

U.S. Department of the Interior  
Geological Survey

Gravity base stations in the  
White Sulphur Springs 1<sup>0</sup> x 2<sup>0</sup> quadrangle, Montana

Viki Bankey and M.D. Kleinkopf

Open-File 85-108

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards. Any use of trade names is for descriptive purposes only and does not imply endorsement by the USGS.

U.S. Department of the Interior  
Geological Survey

Gravity base stations in the  
White Sulphur Springs 1° x 2° quadrangle, Montana

Viki Bankey and M.D. Kleinkopf

Open-File 85-108

This report describes 22 gravity base stations set by the U.S. Geological Survey (USGS) in the White Sulphur Springs, Montana, 1° x 2° quadrangle. Each USGS gravity base is referenced or updated to the International Gravity Standardization Net of 1971 (IGSN-71). Most of these bases were tied to one of the U.S. Department of Defense (DOD) gravity bases, although some bases were tied to secondary USGS bases previously tied to DOD bases. The DOD bases in the White Sulphur Springs quadrangle are at Harlowton, Helena (updated, this report), and White Sulphur Springs. Secondary bases were tied two or more times to ensure accuracy, and the average value of these ties is used as the observed gravity value.

Many of the gravity bases are set at bench marks. Those that are not are given estimated elevations based on contour interpolation from 1:24,000 or 1:62,500 scale topographic maps. These elevations are noted by the letters "est", which signifies an estimated elevation for that gravity base station.

These base description sketches are not drawn to scale and should be used with topographic maps.

SELECTED REFERENCES

Defense Mapping Agency Aerospace Center, 1974, World Relative Gravity Reference Network, North America, Part 2: DMAAC Reference Publication 25, with supplement updating gravity values to the International Gravity Standardization Net 1971, 1635 p.

International Association of Geodesy, 1967, Geodetic Reference System, 1967, International Association of Geodesy Special Publication 3, 74 p.

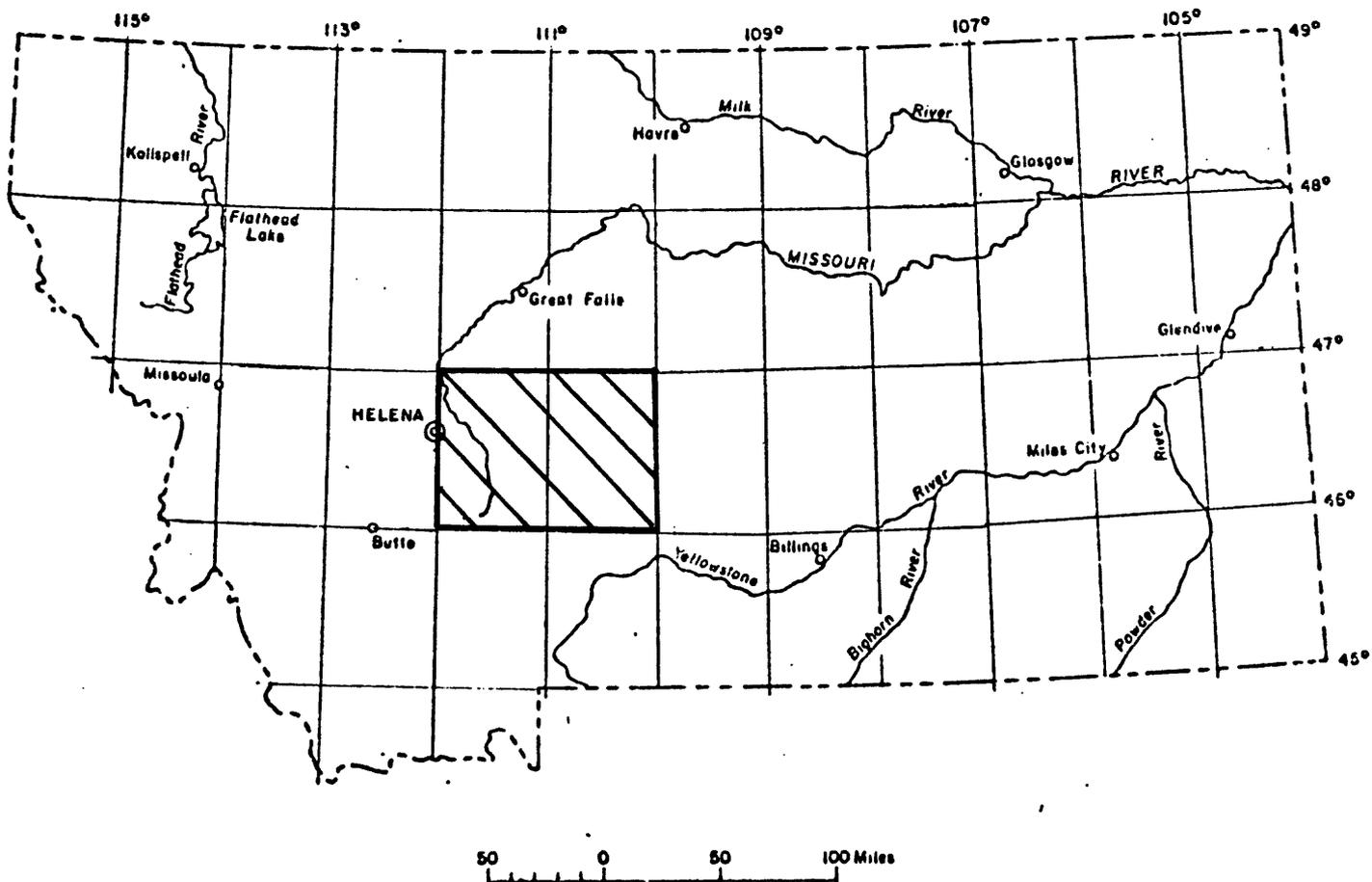


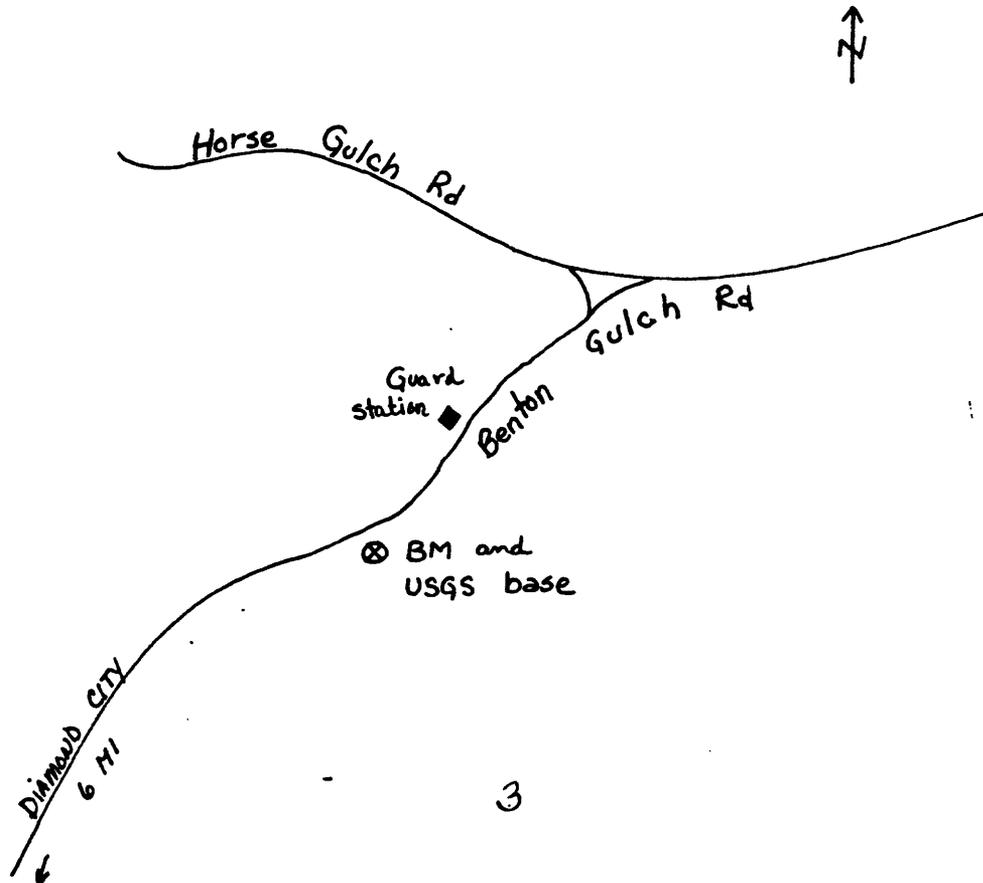
Figure 1--Location map of the White Sulphur Springs 1° x 2° quadrangle, Montana.

GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY Montana		STATION DESIGNATION Benton		OBSERVED GRAVITY 980315.00 mgals
NEAREST TOWN Diamond City		LONGITUDE 111° 21.46'		LATITUDE 46° 40.75'
ELEVATION 5173' (1576.73 m)		TOPOGRAPHIC MAP(S) Watson 1:24,000 White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/78	Kleinkopf	G-235	Helena DOD	980363.50 mgals

DESCRIPTION/SKETCH

Benton gravity base is located 6 miles northeast of Diamond City, Montana, on Benton Gulch Road and 0.2 miles southwest of old Benton Gulch Guard Station site (0.6 mi southwest of junction with Horse Gulch Road). Base is read on north side of bench mark "Q79 1934", on the east side of the road.

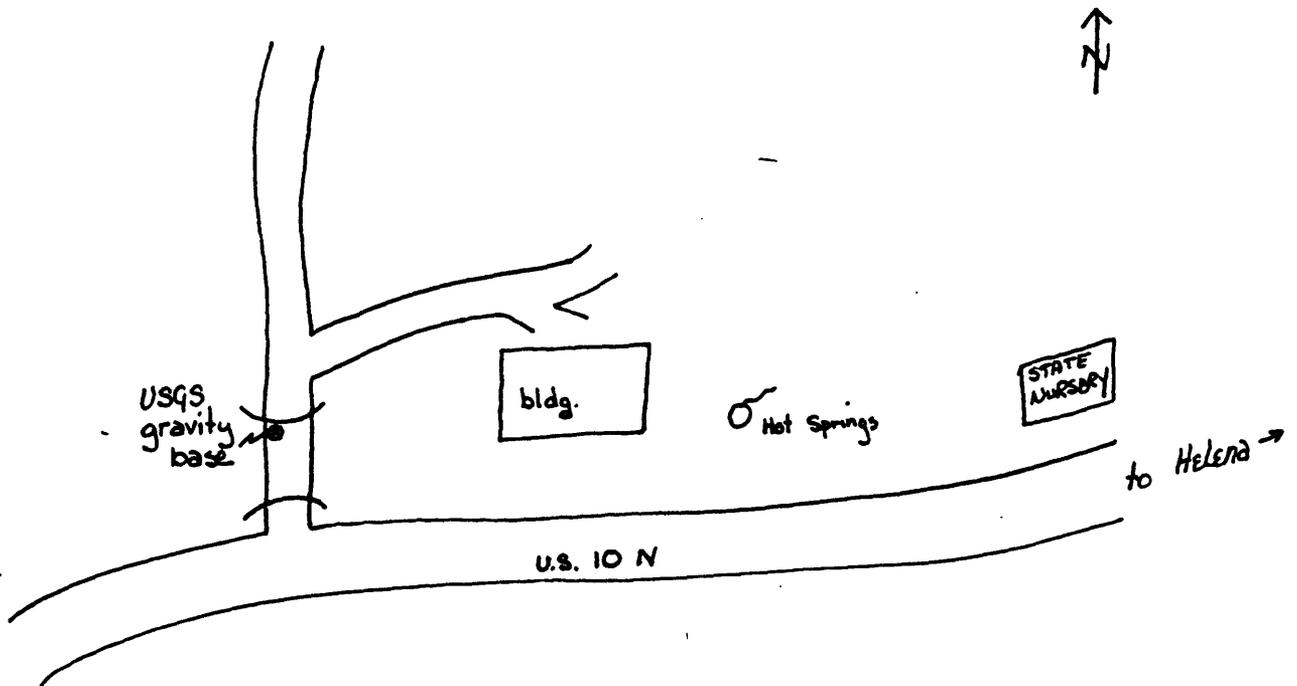


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY Montana		STATION DESIGNATION Broadwater		OBSERVED GRAVITY 980347.42 mgal.
NEAREST TOWN Helena		LONGITUDE 112° 06.74'		LATITUDE 46° 35.74'
ELEVATION 4047.3 feet (1233.6m)		TOPOGRAPHIC MAP(S) Helena 1:62,500 Butte 1:250,000.		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
8/19/79	Bankey	G-235	Helena Airport	980363.26 mgal.

DESCRIPTION/SKETCH

Base is approximately one mile past turnoff to State Nursery, west of Helena on Highway U.S. 10N. Base is on northwest corner of bridge at turnoff to hot springs area which is being made into a resort.

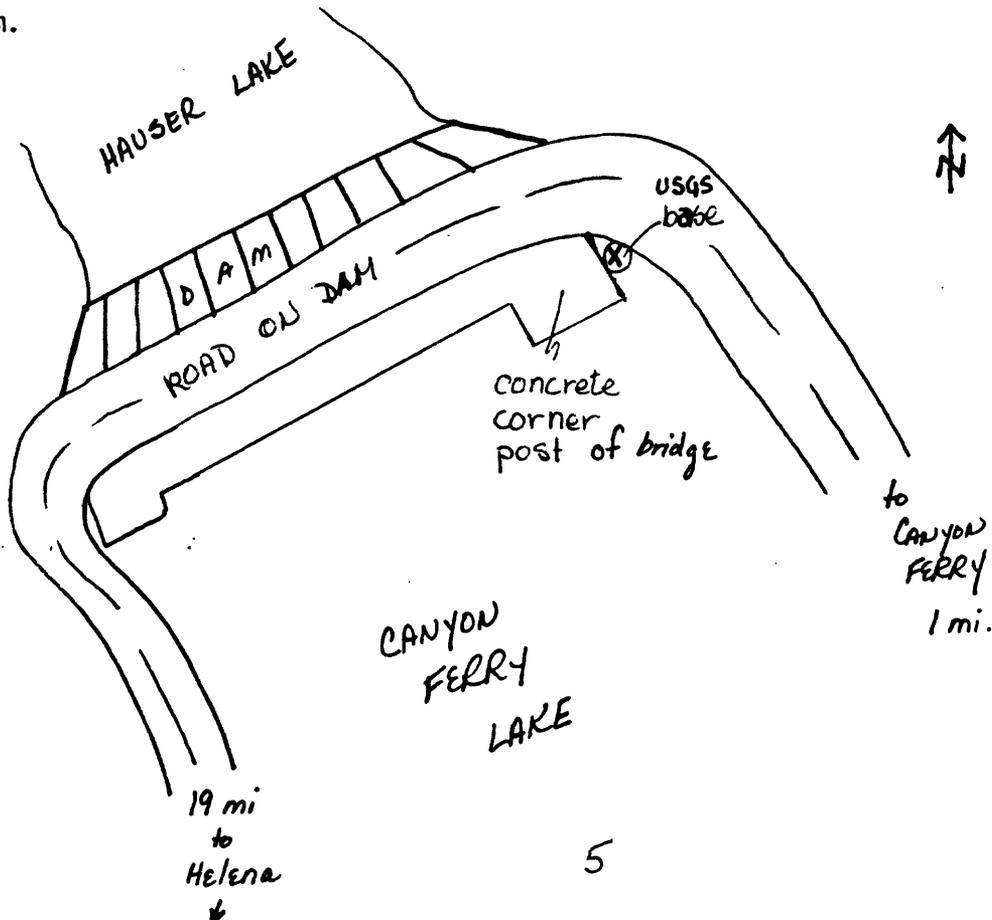


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY Montana		STATION DESIGNATION Canyon Ferry Dam		OBSERVED GRAVITY 980386.57 mgals
NEAREST TOWN Canyon Ferry		LONGITUDE 111° 43.54'		LATITUDE 46° 38.95'
ELEVATION 3800 ft (1158.2 m) est		TOPOGRAPHIC MAP(S) White Sulphur Springs 1:250,000 Canyon Ferry 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/1/78	Kleinkopf	G-235	Helena Airport	980363.26 mgals

DESCRIPTION/SKETCH

Base is at northeast end of dam at base of bridge abutment on left as one faces the dam.

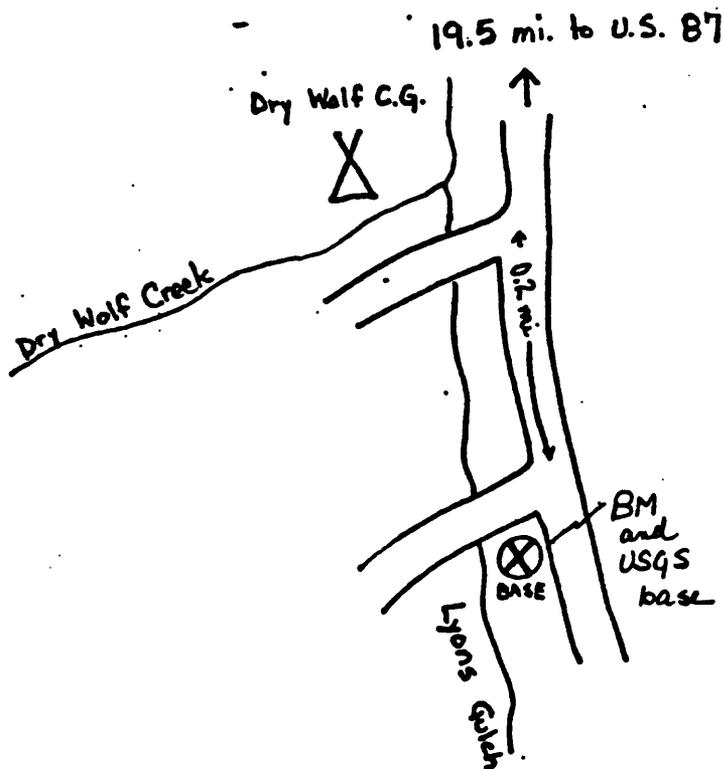


**U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION**

<b>STATE/COUNTRY</b> Montana/USA		<b>STATION DESIGNATION</b> Dry Wolf		<b>OBSERVED GRAVITY</b> 980286.95 mgals
<b>NEAREST TOWN</b> Dry Wolf Campground		<b>LONGITUDE</b> 110°30.85'		<b>LATITUDE</b> 46°58.64'
<b>ELEVATION</b> 5929 ft (1807.1 m)		<b>TOPOGRAPHIC MAP(S)</b> Yogo Peak 1:24,000 White Sulphur Springs 1:250,000		
<b>DATE</b>	<b>OBSERVER</b>	<b>METER</b>	<b>REFERENCE STATION</b>	<b>REFERENCE VALUE</b>
9/14/79	McBride	G-235	Stanford DOD	980422.55 mgals
9/6/79	McBride	G-235	White Sulphur Springs	980291.11 "
8/17/79	McBride	G-235	Neihart	980286.52 "

**DESCRIPTION/SKETCH**

The base is located .2 miles south of Dry Wolf Campground turn-off. Bench mark X188 is approximately 5 feet west of the road. The bench mark is broken off the concrete marker.

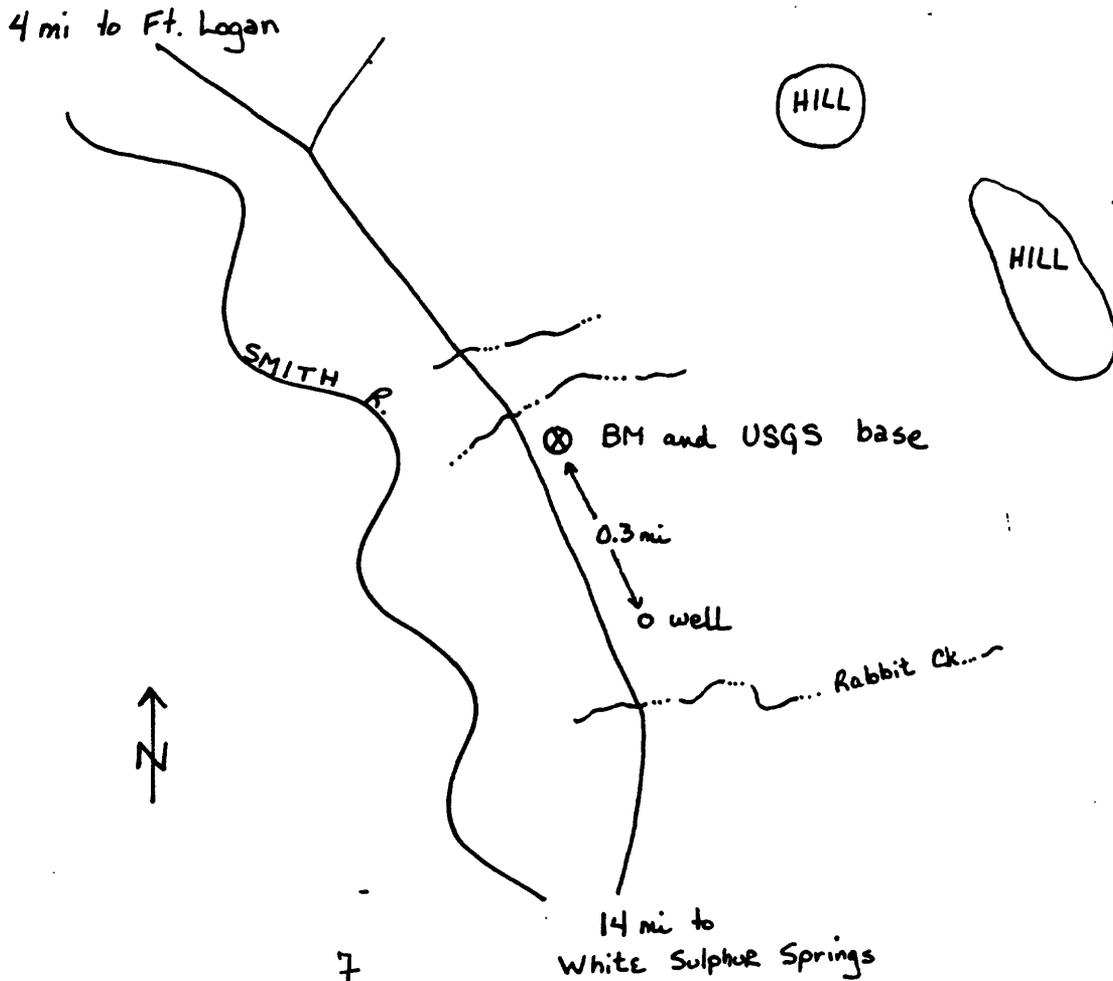


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY Montana		STATION DESIGNATION Fort Logan (gogas)		OBSERVED GRAVITY 980326.70 mgals
NEAREST TOWN Fort Logan		LONGITUDE 111° 05.96'		LATITUDE 46° 39.43'
ELEVATION 4664' (1421.58 m)		TOPOGRAPHIC MAP(S) Whitetail Reservoir 1:24,000 White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/82	Gogas	D-66	White Sulphur DOD	980291.11 mgals

DESCRIPTION/SKETCH

Fort Logan base is a benchmark located between Fort Logan and White Sulphur Springs, Montana, on the east side of a blacktop road.

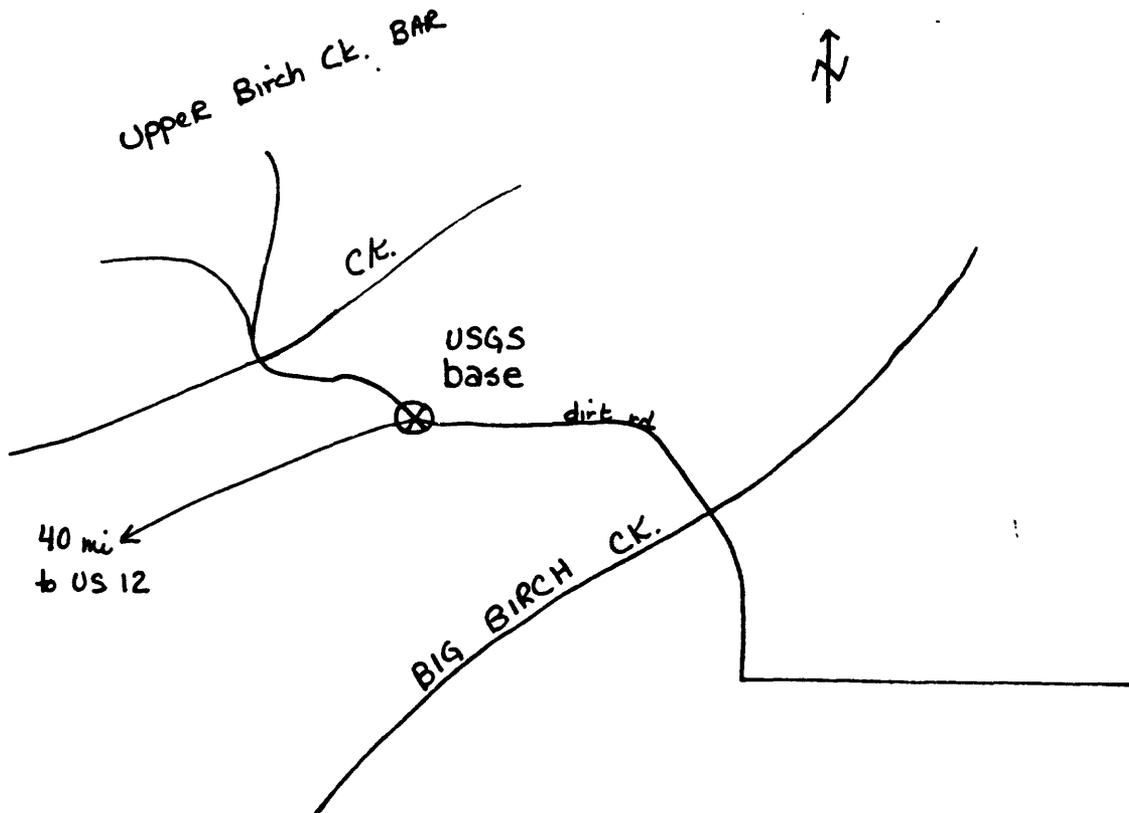


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY
Montana		Galt		980283.28 mgals
NEAREST TOWN		LONGITUDE		LATITUDE
White Sulphur Springs		111° 06.76'		46° 33.74'
ELEVATION		TOPOGRAPHIC MAP(S)		
5253' (1601.11 m)		Hanson Reservoir 1:24,000 White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/82	Gogas	D-66	White Sulphur DOD	980291.11 mgals

DESCRIPTION/SKETCH

Galt base is located between Upper Birch Creek Bar and Big Birch Creek, east of White Sulphur Springs, in the middle of two dirt roads, one which leads to US 12.

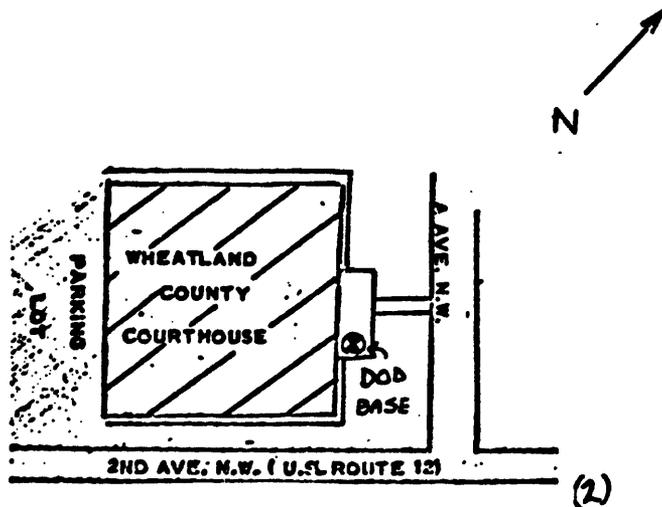


## GRAVITY BASE STATION

LATITUDE <div style="text-align: center;"><b>46° 26.25' N</b></div> (1)	STATION DESIGNATION <div style="text-align: center;"><b>HARLOWTON</b></div>
LONGITUDE <div style="text-align: center;"><b>109° 50.25' W</b></div> (1)	
ELEVATION <div style="text-align: center;"><b>1285.42</b></div> METERS (1)	COUNTRY/STATE <div style="text-align: center;"><b>USA/Montana</b></div>
REFERENCE CODE NUMBERS	ADOPTED GRAVITY VALUE
AGIC 1215-0 IGC 15569B	g = <b>980 362.35</b> mgals
	ESTIMATED ACCURACY
	DATE
	MONTH/YEAR
	<b>Aug/73</b>
	± <b>0.1</b> mgals

**DESCRIPTION AND/OR SKETCH**

Base is located at the Wheatland County Court House in Harlowton, Mont., six inches NE of the USC&GS BM A 126. The BM is located seven feet south of the main entrance, in the face of the SE portico over the main doorway, and 13 inches above the ground. The standard disk, stamped "A 126 1934," is set vertically. The building, once used as a high school, is located at the corner of A Avenue N.W. and 2nd Avenue N.W. (U. S. Highway 12). (1)



**REFERENCE SOURCE**

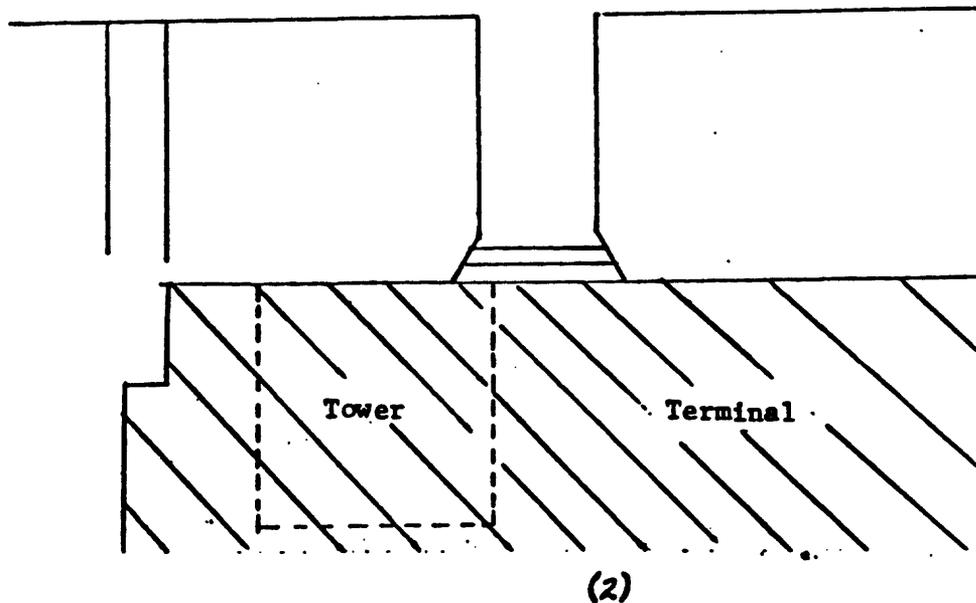
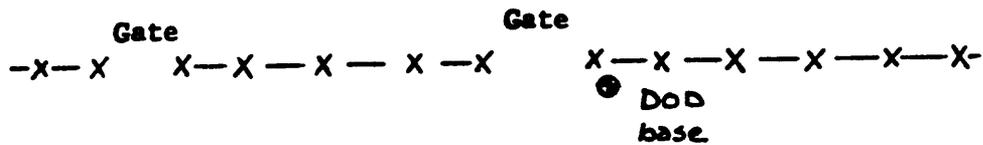
(1) 01355 (2) 05100

## GRAVITY BASE STATION

LATITUDE $46^{\circ} 36.5' N$ (1)	STATION DESIGNATION <p style="text-align: center;"><b>HELENA DOD</b></p>	
LONGITUDE $111^{\circ} 59.5' W$ (1)		
ELEVATION $1180.5$ METERS (1)	COUNTRY/STATE <p style="text-align: center;"><b>USA/Montana</b></p>	
REFERENCE CODE NUMBERS		ADOPTED GRAVITY VALUE
ACTC 0475-0 IGC 15661J WA 31	$g = 980\,363.50$ mgals	
		ESTIMATED ACCURACY $\pm 0.1$ mgals
		DATE MONTH/YEAR <p style="text-align: center;"><b>Aug/ 73</b></p>

**DESCRIPTION AND/OR SKETCH**

Station is located at Helena, Mont., Municipal Airport, at the gate of the barrier, on the ramp side of the terminal building, opposite the terminal exit to planes, on the asphalt. (1)



**REFERENCE SOURCE**

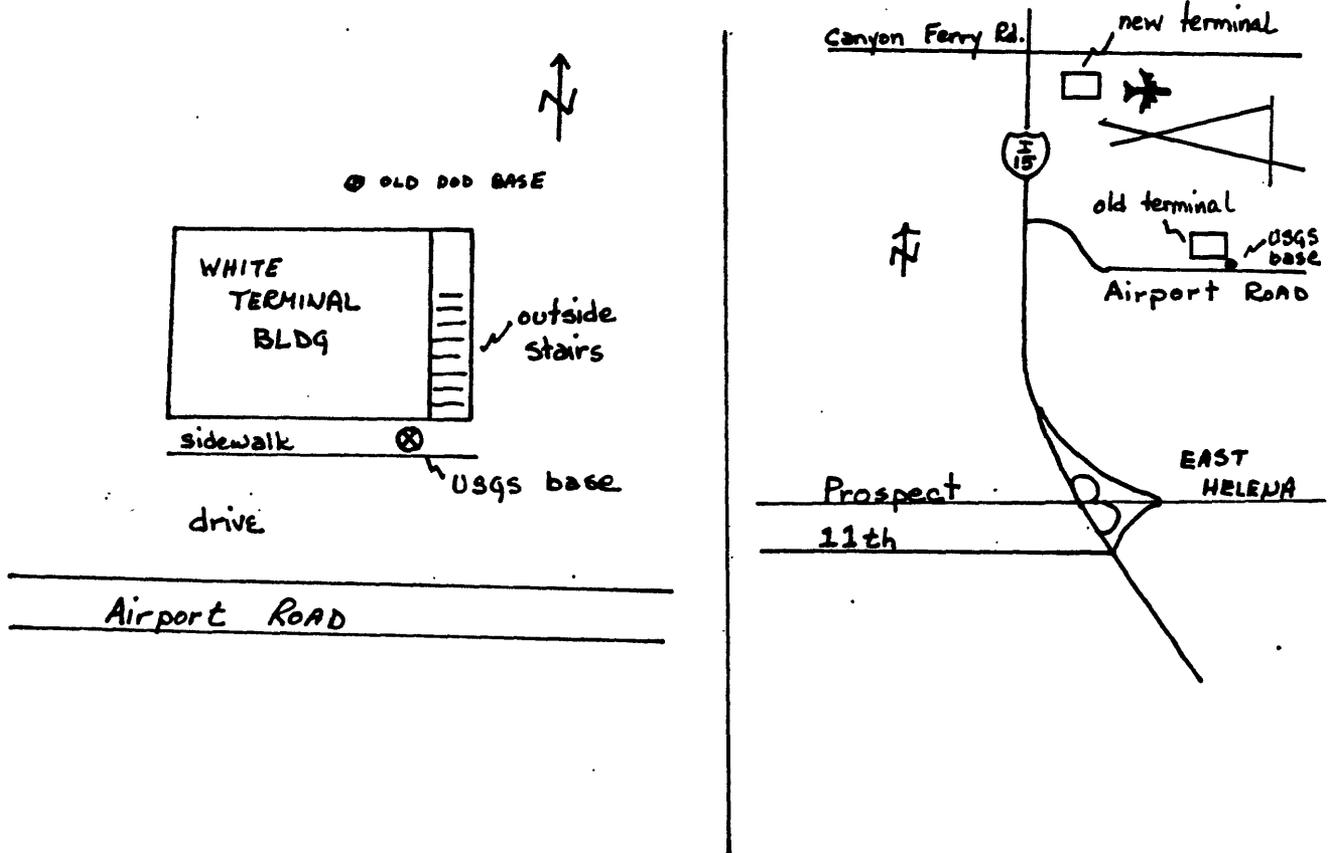
(1) 01355 (2) 05100

U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY Montana		STATION DESIGNATION Helena Airport (USGS)		OBSERVED GRAVITY 980363.26 mgals
NEAREST TOWN Helena		LONGITUDE 111° 59.50'		LATITUDE 46° 36.50'
ELEVATION 3872 ft (1180.2 m) est		TOPOGRAPHIC MAP(S) East Helena 1:62,500 White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/77	Kleinkopf	E-134	Helena airport DOD	980363.50 mgals

DESCRIPTION/SKETCH

Base is on concrete walk at southeast corner of the old airport terminal building, at west side of outside stairway. The DOD location is on the north side of the terminal.

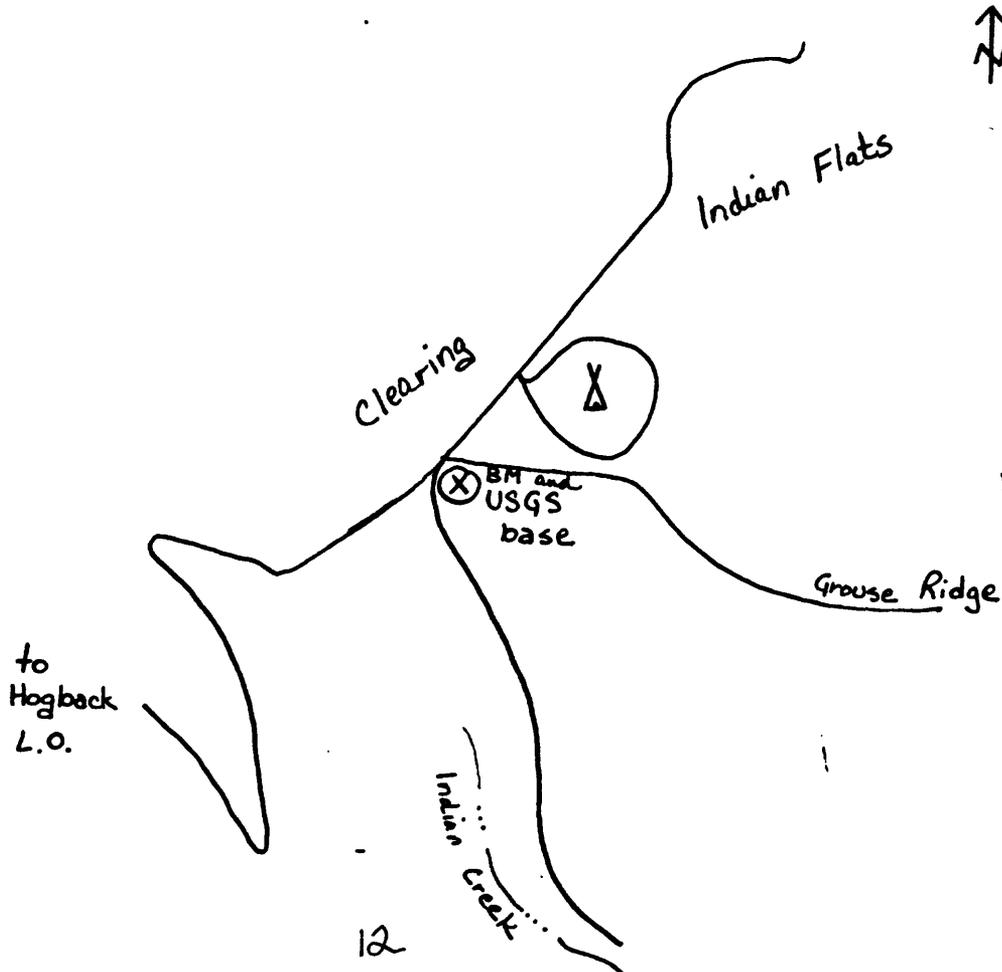


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY Montana		STATION DESIGNATION Hogback		OBSERVED GRAVITY 980238.86 mgals
NEAREST TOWN York		LONGITUDE 111° 40.80'	LATITUDE 46° 49.74'	
ELEVATION 6697 ft (2041.2 m)		TOPOGRAPHIC MAP(S) Hogback Mtn 1:24,000 White Sulphur 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/78	Kleinkopf	G-235	Helena Airport	980363.50 mgals

DESCRIPTION/SKETCH

Meter read over USGS Bench Mark, 11BAS 1958, located 10 miles east of Loop Road and 1.5 miles southwest of Pike Forest Service Campground. BM is at northeast intersection of Loop Road with Hogback Lookout Station.

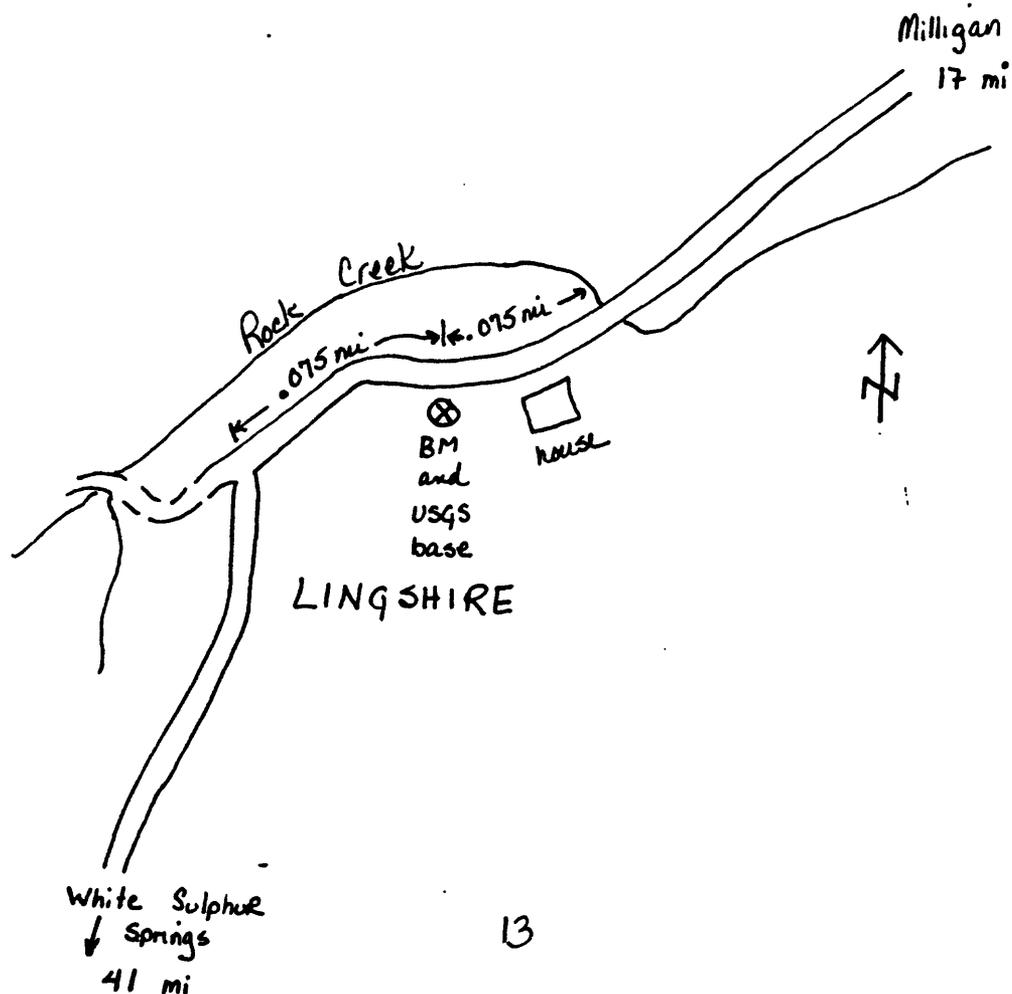


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY Montana		STATION DESIGNATION Lingshire		OBSERVED GRAVITY 980367.83 mgals
NEAREST TOWN Lingshire		LONGITUDE 111° 24.33'		LATITUDE 47° 50.47'
ELEVATION 4683 ft (1427.4 m)		TOPOGRAPHIC MAP(S) lingshire 1:24,000 White Sulphur 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/78	Kleinkopf	G-235	Helena DOD	980363.26 mgals

DESCRIPTION/SKETCH

Gravity base is located at USC&GS benchmark H136, set in rock about 12 meters south of the gravel road in the village of Lingshire.

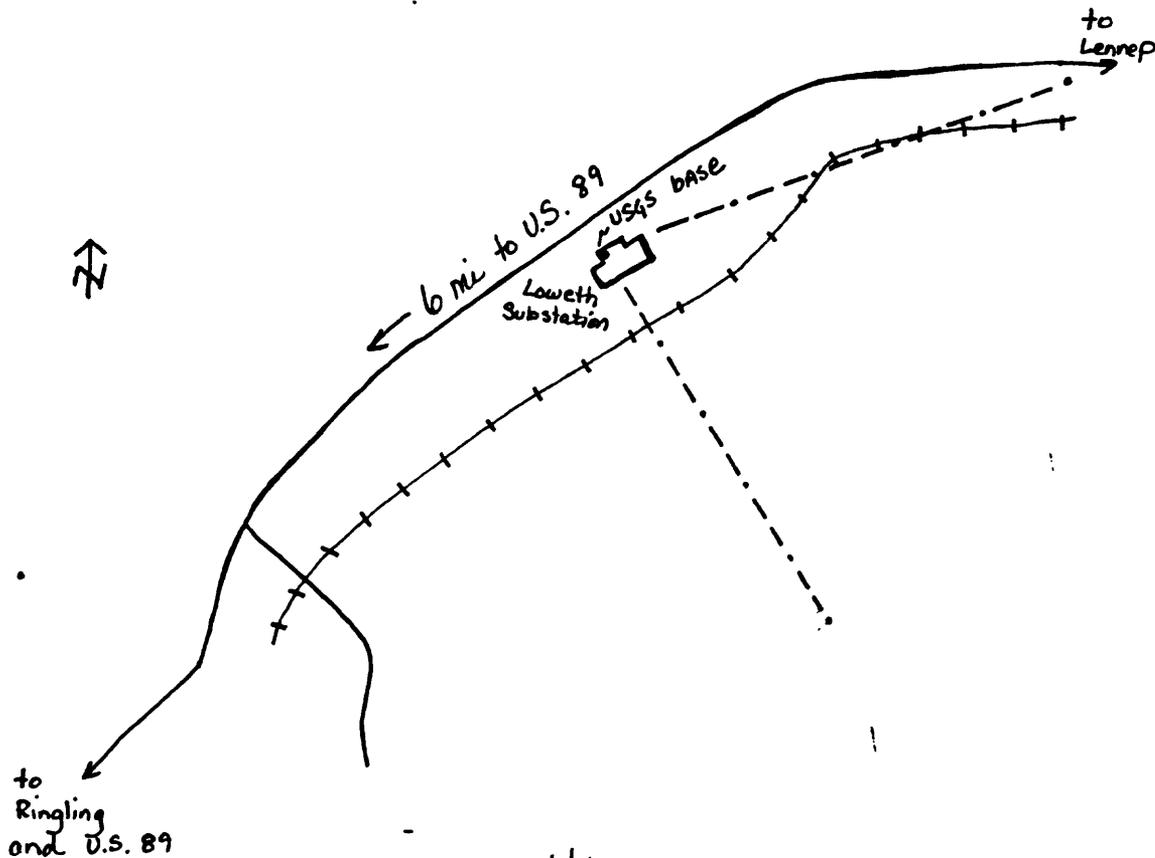


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY Montana		STATION DESIGNATION Loweth		OBSERVED GRAVITY 980229.28 mgals
NEAREST TOWN Ringling		LONGITUDE 110° 42.36'		LATITUDE 46° 22.16'
ELEVATION 5796 ft (1766.6 m)		TOPOGRAPHIC MAP(S) Hamen 1:24,000 White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/82	Bankey	G-550	White Sulphur Spgs	980291.11 mgals

DESCRIPTION/SKETCH

Loweth base is located on the road to Lennepe, 6 mi east of U.S. 89. The station is located at an old substation called "Loweth", on the concrete step near the door of the substation.

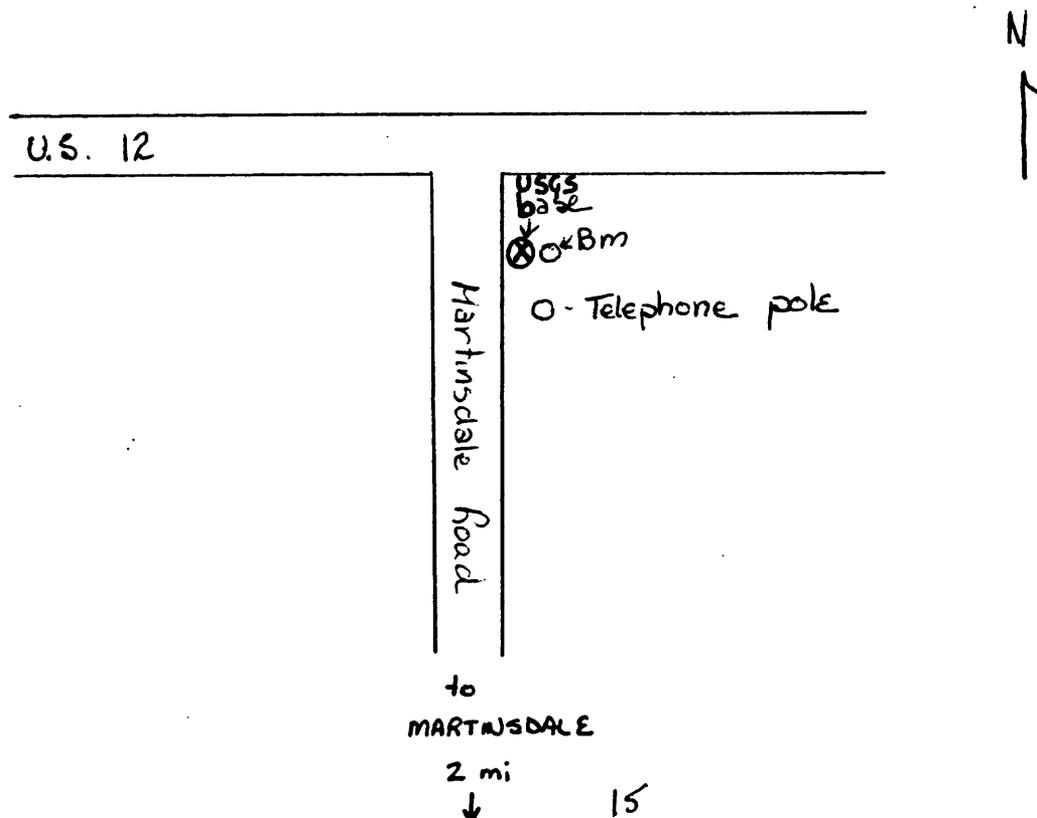


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY	
Montana		Martinsdale		980315.49 mgals	
NEAREST TOWN		LONGITUDE		LATITUDE	
Martinsdale		110° 18.31'		46° 29.20'	
ELEVATION		TOPOGRAPHIC MAP(S)			
4741 ft (1445.1 m)		White Sulphur Springs 1/250,000, Martinsdale 1:24,000			
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE	
9/1/78	Kleinkopf	G-235	White Sulphur Springs P.O.	980291.11 mgals	

DESCRIPTION/SKETCH

Base is located on west side of USGS BM located just southeast of intersection of US-12 and Martinsdale Road.

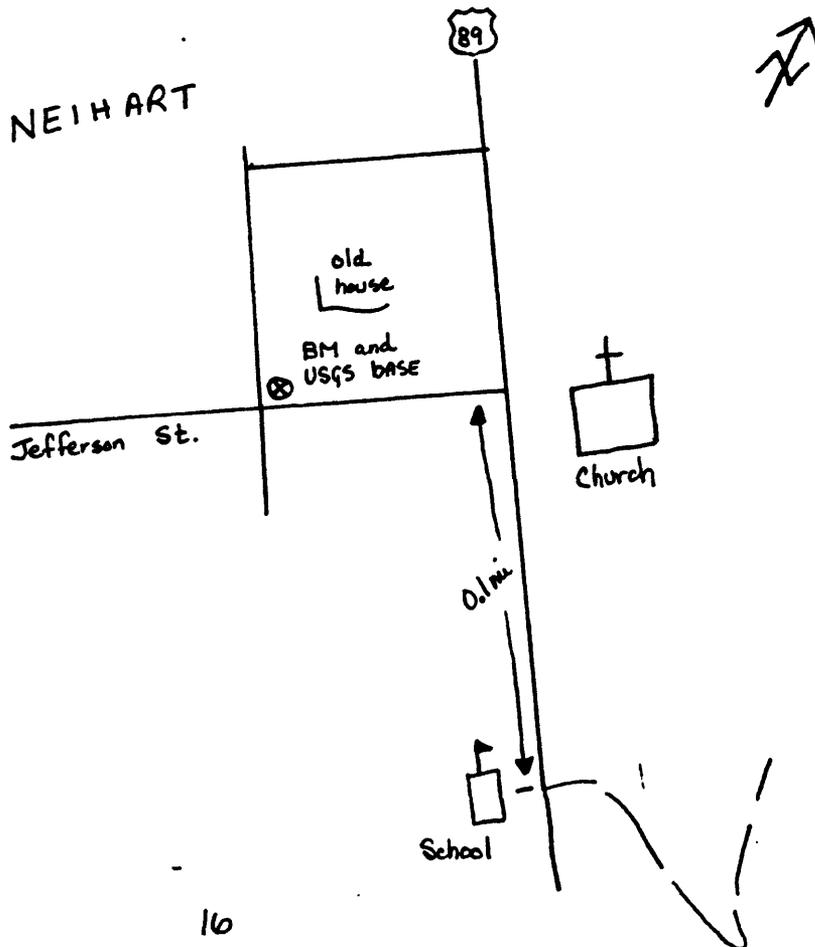


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY Montana		STATION DESIGNATION Neihart		OBSERVED GRAVITY 980286.52 mgals
NEAREST TOWN Neihart		LONGITUDE 110° 43.97'		LATITUDE 46° 55.85'
ELEVATION 5635 ft (1717.6 m)		TOPOGRAPHIC MAP(S) Neihart 1:24,000 White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
6/77	Kleinkopf	E-134	White Sulphur Spgs	980291.11 mgals
9/79	McBride	G-235	" "	" "

DESCRIPTION/SKETCH

Base is at USC & GS Bench Mark 129 in Neihart, one block west of U.S. Hwy. 89 near Jefferson St. As of 1979, the brass marker is no longer there, but the concrete post remains.

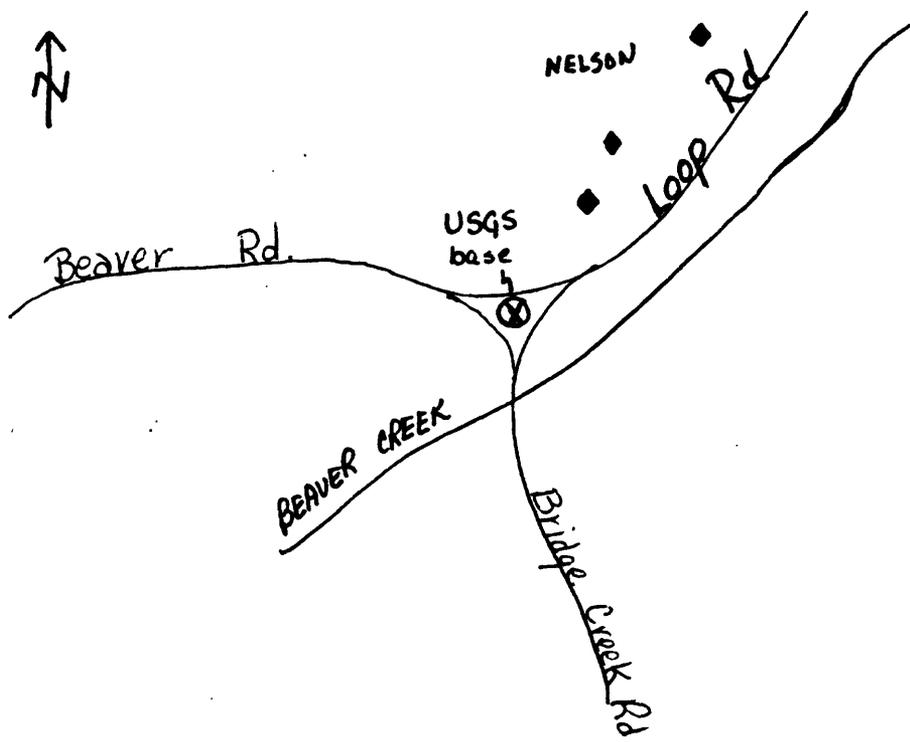


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY
Montana		Nelson		980395.48 mgals
NEAREST TOWN		LONGITUDE		LATITUDE
Nelson		111° 48.52'		46° 48.99'
ELEVATION		TOPOGRAPHIC MAP(S)		
3996 ft (1218.0 m)		White Sulphur Springs 1 250,000 , Nelson 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/3/77	Kleinkopf	Worden E-134	Helena Airport	980363.26 mgals
7/16/78	Kleinkopf/Brickey	G-235	Helena Airport	980363.26 mgals

DESCRIPTION/SKETCH

Base is on south edge of Nelson and is located 9 m northwest of center of Bridge Creek Road.

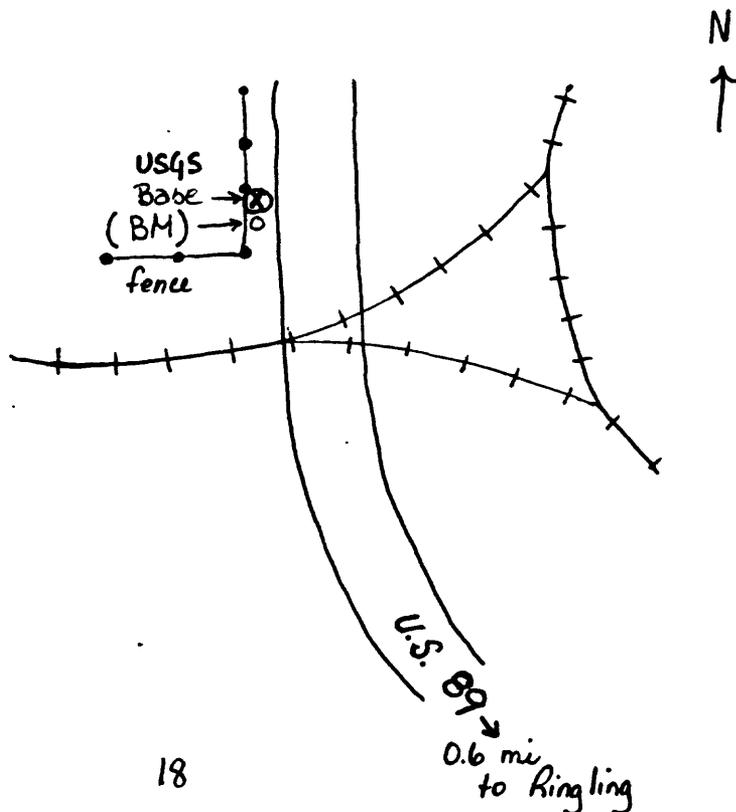


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY
Montana		Ringling		980246.94 mgals
NEAREST TOWN		LONGITUDE		LATITUDE
Ringling		110° 48.22'		46° 16.84'
ELEVATION		TOPOGRAPHIC MAP(S)		
5313 ft (1619.4 m)		White Sulphur Springs 1 250,000, Ringling 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/1/78	Kleinkopf	G-235	White Sulphur Springs P.O.	980291.11 mgals

DESCRIPTION/SKETCH

on north side of USC & GS BM WA-15, 1 Km north of Ringling village. BM is on bank next to fence and on north side of RR spur.

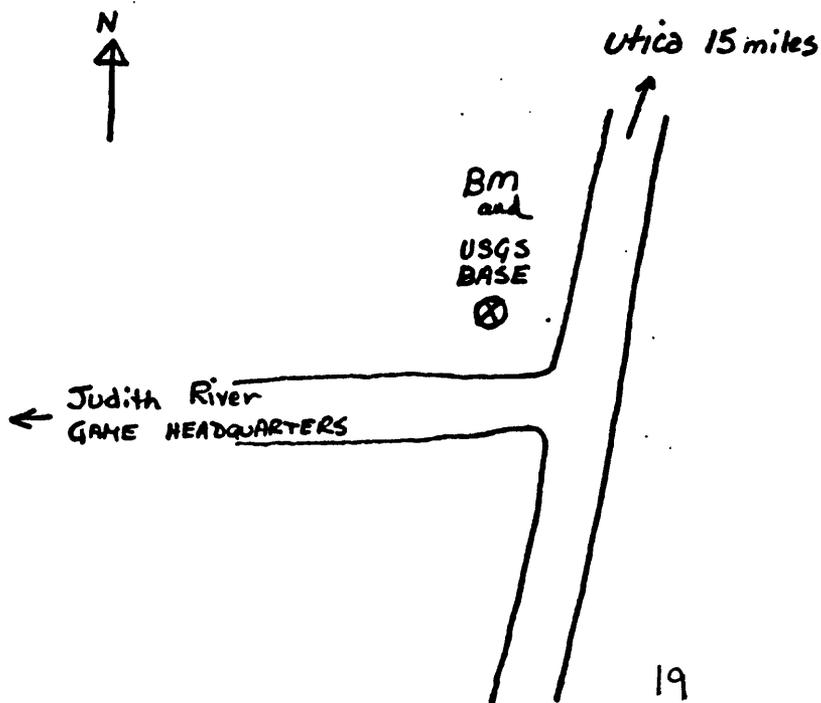


**U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION**

<b>STATE/COUNTRY</b> Montana/USA		<b>STATION DESIGNIATION</b> Sapphire		<b>OBSERVED GRAVITY</b> 980350.20 mgals
<b>NEAREST TOWN</b> Utica		<b>LONGITUDE</b> 110°15'21		<b>LATITUDE</b> 46°53'18
<b>ELEVATION</b> 4894 ft (1491.7 m)		<b>TOPOGRAPHIC MAP(S)</b> Woodhurst 1:24,000, White Sulphur Springs		
<b>DATE</b>	<b>OBSERVER</b>	<b>METER</b>	<b>REFERENCE STATION</b>	<b>REFERENCE VALUE</b>
9/7/79	McBride	G-235	White Sulphur Springs	980291.11 mgals
9/14/79	McBride	G-235	Stanford	980422.55 "

**DESCRIPTION/SKETCH**

The base is benchmark Z182, which is located on top of a large rock about 1.5 feet high and 3 feet in diameter. It is found about 100 feet north of the road to Judith River Game Headquarters.

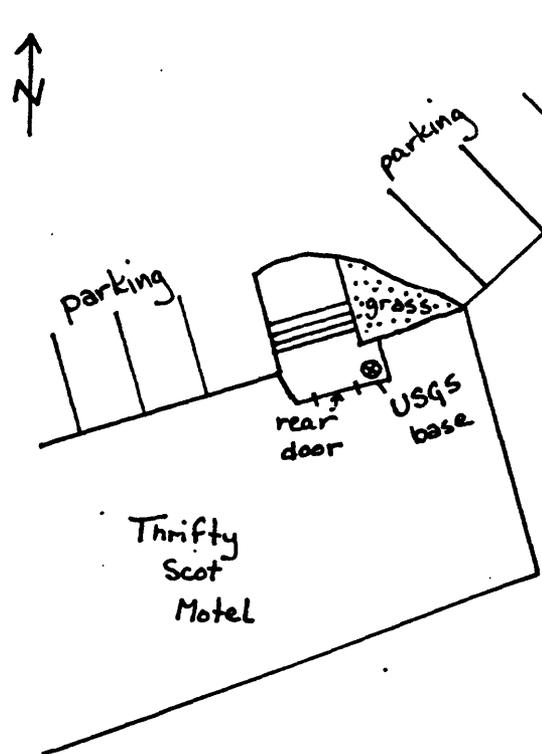
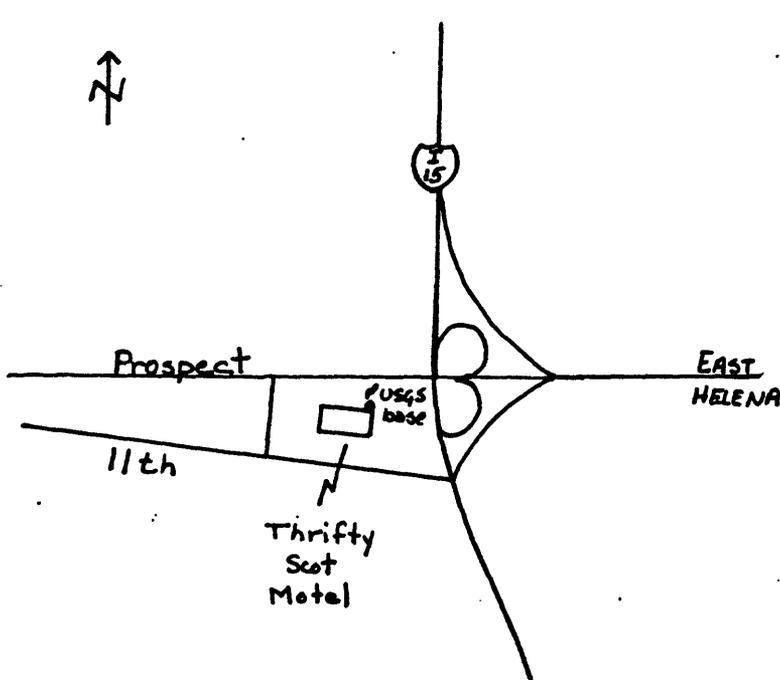


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY Montana		STATION DESIGNATION Thrifty Scot Motel, Helena		OBSERVED GRAVITY 980355.98 mgals.
NEAREST TOWN Helena		LONGITUDE 112° 00.00'	LATITUDE 46° 35.40'	
ELEVATION 4020 ft (1225.3 m) est.		TOPOGRAPHIC MAP(S) Helena 1:62,500 Butte 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/24/83	Bankey	G-550	Helena Airport DOD	980363.26 mgals

DESCRIPTION/SKETCH

The Thrifty Scot Motel is located in Helena, Montana, off of the Prospect St. exit of I-15. The base is located at the northeast corner of the motel, at the top of the stairs, to the left of the rear door.

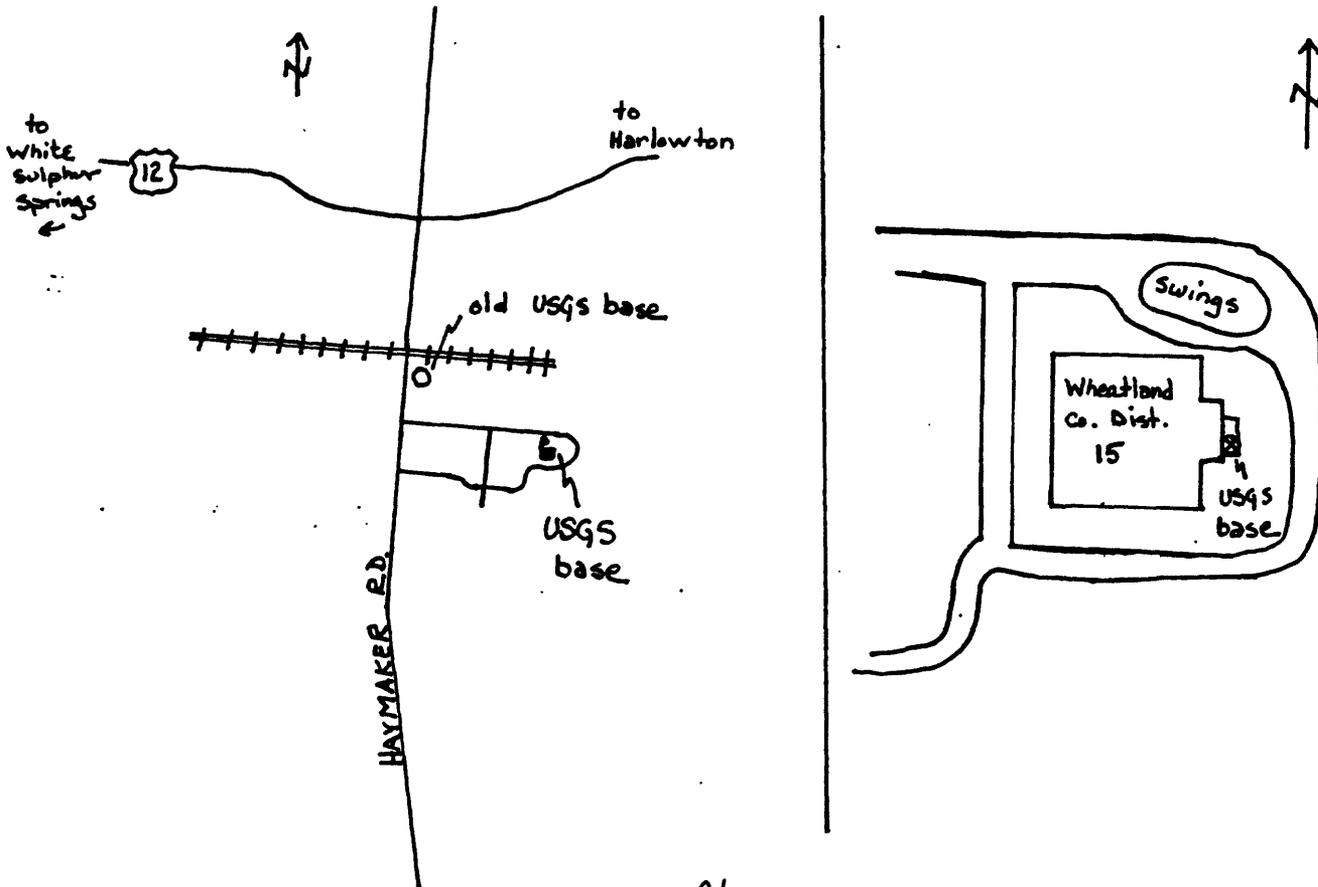


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY
Montana		Twodot School		980338.40 mgals
NEAREST TOWN		LONGITUDE		LATITUDE
Twodot		110° 04.10'		46° 25.42'
ELEVATION		TOPOGRAPHIC MAP(S)		
4430 ft (est) 1350 m		Twodot 1:24,000 White Sulphur Springs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/21/82	Bankey	G-550	White Sulphur,	980291.11 mgals

DESCRIPTION/SKETCH

Twodot School base is located in Twodot, at the Wheatland County District School #15. The base is located on the left side of the step as you face the front door of the school.

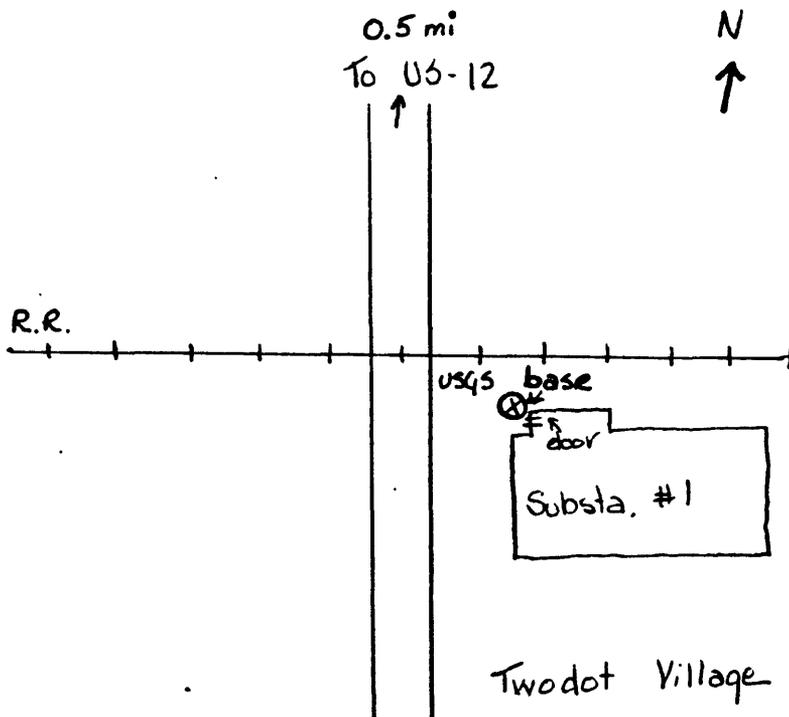


U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY Montana		STATION DESIGNATION Twodot Substation		OBSERVED GRAVITY 980339.00 mgals
NEAREST TOWN Twodot		LONGITUDE 110° 04.32'	LATITUDE 46° 25.57'	
ELEVATION 4432 ft (1350.9 m)		TOPOGRAPHIC MAP(S) White Sulphur Springs 1:250,000 , Twodot 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
9/1/78	Kleinkopf	G-235	White Sulphur Springs P.O.	980291.11 mgals

DESCRIPTION/SKETCH

Base is located near BM (not found) along south side of RR track, at north side of door on concrete step of abandoned substation #1. Door faces west.

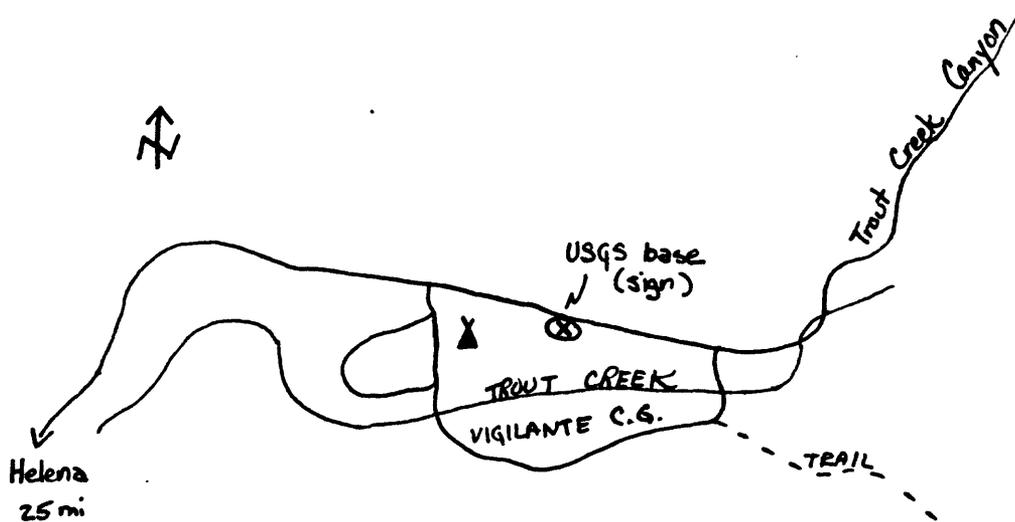


GRAVITY BASE STATION  
U.S. GEOLOGICAL SURVEY

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY
Montana		Vigilante Campground		980349;81 mgals
NEAREST TOWN		LONGITUDE		LATITUDE
York		111° 38.87'		46° 46.03'
ELEVATION		TOPOGRAPHIC MAP(S)		
4440 ft (1353.3 m) est		Hogback Mtn. White Sulphur Springs 1:250,000 1:24,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
7/78	Kleinkopf	G-235	Helena Airport	980363.26 mgals

DESCRIPTION/SKETCH

Base is at west base of sign "Helena National Forest Campground - Vigilante" located at turn-off into campground.

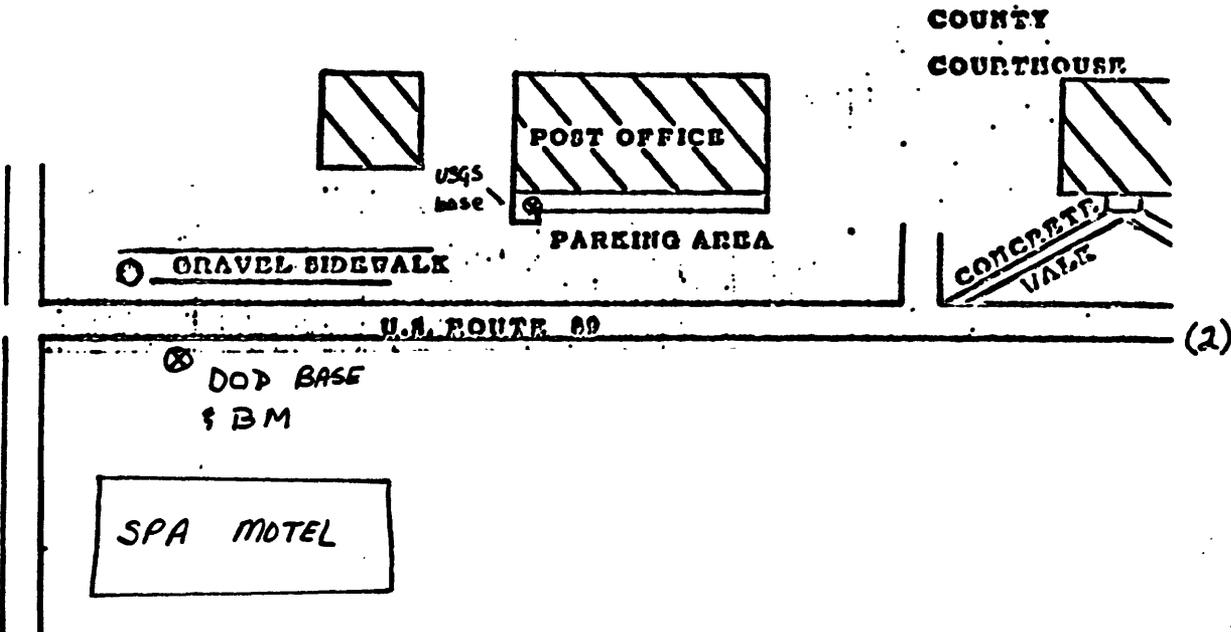


### GRAVITY BASE STATION

LATITUDE <b>46° 33.00' N</b> (1)	STATION DESIGNATION <b>WHITE SULPHUR SPRINGS DOD</b>	
LONGITUDE <b>110° 54.00' W</b> (1)		
ELEVATION <b>1526.73</b> METERS (1)	COUNTRY/STATE <b>USA/Montana</b>	
REFERENCE CODE NUMBERS		ADOPTED GRAVITY VALUE
<b>AGIC 1233-0</b>	<b>g = 980 291.11</b> mgals	
<b>IGC 15660J</b>		
		ESTIMATED ACCURACY
		DATE
<b>± 0.1</b> mgals		MONTH/YEAR <b>Aug/73</b>

**DESCRIPTION AND/OR SKETCH**

Station is located approximately 400 feet west of the U. S. Post Office in White Sulphur Springs, Mont., three feet south of Montana State Highway Survey Bench Mark. The B. M. is a standard disk stamped "Mont. State Road Elev. 5,008.97", and placed on top of a concrete post, four feet above the ground. The post is marked "FA SS 49 (7)". (1)



**REFERENCE SOURCE**

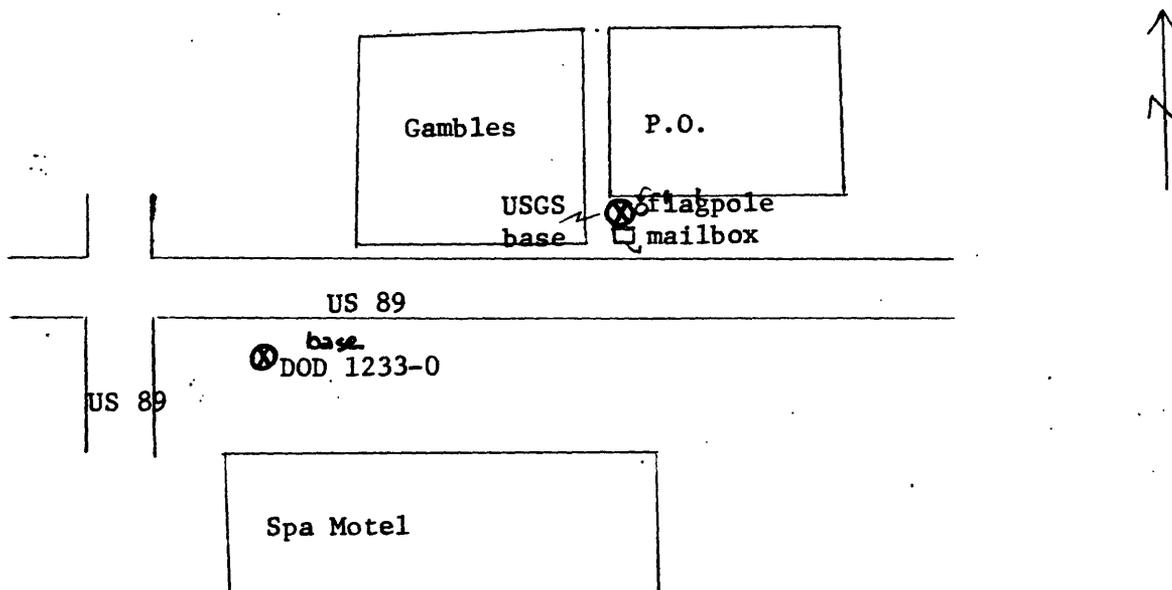
(1) 01355 (2) 05100

U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY Montana		STATION DESIGNATION White Sulphur Springs P.O.		OBSERVED GRAVITY 980291.29 mgals.
NEAREST TOWN White Sulphur Springs		LONGITUDE 110° 54.28'		LATITUDE 46° 32.91'
ELEVATION 5020 ft (1530.1 m) est.		TOPOGRAPHIC MAP(S) White Sulphur Spgs 1:24,000    White Sulphur Spgs 1:250,000		
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE
1979	Kleinkopf	G-235	White Sulphur Spgs DOD	980291.11 mgals

DESCRIPTION/SKETCH

Base is read on concrete sidewalk in front of the post office, to the left of the door as you face it, between the flagpole and the mailbox. The post office is on the northeast corner of US 89, where the highway turns east to go through town. The post office is across the street from the hot springs.



U.S. GEOLOGICAL SURVEY  
GRAVITY BASE STATION

STATE/COUNTRY		STATION DESIGNATION		OBSERVED GRAVITY	
Montana		Wilsall		980228.11 mgals	
NEAREST TOWN		LONGITUDE		LATITUDE	
Wilsall		110° 39.86'		46° 00.79'	
ELEVATION		TOPOGRAPHIC MAP(S)			
5085 ft (1550.0 m)		White Sulphur Springs 1:250,000 Cottonwood Res. 1:24,000			
DATE	OBSERVER	METER	REFERENCE STATION	REFERENCE VALUE	
9/1/78	Kleinkopf	G-235	White Sulphur Springs PQ	980291.11 mgals	

DESCRIPTION/SKETCH

Location is at northwest corner of intersection US-89 and Fairy Lake Road, directly beneath sign and about 17 meters from the intersection.

