**Outline Treatment Technologies**

1. Surface Mining Control and Reclamation Act of 1977 (SMCRA)
2. Primary federal law that regulates the environmental effects of [coal](http://en.wikipedia.org/wiki/Coal_mining) mining in the United States.
3. Taxes coal mining company and puts money into a fund which goes towards the reclamation of land negatively affected by abandoned mine drainage
4. Created two programs:
5. one for regulating active coal mines
6. second for reclaiming abandoned mine lands
7. Also created the Office of Surface Mining
8. Promulgate regulations
9. Fund state regulatory and reclamation efforts
10. To ensure consistency among state regulatory programs
11. Reclamation
12. Reclamation is the process of returning land, which has been adversely affected by past coal mining, as close to its original form as possible.
13. Sometimes this means simply regarding land to remove mine features.
14. It can also include removal of refuse piles, and revegetation of surface mines
15. While the main effort of land reclamation is to return the land to the condition it was in previously this often times removes or decrease drainages as well.

a. This is because as water flows more naturally over the ground with vegetation less water contacts the pyrite in the soil. This means less drainage is made.

b. This also decreases sedimentation as well as less soil erodes when the soil is vegetated.

1. Remining
2. Remining utilizes the coal which often times remains in historic coal mines.

a. Due to a lack of technologies often times coal remains in these historic mines

b. This coal allows the coal company to generate money as they mine the coal

1. As they mine the company adds alkalinity, and regrade the sites. This along with other precautions remove the source of pollution
2. This permanently removes this pollution
3. This also is done at no cost to government, and taxpayers
4. This also provides coal for use with out disturbing new areas.
5. Treatment Systems
6. Treatment Systems work by raising the abandoned mine water and dropping out the dissolved metals in the water.
7. Two types of treatment systems

1. Active

2. Passive

1. Active treatment systems

1. Active treatment utilizes the addition of basic chemicals to the water this include lime, soda ash, sodium hydroxide or any other basic chemical that will neutralize the acid in water.

2. The metals in the treated water precipitate and are allowed to settle out.

3. The resulting water is allowed the discharged into a stream where it can support life.

4. In some cases there is not enough room for a treatment system. In these cases the water is treated in the stream by adding alkaline material to the stream and the metals are allowed to settle in the stream.

a.This sacrifices life in that stream for the health of the receiving stream, in short nothing will live in that stream but the water chemistry of the receiving stream will be improved to support life.

5. Active treatment can range in the way it adds alkalinity to the stream

a. These can be small dosing systems that utilize the power of the flowing water the add the chemicals to the water.

i) Because the water drives the addition of the chemicals the dose of chemical is adapted as the flow increases or decreases.

ii) These systems are easy and the least expensive (~$50,000- $100,000) to install but need to monitored to be sure they are delivering the proper amount of chemicals

b. Large systems can also be built to treat large quantities of water.

i) They can treat large volumes of highly polluted water.

ii) They are very expensive to install (>$5 million) and are very expensive to run (>$100,000).

6. Advantages and disadvantages

a. Active treatment allows for adaptive treatment as flows or chemistry

change the operator of the system can change the amount of chemical added to the water.

b. Small dosing systems take up much less land than passive treatment systems and do not cost as much as passive treatment

c. The larger systems can treat large quantities of water but have large upfront costs

d. Both forms have high operation and maintenance costs as the chemicals are used up and need to be replaces. There are many moving parts and pumps associated with the water treatment and these can easily break

1. Passive Treatment Systems

1. Limestone raises the pH as the water flows over it, this allows the metals to precipitate and then settle with clean water flowing out of the ponds

2. Bacteria in spent mushroom soil remove the oxygen from the water and prevent metal scale from developing on the limestone

* 1. If scaling occurs it removes surface area and prevents the limestone from raising the pH

3. Plants further remove metals and clean the water, most of the time these plants are cattails which do a good job of removing metals as well as slowing down the treated water to allow further settling of the precipitated metals

4. Each system needs to be designed for the specific drainage and land that the system can be built on. This helps engineers design a system that will treat the water in all flow conditions in the area that is feasibly to place a system in. This means flat land with out other streams.

5. The systems can range from small wells which treat water that is low in pH but with out high metals to large systems that involve many ponds and many types of treatment including limestone ponds, wetlands, limestone channels and other treatment options. These include

a. Wetlands contain plants the remove metals and allow metals to settle to the bottom these are often time used as the last step before water discharge

b. Anoxic limestone drains are underground drains that add alkalinity and boost the pH with out oxygen being present. Without oxygen present the metals in the water can not scale the limestone. Requires a drainage that has low dissolved O2 and can be easily placed underground into the ALD. Usually is followed with a settling pond or wetland

c. Vertical flow ponds are ponds force water to enter the pond on the top, then the water is drawn by gravity through mushroom compost which removes oxygen, the water then moves through limestone to pipes on the bottom of the pond that allow the water to exit. Because the water travels vertically through the pond structure they are called vertical flow ponds. Usually is followed with a settling pond or wetland

d. Limestone ponds are simply ponds with limestone in them. These are best if the water has low metals that will not scale or foul the limestone, but with the proper flushing mechanism they can be used even with high metal content. These increase alkalinity and raises pH.

e. Open limestone channels are like a limestone pond but water flows through a channel that has limestone in it. These can be used at the channels that water runs between ponds with, and often time are constructed as overflow for a system in the event of a very high water event. In these cases water is diluted and the limestone channel and help to remove some pollution before it reaches the stream.

f. Diversion wells divert a small amount of stream water into a concrete well. It mixes the water with limestone to increase alkalinity and pH. These systems are best for water with low metal content so the limestone stays clean.

6. Each of the following types of treatment is rarely used alone and usually is followed by a settling pond that allows the water to sit for long periods of time to allow metals to settle out.

7. Advantages and disadvantages

a. Passive treatment requires less maintenance than active treatment. Generally every 5 years maintenance is needed.

b. Monitoring is also less for passive treatment, at most once a month. Active treatment should be monitored at least ever other week and many times once a week.

c. Passive treatment requires large areas of flat land to treat the water in ponds

d. Passive has a mid-level initial cost and low operation and maintenance costs as the materials are slowly used up and there are few to no moving parts.

1. Success Stories
2. Babb Creek
3. History
4. Babb Creek flows through north-central Pennsylvania and discharges into Pine Creek
5. The two streams converge where Pine Creek flows out of the Pine Creek Gorge.
6. Began with deep mining at the end of the Civil War.
7. Underground mining reached a peak in the early 1900s and was largely done by the mid 20th century.
8. Surface mining, while much more limited than underground mining, resurged in the 1970s and 80s. By 1990 active mining had ceased in the watershed, but AMD continued to degrade nearby water bodies.
9. Babb Creek was declared biologically dead by the early 1900s after a prolonged absence of aquatic life.
10. Iron and aluminum precipitate covered the streambed
11. Restoration
12. In 1990 concerned citizens formed the Babb Creek Watershed Association (BCWA)
13. 16 projects throughout the watershed, including:
14. installing successive alkalinity producing systems
15. a lime treatment plant,
16. regrading and re-vegetating land areas
17. removing coal refuse
18. adding settling basins
19. creating wetlands
20. injecting limestone slurry into an underground mine
21. installing a self-flushing limestone cell
22. Other facts about Babb Creak
23. Anna S. Passive Treatment System Constructed in 2004 and covers 20 acres
24. Largest passive treatment system in the world and treats the second largest source of AMD in the watershed.
25. <http://www.epa.gov/owow/NPS/success/state/pdf/pa_babb.pdf>  
    (Visit Website for Detailed Study)
26. <http://greenlifepenn.org/?p=350>  
    (Video on Babb Creek)
27. Other Accomplishments Since SMCRA in 1967
28. Restored approximately 50 miles of stream channel
29. Eliminated 176 dangerous water impoundments or hazardous water bodies
30. Completed 181 replacement water supply projects
31. Restored 17,633 acres of land
32. Eliminated in excess of 125 miles of dangerous highwalls
33. Sealed 921 portals and vertical openings
34. Extinguished mine fires beneath 815 acres of surface land
35. Reduced the subsidence risk to approximately 2,315 acres of land.
36. Constructed 5 active AMD treatment facilities that filter water and improve 65 miles of streams
37. In 2002 alone, constructed several passive treatment systems to restore an estimated 127 miles of streams