# *9/2007 UPDATE REPORT*

# Lausanne Tunnel Abandoned Mine Drainage Restoration Project

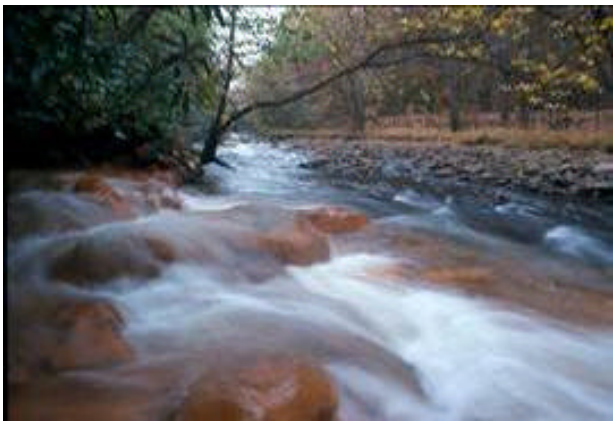
**Project Completed 2004**

**Funding Provided by:**

Pa. Department of Environmental Protection, Section 319
Federal Office of Surface Mining
Department of Conservation and Natural Resources, Rivers Conservation Program
Department of Conservation and Natural Resources, Bureau of State Parks
Eastern Pennsylvania Coalition for Abandoned Mine Reclamation

**Acknowledgements**

Wildlands Conservancy would like to thank the project partners, without the support of these organizations and individuals this project would not have been possible.



Carbon County Commissioners
Carbon County Conservation District
Carbon County Sportsmen Association
County of Carbon
C&S Railroad
Ducks Unlimited
Eastern Pennsylvania Coalition for Abandoned Mine Reclamation
Indiana University of Pennsylvania
Jim Thorpe River Adventures
Kovatch Corporation
Lehigh River Stocking Association
Pa Department of Environmental Protection
- Non-point Management Section
- Bureau of Abandoned Mine Reclamation
- Bureau of Mining and Reclamation

Pa. Department of Conservation & Natural Resources
- Hickory Run State Park
- Rivers Conservation Program
- Bureau of State Parks
- Weiser Forest District

Nesquehoning Borough
No. 1 Contracting Corporation
Parkland High School's "Lehigh River Watch" Educational Program
Pa. Representative Keith McCall
Pa. Senator Raphael Musto
Panther Creek Partners
Pocono Whitewater Adventures
U.S. Office of Surface Mining
U.S. Representative Paul Kanjorski

**Lausanne Tunnel Abandoned Mine Drainage Restoration Project**
Design & Construction: October 1999 – June 2004

**Executive Summary**

The Lausanne Tunnel Mine Restoration Project improves the quality of the Lehigh River, which has been negatively impacted by Abandoned Mine Drainage (AMD). The Lehigh River is impacted by AMD from portions of the Eastern Middle and Southern coalfields where there are numerous pits, culm banks, stripping areas and underground workings that are drained by six AMD tunnels and two mine overflows entering tributaries of the Lehigh River. **In 2007 – the third growing season, more than 48% of the total iron and 56% of the aluminum were removed from the Lausanne Tunnel Mine drainage, exceeding engineer's expectations.**

The Lausanne Tunnel watershed restoration project, located on Lehigh Gorge State Park property, Nesquehoning Borough, Carbon County, had been considered the most impacting mine discharge to the Lehigh River. The water flowing from the Tunnel contributes an average of 4,000 gallons per minute of mine drainage to the Nesquehoning Creek, a tributary to the Lehigh River. The Tunnel's mine drainage contains an average of 16,284 lbs/day of sulfates, 80 lbs/day of aluminum, 123 lbs/day of manganese, 194 lbs/day of iron and 123 lbs/day of ferrous iron.

In order to mitigate the impacts of mine drainage on the Lehigh River, this project used the existing amount of alkalinity contributed by the Lausanne Tunnel to facilitate the oxidation of the heavy metals contained within the discharge. The water is naturally aerated and it has been directed into a 1.5-acre manmade wetland complex, constructed at the Lausanne Tunnel outfall.

In order to complete this worthwhile project, Wildlands Conservancy assembled a broad-based partnership of more than 20 organizations. Over $524,200 was raised to complete the design and construction of the project with $240,000 from Section 319 of the Clean Water Act, $150,000 for the Federal Office of Surface Mining, $105,000 from the Department of Conservation and Natural Resources, Rivers Conservation Program, $25,000 from the Department of Conservation and Natural Resources, Bureau of State Parks and $4,200 from the Eastern Pennsylvania Coalition for Abandoned Mine Reclamation.

*Passive Wetland Treatment System: Lausanne Tunnel water flows through pipes (forefront) into Wetland A*

**Wetland Design**
The design of the passive treatment systems was impacted by many factors outside of the control of the project. Limited space was the largest site constraint which impacted the design. In addition, the presence of cultural resources further impacted the design. The final design that encompassed wetlands that covered a smaller area than anticipated featured two cells with an approximate 1 foot drop between the two cells. This design maximized the area for wetland treatment while protecting the cultural resources on the property.

**Evaluation of the Effectiveness of the Project**
Wildlands Conservancy, along with PA DEP Bureau of Abandoned Mine Reclamation, is conducting flow and water quality sampling at the Lausanne Tunnel, within the wetlands, and the Nesquehoning Creek, below the Lausanne Tunnel discharge. Water quality data has been gathered at Lausanne Tunnel since 1998. This information will provide comparative data for post-project analysis and help us gage the effectiveness of the passive wetland treatment so that we can make improvements to the design.

**Results**
The Lausanne Tunnel passive wetland treatment system has been in operation for three years and removes significant quantities of heavy metals from the discharge during average flow conditions. The constructed 1.5-acre wetland treatment system was originally designed to treat 4,000 gallons per minute of flow, with an average of 4.4 mg/l of iron, which would be the entire discharge from the Lausanne Tunnel during average flow conditions. Engineers anticipated an approximate reduction of 40% of the iron and aluminum loadings after the construction of the passive wetland treatment system.

Upon analysis of annual data gathered from 2004 to 2007, the removal of iron from the water continues to increase significantly. In 2007, more than 48% of the total iron concentration was removed compared to 2006 when 26% was removed from the Lausanne Tunnel discharge. In 2007, 56% of the aluminum concentration was removed compared to 29% in 2006. Sulfate, aluminum and iron removal rates have all improved since the treatment system was completed in 2004.

***Wetland A water flowing over hay bales into Wetland B.***

Using adaptive management to improve the treatment system and meet the target 40% removal rate, several initiatives were implemented. A dye tracer was used to study water flow through the system and hay bales were installed between Wetland A and Wetland B to retard water flow and allow for greater water retention time in 2006. The more slowly the water filters through the wetland, the greater the uptake of chemical parameters by the aquatic plants. After three growing seasons, the data documents a general increase in removal and this may be a result of the system and plants maturing, as well as some changes to the wetland design. Also, a better functioning wetland system over time is expected to further enhance the water quality.

Data gathered details the water discharging from Lausanne Tunnel (first monitoring point) then flowing through Wetland A, then through Wetland B (final monitoring point).

**LAUSANNE TUNNEL**

| Paramater | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Iron Total (ug/L) | 3250.00 | 3280 | 4808 | 4846 |
| Alkalinity (mg/L) | 91.00 | 110.4 | 112 | 103.8 |
| Sulfate Total (mg/L) | 285.30 | 390.4 | 562.8 | 383.1 |
| Aluminum (ug/L) | 900.00 | 500 | 773 | 1241 |
| pH (pH Units) | 6.50 | 6.7 | 6.6 | 6.9 |
| Total Susp. Solids (mg/L) | 2.00 | 6 | 10 | <2 |
| Manganese (ug/L) | 2010.00 | 2620 | 2601 | 2584 |
| HOT Acidity -(mg/L) | 85.20 | 69 | 94 | -13.8 |

**WETLAND A**

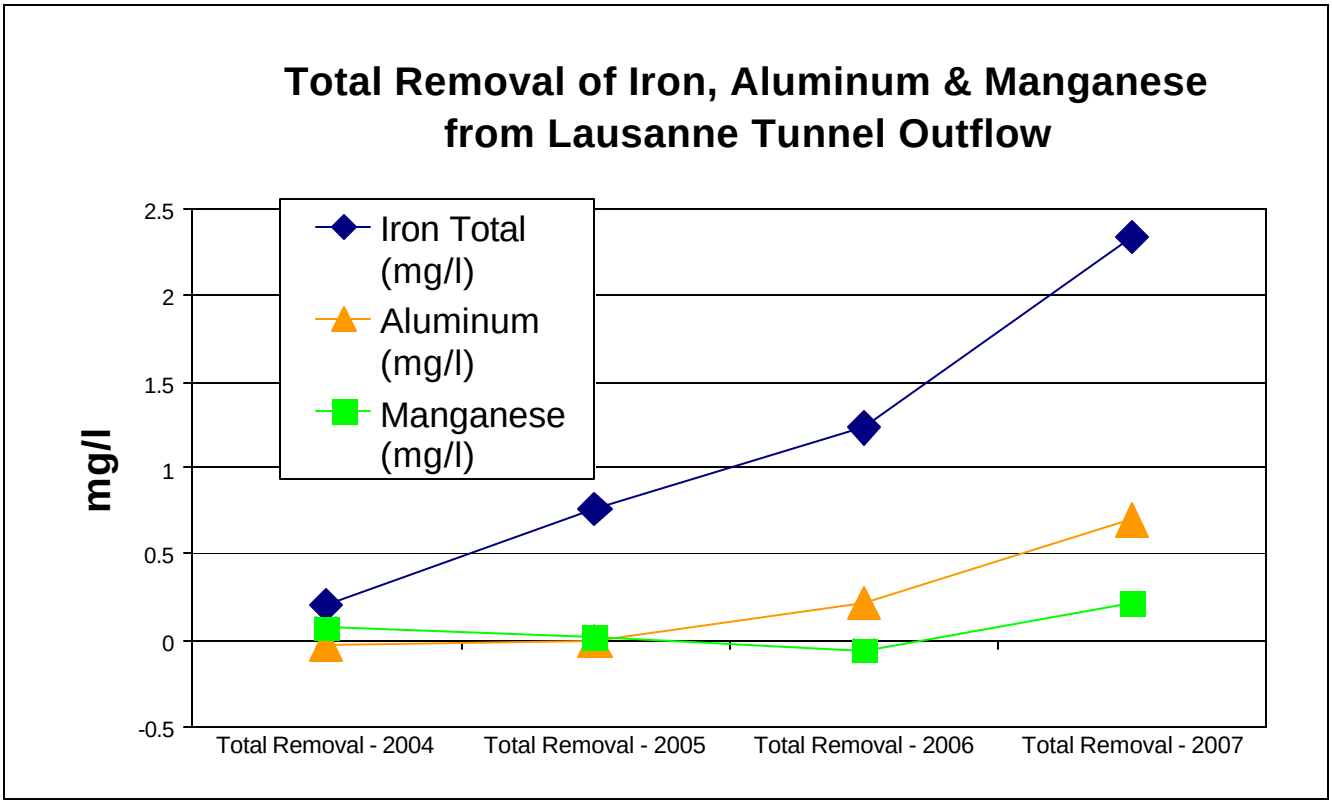
| Paramater | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Iron Total (ug/L) | 3180 | 3080 | 3781 | 3388 |
| Alkalinity (mg/L) | 91 | 107 | 113.2 | 100.6 |
| Sulfate Total (mg/L) | 287.1 | 374.7 | 506.1 | 377.7 |
| Aluminum (ug/L) | 870 | 500 | 517 | 844 |
| pH (pH Units) | 6.8 | 6.9 | 7 | 7 |
| Total Susp. Solids (mg/L) | 40 | 8 | 2 | <2 |
| Manganese (ug/L) | 2010 | 2660 | 2602 | 2429 |
| HOT Acidity -(mg/L) | 83.2 | 73.2 | 89.8 | -11.6 |

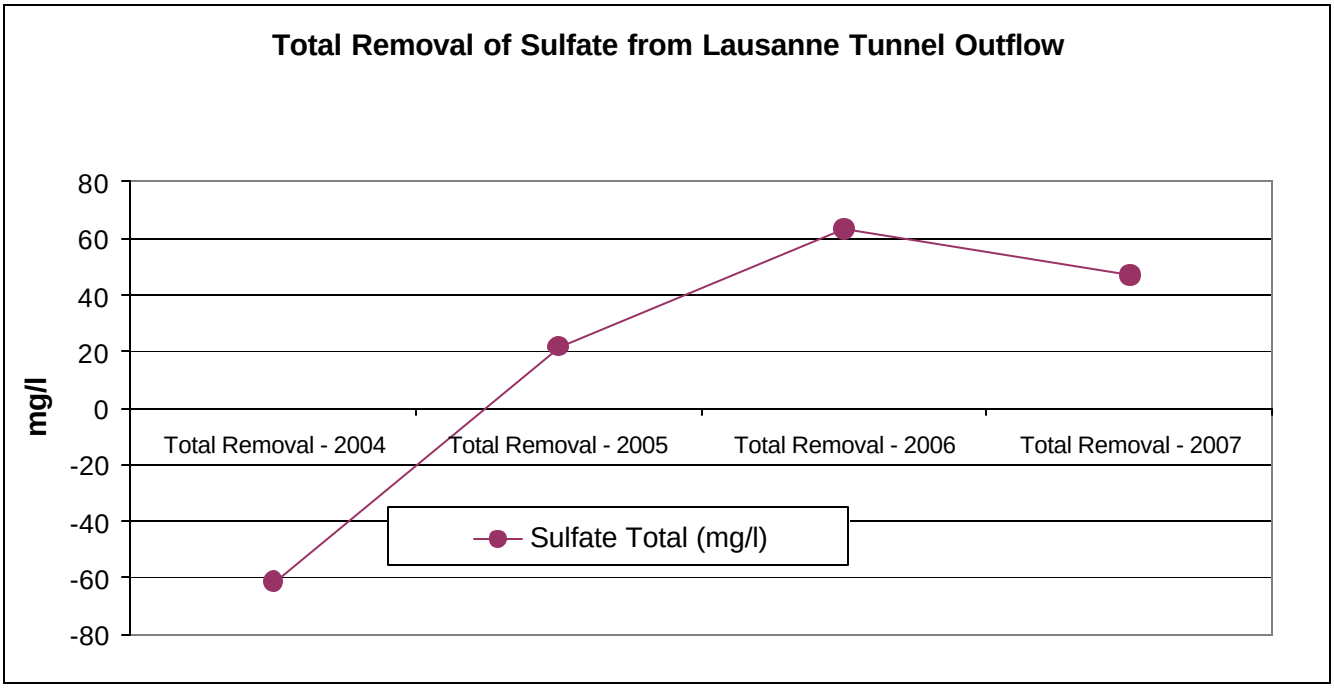
**WETLAND B**

| Paramater | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Iron Total (ug/L) | 3050 | 2520 | 3574 | 2505 |
| Alkalinity (mg/L) | 91.6 | 105.4 | 111.8 | 100.8 |
| Sulfate Total (mg/L) | 346.8 | 369 | 499.6 | 336.4 |
| Aluminum (ug/L) | 880 | 500 | 552 | 546 |
| pH (pH Units) | 6.8 | 7 | 7.2 | 7.2 |
| Total Susp. Solids (mg/L) | 4 | 12 | 4 | 2 |
| Manganese (ug/L) | 1940 | 2600 | 2656 | 2360 |
| HOT Acidity -(mg/L) | 84.6 | 74.6 | 74.6 | -12.6 |

**TOTAL DIFFERENCE OUTFLOW AT TUNNEL WITH WETLAND B**

| Paramater | 2004 | 2005 | 2006 | 2007 |
|---|---|---|---|---|
| Iron Total (ug/L) | -200 | -760 | -1234 | -2341 |
| Alkalinity (mg/L) | 0.6 | -5 | -0.2 | -3 |
| Sulfate Total (mg/L) | 61.5 | -21.4 | -63.2 | -46.7 |
| Aluminum (ug/L) | -20 | 0 | -221 | -695 |
| pH (pH Units) | 0.3 | 0.3 | 0.6 | 0.3 |
| Total Susp. Solids (mg/L) | 2 | 6 | -6 | NA |
| Manganese (ug/L) | -70 | -20 | 55 | -224 |
| HOT Acidity -(mg/L) | -0.6 | 5.6 | -19.4 | 1.2 |


Total Removal of Iron, Aluminum & Manganese from Lausanne Tunnel Outflow
mg/l
2.5
2
1.5
1
0.5
0
-0.5
Iron Total (mg/l)
Aluminum (mg/l)
Manganese (mg/l)
Total Removal - 2004
Total Removal - 2005
Total Removal - 2006
Total Removal - 2007


Total Removal of Sulfate from Lausanne Tunnel Outflow
mg/l
80
60
40
20
0
-20
-40
-60
-80
Total Removal - 2004
Total Removal - 2005
Total Removal - 2006
Total Removal - 2007
Sulfate Total (mg/l)

Water quality data was sampled monthly from February to December 1998, before the project began, and reflected great seasonal variability in flow that in turn affected the concentration levels of the parameters (see last page). In 1998, the concentration of iron was greatest in September when the least amount of flow was recorded. Therefore, the interpretation of subsequent annual monitoring data should take into account natural seasonal and annual variability before drawing firm conclusions. Since the construction of the passive wetland treatment system was completed, monitoring has occurred in October 2004, September 2005, October 2006 and August 2007.

*Wetland Overflow Leaving A and Flowing into Wetland B*

**Conclusion**

The Lausanne Tunnel Mine Restoration Project is significantly improving the quality of the Lehigh River by mitigating the impact of the worst abandoned mine discharge in the Lehigh River watershed. As the system naturally matures, Wildlands Conservancy anticipates that the wetland will increase its capacity to remove more iron, aluminum and sulfates. Our systematic approach to improve the effectiveness of the passive wetland treatment system and annual monitoring will be helpful not only to enhance the Lausanne Tunnel water quality, but also future abandoned mine discharge treatment projects constructed in Pennsylvania. With focused effort, the water quality from the Lausanne Tunnel abandoned mine discharge will continue to improve, benefiting the Lehigh River watershed and its residents.