

Report on the Black Earth Creek Fish Kill

**Wisconsin Department of Natural Resources,
South Central Region, 3911 Fish Hatchery Road, Fitchburg, 53711**

The purpose of this report is to provide information, describe the activities and make recommendations concerning the fish kill that occurred on Black Earth Creek on or around June 12, 2001. Black Earth Creek has for many decades been a very important trout fishery to the State of Wisconsin. It has naturally reproducing brown trout that has been rated as one of the top fisheries in the state, the Midwest, and even the nation. This high regard is not only based on the high numbers of fish present, but because it is on the doorstep of a large urban population, and anglers can fish for wild, "stream bred" trout in a rural landscape that still is relatively pastoral in nature.

Another reason the reputation of Black Earth Creek extends beyond the borders of the state is because the stream typifies what is known as a "spring creek," which are unique to the "Driftless Area" of Wisconsin. Other places in the world where these spring creeks are found in such numbers, other than a few isolated examples, include central Pennsylvania and southwestern England. These streams are characterized by their spring fed base flow which is high in alkalinity and normally maintains temperatures between 50-60 degrees Fahrenheit throughout the year, which provides excellent conditions for natural reproduction, growth of trout, and their food base. Black Earth Creek has also experienced a great deal of attention from organizations and individuals working together to protect and enhance the stream. Several conservation and watershed groups, local units of government, private landowners, and the Wisconsin Department of Natural Resources (Department), have been actively involved in dealing with a multitude of environmental management issues in the watershed for the past two decades.

The fish kill that occurred comes on the heels of a decade long priority watershed project that was conducted by the Dane County Land Conservation Department (LCD) with funding support from the Department. Interestingly, the trigger for this priority watershed project was a study conducted by the United States Geological Survey (USGS) that showed the stream was vulnerable to fish kills because of the low dissolved oxygen concentrations associated with runoff events and the photosynthetic/respiration cycle. The purpose of this priority watershed project was to reduce nonpoint source pollution in the watershed by providing costsharing for the installation of best management practices. When evaluated, out of over 60 watershed priority watershed projects initiated in the state; this project was ranked as one the most successful, primarily because the objectives of the Black Earth Creek Priority Watershed Plan were exceeded and this project had one of the highest landowner participation rates in the history of the program. Many miles of streambank protection and fish habitat improvement were installed, barnyard management systems constructed, and many acres of fields committed to conservation tillage. Over 2 million dollars of public and private funds were spent for the implementation of these best management practices.

Background

Black Earth Creek is 27 miles long and drains a watershed that is 103 square miles in size. Its main stem has 6 miles of Class I Trout Water and 6 miles of Class II Trout Water. In addition, the reach of the stream from Stage Coach Road to the Cross Plains Wastewater Treatment Plant (WWPT) is designated by the state as Outstanding Resource Water (ORW) and the reach below this point to its junction with Garfoot Creek is classed as Exceptional Resource Water (ERW). In addition, two major tributaries, Garfoot Creek and Vermont Creek

are also classified as trout water (Class II). Most of the stream is included in the Black Earth Creek Fishery Area, with lands in public ownership or under easement. In addition, the Southern Wisconsin Chapter of Trout Unlimited has negotiated 20-year leases with several landowners for the purposes of doing streambank habitat restoration work.

Response to the Fish Kill

Anglers notified the Department on Thursday (6/14/01) that they observed dead suckers in the creek east of Black Earth (Park Street) and they observed many dead trout in the vicinity of the stream at South Valley Road. Shortly after notification, Department staff representing several disciplines (law enforcement, fisheries, water resources, animal waste, and watershed management) arrived at South Valley Road and observed dead fish both upstream and downstream from the bridge. Over the next two days (6/14-15/01), the stream was surveyed for dead fish either on foot or in a boat from a point midway between Cross Plains and Middleton (where the stream crosses U.S Highway 14) downstream to Black Earth. Department staff found and collected approximately 150 fish during this survey. The fish were in an advanced state of decomposition. According to the Department’s fish toxicologist it is believed they died, based on their state of decomposition, on early Tuesday morning (6/12). The toxicologist stated the fish were too decomposed to determine the cause of their death. Department staff also began an extensive investigation of the fish kill which included water quality monitoring, site investigations, interviews with landowners, and fishery surveys (electrofishing).

Conditions: Rainfall and Stream Flow

Rainfall

Between the evening of Monday June 11, 2001, and the early morning of June 12, 2001, a storm event occurred in the area. Data from two stations inside of the watershed and two stations outside of the watershed is presented below to provide information on how much rain fell during that event (see Table 1 below). The amount of rain received in Madison, Middleton, and Cross Plains varied, ranging from .99 inches to 2.40 inches. However, one farmer in the Black Earth Creek area reported more than five inches in his rain gauge.

Table 1. Rainfall Amounts on Between June 11 (10 p.m.) and June 12 (6 a.m.)

Station	Rainfall Amount (6/11 and 6/12 combined)
USGS 05406470: Brewery Creek - Upstream Site – at Cross Plains, WI	2.06 inches
USGS 054064775: Black Earth Creek Tributary at CTH KP	.99 inch
USGS 05427948: Pheasant Branch at Middleton, WI	2.40 inches
National Weather Service Station at Dane County Regional Airport (Truax Field)	1.94 inches

Streamflow

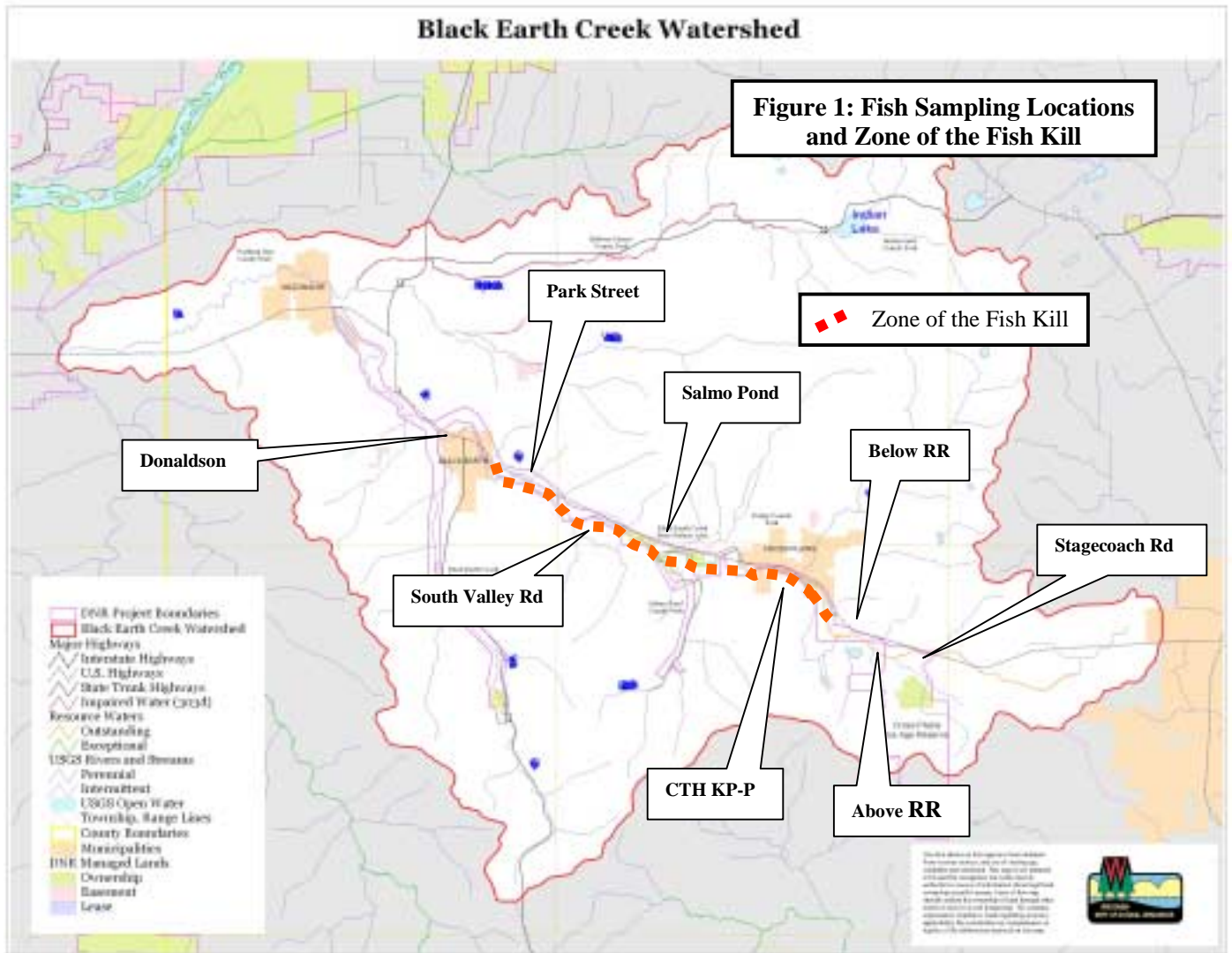
Table 2 shows streamflow for one station on Black Earth Creek and two stations on Brewery Creek. As is shown below, the rain event had a major influence on the stream flow of both Black Earth Creek and its tributary, Brewery Creek. The streamflow increased by 300% as a result of the rain event on June 11 and 12, 2001 (Table 2).

Table 2: Streamflow rates for USGS stations with the change in rate from the previous day.

Station	Date	Streamflow (mean cfs)	Change from Previous Day
05406469: Brewery Creek – Upstream Site – at Cross Plains, WI	6/12/2001	21	813%
05406470: Brewery Creek at Cross Plains, WI	6/12/2001	24	606%
05406500: Black Earth Creek at Black Earth, WI	6/12/2001	172	300%

Investigation: the Fishery

The Department collected approximately 150 trout from a point approximately 1.5 miles east of Cross Plains to Village of Black Earth following the fish kill (see Figure 1). Fish were sent to the Department's fish toxicologist for analysis to determine the cause of the kill. However, the fish were too badly decomposed to provide any information on the cause of death.



Single-run electrofishing was conducted on Black Earth Creek between June 25 and June 28, 2001 and on October 4, 2001, in response to the fish kill (see Figure 1 and 2). Eight electrofishing stations were sampled from east of Cross Plains at Stage Coach Road to the John Donaldson property on the west side of Black Earth to determine the extent and amount of the kill.

BLACK EARTH CREEK

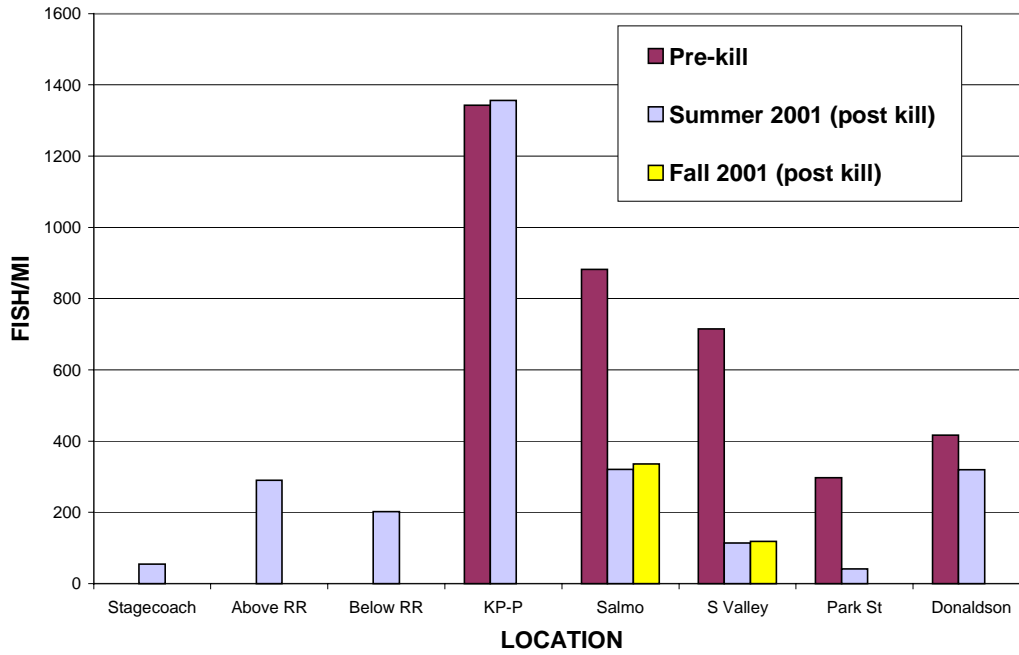


Figure 2. One-run electrofishing densities of trout in Black Earth Creek following and prior to the fish kill of June 12, 2001.

Where possible, stations were chosen where recent electrofishing had been conducted for comparison. All trout were identified, measured to the nearest 0.1 inch total length, and released. Density of trout in Cross Plains showed little difference in density when compared to the previous survey conducted in the spring of 2000. However, densities of trout west of Cross Plains downstream to the village of Black Earth showed decreases of 64-86%. These locations are designated as Salmo Pond, South Valley Road, and Park Street in Figures 1 and 2. Electrofishing conducted in the fall (10/04/01) showed little change in population density from the electrofishing conducted in the summer (6/25,28/01). West of the Village of Black Earth on the Donaldson property, density of trout decreased 23% when compared to the most recent survey. East of Cross Plains at the locations labeled as Stage Coach Road and above and below the railroad bridge on the Festge property, previous surveys were not available, so impact to trout density could not be determined. However, it is believed that density was not as high as that in Cross Plains labeled as KP-P on Figure 2. Confidence in population changes are highest for Highway KP-P and South Valley Road, because these stations have been used as reference stations and have been sampled most frequently.

Future sampling in the spring of 2002 will determine whether instream transport of trout will be necessary. We do not desire to stock brown trout in the stream from the hatchery or even other streams because we want to maintain the genetic integrity of the population of brown trout in Black Earth Creek. A transfer of trout within Black Earth Creek would be considered if: 1) fall densities (fish/mile) in the zones most affected by the kill were still significantly lower than the level that was present before the kill occurred; and 2) the fish population is of adequate density and size structure in the reaches that might provide fish for the transfer.

Water Quality Stream Monitoring

We performed two types of water quality monitoring: 1) grab sampling and 2) unattended water quality monitoring. The purpose of this monitoring effort was to obtain water quality data to determine how water chemistry changes during the normal photosynthetic/respiration cycle and during a rain event. Fortunately, Black Earth Creek has been the subject of several intensive studies conducted by USGS. The water quality monitoring conducted by the Department during the summer of 2001, while not as extensive as these earlier studies conducted by USGS would provide a short term “snap shot” of changes in water chemistry and would serve to supplement earlier studies with more up to date water quality information. This will be discussed more thoroughly in the sections below.

Water Quality Grab Sampling

A number of stream water quality grab samples were collected in the upper reaches of BEC from June 14 to August 3, 2001. As the fish kill investigation progressed, analysis parameters were changed to reflect new information the Department received about conditions and activities on the suspected day of the fish kill. Grab samples were also collected from tile lines and at outfalls from the tile lines into the stream—these tile line grab samples are discussed later in this document. The results of the grab sampling effort are shown in a table found in the appendix.

Unattended Water Quality Monitoring

Unattended (continuous) water quality monitoring devices (YSI/ Hydrolab Sondes) were deployed at six locations from 06/28/01 to 08/07/01. The locations include the following: Festge Property, Rocky Del Road, Stage Coach Road, CTH P, South Valley Road, and Park Street. These units collected continuous water quality data for the following parameters: pH, Temperature, and Dissolved Oxygen. Units were downloaded and calibrated weekly.

The unattended data loggers showed that Black Earth Creek experiences, regular, diurnal swings in dissolved oxygen in the absence of a rain event that make the stream vulnerable to fish kills in the future. When a rain event occurs and oxygen demanding materials (organic matter) are washed into the stream, the dissolved oxygen concentrations will go even lower---especially during the respiration phase (night) of the daily cycle in dissolved oxygen levels. At the monitoring locations County Highway P and South Valley Road, the minimum dissolved oxygen reading dropped below 5.0 mg/l on several occasions. This has been documented in the past and has been a recurring problem over the years (Field and Graczyck, 1990; Graczyck and Sonzogni, 1991). Abundant macrophyte growth, common in naturally fertile spring creeks because of the high alkalinity, contribute to depression of dissolved oxygen levels that will lead to fish kills when additional organic material is added by nonpoint source runoff and point source discharges.

One particular event that was cited in the paper written by Graczyck and Sonzogni (1991), showed that for one event on Black Earth Creek (7/23-26/85), the DO stayed below 4 mg/l for 21 hours during the event and stayed less than 6 mg/l for 30 hours at the USGS monitoring gauge at CTH P. This is similar to the monitoring results that were obtained by the Department during summer (2001) at this same site (see page 8).

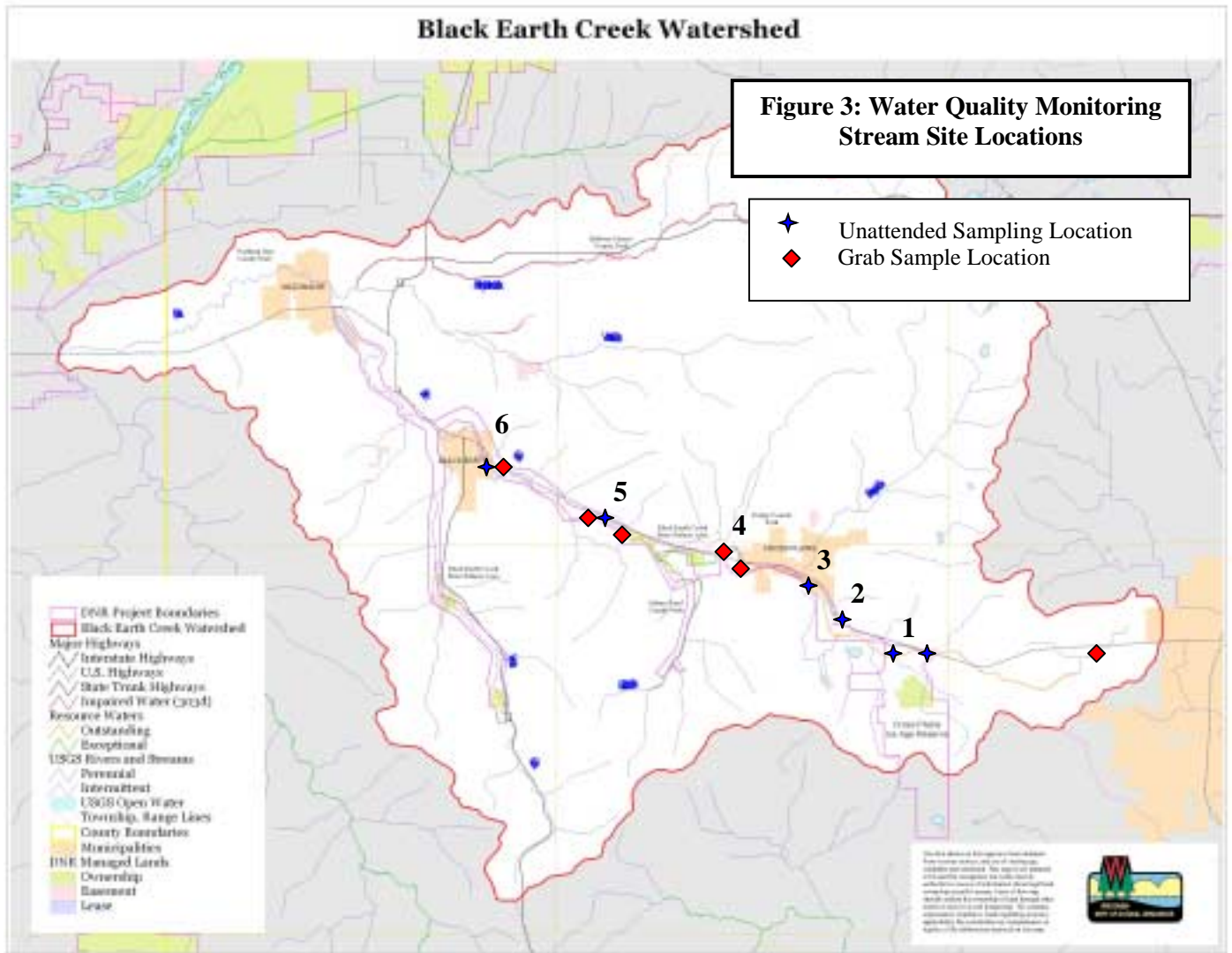


Table 3: Unattended Monitoring Deployment Locations			
Location	Water Body	Start Date	Stop Date
1. Rocky Dell Road	Black Earth Creek	06/28/01	07/05/01
2. Stage Coach Road	Black Earth Creek	06/28/01	07/05/01
3. Festge Property	Black Earth Creek	06/29/01	07/09/01
4. CTH P	Black Earth Creek	07/06/01	08/07/01
5. South Valley Road	Black Earth Creek	07/26/01	08/07/01
6. Park Street	Black Earth Creek	06/29/01	07/09/01

Water Quality Sampling – Unattended Monitors: Individual Site Analysis

Rocky Dell Road

This is the farthest upstream location sampled, and was located 10 meters downstream of Rocky Dell Road. The dissolved oxygen values ranged from 5.8 mg/l to 18.3 mg/l with a mean value of 11.7 mg/l. The percent (%) saturation for dissolved oxygen ranged from 61.3% to 208.9%, and had a mean value of 125.8%. The 5.8 mg/l concentration was 0.8 mg/l above the minimum water quality standard limit of 5 mg/l. Temperature values ranged from 54.5 degrees Fahrenheit to 74.2 degrees Fahrenheit with a mean of 65.2 degrees Fahrenheit. Daily temperature values vary 20 degrees Fahrenheit and had a mean of 65 degrees Fahrenheit.

Stage Coach Road

This unit was located 10 meters upstream of Stage Coach Road. The dissolved oxygen values ranged from 6.2 mg/l to 12.7 mg/l, with a mean value of 9.0 mg/l. The percent saturation for dissolved oxygen ranged from 67.6% to 138.1%, and had a mean value of 97.7%. Temperature values ranged from 56.2 degrees Fahrenheit to 74.2 degrees Fahrenheit with a mean of 66.1 degrees Fahrenheit. Daily temperature values vary 18 degrees Fahrenheit and had a mean of 66 degrees Fahrenheit.

At this location and at Rocky Dell Road, significant fluctuations in temperature, dissolved oxygen, pH, and conductivity were observed. Significant temperature fluctuations are due to fact that this reach does not receive significant spring flow. Abundant aquatic macrophyte growth in the stream caused large diurnal fluctuation in the chemical parameters; this is reflective of daily photosynthetic activity and nighttime respiration. The data logger results indicate that the headwaters appear to be impacted by chronic nutrient enriched runoff, but the instruments were not in place to capture information pertaining to a specific event. Rather, the data loggers reflect the summer background conditions that exist in the stream.

Festge Property

This unit was located 10 meters upstream of the rail road bridge on the eastern edge of the Festge property. The dissolved oxygen values ranged from 16.8 mg/l to 5.6 mg/l with a mean value of 10.4 mg/l. The percent saturation for dissolved oxygen ranged from 53.2% to 175.4%, and had a mean value of 101.6%. This reach of stream is also heavily dominated by in-stream aquatic macrophyte growth.

Temperature values ranged from 51.7 degrees Fahrenheit to 63.6 degrees Fahrenheit with a mean of 57.2 degrees Fahrenheit. This reach of stream is heavily influenced by spring flow and that is visible by the temperature data. Temperature fluctuations were small at 12 degrees Fahrenheit and the mean of 57 degrees. This type of temperature regime is more favorable for trout reproduction and survival.

CTH P

This unit was located 30 meters upstream of the CTH P crossing in Cross Plains. The dissolved oxygen values ranged from 2.8 mg/l to 11.5 mg/l with a mean value of 6.3 mg/l. The percent saturation for dissolved oxygen ranged from 29.7% to 114.4%, and had a mean value of 62.1%. On 08/02/01 the dissolved oxygen probe failed and the data analysis was conducted on the data collected from 07/06/01 to 08/02/01. This reach routinely had dissolved oxygen concentrations that fell below 5.0 mg/l. This is below the water quality standard for cold water (6.0 mg/l) systems. The section of stream from CTH P to where the data logger was located on the Festge Property is also characterized by heavy aquatic macrophyte growth. Based on data that was collected, daily diurnal fluctuations are a concern and a storm event could cause even lower concentrations of DO and be lethal to trout and other fish species.

Temperature values ranged from 52.4 degrees Fahrenheit to 72.6 degrees Fahrenheit with a mean of 61.5 degrees Fahrenheit. Daily temperature values vary as much as 21 degrees Fahrenheit and had a mean of 61.5 degrees Fahrenheit. Although this reach is immediately downstream of the Festge Spring area, which provides a significant amount of spring flow to the creek; the high maximum temperature indicates that this reach is

probably receiving a large amount of surface flow (stormwater)—possibly from stormwater drains and ditches that enter the stream above the sampling station.

South Valley Road

This unit was located downstream of South Valley Road 30 meters downstream from the Ripp machinery crossing. The dissolved oxygen values ranged from 3.8 mg/l to 16.7 mg/l with a mean value of 9.7 mg/l. The percent saturation for dissolved oxygen ranged from 38.9% to 174%, and had a mean value of 99.8%. This reach routinely had diurnal fluctuations dissolved oxygen concentrations that fell below 5.0 mg/l. This is well below the water quality standard for cold water (6.0 mg/l) systems. Historical records from USGS (Walker et al., 1999) show that this has been a reoccurring problem that has plagued this reach since 1990. Dissolved oxygen has been monitored periodically since 1990 at various locations on Black Earth Creek. USGS reports that in 1991, 49 out of 217 days the dissolved oxygen concentrations were less than 6.0 mg/l. Based on data that was collected, daily diurnal fluctuations are a concern and a storm event could further depress DO concentrations to level well below the standard of 6.0 mg/l. This also is consistent with findings by Graczyk and Sonzogni (1991).

Temperature values ranged from 55.4 degrees Fahrenheit to 67.1 degrees Fahrenheit with a mean of 61.5 degrees Fahrenheit. Daily temperature values vary 12 degrees Fahrenheit and had a mean of 61 degrees Fahrenheit. This reach does apparently receive relatively large amounts of spring flow and instream groundwater inputs based on the temperature data.

Park Street

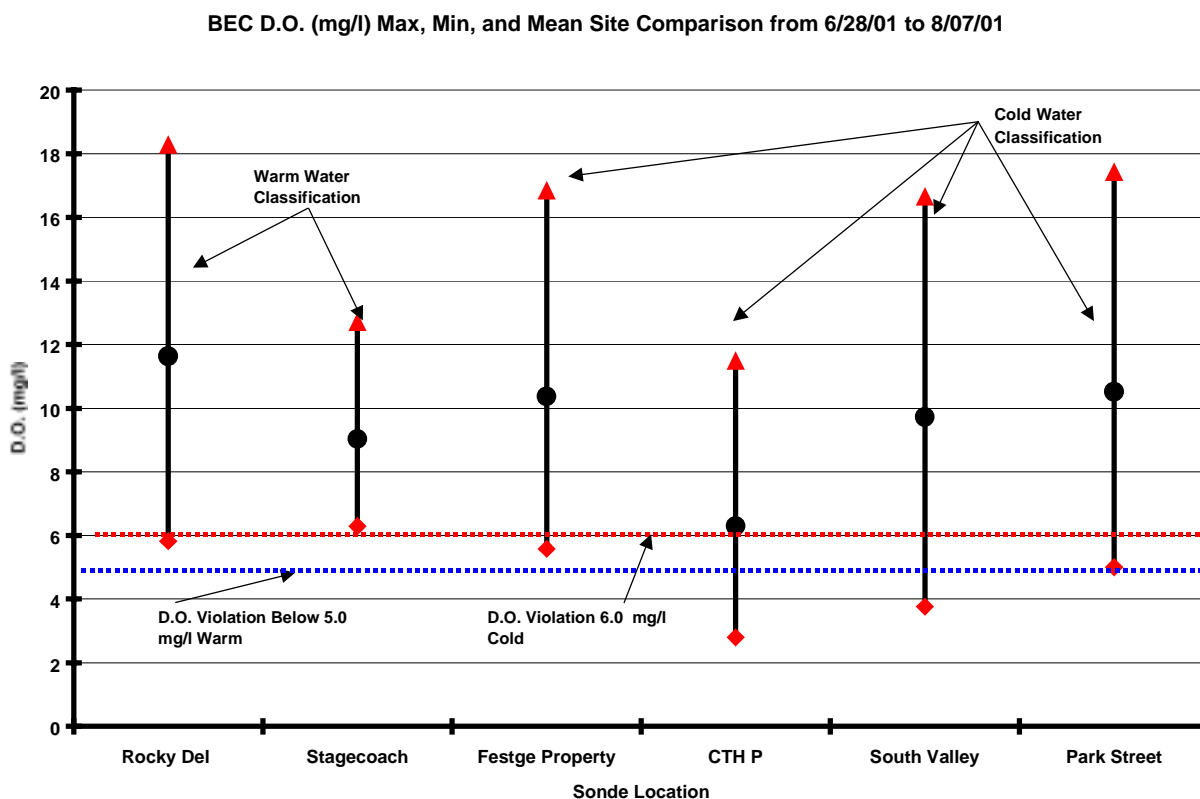
This unit was located upstream 100 meters upstream of the bridge at Park Street. The dissolved oxygen values ranged from 5.0 mg/l to 17.4 mg/l with a mean value of 10.5 mg/l. The percent saturation for dissolved oxygen ranged from 52.9% to 185.3%, and had a mean value of 110.1%. This reach routinely had diurnal fluctuations in dissolved oxygen that fell below 6.0 mg/l, the water quality standard for cold water. As with the sites described above these low dissolved oxygen concentrations during base flow conditions mean that during storm events, the dissolved oxygen concentration could be well below the standard of 6 mg/l—low enough to be lethal to trout.

Temperature values ranged from 56.8 degrees Fahrenheit to 68.6 degrees Fahrenheit with a mean of 62.7 degrees Fahrenheit. Daily temperature values vary 12 degrees Fahrenheit and had a mean of 62.7 degrees Fahrenheit.

Table 4: Min, Max, and Mean Values for Unattended Monitoring Data for Black Earth Creek			
Site	Dissolved Oxygen (mg/l) (MIN/ MAX/ MEAN)	Dissolved Oxygen (%sat) (MIN/ MAX/ MEAN)	Temperature (F) (MIN/ MAX/ MEAN)
Rocky Del Road	5.8/ 18.3/ 11.7	61.3/ 208.9/ 125.8	54.5/ 74.2/ 65.2
Stage Coach Rd.	6.2/ 12.7/ 9.0	67.6/ 138.1/ 97.7	56.2/74.2/ 66.1
Festge Property	5.6/ 16.8/ 10.4	53.2/ 175.4/ 101.6	51.7/ 63.6/ 57.2
CTH P	2.8/ 11.5/ 6.3	29.7/ 114.4/ 62.1	52.4/ 72.6/ 61.5
South Valley Rd.	3.8/ 16.7/ 9.7	38.9/ 174.0/ 99.9	55.4/ 67.1/ 61.5
Park Street	5.0/ 17.4/ 10.5	52.9/ 185.3/ 110.0	56.8/ 68.6/ 62.7

Table 5: Number of Days DO went Below the Standard at Monitoring Locations at Black Earth Creek				
Station	Water Quality Classification	Water Quality Standard	Total Number of Monitoring Days	Number of Days DO Went Below the Standard for Coldwater Streams (6 mg/l)
Rocky Dell Road	Warmwater Stream	5.0 mg/l	7	0
Stage Coach Road	Warmwater Stream	5.0 mg/l	7	0
Festge Springs	Coldwater	6.0 mg/l	11	1
CTH P	Coldwater	6.0 mg/l	8	8
South Valley Road	Coldwater	6.0 mg/l	11	3
Park Street	Coldwater	6.0 mg/l	11	3

Figure 4. Black Earth Creek Dissolved Oxygen Monitoring Results-Unattended Monitors



Conclusions Concerning Water Quality

As past studies have shown (Walker et al., 1999, Graczyk and Sonzogni, 1991) and recent water quality monitoring indicates, Black Earth Creek has chronic problems with low dissolved oxygen concentrations. This situation means that the stream is vulnerable to fish kills such as the one that occurred June 11-12, 2001. However, for that particular event it cannot be said with certainty that low dissolved oxygen concentrations was the primary reason for the fish kill. Other contaminants may have been involved such as pesticides that entered the stream through tile lines. All stations in the coldwater reach of Black Earth Creek showed dissolved oxygen readings during the monitoring conducted by the Department. It should be noted that the lowest dissolved oxygen readings recorded during monitoring conducted by the Department in 2001 occurred at CTH P, in reach of the stream located very close to the Festge Spring Area---the reach which receives major spring flow. It is recommended that site specific water quality monitoring be done in the future to better pinpoint sources of pollution to the stream.

Macroinvertebrates

The purpose of analyzing the macroinvertebrate fauna was to look for major changes in both the species present and the population numbers that could have been attributed to the water quality problems that caused the fish kill. This analysis must be viewed with great caution because the sampling was done at a time of the year when many of the nymphal forms of many species are so small that they will not show up in a sample. Only gross

changes in the benthic community would be noticed. Macroinvertebrates were sampled at eleven locations on the main stem of Black Earth Creek. Samples were collected on 06/26/01 and 06/29/01. Samples were collected using the kick method with a D-frame net and preserved with denatured alcohol. All samples were then identified to the family level and the FBI (Family-level Biotic Index) metrics applied. Data was compared against historical data from May of 1998. No major changes in the macroinvertebrate population or community were observed, according to the comparison shown in the table below. Table 6 shows the locations and the results of the macroinvertebrate sampling.

Table 6: Macroinvertebrate Sampling Locations and Monitoring Results for Black Earth Creek.				
Sample Site	Sample ID #	FBI, June 2001	Result	FBI, May 1998
Cleveland Rd.	200106291307	5.19	Good	
Birch Rd.	200106291306	4.11	Very Good	
CTH P	200106291305	4.62	Good	
Fire Station	200106261304	4.52	Good	3.98-Very Good
CTH KP	200106261303	4.00	Very Good	3.70- Excellent
POTW in CP	200106291304	4.67	Good	
Scherbel Rd.	200106261302	4.28	Good	4.30- Good
South Valley Rd.	200106261301	5.40	Fair	4.59- Good
Park Street	200106291302	4.46	Good	
0.5 mi W of BE	200106291301	4.38	Good	
Olson Rd.	200106291303	4.26	Good	

Potential Causes

Animal Waste

We investigated permitted and non-permitted operations in the watershed, in consultation with the Dane County Land Conservation Department to find out if any discharges from these facilities could have caused the fish kill. With most situations where a discharge of animal waste results in a fish kill according to discussions with other biologists (WDNR) in the state, the fish are killed very near to where the animal waste enters the stream. Since the dead fish were discovered three days after they were apparently killed and because of the size of the event, they could have washed downstream, it is difficult to pinpoint the exact upstream point of where fish mortality first occurred. Therefore, it is not possible to say if a potential source had a major influence on the fish kill. Because, dead fish were observed over a very long reach of Black Earth Creek (from east of Cross Plains all the way to Black Earth) it appears that if animal waste was a key factor in causing the kill; then it is possible that multiple sources of animal waste are responsible for causing the fish kill. Described below are the actions taken by Department staff to determine how a discharge of animal waste may have been a factor in the fish kill.

Permitted Dairy Operations

This single permitted operation that operates in the Black Earth Creek Watershed is a large dairy operation, milking around 900 cows. The facility applied for and received a Wisconsin Pollutant Discharge Elimination System (WPDES) permit in 1997. The current permit expires on June 30, 2002. The home farm is located in

the Six-Mile and the Pheasant Branch Creek Watershed. This facility uses many spreading sites in the Black Earth Creek Watershed for the application of manure. The facility also operates a smaller farm for the housing of replacement animals. This farm is located at 8607 Highway 14, Cross Plains, immediately adjacent to Black Earth Creek

On June 19, 2001, the Department met with the owners on site to assess the situation at the replacement animal barnyard facility. Subsequent meetings have occurred. The following items were observed and discussed:

- Flow patterns in the grass and across the cut hay fields indicate that runoff from the concrete barnyard had occurred in the recent past and that this water ran overland and into Black Earth Creek in two distinct places. Evidence of manure contamination was not observed due to the heavy volume of the storms on June 11/12 2001.
- The group followed the flow path up the bank to the feedlot. Most of the water from the concrete lots appears to flow through a low spot and then north downhill towards the creek. The owners indicated that the low spot is 3-4 feet deep with manure and that the concrete lot was scraped off on Monday June 11, 01 prior to the storms. They said they routinely clean this lot on a weekly basis. They also indicated they were housing 300 - 400 dry cows and heifers which would eventually be transferred to the main farm on Schneider Road.
- There is also a dirt cattle lot attached to the concrete lots which would flow west and this area did not appear to have much runoff. The group walked out the west end of the lot and discussed land application issues and the lot draining to the west. The owners told DNR staff how they land apply manure after hay cuttings.

Spreading Sites

- The permitted facility has an approved manure management plan. The plan lists many fields in the Black Earth Creek watershed for the land application of manure. The fields which are available for land application of manure during the summer months are all alfalfa fields which have recently been cut and harvested. The facility typically uses this time and availability of land to lower the levels in their lagoons.
- The investigation of the land application of manure from the facility includes three basic areas and is ongoing.
 - The first was to request and receive the daily logs for the time period before and after the fish kill. The Dairy provided their daily logs from January 1, 2001 until June 18, 2001.
 - The second area of review involved the three contract manure haulers who work for this facility. Department staff requested and received copies of their log sheets for the time period of June 1, 2001 through June 12, 2001. These records were reviewed to double check dates, sites, and application rates. A phone interview was conducted with each of the contract haulers to discuss the land spreading activities and events around the time of the fish kill. This review resulted in a number of reporting inconsistencies, but an overall conclusion that the dairy had basically followed their manure management plan.
 - The third area of review included an onsite inspection of all the fields which were used by the dairy on the days leading up to and including the day of the fish kill. Department specialists checked all of the fields which had been used for the land application of manure. The investigation revealed operator was in basic

compliance with the permit and the nutrient management plan; however, there was evidence that large volumes of runoff had left some of the fields at certain points.

On August 17, The DNR held an Enforcement Conference concerning the apparent violations with the facility that pertained to spreading sites both inside and outside of the Black Earth Creek Watershed. In the Enforcement Conference (which had been scheduled in advance of the fish kill), a compliance agreement including a schedule was developed. That schedule is still active, including an assessment and improvement of runoff management at the barnyard site located in the Black Earth Creek watershed.

Other Barnyard Investigations

An analysis of available data concerning runoff from barnyards was conducted in consultation with the Dane County LCD and showed there were other possible barnyard sites that possibly could cause significant water quality problems. Several barnyards were evaluated from the road and on site investigations were conducted at three additional barnyards. All three had an opportunity to participate in the BEC Priority Watershed Project, but did not participate. These farms all had violations of the prohibitions which were established by the Animal Waste Advisory Committee and are now required by statute. These sites can contribute significant quantities of manure contaminated runoff to BEC and could cause significant water quality degradation.

- 1) The first farm located in the reach above South Valley Road in the Town of Berry. The landowner currently milks approximately 90 cows. Runoff from the lot is able to enter BEC, making this a significant discharge. It would appear that the greatest impact to the stream would occur at times of limited vegetation. However, on the day of the investigation, there were no visible solids at the lot discharge point. Excessive grazing has historically occurred at this site and may be also significant contributor of pollutants.
- 2) The second farm is located on Garfoot Creek, Town of Cross Plains, on County Highway KP. Detailed information on the numbers of cattle on this farm is not available; however, it appears that approximately 40 cows are present. The cattle lot is directly adjacent to the stream. There is very little, if any, buffering capacity between lot discharge points and the stream. Therefore, significant quantities of manure contaminated runoff are able to enter Garfoot Creek.
- 3) The third farm is located, south of County Highway KP, in the Town of Cross Plains. They currently milk 80 cows, but have the barn capacity to milk 120. There are several open lots which discharge to a nearby road ditch and eventually discharge to BEC below South Valley Road. Manure solids and sediment are obvious. Manure can be transported by a road ditch and later an intermittent stream (channelized) flow to Black Earth Creek.

All have conditions that contribute to the degradation of BEC and possibly contributed to the fish kill of June 2001. By controlling barnyard runoff at each of these farms we will be able to significantly reduce the quantity of pollutants leaving these farms and reduce the risk of future fish kills. The Department is evaluating enforcement action at these three facilities. This action could include issuance of a Notice of Discharge.

Tile Lines and Tile Line Outfalls

During the course of the investigation of the fish kill, a relatively large discharge from a tile line into Black Earth Creek was discovered. This tile outfall was discovered on Friday, June 15, 2001, several days after the occurrence of the fish kill. This tile outfall is located immediately upstream of the railroad bridge, which is east of Cross Plains in the "Festge Springs" area (SW1/4, Section 11, T7N, R7E). The uppermost limit of

observance of dead fish was several hundred yards downstream from this tile outfall. This tile line drains the area south of Black Earth Creek and east of CTH P (see figure 5).

Subsequent investigations up gradient of this tile outfall in addition the area drained by the tile lines showed that at several points surface water had entered the tile drainage system through “blowouts” in the tile lines. This drainage network is relatively complicated and traverses the property of several landowners. Because the tile line appears to be flowing constantly at its outfall point into Black Earth Creek, it likely is intercepting spring flow/groundwater at several points. Interviews with landowners revealed that the main part of the tile line has been in place for many years and that ongoing maintenance is needed to keep the tile line functioning. In the area drained by the tile line, south of Stage Coach Road, ditching occurred in the Spring of 2001 to improve the drainage of a farm field in this area.

This tile line drains a relatively large area of farmed land. The Department’s investigation of this area revealed that fertilizer and pesticides are applied to these fields and that these chemicals could have discharged directly into Black Earth Creek through the tile line. It was learned by Department staff that the pesticides had been applied the on June 11, 2001, the day of the rain event that is believed to be associated with the fish kill. The chemicals applied were Raptor (a.k.a. imazamox), Basagran (a.k.a. Bentazon), ammonium sulfate, and crop oil (see appendix). Raptor has been shown in laboratory test to be acutely toxic to rainbow trout at concentrations of 122 mg/l. It is not known if these concentrations were present in the discharge from this tile line into Black Earth Creek. This field, as well as the fields surrounding it, drains to a swale running south-to-north through the property, toward Black Earth Creek. This swale contains two holes that lead directly to a drainage tile under the fields. No dye test was completed in this tile line; however, the tile also flows in the direction of Black Earth Creek, and a tile outfall was observed at the creek in the area of the field. The potential discharge of these chemicals to the creek through the tile line is enhanced by the presence of “blow outs” in the tile line as is noted above. The owner has been notified of the holes in the tile line that intercepts surface drainage and has agreed to resolve the problem this year.

Water Quality Sampling of Tile Lines and Tile Outfalls

Grab samples taken at tile outfalls and in some cases in actual tile lines indicate that in the majority of cases, they were within the normal range—however, the presence of higher than normal values for some constituents may indicate that this tile system may have been a factor in the fish kill.

Sample BEC-28 had above-normal results was for total phosphorus, 5 day BOD, COD, suspended solids, and ammonia (located at a tile line hole south of the junction of Highway 14 and CTHP-see figure 5). It is to be noted that this sample was collected from a tile line hole containing turbid water. The tile line appeared to be plugged at the time and the water was not flowing. Since the water in the hole had been standing for an unknown amount of time, the sample results may be artificially high compared to the typical situation in that tile line.

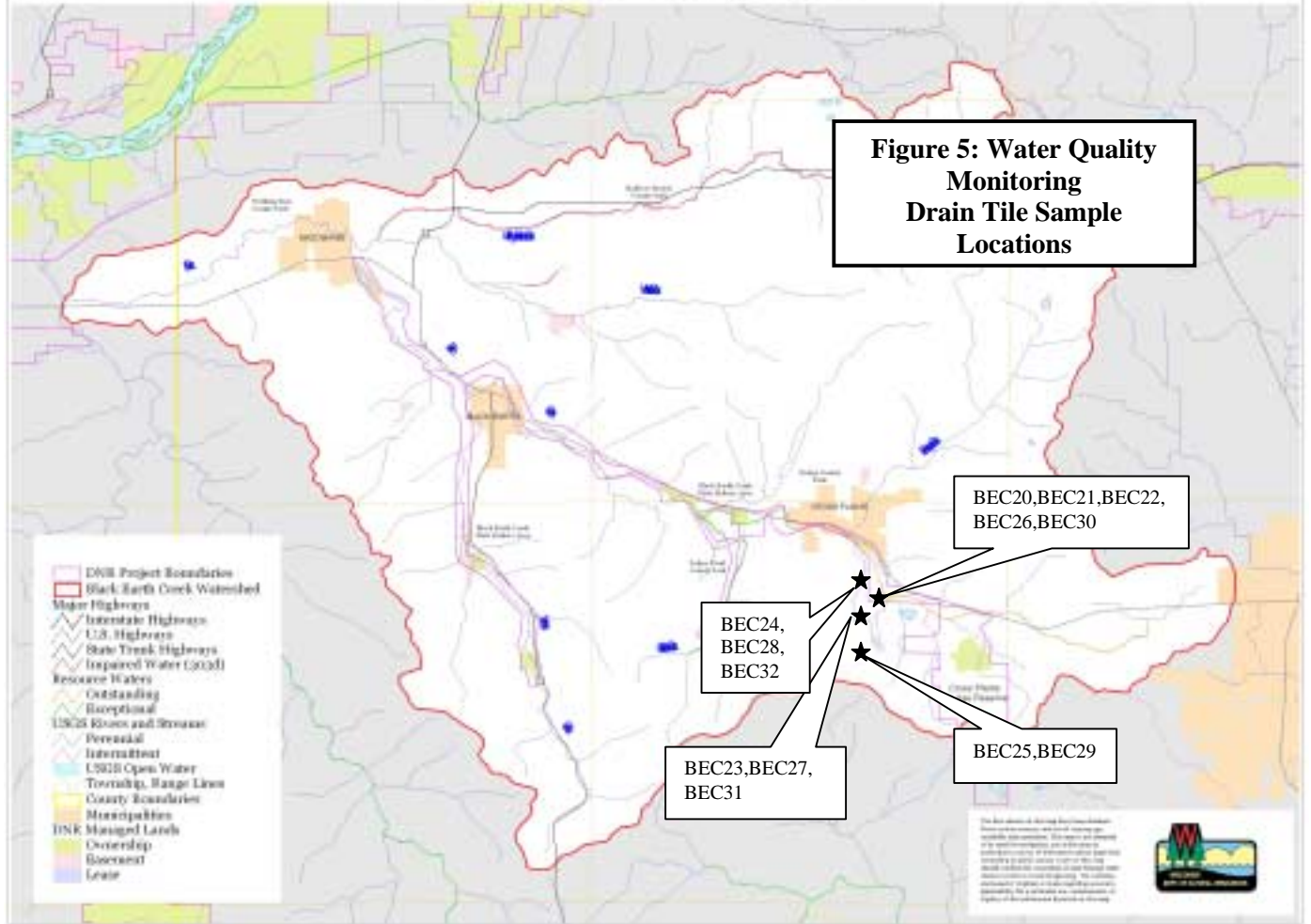
Three samples (BEC-21, BEC-26, and BEC-27 – all tile line pipes or outfalls – see map) were analyzed for total chlorine. The results were 0.15 mg/l, 0.06 mg/l, and 0.24 mg/l, respectively. These results exceeded the acute toxicity standard of 0.037 mg/l for surface waters. These high readings are normally associated with correspondingly high levels of pesticide application. These high readings cannot directly linked to the fish kill on 6/12/01, they do suggest that at times there are high levels of chlorine in the tile line system in question, and that tile line does discharge into Black Earth Creek.

A second parameter of concern was 5-day biological oxygen demand (BOD₅). One sample (BEC-29) had a result of 12.5 mg/l. While this is not exceptionally high, it is higher than the other samples.

Three samples taken on 8/2/01, (BEC-30, BEC-31, and BEC-32) had high results for dissolved-orthophosphate. Not only were the results above normal, the dissolved phosphate represented a high percentage (90%, 100%, and 81%, respectively) of total phosphate. This indicates a potential for runoff of fertilizer or manure to the

sample location. Because the results for BOD₅ were not very high, it is likely that fertilizer is the cause of the high dissolved-orthophosphate results.

Black Earth Creek Watershed



Other Potential Causes

Point Source Discharges

A sand and gravel mining facility located in the upper watershed which discharges to Black Earth Creek was investigated. It was determined they exceeded the WPDES Permit limit for temperature in May and June, but we do not believe these temperature violations caused the fish kill. Their WPDES Permit requires them to meet 15 C (60 F) and to report temperature monthly. On May 16th temperature of the discharge was 17.6 C (63.7 F) and on June 13th 19.8 C (67.6 F). In response to the May temperature exceedance, the facility changed their pumped discharge intake from the 5 foot depth to their 28 foot deep intake point. In response to the June exceedance, they ceased discharging to Black Earth Creek for several weeks, through July, 2001. A Notification of Non-Compliance (NON) letter was sent on August 6th, after the June monthly monitoring forms were received, following regular enforcement procedure. The NON requested a written response describing the action the facility intends to take to regain compliance with the temperature limit. The facility responded September 18th identifying several alternatives they intend to pursue to comply with the temperature limit. The Department will continue follow up activities with this facility.

Additionally, Department staff made several site inspections from mid-June through present, including a temperature profile of the lake taken near the pumped discharge intake. This profile, taken on August 9th showed that lake temperature exceeded the 15 C limit even at the 28 foot depth intake point. Lake temperature didn't reach 15 C until the 50 foot depth, but dissolved oxygen at the 50 foot depth was below the 6.0 mg/l Permit limit (5.96 mg/l).

During the month of June, the Cross Plains wastewater treatment plant (WWTP) met all WPDES Permit effluent limits, except for phosphorus. The phosphorus limit was not met in June because they changed from chemical phosphorus removal to biological phosphorus removal this spring, and it takes time to acclimate the WWTP to achieve biological phosphorus removal. We do not believe that this was a significant factor in causing the fish kill. The WWTP removes about 75% of the influent phosphorus presently, with effluent discharge averaging 1.5 mg/l total phosphorus. No raw wastewater was bypassed during the June rain event. However, the WWTP does discharge oxygen demanding materials to the stream, even though they are within their specified permit limits.

Urban Stormwater

The impact of urban stormwater from the Village of Cross Plains on Black Earth Creek has been a concern in the recent past. With respect to this fish kill, it is not known to what extent that urban stormwater runoff played in the fish kill. However, pollutants and nutrient associated with stormwater runoff were likely a contributing factor to any overall decrease in water quality that occurred in Black Earth Creek during the fish kill. It should be noted that dead fish were found above, in the middle of, and below the Village of Cross Plains in approximately the same numbers. Electrofishing in the Village of Cross Plains, also showed a much lower percentage of fish mortality than that of reaches downstream.

Brewery Creek, a major tributary in the Village of Cross Plains, is the site of a major subdivision development. This site is being monitored by Dane County LCD to study what, in terms of stormwater runoff, is discharged from the site. According to reports from Dane County LCD, excessive amounts of sediment did not leave the site.

Overall Conclusions

We do not have sufficient information to identify a specific cause of the fish kill that occurred in the early morning hours of June 12, 2001, given the state of advanced decomposition when the fish were found and because no single source of the contamination could be confirmed. The fish kill was potentially caused by:

- 1) a depletion in dissolved oxygen due to stormwater runoff which would include manure from barnyards, spread manure, fertilizer applied to fields and urban runoff,
- 2) acute toxicity by pesticides that was applied to fields and then entered the stream through tile lines, or
- 3) a combination of these two phenomenon above.

Sources of these contaminants are located in the upper watershed of Black Earth Creek (east of Cross Plains); however, there where sources of manure located in the stream reach between Black Earth and Cross Plains that were also potential contributors to the stream as well. It is also important to note that the occurrence of low dissolved oxygen concentrations in Black Earth Creek during storm events has been well documented by studies conducted by USGS in the past. Short term monitoring by the Department shows that this phenomenon is still occurring. The storm event that occurred on June 11, 2001, was not an unusual event as far as the amount of rain that fell (approximately 2.5 inches), although it may be been very intense. However, it was learned through interviews with residents and other private citizens that the night before the storm on June 11, 2001, there was spreading activity of both liquid manure and pesticides in the watershed.

Follow Up Activities and Recommended Courses of Action

Fishery Restoration

Future sampling in the fall of 2001 and spring of 2002 will determine whether instream transport of trout will be necessary. We do not desire to stock brown trout in the stream because of concerns for maintaining the genetic integrity of the wild brown trout population of the stream. It is expected that the fishery will return to normal population levels and size structure in 3-4 years.

Agricultural Runoff /Discharges

The Department recommends that a through review of the permit requirements for nutrient management be made when the permit is reissued in July of next year (2002). An updated nutrient management plan which will include a comprehensive phosphorous management strategy should be considered when developing a permit for reissuance.

With regard to the permitted animal waste operating in the watershed, the Department has asked the owners to correct the situation from the lot draining to the north quickly. While the current permit does not contain a specific compliance schedule to require the needed upgrades immediately, failure to correct the problem in a timely manner will likely result in a compliance schedule being added to the permit when it is reissued. The current permit expires on June 30, 2002.

Other Barnyard Sites

Three additional barnyard operations were investigated and were found to contribute significant amounts of manure to Black Earth Creek and its tributaries. It is possible these sources contributed to the fish kill in the reach between Salmo Pond and Black Earth, because they served to add “fresh” pollutants to the stream system just upstream of where the heaviest kill occurred (the reach between South Valley Road and Black Earth). Based on the experience of investigating other fish kills, polluted runoff in the upper watershed (east of Cross Plains) may have been “diluted” to a large degree by the time it reached the South Valley Road reach. The Department is evaluating ways to correct these operations (including enforcement options) to these three farms.

Drainage Tiles

In the course of the investigation, an extensive drainage tile system with several direct entry points from the surface was discovered (east of Cross Plains, and south of the stream). Although these do not appear to fall under any Department jurisdiction, these “blow out” areas, where surface runoff enters the tile system directly should be repaired.

Monitoring Recommendations

One of the main problems encountered during the investigation was that the Department was not able to gather adequate water quality data pertaining to the period when the fish kill occurred. Department staff were not notified of the fish kill until three days after it occurred. It is recommended that watershed and conservation organizations that have an interest in the welfare of the creek work together with the Department to support an ongoing monitoring effort. This could range from a network of volunteers that take responsibility to watch the stream and report suspicious events and stream conditions to the Department, to actual monitoring that would be supported in part by volunteers. Maintaining monitoring stations and deployment of instream data loggers could also be discussed among agencies and conservation organizations would also be advantageous. The expense of this effort might be justified since it is Outstanding Resource Water, Class I Trout Stream, and is one of the most popular fisheries in the region.

Urban Stormwater

While urban stormwater from the Village of Cross Plains, was apparently not a major factor in the fish kill. Increased development which brings with it an increase in impervious surfaces poses a long-term threat to the stream ecosystem. Development sites in excess of 5 acres in size would have to be approved under the Storm Water Permit Program and will be required to follow best management practices to control stormwater runoff.

Stream Buffers/Land Protection

Several programs are available now that could be used to provide permanent protection for the riparian zone of Black Earth Creek—indeed much of the riparian zone is already under state ownership. Organizations such as the Dane County Natural Heritage Foundation, Trout Unlimited, Black Earth Creek Watershed Association, and the Black Earth Conservation Organization should work in a coordinated fashion to take full advantage of the programs that can be used to protect riparian and other critical areas (i.e. wetlands). Examples of these programs include the Stewardship Program (state), Wetland Reserve Program (WRP)(federal), and the Cropland Reserve Enhancement Program (CREP) (federal).

The Role of Watershed Organizations

Watershed organizations will continue to play a vital role in the ongoing protection and welfare of the Black Earth Creek ecosystem. These groups will continue be critical to achieving success in stream monitoring,

riparian corridor management, dealing with development, sponsoring educational programs, obtaining funding, organizing local support, and performing a strong facilitative role. In particular, members of these groups can serve as a “watershed watch” group to sound the alarm when there is a future fish kill, a spill, or pollutants are observed entering the stream.

11/09/01

References

- Field, S.J., and D.J. Graczyk. 1990. Hydrology, aquatic macrophytes and water quality in Black Earth Creek and its Tributaries. 1985-86. U.S. Geol. Surv. Water Resour. Invest. Rep. WRIR89-4089. U.S. Gov. Print Office, Washington, DC
- Walker, J.F., D.J. Graczyk, S.R. Corsi, J.A. Wierl, and D.W. Owens. 2001. Evaluation of Nonpoint Source Contamination, Wisconsin: Water Year 1999. U.S. Geological Survey. Open-File Report 01-105. Middleton, Wisconsin
- Graczyk, D.J. and W. C. Sonzogni. 1991. Reduction of Dissolved Oxygen Concentration in Wisconsin Streams During Summer Runoff. *J. Environ. Qual.* 20:445-451 (1991)

Appendix

The following information about the applied chemicals was obtained from staff at the WDNR and the State Laboratory of Hygiene (SLOH), as well as information from Cornell University, the Honeywell Corporation, Pammark Farms, and the U.S. Environmental Protection Agency (EPA):

- Raptor** Raptor is the brand name of imazamox, which is used as a herbicide in soybean fields. Imazamox is applied in low concentrations, typically 0.040 pound acid equivalents per acre (lb ae/A), using 10 or more gallons of water per acre. Imazamox impacts weed growth, causing the weed to die or become uncompetitive with the crop. Imazamox is only moderately persistent and degrades aerobically to a non-herbicidal metabolite, which is immobile or moderately mobile. The range of dissipation half-lives is 15 to 130 days, with the more representative half-lives being 35 to 50 days. Testing of imazamox on rainbow trout indicates an acute toxicity of greater than 122 milligrams per liter (mg/l) (EPA, 1997). Currently, the SLOH does not have a test for detecting imazamox. The Wisconsin Department of Agriculture is in the process of developing a test.
- Bentazon** Bentazon is also known as Basagran, both of which are trade names for herbicides containing sodium bentazon as the active ingredient. Bentazon is a contact herbicide that interferes with the photosynthesis of susceptible plants. Visible injury occurs in 4-8 hours, followed by plant death. Technical and formulated forms of bentazon are classified by the EPA as practically nontoxic to coldwater and warmwater fish. The 96-hour lethal concentration fifty (LC50) in rainbow trout is 510 mg/l for wettable powder, 190 parts per million (ppm) for technical bentazon, and 636 ppm for formulated bentazon. Bentazon is highly soluble in water, but rapidly degrades in the upper soil layers by sunlight and soil microbes. This typically keeps it from leaching below the plow layer of the soil. The half-life of bentazon is less than two weeks and reaches undetectable levels in six weeks. At concentrations of 2-10 ppm, bentazon's half-life is 2-5 weeks on soil. However, bentazon has the potential to contaminate surface water because of its mobility in runoff water or application to fields prior to flooding (Cornell University, 2001).
- Ammonium sulfate** This chemical is used as a fertilizer. Ammonium sulfate is not seen to have toxic effects. Ammonium sulfate dissolves completely in water (38% solution by weight); however, the ions bond readily with the soil, minimizing leaching (Honeywell, undated). Discharging ammonium sulfate to waterways may promote eutrophication (Honeywell, 2000).
- Crop oil** Crop oil is used as a carrier for other pesticides. Most pesticides are applied using a water mist; however, typical leaf surfaces have a waxy layer which repels water, causing the pesticide to run off. Crop oil aids in dissolving the waxy layer, allowing a higher percentage of the pesticide to be absorbed into the leaf (Pammark Farms, undated). Since "crop oil" refers to a number of chemical mixtures, the SLOH has no test to detect it.