TARGET RANGE BASELINE AND SITE CHARACTERIZATION STUDY

MICHAUX STATE FOREST
FRANKLIN TOWNSHIP; ADAMS COUNTY
PENNSYLVANIA

Prepared for:

Dept. of Conservation & Natural Resources
Bureau of Forestry

May 19, 2011

Prepared by:

Groundwater Sciences Corporation
2601 Market Place Street, Suite 310
Harrisburg, Pennsylvania 17110

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Table of Contents

1 PURPOSE 1
2 SITE DESCRIPTION 2
3 APPROACH 3
4 OBJECTIVES 4
4.1 Objective 1 – Scatter Zone Delineation 4
4.2 Objective 2 – Soil Sampling 4
4.3 Objective 3 – Groundwater Sampling 4
4.4 Objective 4 – Potential Offsite Migration 5
4.5 Objective 5 – Potential Natural Wetlands 5
5 CHARACTERIZATION ACTIVITIES 6
5.1 Soil and Sediment Sampling 6
5.2 Groundwater Monitoring Well Installation and Sampling 8
5.3 Groundwater and Surface Water Sampling 8
6 SAMPLING RESULTS 10
6.1 Soil and Sediment Sampling Results 10
6.2 Groundwater and Surface Water Results 11
7 CONCLUSIONS 13
7.1 Soil and Sediment Impacts 13
7.2 Groundwater and Surface Water Impacts 13
7.3 Potential Offsite Migration 13
7.4 Wetlands 13

Table of Tables

Table 1 Soil Sampling Results (March 17 to 21, 2011)

Table 2 Soil Toxicity Characteristic Leaching Procedure (TCLP) Data (March 28, 2011)

Table 3 Groundwater and Surface Water Sampling Results (March 21 to April 12, 2011)

Table of Figures

Figure 1 Topographical Map

Figure 2 Site Map

Figure 3 Rifle and Pistol Ranges, Sample Location Map

Figure 4 Historical Aerial Photo dated October 18, 1970

Table of Appendices

Appendix A Laboratory Results

1 PURPOSE

This study of the target range in the Michaux State Forest was prepared at the request of the Pennsylvania Department of Conservation and Natural Resources (DCNR).

The most critical potential concerns with continued use of the site as a target range include potential impacts of lead and other contaminants to the reservoir, and costs associated with monitoring, mitigating, and managing the range alongside other state forest uses. Developing objective baseline measures of existing environmental impacts to the site from its use as a target range are critical to maintaining constructive dialogue among stakeholders and making credible management decisions about the feasibility of future use of this or other sites within the Michaux to support target range activities.

The range is currently closed and may stay closed depending on the study findings. Study results will be used in collaboration with DCNR, Pennsylvania Department of Environmental Protection (DEP), and state forest stakeholders to determine the feasibility of future use of this site as a target range. Should continued use prove to be a desirable option, it will also provide baseline conditions from which to constructively discuss goals, management options, and criteria and indicators to be used to ensure future range use remains compatible with other state forest management objectives.

2 SITE DESCRIPTION

The site is located in Franklin Township, Adams County, Pa within the Michaux State Forest. It consists of both a pistol and a rifle range and is approximately 8 acres in size. The project area is situated along Birch Run Road approximately 0.3 miles northeast of the intersection with Milesburn Road. Long Pine Run Reservoir lies a short distance to the east and south. The site is found on the Caledonia Park, Pennsylvania, United States Geological Survey (USGS) 7.5 Quadrangle Map (Figure 1).

3 APPROACH

The objectives of the study are to determine whether or not the possibility for impacts to the nearby reservoir with regard to water quality exists, to establish a baseline of soil and groundwater concentrations, and to gather data appropriate for possible mitigation or management options. Whether soil and groundwater require remediation under Pennsylvania statutes was determined by collecting soil samples and analyzing them for total metals concentrations and groundwater samples analyzed for dissolved metals. Sediment and surface water samples were also collected. Determining if the soil in the berms is hazardous waste under RCRA requires a soil analysis using the USEPA TCLP method. Therefore, TCLP analyses were performed in the area expected to be most heavily impacted. This also provides information regarding the potential leaching of these materials to groundwater.

A wide variety of constituents, particularly metals, are found in bullets and shot. The primary constituent of most projectiles is lead and so lead was analyzed for in samples. A lesser constituent is arsenic used in lead shotgun shot. However, the toxicity of arsenic is greater than that of lead and so arsenic was analyzed for in the samples as well. Antimony is used as a hardening agent in some lead alloys. It is not expected to be present in high concentrations compared to lead, but its toxicity is such that it is of concern along with lead or arsenic. Therefore, antimony was analyzed for in samples. Other metals, including copper, tin, zinc, iron, tungsten, nickel, cobalt and chromium may all be present in projectiles, but are judged to be either of such low concentration (for example, cobalt) or such low toxicity (such as copper and iron) that it is not cost effective or necessary to analyze for these constituents.

The principal activities at the site are a pistol range where shotguns are occasionally used, and a rifle range where shotguns are more commonly used. The rifle range contained a relatively large number of shells, clay targets and target fragments suggesting that it is also used as an informal trap range for shotguns.

4 OBJECTIVES

There are five interrelated objectives for the study.

4.1 Objective 1 – Scatter Zone Delineation

In Task 1, scatter zones and surface water flow were delineated and mapped (Figures 2 and 3). As shown on Figure 3, there are three scatter zones. The area down range of the pistol range berm is impacted as evidenced by the frequent observation of damage in the trees just beyond this relatively low berm. The scatter zone extends to the top of the steep slope to the north of the pistol range (Figure 3). The rifle range scatter zone is the steep slope just beyond and uphill from the berm and the native mixed forest beyond the grassy bench which lies at the top of the slope as shown on Figure 3. ITRC Characterization and Remediation of Soils at Closed Small Arms Firing Ranges guidance indicates that the scatter zone for clay target shooting lies between 375 feet and 600 feet from the shooter as well as the area closer to the shooter where clay targets may be hit. For this study, this closer area lies within the footprint of the rifle range and the more distant arc for the shotgun scatter zone generally lies to the north and west of the rifle range as shown on Figure 3.

Surface water flows along the base of the steep slope from northeast to southwest past the rifle and pistol ranges and exits this area through a relatively narrow channel to the south of the pistol range near Burch Run Road as shown on Figure 2.

4.2 Objective 2 – Soil Sampling

Soil samples were collected using PaDEP and USEPA methodologies to characterize soil quality. These include the intended impact areas, the areas between the benches and impact areas, and the rifle, pistol and shotgun scatter zones.

4.3 Objective 3 – Groundwater Sampling

Two groundwater monitoring wells were installed. One will be installed immediately adjacent to and downgradient from the rifle range in the wet area near the toe of the slope. This monitoring well was used to gauge the depth-to-groundwater and was sampled to determine if the range and

impact areas have impacted groundwater quality. The groundwater samples were analyzed for dissolved lead, arsenic and antimony.

4.4 Objective 4 – Potential Offsite Migration

One of the groundwater monitoring wells was drilled off the southwest corner of the pistol range to determine depth-to-groundwater and groundwater quality with respect to lead, arsenic and antimony.

A sediment sample was collected in the swale where surface water leaves the site and was analyzed for total lead, arsenic and antimony.

Two surface water samples were also collected. One at the outfall of the pipe which flows beneath the rifle range near the benches and the other approximately 150 feet to the south southwest of the pistol range where surface water leaves the site. These samples were analyzed for total and dissolved lead, arsenic and antimony to determine modes of transport.

4.5 Objective 5 – Potential Natural Wetlands

There are locations within the target range area that have wetland vegetation and other indications of wetlands. This objective is to determine whether these are natural wetlands.

5 CHARACTERIZATION ACTIVITIES

Soil, sediment and surface water samples were collected at various locations across the site as described below. Two groundwater monitoring wells were installed and samples were collected for both dissolved and total constituents.

5.1 Soil and Sediment Sampling

Soil sampling is summarized on Table 1 and shown on Figure 3. Soil samples were collected from the pistol and rifle range footprints, impact berms, and down range scatter zones. Soil samples were also collected from the shotgun scatter zone assuming shooters were standing near the benches on the rifle range. Three background samples were also collected as a point of comparison for the other soil samples. The rifle berm and pistol berm samples were collected by driving a standard three-inch diameter by 24-inch long split spoon sampler horizontally into the berm with a sledge hammer. The split spoon sampler was extracted and opened and grab samples were collected from the 0 to 6” interval, the 6” to 12” interval and the 12” to 24” interval representing various depths of penetration in to the berm. This process was repeated in the center of each impact area and in the impact area to the right of center. These soil samples were placed into laboratory provided containers, cooled, and conveyed to Analytical Laboratory Services, Inc. in Middletown, Pennsylvania for analysis for total lead, arsenic and antimony.

Portions of the 0 to 6”sample from the right side sample in the rifle berm and pistol berm were also placed into laboratory-provided containers for analysis for lead, arsenic, and antimony by the toxicity characteristic leaching procedure or TCLP. TCLP analyses are used to determine whether constituents in a sample meet the toxicity characteristic which determines whether or not they meet the definition of hazardous waste.

Three samples were collected from the rifle range footprint and two from the pistol range footprint (Table 1). That is, the area between the firing line and berms at the pistol range and the area between the benches and the impact area in the rifle range. These samples were collected as composite samples as were many of the other soil samples. The sample “location” is the center of a 20- x 20-foot area. Sample aliquots were collected from each of the four quadrants from this 20- x 20-foot area from surficial soils. Soil was loosened with decontaminated stainless steel trowels.

Coarse material (larger gravel sized particles, sticks, twigs, bullet fragments, etc.) were removed and the sample aliquot was placed in a decontaminated stainless steel bowl. All four sample aliquots were homogenized in the stainless steel bowl and the homogenized composite sample was placed into a laboratory-provided container for analysis for total lead, arsenic and antimony. Periodically through the sampling process as necessary, the trowels and stainless steel bowls were washed with water and alconox detergent, double rinsed with tap water and then double rinsed with de-ionized water. These sampling tools were allowed to air dry after being decontaminated.

Five sample composite were collected in the rifle range scatter zone. These samples are labeled RFSL-1, RFSL-2, RFSC-1, RFSC-2 and RFSC-3 (Table 1). Two of these samples were collected from the slope immediately behind the impact area in the rifle range. Above the slope lies a relatively flat topographic bench which is not within the line of sight from the rifle range benches. However, beyond the bench, the slope continues and three samples were collected from this upper slope. These three samples were collected from randomized locations within the scatter area which was judged to extend to an elevation of 1,550 feet. The benches for the rifle range are located at an approximate elevation of 1,478 feet.

The scatter zone for the pistol range is a continuous slope from the impact berm to the grassy topographic bench that lies at the top of this slope. Three samples were collected from the scatter zone representing the left and right side of the scatter zone and locations closer and farther from the impact berm. These were also composite surficial samples.

Four composite surficial samples were collected from within the area that was judged to be part of the shotgun scatter zone, but not in areas that were common with the rifle range scatter zone and pistol range scatter zone. These sample locations are identified as SHSC-1, SHSL-1, SHSC-2 and SHSL-2 on Figure 3.

Surficial composite soil samples were collected from areas that were not impacted by target range activities in order to determine background soil concentrations. These samples were collected in the same manner as the surficial composite samples from the rifle range, pistol range, and shotgun scatter areas.

One sediment sample was collected from within the surface water channel that drains the area a short distance to the southwest of the pistol range. This was a grab sample of the sediment beneath the surface of the water.

5.2 Groundwater Monitoring Well Installation and Sampling

Two groundwater monitoring wells were installed as part of the study. These are shown as MW-101 and MW-102 on Figure 3 adjacent to the rifle range and pistol range, respectively. Each well was installed using a geoprobe brand drilling rig. The geoprobe boring was advanced by direct push methods to a depth of ten feet below grade. Five feet of one-inch diameter PVC flush joint pre-packed screen was installed in the boring along with five feet of one-inch diameter riser. The annulus between the borehole and the pre-pack screen was filled with sand and the interval above with bentonite chips. A flush mount manhole was placed at the surface in a concrete pad. These wells were installed on March 18. On March 21, 2011 each well was sounded and groundwater level measurements were attempted. Each of the wells was dry indicating that soil in the vicinity of the monitoring wells has a low hydraulic conductivity and that a significant period of time will be necessary for water to enter the wells and come to equilibrium. On April 12, almost 30 days after the wells were installed, the water level measured in MW-101 was 8.68 feet below the top of casing (approximately 9 feet below grade) and the depth–to-water in MW-102 was 6.20 feet below the top of casing. Because the wells recovered so slowly and no water was used in drilling the wells, it was judged that it would be appropriate to withdraw water without purging for sampling. Groundwater was extracted using dedicated polyethylene tubing and a peristaltic pump and placed in to laboratory-provided containers for total metals analysis. A second sample was collected from each monitoring well and passed through a 0.45 micron filter before being placed into laboratory containers for analysis for dissolved metals analysis.

5.3 Groundwater and Surface Water Sampling

Surface water samples were collected from two locations. The outfall of the storm sewer pipe that passes beneath the rifle range near the firing bench was sampled for both dissolved and total lead, arsenic and antimony. The total sample was collected by simply dipping a laboratory-preserved container into the standing water. The dissolved surface sample was collected by placing a dedicated polyethylene tubing in to the standing water and withdrawing the sample using a

peristaltic pump. The sample was passed through a 0.45 micron filter before flowing in to a laboratory-provided container for dissolved metals analysis. The sample of the stream collected at the downstream area were all surface within the target range area flows was collected in the same manner, that is, one sample for total metals analysis and one sample for dissolved metals analysis.

6 SAMPLING RESULTS

Laboratory results are presented in Appendix A and sampling results are summarized on Tables 1, 2 and 3.

6.1 Soil and Sediment Sampling Results

All of the soil and sediment samples were analyzed for total lead, arsenic and antimony. These results are summarized on Table 1 which presents the sample location, the type of sample that was collected, the sample ID that can be used to cross reference the results to Figure 3 and the laboratory reports in Appendix A, the sample's UTM coordinates, and the results. The results that are greater than Act 2 cleanup criteria are highlighted. Those results highlighted in orange are greater than the residential used aquifer soil-to-groundwater MSC. Those results that are highlighted in yellow are greater than both the soil-to-groundwater MSC and the direct-contact MSC.

Rifle Range

All six of the rifle range berm samples ranging in depth up to 24" have concentrations greater than the Act 2 lead cleanup criteria. The two shallower samples from the right side of the impact area also have concentrations of antimony greater than the soil MSCs. These results indicate impacts to this soil, particularly when compared to background concentrations shown at the bottom of the table. The background concentrations from background samples BG-1, BG-2 and BG-3 are relatively consistent with antimony not being detected, arsenic ranging from 2.4 to 6.6 milligrams per kilogram (mg/kg) and lead ranging from 14.5 to 30.5 mg/kg.

The rifle range footprint and the scatter zone in the slope directly behind the impact area also have concentrations of lead above the MSCs. Concentrations of antimony and arsenic in the remaining rifle range samples from the footprint, the slope, and the scatter zone beyond the bench are all below regulatory criteria. The three samples in the rifle scatter zone on the wooded slope to the northwest of the topographic bench are generally lower than the other rifle range samples with only one sample being slightly above the soil MSC.

Pistol Range

The only samples above the Act 2 cleanup criteria associated with the pistol range are the 0 to 6" samples from the impact berm. Both antimony and lead were above cleanup criteria in these samples. Deeper samples from the impact berms, the pistol range footprint samples, and the pistol range scatter samples were all below Act 2 cleanup criteria.

Shotgun Scatter Zone

The four samples collected in areas within the shotgun scatter zone, but outside the scatter zones for the rifle range and pistol range were all below Act 2 regulatory criteria for lead, arsenic and antimony.

Sediment Sample

The sediment sample collected in the channel where the surface water stream leaves the target range were below regulatory criteria for soil. Although Act 2 soil criteria do not apply to sediment, the antimony and arsenic values for the sediment fall within the range of background soil samples and the lead value of 45 mg/kg is only slightly greater than the median lead background concentration of 28 mg/l.

TCLP Sampling Results

One shallow sample from the pistol range impact berm and one from the rifle range impact berm were analyzed for TCLP to determine whether these samples meet the definition of hazardous waste because they exhibit the toxicity characteristic. Lead was found in both samples at concentrations greater than the regulatory threshold (Table 2) and so this soil would be considered hazardous waste for disposal purposes.

6.2 Groundwater and Surface Water Results

Groundwater sampling results are shown on Table 3. The samples collected from wells MW-101 and MW-102 did not contain lead, arsenic or antimony above the laboratory detection limits.

Surface water results are also shown on Table 3. The outfall sample adjacent to the rifle range analyzed for dissolved metals contained lead above the Chapter 93 continuous criteria. The total sample was also above this criteria. (The criteria only apply to the dissolved metals sample). However, farther down slope at the point where surface water exits the target range ("Adjacent Stream" on Table 3), no metals were detected in either the total or dissolved metals samples.

7 CONCLUSIONS

7.1 Soil and Sediment Impacts

Soil is impacted by target shooting activities. Using Act 2 cleanup criteria, all of the soil areas of the rifle range have been impacted above the cleanup criteria in at least one sample. The soil sample collected in the target impact area has TCLP concentrations indicating that it is hazardous waste.

The pistol range is less severely impacted. Only the shallowest soil in the impact berm has concentrations above the Act 2 cleanup criteria. The shallow berm soil, however, meets the definition of hazardous waste.

The sediment sample has concentrations similar to background soil samples and does not indicate that sediment is impacted.

7.2 Groundwater and Surface Water Impacts

Groundwater samples do not indicate that groundwater beneath the target range has been impacted by site activities.

Surface water is impacted above the Chapter 93 criteria adjacent to the rifle range. However, surface water that leaves the target range is not impacted by target range activities.

7.3 Potential Offsite Migration

Based on the data collected for this study, although soil and to a lesser extent surface water within the target range are impacted, these impacts appear to be confined to the target range. Groundwater, surface water leaving the site, sediment at the downstream site boundary, and background soil are not impacted by target range activities.

7.4 Wetlands

The question of whether the wetlands in the vicinity of the rifle range and pistol range are natural or not can be addressed in several ways. The LiDar contours as shown on Figure 2 and Figure 3 indicate a natural slope with irregularities down Wolf Hill from the summit covered by a forest that

is predominantly deciduous with a few conifers transitioning into a different terrain with different vegetation. A grassy topographic bench is encountered at the downhill edge of the native forest which after approximately 50 feet transitions in to a steep slope down to the impact area in the rifle range. This steep slope extends in what appears to be an unnaturally smooth and uniform manner to the northeast and southwest where it bends around to the southeast. To the south of this area near the firing benches of the rifle range, the slope appears to reverse itself - downhill being to the northwest. This basin is emptied through a relatively narrow neck approximately 150 feet to the south of the pistol range. This entire area is covered by a different type of forest consisting generally of open areas with pine trees. The transition between the two forest types, including relatively straight edges that match the changes in slope can be seen well on Google Earth images. These circumstances suggest that this area was used as a borrow area for the construction of the reservoir to the south.

The apparently anomalous target range area (in terms of geomorphology) was investigated through the use of historical air photos. A 1970 air photo, Figure 4, shows the area at the time of the construction of the reservoir dam and indicates that wetlands in this area are not developed on native soils, but rather on soil that has been exposed by excavation.

Table 1
Michaux State Forest
Soil Sampling Results (March 17 to 21, 2011)

Sample Location	Sample Type	Sample ID	Sample UTM Coordinate*	Antimony (Sb) (mg/kg)	Arsenic (As) (mg/kg)	Lead (Pb) (mg/kg)
Rifle Berm	Soil Grab	RF BM [0-6]	18S0290536 18S4424747	6.9	2.9	**803**
		RF BM [6-12]		7.3	2.1	**1,110**
		RF BM [12-24]		12.7	ND @ 1.8	**1,240**
Rifle Berm (Right Side)		RF BMR [0-6]	18S0290546 18S4424753	**91.8**	7.9	**7,020**
		RF BMR [6-12]		**54.0**	ND @ 1.6	**18,600**
		RF BMR [12-24]		5.3	ND @ 1.9	**1,100**
Rifle Slope (Scatter Above Berm)	Soil Composite	RF SL 1	18S0290524 18S4424766	9.4	2.2	**1,860**
		RF SL 2	18S0290521 18S4424754	ND @ 1.3	ND @ 1.9	**142**
Rifle Footprint		RF FP 1	18S0290545 18S4424737	12.7	3.9	**1,500**
		RF FP 2	18S0290542 18S4424726	2.5	ND @ 2.2	287
		RF FP 3	18S0290562 18S4424721	3.2	ND @ 1.7	**536**
Rifle Scatter Zone (Wooded Slope)		RF SC 1	18S0290484 18S4424798	ND @ 2.1	ND @ 3.2	**455**
		RF SC 2	18S0290495 18S4424811	ND @ 2.1	ND @ 3.2	233
		RF SC 3	18S0290455 18S4424781	ND @ 3.3	ND @ 5.0	122
Pistol Berm (Top)	Soil Grab	PS BMT [0-6]	18S0290460 18S4424624	**57.5**	5.0	**3,540**
		PS BMT [6-12]		3.1	2.1	73.5
		PS BMT [12-24]		ND @ 1.0	ND @ 1.5	27.4
Pistol Berm (Right Side)		PS BMR [0-6]	18S0290465 18S4424626	**51.0**	7.8	**4,810**
		PS BMR [6-12]		6.5	3.1	64.5
		PS BMR [12-24]		ND @ 1.2	2.1	20.1
Pistol Footprint	Soil Composite	PS FP1	18S0290458 18S4424618	9.5	3.7	430
		PS FP 2	18S0290466 18S4424608	ND @ 1.1	2.9	14.2
Pistol Scatter Zone		PS SC 1	18S0290449 18S4424661	ND @ 1.8	ND @ 2,7	1.8
		PS SC 2	18S0290447 18S4424694	1.5	2.9	243
		PS SC 3	18S0290432 18S4424663	1.4	3	251
Shotgun Scatter Zone (Bench)		SH SC 1	18S0290570 18S4424818	ND @ 1.7	ND @ 2.5	96.2
		SH SC 2	18S0290470 18S4424751	ND @ 1.3	ND @ 2.0	65.3
Shotgun Slope (Scatter Zone)		SH SL 1	18S0290608 18S4424819	ND @ 1.2	ND @ 1.8	12.7
		SH SL 2	18S0290418 18S4424660	ND @ 1.4	3.3	108
Adjacent to MW-102	Sediment Grab	Sediment	18S0290448 18S4424580	ND @ 1.3	2.5	45.0
Background	Soil Composite	BG 1	18S0290782 18S4424904	ND @ 1.4	6.6	28.0
		BG 2	18S0290753 18S4424809	ND @ 1.5	2.4	14.5
		BG 3	18S0290561 18S4424604	ND @ 1.6	2.8	30.5

Residential, Used Aquifer MSC (unsaturated)	27	29	450
Residential Direct Contact (0 - 15 feet) MSC	88	12	500

Notes
* NAD83
mg/kg - milligrams per kilogram dry weight basis
[XX - XX] - Sample depth in inches
MSC - Medium Specific Concentration
ND @ X - Not Detected at laboratory report detection "X"
- Reported Concentration Above Residential, Used Aquifer Soil to Groundwater MSC and Residential Direct Contact MSC
- Reported Concentration Above Residential, Used Aquifer Soil to Groundwater MSC only

Table 2
Michaux State Forest
Soil Toxicity Characteristic Leaching Procedure (TCLP) Data (March 18, 2011)

Sample Location	Sample Type	Analysis Type	Sample ID	Sample UTM Coordinate*	Antimony (Sb) (mg/l)	Arsenic (As) (mg/l)	Lead (Pb) (mg/l)
Pistol Berm (Top)	Soil Grab	TCLP	PS BMT [0-6]	18S0290460 18S4424624	1.0	0.22	**379**
Rifle Berm		TLCP	RF BM [0-6]	18S0290536 18S4424747	0.13	0.018	**40.7**
Maximum Concentration of Contaminants for the Toxicity Characteristic					NA	5.0	5.0

Notes
* NAD83
mg/l - milligrams per liter
- Reported Concentration Above Regulatory Limit

Table 3
Michaux State Forest
Groundwater and Surface Water Sampling Results (March 21 to April 12, 2011)

Sample ID	Sample Location	Sample UTM Coordinates*	Sample Type	Analysis Type	Antimony (Sb) (mg/l)	Arsenic (As) (mg/l)	Lead (Pb) (mg/l)
MW-101	Monitroing Well Adjacent to Rifle	18S0290529 18S4424712	Groundwater	Dissolved	ND @ 0.0020	ND @ 0.0030	ND @ 0.0020
MW-102	Monitoring Well Adjacent to Pistol	18S0290465 18S4424588			ND @ 0.0020	ND @ 0.0030	ND @ 0.0020
DIS Outfall	Outfall Discharge	18S0290570 18S4424692	Surface Water	Dissolved	0.0060	ND @ 0.0030	**0.0079**
TOT Outfall	Outfall Discharge			Total	0.0056	ND @ 0.0030	**0.018**
DIS Stream	Adjacent Stream	18S0290457 18S4424536		Dissolved	ND @ 0.0020	ND @ 0.0030	ND @ 0.0020
TOT Stream	Adjacent Stream			Total	ND @ 0.0022	ND @ 0.0030	ND @ 0.0022

Groundwater - Residential, Used Aquifer MSC (Chapter 250)	0.006	0.01	0.005
Surface Water Quality Criteria for Toxic Substances (Fish and Aquatic Life Criteria, Continous) (Chapter 93)	0.22**	0.15**	0.0025***
Surface Water Quality Criteria for Toxic Substances (Fish and Aquatic Life Criteria, Maximum) (Chapter 93)	1.1**	0.34**	0.065***
Surface Water Quality Criteria for Toxic Substances (Human Health Criteria) (Chapter 93)	0.0056**	0.0 1**	N/A

Notes
* - NAD83
** - Water Quality Critiera for Analyzed Substance for Total Analsyis Type
*** - Water Quality Criteria for Analyzed Substance for Dissolved Analysis Type and Assumes Hardness of 100 mg/L $CaCO_3$
mg/l - milligrams per liter
MSC - Medium Specific Concentration
ND @ X - Not Detected at laboratory report detection "X"
N/A - Criterion Not Developed
- Reported Concentration Above Continuous Fish and Aquatic Life Criteria

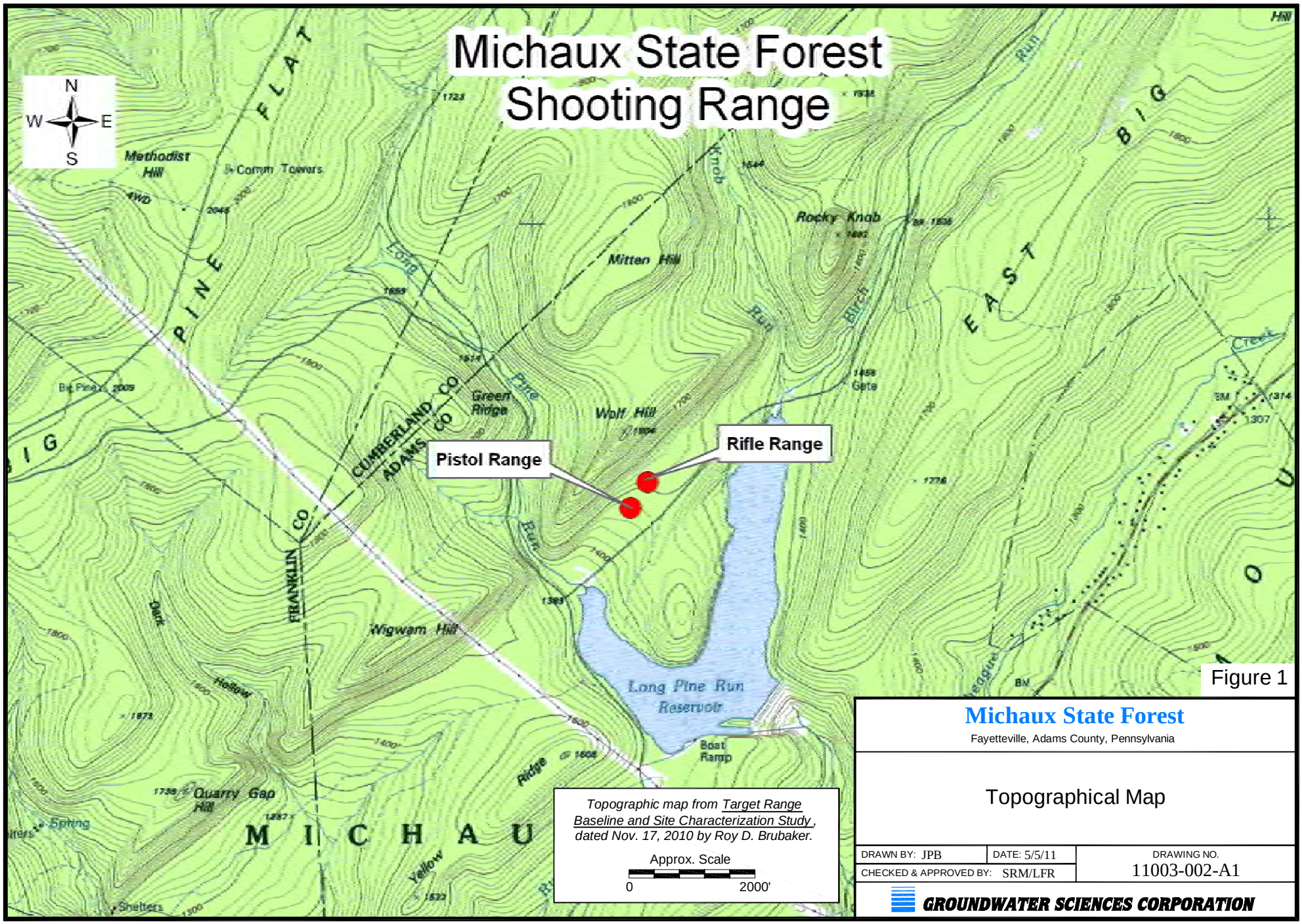


Figure 1

Michaux State Forest

Fayetteville, Adams County, Pennsylvania

Topographical Map

DRAWN BY: JPB	DATE: 5/5/11	DRAWING NO.
CHECKED & APPROVED BY: SRM/LFR		11003-002-A1

GROUNDWATER SCIENCES CORPORATION

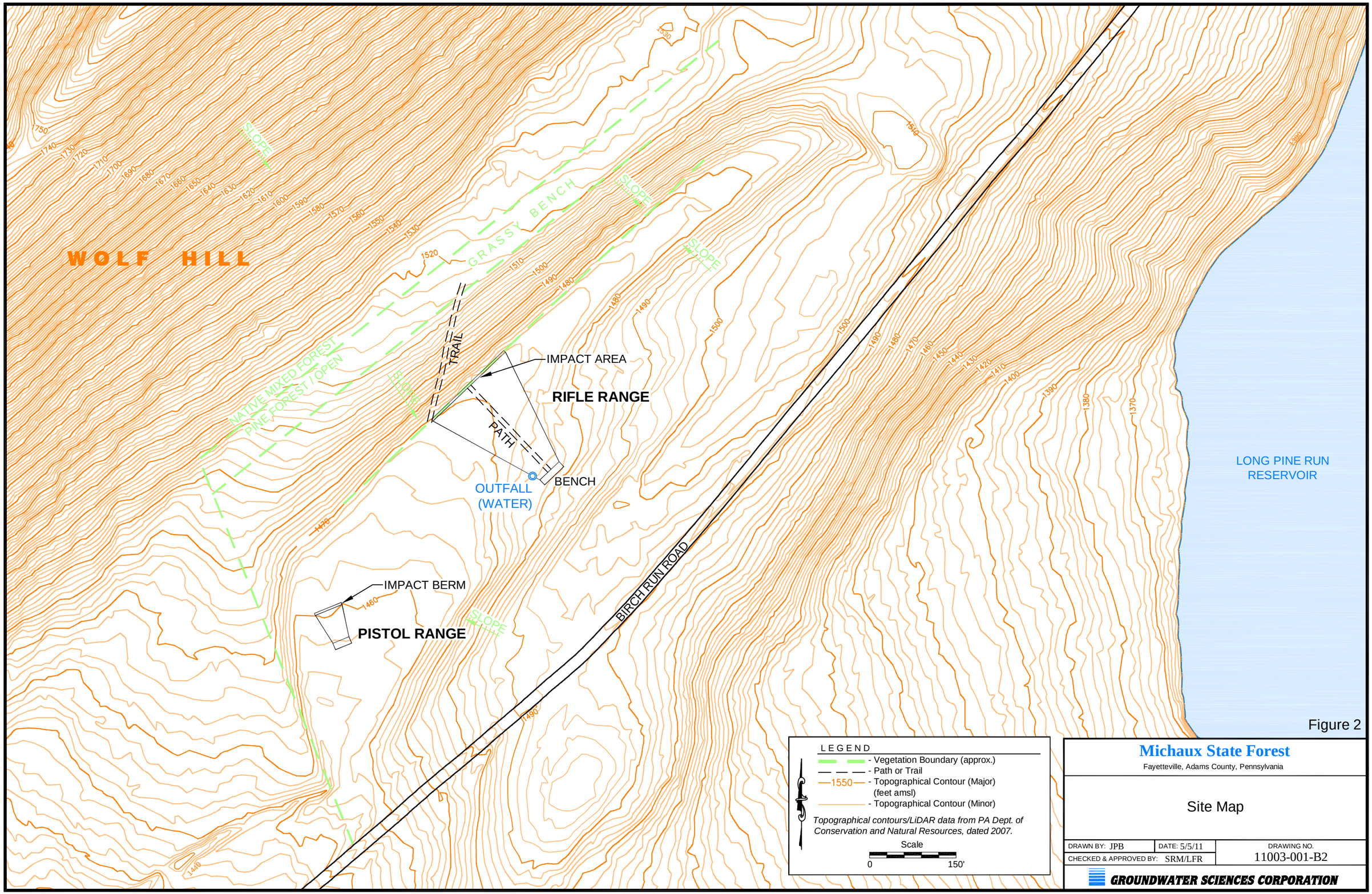
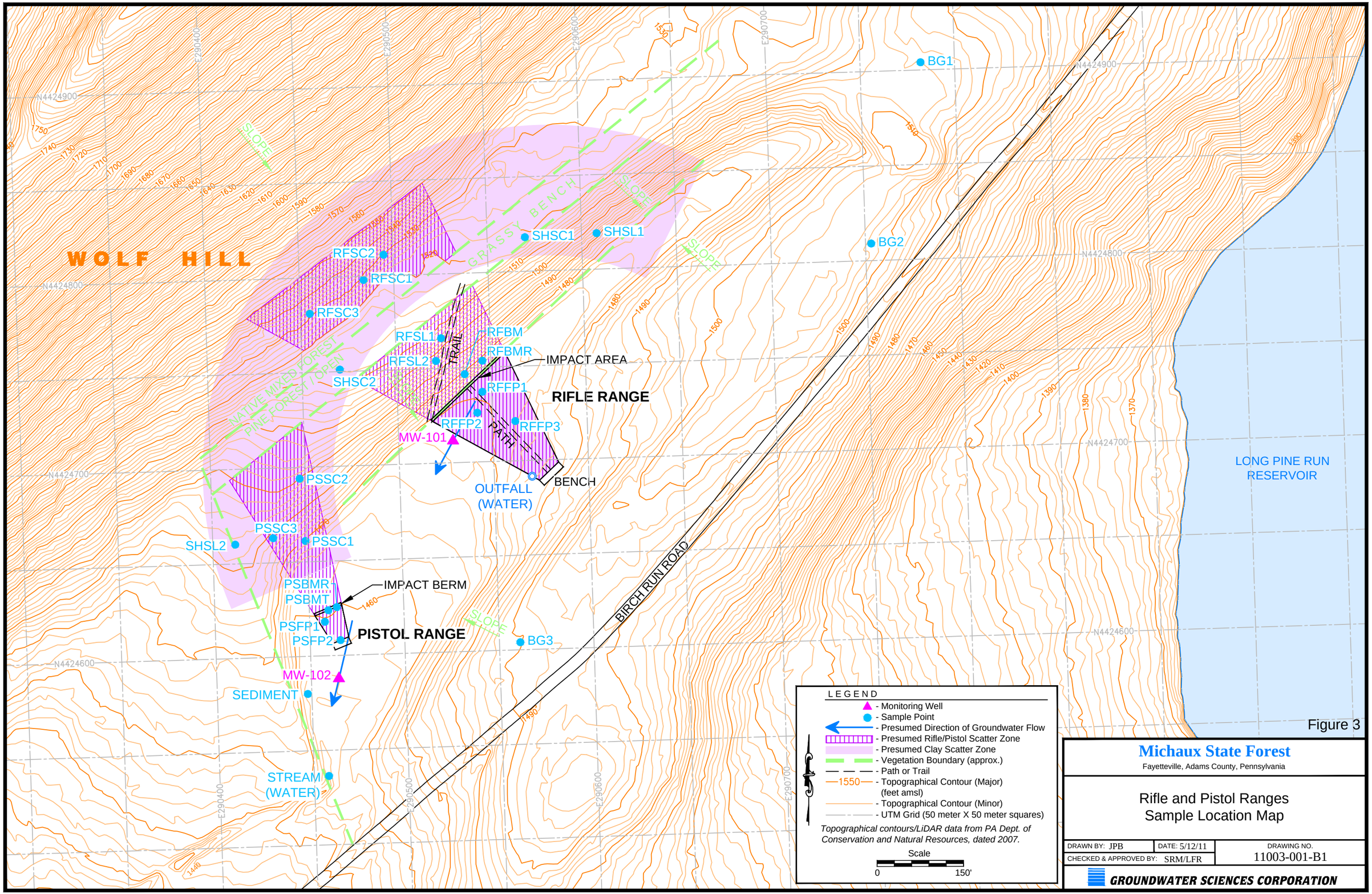

WOLF HILL
GRASSY BENCH
SLOPE
NATIVE MIXED FOREST
PINE FOREST / OPEN
TRAIL
PATH
IMPACT AREA
RIFLE RANGE
BENCH
OUTFALL
(WATER)
IMPACT BERM
PISTOL RANGE
BIRCH RUN ROAD
LONG PINE RUN
RESERVOIR
LEGEND
- Vegetation Boundary (approx.)
- Path or Trail
1550 - Topographical Contour (Major) (feet amsl)
- Topographical Contour (Minor)
Topographical contours/LiDAR data from PA Dept. of Conservation and Natural Resources, dated 2007.
Scale
0
150'
Michaux State Forest
Fayetteville, Adams County, Pennsylvania
Site Map
DRAWN BY: JPB
DATE: 5/5/11
CHECKED & APPROVED BY: SRM/LFR
DRAWING NO.
11003-001-B2
GROUNDWATER SCIENCES CORPORATION

Figure 2


WOLF HILL
GRASSY BENCH
SLOPE
NATIVE MIXED FOREST
PINE FOREST / OPEN
BG1
BG2
BG3
SHSC1
SHSL1
RFSC1
RFSC2
RFSC3
RFSL1
RFSL2
RFBM
RFBMR
SHSC2
RFFP1
RFFP2
RFFP3
TRAIL
IMPACT AREA
RIFLE RANGE
MW-101
OUTFALL
(WATER)
BENCH
PSSC1
PSSC2
PSSC3
SHSL2
PSBMR
PSBMT
IMPACT BERM
PSFP1
PSFP2
PISTOL RANGE
MW-102
SEDIMENT
STREAM
(WATER)
BIRCH RUN ROAD
LONG PINE RUN
RESERVOIR
N4424900
N4424800
N4424700
N4424600
E290400
E290500
E290600
E290700
LEGEND
- Monitoring Well
- Sample Point
- Presumed Direction of Groundwater Flow
- Presumed Rifle/Pistol Scatter Zone
- Presumed Clay Scatter Zone
- Vegetation Boundary (approx.)
- Path or Trail
1550 - Topographical Contour (Major) (feet amsl)
- Topographical Contour (Minor)
- UTM Grid (50 meter X 50 meter squares)
Topographical contours/LiDAR data from PA Dept. of Conservation and Natural Resources, dated 2007.
Scale
0
150'
Figure 3
Michaux State Forest
Fayetteville, Adams County, Pennsylvania
Rifle and Pistol Ranges
Sample Location Map
DRAWN BY: JPB
DATE: 5/12/11
DRAWING NO.
CHECKED & APPROVED BY: SRM/LFR
11003-001-B1
GROUNDWATER SCIENCES CORPORATION

Michaux State Forest

Fayetteville, Adams County, Pennsylvania

Historical Aerial Photo
Dated October 18, 1970

DRAWN BY: JPB	DATE: 5/6/11	DRAWING NO.
CHECKED & APPROVED BY: SRM/LFR		11003-003-A1

GROUNDWATER SCIENCES CORPORATION

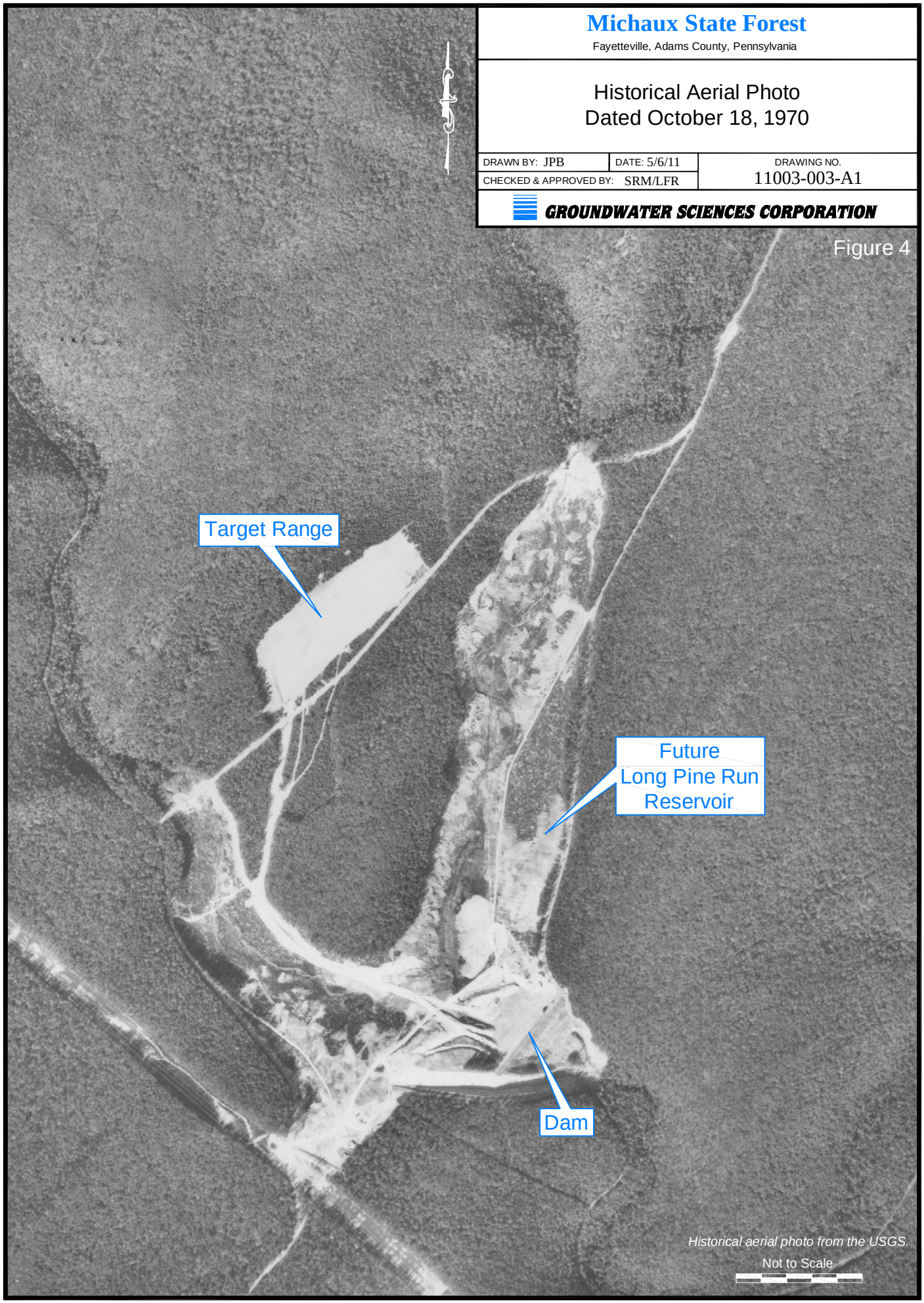



Figure 4