

Progress Report
Palmerton Zinc Superfund Site Appalachian Trail Degradation Study

Prepared by

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1.0 Introduction

The Palmerton Zinc Superfund Site (Site), located in Carbon, Lehigh, and Northampton Counties of eastern Pennsylvania, has released metals to the environment from zinc smelting operations for decades. The goal of this study is to evaluate the degree and extent to which the Appalachian Trail (AT) and associated side trails have been degraded by the loss of vegetation and subsequent erosion due to Site-related metals.

This progress report summarizes the field activities and data collected during the Problem-Based Census component of this study. Data were collected along the AT sections of concern (Blue Mountain ridgeline immediately south of the city of Palmerton, PA; Figure 1), and in control areas (i.e., areas unaffected by deposition; Monz 2008). In accordance with the Study Plan (Monz 2008), the Systematic-Random Point Sampling component will be conducted in May 2009. This report does not interpret the data collected during the Problem-Based Census, nor does it draw any conclusions regarding the impact of zinc contamination on trail conditions. These interpretations and conclusions will be developed after the Systematic-Random Point Sampling component of the study has been completed.

2.0 Field Activities

A complete census of all trail segments specified in the Study Plan (Monz 2008) was conducted by Dr. Monz and a field assistant from September 19 to 23, 2008. These assessments measured the lineal extent of trail conditions and the location and condition of maintenance features. A Trimble Geo XT sub-meter capable GPS was used to determine the location and lineal extent of pre-defined trail characteristics (Table 1) using a methodology that followed Cole (1983) and Marion (1994 and 2006). The following is a brief description of the data protocols, for a full description refer to the complete study plan (Monz 2008).

Linear features (trails) and point features (maintenance features, photo points) were measured utilizing a Trimble XT sub-meter capable GPS configured with a Hurricane antenna for increased signal strength under the tree canopy. The Trimble used the Satellite Based Augmentation System (SBAS) for real time correction in the field. All data were post-processed for differential correction using Pathfinder Office software.

Designated Trail Condition Class was determined by a visual rating of trail conditions based on four categories that describe a range of trail conditions from normal to highly degraded (Table 2). The location and lineal extent of trail conditions by condition class was evaluated using a minimum mapping unit for segment length of 5 meters.

Trail Tread Surface Type was determined by a visual rating of the existing tread surface according to the categories of soil, soil/rock, exposed rock, and scree (Table 3). As in condition class determinations, the location and lineal extent of tread type was evaluated using a minimum mapping unit for segment length of 5 meters.

Trail Maintenance Features (for example, water bars and checks) were assessed as point features for their location and condition ranging from appears functional to replacement needed (Table 4). High accuracy GPS locations (approximately 30 positions per feature) were collected on all maintenance features.

Unofficial Trails were assessed as to their location and extent as linear features and evaluated in accord with unofficial trail condition class (Table 5).

3.0 Data Summary

All trails were assessed in the field on September 19-23, 2008. Data were downloaded and post processed (differentially corrected) at the end of each sampling day.

3.1 Trails West of Lehigh Gap.

A total of 11.96 km of trail were assessed for condition class, tread condition and maintenance features in the area west of Lehigh Gap (Table 6, Figures 2 through 7). This includes the entire extent of the Appalachian Trail and the entire Blue Trail. For trail condition, a total of 96 segments were identified. Overall 73.9% of the trail was of condition class 1, 23.4% was of condition class 2 and 2.6 % of condition class 3. No areas of condition class 4 were identified. Soil and soil rock tread types comprised the vast majority of the tread, 33.6% and 63.2% respectively. Exposed rock tread surfaces were found on 3.1% of the trail. Eleven informal trails totaling 294 m and 47 maintenance features were located and evaluated for condition characteristics.

3.2 Trails East of Lehigh Gap

A total of 5.15 km of trail were assessed for condition class, tread condition and maintenance features in the area east of Lehigh Gap (Table 7, Figures 8 through 10). This includes the entire extent of the AT and the Winter Trail. The trail assessment ended at a point east along the AT that was determined during the scoping meetings in May. The extent of the Winter trail along the abandoned railroad grade was mapped, but not assessed for trail condition (see Figure 9- “unspecified” condition class). For trail condition, a total of 52 segments were identified. Overall 7.4% of the trail was of condition class 1, 9.3% was of condition class 2, 37.9% of condition class 3 and 23.4% of condition class 4. In total, 61.3% of the trail showed moderate to severe degradation. Soil/rock tread types comprised 45% of the tread surface, but exposed rock and scree tread types were also substantial with 15.2% and 19.7% respectively. Soil tread surfaces were infrequent—on just 2.1% of the trail. One informal trail of 50.4 m in length and 29 maintenance features were located and evaluated for condition characteristics.

3.3 Trails at the Wind Gap Control Site

A total of 3.9 km of trail were assessed for condition class, tread condition and maintenance features at the Wind Gap control site (Table 8, Figures 11 through 16). This is somewhat less than the intended length for this control site (5km total was planned)

due to a GPS error in the field. However, it does include a sufficient representation of valley, slope and ridge locations to properly classify the site, both east and west of the Gap. For trail condition, a total of 29 segments were identified. Overall 85.2% of the trail was of condition class 1, and 12.2% was of condition class 2. No areas of condition class 3 or 4 were found. One unspecified area of 101 meters was identified at the origin of the trail on the east side of the Gap. This section was undergoing maintenance and construction and was eliminated from the assessment. Soil and soil rock tread types comprised the vast majority of the tread, comprising 61% and 36.2% respectively. No exposed rock or scree tread surfaces were found. A total of 6 informal trails totaling 187m and 19 maintenance features were located and evaluated for condition characteristics.

3.3 Trails at the Port Clinton/Schuylkill Gap Control Site

A total of 5.2 km of trail were assessed for condition class, tread condition and for maintenance features at the Port Clinton/Schuylkill Gap control site (Table 9, Figures 17 through 22). For trail condition, a total of 44 segments were identified. Overall 85.5% of the trail was of condition class 1, and 14.4% was of condition class 2. No areas of condition class 3 or 4 were found. Soil and soil rock tread types comprised the vast majority of the tread, comprising 56.2% and 43.8% respectively. No exposed rock or scree tread surfaces were found. A total of 19 maintenance features were located and evaluated for condition characteristics and no informal trails were found.

3.4 Summary

Tables 10 and 11 summarize the data collected across the four locations. Table 10 summarizes trail condition class and tread condition by location, while Table 11 summarizes maintenance features requiring repair by location.

Both the Wind Gap and Port Clinton/Schuylkill control sites contained the greatest lineal extent of condition class 1 trail with 85.2% and 85.5% respectively (Table 10). Lehigh Gap East contained the most condition class 3 and 4 trail, with 37.9% of the length in condition class 3 and 23.4% in condition class 4. For tread conditions, Wind Gap and Port Clinton/Schuylkill control sites contained soil and soil/rock surfaces exclusively, while Lehigh Gap East contained little soil and a substantial amount of exposed rock and scree tread surface (Table 10). For both condition class and tread condition, Lehigh Gap West fell between the control sites and Lehigh Gap East, containing 79% condition class 1 trail and 33.6% soil tread, for example.

For maintenance features, 33.3% at Port Clinton/Schuylkill and 61.1% at Wind Gap were found to be in need of repair and replacement (Table 11). Much higher repair and replacement rates were found at Lehigh Gap West and East with 87.8% and 90.7% respectively.

4.0 Quality Assurance/Quality Control

For this field sampling a high level of QA/QC was maintained. Assessment errors were minimized by following the specific definitions/protocols developed for condition class and tread types in the study plan. In all cases two independent observers rated trail sections.

Linear feature data (i.e., trail segments) were collected by obtaining positions every second. Post processing of these data revealed a high degree of positional accuracy. For example, for Lehigh Gap east trails and maintenance features, 10,541 positions were obtained with 68% falling in the 1-2 m range and 31.6% in the 2-5 m range. For the other areas similar accuracies were obtained. Positional accuracies for the point data (e.g., maintenance features) were sub-meter for approximately 70% of the points collected and 1-2 meter for the remainder. In general positional accuracies were excellent throughout the study and were particularly high in the affected area where a sparse tree canopy improved satellite reception.

5.0 Literature Cited

Cole, D. N. 1983. Assessing and Monitoring Backcountry Trail Conditions. Research Paper INT-303. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 10p.

Marion, J. L. 1994. An assessment of trail conditions in Great Smoky Mountains National Park. Research/Resources Management Report. Atlanta, GA: USDI National Park Service, Southeast Region. 155p.

Marion, J. L. 2006. Trail Condition Monitoring Manual-Haleakala National Park. U.S. Geological Survey, Patuxent Wildlife Research Center, Virginia Tech Field Station, Dept. of Forestry, Blacksburg, VA. 12p.

Monz, C. A. 2008. Final Quality Assurance Work Plan Palmerton Zinc Superfund Site Appalachian Trail Degradation Study. 21p.

6.0 Tables

Table 1. Trail Measures for Problem Based Census

Indicator Category	Measures	Assessment Approach
Trail Location		Sub-Meter GPS
Trail Condition Class	Lineal length of trail condition based on a categorical rating. Rating will include aspects of trail width and erosion	Direct on-site assessment based on standardized visual ratings
Tread Surface	Location and lineal extent of tread surface type along the designated trail. Types will include soil, cobble, gravel, scree, etc.	GPS measurement of location and linear extent
Maintenance Features	Point locations and condition of water bars, checks, steps, etc.	GPS locations and mapping
Unofficial Trail Formation	Location and lineal extent of visitor created trails	GPS locations and mapping, lineal extent

Table 2. The designated trail condition class system to be employed at the Palmerton Site

Condition Class	Description
Class I	A trail with an observable tread in an established soil profile. Minimal if any observable soil erosion in or adjacent to the tread. Maximum incision 25cm or less: maximum width 1 meter or less.
Class II	A trail with an observable tread in an established soil profile. Minimal if any observable erosion adjacent to tread. Soil loss present in the tread as indicated by a maximum incision 50cm or less and a width of 1-1.5 meters
Class III	A trail with an observable tread in an established soil profile. Soil loss present in and adjacent to the tread resulting in an alteration of maximum incision from historical conditions. Tread width observable, but some margins may be indeterminate.
Class IV	Observable tread and soil profile lacking. Trail tread and trail side largely devoid of soil (<20% of exposed surface). Tread margins may be indeterminate. Trail surface is primarily (>80% of surface) exposed rock.

Table 3. Trail Tread Surface Inventory Characteristics

Trail Tread Types	Characteristics
Soil	Predominantly soil, less than 33% of surface comprised of exposed rock.
Soil/Rock	Tread comprised of soil and rock, with rock accounting for 34-67% of surface. Exposed rocks generally embedded in a soil matrix.
Exposed Rock	Mostly rock surfaces (>67%) of varying sizes in the tread surface, primarily stable. Observable, but minimal amounts of soil (<33% of surface area).
Scree	Largely devoid of soil (<33%), primarily loose rock surfaces of varying sizes in the tread surface

Table 4. Trail Maintenance Feature Assessment

Maintenance Feature	Quality Ratings	Materials
Trail Signs	1= Appears Functional	1= Natural Timber
Water Bars	2= Maintenance Needed	2= Treated Lumber
Checks	3= Replacement Needed	3= Stone
Constructed Steps		

Table 5. Unofficial Trail Condition Class Definitions

Condition Class	Definition
Class 1	Trail distinguishable; slight loss of vegetation cover and/or minimal disturbance of organic litter.
Class 2	Trail obvious; vegetation cover lost and/or organic litter pulverized in primary use areas
Class 3	Vegetation cover lost and/or organic litter pulverized within the center of the tread, some bare soil exposed
Class 4	Nearly complete or total loss of vegetation cover and organic litter within the tread, bare soil widespread.
Class 5	Soil erosion obvious, as indicated by exposed roots and rocks and/or gullying

Table 6. Palmerton Site designated trail assessment- Trails west of Lehigh Gap

	Number of Segments	Total Length (m)	Avg. Length per Segment (m)	% of Total Length
<u>Condition Class</u>				
1	61	8847	145	73.9
2	25	2799	112	23.4
3	10	315	31	2.6
4	--	--	--	--
Unspecified	--	--	--	--
<u>Tread Condition</u>				
Soil	27	4021	149	33.6
Soil/Rock	61	7562	123	63.2
Exposed Rock	8	378	47.2	3.1
Scree	--	--	--	--

Table 7. Palmerton Site designated trail assessment- Trails east of Lehigh Gap

	Number of Segments	Total Length (m)	Avg. Length per Segment (m)	% of Total Length
<u>Condition Class</u>				
1	7	380	54	7.4
2	5	483	96	9.3
3	24	2182	90.9	37.9
4	15	1206	80	23.4
Unspecified	1	901	--	17.4
<u>Tread Condition</u>				
Soil	2	109	55	2.1
Soil/Rock	23	2338	101	45
Exposed Rock	11	785	71	15.2
Scree	15	1018	67	19.7
Unspecified	1	901	--	17.4

Table 8. Wind Gap Control Site designated trail assessment

	Number of Segments	Total Length (m)	Avg. Length per Segment (m)	% of Total Length
<u>Condition Class</u>				
1	20	3329	166	85.2
2	8	475	59	12.2
3	--	--	--	--
4	--	--	--	--
Unspecified	1	101	--	2.5
<u>Tread Condition</u>				
Soil	13	2388	183	61
Soil/Rock	15	1416	94	36.2
Exposed Rock	0	--	--	--
Scree	0	--	--	--
Unspecified	1	101	--	2.5

Table 9. Port Clinton/Schuylkill Gap Control Site designated trail assessment

	Number of Segments	Total Length (m)	Avg. Length per Segment (m)	% Total Length
<u>Condition Class</u>				
1	31	4486	144	85.5
2	13	757	58.2	14.4
3	--	--	--	--
4	--	--	--	--
Unspecified				
<u>Tread Condition</u>				
Soil	25	2944	117	56.2
Soil/Rock	19	2299	121	43.8
Exposed Rock	--	--	--	--
Scree	--	--	--	--

Table 10. Summary of Trail and Tread Conditions for the Palmerton AT Study

	Lehigh Gap West	Lehigh Gap East	Wind Gap Control	Port Clinton/Schuylkill Gap Control
<u>Condition Class</u>				
1	73.9%	7.4%	85.2%	85.5%
2	23.4%	9.3%	12.2%	14.4%
3	2.6%	37.9%	--	--
4	--	23.4%	--	--
Unspecified	--	17.4%	2.5%	--
	100%	100%	100%	100%
<u>Tread Condition</u>				
Soil	33.6%	2.1%	61%	56.2%
Soil/Rock	63.2%	45%	36.2%	43.8%
Exposed Rock	3.1%	15.2%	--	--
Scree	--	19.7%	--	--
Unspecified	--	17.4%	2.5%	--
	100%	100%	100%	100%

Table 11. Summary of Maintenance Feature Condition in the Palmerton AT Study

Maintenance Features	Lehigh Gap West	Lehigh Gap East	Wind Gap Control	Port Clinton/Schuylkill Gap Control
Total Number Assessed	49	32	18	27
% in need of Repair/Replacement	87.8%	90.7%	61.1%	33.3%

FIGURE 1. STUDY AREAS

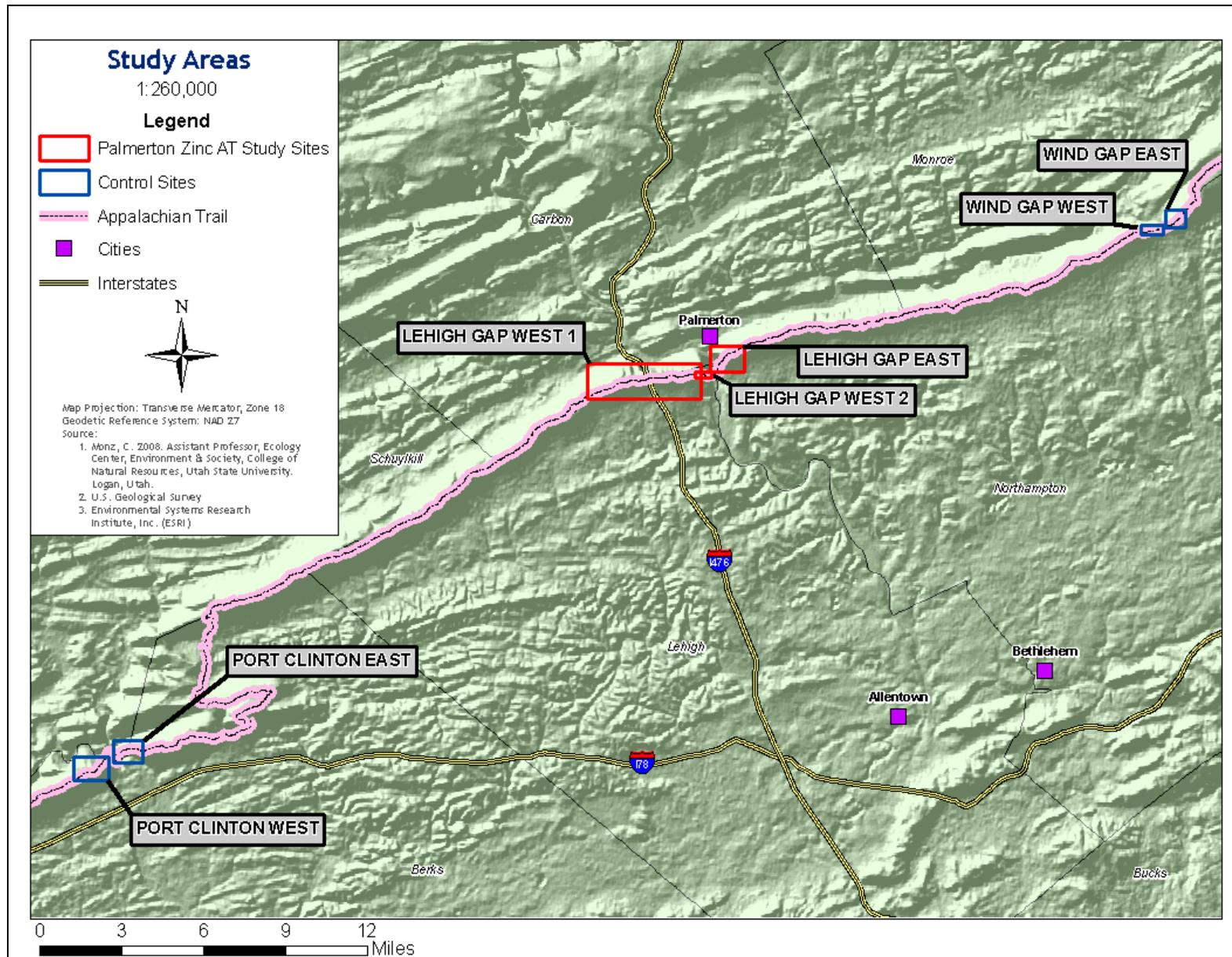


FIGURE 2. LEHIGH GAP WEST AREA 1: MAINTENANCE FEATURES

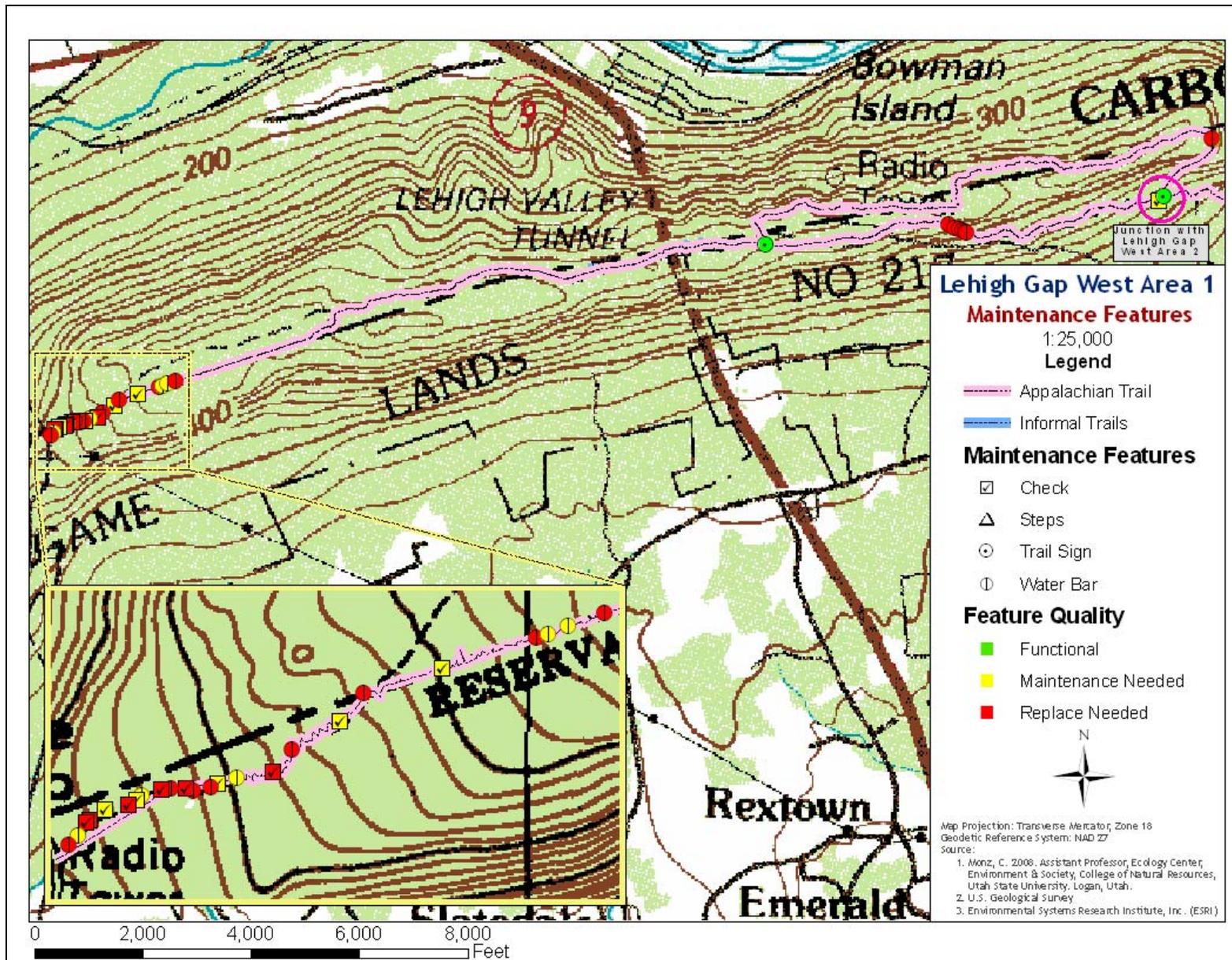


FIGURE 3. LEHIGH GAP WEST AREA 1: TRAIL CONDITION

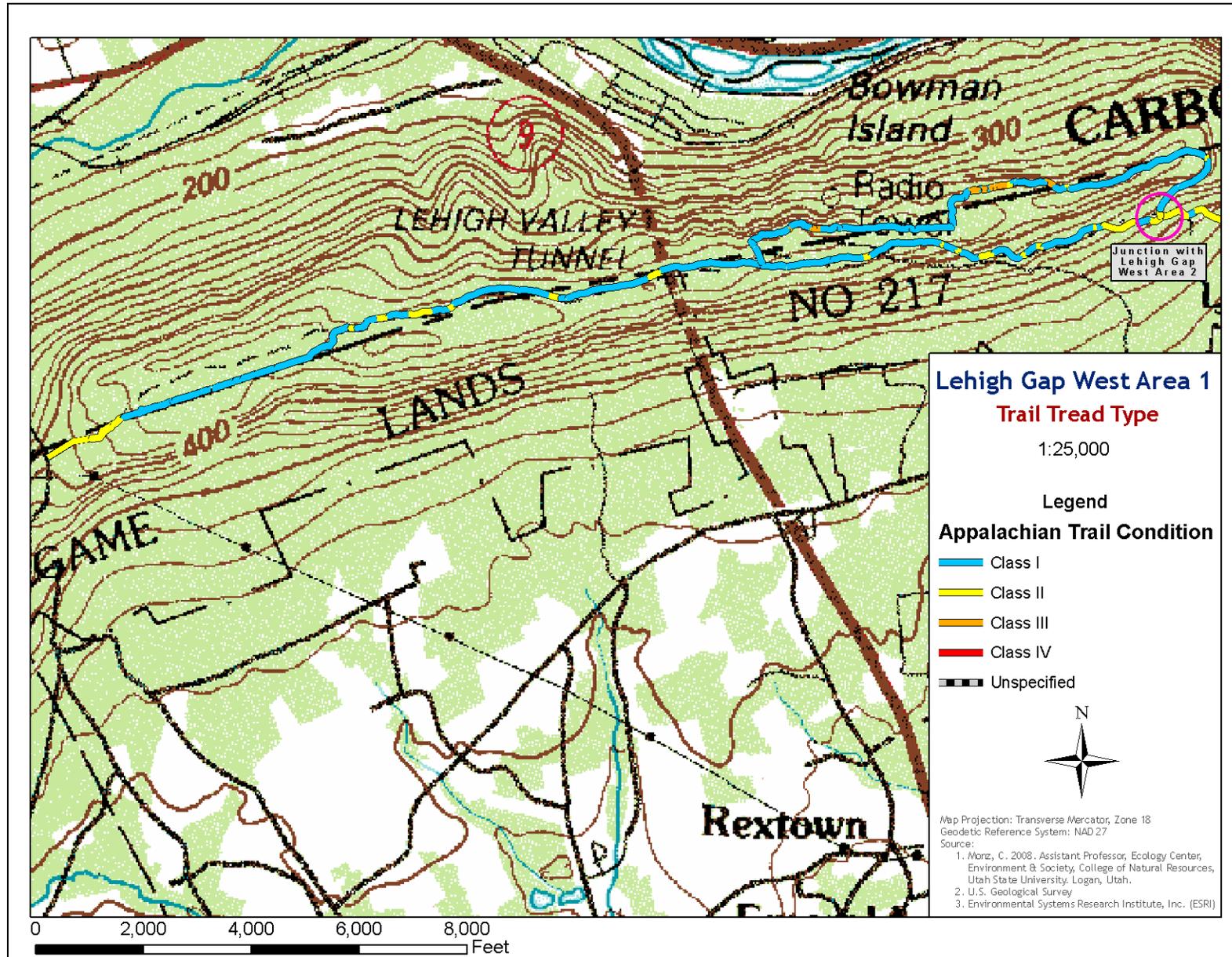


FIGURE 4. LEHIGH GAP WEST AREA 1: TRAIL TREAD TYPE

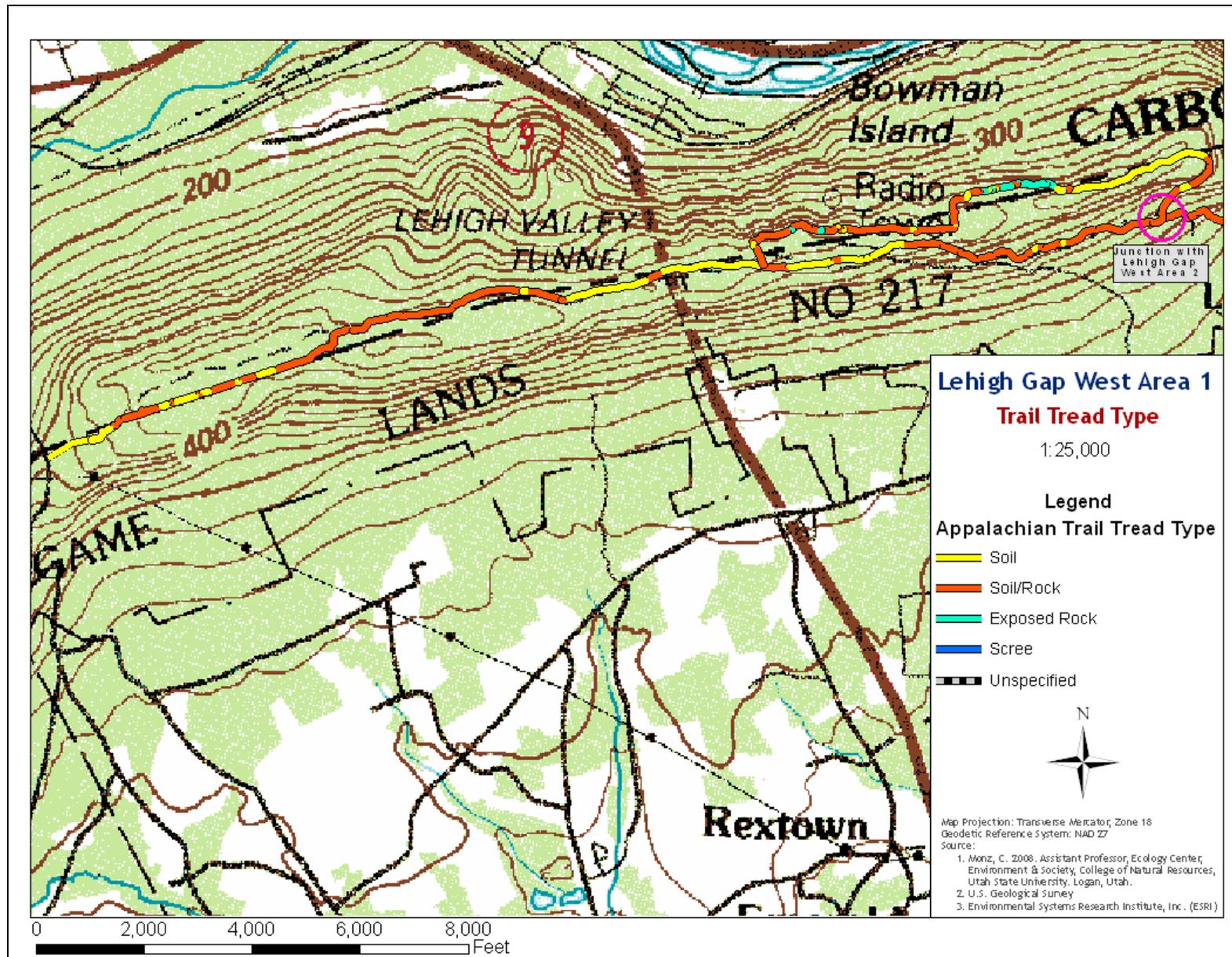


FIGURE 5. LEHIGH GAP WEST AREA 2: MAINTENANCE FEATURES

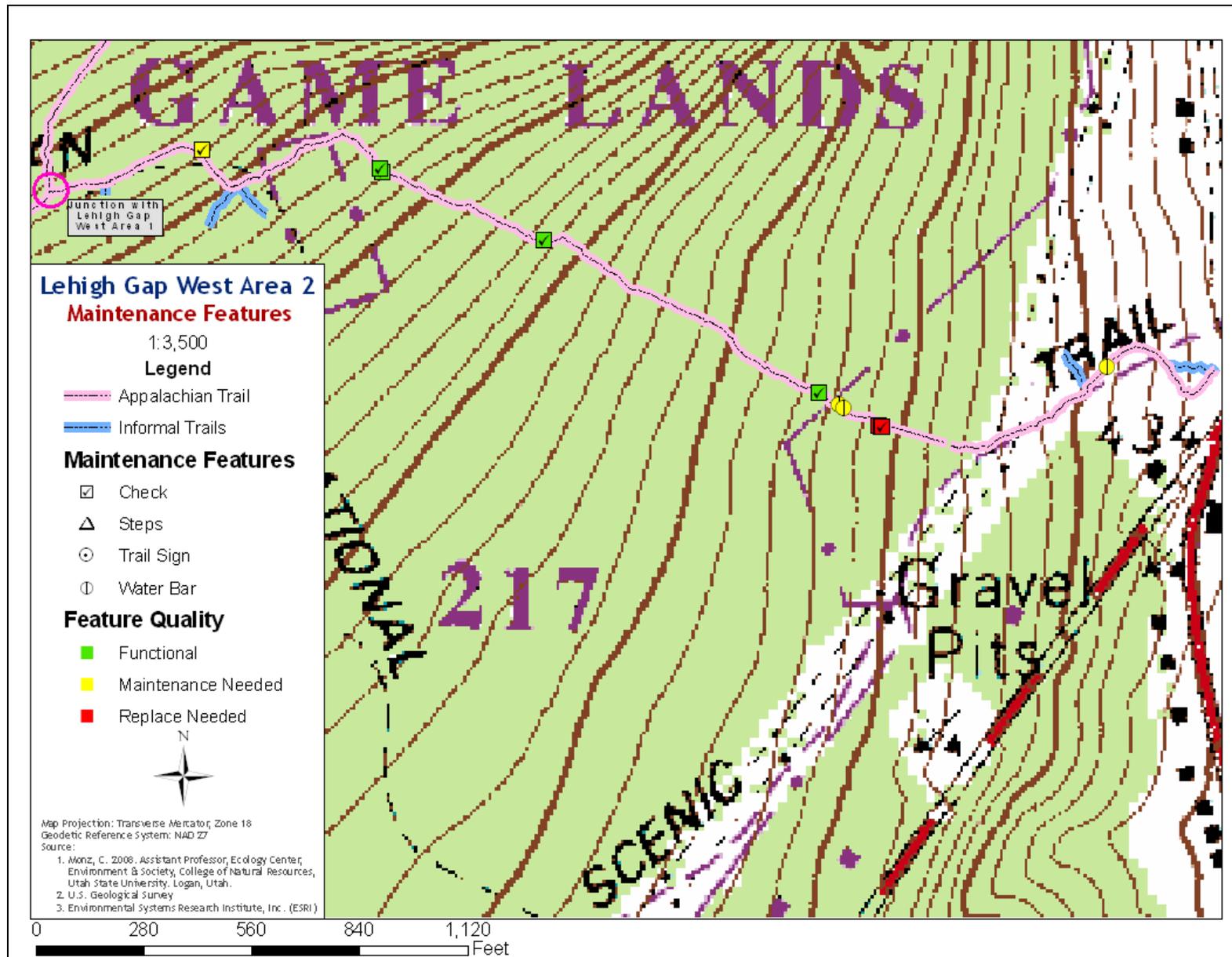


FIGURE 6. LEHIGH GAP WEST AREA 2: TRAIL CONDITION

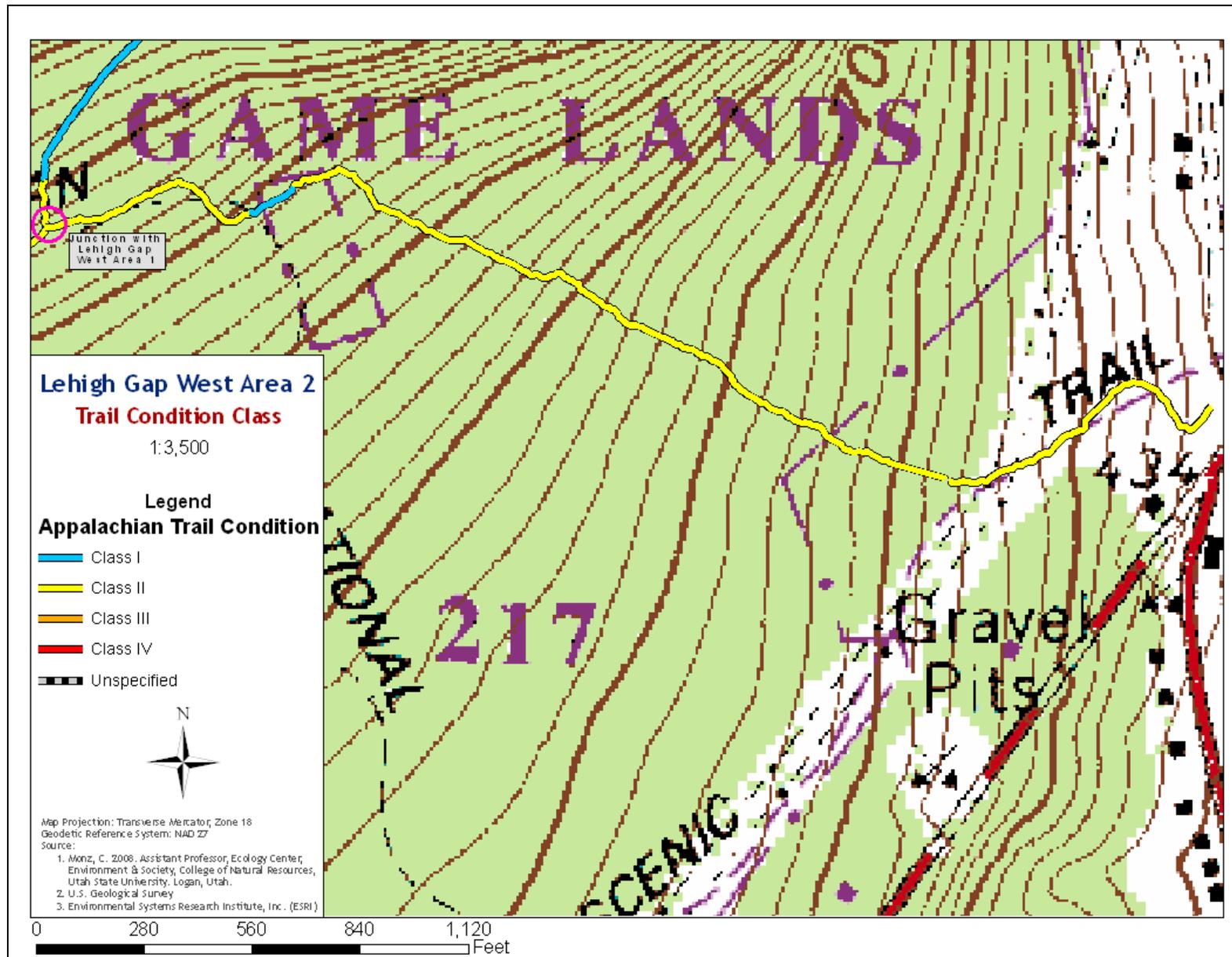


FIGURE 7. LEHIGH GAP WEST AREA 2: TRAIL TREAD TYPE

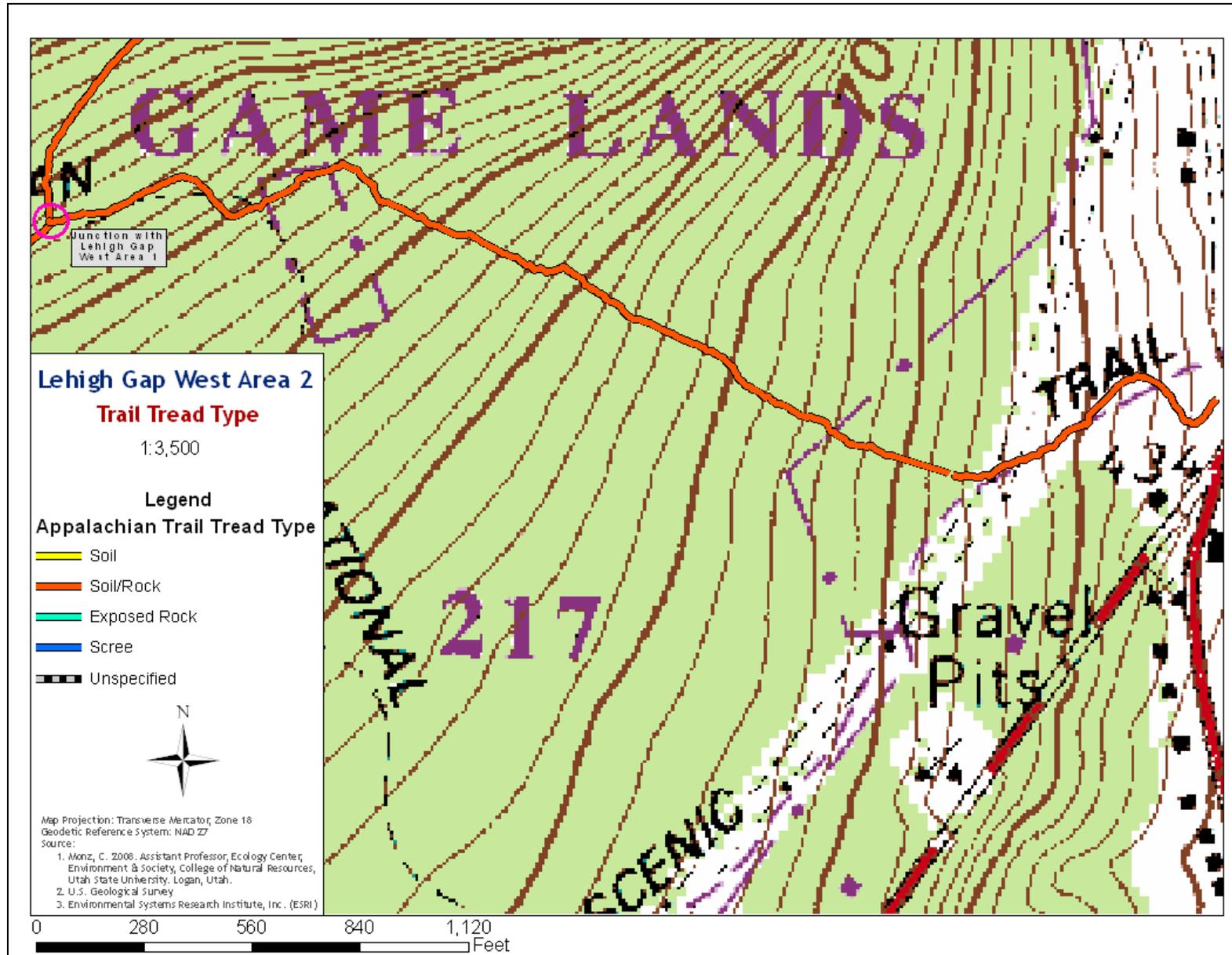


FIGURE 8. LEHIGH GAP EAST AREA: MAINTENANCE FEATURES

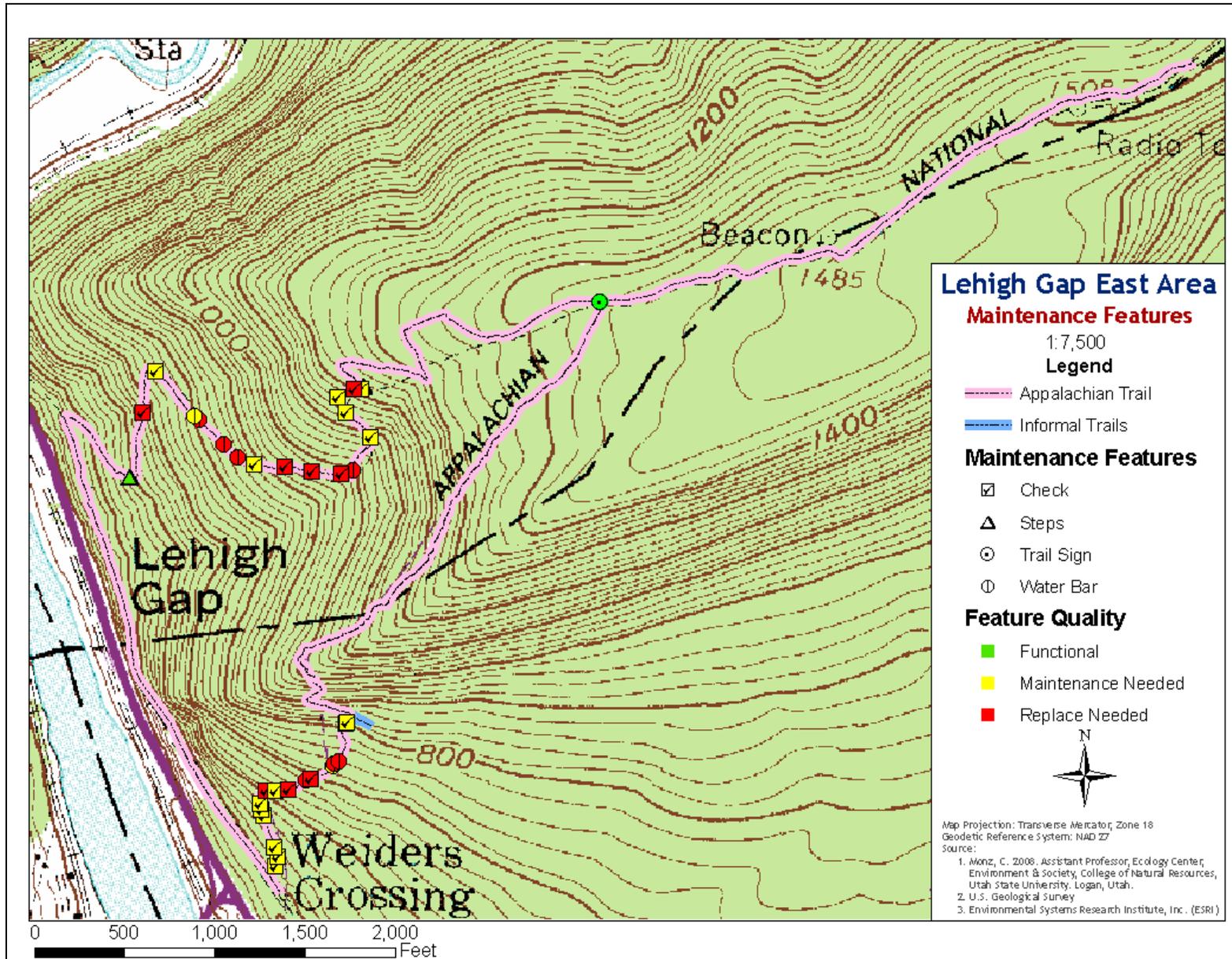


FIGURE 9. LEHIGH GAP EAST AREA: TRAIL CONDITION

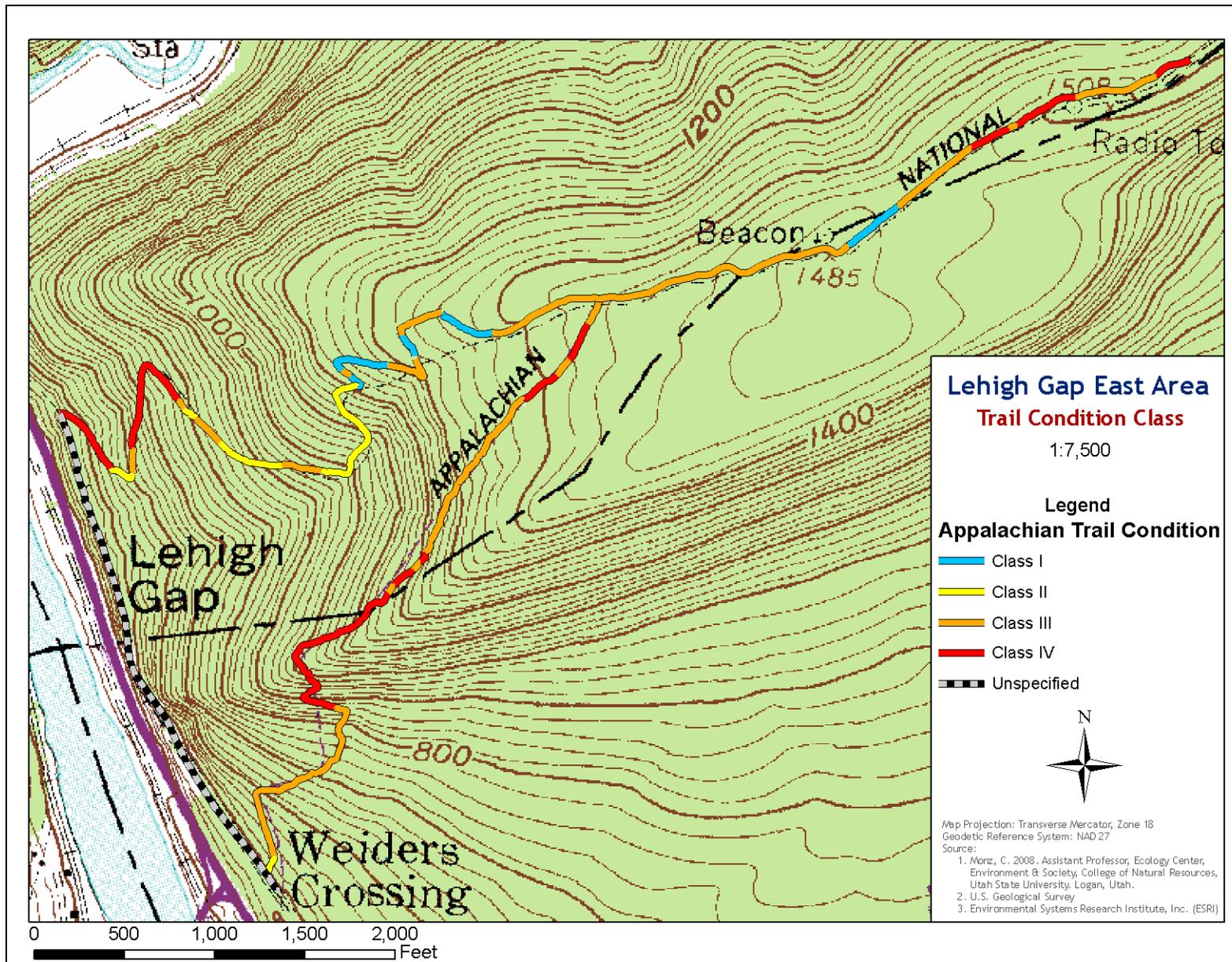


FIGURE 10. LEHIGH GAP EAST AREA: TRAIL TREAD TYPE

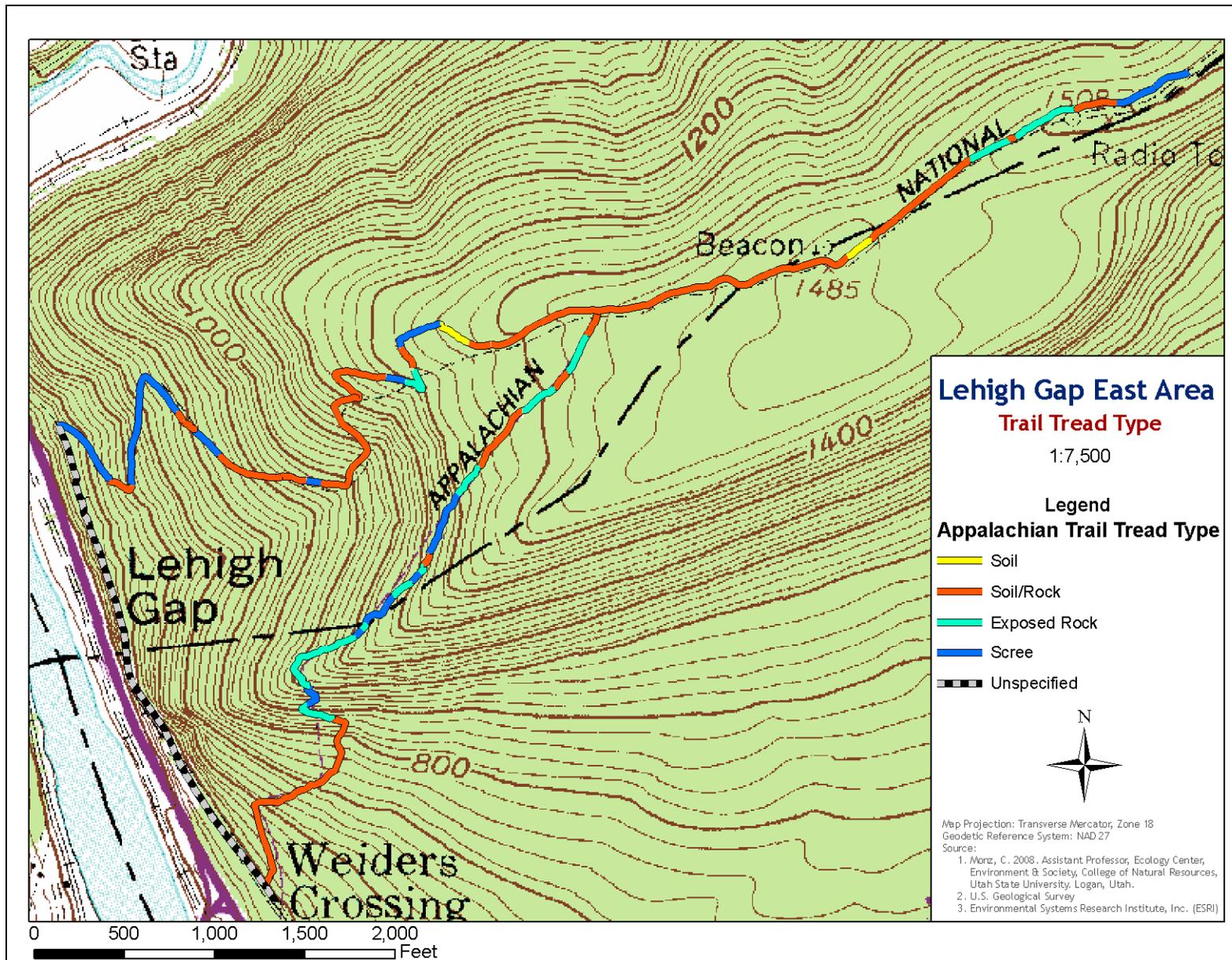


FIGURE 11. WIND GAP WEST AREA: MAINTENANCE FEATURES

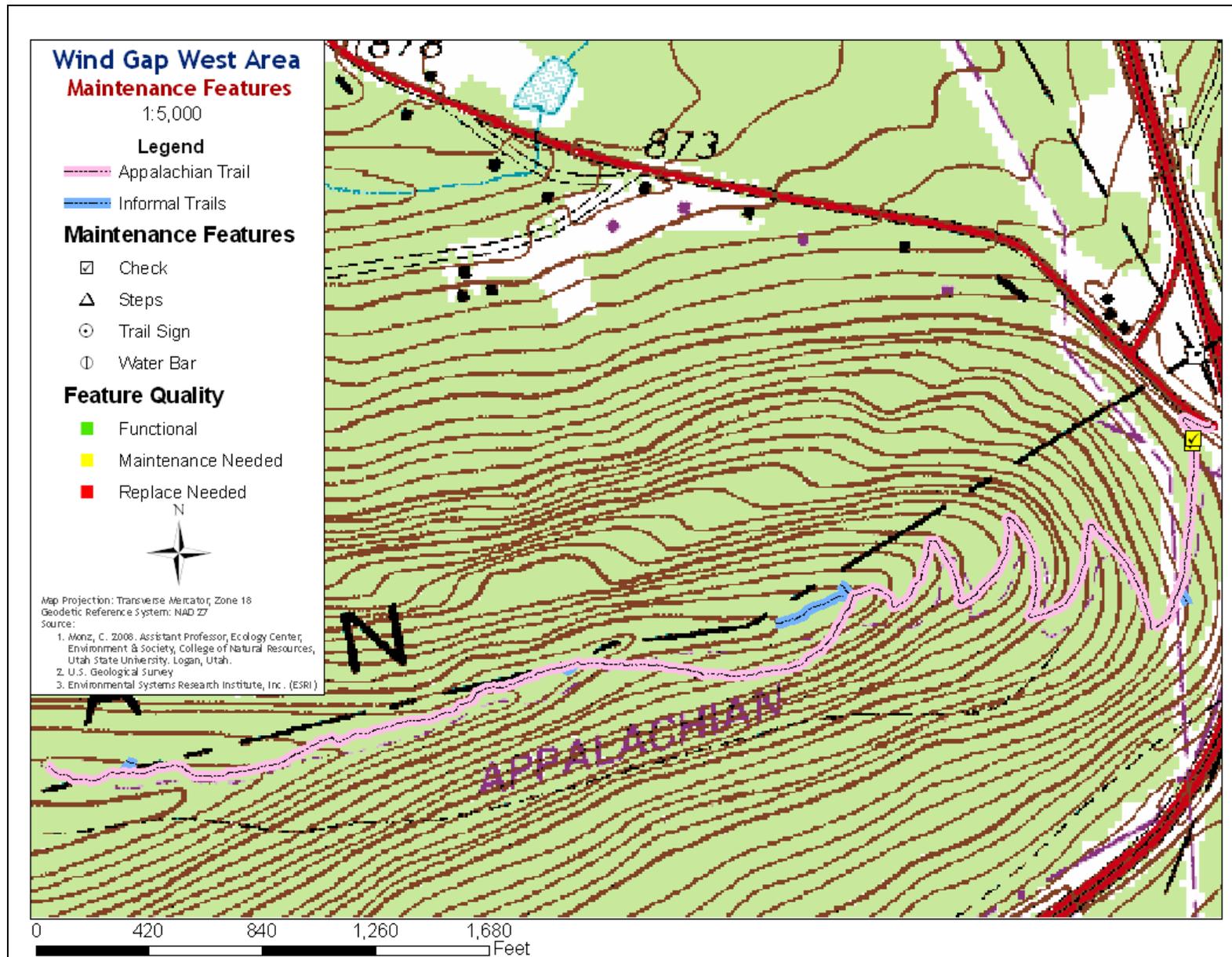


FIGURE 12. WIND GAP WEST AREA: TRAIL CONDITION

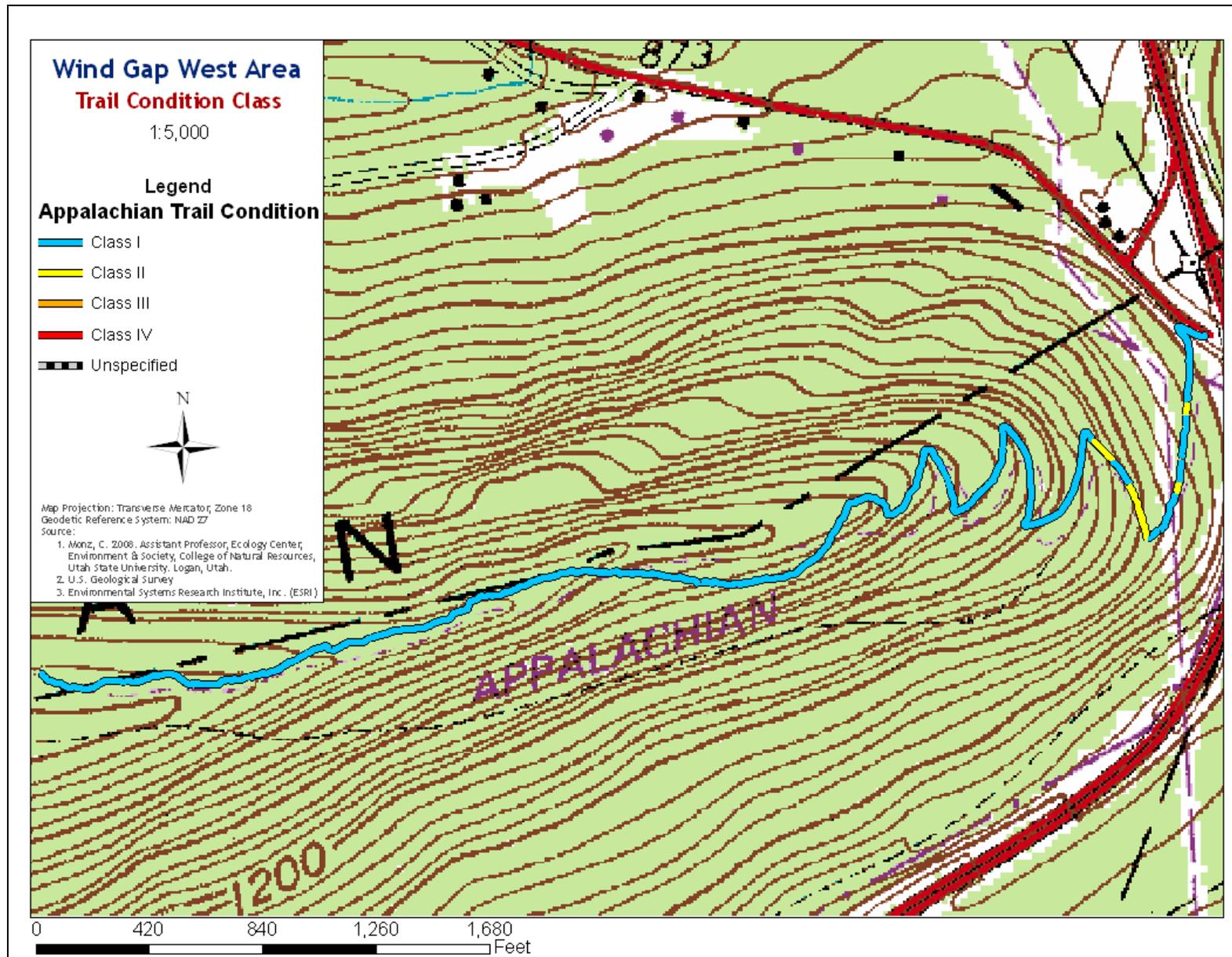


FIGURE 13. WIND GAP WEST AREA: TRAIL TREAD TYPE

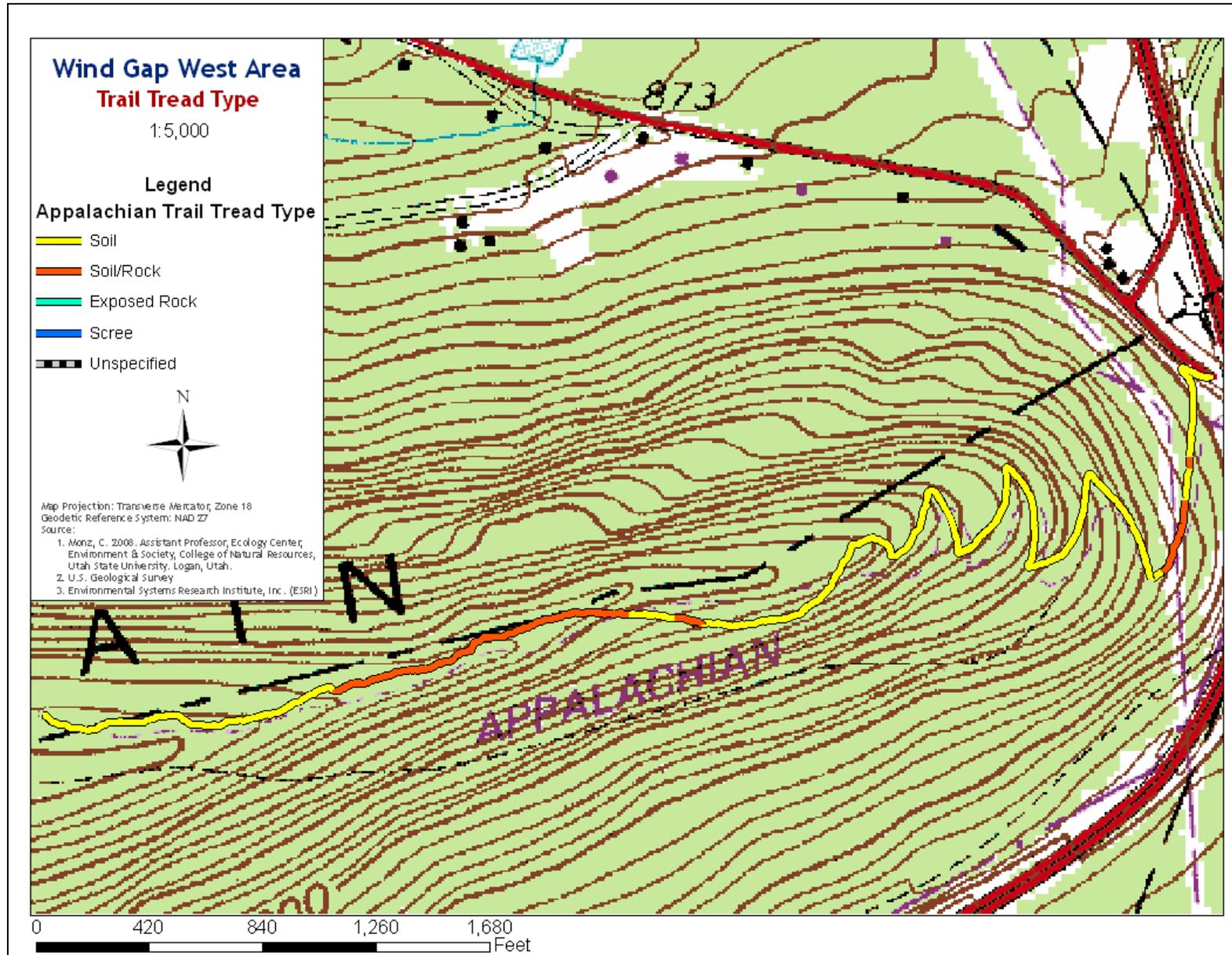


FIGURE 14. WIND GAP EAST AREA: MAINTENANCE FEATURES

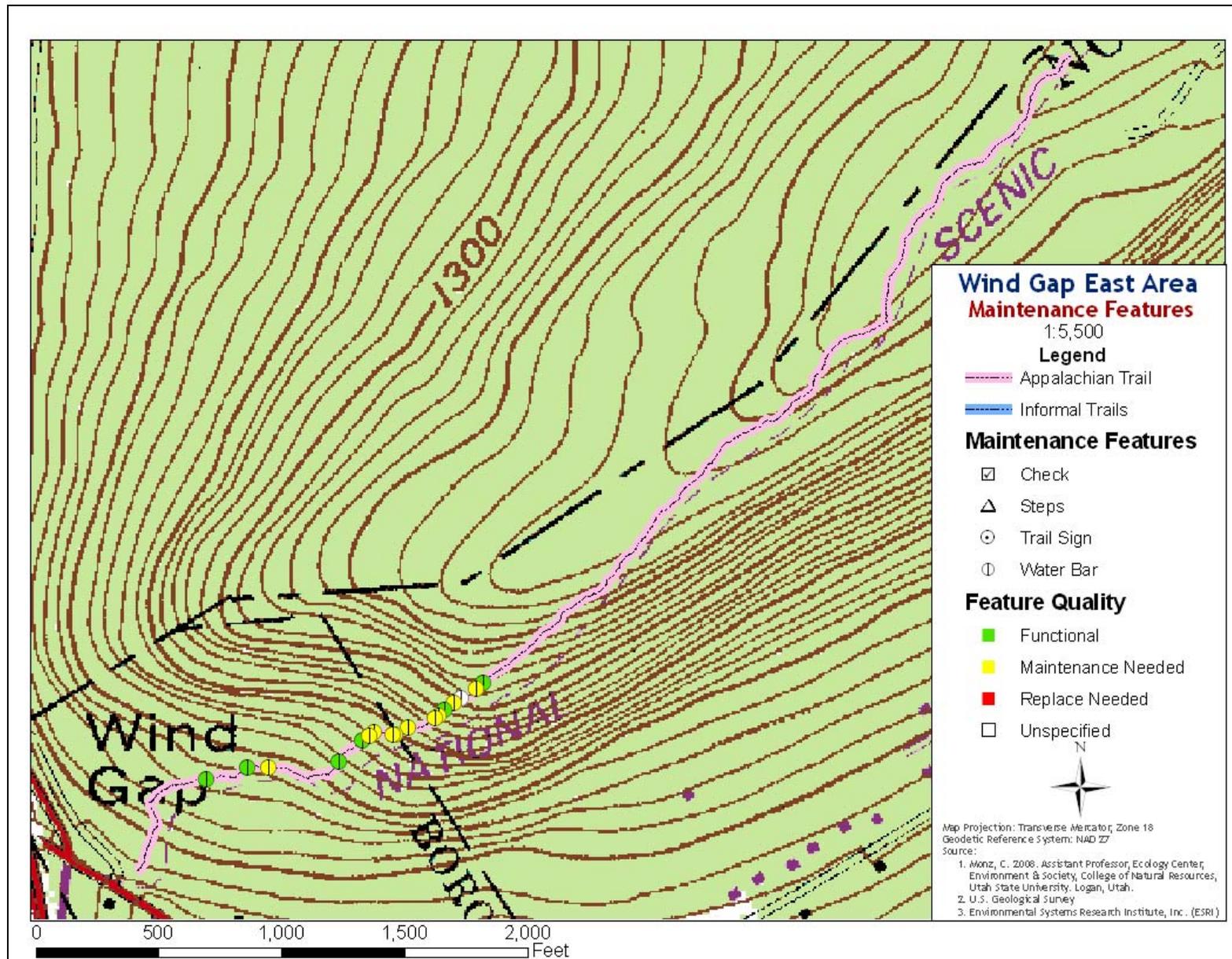


FIGURE 15. WIND GAP EAST AREA: TRAIL CONDITION

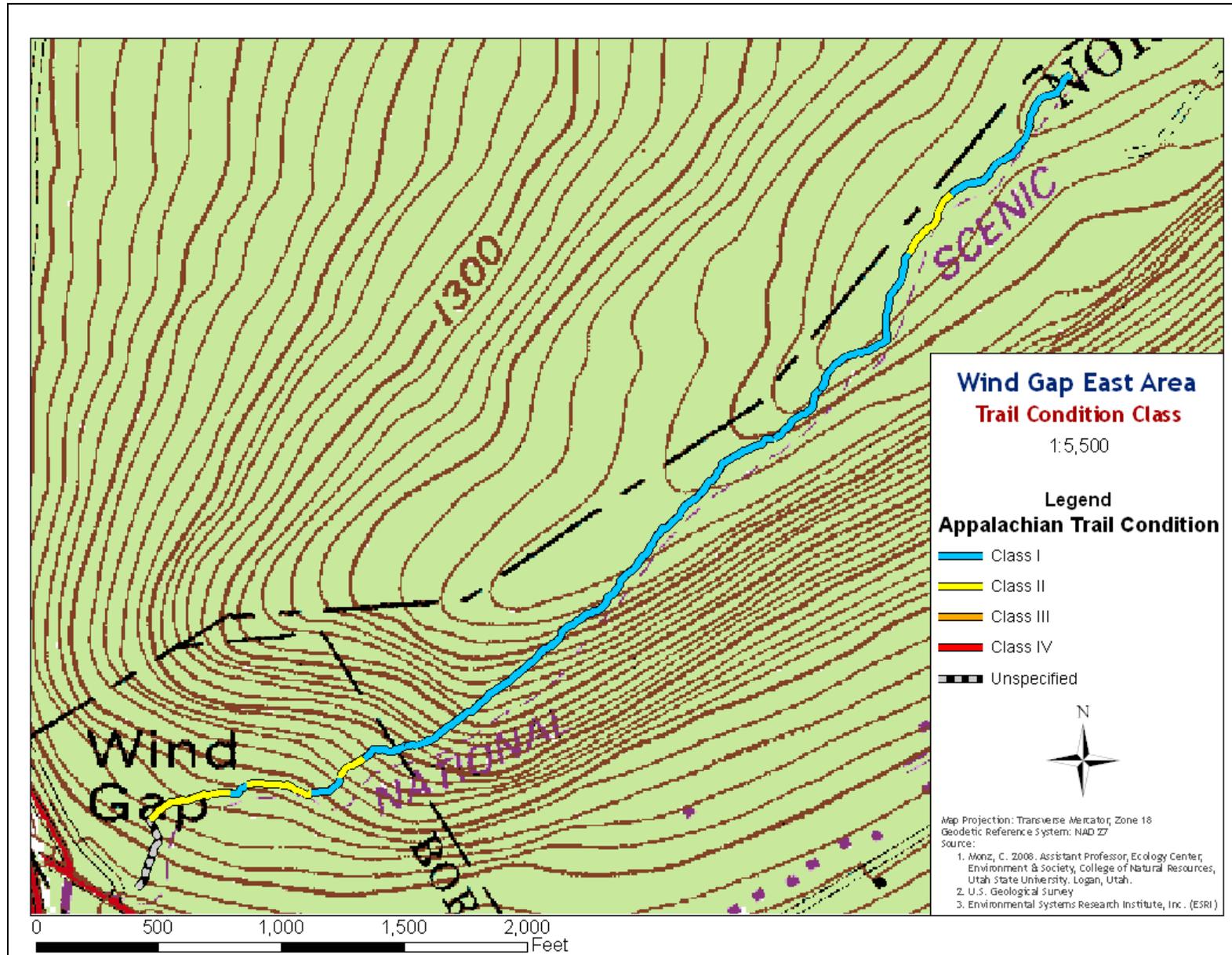


FIGURE 16. WIND GAP EAST AREA: TRAIL TREAD TYPE

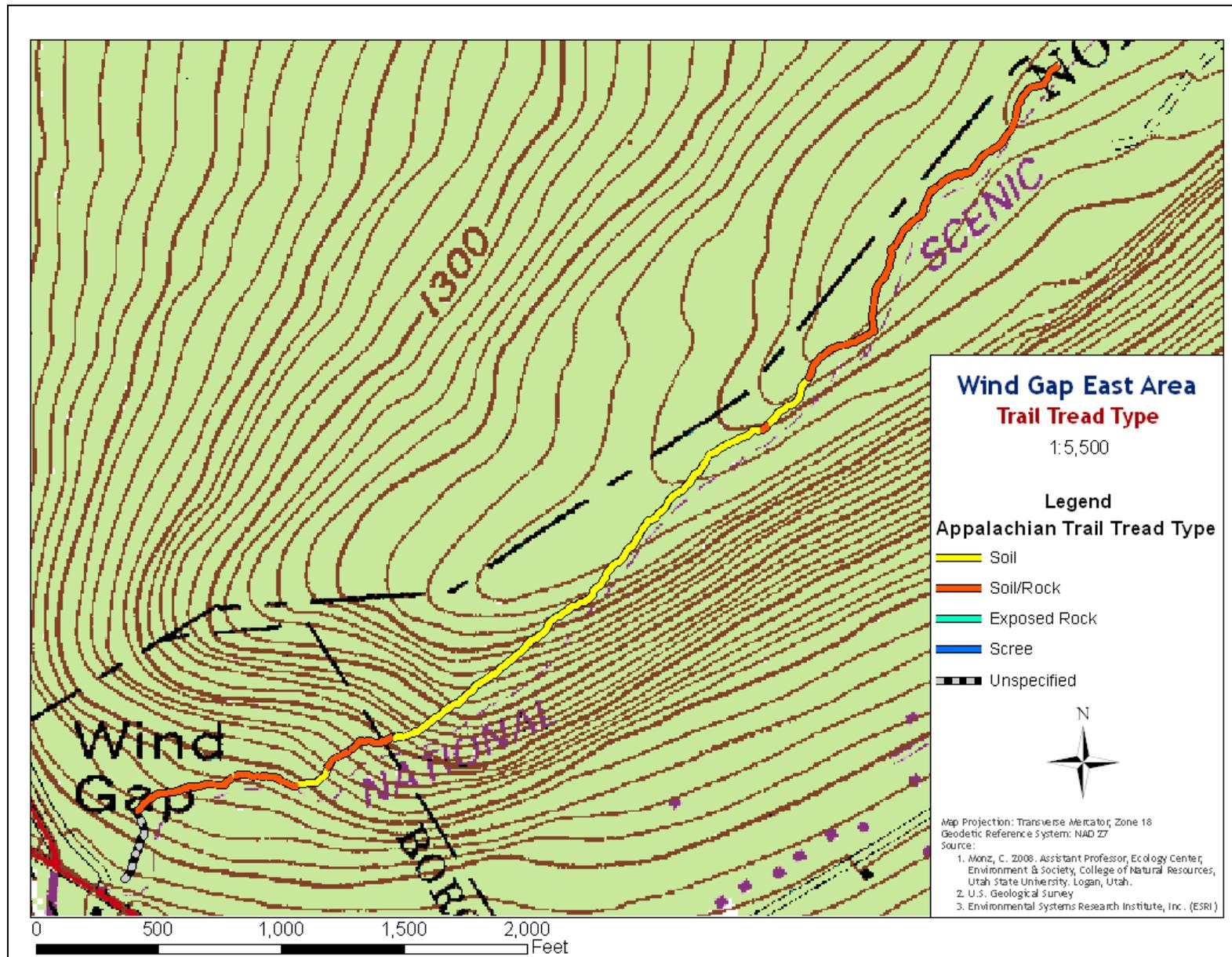


FIGURE 17. PORT CLINTON WEST AREA: MAINTENANCE FEATURES

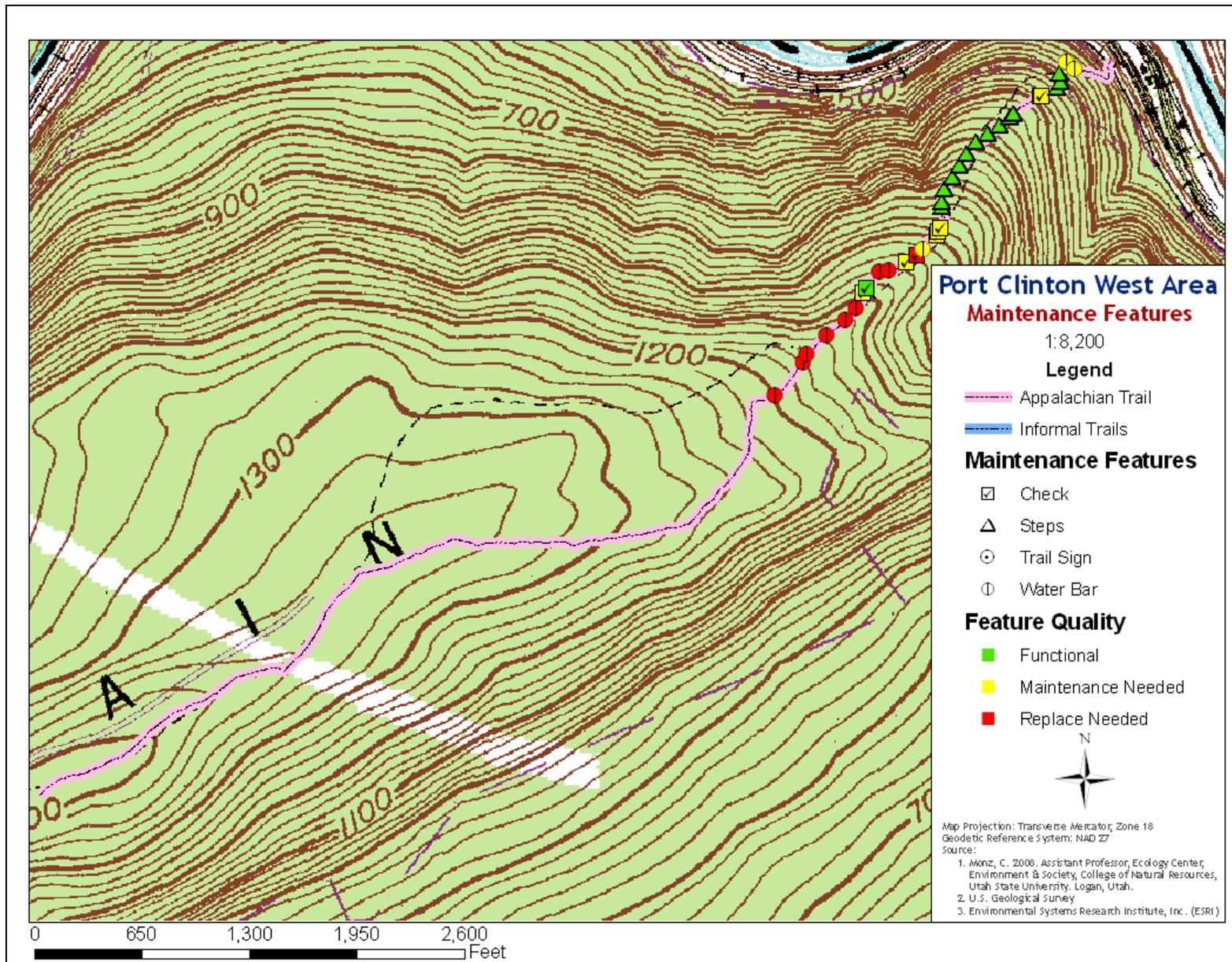


FIGURE 18. PORT CLINTON WEST AREA: TRAIL CONDITION

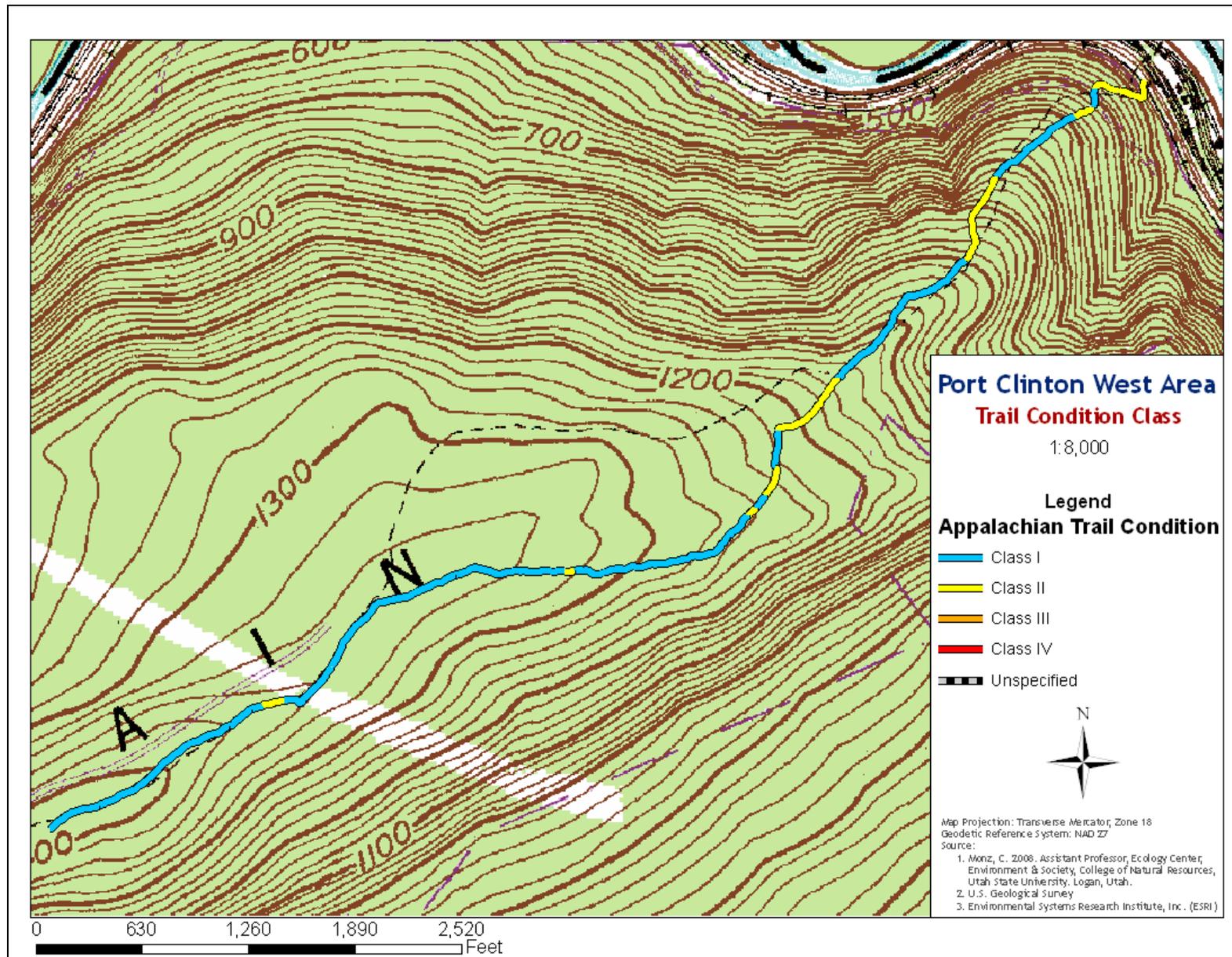


FIGURE 19. PORT CLINTON WEST AREA: TRAIL TREAD TYPE

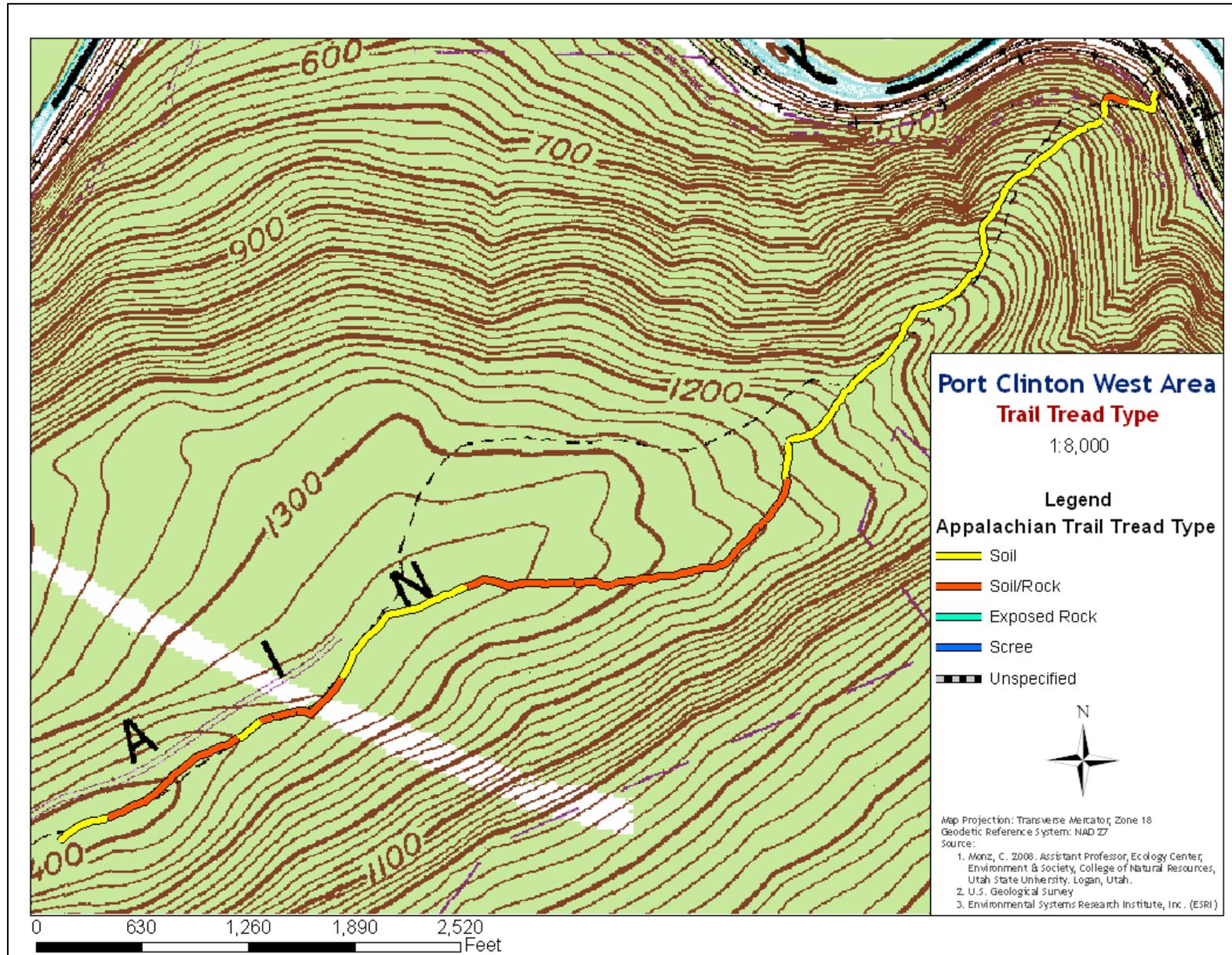


FIGURE 20. PORT CLINTON EAST AREA: MAINTENANCE FEATURES

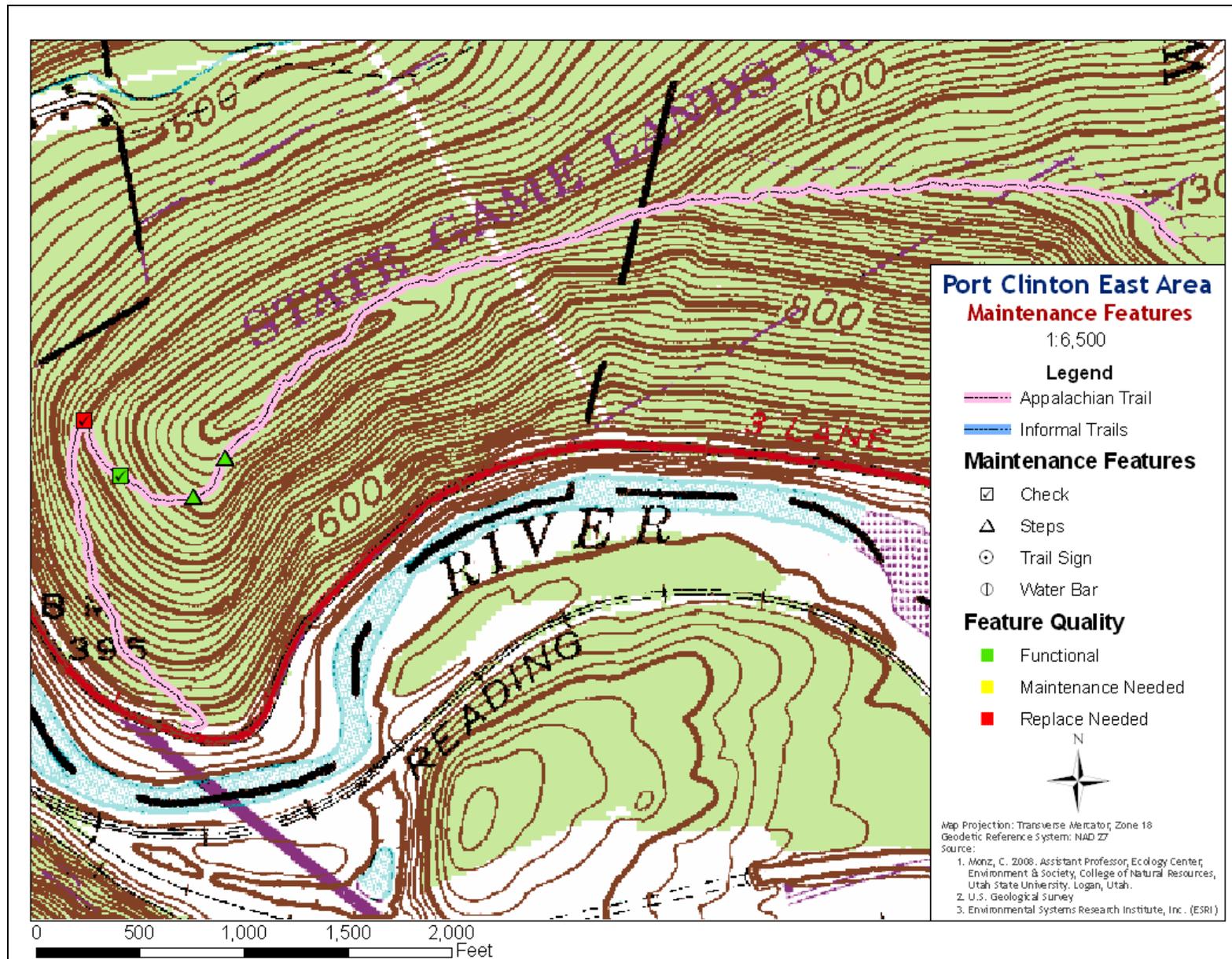


FIGURE 21. PORT CLINTON EAST AREA: TRAIL CONDITION

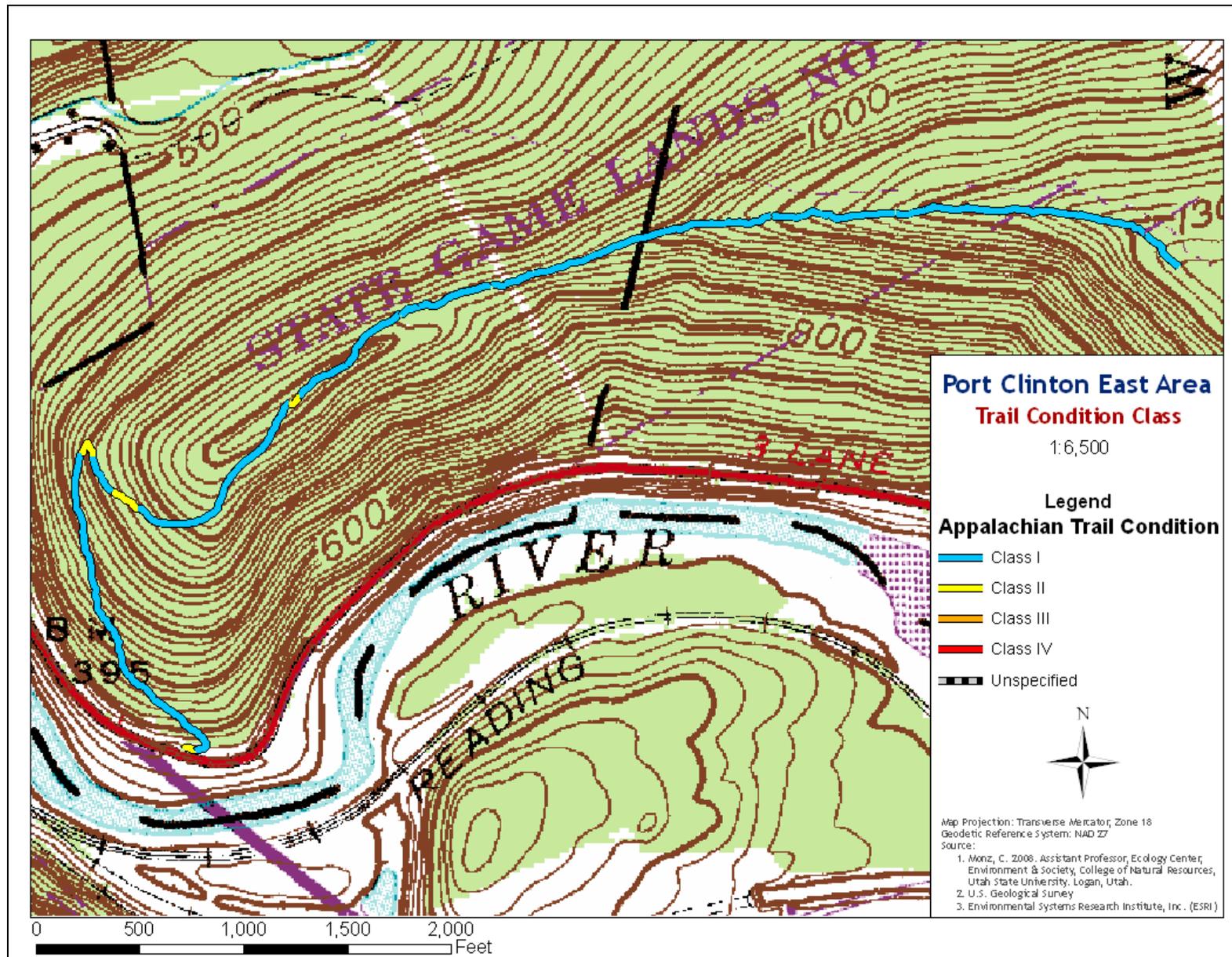


FIGURE 22. PORT CLINTON EAST AREA: TRAIL TREAD TYPE

