The Survey of the 1899 USGS Grand Teton Topographic Quadrangle

By Todd Cedarholm
USGS Teton South Base, T.M. Bannon 1896, 1898
USGS BM, 6404.651 ft, G. Drummond, 1899 ID-WY State Line, 2013 OPUS solution 6408.523 ft NAVD88 = 3.87’
Grand Teton Quadrangle

Surveyed by TM Bannon and Arthur Stiles in 1899
Published in 1901
Scale = 1/125000, 30 min x 30 min
Contour interval 100 feet
Datum is mean sea level
Sheet size 16 ½ “ x 20”
Modern 7.5’ quad 18” x 26”
Grand Teton 13,747 feet 1899
Grand Teton 13,750 feet 1912
The Four Great Surveys

The Geological Exploration of the Fortieth Parallel
    The King Survey, 1867-1879

The U.S. Geographical Survey West of the 100th Meridian
    The Wheeler Survey, 1868-1879

The U.S. Geographical and Geological Survey of the Territories
    The Hayden Survey, 1867-1879

The U.S. Geographical and Geological Survey of the Rocky Mountain Region
    The Powell Survey, 1867-1879
“1875 Progress Map of the Geographical Surveys West of the 100th Meridian”
1st Lieutenant George M. Wheeler, Corps of Engineers
“Preliminary Map No. 2, 1872 and 1873”
US Geological and Geographical Survey of the Territories
J.W.Powell, Geologist in Charge
Topographical Maps I-V, 1876
Geological Exploration of the Fortieth Parallel
Clarence King, U.S. Geologist in Charge
Topographical Sheet V, Rocky Mountains, 1876
Geological Exploration of the Fortieth Parallel
Clarence King, U.S. Geologist in Charge
Sources of the Snake River

US Geological Survey of the Territories,
Snake River Expedition, 1872
FV Hayden in Charge
Gustavus R. Bechler
Chief Topographer
W.H. Holmes profile sketch of the Teton Range from the top of Black Tail Butte, Hayden Survey, 1872.

inset: copper bolt survey marker, Black Tail Butte
“Map Showing the Primary Triangulation of 1877-8”
US Geological Survey of the Territories,
F.V. Hayden in charge, A.D. Wilson Chief Topographer
“Parts of Western Wyoming and Southeastern Idaho”
US Geological and Geographical Survey of the Territories,
F.V. Hayden 1878
Original scale 4 miles = 1 inch  1:253440 Contour interval = 200 feet
Triangulation by A.D. Wilson, G.R. Bechler and Fred A. Clark Topographical Asst.s
Grand Teton Quadrangle

Surveyed by TM Bannon and Arthur Stiles in 1898-1899
Published in 1901
Scale = 1/125000, 30 min x 30 min
Contour interval 100 feet
Datum is mean sea level
Sheet size 16 ½ “ x 20”
Modern 7.5’ quad 18” x 26”
Grand Teton 13,747 feet 1899
Grand Teton 13,750 feet 1912
USGS NW Wyoming Chronology of Events

- 1891 Edward Gillette performs a railroad level survey from the South Fork of the Shoshone River south west of Cody, over the continental Divide and downstream along the Buffalo Fork. He sets a iron post in a meadow for a bench mark 15 miles upstream of Turpin Meadow.

- 1892 USC & GS personnel establish the latitude and longitude of the Lake Astro Station in Yellowstone NP by a telegraphic connection to the Helena MT observatory.

- 1894 Charles D. Walcott succeeds Powell as the 3rd Director of the USGS.

- 1896 S.S. Gannett measured the Ranchester Base Line for the Sheridan to Jackson Hole triangulation network.

- 1896 S.S. Gannett determined the latitude and longitude of the Sheridan Astro Station in Sheridan, WY by a telegraphic connection to the Washington University Observatory, in St. Louis, MO.

- 1896 W.S. Post commences the Sheridan to Jackson Hole triangulation network working west from Sheridan and Ranchester to Cloud Peak and Heart Mountain.

- 1896 Congress passes the Sundry Civil Act requiring “..at least two posts or bench marks to be established in each township or equivalent area…”

- 1897 Congress passes the Sundry Civil Act authorizing the topographic survey of the Forest Reserves including the Teton and Yellowstone.
USGS NW Wyoming Chronology of Events (cont)

- 1897-8 USGS topographers Frank Tweedy and T.M. Bannon continue the triangulation network westward to the Lake Astro Station in Yellowstone and southward to Jackson Hole.
- 1897 USGS level team C.W. Beach and Goyne Drummond run levels from the Buffalo Fork/Gillette post to the Teton North Base.
- 1898 T.M. Bannon measures the Teton Verification Baseline.
- 1898, August 11. William Owen climbs the Grand Teton and plants a flag on the summit allowing the USGS surveyors to precisely triangulate to the summit and calculate the height of the peak.
- 1898 “late August” T.M. Bannon survey party ascend a unclimbed peak south of the Grand Teton and establish “Buck Station”, the first topographic station in the high peaks of the Tetons.
- 1898, August 13. T.M. Bannon “accidently noticed Owen’s flag on the summit of the Grand Teton and so appropriated this for subsequent triangulations”
- 1899 Goyne Drummond continues the level survey from Jackson Hole, over Teton Pass, through Pierres Hole and connects with the Oregon Short Line Railroad in St. Anthony Idaho.
- 1899 T. M. Bannon completes the topographic survey of the Grand Teton quadrangle.
- 1901 The USGS publishes the first edition of the Grand Teton quadrangle.
Determination of Latitude by the Talcott Method

1. Determine local meridian by polars.
2. Orient instrument along meridian.
3. Choose a pair of stars of similar longitude and with declinations of similar magnitude north and south of zenith. This eliminates error due to atmospheric refraction.
4. Measure the zenith angle of each star at meridian passage.
5. Calculate latitude.

**Figure 4.4. Horrobow-Talcott Method.**

The observer measures the zenith distances \( z \) and \( z' \) and looks up declinations \( d \) and \( d' \) for a pair of stars, \( S \) and \( S' \). He then calculates the latitude as

\[
L = \frac{1}{2}(d + d') + \frac{1}{2}(z - z').
\]

Illustration by Marjory Philp
Detail from Grand Teton Quadrangle
Surveyed by TM Bannon and Arthur Stiles in 1898-1899
Differential Leveling
Map of the Progress of Precise Leveling in the United States 1903-1907
US Coast and Geodetic Survey, Washington, 1909
The Erie Canal, constructed July 4, 1817 to October 26, 1825
Northern Pacific Railway, 1900
Red Lodge MT passenger station, Northern Pacific Railroad Co.

“The initial elevation for this work is a spike in a tie in front of the station at Red Lodge, taken as 5531 feet, as determined by the railroad company’s levels from St. Paul.” 18th Annual Report USGS pp360
Camp on Buffalo Creek, south of Yellowstone Park

Edward Gillette, Burlington and Missouri Railroad survey camp, 1891
Turpin Meadows USGS Benchmark 1st elevation established in Jackson Hole by differential leveling.

Buffalo Fork USGS Benchmark “B&M” Burlington and Missouri Railroad datum
Teton North Base, USGS 1896
“6832 Feet B&M Datum” Burlington & Missouri Railroad, E. Gillette 1891
Elevation of 6831.753 ft reported in Bulletin 558, “Results of Spirit Leveling in Wyoming, 1896-1912” Adjusted in 1912 up 3 feet to 6834.753’
2013 OPUS elevation 6838.880 feet NAVD88
2016 NGS Data Sheet 6839.3’ +/- 2cm △ = 4.127 feet

Stone reference mark for North Base
The Greenwich Meridian
The American Meridian
Originally established by the transfer of chronometers across the Atlantic.
The completion of the Trans-Atlantic cable in 1866 allowed for longitude determinations to be made with time measured via telegraph.
“Chart Showing Longitude Stations and Connections” 1846-1884
US Coast and Geodetic Survey report for 1884
Detail showing USC&GS telegraphic longitude connections to Greenwich
Sherman Astro Station
1st Astronomic Geodetic point established in Wyoming.
US Coast Survey, 1872
“…the astronomic position of this place was determined by Mr. S.S. Gannett in July. Telegraphic connection for longitude was had with the Washington Observatory at St. Louis and the latitude was determined by the Talcott Method…”
Sheridan train station 1896

Sheridan Astro Station and B & M Railroad station

Sheridan Astro Station marker
Latitude  44°48′31.10″
Longitude 106°56′45.21″
Sheridan Astro Station

Observed 1896
Latitude 44°48’31.10”
Longitude 106°56’45.21”

Adjusted 1896
Latitude 44°48’24.28”
Longitude 106°56’59.06”

OPUS-GPS 2015
Latitude 44°48’21.26463”
Longitude 106°57’05.48893”

Sheridan Astro Station GPS Survey, 11-9-2015
Station Buttermilk, the oldest existing triangulation marker in the US. First occupied on June 11, 1832 as part of the U.S. Coast Survey, New York Harbor Survey, by Ferdinand Hassler. Hassler was appointed the first superintendent of the US Coast Survey in 1816, later the US Coast and Geodetic Survey, now known as the NGS, National Geodetic Survey.
Figure 2.1. Triangulation Network.

Triangulation is a precise method of determining the relative distance and direction of points to be plotted on a map. The surveyor measures baseline $A-B$ and the angles of the triangles. He then computes the length of the sides of the triangles. Another baseline, $C-D$, is measured to check the accumulation of errors. Using the measured angles and computed side lengths, together with the latitude and longitude of one point, such as $A$, he then can calculate the latitude and longitude of every other point in the network. Illustration by Marjory Philp.
United States Coast and Geodetic Survey, “Status of the Survey, 1921”
USGS map “Astronomical Location, Primary Triangulation, Primary Traverse and Precise Leveling” USGS 21st Annual Report, 1898-1899
Measuring a triangulation baseline. Tripods or stools were used to support the steel tape against sag.

The south-east end of the Ranchester Base
A “Stone Man” cairn.

This is a sheep herder cairn on a bluff above the Shirley Basin north of Medicine Bow, WY. Probably very similar to the cairns used by the USGS surveyors as triangulation targets.
Cloud Peak mark
Elev 13,167’
Big Horn Mountains
Wyoming
Jackson Peak reference mark

Sheep Mountain reference mark
“Buck Station” reference mark

“Housetop Mt” now Fossil Peak, reference mark with elevation = 10800
1977 Mt Bannon quad 10916’
Lake Astro Station, Yellowstone NP, U.S. Coast and Geodetic Survey, C.H. Sinclair and G.R. Putnam, May 30 to June 30 1892. T.M. Bannon included this station in his triangulation network as a latitude-longitude check.
Ellipsoid Distance from 1896-8 positions: 319,797.521m
Calculated from 2015 OPUS-GPS: 319,772.530m
Difference = 24.99m
Precision = 1/13,000 +/-

Measured, 1898: 7586.46m
Calculated from Ranchester Base: 7586.24m
Calculated from OPUS-GPS Positions, 2015: 7586.25m
Two days later the banner and our stone monument on the summit were seen by Mr. T.M. Bannon of the United States Geological Survey, now operating in Jackson’s Hole.
Thank you to:

Wyoming Historical Society, 2014 Homsher Grant
Bill Resor, generous loan of original USGS quad sheets for scanning.
Cam Foster, Asymbol Imaging
Clifford M. Nelson, USGS Geologist/Historian, retired
Herbert W. Stoughton, PhD, US Defense Mapping Agency, retired
Angus Theurmer, Wyofile
The Geologists of Jackson Hole, John Hebberger and Steve Weichman
Mike Johnson, Sheridan, WY “The Keeper of the Astro Station”

Jen Ziegler