Table 11. Rank of Monitoring Stations Exceeding Pa. DEP Water Quality Criterion for Total Aluminum

Site Name	Average Total Aluminum Concentration, mg/l	Severity Rank
COAL1*	27.38	1
MORR2	15.85	2
BEAR1*	15.63	3
MORR1*	15.50	4
UNT5	10.22	5
TIOG3	5.75	6
FALL1*	4.36	7
UNT3	3.95	8
TIOG2	3.75	9
TIOG1	2.87	10
UNT2	2.54	11
FALL2	0.99	12
FALL3	0.98	13

*Sites are at the mouths of tributaries draining into the Tioga River

COMPARISON TO HISTORICAL ACCOUNTS

The most pronounced change in the Tioga River Watershed in comparison to historical accounts is in the reclamation of surface mined areas. Previous to this project, the most comprehensive assessment was completed by Gannett Fleming Corddry & Carpenter in 1968 for the Federal Water Pollution Control Administration. At that time, 41 surface mines were identified, 39 of which were abandoned and five of which had intermittent discharges of AMD to surface streams. Active surface mining was producing 300,000 tons of coal per year. However, surface mining ended in 1990 when the remaining mining company, Jones and Brague Coal Company, finished reclaiming its active surface mines, as well as some pre-Act surface mines. Since that time, no new surface mining has been conducted and further mining, with the exception of remining, is not anticipated in the watershed in the future. Thirty-seven areas of surface disturbance were identified in this study, including 18 new surface disturbance features not identified in the 1968 study. This increase was largely due to the expansion of the study area to include the entire Upper Tioga River Watershed, not just the Morris Run/Coal Creek/Bear Creek area. These areas not only included abandoned and reclaimed surface mines, but also problem refuse piles and a gravel mining operation. Many of the areas of surface disturbance are classified as partly reclaimed; these areas are still in need of some type of surface reclamation on at least part of their area. For this reason, a net gain/loss of square miles was not computed for disturbed surface areas between this study and historical reports.

Seventy-two deep mine entries were identified in the 1968 study; however, one of them was not identified on a map, so it was not included in the historical total. Many of these deep mine entries were visible in highwalls of abandoned surface mines, creating direct access for water accumulating in the pits to abandoned deep mine workings. Twenty-two of the openings identified in 1968 were no longer present during this study. The loss of these openings is due to reclamation of abandoned surface mines where openings were visible in the highwall. However, because of the larger scope of this project compared to the 1968 study, six additional mine openings were identified in this study that were not previously documented. Fifty-five deep mine entries were identified in this study, resulting in a net loss of 16 mine openings.

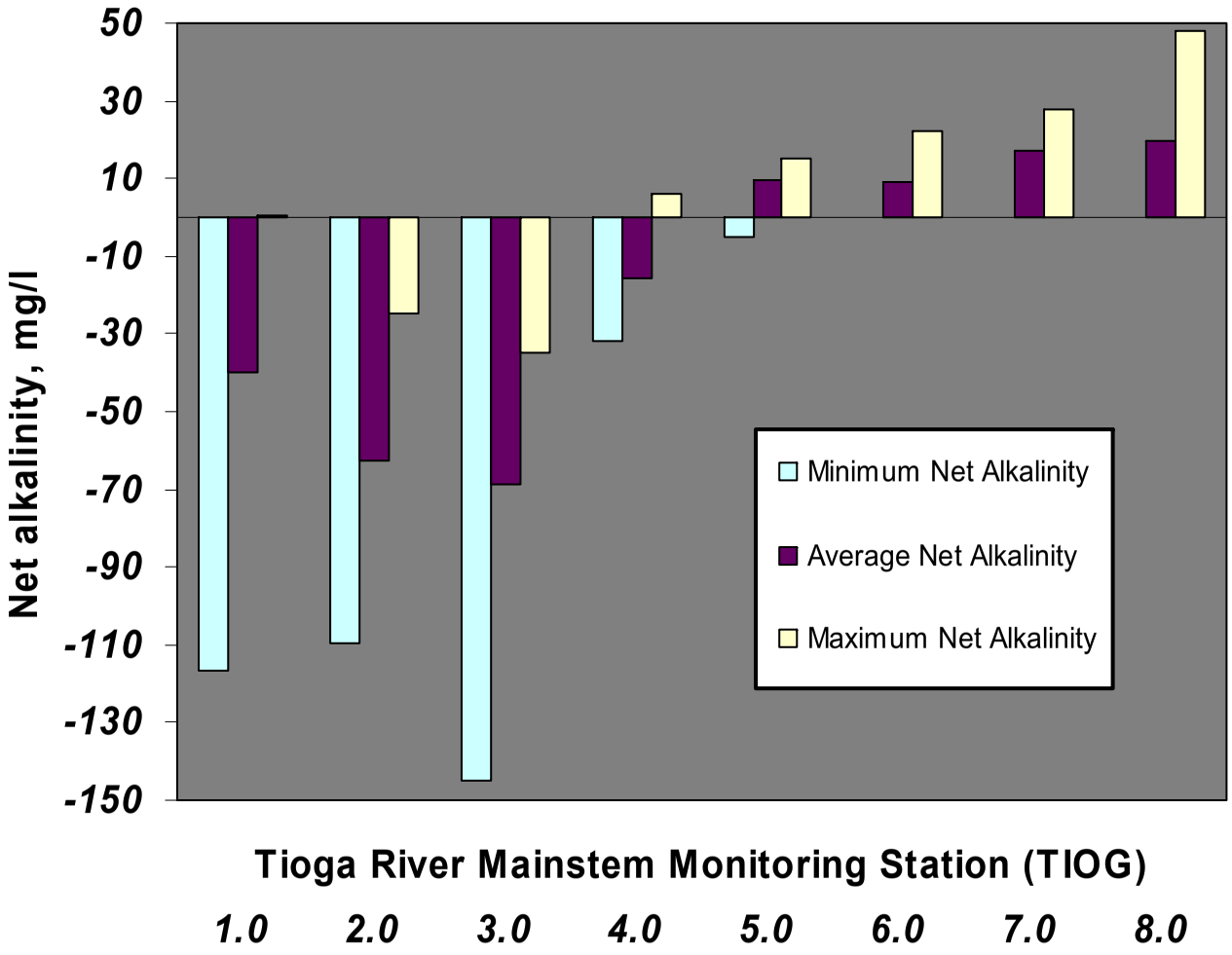

Figure 12. Net Alkalinity (Maximum, Average, Minimum) Change Along the Tioga River Mainstem

Sixteen major mine drainage discharges were identified in the 1968 study, six of which were from surface mine or refuse dump sources and 10 of which were from deep mines. Four of the mine discharges were associated with surface mines that have been reclaimed and no longer exist; one was associated with a refuse dump area that has been reclaimed and no longer exists; one discharge exists only as a deep mine opening but no longer discharges any water. An additional two discharges were confirmed that had significantly less impact than in 1968, being identified as intermittent discharges; eight discharges from 1968 were confirmed that are considered major discharges in this study. In addition to confirming the 16 previously identified discharges, 26 additional discharges were identified that were not previously documented. This net gain resulted in a total of 36 mine drainage discharges being identified in this study.

Four of five areas of stream infiltration identified in 1968 were confirmed in this study. One area of stream infiltration identified in 1968 was restored in 1975 through an extensive reclamation project that reclaimed an abandoned surface mine in the headwaters of Morris Run (Miorin and others, 1979). One additional zone of stream flow fluctuation was identified and delineated during this study resulting in a net total of five stream flow fluctuation zones identified in the Upper Tioga River Watershed.

THE WATERSHED RESTORATION PLAN[9]

Gannet Fleming, Inc. was contracted by SRBC to prepare a conceptual AMD restoration plan for the Upper Tioga River Watershed (Rightnour & Hoover, 2003). Thirty-six AMD features were identified by SRBC in the Upper Tioga River Watershed, of which 21 had at least intermittent flow and were able to be sampled within the study period. Based on field reviews, a number of the AMD sources could be combined in common treatment systems for an economy of scale. For each treatment plan developed, conceptual passive and chemical system designs were prepared using the Tarco Technologies, Inc. Watershed Restoration Analysis Model (WRAM v1.2), which generated conceptual component sizing requirements, construction cost estimates, operation and maintenance cost estimates, 15-year present values, and construction area requirement estimates[10]. The more appropriate of the two treatment alternatives was selected based on construction area constraints, cost considerations, and ability of the technologies to meet water quality goals. Of the 10 conceptual treatment plans, four were best addressed by chemical systems and six by passive systems. Following development of the conceptual treatment plans, another component of WRAM was used to predict the downstream water quality improvements that could result from implementing these plans and to guide development of the restoration plan.

Project Benefits/Endpoint

Local stakeholders have expressed a final goal of restoring the Tioga River to a natural ecological condition, with interim water quality and ecological improvements being made to the affected tributaries and contributing to the restoration of the mainstem. While the goal of

[9] The complete restoration plan is contained in the document "Upper Tioga River Watershed: Acid Mine Drainage Conceptual Treatment and Restoration Plan" prepared by Gannett Fleming, Inc., for SRBC.

[10] All costs mentioned are the prices for supplies, labor, operation, and maintenance of systems. They do not include monetary values for benefits from the project(s).