Restoration of Little Hefren Run
Cook Forest State Park
Final Report

September 28, 2001

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This system was designed and constructed using funds provided to the PA Bureau of Watershed Conservation by the EPA Nonpoint Source 319 Program.

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I. Introduction

This is the final project report for the Little Hefren Passive Mine Drainage Treatment System. The project is located in Cook Forest State Park in Clarion County, PA (Figure 1). Little Hefren Run is a tributary of Toms Run, which runs through Cook Forest State Park and joins with the Clarion River in Cooksburg. Toms Run and most of its lower tributaries are exceptional value cold-water fisheries that support both native and stocked trout populations. The principal exception is Little Hefren Run which, because of mine drainage pollution, was excluded in 1995 from the DEP's exceptional value designation.

The Toms Run watershed has been historically affected by timbering operations, oil and gas operations, and surface mining. In the 1800's most of the watershed was logged. In the 1900's dozens of gas and oil wells were drilled in the lower watershed. While some of the wells continue to be managed for gas production, most were abandoned decades ago. Underground and surface mining for lower Clarion coals occurred in the upper watershed in the early and middle 1900's. The lower portion of watershed is below the coal-bearing units and has no coal mines.

The first recorded complaint about the pollution of Toms Run was made in 1949. A subsequent investigation identified the problem as acid mine drainage from five abandoned coal mines in the stream's headwaters. Reclamation efforts did not correct the problem, and complaints continued to be filed. In 1965 and 1966 additional mine reclamation occurred, but water quality improvements were not observed. A study in 1970 by Meritt and Emrich (Bureau of Sanitary Engineering, PA Department of Health) identified abandoned oil/gas wells as the principal problem. AMD produced in the headwater mines was apparently draining into the underlying sandstone aquifer and discharging through abandoned wells in the lower watershed. As a result of this investigation, the surface mines were further reclaimed, deep mines were sealed and injected with lime slurry, and most of the abandoned wells were plugged in 1975. The efforts were effective. Water quality improved substantially and in 1979 the PA Fish and Boat Commission began stocking Toms Run with trout.

In 1995 the DEP Bureau of Water Quality Management assessed the quality of Toms Run and its tributaries. The study was prompted by the PA Fish and Boat Commission's interest in including Toms Run and its tributaries in the Special Protection Waters Program. The DEP investigation found that Toms Run and its tributaries carry poorly buffered water that are, nonetheless, of good quality. The single exception noted by the DEP was Little Hefren Run which was affected by acid mine drainage and discharged acidic, metal-contaminated water to Toms Run. The source of AMD to Little Hefren was not sealed by earlier operations because the contractors could not locate a well, suggesting that the discharge was a spring.

In 1998 Hedin Environmental investigated Little Hefren and developed a remediation proposal that was submitted to the Bureau of Watershed Management Section 319 Program. The project was funded and a treatment system was constructed in the autumn of 2000. This report describes that system and the results of monitoring efforts.

II. Project History

This project has taken three years to complete. Table 1 shows the project timeline.

Table 1: Project Timeline

Date	Milestone
March 1998	Original Proposal Submitted
December 1998	Funding Provided for Project ($128,932)
January 1999	Project Design Begins
April 1999	Site Mapping Completed
July/August 1999	Project Permit Applications Submitted
July 1999	Notification from PHMC of Archeological Delay
September 1999	Restoration Waiver granted by DEP
September 1999 – May 2000	Phase I Archeological Assessment by DCNR
July 2000	Approval from PHMC to Proceed
September 2000	One year No-cost Time Extension Granted by DEP
September 2000 – November 2000	System Construction
November 2000 – September 2001	Performance Evaluation
June 2001	Request for System Additions Submitted
August 2001	Funding for System Additions Approved ($4,227)
September 2001	System Additions Completed
September 2001	Final Report and Invoices Completed

The project was delayed one year by a Phase I archeological investigation required by the Pennsylvania Historical and Museum Society (PHMC). Because of the delay, a no-cost time extension was requested and granted. The system was constructed in autumn 2000. In the summer of 2001, additional funds for several system enhancements were requested and received from DEP. The enhancements were installed in September 2001. The project is completed.

III. System Construction

The purpose of this section is to describe the treatment system elements and to discuss the construction sequence, changes from the original design, and special on-site conditions that were discovered during construction. A copy of as-built plans is attached. A simplified cross section is shown in Figure 2.

A. System Description

The Little Hefren Passive Treatment System consists of the following units.

- **Discharge Collection System** – The discharge was collected into a 10-inch plastic pipe that carries the water to the ALD. The collection was done in an anoxic manner to assure that the water is not oxygenated before entering the limestone bed.

- **Anoxic Limestone Drain (ALD)** – The ALD is 5 feet deep by 12 feet wide by 165 feet long. The ALD contains 500 tons of Vanport limestone, most of which is PennDOT #1 aggregate.
- **Conveyance Pipe** – A 550 ft long SDR35 10-inch drainpipe carries water from the ALD to the sedimentation pond. The pipe is buried and slopes downward to an elbow, which turns towards the surface and discharges to the pond influent ditch.
- **Sedimentation Pond** – The sedimentation pond has a surface area of 4,000 square feet and has a maximum depth of 4.5 feet. The pond's capacity is approximately 100,000 gallons.
- **Polishing Wetland** – The polishing wetland has a surface area of 10,200 square feet. The discharge of the wetland flows directly into Little Hefren Run.

B. Construction Sequence

System construction began in September 2001. Nick Construction of Lucinda, PA was chosen to construct the system. Access to the site was obtained by installing a road from Toms Run Road to Toms Run, where a crossing was constructed. The crossing was made with large limestone aggregate and smaller aggregate at the crossing surface. The base flow of Toms Run flows through three large culvert pipes (two 24 inch and one 18 inch diameter) placed at the bottom of the crossing and on the stream bottom. Under high flow conditions, water can flow over the crossing. Toms Run overtopped the crossing once in the spring of 2001. No substantial damage occurred.

As soon as access to the site was gained, the affected area was cleared. Small trees and tops were windrowed to the north of the construction area. A bench was constructed from the principle construction area (pond and wetland) upstream to the AMD discharge. The bench was wide enough to allow passage of excavation equipment and trucks carrying supplies necessary to construct the collection system and ALD.

The discharge was collected underground so that the water could be delivered to the ALD in an anoxic condition. The discharge site was excavated to form a pit. The pit was filled with large inert rock and drainage pipe was installed that collected the water and carried it outside of the seepage zone. The collection system was covered with geotextile fabric and buried under 2-3 feet of clay. A sampling port was installed on the pipe to allow for sampling of the untreated water (See Figure 2).

In the original design, the water was to be collected and piped 800 feet to a flat area where the ALD, pond and wetland were to be constructed. The design was revised during construction when it became apparent that the ALD could be constructed near the AMD source. This modification alleviated concerns about the oxygenation of the mine water between its collection and treatment with the ALD. The modified design placed the ALD near the collection system. The ALD discharge was then piped 550 feet to the sedimentation pond. The ALD modification presented several construction problems. The area where the ALD was constructed contained fractured sandstone bedrock that was unlikely to hold water. To assure that the ALD did not leak, the limestone bed was enclosed with a plastic liner obtained from a local landfill. As a further precaution against leakage, six inches of sand, geotextile webbing, and a Claymax®

bentonite liner were placed beneath the plastic liner. To protect the sides of the from sharp sandstone rocks, plywood sheets were placed between the liner and the sandstone sides.

Water exits the ALD and flows to the sedimentation pond in a buried 8-inch diameter pipe. The pipe is intentionally trapped on both ends by inundated conditions (see Figure 2). The unflooded portion of the pipe was found to be prone to the buildup of gases that, if unrelieved, would form a gas lock condition and prevent water from discharging down the pipe. This problem was initially corrected by installing a flexible hose in the discharge pipe that allowed gas to escape. In September 2001, a permanent relief valve was installed on the pipe.

The sedimentation pond receives flow from a 50-foot long rock-lined ditch that carries the discharge of the ALD conveyance pipe. Water discharges from the surface of the pond through a short pipe that extends through the embankment and discharges down a steep rock-lined spillway to the polishing wetland. In September 2001, an emergency spillway was added to the pond.

The wetland has water depths that range from 2 – 6 inches. The wetland was constructed from the site's original A horizon soil. The wetland was planted in the autumn of 2000 with cattail root stock obtained from a nursery. Plant establishment was poor, partly because of herbivory by geese, ducks, and deer. In the summer of 2001, the wetland was replanted with cattails dug from a constructed wetland site in Jefferson County. Many of the plants have become established. Several other plant species including arrowroot and rushes have also appeared in the wetland.

After completion of the system in November 2000, concerns were raised about the ability of the wetland berms to withstand an overflow event by Little Hefren. In September 2001, the berms of the wetland are raised one foot and reinforced with limestone rip rap.

IV. System Performance and Results

This section presents both the performance of the system and the effects the system has demonstrated on Toms Run and Little Hefren Run. These results are for the first year of system operation only. Continued monitoring should be performed in order to further demonstrate chemical and biological improvements. Eventually, reclassification of Little Hefren Run may be merited.

Clarion University of Pennsylvania and Hedin Environmental collected the data presented here. Clarion University of Pennsylvania (CUP) acted as a subcontractor to Hedin Environmental. All of the biological data and much of the water chemistry data were collected by Jason Jones, a graduate student at CUP. The data are incorporated into Jason's master's thesis, which is not completed at this date. Both CUP and HE collected flow rate and chemistry data. Field measurements were made for pH, temperature, and alkalinity. Laboratory analyses of Fe, Mn, Al, SO_4, acidity, conductivity, and dissolved solids were done by Stewart Laboratories (Strattonville, PA).

A. System Chemistry

The purpose of the passive treatment system is to raise the alkalinity and precipitate iron so that high levels of acidity and metals do not reach Little Hefren Run or Toms Run. A summary of system's performance is shown below.

Table 2. Average performance of the passive treatment system.

	Period	pH	Alk	Acid	Fe	Mn	Al	SO_4
Seep	Jan'98 – Sep'00	5.9	38	108	76	5	<1	352
ALD	Nov'00 – Sep'01	6.6	150	-17	69	5	<1	331
Pond	Nov'00 – Sep'01	6.6	72	-10	29	5	<1	323
Wetland	Nov'00 – Sep'01	6.2	33	-18	3	5	<1	293

alkalinity and acidity are mg/L as $CaCO_3$; Fe, Mn, Al and SO_4 are mg/L

The system is functioning as designed. The acidic Fe-contaminated water has been replaced with net alkaline water with low Fe concentrations. The latest round of samples show a final wetland discharge with <1 mg/L Fe (see Table 4). The system has negligible affect on Mn. (It was not designed to remove Mn.) The ALD was expected to discharge water with ~180 mg/L alkalinity. The ALD has stabilized during the last six months at ~140 mg/L alkalinity. We cannot explain the lower-than-expected alkalinity generation. Even at these lower alkalinity generation levels, the system continues to discharge net alkaline water.

Figure 3 shows the performance of the system on September 9, 2001. The ALD generates alkalinity that is consumed by the oxidation and hydrolysis of iron in the pond and wetland. Virtually all of the iron is retained in the system. pH rises moderately with flow through the system. The final discharge has circumneutral pH, no Fe, and a small amount of residual alkalinity.

B. Stream Recovery

Three stations in Little Hefren Run were monitoring regularly before and after the treatment system was constructed. Little Hefren was sampled upstream of the seep. Data at this station, LHMM1, represent background conditions. Little Hefren was sampled at a downstream point above the treatment system influent. The stream at this station, LHMM2, benefits from the removal of AMD from Little Hefren. Little Hefren was sampled below the treatment system inflow. The stream at his station, LHMM3, benefits from the inflow of treated water.

Summary data for the stations, before and after the system was installed in the autumn of 2000, are shown in Table 3. Little Hefren above the discharge was a poorly buffered acidic stream both pre- and post system construction. Acidity varied, generally, with flow. Higher alkalinity values occurred under higher flow conditions. A portion of the pre-system monitoring period was very dry, so the average condition was more acidic than the post-system period, which had normal flow conditions.

Table 3. Pre- and Post-system chemical data for stations in Little Hefren Run.

	pH		**Alk**		**Acid**		**Fe**		**SO_4**	
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**	**Pre**	**Post**
Above Seep	5.1	5.0	11	24	10	8	0.3	0.1	25	18
Above Treatment	4.4	4.8	7	18	24	9	4.5	0.4	65	22
Below Treatment	4.4	5.5	6	25	22	9	2.5	1.0	61	50

alkalinity and acidity are mg/L as $CaCO_3$; Fe and SO_4 are mg/L

The "Above Treatment" station shows the effects of removing the discharge from Little Hefren. The stream chemistry is somewhat improved. The post-system Little Hefren has higher pH and alkalinity, and lower acidity and Fe. A comparison of the Post-system Above Seep and Post-system Above Treatment shows a slight degradation of water quality. This comparison evaluates the chemistry of the unpolluted stream as it flows down the formerly-polluted stream channel. This slight degradation is likely attributable to the very slow dissolution of acidic iron compounds that accumulated on the stream bottom during the decades that stream was polluted with acid mine drainage. Because the upstream waters are so poorly buffered, this remediation process is very slow and may take many years before the stream bottom is naturally restored.

Below the inflow of the treatment system, Little Hefren has pH 5-6, low metals and a net alkaline condition. This is a substantial improvement over pre-project conditions, when the stream had pH 3-5 and was net acidic.

The chemical effects of the AMD discharge on Little Hefren and Toms Run were most significant during low flow periods. Samples of Little Hefren and Toms Run were collected in September 1999 and September 2001 during low-flow periods. The data are shown in Table 4. Based on changes in sulfate concentrations in Toms Run, it appears that Little Hefren's flow was ~45% of the flow of Toms Run (upstream) in 1999, and ~43% of the flow of Toms Run in 2001. In September 1999 (pre-system), the Little Hefren inflow to Toms Run had very low pH and contained excessive concentrations of acidity and Fe. Little Hefren's acidity loading in September 1999 was enough to consume Toms Run limited buffering capacity and cause low pH, acidic conditions in Toms Run downstream. In September 2001 (post-system), Little Hefren discharged circumneutral water with low metal concentrations. Downstream of the inflow of Little Hefren, Toms Run maintained its circumneutral, poorly buffered condition.

Table 4. Water sampling results during low flow in 1999 (pre-system) and 2001 (post-system).

	Date	pH	Alk	Acid	Fe	Mn	Al	SO4
LH above	9/24/99	4.4	0	15	0.1	1.1	0.5	59
Discharge to LH	9/24/99	5.9	32	101	88.0	5	0.1	337
LH mouth	9/24/99	3.1	0	53	4.3	4.4	0.7	218
Toms Run up	9/24/99	5.8	<1	11	0.4	2.8	0.4	50
Toms Run down	9/24/99	3.7	0	22	0.9	2.4	0.4	102
LH above	9/7/01	4.8	0	13	0.3	0.7	0.3	34
Discharge to LH*	9/7/01	6.5	19	2	0.8	3.3	0.1	314
LH mouth	9/7/01	6.0	5	21	0.6	1.7	0.7	147
Toms Run up	9/7/01	7.2	6	2	0.3	0.8	0.2	40
Toms Run down	9/7/01	5.7	4	2	0.3	0.9	0.1	72

alkalinity and acidity are mg/L as $CaCO_3$; Fe, Mn, Al and SO_4 are mg/L
** Discharge from treatment system to Little Hefren*

C. Biological Results

Biological monitoring included stream invertebrates and fish. At this time, Hedin Environmental has not received final analysis of the data. Robert Hedin has summarized the invertebrate data. The fish data are still undergoing analysis by CUP and are not presented. For more information on the biological study, the reader is advised to contact the Clarion University library about the availability of a copy of Jason Jones' masters thesis.

Stream invertebrates were sampled in Little Hefren and Toms Run eight times before construction of the treatment system and four times after construction. Pre-system data were collected between April 1999 and July 2000. The pre-system period was affected by a drought during the spring and summer of 1999. The post-system data were collected between November 2000 and May 2001.

Summary results of the benthic sampling are shown in Tables 5, 6, 7, 8, and 9. Table 5 shows the benthic community in Little Hefren upstream of the inflow of AMD. Despite its acidic condition, the stream supports an abundant rich benthic community. The 1999 drought caused a decline in abundance and richness. Recovery occurred in 2000. Post-system data (2001) are similar to pre-system non-drought data.

Table 6 shows the benthic community in Little Hefren downstream of the original AMD inflow and upstream of the current inflow of the treatment system. Changes in this station should be affected by the removal of AMD. Benthos abundance and diversity were similar pre-system and post-system. Recall from the chemistry data (Table 3) that removal of the discharge from this stretch of Little Hefren improved the chemistry, but the stream was still acidic with low pH. The largest number of individuals and EPT were observed at this station on the last sampling date, May 2001.

Table 5. Insects (individuals/m²) collected in Little Hefren above the AMD discharge
(LHMM1)

	Apr-99	Jun-99	Sep-99	Nov-99	Jan-00	Mar-00	May-00	Jul-00	Nov-00	Jan-01	Mar-01	May-01
Trichoptera	23	3	2	21	4	32	8	3	84	23	167	34
Plecoptera	202	1	11	6	27	383	322	85	561	314	167	373
Ephemeroptera	0	0	1	0	3	0	0	1	0	0	0	5
Diptera	28	6	82	31	38	91	33	16	33	24	19	108
Odonata	0	0	0	0	0	0	0	2	0	0	0	0
Coleoptera	2	0	3	2	0	2	0	0	0	0	0	0
Megaloptera	0	0	6	2	0	0	0	0	0	0	0	0
Total insects	255	10	105	62	72	508	363	107	678	361	353	520
EPT	225	4	14	27	34	415	330	89	645	337	334	412
# genera	16	7	13	12	12	16	11	15	19	17	15	22

The dark vertical line indicates system construction (September-October 2000).

Table 6. Insects (individuals/m²) collected in Little Hefren above treatment
(pre-system affected by AMD, post-system, no drainage) (LHMM2)

	Apr-99	Jun-99	Sep-99	Nov-99	Jan-00	Mar-00	May-00	Jul-00	Nov-00	Jan-01	Mar-01	May-01
Trichoptera	8	2	0	2	0	3	0	1	1	18	5	6
Plecoptera	26	7	0	1	1	14	33	2	2	20	27	95
Ephemeroptera	0	0	0	0	0	0	0	0	0	2	0	0
Diptera	35	3	0	0	0	13	1	0	0	4	11	74
Odonata	0	0	0	0	0	0	0	0	0	0	0	0
Coleoptera	0	0	0	1	0	0	1	0	0	0	0	0
Megaloptera	3	4	17	11	11	1	0	3	0	0	0	1
Total insects	72	16	17	15	12	31	35	6	3	44	43	176
EPT	34	9	0	3	1	17	33	3	3	40	32	101
# genera	9	5	1	4	2	11	4	4	2	7	9	10

The dark vertical line indicates system construction (September-October 2000).

Table 7. Insects (individuals/m²) collected in Little Hefren below inflow of treatment system (LHMM3)

	Apr-99	Jun-99	Sep-99	Nov-99	Mar-00	May-00	Jul-00	Nov-00	Mar-01	May-01
Trichoptera	0	0	0	5	0	0	1	3	1	1
Plecoptera	1	2	0	1	1	0	3	8	64	69
Ephemeroptera	0	0	0	0	0	0	0	0	0	0
Diptera	1	1	2	1	7	0	3	14	15	92
Odonata	0	0	0	0	0	0	0	0	0	0
Coleoptera	0	0	10	0	0	0	0	0	0	0
Megaloptera	0	4	27	0	0	0	0	1	0	1
Total insects	2	7	39	7	8	0	7	26	80	163
EPT	1	2	0	6	1	0	4	11	65	70
# genera	2	3	4	3	3	0	4	9	10	9

The dark vertical line indicates system construction (September-October 2000).

Table 8. Insects (individuals/m²) collected in Toms Run upstream of Little Hefren (LHMM4)

	Apr-99	Jun-99	Sep-99	Nov-99	Jan-00	Mar-00	May-00	Jul-00	Nov-00	Jan-01	Mar-01	May-01
Trichoptera	0	1	0	3	2	1	1	6	0	3	15	11
Plecoptera	8	12	2	27	21	9	29	111	2	21	70	15
Ephemeroptera	3	5	2	1	1	2	0	6	2	11	18	19
Diptera	17	8	20	23	96	22	22	13	18	16	77	87
Odonata	0	7	0	0	0	1	0	0	0	0	0	0
Coleoptera	1	11	4	6	1	3	2	2	0	0	0	0
Megaloptera	1	0	0	0	0	0	0	1	0	0	0	0
Total insects	30	44	28	60	121	38	54	139	22	51	180	132
EPT	11	18	4	31	24	12	30	123	4	35	103	45
# genera	14	9	11	16	11	15	11	15	9	17	22	15

The dark vertical line indicates system construction (September-October 2000).

Table 9. Insects (individuals/m^2) collected in Toms Run downstream of Little Hefren inflow (LHMM5)

	Apr-99	Jun-99	Sep-99	Nov-99	Jan-00	Mar-00	May-00	Jul-00	Nov-00	Jan-01	Mar-01	May-01
Trichoptera	7	6	3	3	3	3	1	0	21	2	8	2
Plecoptera	24	9	1	22	9	39	28	68	41	16	9	28
Ephemeroptera	3	3	0	0	1	2	4	2	8	10	5	4
Diptera	27	7	3	0	20	6	3	12	31	5	0	27
Odonata	1	1	2	0	0	0	0	1	2	0	0	0
Coleoptera	6	1	0	0	0	1	1	0	1	0	0	0
Megaloptera	0	0	0	0	0	0	1	1	0	0	0	0
Total insects	68	27	9	25	33	51	38	84	104	33	22	61
EPT	34	18	4	25	13	44	33	70	70	28	22	34
# genera	17	13	8	4	12	10	10	12	20	14	6	13

The dark vertical line indicates system construction (September-October 2000).

Table 7 shows the benthic community in Little Hefren downstream of the inflow of treated mine water. Pre-system, the station commonly had a pH less than 4 and the benthic community was negligible. After treatment, the chemistry and benthic communities both improved substantially. Compared to pre-system data, the post-system sampling efforts produced 10 times more individuals, 20 times more EPT, and 3 times more genera.

Tables 8 and 9 show the benthic communities of Toms Run upstream and downstream, respectively, of Little Hefren. The effects of the Little Hefren restoration on Toms Run are not readily apparent in the data. Above Little Hefren the benthic measures were similar pre-system and post-system. The aquatic community was characterized by a fairly rich Dipterian community. Below Little Hefren, the diversity was maintained, but numbers were consistently lower. A comparison of winter/spring 2000 (pre-season, non-drought) to winter/spring 2001 (post-system) did not reveal substantial differences. The best assessment of the effect of the Little Hefren restoration on Toms Run would occur during low flow conditions. In September 1999, when the Toms Run was acidified by Little Hefren (Table 5), few insects were collected (Table 10). Unfortunately, no benthic data are available for Toms Run under low-flow conditions after the system was constructed.

V. Operation and Maintenance

Because this system is a passive treatment system, it should require little operation and maintenance. However, the site should be monitored, particularly during its first few years of operation, to determine whether it is functioning properly.

A. Chemical Monitoring

Water samples should be taken periodically at the following locations:

- A pre-ALD sample collected from the valved hose on the pipe above the ALD;
- A post-ALD sample collected from the discharge of the conveyance pipe;
- A post-pond sample collected from the treatment pond discharge pipe;
- A post-wetland sample collected from the discharge of the wetland

It will be necessary to take a raw sample and a preserved (acidified) sample.

1. Take at least 500 mL of raw and 100 mL of acidified sample
2. Fill sample bottles as completely as possible and cap tightly.
3. For the acidified sample, add about 3 drops of 50% nitric acid to the sample.
4. Mark each bottle clearly with the sample location, the sample date, and raw or acidified. (For example, "Little Hefren Post-ALD Raw, 1/15/01")
5. Store the samples in a cooler with ice during transport to the analyzing laboratory.

Samples should be analyzed, at a minimum, for pH, alkalinity, acidity, iron, and sulfate. If possible, pH and alkalinity should be done in the field. The other analyses will require a laboratory. Sample dates should be recorded and results should be kept on file.

B. ALD Observation

Regular observations should be made of the ALD. A visual inspection of the area between the ALD and Little Hefren Run should be made for leaks. If any leaks are located, they should be sampled for pH, alkalinity, acidity, iron and sulfate.

In addition, the level of water in the ALD should be checked and recorded monthly. This can be done when the pre-ALD sample is taken. The method for this is outlined below.

1. Release the valve on the pre-ALD sample location. The valve is in the OFF position when the handle points straight up. To turn the valve on, rotate the handle down in the direction of Little Hefren Run. To turn the valve off, return the handle to the upright position.
2. Hold the discharge hose up next to the metal monitoring stake located near the sample port.
3. Measure the vertical distance between the top of the metal stake and the water level in the hose. If the water level cannot be seen through the hose, move the end of the hose up and down the stake slowly until the water just flows from the top of the hose.
4. Record the measurement and turn the valve off. (Record a positive measurement if the water is above the stake, a negative measurement if it is below.)
5. If the measurement is greater than 4 inches, contact Hedin Environmental personnel.

C. Channel and Pipe Maintenance

Leaves, sticks, and other debris will tend to collect around influent and effluent pipes and channels. Regularly check all pipes and channels for debris. Remove debris and place it outside of the pond or wetland.

If the temporary stream crossing of Tom's Run is still in place, check the upstream side of the culverts for sticks and debris. Remove any debris and place it on the stream bank or downstream.

D. Berm Monitoring

The berms on the pond and treatment wetland should be visually inspected monthly to check for leaks, uneven settling, or muskrat activity. If any major problems are observed, contact Hedin Environmental. If muskrat activity is observed, trapping may be necessary.

E. Sludge Management

After about 25 years of operation, the treatment pond will be 50% full of iron sludge. It will then be necessary to excavate the iron sludge and remove it from the site. This can be done by diverting the flow from the ALD directly to the wetland and draining the water from the pond. Sludge can then be pumped or excavated. The sludge is non-hazardous and has pigmentary values that might off-set some of the removal costs.

VI. Hedin Environmental Contact Information

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VII. List of Attachments

Attachment A: Original System Proposal, March 3, 1998
Attachment B: Final System Map

Figure 1: Project Location

This figure was taken from the USGS 7.5' quad maps of Cooksburg, Lucinda, Marienville West and Tylersburg . The project location is the red area near the middle of the figure. The site is on the Cooksburg Quad near the top left-hand corner.

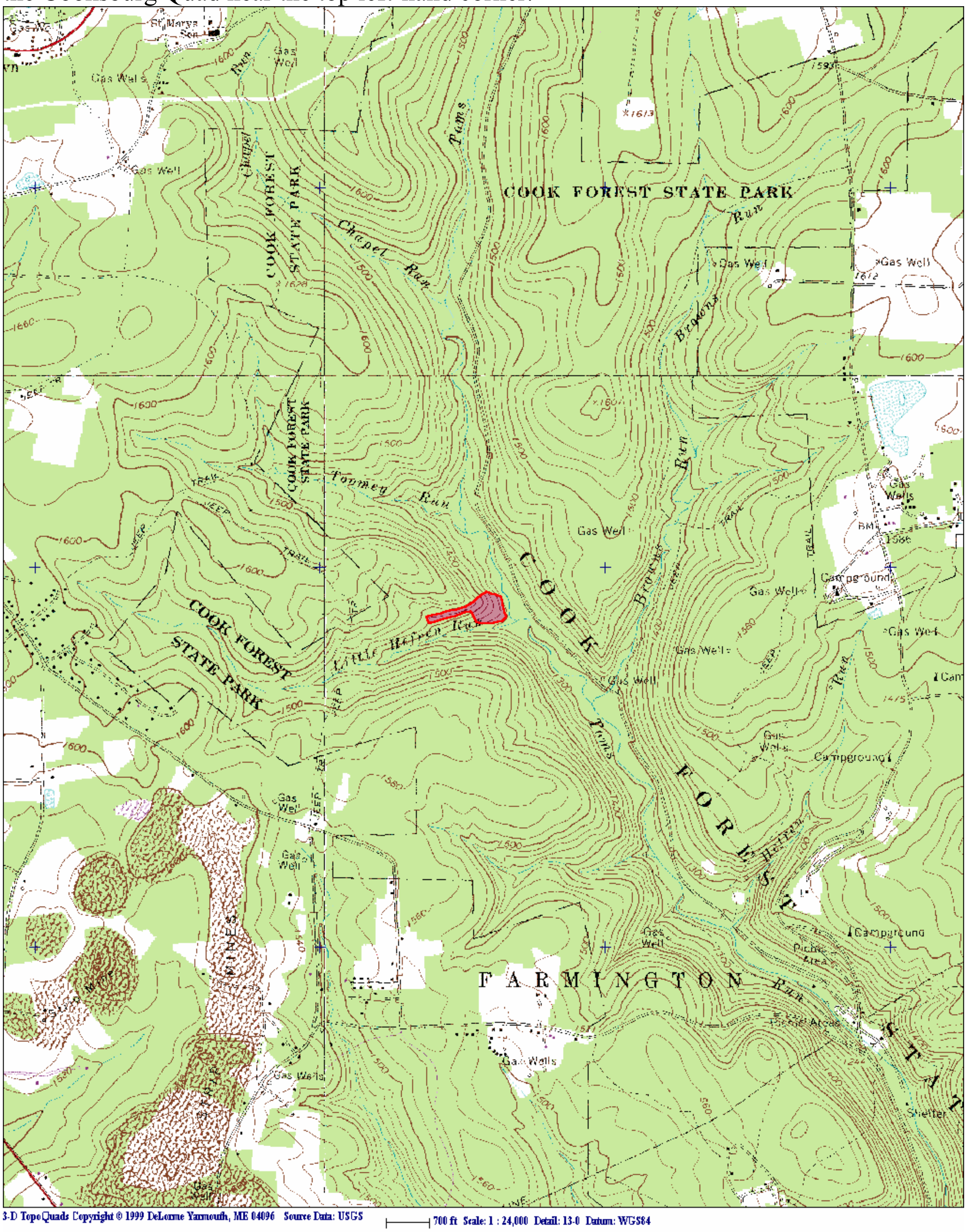

Figure 2: Generalized system cross-section (not to scale).

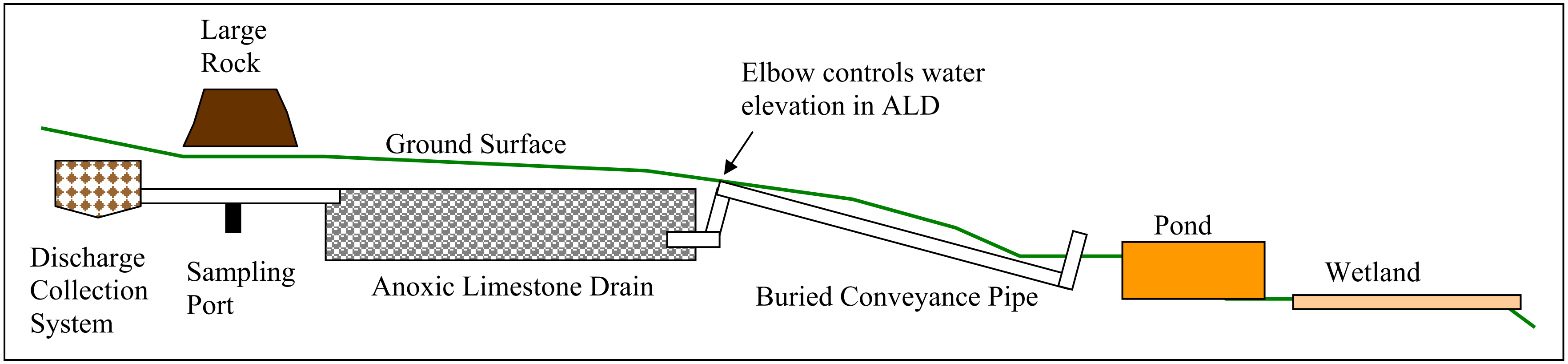

Figure 3: Performance of the Passive System, 9/7/01