Sensitivity Analysis of Mine Refuse Pile Rating System

Conducted for the Western Pennsylvania Coalition for Abandoned Mine Reclamation

by
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Executive Summary

Project Gob Pile is sponsored by the Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR). The primary purpose of this project is to identify, assess, and prioritize for reclamation mine refuse piles within Westmoreland County. Thus far, WPCAMR has identified, assessed, and ranked 102 mine refuse piles.

In order to prioritize the mine refuse piles, WPCAMR has developed a ranking system that incorporates 19 criteria. These criteria cover socio-economic, environmental, and health and safety factors, as well as the development and removal potential of the mine refuse piles. Each criterion has been assigned a maximum point score (ranging from 5 points to 25 points) based on the perceived importance of the criterion. Based on this point scale, the maximum total score possible for any pile is 150 points.

The purpose of this report is to evaluate the ranking system used by WPCAMR to prioritize the piles, particularly the weights applied to the 19 criteria. Many aspects of the ranking system, including the list of criteria, the point scale, and the numerical ratings of the piles necessarily involve subjective human judgements. Such subjectivity cannot be avoided in a project that attempts to prioritize a list of sites; however, it is prudent to explore the sensitivity of the final rankings to subjective framework by which the piles are ranked. This report evaluates the extent to which the final rankings are sensitive to maximum point scales assigned to each of the 19 rating criteria.

I used a two-step process to evaluate the WPCAMR ranking system. First, I eliminated from consideration piles that did not have a reasonable chance of being selected for reclamation. At the present time, WPCAMR is attempting to identify roughly 15 piles for reclamation, and most of the piles do not score high enough on the criteria to have a reasonable chance of being selected among the top 15. After eliminating piles from consideration, 40 piles remained for further examination.

I developed two alternative measures for ranking the remaining 40 piles. Both of these alternative measures are “weight-free” in the sense that neither involves placing differentiated weights on the 19 criteria. By comparing the new rankings arising from the weight-free measures to the original rankings, we can observe the extent to which the original rankings are sensitive to the specific weights applied to each criterion. If the new rankings closely correspond to the original rankings, then we can conclude that original ranking system is robust to changes in the weights. On the other hand, if the new rankings deviate substantially from the original, then we conclude that the original ranking system is sensitive to the chosen weights. This would not necessarily imply that the original ranking system is flawed, however, it would suggest that we should be very careful to ensure that the weights specified for each criterion are defensible.

A comparison of the original rankings to the rankings resulting from the alternative measures suggests that the original ranking system is quite robust to changes in the maximum point scales, particularly with regard to the highly-ranked piles. More

specifically, 12 of the top 15 piles from the original rankings also rank in the top 15 of both of the alternative measures. Furthermore, two of the three exceptions missed the top 15 in the dominance rankings by only one place on one of the two measures. The strong correlation between the original rankings and the alternative measures breaks down somewhat after the top 15. Only one of the five piles originally ranked between 16 and 20 in the original rankings also ranks in the top 20 of both alternative measures. The exception is the Fitz Henry pile, which ranks 13th and 14th in the equal weighting and dominance measures, respectively.

Given the fact that the WPCAMR hopes to reclaim only about 15 piles at the present time, these results strongly support the use of the original ranking system as a means of prioritizing the mine refuse piles. In addition, I would suggest that the WPCAMR consider adding the Fitz Henry pile to the priority list of piles to be reclaimed. This site, which ranked 17th in the original ranking scored well in both of the alternative measures.

Background

Project Gob Pile is sponsored by the Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR). The primary purpose of this project is to identify, assess, and prioritize for reclamation mine refuse piles within Westmoreland County. Thus far, WPCAMR has identified, assessed, and ranked 102 mine refuse piles.

In order to prioritize the mine refuse piles, WPCAMR has developed a ranking system that incorporates 19 criteria. These criteria cover socio-economic, environmental, and health and safety factors, as well as the development and removal potential of the mine refuse piles. Each criterion has been assigned a maximum point score (ranging from 5 points to 25 points) based on the perceived importance of the criterion. Based on this point scale, the maximum total score possible for any pile is 150 points. Appendix 1 of this report contains a sample site scoresheet, listing the 19 criteria, the maximum point score for each criterion, and the point scores for the Adamsburg site (65-012). Appendix 2 provides a complete list of the piles and their rankings.

The purpose of this report is to evaluate the ranking system used by WPCAMR to prioritize the piles, particularly the weights applied to the 19 criteria. Many aspects of the ranking system, including the list of criteria, the point scale, and the numerical ratings of the piles necessarily involve subjective human judgements. Such subjectivity cannot be avoided in a project that attempts to prioritize a list of sites; however, it is prudent to explore the sensitivity of the final rankings to subjective framework by which the piles are ranked. This report evaluates the extent to which the final rankings respond to changes the point-scale applied to the list of criteria.

Evaluation of the Ranking System

I used a two-step process to evaluate the WPCAMR ranking system. First, I eliminated from consideration piles that did not have a reasonable chance of being selected for reclamation. At the present time, WPCAMR is attempting to identify roughly 15 piles for reclamation, and most of the piles do not score high enough on the criteria to have a reasonable chance of being selected among the top 15. After eliminating piles from consideration, 40 piles remained for further examination. In the next section, I describe processed I used to eliminate these piles from consideration.

I developed two alternative measures for ranking the remaining 40 piles. Both of these alternative measures are “weight-free” in the sense that neither involves placing differentiated weights on the 19 criteria. By comparing the new rankings arising from the weight-free measures to the original rankings, we can observe the extent to which the original rankings are sensitive to the specific weights applied to each criterion. If the new rankings closely correspond to the original rankings, then we can conclude that original ranking system is robust to changes in the weights. On the other hand, if the new rankings deviate substantially from the original, then we conclude that the original ranking system is sensitive to the chosen weights. This would not necessarily imply that the original

ranking system is flawed, however, it would suggest that we should be very careful to ensure that the weights specified for each criterion are defensible.

Sample Subset of Mine Refuse Piles

In order facilitate the explanation of the evaluation process used in this report to eliminate piles from consideration and rank the remaining piles according to alternative measures, I have chosen four a subset of four sample piles to serve as an example. The scores for these sample piles are shown in Table 1 on the following page.

Eliminating Piles from Consideration

Suppose that we wanted to select for reclamation one of the four piles from our sample subset. Carbon (65-029) has the highest score according to the original ranking system and would therefore be a natural contender for selection.[1] The purpose of this report, however, is to evaluate the effectiveness of the original ranking system. Thus, we must develop alternative methods for ranking the piles.

The first step that I took in this process was to eliminate from consideration those piles that are unlikely to rank highly in any reasonable priority measure. In particular, I used the concept of "dominance" to perform the elimination process. More specifically, I eliminated those piles that were dominated by a sufficient number of other piles on a specified number of the 19 evaluation criteria. For our purposes, we will say that Pile 1 is dominated by Pile 2 on all criteria if Pile 1 has a score that is less than or equal to its competitor on every criterion.[2] We can extend the concept of dominance to include piles that are dominated on all but one criterion, all but two criterion, and so forth.

A concrete example may be helpful at this point. Consider our sample subset of four piles, and again suppose that we wish to reclaim just one of these piles. If we compare Old Diamond Road to Carbon, we see that on each criterion Old Diamond Road has a score that is less than or equal to that of Carbon. Given the fact that we will only reclaim one pile, we are safe to eliminate Old Diamond Road from further consideration. This follows because regardless of how much weight we place on any given criterion, it would be impossible for Old Diamond Road to attain a higher score than Carbon. Similarly, we can eliminate Middle Churches from consideration because it, too, is dominated by Carbon on all 19 criteria.

I used a similar process to eliminate piles from consideration in the larger population of mine refuse piles. Because the goal is to reclaim a total of roughly 15 piles, I eliminated from consideration all piles that are dominated on all criteria by at least 15

[1] In the original ranking system, piles with higher numerical scores are preferred to those with lower scores.
[2] This form of dominance is "weak dominance," because it requires only that the score of the first pile be less than *or equal to* that of the second pile. "Strict dominance" would require that the score of the first pile be strictly less than that of the second pile.

other piles; however, only 6 of the 102 piles could be eliminated from consideration using this method.

In order to eliminate more piles from consideration, I extended the concept of dominance to eliminate piles that are dominated on most, but not all, criteria. Returning to our subset of four piles, notice that White Valley is dominated by Carbon on all but three criteria (Water/Stream Impact/Proximity, Steep Slope, and Natural Heritage Inventory, ¼ mile).

Table 1: Sample Subset of Four Mine Refuse Piles

	Old Diamond Road (65-099)	Middle Churches (65-086)	White Valley (65-042)	Carbon (65-029)
Socio-Economic				
Social Impact and/or Interest	0.00	0.67	9.00	9.33
Political Interest and/or Activity	0.33	2.33	4.00	4.00
Population Density , ¼ Mile	1.67	5.00	9.00	9.00
Adjacent Land Use	1.00	3.33	3.00	4.00
Tourism Impact or Potential	0.33	0.33	4.00	4.33
Economic Impact on Community	0.33	0.33	4.67	5.00
Environmental				
Flora/Fauna	0.00	5.00	8.00	8.00
Water/Stream Impact/Proximity	6.33	5.67	22.67	21.00
Health & Safety				
Fire	0.00	0.00	0.00	0.00
Steep Slope	0.33	3.33	4.33	3.67
Illegal Dumping and other Crimes	1.67	3.00	0.00	4.67
ATVs / Motorcycles	0.00	0.00	4.00	9.00
Development & Removal Potential				
Legal Status	0.00	0.00	1.67	3.33
BTU/Sulfur	0.00	5.00	9.33	16.67
Topography	1.33	1.00	0.00	4.00
Available Space	2.00	0.67	0.00	4.33
Access	0.00	4.67	3.67	5.00
Bonus Points				
Natural Heritage Inventory, ¼ Mile	0.00	0.00	1.67	0.00
River Conservation Plan	0.00	0.00	0.00	0.00
Totals	15.33	40.33	89.00	115.33

In order to eliminate piles from consideration in the entire mine refuse pile population, I first eliminated the 6 piles that are dominated by at least 15 piles on *all* criteria. Next, I eliminated the 8 piles dominated by at least 15 piles on *all but one criteria*. Then, I eliminated the 14 piles dominated by at least 15 piles on *all but two criteria*, the 20 piles dominated by at least 15 piles on *all but three criteria*, and finally the 14 piles dominated by at least 15 piles on *all but four criteria.* A summary of the eliminated piles is given on the following page.

Dominated by at least 15 piles on all criteria

Loyalhanna (65-058)	Brinkerton (65-001)	Old Diamond Road (65-099)
Jamison #20 (65-037)	Southwest (65-003)	Loyalhanna Dam (65-078)

Dominated by at least 15 piles on all but ONE criteria

Edna #1 South (65-044)	Atlantic West (65-059)	Middle Churches (65-086)
Zane Avenue (65-048)	Superior (65-038)	Pleasant Valley (65-020)
Crabtree (65-033)	School Street (65-073)	

Dominated by at least 15 piles on all but TWO criteria

Morewood #4 (65-065)	Moween (65-079)	Southwest Southeast (65-004)
Bradenville (65-075)	Export (65-039)	Calumet Southeast (65-006)
Donnelly (65-071)	Getty Run (65-094)	Southwest Northwest (65-104)
Arona West (65-016)	Luxor (65-023)	Whitney (65-036)
Standard Shaft (65-011)	Bolivar (65-096)	

Dominated by at least 15 piles on all but THREE criteria

Snydertown (65-064)	United (65-005)	Motordrome West (65-067)
Byers Run (65-019)	Peanut (65-051)	Mushroom Farm (65-049)
Export North (65-082)	Keystone (65-102)	Delmont Mine (65-103)
Buffalo Run (65-101)	Adamsburg (65-013)	Lauffer Mine (65-061)
Fairbanks #1 (65-060)	Elrico Park (65-057)	Greenwald (65-050)
McCullough (65-017)	Export (65-040)	McCullough (65-018)
Elora East (65-070)	Fairbanks #2 (65-077)	

Dominated by at least 15 piles on all but FOUR criteria

Adamsburg (65-012)	Truxall (65-054)	North Belle Vernon (65-069)
Marguerite (65-062)	Trauger (65-007)	Smithton (65-071)
Marguerite (65-063)	Trauger (65-008)	Smithton East (65-072)
Bolivar (65-095)	Scab Hill (65-097)	Forbes Road (65-024)
Baggaley (65-041)	Highland (65-025)	

The 40 piles remaining in consideration after this elimination process do not correspond exactly to the top 40 piles from the original ranking system. Three piles in the original top 40 were eliminated (Smithton East, Smithton, and Highland). Still, this elimination process produces results remarkably similar to the original ranking. Consider that all of the top 33 piles from the original rankings remain in consideration and that the lowest ranked of the 40 piles in still in consideration is Penn, which ranks 46th in the original rankings.

Table 2 lists the new rankings of the 40 piles remaining after the process of elimination. Please note that a * next to a pile indicates that the pile directly preceding the marked pile in the original rankings has been eliminated. Because some higher-ranked piles have been eliminated from consideration, the new rankings do not correspond exactly to the original rankings. For example, Penn ranks 40th in the new rankings

compared to 46th in the original rankings because six piles that originally ranked ahead of Penn have been eliminated from consideration.

Table 2: New Rankings of 40 Remaining Piles

New Rank	Name	Gob ID	Total Score
1	Carbon	65-029	115.3
2(t)	Bovard	65-021	113.0
2(t)	Bovard	65-022	113.0
2(t)	Yukon	65-088	113.0
2(t)	Yukon	65-089	113.0
2(t)	Yukon	65-090	113.0
2(t)	Yukon	65-091	113.0
8	Adamsburg	65-014	110.3
9(t)	Sharon	65-027	108.0
9(t)	Sharon	65-028	108.0
9(t)	Wendel	65-080	108.0
12	Carbon	65-031	107.7
13	Darragh	65-0??	106.7
14	Buckeye	65-087	103.7
15	Drive-in Theater	65-047	103.3
16	Adamsburg	65-015	102.7
17	Fitz Henry	65-084	102.3
18	Mount Joy	65-009	101.3
19	Seger	65-053	99.0
20	Bell Point West	65-035	97.0
21	Delmont Mine	65-083	94.3
22	Wilpen	65-098	93.3
23	Mount Joy	65-085	93.0
24	Claridge	65-074	92.3
25	Brenizer	65-034	92.0
26	Compost Area	65-046	91.3
27	Hitchinson	65-068	91.0
28	Slickville	65-026	89.3
29(t)	Herminie #2	65-032	89.0
29(t)	White Valley	65-042	89.0
29(t)	White Valley	65-043	89.0
32(t)	Newlonsburg South #1	65-055	87.7
32(t)	Newlonsburg South #2	65-056	87.7
34*	Boyer Run	65-002	86.0
35	Carbon	65-030	85.7
36*	Atlantic	65-076	82.3
37(t)	Upper Whyel	65-092	81.0
37(t)	Upper Whyel	65-093	81.0
39*	Pine Run	65-052	79.7
40*	Penn	65-045	78.0

Ranking the Remaining 40 Piles

The discussion that follows examines two alternative measures to rank the remaining 40 piles. Both of these measures are "weight-free" in the sense that they do not involve placing a different weight on the various criteria.

Alternative Measure 1: Equal weighting of the 19 criteria

The first alternative measure places an equal weight on each of the 19 criteria. This is accomplished by dividing a pile's score on a given criterion by the maximum possible score for that criterion. The total score for a pile is calculated as the average of the scores on each individual criterion.

Table 3 displays the "equal weighting" calculations for Carbon (65-029). According to these calculations, Carbon's score would be 0.720 for the equal weighting measure, which means that on average Carbon received 72.0% of the maximum possible points for each criterion.

Table 3: "Equal Weighting" Calculations for Carbon (65-029)

	Max Points	Carbon (65-029)	Ratio (Actual/Max)
Socio-Economic			
Social Impact and/or Interest	10	9.33	0.933
Political Interest and/or Activity	5	4.00	0.800
Population Density , ¼ Mile	10	9.00	0.900
Adjacent Land Use	5	4.00	0.800
Tourism Impact or Potential	5	4.33	0.867
Economic Impact on Community	5	5.00	1.000
Environmental			
Flora/Fauna	10	8.00	0.800
Water/Stream Impact/Proximity	25	21.00	0.840
Health & Safety			
Fire	5	0.00	0.000
Steep Slope	5	3.67	0.733
Illegal Dumping and other Crimes	5	4.67	0.933
ATVs / Motorcycles	10	9.00	0.900
Development & Removal Potential			
Legal Status	5	3.33	0.667
BTU/Sulfur	20	16.67	0.833
Topography	5	4.00	0.800
Available Space	5	4.33	0.867
Access	5	5.00	1.000
Bonus Points			
Natural Heritage Inventory, ¼ Mile	5	0.00	0.000
River Conservation Plan	5	0.00	0.000
Average			0.720

Applying this measure to the other piles in our sample subset yields 0.099 for Old Diamond Road, 0.281 for Middle Churches, and 0.514 for White Valley. Thus, in our sample subset, the equal weighting measure produces exactly the same order ranking as our original ranking system.

Below, Table 4 lists the equal weighting scores and ranks for the 40 remaining piles.

Table 4: "Equal Weighting" Scores and Ranks

New Rank*	Name	Gob ID	Equal Weight Score	Equal Weight Rank
1	Carbon	65-029	0.720	5
2(t)	Bovard	65-021	0.744	1(t)
2(t)	Bovard	65-022	0.744	1(t)
2(t)	Yukon	65-088	0.709	6(t)
2(t)	Yukon	65-089	0.709	6(t)
2(t)	Yukon	65-090	0.709	6(t)
2(t)	Yukon	65-091	0.709	6(t)
8	Adamsburg	65-014	0.723	4
9(t)	Sharon	65-027	0.656	14(t)
9(t)	Sharon	65-028	0.656	14(t)
9(t)	Wendel	65-080	0.726	3
12	Carbon	65-031	0.696	11
13	Darragh	65-0??	0.687	12
14	Buckeye	65-087	0.706	10
15	Drive-in Theater	65-047	0.615	21
16	Adamsburg	65-015	0.624	18
17	Fitz Henry	65-084	0.656	14(t)
18	Mount Joy	65-009	0.593	27
19	Seger	65-053	0.620	20
20	Bell Point West	65-035	0.535	35
21	Delmont Mine	65-083	0.663	13
22	Wilpen	65-098	0.540	34
23	Mount Joy	65-085	0.622	19
24	Claridge	65-074	0.611	22
25	Brenizer	65-034	0.546	31
26	Compost Area	65-046	0.542	32(t)
27	Hitchinson	65-068	0.606	23
28	Slickville	65-026	0.549	30
29(t)	Herminie #2	65-032	0.514	40
29(t)	White Valley	65-042	0.532	36
29(t)	White Valley	65-043	0.526	38
32(t)	Newlonsburg South #1	65-055	0.596	25(t)
32(t)	Newlonsburg South #2	65-056	0.596	25(t)
34	Boyer Run	65-002	0.598	24
35	Carbon	65-030	0.644	17
36	Atlantic	65-076	0.527	37
37(t)	Upper Whyel	65-092	0.551	28(t)
37(t)	Upper Whyel	65-093	0.551	28(t)
39	Pine Run	65-052	0.542	32(t)
40	Penn	65-045	0.522	39

** Note that the "New Rank" in Table 4 refers to the rankings according to the original ranking system after the piles eliminated from consideration are removed.*

The equal weighting measure produces an order ranking similar to, but not exactly the same as, the original ranking system. Although the order changes somewhat, 14 of the top 15 piles from the original ranking system are also in the top 15 of the equal weighting

system. The only pile that drops out of the top 15 is Drive-in Theater, which ranks 21st according to the equal weighting measure.

Alternative Measure 2: Dominance

The second alternative measure uses the concept of dominance to rank the piles, the same concept that was used earlier to eliminate piles from further consideration. According to this concept we would say that Pile 1 is dominated by Pile 2 on a criterion if Pile 1 receives a score on that criterion that is less than or equal to that received by Pile 2. To apply this concept as a ranking measure, I matched each pile against every other pile, and for each match I counted the number of criteria over which the pile was dominated by the other pile. To derive a total score for a given pile, I calculated the average score for every match of that pile.

For example, consider calculation for Old Diamond Road from our sample subset. First, we would match Old Diamond Road against Middle Churches. Old Diamond Road is dominated by Middle Churches on 16 of the 19 criteria.[3] Then we match Old Diamond Road against White Valley, and it is dominated on 16 of the 19 criterion. Finally, we match Old Diamond Road against Carbon, and it is dominated on all 19 of the criteria. Taking the average of these three matches, Old Diamond Road receives a score of 17.00. This information is summarized in the first row of Table 5. Each row of Table 5 displays the same information for the other three piles in our sample subset.

Table 5: Dominance Calculations for our Sample Subset

Pile Under Consideration	Pile Matched Against				
	Old Diamond Road	Middle Churches	White Valley	Carbon	Total Score (Average)
Old Diamond Road	-----	16	16	19	17.00
Middle Churches	10	-----	14	19	14.33
White Valley	5	7	-----	16	9.33
Carbon	3	3	8	-----	4.67

The score of 17.00 for Old Diamond Road indicates that when matched against the three other piles in the sample subset individually, Old Diamond Road is dominated, on average, on 17 of the 19 criterion. Similarly, Carbon's score of 4.67 indicates that it is dominated, on average, on between 4 and 5 of the 19 criterion. Thus, a lower score on the dominance measure implies a higher ranking. As with the equal weighting measure, the dominance measure yields exactly the same order ranking as the original ranking system in our sample subset.

[3] Recall that a pile is dominated by another on a given criterion if it receives a score that is less than *or equal to* the other pile. Put another way, a tie on any criterion goes *against* the pile under consideration. In this particular case, Middle Churches has a higher score than Old Diamond Road on 9 criteria, and the two piles have the same score on 7 criteria. We add these two numbers together to get a total of 16.

Table 6 lists the dominance scores and ranks for the 40 remaining piles. Like the equal weighting measure, the dominance measure produces an order ranking similar to, but not exactly the same as, the original ranking system. In particular, 13 of the top 15 piles from the original ranking system are also in the top 15 of the dominance. Only the two Sharon piles drop out of the top 15. Moreover, these piles are only one slot out of the top 15, as they are tied for 16th according to the dominance measure.

Table 6: "Dominance" Scores and Ranks

Original Rank	Name	Gob ID	Dominance Score	Dominance Rank
1	Carbon	65-029	9.44	7
2(t)	Bovard	65-021	8.91	1(t)
2(t)	Bovard	65-022	8.91	1(t)
2(t)	Yukon	65-088	9.53	8(t)
2(t)	Yukon	65-089	9.53	8(t)
2(t)	Yukon	65-090	9.53	8(t)
2(t)	Yukon	65-091	9.53	8(t)
8	Adamsburg	65-014	9.22	5
9(t)	Sharon	65-027	10.88	16(t)
9(t)	Sharon	65-028	10.88	16(t)
9(t)	Wendel	65-080	9.09	3
12	Carbon	65-031	9.91	12
13	Darragh	65-0??	9.13	4
14	Buckeye	65-087	9.34	6
15	Drive-in Theater	65-047	10.69	15
16	Adamsburg	65-015	11.94	24
17	Fitz Henry	65-084	10.06	13
18	Mount Joy	65-009	12.03	27
19	Seger	65-053	11.81	23
20	Bell Point West	65-035	14.03	40
21	Delmont Mine	65-083	10.38	14
22	Wilpen	65-098	13.28	37
23	Mount Joy	65-085	10.91	18
24	Claridge	65-074	12.34	30
25	Brenizer	65-034	13.53	39
26	Compost Area	65-046	11.63	22
27	Hitchinson	65-068	12.06	28
28	Slickville	65-026	12.34	29
29(t)	Herminie #2	65-032	11.31	20
29(t)	White Valley	65-042	13.19	36
29(t)	White Valley	65-043	12.53	31
32(t)	Newlonsburg South #1	65-055	12.00	25(t)
32(t)	Newlonsburg South #2	65-056	12.00	25(t)
34	Boyer Run	65-002	11.53	21
35	Carbon	65-030	11.22	19
36	Atlantic	65-076	13.44	38
37(t)	Upper Whyel	65-092	13.06	34(t)
37(t)	Upper Whyel	65-093	13.06	34(t)
39	Pine Run	65-052	12.63	32
40	Penn	65-045	12.75	33

Comparison of Alternative Measures to Original Ranking System

Table 7 summarizes the rankings of the 40 remaining piles according to the original ranking system and the two alternative measures.

Table 7: Summary of Ranking Measures

Name	Gob ID	Original Rank	Equal Weight Rank	Dominance Rank	Average Rank
Carbon	65-029	1	5	7	4.33
Bovard	65-021	2(t)	1(t)	1(t)	2.50
Bovard	65-022	2(t)	1(t)	1(t)	2.50
Yukon	65-088	2(t)	6(t)	8(t)	7.17
Yukon	65-089	2(t)	6(t)	8(t)	7.17
Yukon	65-090	2(t)	6(t)	8(t)	7.17
Yukon	65-091	2(t)	6(t)	8(t)	7.17
Adamsburg	65-014	8	4	5	5.67
Sharon	65-027	9(t)	14(t)	16(t)	13.83
Sharon	65-028	9(t)	14(t)	16(t)	13.83
Wendel	65-080	9(t)	3	3	5.33
Carbon	65-031	12	11	12	11.67
Darragh	65-0??	13	12	4	9.67
Buckeye	65-087	14	10	6	10.00
Drive-in Theater	65-047	15	21	15	17.00
Adamsburg	65-015	16	18	24	19.33
Fitz Henry	65-084	17	14(t)	13	15.00
Mount Joy	65-009	18	27	27	24.00
Seger	65-053	19	20	23	20.67
Bell Point West	65-035	20	35	40	31.67
Delmont Mine	65-083	21	13	14	16.00
Wilpen	65-098	22	34	37	31.00
Mount Joy	65-085	23	19	18	20.00
Claridge	65-074	24	22	30	25.33
Brenizer	65-034	25	31	39	31.67
Compost Area	65-046	26	32(t)	22	26.83
Hitchinson	65-068	27	23	28	26.00
Slickville	65-026	28	30	29	29.00
Herminie #2	65-032	29(t)	40	20	30.00
White Valley	65-042	29(t)	36	36	34.00
White Valley	65-043	29(t)	38	31	33.00
Newlonsburg South #1	65-055	32(t)	25(t)	25(t)	27.83
Newlonsburg South #2	65-056	32(t)	25(t)	25(t)	27.83
Boyer Run	65-002	34	24	21	26.33
Carbon	65-030	35	17	19	23.67
Atlantic	65-076	36	37	38	37.00
Upper Whyel	65-092	37(t)	28(t)	34(t)	33.50
Upper Whyel	65-093	37(t)	28(t)	34(t)	33.50
Pine Run	65-052	39	32(t)	32	34.50
Penn	65-045	40	39	33	37.33

In general, those piles that rank highly on the original scale also rank highly on the alternative measures. In particular, 12 of the top 15 piles from the original rankings also rank in the top 15 of both of the alternative measures. Furthermore, two of the three

exceptions missed the top 15 in the dominance rankings by only one place (the two Sharon piles tie for 16th in the dominance rankings).

The correlation between the original rankings and the alternative measures breaks down somewhat after the top 15. Only one of the five piles originally ranked between 16 and 20 in the original rankings also ranks in the top 20 of both alternative measures. The exception is the Fitz Henry pile, which ranks 13th and 14th in the equal weighting and dominance measures, respectively.

Conclusion

This report evaluates the extent to which the rankings developed by the Western Pennsylvania Coalition for Abandoned Mine Reclamation (WPCAMR) to rank mine refuse piles are sensitive to maximum point scales assigned to each of the 19 rating criteria. In order to conduct this evaluation, I developed two alternative "weight free" measures to rank the piles.

A comparison of the original rankings to the rankings resulting from the alternative measures suggests that the original ranking system is quite robust to changes in the maximum point scales, particularly with regard to the highly-ranked piles. In particular, the list of the top 15 piles is nearly identical regardless of which ranking measure is used.

Given the fact that the WPCAMR hopes to reclaim only about 15 piles at the present time, these results strongly support the use of the original ranking system as a means of prioritizing the mine refuse piles. My only qualification in this regard is a suggestion that the WPCAMR consider adding the Fitz Henry pile to the priority list of piles to be reclaimed. This site, which ranked 17th in the original ranking scored well in both of the alternative measures.

Appendix 1:
Sample Pile Scoresheet

Name: **Adamsburg** ID: **65-012**					
Socio-Economic	Max Points	Person 1	Person 2	Person 3	Mean
Social Impact and/or Interest	10	9	10	9	9.33
Political Interest and/or Activity	5	4	4	4	4.00
Population Density , ¼ Mile	10	9	8	8	8.33
Adjacent Land Use	5	4	5	3	4.00
Tourism Impact or Potential	5	3	1	3	2.33
Economic Impact on Community	5	5	5	4	4.67
Environmental					
Flora/Fauna	10	7	4	6	5.67
Water/Stream Impact/Proximity	25	0	7	5	4.00
Health & Safety					
Fire	5	0	0	0	0.00
Steep Slope	5	4	5	3	4.00
Illegal Dumping and other Crimes	5	3	0	3	2.00
ATVs / Motorcycles	10	7	8	7	7.33
Development & Removal Potential					
Legal Status	5	0	0	0	0.00
BTU/Sulfur	20	10	6	10	8.67
Topography	5	4	3	4	3.67
Available Space	5	5	0	5	3.33
Access	5	5	5	5	5.00
Bonus Points					
Natural Heritage Inventory, ¼ Mile	5	0	0	0	0.00
River Conservation Plan	5	0	0	0	0.00
Totals	150	79	71	79	76.33

Appendix 2:
Gob Pile Rankings

Rank	Name	Gob ID	Total Score
1	Carbon	65-029	115.3
2(t)	Bovard	65-021	113.0
2(t)	Bovard	65-022	113.0
2(t)	Yukon	65-088	113.0
2(t)	Yukon	65-089	113.0
2(t)	Yukon	65-090	113.0
2(t)	Yukon	65-091	113.0
8	Adamsburg	65-014	110.3
9(t)	Sharon	65-027	108.0
9(t)	Sharon	65-028	108.0
9(t)	Wendel	65-080	108.0
12	Carbon	65-031	107.7
13	Darragh	65-0??	106.7
14	Buckeye	65-087	103.7
15	Drive-in Theater	65-047	103.3
16	Adamsburg	65-015	102.7
17	Fitz Henry	65-084	102.3
18	Mount Joy	65-009	101.3
19	Seger	65-053	99.0
20	Bell Point West	65-035	97.0
21	Delmont Mine	65-083	94.3
22	Wilpen	65-098	93.3
23	Mount Joy	65-085	93.0
24	Claridge	65-074	92.3
25	Brenizer	65-034	92.0
26	Compost Area	65-046	91.3
27	Hitchinson	65-068	91.0
28	Slickville	65-026	89.3
29(t)	Herminie #2	65-032	89.0
29(t)	White Valley	65-042	89.0
29(t)	White Valley	65-043	89.0
32(t)	Newlonsburg South #1	65-055	87.7
32(t)	Newlonsburg South #2	65-056	87.7
34	Smithton East	65-072	87.3
35	Boyer Run	65-002	86.0
36	Carbon	65-030	85.7
37	Smithton	65-071	84.3
38	Atlantic	65-076	82.3
39(t)	Highland	65-025	81.0
39(t)	Upper Whyel	65-092	81.0
39(t)	Upper Whyel	65-093	81.0
42	Pine Run	65-052	79.7
43	Forbes Road	65-024	79.0
44(t)	Trauger	65-007	78.3
44(t)	Trauger	65-008	78.3
46	Penn	65-045	78.0
47	Adamsburg	65-012	76.3
48	Truxall	65-054	76.0

Rank	Name	Gob ID	Total Score
49(t)	McCullough	65-017	75.0
49(t)	McCullough	65-018	75.0
51	Fairbanks #2	65-077	74.7
52(t)	Bolivar	65-095	72.3
52(t)	Scab Hill	65-097	72.3
54(t)	Baggaley	65-041	72.0
54(t)	Elrico Park	65-057	72.0
56	Delmont Mine	65-103	71.0
57(t)	Adamsburg	65-013	70.7
57(t)	Fairbanks #1	65-060	70.7
59	Bolivar	65-096	69.3
60(t)	Motordrome West	65-067	68.7
60(t)	Export North	65-082	68.7
62(t)	Marguerite	65-062	67.7
62(t)	Marguerite	65-063	67.7
64(t)	United	65-005	67.3
64(t)	Whitney	65-036	67.3
66	Export	65-040	66.3
67	Elora East	65-070	66.0
68	Greenwald	65-050	65.3
69	Mushroom Farm	65-049	65.0
70	Getty Run	65-094	63.3
71	North Belle Vernon	65-069	62.0
72	Lauffer Mine	65-061	60.3
73	Buffalo Run	65-101	59.0
74	Southwest Northwest	65-104	58.3
75(t)	Keystone	65-102	57.3
75(t)	Export	65-039	57.3
77	School Street	65-073	56.7
78	Calumet Southeast	65-006	56.3
79	Peanut	65-051	50.7
80	Moween	65-079	50.0
81	Byers Run	65-019	49.3
82	Standard Shaft	65-011	46.7
83	Luxor	65-023	46.3
84	Arona West	65-016	45.7
85	Southwest Southeast	65-004	43.7
86	Donnelly	65-071	41.3
87	Pleasant Valley	65-020	40.7
88	Middle Churches	65-086	40.3
89(t)	Zane Avenue	65-048	39.7
89(t)	Snydertown	65-064	39.7
91	Crabtree	65-033	35.0
92	Bradenville	65-075	28.3
93	Superior	65-038	27.3
94	Morewood #4	65-065	27.0
95	Loyalhanna Dam	65-078	25.0
96	Atlantic West	65-059	24.0
97	Southwest	65-003	23.3
98	Edna #1 South	65-044	23.0
99	Brinkerton	65-001	16.3
100	Old Diamond Road	65-099	15.3
101	Jamison #20	65-037	14.3