Misc

No. 10

Report on Water Development on

PORTION OF THE LITTLE COLORADO VALLEY

by Professor Gregory 1914

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REPORT ON WATER DEVELOPMENT

OF A

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by

Herbert E. Gregory.

February 3, 1914.

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Location.

The area discussed in this report, and regarding which information is desired by the Indian Office, includes Towns 25, 26, 27, 28, 29 N., Ranges 8, 9, and 10 E., Gila and Salt River Base and Meridian. The area is located within Coconino County, Arizona, and embraces portions of the Tusayan National Forest, of the Western Navajo Indian Reservation, and of the unassigned public lands.

Geography.

Topographically, the district consists of four areas of unlike expression; viz: (1) the Coconino Plateau, parts of Towns 28, 29, Range 8; (2) the lava plateau, portions of Towns 25, 26, 27, Ranges 8, 9, 10; (3) the canyoned lowland between the Coconino and lava plateaus on the west and south, and the Little Colorado on the northeast, embracing all or parts of Towns 28 and 29, Ranges 8, 9, and 10;

(4) the flat lowland bordering the Little Colorado river on the east, towns 28, 29, and part of 27, Ranges 9 and 10. All locations given above are approximate since part of the area has not been surveyed.

Area I.-

The Coconino plateau, 6700-7000 feet elevation, is sharply bounded on the southeast, east and north by sloping walls 800-1000 feet in height, ascended at one point by a trail. Much work has been done on this trail and by the expenditure of some thousands of dollars it could be made practicable for lightly loaded wagons. A much more feasible route to the plateau from the Indian Reservation is obtained by following the southeastern edge of the plateau southwestward, then turning north into the National Forest via Willow Tanks. The surface of the plateau is generally forested and is marked, except near its borders, by wide, flat-floored, shallow valleys; broad flat divides, and level parks. Only at the rim of the plateau are impassible canyons encountered. Forage is sufficiently abundant to make this area a stock country.

Area II.-

The lava plateau is in general rolling, and except for a few narrow, sharply cut canyons and the rough lava

flows is easy to traverse. Wide highland flats supply good grazing, which decreases in value toward the Little Colorado river. The most desirable portions are south and southwest of Black Point, where with development of water a considerable tract could be utilized the year round. Scattering trees of small size dot the plateau.

Area III. -

The canyoned lowland between Coconino Point and the Little Colorado river is exceedingly rough, being cut by innumerable narrow, steep-walled, shallow canyons, cut in sandstone and shales. The valley bottoms are of bed rock or thinly floored with gravel; the divides are narrow, generally of bare rock, and frequently wind-scoured. Strong winds tend to remove the soil and to expose rock or gravel pavements. The grass, though of good quality, is scattering and limited in amount. The Indians report that in certain years the forage is satisfactory, but in general the supply of feed is too limited to justify any large expenditure in water development.

Area IV.-

The flat lowland between the Little Colorado and the line of high cliffs bordering the Little Colorado on the east is desert and could not be utilized by more than a few Indians, even if water were abundant.

Surface Water Supplies.-

The Little Colorado is available for water in all seasons, for even when its bed is dry, water may be found in pools or obtained by digging shallow pits. A group of springs containing abundant water of excellent quality is found at A, ranch, another at Tanners Crossing. Both springs, however, are so close to the Little Colorado as to be of no value in extending the grazing range. Tappan Springs, 4± miles from the Little Colorado, is one of the best water supplies within the Indian country. This spring serves as an outlet for the underground drainage from Cedar Wash (Hull Wash?) which insures a permanent flow of about 15 gallons per minute, and supplies a small stream at all seasons. The area immediately surrounding Tappan Spring is of little value for grazing, even if not overgrazed; but this unfailing supply makes possible the utilization of a district to the west and northwest, and in connection with a supply which could be developed between Tappan Spring and Coconino Point, will serve to bring the grazing lands of Town 29, Range 8, within the reach of water. Irrigation could here be practised in a small way, and if a resident farmer is to be located in this section, Tappan Springs is recommended as a site.

With the exception of the river and these springs, and a few unimportant seeps, no permanent surface water is to be found in the area studied. The absence of surface water is due to the configuration of the ground and the

quality of the rainfall, as well as to the amount of precipitation. The water which falls passes rapidly into drainage channels and hurries to the river or is absorbed by cracks and by the gravel floors of the washes. The problem is, therefore, how best to conserve the rainfall. On the Coconino plateau where the precipitation of about fifteen inches is rendered more valuable because of snow, inexpensive earth dams constructed at suitable places in the larger washes have been found to meet the needs of cattlemen. Many more such tanks could be constructed in this area (No. I) by use of either earth or concrete. On the lava plateau (Area No.II) which has a precipitation, including snow, of probably 6-8 inches per year, "tanks" are feasible, but their sites must be chosen with care in order to provide against soakage into the porous ash and fractured lava. The run-off from regions nearer the river (Areas 3 and 4) may likewise be preserved by "tanks", though with less assurance of success, since the rainfall averages less than 5 inches and the evaporation is excessive (6+ inches per year). Too much reliance should not be placed on "tanks", unless they are planned to meet the demands of the drier seasons, and even then times will come when stock must rely on Tappan Spring and the Little Colorado River, for the rainfall records indicate a variability of 100 inches, and seasons or years may record practically no precipitation in the Little Colorado valley.

Underground Water Supplies.-

The geological structure of the area under consideration, in respect to position of deep ground water supplies, is indicated in the accompanying diagrams. Along the line of Section I, the favorable structure is offset by the fact that a relatively small portion of the limited rainfall of the Coconino plateau is absorbed by the continuous strata of resistant limestone, and by the greatly dissected, canyoned rock floor largely bare of soil and of vegetation between Coconino Point and the river. There is, however, a reasonably favorable prospect for wells reaching the shales at a depth of 400-600 feet, and located at the base of the plateau,-for example at W_1. Along the line II, a drilled well at W_2 to a depth of 200-300 feet in, or on the border of, Cedar Wash, would tap ground water from the Coconino plateau and intercept the underflow of Cedar wash. Wells sunk along the lines of Sections III and IV, as at W_4 or W_5 or further south, would be problematical. The relations of ash and lava to the underlying limestone, sandstone, and shale are unknown. Wells sunk in similar materials in this region have so far proven failures. For instance, the 657-foot well at Winona obtained no water. All these wells will yield hard water, and those terminating in sandstone and shale are very likely to give alkaline or salt water. If experimental wells are to be sunk in this region, the points indicated on the map (W_1, W_2, W_3, W_4, W_5) are recommended as likely to furnish the most useful data. It should be noted

that wells sunk anywhere in this area except on the Coconino plateau are liable to be useless, not because of failure of water, but because of the fact that in seasons when wells are most needed, the absence of feed in their vicinity demands the removal of stock to other districts.

For domestic purposes 10-20-foot dug wells in the washes of the Coconino plateau, as well as in the stream channels of the lower lands, will furnish small amounts of water of good quality, and less contaminated than the supplies from tanks and from the river.

Conclusions.-

(1) Because of aridity and consequent distribution of feed the only portion of this area which will justify the expenditure of considerable funds for water development is the Coconino Plateau (Area I). The lava plateau (Area II) ranks next in possibilities.

(2) Without the free use of a considerable portion of the Coconino Plateau, the Navajos can maintain themselves as sheep men in this area only on a precarious footing, unless their numbers are strictly limited.

(3) Considerable portions of the Navajo reservation, at present not utilized, furnish better opportunities for successful sheep raising than do Areas 2, 3, and 4.

(4) The whole region is much better adapted to cattle than to sheep, and regardless of future water developments will remain so, on account of scattered and limit-

ed feed. For cattle the present water supply, supplemented by a few more tanks, is ample in average years.

(5) Agriculture relying on irrigation is beyond reasonable possibilities except at Black Falls, where the conditions are good (See my report, submitted January 11, 1910).

(6) The region is distinctly one for the development of tanks rather than of wells - except shallow wells for limited domestic supply.

(7) Development of water in this region is better handled by a practical farmer and stockman, equipped with scrapers, shovels and concrete, than by well-drilling outfits under the direction of a geologist or engineer.

Recommendations.-

(1) That the advisability of removing all Indians from the west side of the Colorado river be considered.

(2) That if the Indians are to remain and to increase in population and in size of sheep holdings, a considerable portion of the Coconino plateau be thrown open to them.

(3) That an effort be made to meet the local needs by the construction of rain-water tanks before drilling for stock purposes is resorted to.

(4) That if sinking of experimental wells be considered advisable they be first sunk at the points indicated on the map.

(5) That development of water in the four areas proceed in the following manner:

Area I, Coconino Plateau. Construct tanks by building earth dams. Fairly impervious material for dams is abundant and the topography is such that one of several suitable locations would be noted by any practical man in the field. A site should, of course, be chosen on bed rock or clay in a wash whose drainage area includes a high per cent of grass lands or of bare rock. Water for domestic purposes may be obtained from shallow wells dug in, or on the borders of, the wash floor. Drilled wells are not advised for Area I.

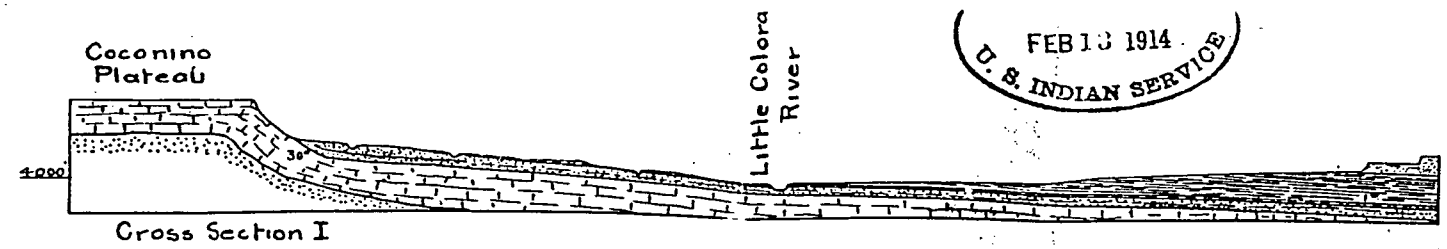
Area II, The lava plateau. Construct tanks on rock floors of narrow washes, or in any one of the numerous shallow canyons, especially at dry waterfalls. Any one of a number of localities are suitable for impounding small supplies, provided the pervious volcanic ash is avoided. On account of the poor quality of fill material, concrete is advised. All tanks in this area should be of generous proportions, and should be cleaned of debris each season. As indicated above, wells in this area are of uncertain value, but there is a fair chance of striking a water bed in the ash between the lava and the limestone, and in the joints of the limestone and sandstone.

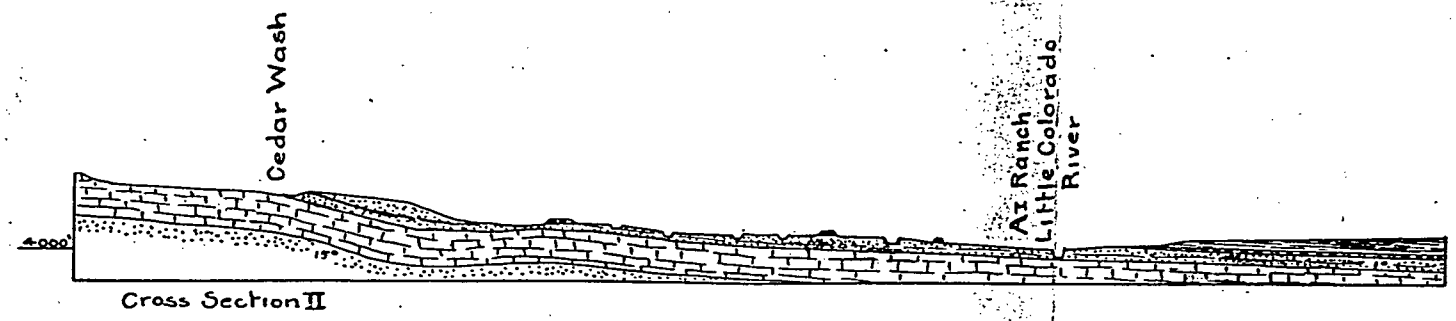
Area III. Construct tanks by building earth or concrete dams. The most favorable localities are within two

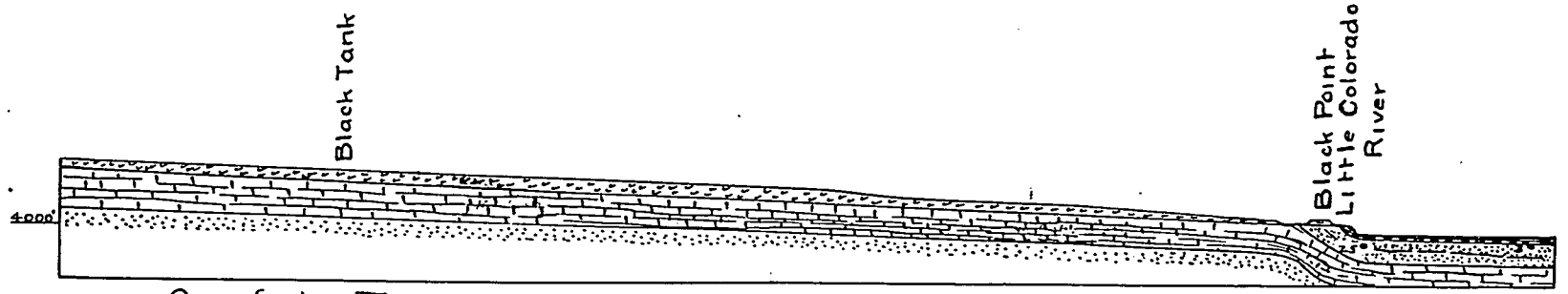
miles of the steep east face of Coconino plateau. Along this line sixteen (16) limestone-floored channels conducting water from the plateau rim were noted, any one of which is capable of development by constructing dams 40-100 feet long. The stream gradients are 3°-10° and the rock walls are practically vertical. Drilled wells in Area III may reasonably be expected to recover water, but are not recommended because of the probable limited supply, the probability of poor quality, and their cost as compared to tanks, for the building of which Indian labor is available. Much more could be made of Tappan Springs, by constructing a reservoir (preferably of concrete) and piping the water to nearby points.

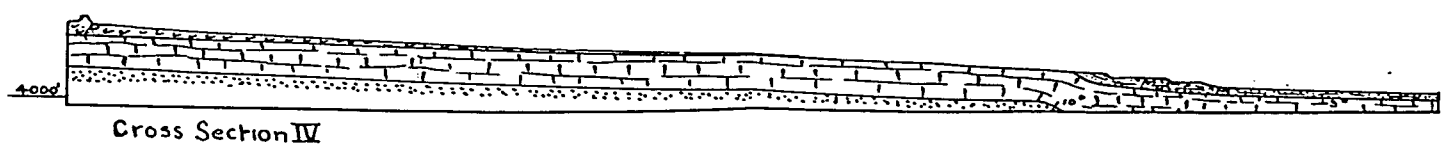
Area IV, Flat lowland. Wells sunk to depths of 50-100 feet in the alluvial deposits, at the base of the cliffs along the eastern edge of Town 29, Range 10, would doubtless yield water. The shales of this area are, however, charged with much gypsum and some salt, and there is exceedingly little forage to be obtained.

(6) That if the Navajos are to be left in possession of this area, a resident farmer be supplied, not only because of possible conflicts of Indians with whites, but also to see that the limited water supplies are properly husbanded and utilized. Locations recommended are Black Falls, Black Point, A1 ranch, and Tappan Springs.









Legend

- Lava
- Shale
- Sandstone and Shale
- Conglomerate
- Massive Limestone

Semi Diagramatic Sections

to

Accompany Report

by.

H. E Gregory

For Locations See Map 1 in. horizontally = 2 mi. 1 in. vertically = 5000'

DESCRIPTION OF THE TOPOGRAPHIC MAP OF THE UNITED STATES

The United States Geological Survey is making a topographic map of the United States. This work has been in progress since 1882, and about one-fifth of the area of the country, including Alaska, has been mapped. The mapped areas are widely scattered, nearly every State being represented, as shown on the progress map accompanying each annual report of the Director.

This great map is being published in atlas sheets of convenient size, which are bounded by parallels and meridians. The four-cornered division of land corresponding to an atlas sheet is called a *quadrangle*. The sheets are of approximately the same size: the paper dimensions are 20 by 16½ inches; the map occupies about 17½ inches of height and 11½ to 16 inches of width, the latter varying with latitude. Three scales, however, are employed. The largest scale is 1:62500, or very nearly one mile to one inch; i. e., one linear mile on the ground is represented by one linear inch on the map. This scale is used for the thickly settled or industrially important parts of the country. For the greater part of the country an intermediate scale of 1:125000, or about two miles to one inch, is employed. A third and still smaller scale of 1:250000, or about four miles to one inch, has been used in the desert regions of the far West. A few special maps on larger scales are made of limited areas in mining districts. The sheets on the largest scale cover 15′ of latitude by 15′ of longitude; those on the intermediate scale, 30′ of latitude by 30′ of longitude; and those on the smallest scale, 1° of latitude by 1° of longitude.

The features shown on this map may, for convenience, be classed in three groups: (1) *water*, including [illegible] lakes, [illegible] and the like; (2) *relief*, including mountains, hills, valleys, cliffs, etc.; (3) *culture*, i. e., works of man, such as towns, cities, roads, railroads, boundaries, etc. The conventional signs used for these features are grouped below. Various

the larger streams, lakes, and the sea by blue water lining. Certain streams, however, which flow during only a part of the year, their beds being dry at other times, are shown, not by full lines, but by lines of dots and dashes. Ponds which are dry during a part of the year are shown by oblique parallel lines. Salt-water marshes are shown by horizontal ruling interspersed with tufts of blue, and fresh-water marshes and swamps by blue tufts with broken horizontal lines.

Relief is shown by contour lines in *brown*. Each contour passes through points which have the same altitude. One who follows a contour on the ground will go neither uphill nor downhill, but on a level. By the use of contours not only are the shapes of the plains, hills, and mountains shown, but also the elevations. The line of the seacoast itself is a contour line, the datum or zero of elevation being mean sea level. The contour line at, say, 20 feet above sea level is the line that would be the seacoast if the sea were to rise or the land to sink 20 feet. Such a line runs back up the valleys and forward around the points of hills and spurs. On a gentle slope this contour line is far from the present coast line, while on a steep slope it is near it. Thus a succession of these contour lines far apart on the map indicates a gentle slope; if close together, a steep slope; and if they run together in one line, as if each contour were vertically under the one above it, they indicate a cliff. In many parts of the country are depressions or hollows with no outlets. The contours of course surround these, just as they surround hills. Those small hollows known as sinks are usually indicated by hachures, or short dashes, on the [illegible] side of the curves. The [illegible] between one contour and the next [illegible] the bottom of each map. This interval varies according to the character of the area mapped; in a flat country it may be as small as 10 feet, in a mountainous region it may be 200 feet. Certain

are also given, the number in each case being placed in close proximity to the point to which it applies.

The works of man are shown in *black*, in which color all lettering also is printed. Boundaries, such as State, county, city, land-grant, reservation, etc., are shown by broken lines of different kinds and weights. Cities are indicated by black blocks, representing the built-up portions, and country houses by small black squares. Roads are shown by fine double lines (full for the better roads, dotted for the inferior ones), trails by single dotted lines, and railroads by full black lines with cross lines. Other cultural features are represented by conventions which are easily understood.

The sheets composing the topographic atlas are designated by the name of a principal town or of some prominent natural feature within the district, and the names of adjoining published sheets are printed on the margins. The sheets are sold at five cents each when fewer than 100 copies are purchased, but when they are ordered in lots of 100 or more copies, whether of the same sheet or of different sheets, the price is two cents each.

The topographic map is the base on which the facts of geology and the mineral resources of a quadrangle are represented. The topographic and geologic maps of a quadrangle are finally bound together, accompanied by a description of the district, to form a folio of the Geologic Atlas of the United States. The folios are sold at twenty-five cents each, except such as are unusually comprehensive, which are priced accordingly.

Applications for the separate topographic maps or folios of the Geologic Atlas should be addressed to—

THE DIRECTOR,

United States Geological Survey,

intermediate scale, 30′ of latitude by 30′ of longitude; and those on the smallest scale, 1° of latitude by 1° of longitude.

The features shown on this map may, for convenience, be classed in three groups: (1) *water features*, [illegible] streams, canals, swamps, etc.; (2) *relief features*, mountains, hills, valleys, cliffs, etc.; (3) *culture*, i. e., works of man, such as towns, cities, roads, railroads, boundaries, etc. The conventional signs used for these features are grouped below. Variations appear in some maps of earlier dates.

All water features are shown in *blue*, the smaller streams and canals in full blue lines, and

the country are depressions or hollows with no outlets. The contours of course surround these, just as they surround hills. Those small hollows known as sinks are usually indicated by hachures, [illegible] the bottom of each map. This interval varies according to the character of the area mapped; in a flat country it may be as small as 10 feet, in a mountainous region it may be 200 feet. Certain contours, usually every fifth one, are accompanied by numbers stating elevation above sea level. Many other heights, instrumentally determined,

of the United States. The folios are sold at twenty-five cents each, except such as are unusually comprehensive, which are priced accordingly.

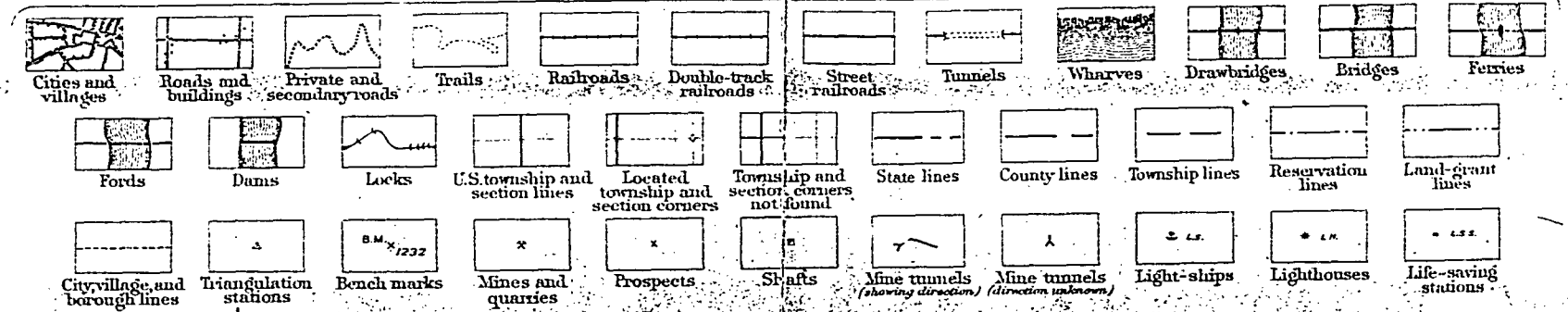
Applications for the separate topographic [illegible] of the Geological Atlas should be addressed to—

THE DIRECTOR,
United States Geological Survey,
Washington, D. C.

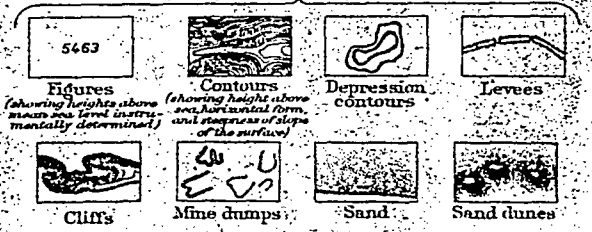
September, 1899.

CONVENTIONAL SIGNS

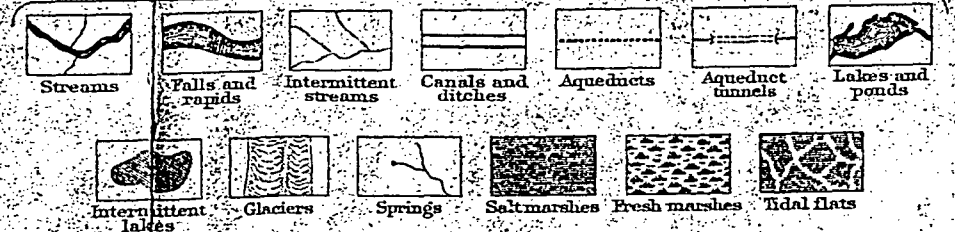
CULTURE
(printed in black)

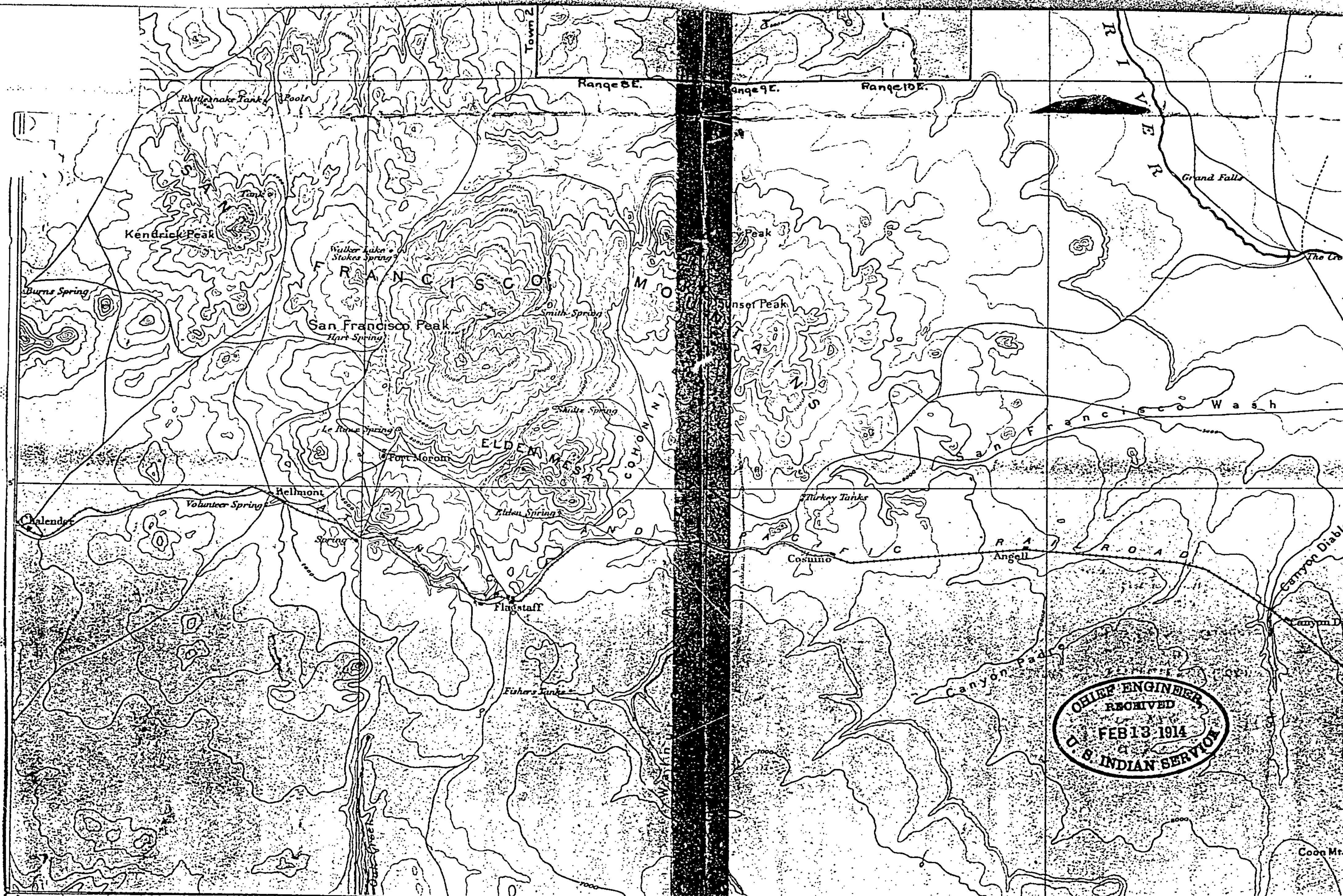


RELIEF
(printed in brown)



WATER
(printed in blue)





Henry Gannett, Chief Geographer.
A.H. Thompson, Geographer in charge.
Triangulation by H.M. Wilson and A.P. Davis.
Topography by the U.S. Geological and Powell Surveys.

Powell 1878	
H.M. Wilson 1884	1880
H.L. Goode	

Contour interval 250 feet

Edition of Sept 1894 reprinted

AL SURVEY.
DIRECTOR.

RECONNAISSANCE MAP

SAN FRANCISCO MTS