

Great Smoky Mountain National Park
2021 Summary of Activities
North Carolina Division of Water Resources
Permit # GRSM-2020-SCI-1257

On January 1, 2020, the North Carolina Department of Environmental Quality (DEQ), Division of Water Resources (DWR) renewed their agreement with the United States Department of the Interior, National Park Service, Permit # GRSM-2020-SCI-1257, to collect groundwater data from several wells in the Great Smoky Mountains National Park (GSMNP). These wells have been included into North Carolina's statewide monitoring well network as individual monitoring stations. This permit allows DWR to collect depth to groundwater measurements to assess how climatic conditions impact groundwater supplies, how these climatic conditions affect base flow to streams and rivers, and to assess these data and their relationship to drought conditions in the mountain physiographic province of North Carolina. The following summarizes work performed from January 1, 2021 through December 31, 2021 in accordance with the referenced permit.

The monitoring wells that have been included into the North Carolina statewide monitoring well network and are now individual monitoring well stations include the following:

1. Beach Grove School Field Well (M 93L1), Cataloochee Valley
2. Woody Creek Well (M 93R1), Cataloochee Valley
3. Oconaluftee Overlook (M 97S1)
4. Smokemont Campground G1 (N 95G1), Smokemont Campground
5. Smokemont Ranger Station (N 95G2), Smokemont Campground
6. Clingmans Dome (N 97F1)
7. Deep Creek Campground (O 97L1)

The following activities have been conducted in 2021 at one or more of the monitoring well stations:

- Depth to groundwater measurements have been collected at each monitoring well station at least quarterly, with the exception of Clingmans Dome which is not accessible during the February quarterly event. The quarterly events take place in the months of February, May, August, and November;
- Barometer and water level data loggers (manufactured by Onset Computer Inc.) have been downloaded at least quarterly in each of the wells except for Clingmans Dome. The data loggers record water levels every hour;
- Data logger was replaced at Smokemont Ranger Station in March 2021;

- Data loggers were replaced at Beach Grove School Field Well, Woody Creek, Oconaluftee Overlook, Smokemont Campground G1, and Smokemont Ranger Station monitoring stations in September 2021; and
- Groundwater samples were collected from Oconaluftee Overlook on 9/27/21. Parameters measured in the field included temperature, pH, specific conductivity, dissolved oxygen (DO), oxidation-reduction potential (ORP), turbidity, and salinity. Parameters measured in the laboratory included metals (total and dissolved), nutrients, wet chemistry, microbiological parameters, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, and per- and polyfluoroalkyl substances (PFAS). Manganese (Mn) was the only measured analyte that exceeded the Title 15A North Carolina Administrative Code 2L Groundwater Standards (15A NCAC 2L). Manganese was detected at 200 micrograms per liter (ug/L); the 15A NCAC 2L allowable limit for manganese is 50 ug/L. However, this concentration of manganese is most likely naturally occurring in the area.

Groundwater data collected from the monitoring stations is most beneficial when collected regularly over the course of many years. In order to assess trends, such as climate change and drought impacts, the GSMNP wells should continue to be monitored as part of the long-termed monitoring program currently in place.

All data collected is stored electronically and a large portion of that data is available to the public via the DWR website <https://www.ncwater.org/GWMB>. Due to the large volume of water level data collected, a daily groundwater level measurement is published for public access in lieu of all hourly data. However, upon request from the GSMNP, DWR will forward the complete dataset.

Analytical data is available for viewing and downloading from the DWR groundwater quality website at <https://www.ncwater.org/?page=343> or through the DWR groundwater quality mapping interface at <https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=6a0293762cf249ed92b657bd9b7465cf>.

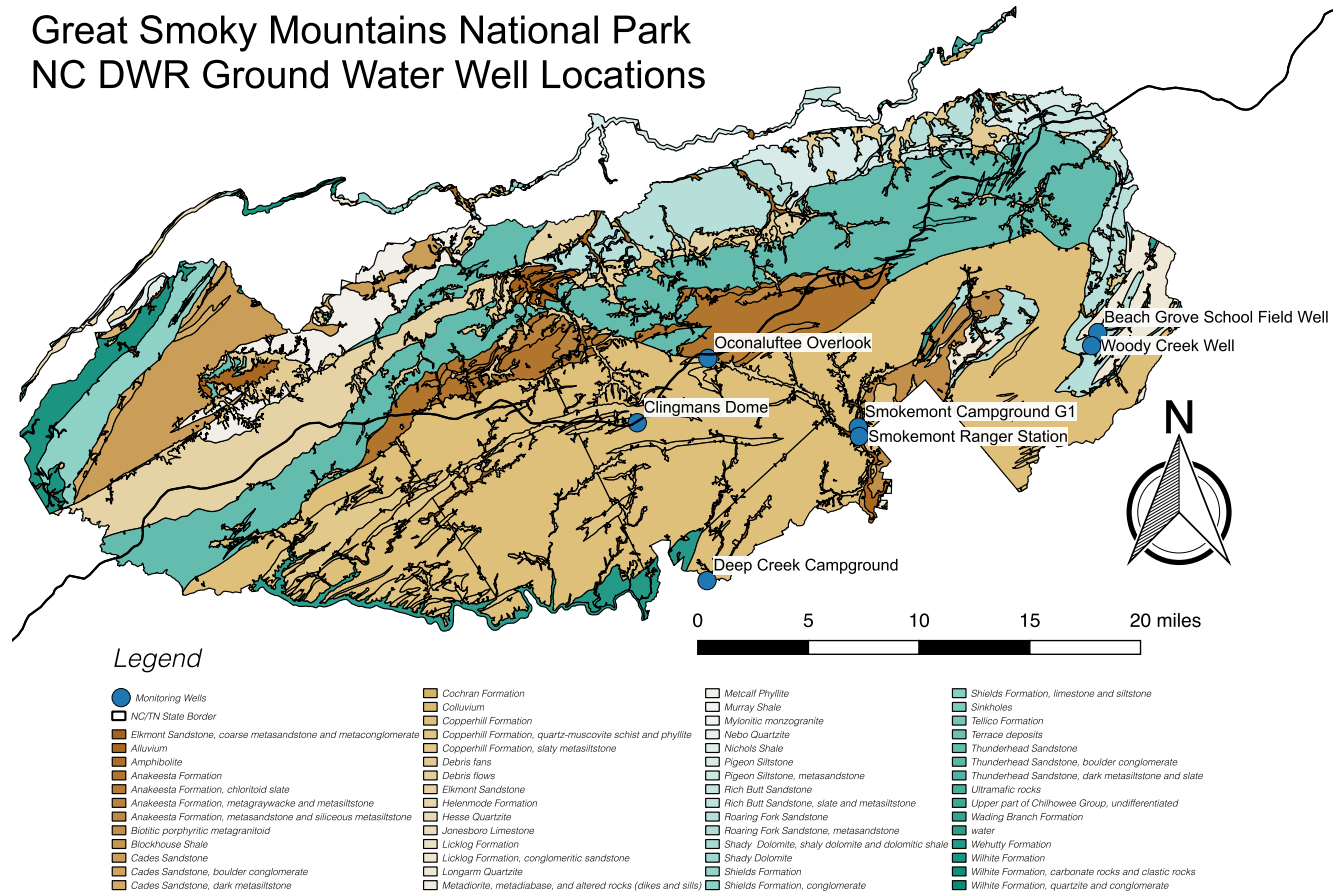
A map of well locations within the GSMNP and detailed maps of each specific monitoring well station are included in Appendix A. Tables summarizing specific dates of activities performed at each monitoring well station are included in Appendix B. Hydrographs and manually collected water level data for each station are located in Appendix C. Specific groundwater quality parameters and analytical methods, field parameter data, and laboratory analytical results exceeding the 15A North Carolina Administrative Code 2L standards are also included for the Oconaluftee Overlook Station in Appendix C. Appendix D includes a drought statistics plot for each monitoring station.

APPENDIX A

SITE MAPS

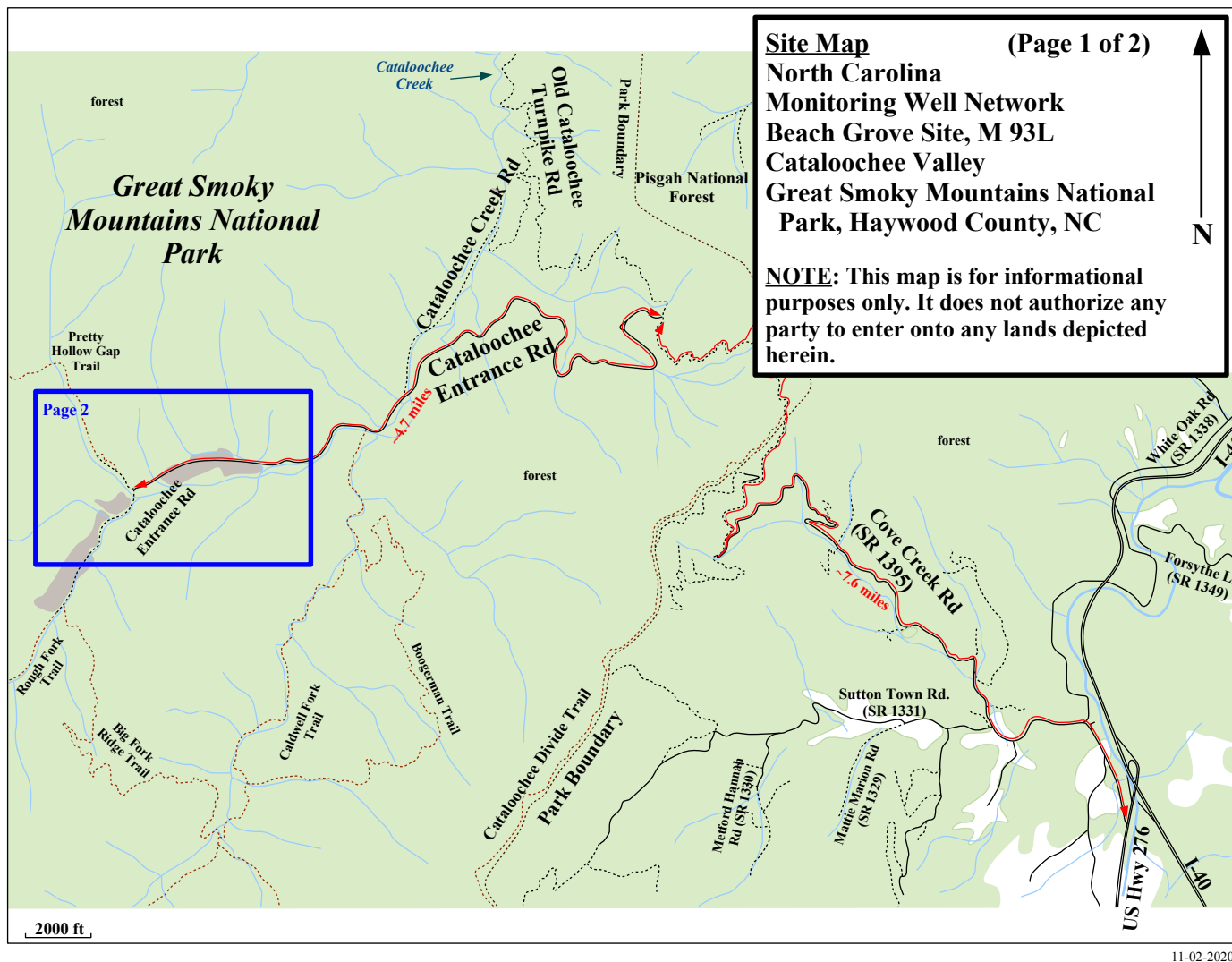
**GREAT SMOKY MOUNTAIN NATIONAL PARK
NORTH CAROLINA DIVISION OF WATER RESOURCES
MONITORING WELL STATION
LOCATION MAP**

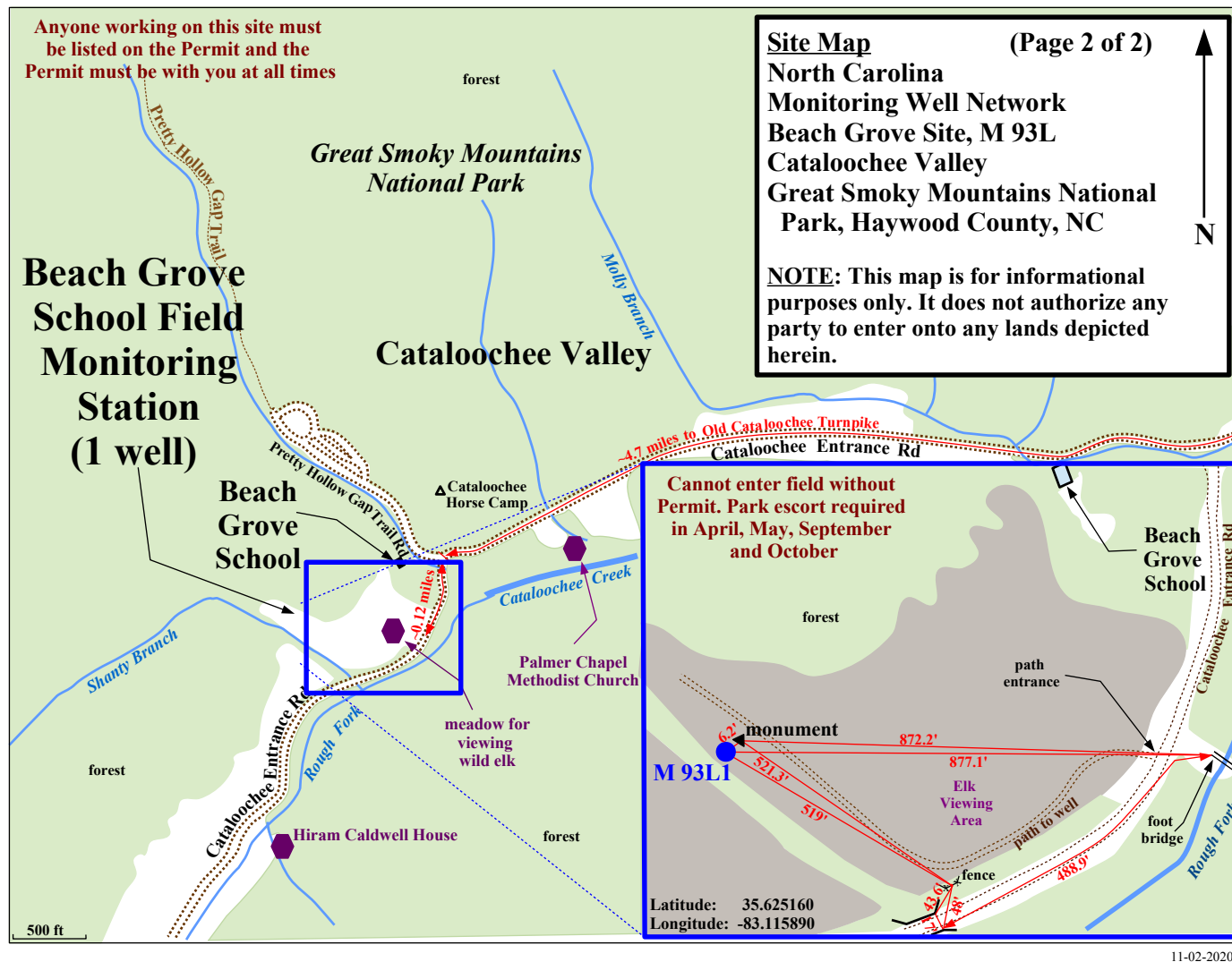
Great Smoky Mountains National Park NC DWR Ground Water Well Locations

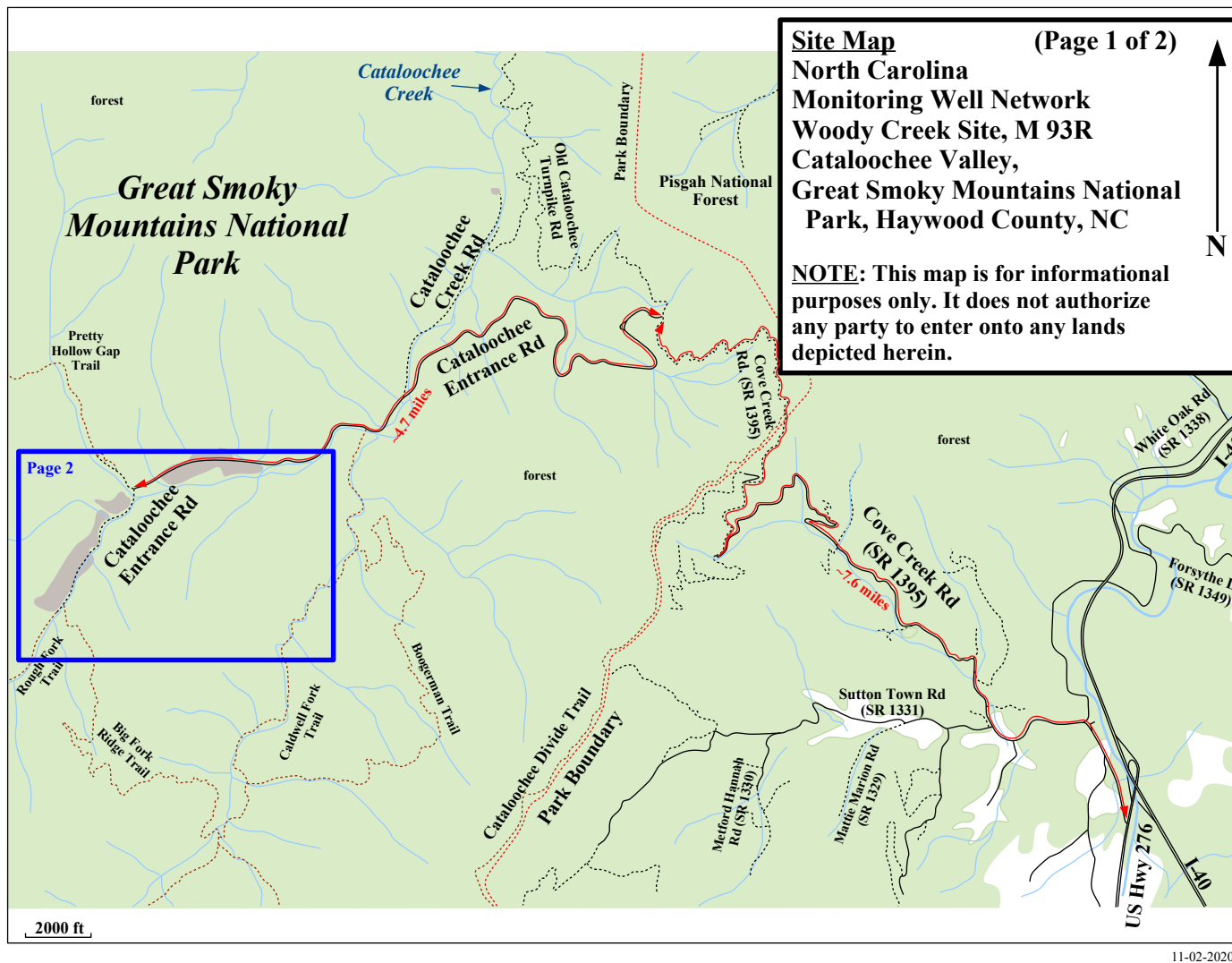


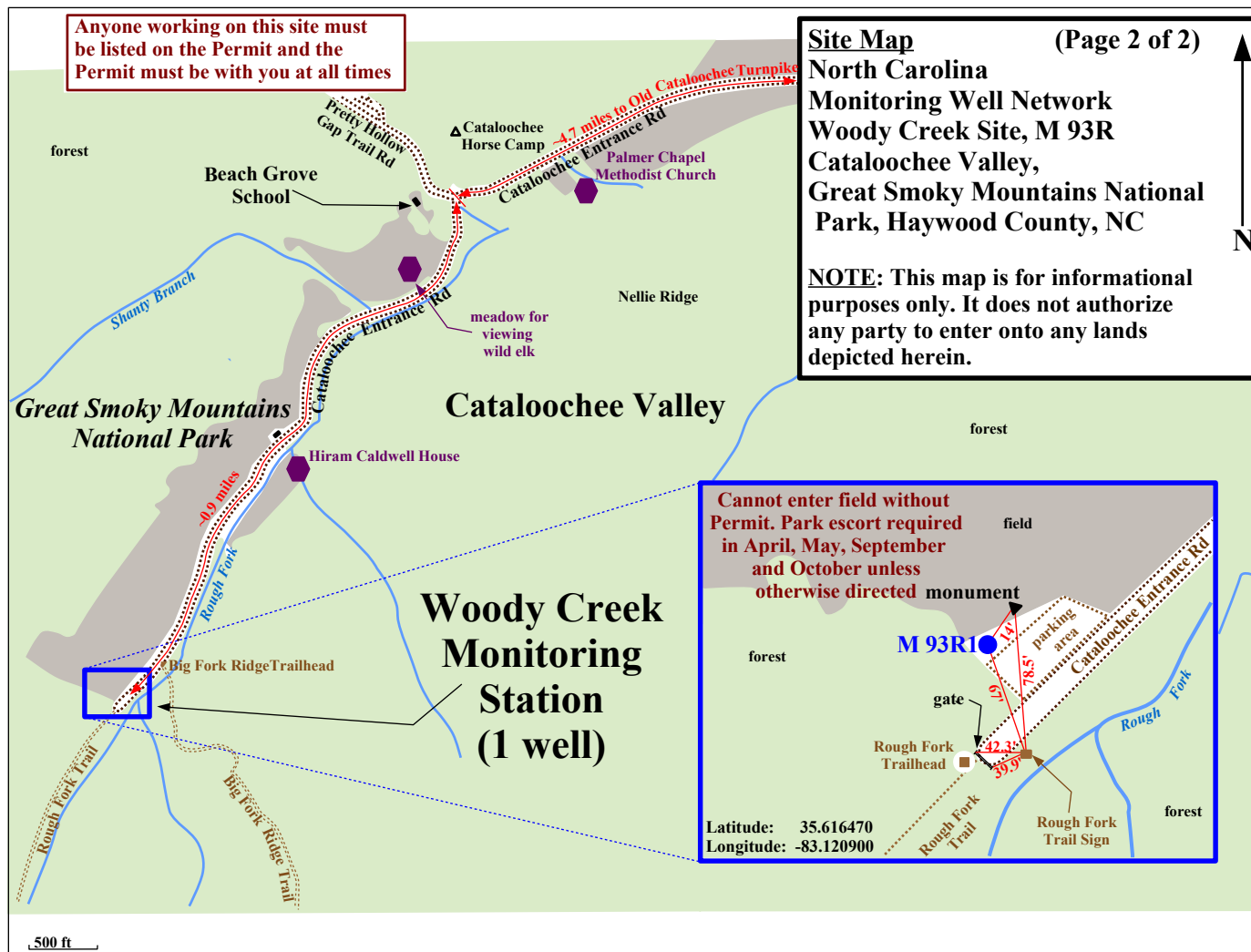
MONITORING WELL STATION MAPS

**Beach Grove School Field Well
Woody Creek
Oconaluftee Overlook
Smokemont Campground G1
Smokemont Rangers Station
Clingmans Dome
Deep Creek Campground**

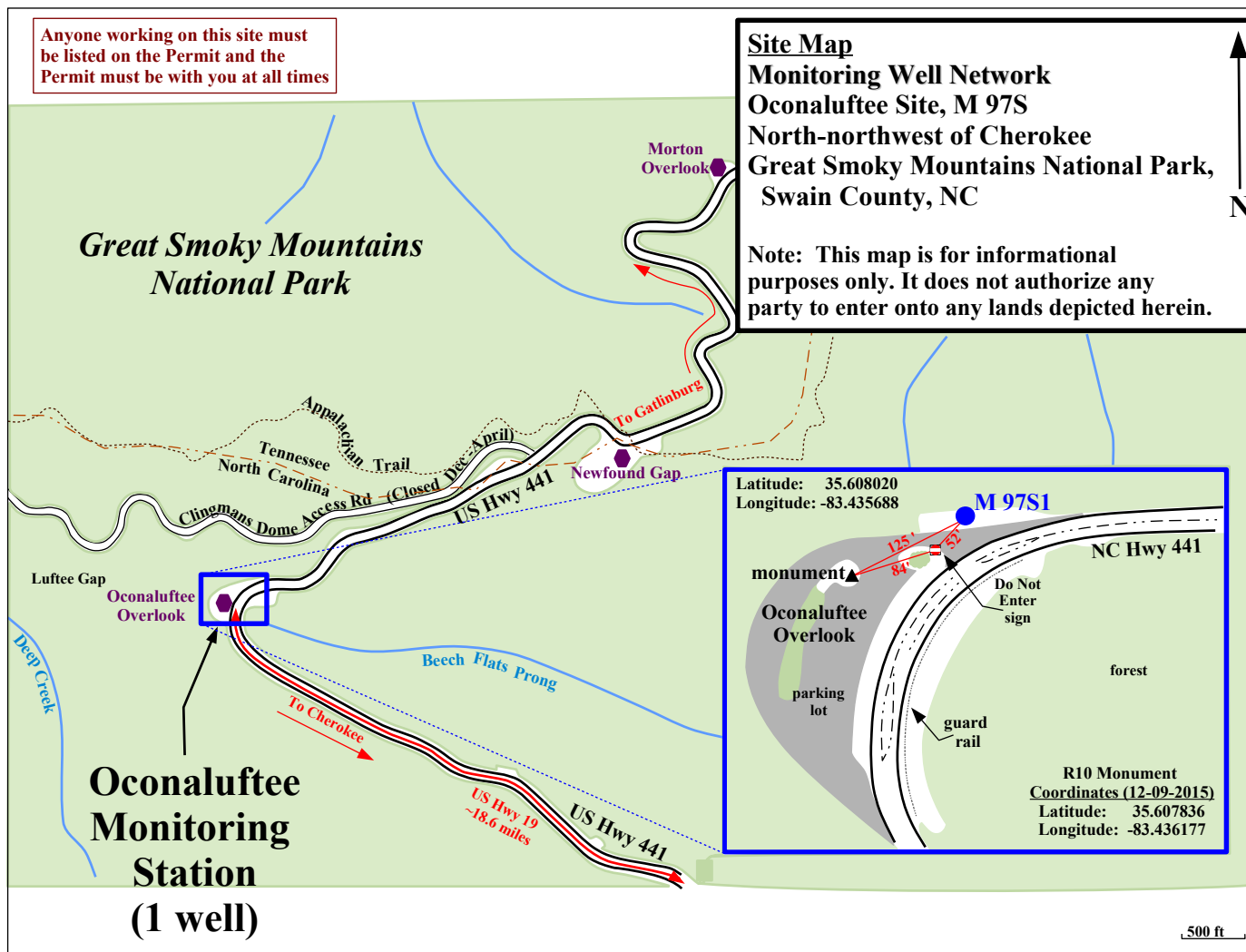




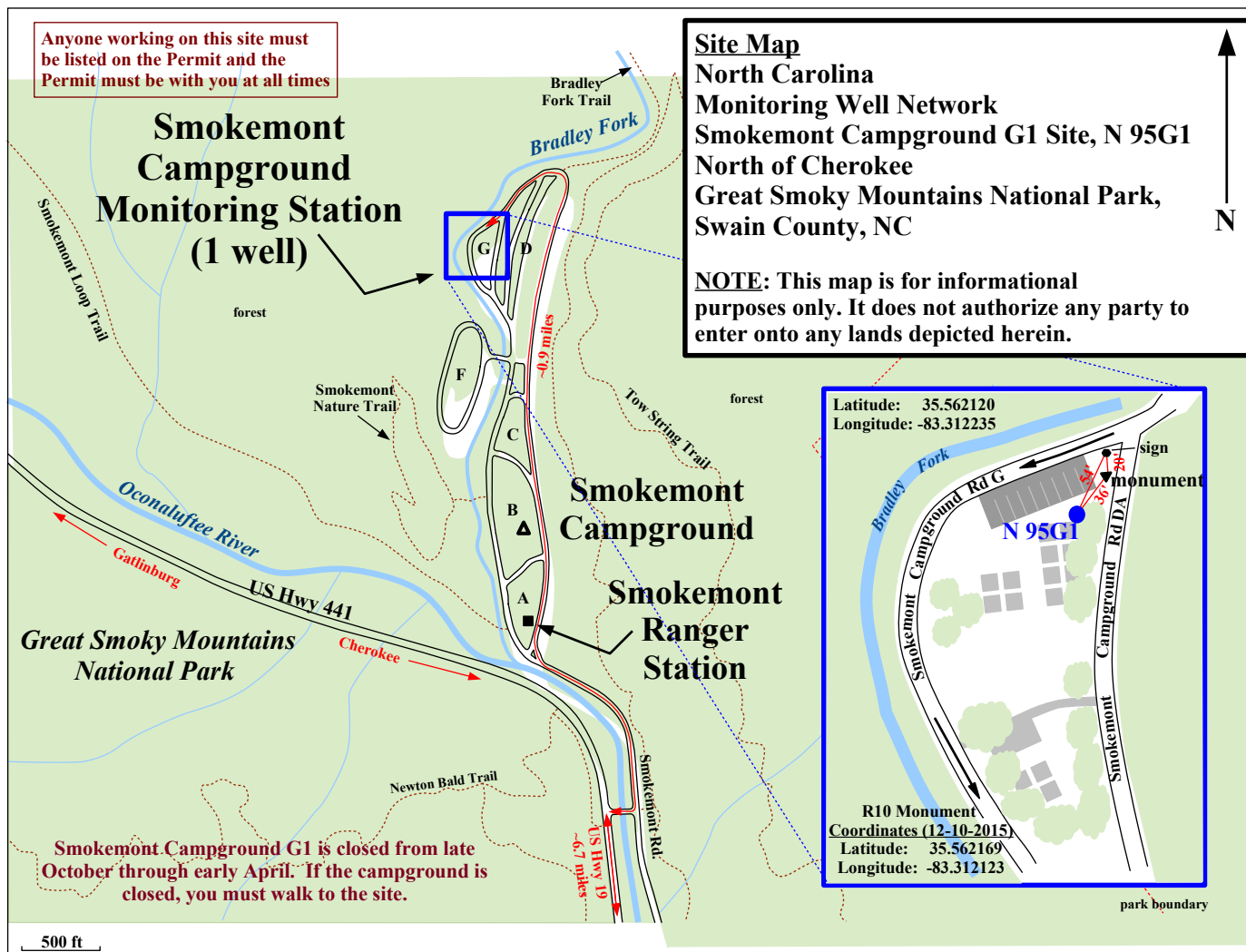


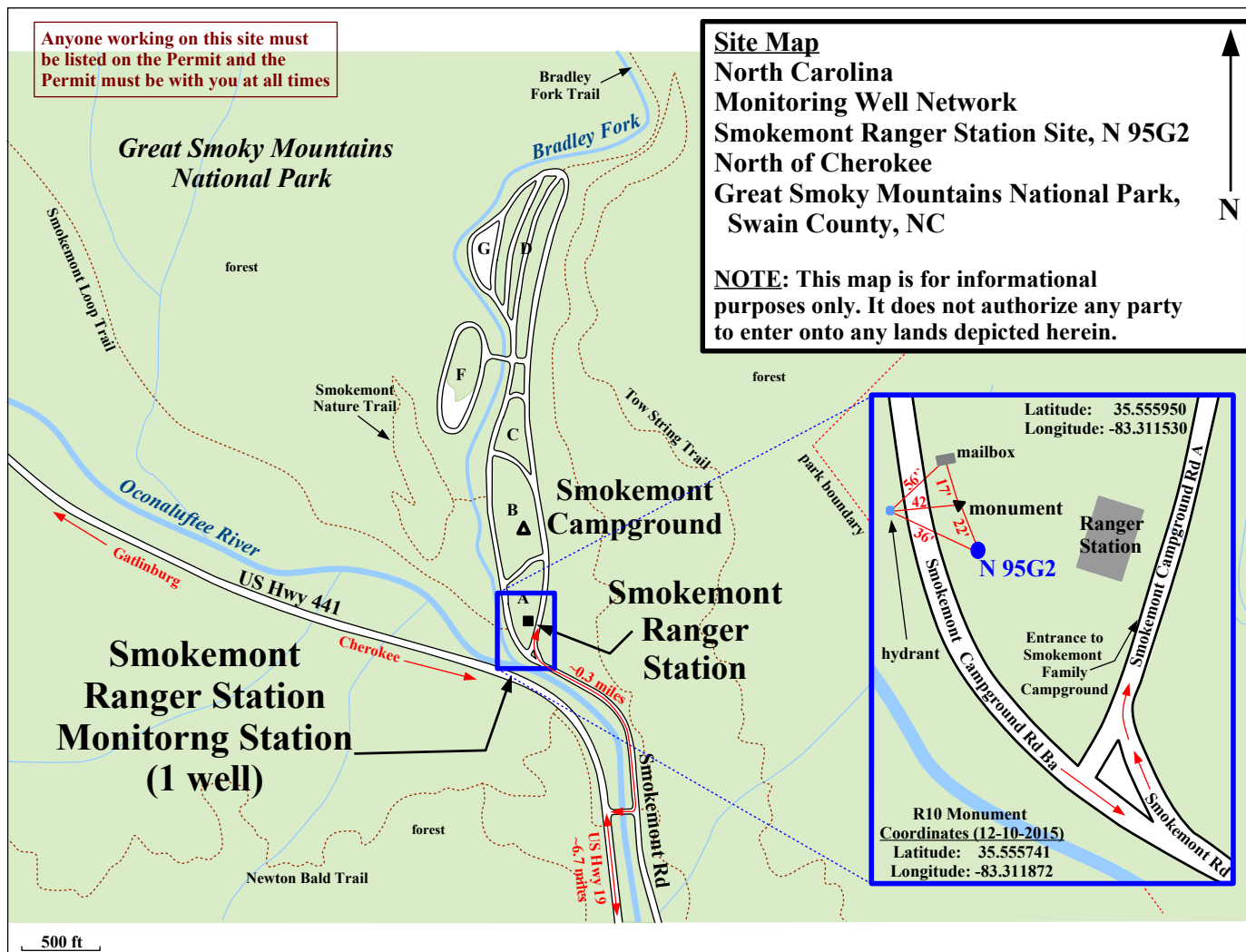


11-02-2020

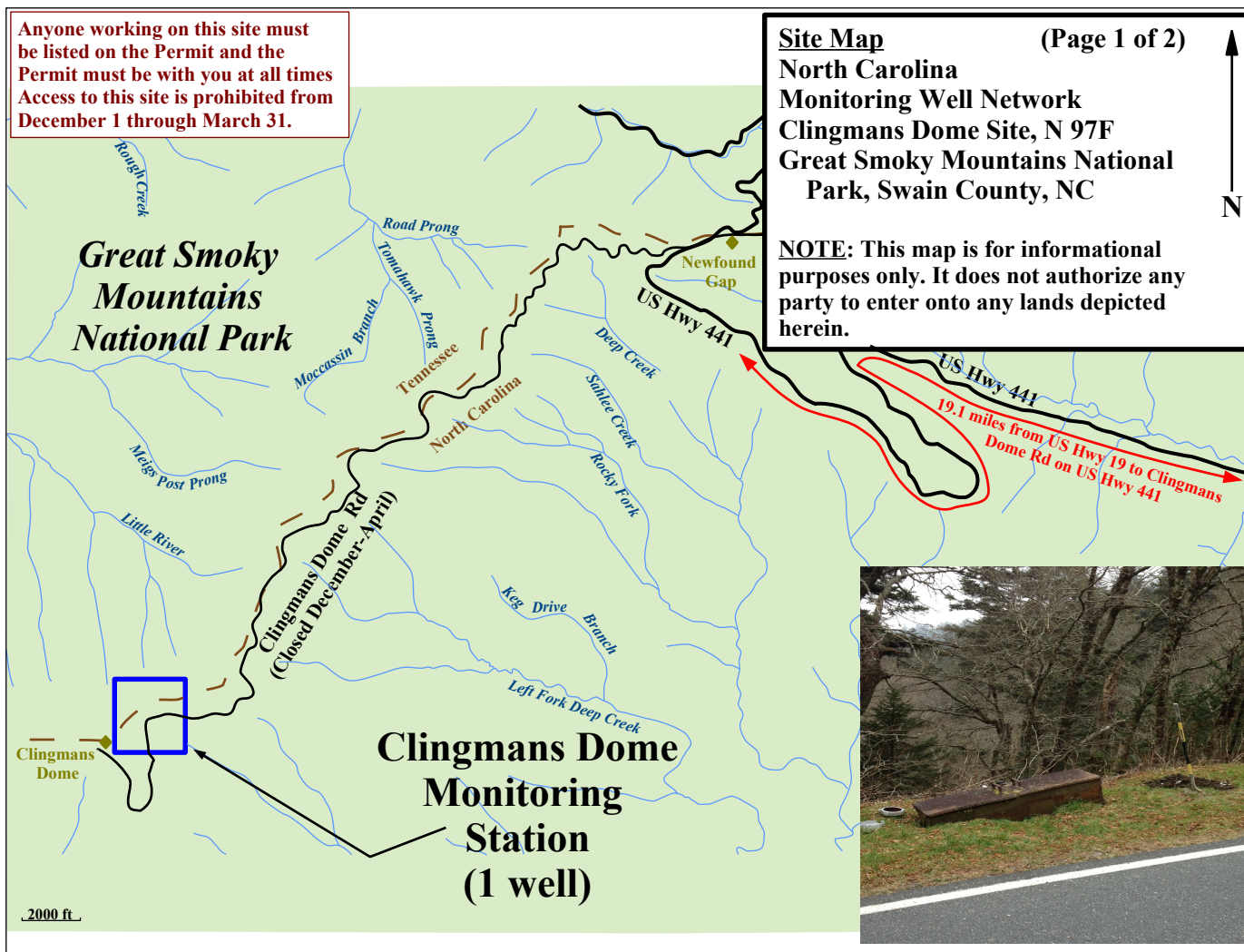


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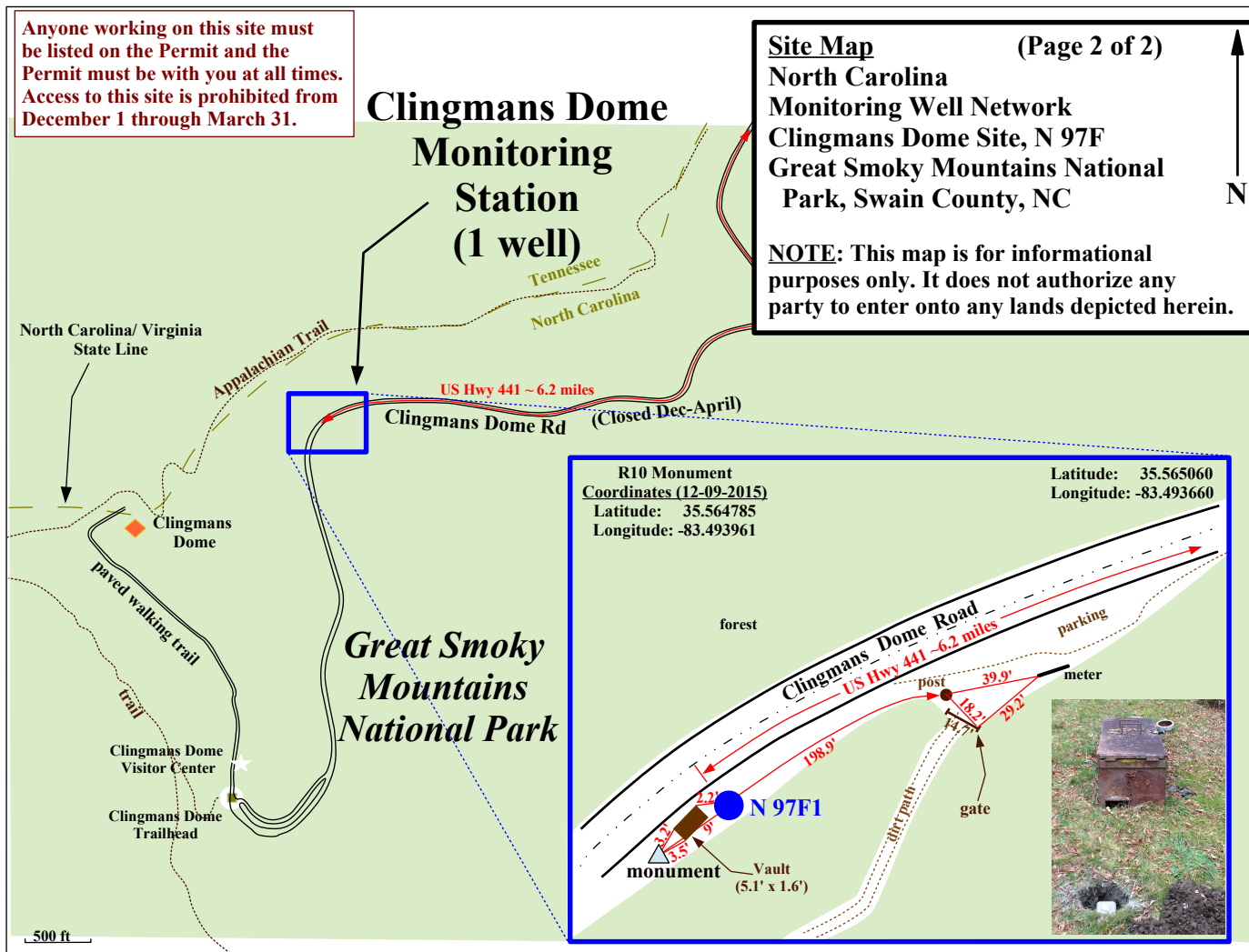




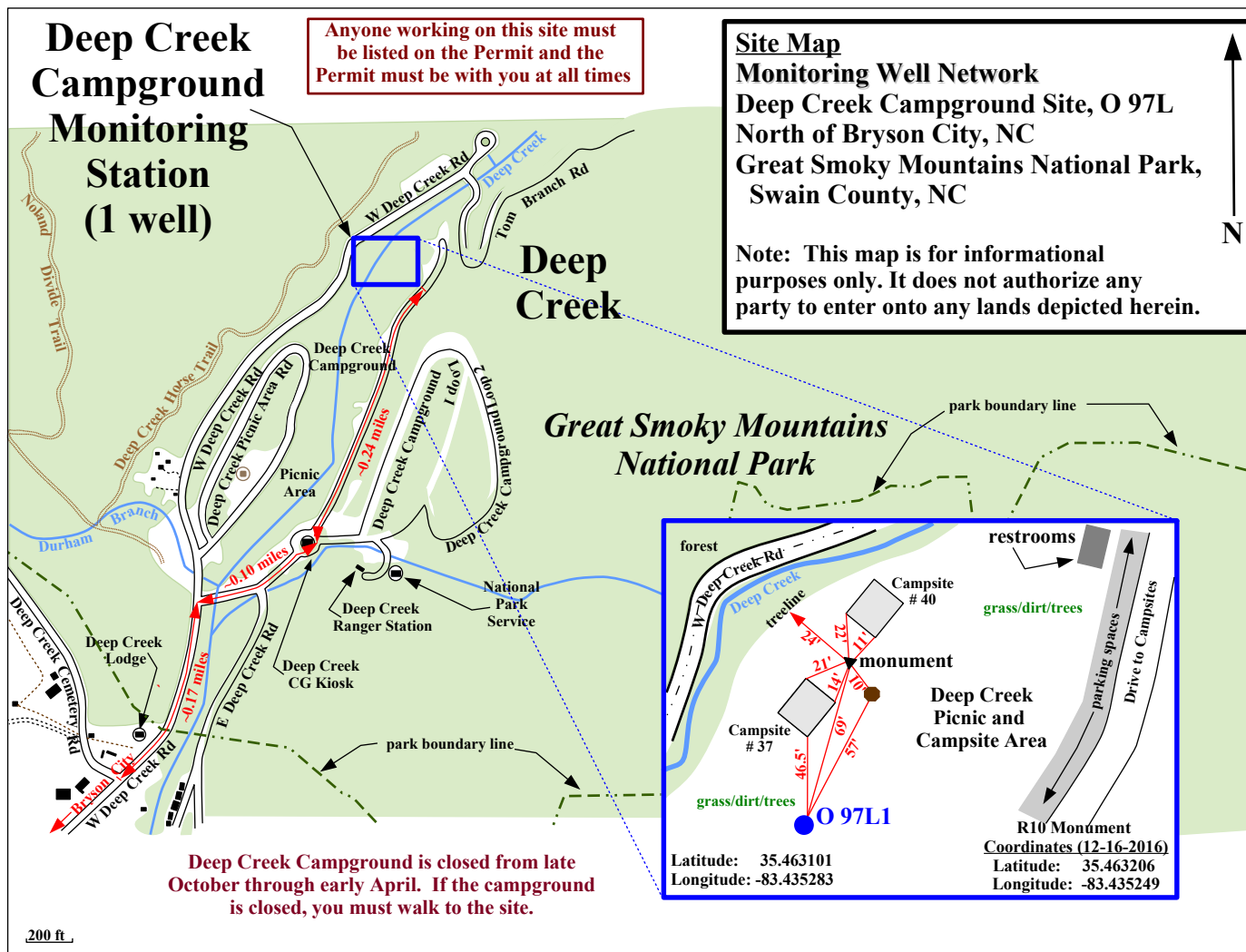
11-02-2020



11-02-2020



11-02-2020



11-02-2020

APPENDIX B

SUMMARY OF FIELD ACTIVITIES

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Beach Grove School Field Well Station (M 93L1), Haywood Co., NC	
Date	Activity
12/03/2015	Latitude: 35.62516, Longitude: -83.11589 water level data collected video-logged, 8-inch well, had to abandon early due to approaching elk herd
12/16/2015	met with Park Service archaeologist Heath Baily to install monument leveled monument could not obtain horizontal and vertical data using Trimble R10 GPS (no cell phone signal) water level data collected
04/14/2016	water level data collected developed well using the tornado pump by ProActive Environmental Products
04/20/2016	water level data collected video-logged - well cased to ~74', open hole from 74'-172', total depth ~172' install Hobo 30R SN 10817685 @ 24' below water level
08/03/2016	water level data collected
11/08/2016	water level data collected
02/01/2017	water level data collection
04/05/2017	water level data collection
04/25/2017	water level data collection
04/26/2017	water level data collection
08/22/2017	water level data collection
11/07/2017	water level data collection
02/06/2018	water level data collection
05/08/2018	water level data collection
08/08/2018	water level data collection
10/29/2018	water level data collection
02/05/2019	water level data collection
04/30/2019	water level data collection
07/30/2019	water level data collection
10/29/2019	water level data collection
02/03/2020	water level data collection
06/17/2020	water level data collection
08/10/2020	water level data collection
10/27/2020	water level data collection
03/12/2021	water level data collection
04/27/2021	water level data collection
08/09/2021	water level data collection
09/29/2021	water level data collection, replace water level data logger
11/03/2021	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Woody Creek Station (M 93R1), Haywood County, NC	
Date	Activity
12/02/2015	Latitude: 35.616470, -83.120900 chose proposed monument location
12/03/2015	video-logged, 8-inch well, total depth ~ 68'
12/16/2015	met with Park Service archaeologist Heath Bailly to install monument leveled monument could not obtain horizontal and vertical data using Trimble R10 GPS (no cell phone signal) water level data collected
03/02/2016	install Hobo hardware water level data collection
04/13/2016	water level data collected developed well using the tornado pump by ProActive Environmental Products
04/20/2016	water level data collected video-logged, 8-inch well, well cased ~35', open hole ~35'-70.5', total depth ~70.5' install Hobo 30R SN 10817688 set @ 24' below water level install barometer SN 10860797 set at 3' below measuring point (MP)
08/03/2016	water level data collection
11/08/2016	water level data collection
02/01/2017	water level data collection
04/05/2017	water level data collection
04/25/2017	water level data collection
04/26/2017	water level data collection
08/22/2017	water level data collection
11/07/2017	water level data collection
02/06/2018	water level data collection
05/08/2018	water level data collection
08/08/2018	water level data collection
10/29/2018	water level data collection
11/06/2018	Replace broken locking cap
02/05/2019	water level data collection
04/30/2019	water level data collection
05/07/2019	Level/Survey Well
07/30/2019	water level data collection
10/29/2019	water level data collection
02/03/2020	water level data collection
06/17/2020	water level data collection
08/10/2020	water level data collection
10/27/2020	water level data collection
03/12/2021	water level data collection
04/27/2021	water level data collection
08/09/2021	water level data collection
09/29/2021	water level data collection, replace water level and barometer data loggers
11/03/2021	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Oconaluftee Overlook (M 97S1), Swain County, NC	
Date	Activity
10/21/2015	cut off welded top, install locking cap video-logged water level data collection
11/04/2015	water level data collection
12/02/2016	water level data collection proposed monument location
12/03/2015	water level data collection
12/09/2015	water level data collection survey using Trimble R10 and level monument
12/16/2015	water level data collection
01/28/2016	could not locate well due to snow for water level data collection
03/02/2016	water level data collection install Hobo hardware
03/07/2016	water level data collection developed well using the tornado pump by ProActive Environmental Products
03/22/2016	water level data collection video-logged, 6-inch well, well casing ~24', open hole 24'-50', total depth ~50' install Hobo 30R SN 10817693 set @ 10' below water level install barometer 13R SN 10860772
04/20/2016	water level data collection
05/04/2016	water level data collection
08/03/2016	water level data collection
01/31/2017	water level data collection
04/25/2014	water level data collection
08/23/2017	water level data collection
11/07/2017	water level data collection
02/21/2018	water level data collection
05/08/2018	water level data collection
08/08/2018	water level data collection
10/29/2018	water level data collection
02/05/2019	water level data collection
04/30/2019	water level data collection
07/29/2019	water level data collection
10/29/2019	water level data collection
02/02/2020	water level data collection
05/12/2020	water level data collection
08/11/2020	water level data collection
10/27/2020	water level data collection
03/12/2021	water level data collection
04/27/2021	water level data collection
08/10/2021	water level data collection
09/15/2021	water level data collection
09/27/2021	water level data collection, pulled and replaced water level data logger, collected groundwater samples for field parameters and laboratory analysis
11/02/2021	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Smokemont Campground G1 (N 95G1), Swain County, NC	
Date	Activity
09/22/2015	locate well, Latitude:35.562120, Longitude: -83312235 water level data collection
10/21/2015	water level data collection video-logged – 8-inch well, well casing ~48~50', open hole ~50'-60', total depth ~60'
11/05/2015	water level data collection
12/02/2016	water level data collection proposed monument location
12/03/2016	water level data collection
12/10/2015	install monument level and survey monument using Trimble R10 water level data collection
12/16/2015	water level data collection
01/28/2016	water level data collection
03/02/2016	water level data collection
03/08/2016	water level data collection install Hobo hardware developed well using the tornado pump by ProActive Environmental Products
03/22/2016	water level data collection video-logged, 8-inch well, well casing ~ 48', open hole ~48'- 65' install Hobo 30R SN 10817687 @ 20' below water level share barometer with Smokemont Rangers Station, N95G2
04/19/2016	water level data collection video-logged - totally filled with suspended solids, zero visibility need to redevelop with hand pump
05/04/2016	water level data collection
08/03/2016	water level data collection
10/25/2016	water level data collection
01/31/2017	water level data collection
04/25/2017	water level data collection
08/23/2017	water level data collection
11/07/2017	water level data collection
02/06/2018	water level data collection
05/08/2018	water level data collection
08/08/2018	water level data collection
10/29/2018	water level data collection
04/30/2019	water level data collection
07/29/2019	water level data collection
10/28/2019	water level data collection
11/14/2019	water level data collection
02/03/2020	water level data collection
05/12/2020	water level data collection
08/11/2020	water level data collection
10/27/2020	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Smokemont Campground G1 (N 95G1), Swain County, NC (continued)	
Date	Activity
03/12/2021	water level data collection
04/27/2021	water level data collection
08/10/2021	water level data collection
09/15/2021	water level data collection
09/27/2021	water level data collection, pulled and replaced water level and barometer data loggers
11/02/2021	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Smokemont Ranger Station (N 95G2), Swain County, NC	
Date	Activity
12/02/2015	locate well, Latitude: 35.555950, Longitude: -83.311530
	locate proposed monument
	cut strap remove top - install locking cap
	Video-logged, 8-inch well, difficult to see
	water level data collection
12/03/2015	water level data collection
12/10/2015	install monument
	level and survey monument using Trimble R10
	water level data collection
12/16/2015	water level data collection
01/28/2016	water level data collection
03/02/2016	water level data collection
03/08/2016	water level data collection
	developed well using the tornado pump by ProActive Environmental Products
03/22/2016	water level data collection
	video-logged, 8-inch well, well casing ~25', open hole ~ 25'-94', total depth ~94'
	install Hobo 30R SN 10817684 @ 23' below water level
	install barometer 13R SN 10860793 @ 3' below MP
04/19/2016	video-logged
	need to redevelop using hand pump
05/04/2016	water level data collection
08/03/2016	water level data collection
10/25/2016	water level data collection
01/31/2017	water level data collection
04/25/2017	water level data collection
08/23/2017	water level data collection
11/07/2017	water level data collection
02/06/2018	water level data collection
05/08/2018	water level data collection
08/08/2018	water level data collection
10/29/2018	water level data collection
02/05/2019	water level data collection
04/30/2019	water level data collection
07/29/2019	water level data collection
10/29/2019	water level data collection
02/03/2020	water level data collection
05/12/2020	water level data collection
08/11/2020	water level data collection
10/27/2020	water level data collection
11/22/2020	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Smokemont Ranger Station (N 95G2), Swain County, NC (continued)	
Date	Activity
03/12/2021	water level data collection, pulled and replaced barometer data logger
04/27/2021	water level data collection
08/10/2021	water level data collection
09/15/2021	water level data collection
09/27/2021	water level data collection, pulled and replaced water level data logger
11/02/2021	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Clingmans Dome (N 97F1), Swain County, NC	
Date	Activity
10/21/2015	Locate well, Latitude: 35.5650626, Longitude: -83.4936697 6-inch well, depth unknown, pump is still in well water level data collection
11/04/2016	water level data collection
12/02/2016	water level data collection
12/09/2016	install monument, level and survey monument using Trimble R10 water level data collection
05/04/2016	water level data collection
08/03/2016	water level data collection
10/25/2016	water level data collection
04/25/2017	water level data collection
08/23/2017	water level data collection
11/07/2017	water level data collection
05/08/2018	water level data collection
08/08/2018	water level data collection
10/29/2018	water level data collection
04/29/2019	water level data collection
07/29/2019	water level data collection
10/29/2019	water level data collection
08/11/2020	water level data collection
10/27/2020	water level data collection
04/27/2021	water level data collection
08/10/2021	water level data collection
11/02/2021	water level data collection

SUMMARY OF FIELD ACTIVITIES Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report	
Deep Creek Campground (O 97L1), Swain County, NC	
Date	Activity
11/05/2015	8-inch well / Cased 24.5' / Open bore 24.5'-112'
11/05/2015	locate well - Latitude: 35.463206, Longitude: -83.435249
12/16/2015	met with Park Service archaeologist Heath Baily to install monument survey using Trimble R10
04/19/2016	video-logged - well cased ~24.5', open hole ~ 24.5' to 112', total depth ~112' water level data collection and leveling monument install Hobo 30R SN 10817691 @ 22' below water level install barometer Hobo13R SN 10860794 @ 2' below MP
05/04/2016	water level data collection
08/02/2016	water level data collection
10/25/2016	water level data collection
02/01/2017	water level data collection
04/25/2017	water level data collection
08/23/2017	water level data collection
11/07/2017	water level data collection
02/06/2018	water level data collection
02/21/2018	water level data collection - pulled barometer data logger
03/19/2018	water level data collection - installed barometer data logger
05/08/2018	water level data collection
08/07/2018	water level data collection
10/30/2018	water level data collection
02/05/2019	water level data collection
04/29/2019	water level data collection
07/28/2019	water level data collection
10/28/2019	water level data collection
02/03/2020	water level data collection
05/12/2020	water level data collection
08/11/2020	water level data collection
10/27/2020	water level data collection
11/22/2020	water level data collection, replace both water level and barometer data loggers
02/08/2021	water level data collection
04/27/2021	water level data collection
08/10/2021	water level data collection
09/28/2021	water level data collection
11/02/2021	water level data collection

APPENDIX C

**GROUND WATER DATA
AND
HYDROGRAPHS**

**BEACH GROVE SCHOOL FIELD WELL (M 93L1)
HAYWOOD COUNTY, NC**

**Manual Water Level Data
Beach Grove School Field Well (M 93L1)
Great Smoky Mountain National Park
NC Division of Water Resources
2021 Summary Report**

Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
12/03/2015	14:23	3.46	1.5
12/16/2015	11:08	5.50	
04/14/2016	08:26	5.19	
04/20/2016	10:08	5.55	
08/03/2016	12:06	6.37	
11/08/2016	14:33	6.43	
02/01/2017	15:06	5.93	
04/05/2017	07:31	4.62	
04/26/2017	08:53	3.75	
08/22/2017	15:26	6.44	
11/07/2017	09:46	5.98	
02/06/2018	09:02	5.25	
05/08/2018	14:53	5.25	
08/08/2018	11:43	5.00	
10/29/2018	12:10	6.09	
02/05/2019	13:35	4.67	
04/30/2019	12:58	4.10	
07/30/2019	10:19	5.46	
10/29/2019	13:07	6.66	
02/03/2020	14:25	4.82	
06/17/2020	09:42	5.17	
08/11/2020	08:36	5.69	
10/27/2020	14:51	5.69	
03/12/2021	11:24	2.73	
04/27/2021	15:20	3.38	
08/09/2021	14:53	4.66	
09/29/2021	10:08	4.94	
11/03/2021	09:54	5.13	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Groundwater Level Database Detail

Field	Data
County	Haywood
Quad	M 93L1
Name	Beach Grove School Field Well
Latitude	35.625160
Longitude	-83.115890
Location Accuracy	GPS
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	2773.73
NED elevation = 2,773.63 feet	
Date Constructed	
Measuring Point	1.50
Depth	172
Diameter	8
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	74
Bottom of Screen Depth	172
Temperature	55.826
Number of Water Levels	1,993
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well
2015-12-03 to 2021-11-03	-222.22 feet above land surface value indicates a flowing well

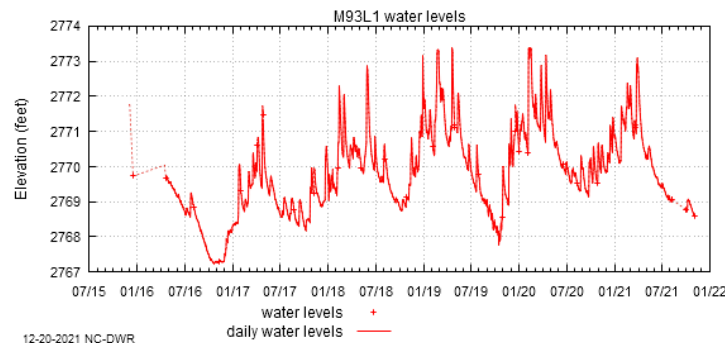
output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(~10 X 10 meter grid)



DWR Monitoring Database Detail for M93L1

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



slope: -1.59 feet/year between 2020-10-01 and 2021-11-03

Plotly tools are available above lower chart to zoom into rectangular area, pan, zoom in, zoom out, scale to extremes of data, return to initial view, and show closest data point information.

**WOODY CREEK WELL (M 93R1)
HAYWOOD COUNTY, NC**

Manual Water Level Data Woody Creek Well (M 93R1) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report			
Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
12/03/2015	13:13	7.92	1.73
12/16/2015	08:54	8.61	
03/02/2016	12:35	8.21	
04/13/2016	07:36	8.59	
04/20/2016	08:22	8.62	
08/03/2016	12:18	8.78	
11/08/2016	14:20	8.82	
02/01/2017	15:18	8.59	
04/04/2017	16:44	8.29	
04/05/2017	08:53	8.37	
04/26/2017	09:06	8.27	
08/22/2017	15:42	8.75	
11/07/2017	09:54	8.27	
02/06/2018	09:11	8.51	
05/08/2018	15:03	8.62	
08/08/2018	12:02	8.46	
10/29/2018	12:18	8.54	
02/05/2019	13:46	8.54	
04/30/2019	12:40	8.49	
05/07/2019	12:37	8.51	1.72
07/30/2019	10:39	8.57	
10/29/2019	12:53	8.67	
02/03/2020	14:38	8.49	
06/17/2020	10:02	8.67	
08/11/2020	09:06	8.78	
10/27/2020	15:18	8.75	
03/12/2021	11:42	6.89	
04/27/2021	15:43	6.98	
08/09/2021	15:07	7.02	
09/29/2021	09:34	7.18	
11/03/2021	10:07	7.13	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Groundwater Level Database Detail

Field	Data
County	Haywood
Quad	M 93R1
Name	Woody Creek Well
Latitude	35.616470
Longitude	-83.120900
Location Accuracy	GPS
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	2827.73
NED elevation = 2,827.40 feet	
Date Constructed	
Measuring Point	1.72
Depth	70
Diameter	8
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	35
Bottom of Screen Depth	70
Temperature	55.032
Number of Water Levels	1,996
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well -222.22 feet above land surface value indicates a flowing well
2015-12-03 to 2021-11-03	

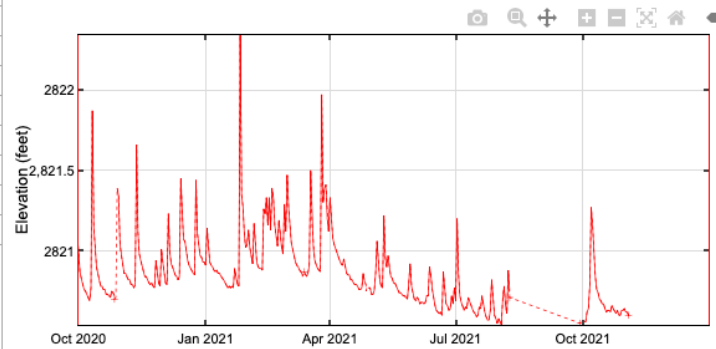
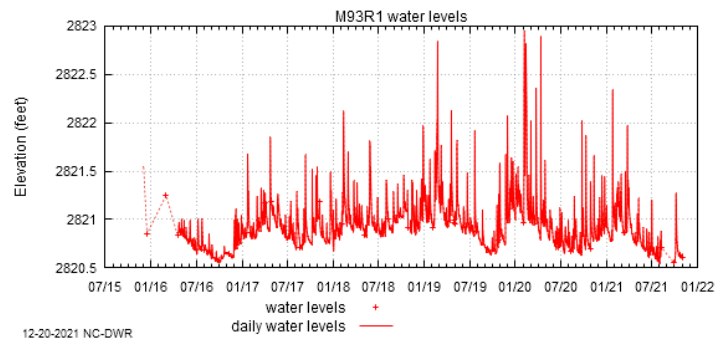
output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(-10 X 10 meter grid)



DWR Monitoring Database Detail for M93R1

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



slope: -0.32 feet/year between 2020-10-01 and 2021-11-03

Plotting tools are available above lower chart to zoom into rectangular area, pan, zoom in, zoom out, scale to extremes of data, return to initial view, and show closest data point information.

OCONALUFTEE OVERLOOK (M 97S1)
SWAIN COUNTY, NC

**Manual Water Level Data
Oconaluftee Overlook (M 97S1)
Great Smoky Mountain National Park
NC Division of Water Resources
2021 Summary Report**

Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
10/21/2015	12:15	38.51	1.25
11/04/2015	16:53	29.82	
12/02/2015	13:06	23.85	
12/03/2015	17:05	21.48	
12/09/2015	12:24	30.14	
12/16/2015	16:41	34.42	
03/02/2016	16:04	35.20	
03/07/2016	14:19	31.09	
03/22/2016	10:09	35.85	
04/20/2016	14:41	36.44	
05/04/2016	07:05	35.59	
08/03/2016	09:37	40.30	
10/25/2016	15:10	44.87	
01/31/2017	16:19	30.40	
04/25/2017	16:36	23.86	
08/23/2017	11:20	38.21	
11/07/2017	12:25	33.33	
02/21/2018	13:04	29.14	
05/08/2018	13:20	34.46	
08/08/2018	08:20	28.51	
10/29/2018	14:58	30.43	
02/05/2019	16:47	34.20	
04/30/2019	09:52	31.80	
07/29/2019	12:53	31.73	
10/29/2019	09:44	31.74	
02/03/2020	11:28	33.09	
05/12/2020	19:44	33.28	
08/11/2020	16:54	35.22	
10/27/2020	11:59	35.64	
03/12/2021	14:14	32.48	
04/27/2021	12:43	36.89	
08/10/2021	13:07	39.13	
09/15/2021	09:32	33.63	
09/27/2021	07:49	34.64	
11/02/2021	14:07	36.22	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

**Specific Parameters and Analytical Methods
Oconaluftee Overlook (M 97S1)
Great Smoky Mountain National Park
NC Division of Water Resources
2021 Summary Report**

Analyte Names	Method Reference
Alkalinity, Bicarbonate, Carbonate	SM 2320 B-1997
Total Organic Carbon (TOC)	SM 5310 B-2000
Turbidity	SM 2130 B-2001
NH ₃ as N	EPA 350.1 REV2
NO ₂ +NO ₃ as N	EPA 353.2 REV 2
Total Phosphorus	EPA 365.1 REV 2
Total Kjeldahl Nitrogen as N (TKN)	EPA 351.2 REV 2
Bromide, Chloride, Fluoride, Sulfate	EPA 300.0 REV 2.1
Silica	SM 4500-SiO ₂ -C-1997
Sulfide	SM 4500-S ₂ -D-2000
Total Dissolved Solids (TDS)	SM 2540 C-1997
Mercury (Hg) 245.1	EPA 245.1 REV 3
Chlorinated Pesticides	EPA 608 / SW8081B
Nitrogen-based Pesticides	EPA 619
Phosphorus-based Pesticides	EPA 641
Semivolatile Organic Compounds (SVOCs)	EPA 625/8270D
Volatile Organic Compounds (VOCs)	EPA 624/8260C
Metals by ICPMS - Silver (Ag), Antimony (Sb), Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Molybdenum (Mo), Nickel (Ni), Lead (Pb), Selenium (Se), Tin (Sn), Strontium (Sr), Thallium (Tl), Zinc (Zn)	EPA 200.8 REV 5.4
Metals by ICP - Aluminum (Al), Boron (B), Barium (Ba), Beryllium (Be), Calcium (Ca), Cobalt (Co), Iron (Fe), Potassium (K), Lithium (Li), Magnesium (Mg), Manganese (Mn), Sodium (Na), Titanium (Ti), Vanadium (V)	EPA 200.7 REV 4.4
Per- and polyfluoroalkyl substances (PFAS)	In-house Isotope Dilution Method (w/ solid phase extraction)

Summary of Field Parameters (Sorted by Well) (Measured using a YSI ProDSS meter) Oconaluftee Overlook (M 97S1) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report										
Well	Station Name	County	Date	Temp °C	DO (mg/L)	Specific Conductivity (µS/cm)	Salinity (ppt)	pH	ORP (mV)	Turbidity (NTU)
M97S1	Oconaluftee Overlook	Swain	09/27/2021	10.9	17.4	124.9	0.06	7.36	-3.7	3.24

°C - Degrees Centigrade
 DO - Dissolved Oxygen
 mg/L milligrams per liter
 µS/cm- micro-Siemens per centimeter
 ppt - parts per trillion
 ORP - oxidation potential reduction
 mV - millivolts
 NTU - Nephelometric Turbidity Units

Groundwater Quality Water Results Exceeding the 15A NCAC 2L Standards Oconaluftee Overlook (M 97S1) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report											
Well	Station Name	Collection Date	Parameter	Results (µg/L ¹)	NCAC 2L Standard (µg/L ¹)	County	Aquifer	Depth (ft bgs ²)	Open Hole (ft bgs ²)	Casing Material	Screen Material
M97S1	Oconaluftee Overlook	09/27/2021	Manganese (Mn)	200	50	Swain	Basement Rock (Br)	50	24-50	Black Ductile Iron	Open Hole

¹ µg/L - micrograms per liter

² bgs - below ground surface

Groundwater Level Database Detail

Field	Data
County	Swain
Quad	M 97S1
Name	Oconaluftee Overlook
Latitude	35.608020
Longitude	-83.435688
Location Accuracy	GPS
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	4903.329
NED elevation = 4,903.13 feet	
Date Constructed	
Measuring Point	1.25
Depth	50
Diameter	6
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	24
Bottom of Screen Depth	50
Temperature	50.165
Number of Water Levels	2,038
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well
2015-10-21 to 2021-11-02	-222.22 feet above land surface value indicates a flowing well

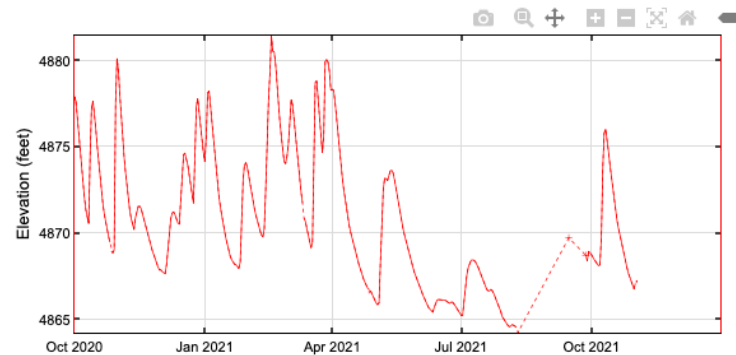
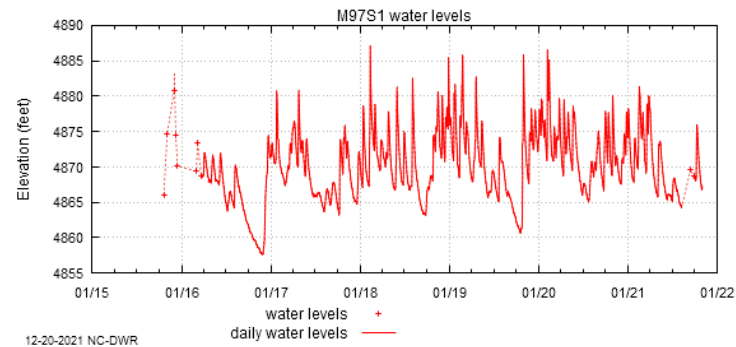
output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(~10 X 10 meter grid)



DWR Monitoring Database Detail for M97S1

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



slope: -6.15 feet/year between 2020-10-01 and 2021-11-02

Plotly tools are available above lower chart to zoom into rectangular area, pan, zoom in, zoom out, scale to extremes of data, return to initial view, and show closest data point information.

SMOKEMONT CAMPGROUND G1 (N 95G1)
SWAIN COUNTY, NC

**Manual Water Level Data
Smokemont Campground G1 (N 95G1)
Great Smoky Mountain National Park
NC Division of Water Resources
2021 Summary Report**

Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
09/22/2015	11:30	9.72	0.87
10/21/2015	09:37	9.22	
11/05/2015	08:39	8.51	
12/02/2015	15:13	5.62	
12/03/2015	17:33	6.34	
12/10/2015	10:30	8.51	
12/16/2015	16:10	8.85	
01/28/2016	11:45	8.70	
03/02/2016	16:59	8.31	
03/08/2016	08:11	8.68	
03/22/2016	09:47	8.93	
04/19/2016	14:00	9.00	
05/04/2016	09:03	8.62	
08/03/2016	10:06	9.09	
10/25/2016	11:31	9.57	
01/31/2017	15:33	8.62	
03/21/2017	08:09	8.49	
04/04/2017	14:03	8.10	
04/25/2017	15:10	7.33	
08/23/2017	09:54	9.05	
11/07/2017	11:49	8.61	
02/06/2018	10:52	8.87	
05/05/2018	12:19	9.20	
08/08/2018	07:46	8.51	
10/29/2018	15:24	8.70	
02/05/2019	15:58	8.92	
04/30/2019	10:24	8.71	
07/29/2019	11:12	8.79	
10/28/2019	17:57	8.35	
11/14/2019	11:14	8.98	
02/03/2020	12:10	8.82	
05/12/2020	19:05	8.85	
08/11/2020	16:19	8.86	
10/27/2020	12:33	9.09	

Manual Water Level Data (Continued) Smokemont Campground G1 (N 95G1) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report			
Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
02/08/2021	17:59:00	8.01	0.87
03/12/2021	13:46:00	8.15	
04/27/2021	13:25:00	8.26	
08/10/2021	13:38:00	8.07	
09/15/2021	10:09:00	8.41	
09/27/2021	17:56:00	8.35	
11/02/2021	12:28:00	8.26	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Groundwater Level Database Detail

Field	Data
County	Swain
Quad	N 95G1
Name	Smokemont Campground G1
Latitude	35.562120
Longitude	-83.312235
Location Accuracy	GPS
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	2239.822
NED elevation = 2,239.52 feet	
Date Constructed	
Measuring Point	0.87
Depth	65
Diameter	8
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	48
Bottom of Screen Depth	65
Temperature	57.319
Number of Water Levels	2,044
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well -222.22 feet above land surface value indicates a flowing well
2015-09-22 to 2021-11-02	

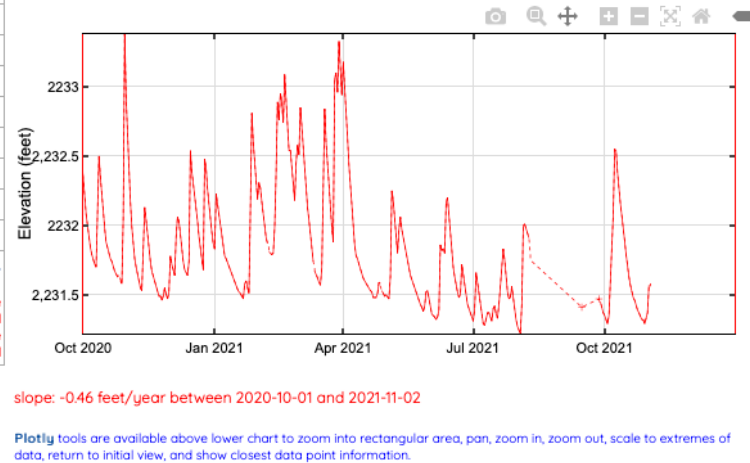
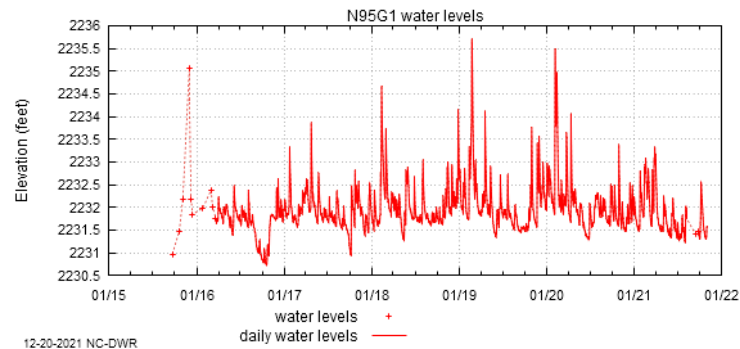
output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(-10 X 10 meter grid)



DWR Monitoring Database Detail for N95G1

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



SMOKEMONT RANGER STATION (N 95G2)
SWAIN COUNTY, NC

Manual Water Level Data Smokemont Rangers Station (N 95G2) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report			
Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
12/02/2015	14:03	8.84	0.91
12/03/2015	17:43	9.99	
12/10/2015	11:52	11.15	
12/16/2015	16:22	11.61	
01/28/2016	11:35	11.27	
03/02/2016	15:35	10.76	
03/08/2016	13:40	11.11	
03/22/2016	08:40	11.78	
04/19/2016	14:36	11.91	
05/04/2016	09:12	11.68	
08/03/2016	10:12	12.51	
10/25/2016	13:27	13.05	
01/31/2017	15:53	11.77	
03/23/2017	09:19	11.52	
04/03/2017	17:16	10.87	
04/25/2017	15:26	10.39	
08/23/2017	10:07	12.37	
11/07/2017	12:03	11.21	
02/06/2018	11:03	10.92	
05/08/2018	12:31	11.57	
08/08/2018	07:36	11.30	
10/29/2018	15:33	10.94	
02/05/2019	16:12	11.34	
04/30/2019	10:40	11.00	
07/29/2019	11:23	11.55	
10/29/2019	08:41	11.88	
02/03/2020	12:23	11.10	
05/12/2020	19:24	11.18	
08/11/2020	16:29	11.81	
10/27/2020	12:49	11.88	
11/22/2020	15:46	11.64	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Manual Water Level Data (Continued) Smokemont Ranger Station (N 95G2) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report			
Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
02/08/2021	17:47:00	10.12	0.91
03/12/2021	13:29:00	9.99	
04/27/2021	13:37:00	10.60	
08/10/2021	13:50:00	11.15	
09/15/2021	10:21:00	11.08	
09/27/2021	18:26:00	11.12	
11/02/2021	12:44:00	11.11	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Groundwater Level Database Detail

Field	Data
County	Swain
Quad	N 95G2
Name	Smokemont Ranger Station
Latitude	35.555950
Longitude	-83.311530
Location Accuracy	GPS
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	2203.623
NED elevation = 2,208.89 feet	
Date Constructed	
Measuring Point	0.91
Depth	94
Diameter	8
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	10
Bottom of Screen Depth	94
Temperature	55.902
Number of Water Levels	2,013
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well
2015-12-02 to 2021-11-02	-222.22 feet above land surface value indicates a flowing well

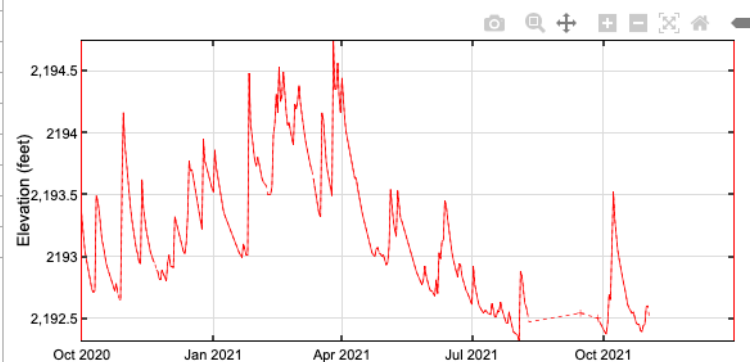
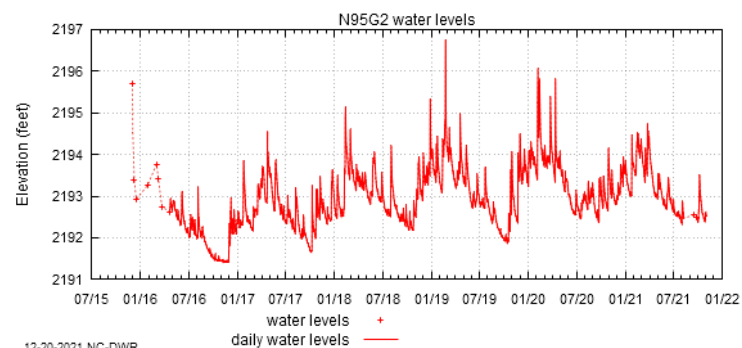
output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(-10 X 10 meter grid)



DWR Monitoring Database Detail for N95G2

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



slope: -0.77 feet/year between 2020-10-01 and 2021-11-02

Plotly tools are available above lower chart to zoom into rectangular area, pan, zoom in, zoom out, scale to extremes of data, return to initial view, and show closest data point information.

CLINGMANS DOME (N 97F1)
SWAIN COUNTY, NC

Manual Water Level Data Clingmans Dome (N 97F1) Great Smoky Mountain National Park NC Division of Water Resources 2021 Summary Report			
Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
10/21/2015	10:22	33.86	0.34
11/04/2015	16:53	27.66	
12/02/2015	13:06	23.85	
12/09/2015	10:37	31.75	
05/04/2016	08:09	28.68	
08/03/2016	09:15	36.04	
10/25/2016	14:35	39.32	
04/25/2017	16:42	27.38	
08/23/2017	10:56	33.62	
11/07/2017	12:42	31.71	
05/08/2018	13:03	34.21	
08/08/2018	08:47	28.37	
10/26/2018	14:41	28.46	
04/29/2019	09:32	29.62	
07/29/2019	12:31	30.98	
10/29/2019	09:26	25.22	
08/11/2020	17:22	31.50	
10/27/2020	11:41	35.03	
04/27/2021	12:15	31.13	
08/10/2021	12:44	30.88	
11/02/2021	13:24	30.08	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Groundwater Level Database Detail

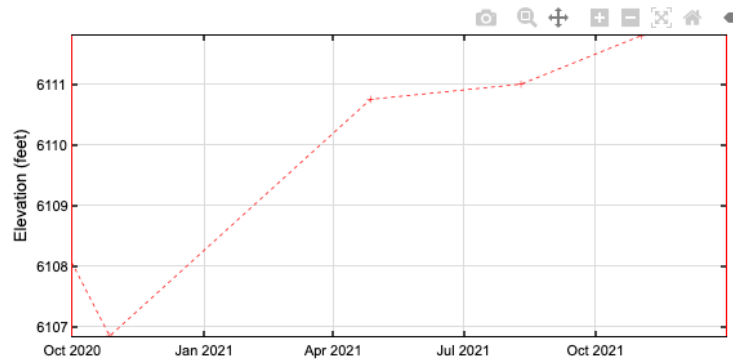
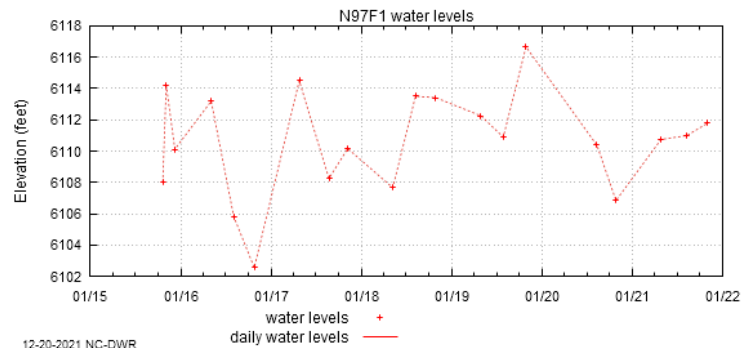
Field	Data
County	Swain
Quad	N 97F1
Name	Clingmans Dome
Latitude	35.565060
Longitude	-83.493660
Location Accuracy	GPS
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	6141.54
NED elevation = 6,138.51 feet	
Date Constructed	
Measuring Point	0.34
Depth	0
Diameter	6
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	0
Bottom of Screen Depth	0
Temperature	
Number of Water Levels	20
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well
2015-10-21 to 2021-11-02	-222.22 feet above land surface value indicates a flowing well

output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(~10 X 10 meter grid)

DWR Monitoring Database Detail for N97F1

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



Plotly tools are available above lower chart to zoom into rectangular area, pan, zoom in, zoom out, scale to extremes of data, return to initial view, and show closest data point information.

**DEEP CREEK CAMPGROUND (O 97L1)
SWAIN COUNTY, NC**

**Manual Water Level Data
Deep Creek Campground (O 97L1)
Great Smoky Mountain National Park
NC Division of Water Resources
2021 Summary Report**

Date	EST	Water Level (feet below MP)	MP (feet above ground surface)
04/19/2016	11:24	7.75	0.67
05/04/2016	10:03	7.60	
08/02/2016	17:05	8.46	
10/25/2016	10:21	8.65	
02/01/2017	11:14	7.67	
03/22/2017	09:24	7.34	
04/04/2017	11:54	6.89	
04/25/2017	11:36	6.31	
08/23/2017	09:08	8.37	
11/07/2017	13:52	7.03	
02/06/2018	14:24	7.97	
02/21/2018	14:06	6.90	
03/19/2018	14:43	7.27	
05/08/2018	16:41	7.60	
08/07/2018	17:10	6.98	
10/30/2018	06:13	7.99	
02/05/2019	10:54	7.40	
04/29/2019	18:26	7.03	
07/28/2019	19:06	7.57	
10/28/2019	17:08	7.67	
02/03/2020	09:54	7.16	
05/12/2020	18:14	7.22	
08/11/2020	13:03	7.77	
10/27/2020	10:13	7.78	
11/22/2020	14:03	7.67	
02/08/2021	16:03:00	6.65	
04/27/2021	10:52:00	6.88	
08/10/2021	11:22:00	7.47	
09/28/2021	16:46:00	7.41	
11/02/2021	10:32:00	7.21	

EST – Eastern Standard Time displayed using military time

MP – Measuring Point

Groundwater Level Database Detail

Field	Data
County	Swain
Quad	O 97L1
Name	Deep Creek Campground
Latitude	35.463206
Longitude	-83.435249
Location Accuracy	Map
Netname	
(link to USGS data)	
USGS ID	
Aquifer	Basement rock
Land Surface Elevation	1817.115
NED elevation = 1,817.00 feet	
Date Constructed	
Measuring Point	0.67
Depth	112
Diameter	8
Yield	0
Existing	yes
Recorder Box	no
Top of Screen Depth	24.5
Bottom of Screen Depth	112
Temperature	57.408
Number of Water Levels	2,004
{date * feet below land surface * elevation}	999.99 feet below land surface value indicates dry well -222.22 feet above land surface value indicates a flowing well
2016-04-19 to 2021-11-02	

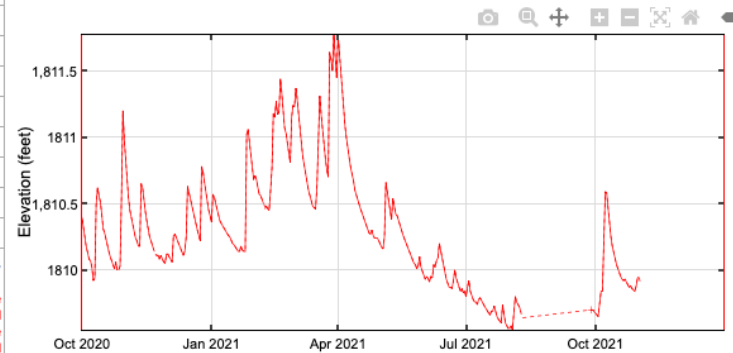
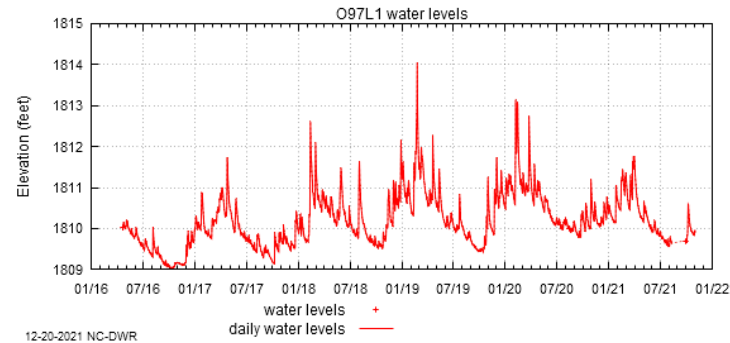
output file(s) is(are) tab-delimited text

NED = National Elevation Dataset, 1/3 arc second value
(-10 X 10 meter grid)



DWR Monitoring Database Detail for O97L1

[Show Map](#) -- [Monthly Statistics Plot](#) -- [Site Map](#)



slope: -0.61 feet/year between 2020-10-01 and 2021-11-02

Plotly tools are available above lower chart to zoom into rectangular area, pan, zoom in, zoom out, scale to extremes of data, return to initial view, and show closest data point information.

APPENDIX D

2021 DROUGHT STATISTICS PLOT

Beach Grove School Field Well (M 93L1), Cataloochee Valley

Woody Creek Well (M 93R1), Cataloochee Valley

Oconaluftee Overlook (M 97S1)

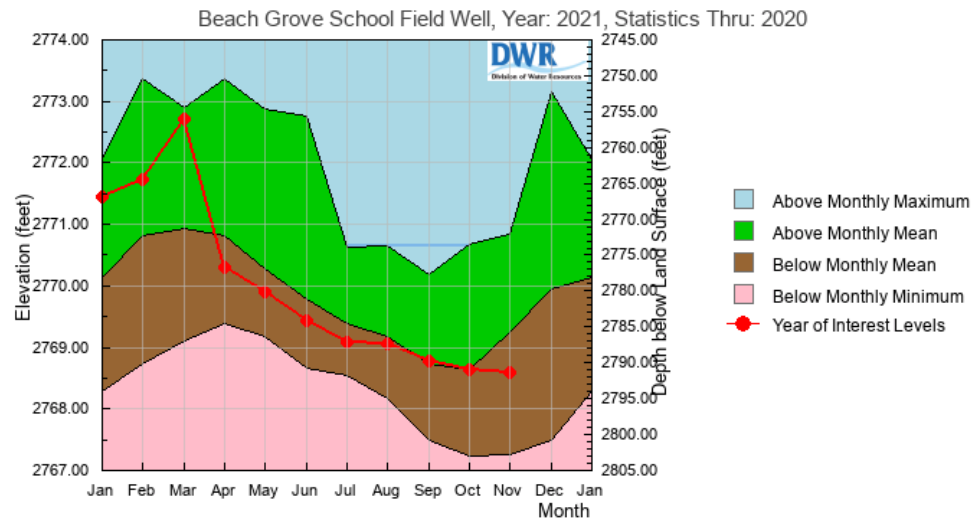
Smokemont Campground G1 (N 95G1), Smokemont Campground

Smokemont Ranger Station (N 95G2), Smokemont Campground

Clingmans Dome (N 97F1)

Deep Creek Campground (O 97L1)

Groundwater Level Monthly Statistics



Well: M 93L1 -- Beach Grove School Field Well part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max

☐ Percentile Distribution

☐ DMAC Percentile Distribution

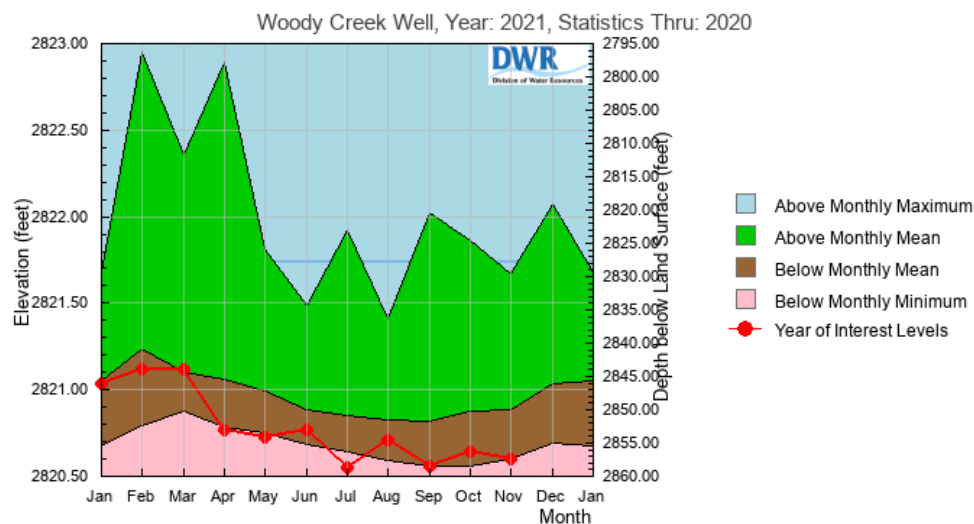
Select Year of Interest (red points): 2021

Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.

Groundwater Level Monthly Statistics



Well: M 93R1 -- Woody Creek Well part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max

☐ Percentile Distribution

☐ DMAC Percentile Distribution

Select Year of Interest (red points): 2021

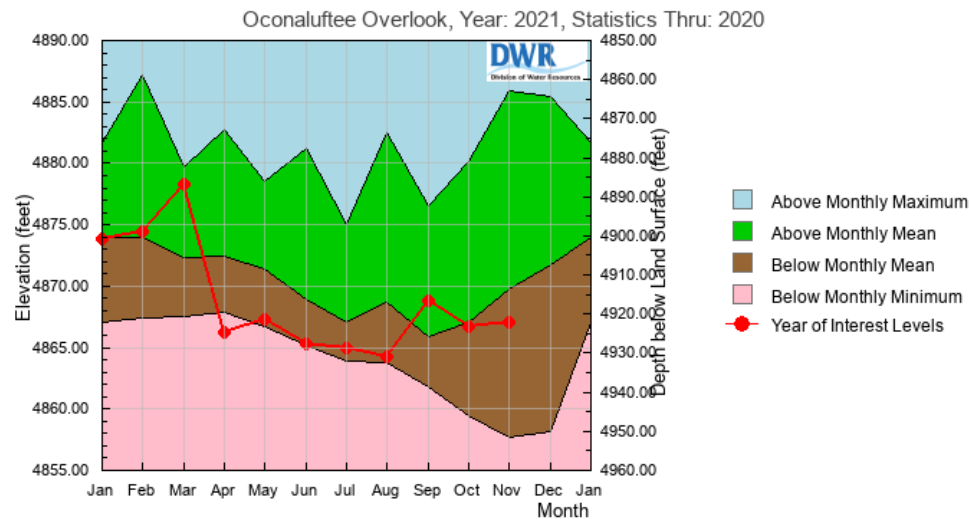
Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.

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Groundwater Level Monthly Statistics



Well: M 97S1 -- Oconaluftee Overlook part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max

☐ Percentile Distribution

☐ DMAC Percentile Distribution

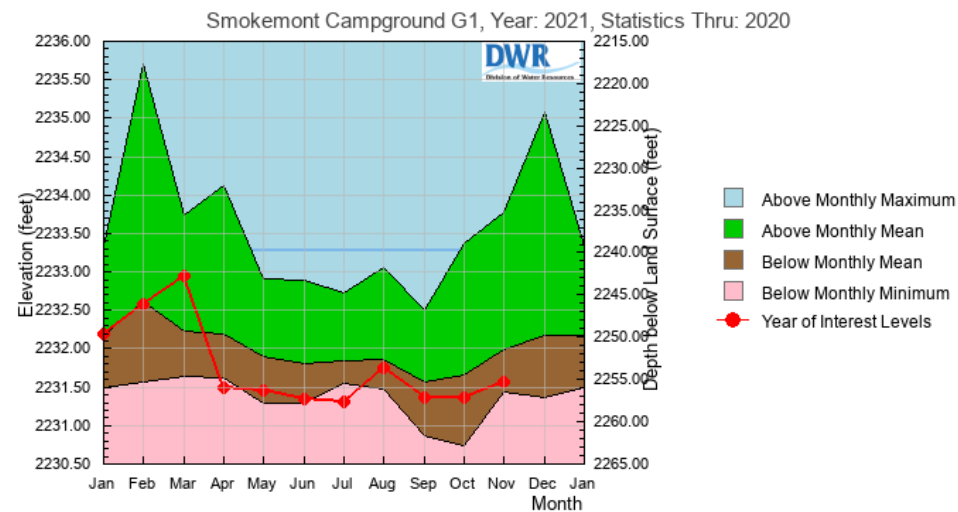
Select Year of Interest (red points): 2021

Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.

Groundwater Level Monthly Statistics



Well: N 95G1 -- Smokemont Campground G1 part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max

☐ Percentile Distribution

☐ DMAC Percentile Distribution

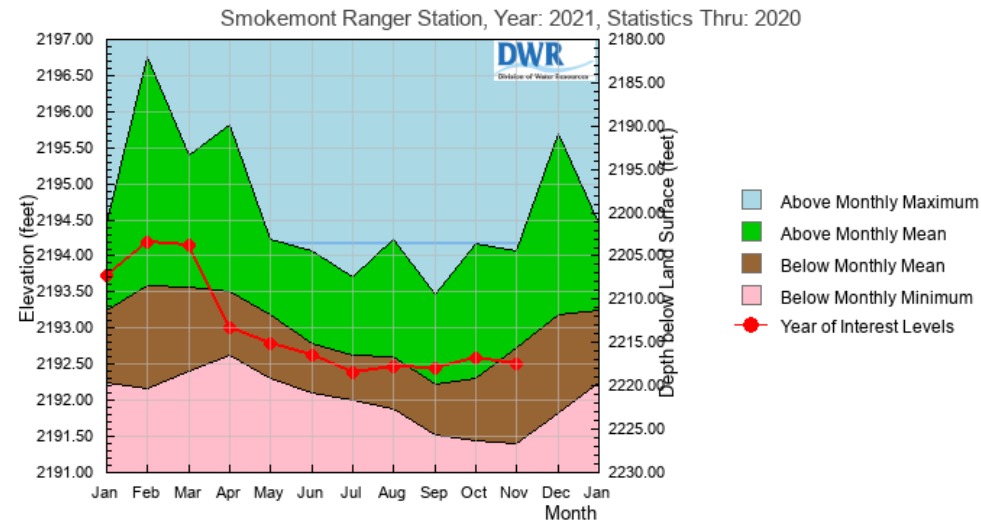
Select Year of Interest (red points): 2021

Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.

Groundwater Level Monthly Statistics



Well: N 95G2 -- Smokemont Ranger Station part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max
☐ Percentile Distribution
☐ DMAC Percentile Distribution

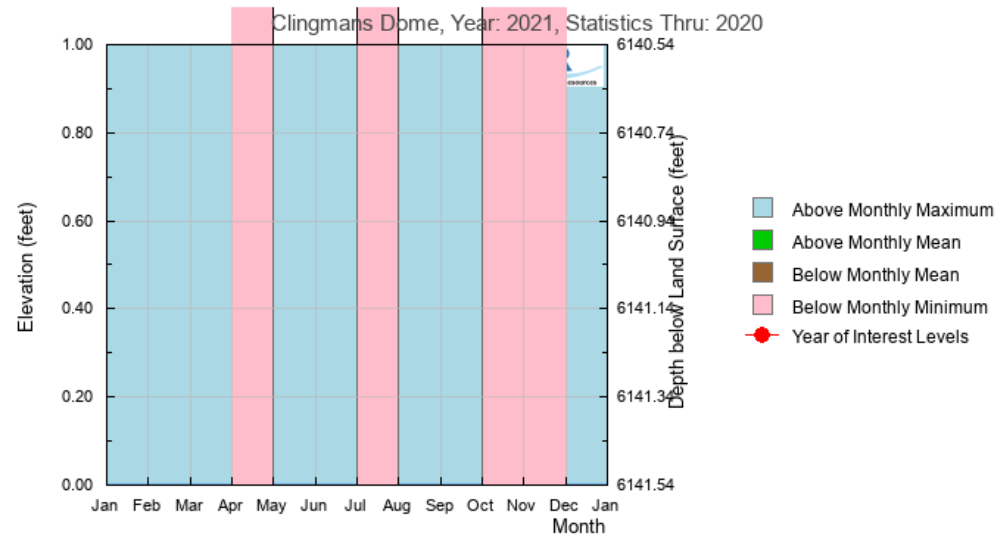
Select Year of Interest (red points): 2021

Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.

Groundwater Level Monthly Statistics



Well: N 97F1 -- Clingmans Dome part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max

☐ Percentile Distribution

☐ DMAC Percentile Distribution

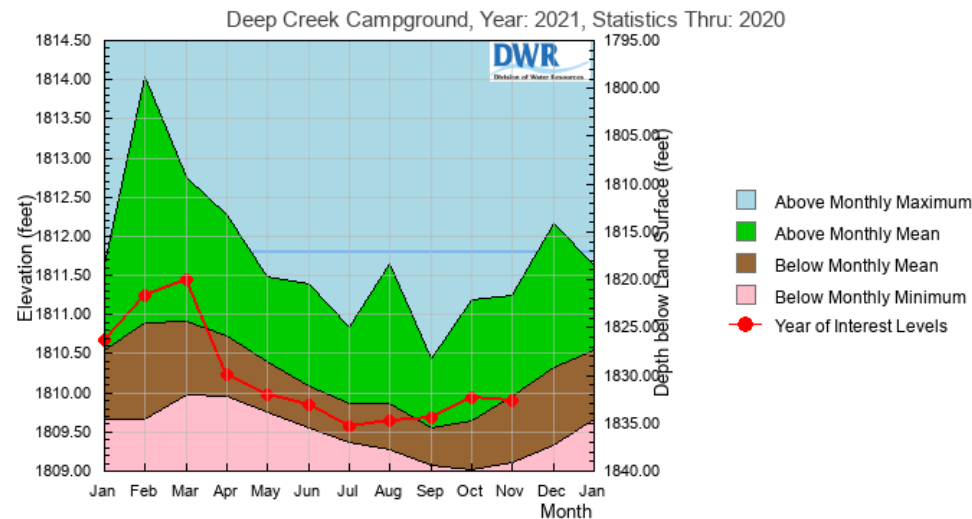
Select Year of Interest (red points): 2021

Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.

Groundwater Level Monthly Statistics



Well: O 97L1 -- Deep Creek Campground part of the Division of Water Resources Network

Statistical curves are monthly minimum, mean, & maximum of the record through 2020. Red points are 2021, latest date in month data. Statistics based on all DWR data for well.

Choose Plot Type: ☒ Min-Mean-Max
☐ Percentile Distribution
☐ DMAC Percentile Distribution
 Select Year of Interest (red points): 2021
 Select the last year for statistical curves: 2020

Plot will redraw with each selection change.

A distinctive feature of this plot is the drop in groundwater levels associated with April - May - June (and sometimes longer) time period. This is when evapo-transpiration typically exceeds rainfall which leads to less recharge and a decline in groundwater levels. Recovery of groundwater levels usually begins in October - November (and sometimes later) when precipitation begins to exceed evapo-transpiration.