CONSTRUCTION OF A LIMESTONE LEACH BED AND PRELIMINARY WATER QUALITY RESULTS IN BEAVER CREEK

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Introduction

The Big Bear Lake Campground lies in the headwaters of Beaver Creek in Preston County, West Virginia. The watershed is impacted by pre-law mining in its lower stretches, but the headwaters are unaffected by mining. However, timber harvesting around the turn of the century removed almost all trees from the headwaters. Subsequent storm events caused erosion and loss of topsoil in much of the area and exposed the underlying sandstone bedrock. Slightly acid conditions are present in the surface runoff water of the area. So the streams in this area are characterized by low pH (from 4.0 to 5.5), low acidity (between 20 to 75 mg/L as $CaCO_3$), and no alkalinity. The 35-acre Big Bear Lake receives this acidic, unbuffered water containing no metals. The lake, which discharges into Beaver Creek, typically exhibits a pH of 5.5 and has an acidity concentration of 20 mg/L as $CaCO_3$. Beaver Creek flows into Little Sandy Creek, then into Big Sandy Creek, and finally into the Cheat River.

The West Virginia Division of Environmental Protection, Stream Restoration Group began sampling the Beaver Creek watershed in conjunction with its water quality inventory of the Lower Cheat River Sub-basin in 1996. Their data also confirms the slightly acidic nature of the headwaters of Beaver Creek. If a small amount of alkalinity could be added to the headwaters in the Big Bear Lake area, the possibility exists for Beaver Creek to support fish.

In order to add alkalinity to the headwaters, several methods were considered. The first was limestone sand addition. The WVDEP has had great success in raising the water quality in similar watersheds using limestone sand. The method involves adding limestone sand to the banks of a small stream and allowing the sand to gradually wash into the stream. Most of the limestone sand dissolves in the water and some of the undissolved limestone may become incorporated into the stream bed. This method requires periodic replenishing of the limestone sand as it is exhausted. Various passive systems were also considered.

Another method, developed under the Office of Surface Mining's Clean Streams Initiative, is the use of limestone leach beds. In this method, cells containing varying sizes of limestone are constructed, and water containing no metals is passed through them. The water slowly

dissolves the limestone and the effluent water generally contains an alkalinity concentration from 50 to 80 mg/L as $CaCO_3$. Other materials can generate higher alkalinities in water but they are usually more expensive to acquire. For this project, one large cell of limestone was designed to add alkalinity to the water entering Big Bear Lake. It was anticipated that a small alkaline leach bed, coupled with future work planned by the Abandoned Mine Land Reclamation Program of WVDEP further downstream, has the potential to restore a fishery in Beaver Creek.

Project Description

A limestone leach bed was designed to add alkalinity to the water entering the 35-acre Big Bear Lake. The amount of limestone to place in the leach bed was estimated by a spreadsheet developed by Paul Ziemkiewicz. The input variables and the resulting values are displayed in Table 1.

Table 1. Input variables and the expected results from the construction of a limestone leach bed near Big Bear Lake.

Input Variable	Leach bed	Units
Original Alkalinity	-20	ppm
Flow	120	gpm
Channel Cross Section	200	Sq. Ft.
Depth	4	Ft.
Width	50	Ft.
Length	200	Ft.
Void Ratio	50	%

Results	Leach bed	Units
Velocity	0.0033	Ft./Sec.
Residence Time	16.6	Hrs.
Final Alkalinity Conc.	54	PPM
Original Alkalinity Load	-18	Tons/Yr.
Final Alkalinity Load	48	Tons/Yr
Limestone Required	2200	Tons

A total of 48 tons of alkalinity are predicted to be released from the system per year. The initial design of the system was completed by the National Mine Land Reclamation Center at West Virginia University and a final detailed design of the structure was completed by Triad Engineering, Inc. of Morgantown, WV (Figure 1).

The land area contributing drainage to the alkaline leach bed covers approximately 835 acres. The water from this area is collected into a small lake, which is used as a swimming area for the Big Bear Lake Campground. The water exits this small lake through two culverts under a road. The current culverts on the site could only handle about 4% of a 100-year storm event. After conversations with the landowner, it was agreed to place larger culverts under the road to reduce the potential of flooding and to protect the leach bed from being washed out during a storm event. Triad Engineering designed additional culverts and the contractor installed these culverts underneath a redesigned and raised road bed to protect the leach bed from flooding. The additional culverts now handle greater than 15% of a 100-year storm event.

The limestone leach bed receives water from one 8-inch inlet pipe. This pipe was installed just below the elevation of the lowest culvert and receives water from the swimming lake. The inlet allows from 100 to 120 gpm into the leach bed. Any amount of water over what the 8-inch pipe can take will flow through culverts under the road into Beaver Creek.

An area of about 200 feet in length, 50 feet across and 4 feet deep was excavated near the stream and below the swimming lake. A synthetic liner was placed in the excavation to make sure water does not leak from the leach bed. Approximately one foot of limestone chips was first placed in the bottom of the limestone leach bed to increase surface area and reaction between limestone and water. Next, about three feet of large, 2- to 4-inch limestone rock was placed on top of the layer of limestone chips. A total of about 2,000 tons of limestone was placed in the leach bed.

In addition to the concerns with leaking and flooding, the site is frequented by campers, which may find the leach bed interesting. As mentioned, the leach bed is located just downstream from a small lake used for swimming by property owners and campers at Big Bear Lake Campground. A wooden split rail fence was built around the leach bed to restrict access to the limestone leach bed. Also, to prevent the 8-inch pipe inlet from being clogged, a gate system was devised so that Big Bear Lake Campground personnel could periodically clean the inlet from debris. The leach bed is also designed so that no water will extend above the limestone.

Initial Performance

Water samples were taken from five points to evaluate initial performance of the limestone leach bed. The first water sample was taken from the small swimming lake above the limestone leach bed. The second came from the inflow pipe and the third sample came from the outflow of the leach bed. The fourth water sample was taken between the limestone leach bed and Big Bear Lake, and the fifth sample was taken at the outflow of Big Bear Lake.

Prior to construction, Big Bear Lake exhibited a pH of 6.0 and an acidity of 20 mg/L as $CaCO_3$. The analysis of these water samples taken in January 1999, approximately two months after construction, and February 1999 are shown in Table 2.

At the January sampling date, the water quality of the swimming lake was much like we

expected: the pH was around 5.0 and acidity was 20 mg/L as $CaCO_3$. At the inlet to the leach bed, the water quality had improved slightly. At the outlet, the water pH was 7.2 and the water had gone from net acid to slightly alkaline (15 mg/L as $CaCO_3$). At the outlet of Big Bear Lake, the discharging water had a pH of 6.8 with low acidity and low alkalinity.

At the sampling time in February, much of the swimming lake, the leach bed and the sides of Big Bear Lake were frozen. According to our analysis, the limestone leach bed raised water pH from 4.5 to 5.8, but did not generate net alkaline water. The frozen conditions did not allow sufficient contact between the water and the limestone, and it is likely that the water short circuited through a channel in the middle of the leach bed allowing very little treatment. Cold temperatures also slowed limestone reaction and dissolution. By the time the water discharged from Big Bear Lake, water pH remained about the same as that coming from the leach bed, and some of the acidity had been neutralized. In this area of Preston County, February is normally a very cold and snowy period and sampling water at this time is an unpleasant experience.

Personnel at Big Bear Lake will continue to monitor the water quality at these five points in the Big Bear Lake area. In the spring of 1999, a depth profile of Big Bear Lake is planned. Parameters of interest include pH, acidity, alkalinity, conductivity, iron and aluminum at various depths in the lake. Water quality will also be monitored in Beaver Creek downstream of Big Bear Lake. Benthic sampling is planned for the fall of 1999 and in future years to monitor the health of Beaver Creek.

Acknowledgments

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Table 2. Water quality results in January and February 1999 (project completed in October 1998) from five sampling locations around the limestone leach bed constructed at the Big Bear Lake Campground.

Location	pH	Alkalinity	Acidity
		----------mg/L as $CaCO_3$----------	
January 1999 Data			
1. Swimming Lake	5.0	0	20
2. Inlet to Leach Bed	6.0	2	15
3. Outlet from Leach Bed	7.2	15	0

4. Midway between			
Leach Bed and Lake	7.0	9	6
5. Outlet at Big Bear Lake	6.8	6	7

<u>February 1999 Data</u>

1. Swimming Lake	4.3	0	41
2. Inlet to Leach Bed	4.5	0	46
3. Outlet from Leach Bed	5.8	5	35
4. Midway between			
Leach Bed and Lake	5.2	2	21
5. Outlet at Big Bear Lake	5.5	4	14

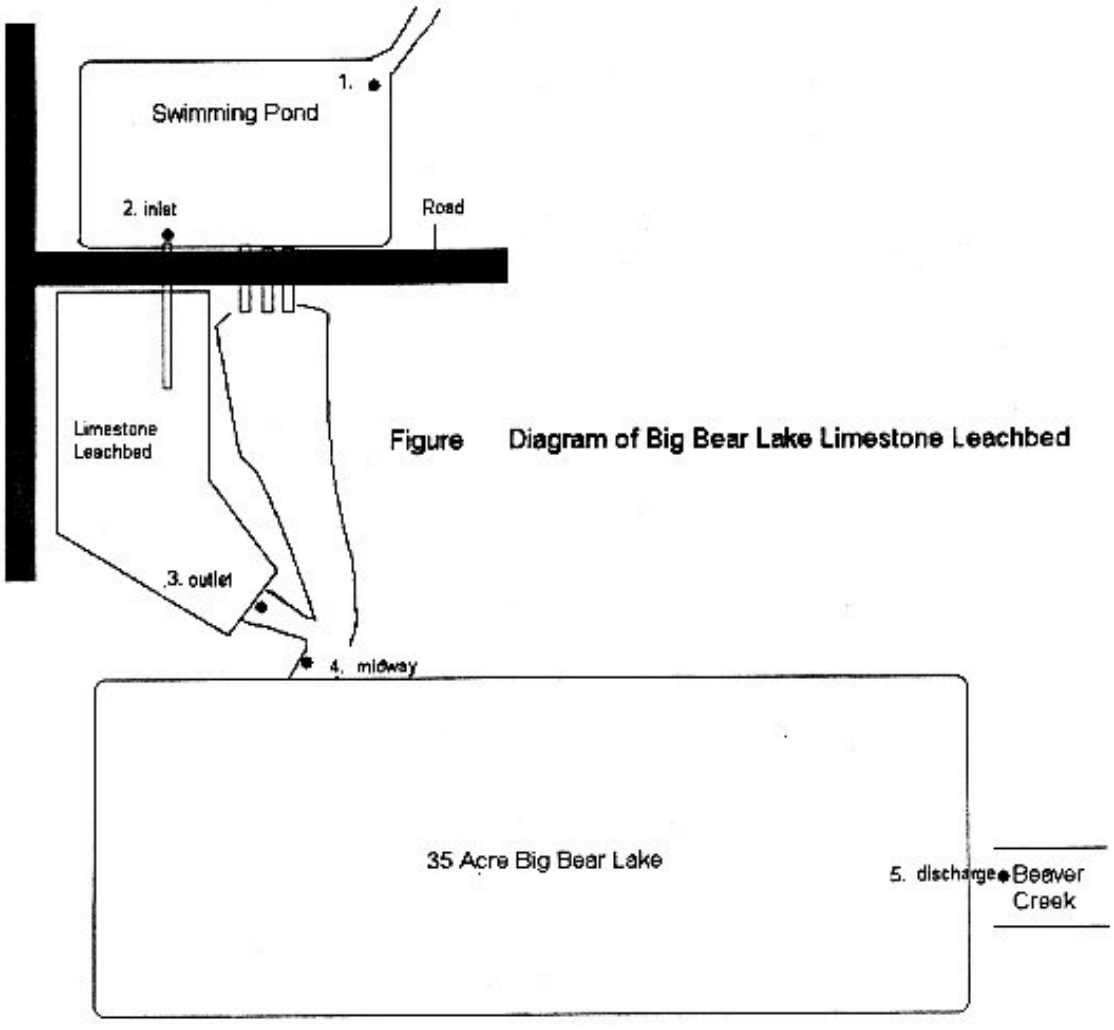

Figure Diagram of Big Bear Lake Limestone Leachbed