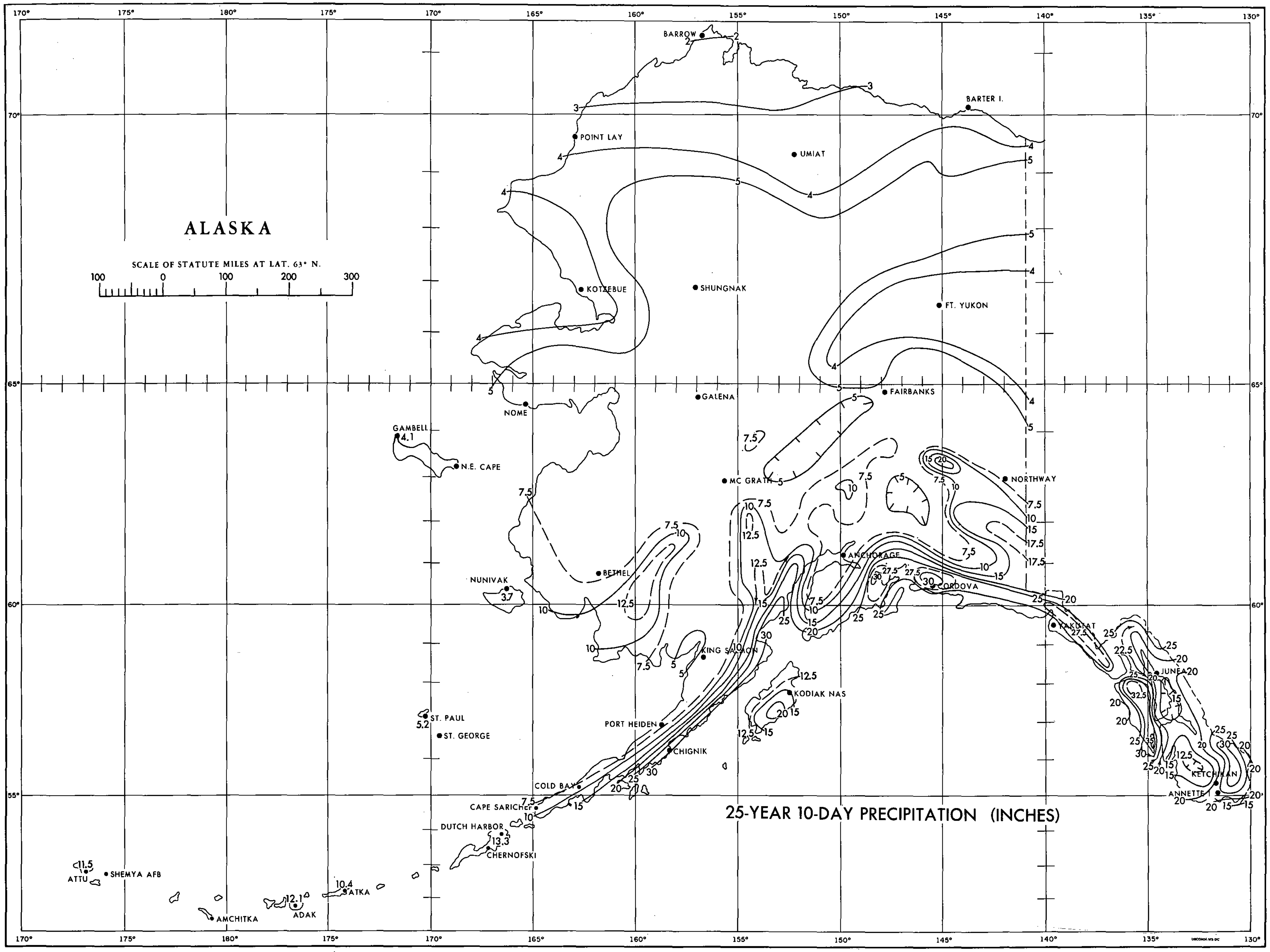

FIGURE 32.—25-year 10-day precipitation (in.).

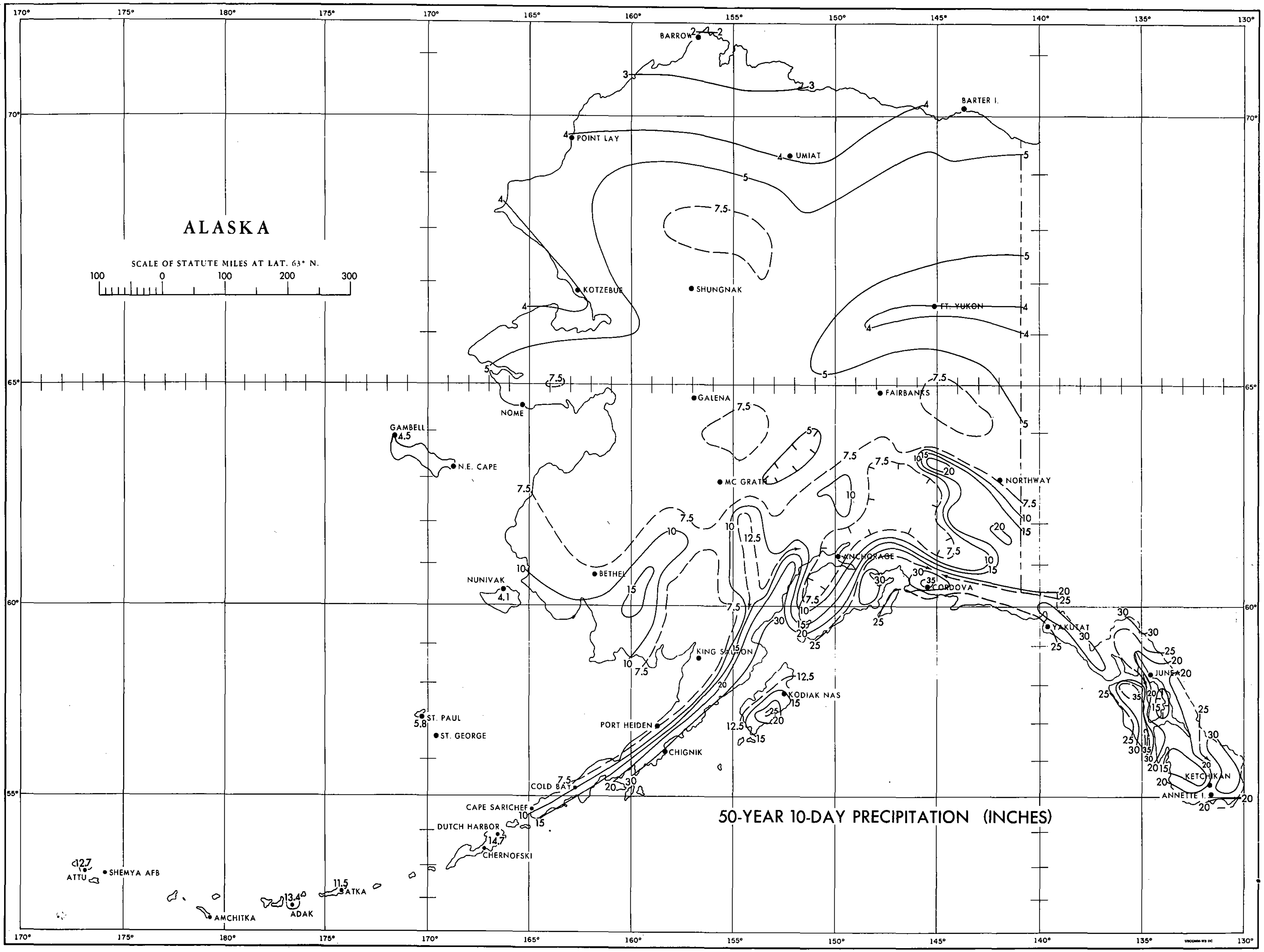

FIGURE 33.—50-year 10-day precipitation (in.).

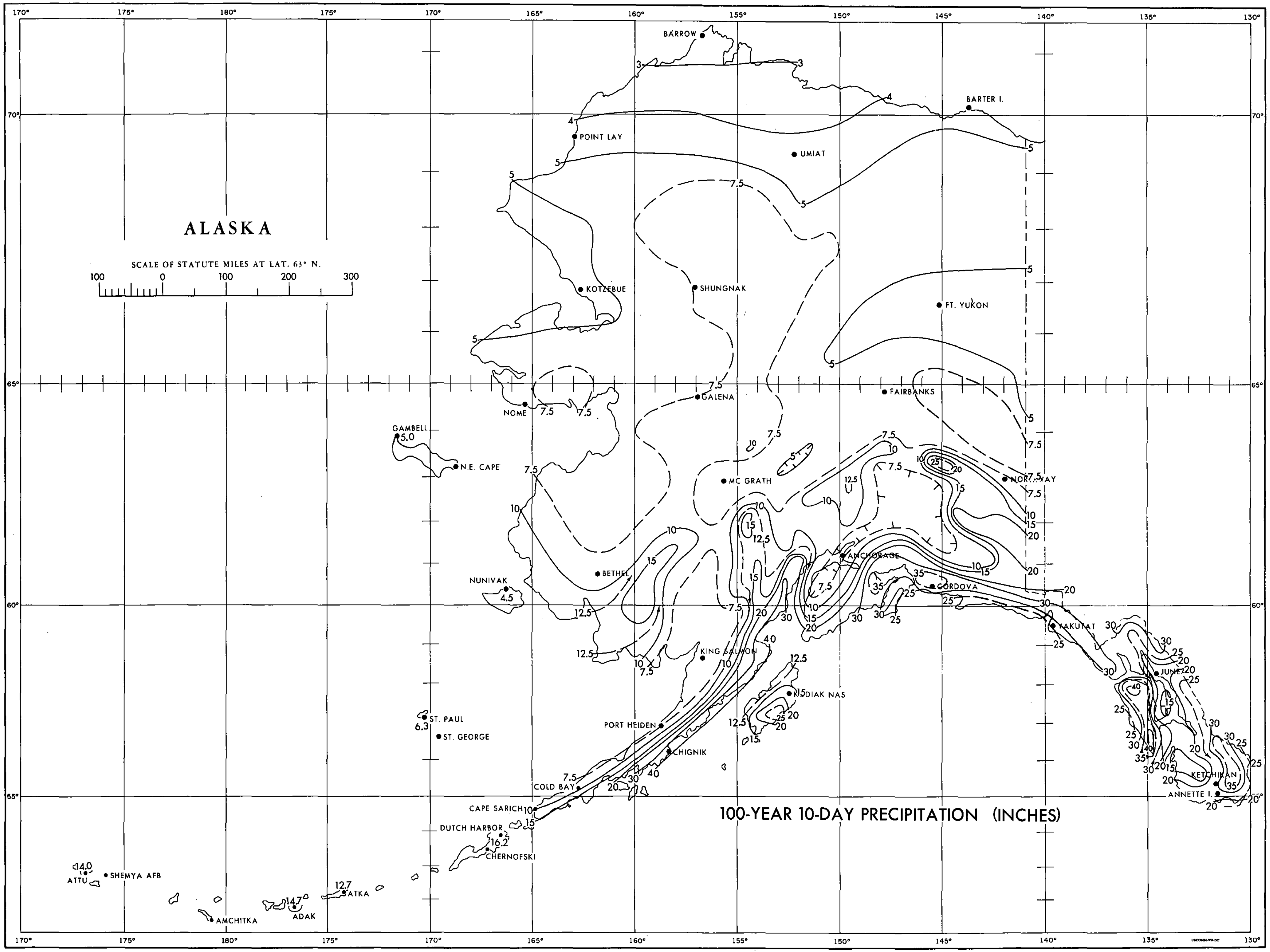

Figure 34.—100-year 10-day precipitation (in.).

U.S. GOVERNMENT PRINTING OFFICE: 1965 O—758-887

U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU
WASHINGTON, D.C. 20235