Attachment 23:

Photograph of quarry with manure stacks

R2012-023
S James

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Attachment 24:

Complaint, *People of the State of Illinois v. Donald Irlam*

IN THE CIRCUIT COURT FOR THE SEVENTH JUDICIAL CIRCUIT
MORGAN COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS, ex rel. LISA MADIGAN, Attorney General of the State of Illinois,	)	FILED AUG 07 2009 THERESA LONERGAN Clerk of Circuit Court Morgan, Co. IL
Plaintiff,	)	
vs.	)	**No. 09-CH-** 49
DONALD IRLAM	)	
Defendant.	)	

AGREED INJUNCTION ORDER

THIS CAUSE coming on to be heard upon the request of the Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, and the Defendant, DONALD IRLAM, and the Court being fully advised in the premises:

IT IS THEREFORE ORDERED:

1. Immediately cease the discharge of wastewater, livestock waste, and manure from the facility.

2. By August 10, 2009, the Defendant shall remove and clean-up all livestock waste existing on the land and in surface water drainage in the subject ravine and creek flowing to the neighbor's pond. The Defendant shall flush the creek of all remaining waste, and collect said flush water for disposal by proper land application.

3. By August 15, 2009, the Defendant shall pump waste from the storage pits below the confinement buildings populated with swine so as to secure the availability of three months storage capacity. By August 15, 2009, the Defendant shall pump waste from the two buildings that currently do not house swine so as to secure the availability of sufficient storage to avoid any

possibility of waste discharge.

4. The Defendant shall not bring any additional swine onto the site until he receives approval from the Court to do so.

5. By September 15, 2009, the Defendant shall propose to the Illinois EPA a plan to investigate and remediate any damage to the pond.

6. By September 15, 2009, the Defendant shall submit a waste management plan to the Illinois EPA for approval.

7. A status hearing is set for 9/28, 2009, at 9:00 am.

AGREED TO:

DONALD IRLAM

BY: Donald E. Irlam
Defendant

PEOPLE OF THE STATE OF ILLINOIS,

LISA MADIGAN
Attorney General State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement Division,

BY: ____________________
THOMAS DAVIS
CHIEF
ENVIRONMENTAL BUREAU

ENTERED: 8/7/09

____
JUDGE

FILED
AUG 07 2009
THERESA LONERGAN
Clerk of Circuit Court Morgan, Co. IL

IN THE CIRCUIT COURT FOR THE SEVENTH JUDICIAL CIRCUIT
MORGAN COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS, ex rel. LISA MADIGAN, Attorney General of the State of Illinois,

Plaintiff,

vs.

DONALD IRLAM,

Defendant.

FILED AUG 07 2009 THERESA LONERGAN Clerk of Circuit Court Morgan, Co. IL

COPY

No. 09-CH- 49

VERIFIED COMPLAINT FOR INJUNCTIVE AND OTHER RELIEF

The PEOPLE OF THE STATE OF ILLINOIS, *ex rel.* Lisa Madigan, Attorney General of the State of Illinois, on her own motion and at the request of the ILLINOIS ENVIRONMENTAL PROTECTION AGENCY, complains of the Defendant, DONALD IRLAM, as follows:

COUNT I
WATER POLLUTION VIOLATIONS

1. This count is brought on behalf of the People of the State of Illinois, *ex rel.* Lisa Madigan, the Attorney General of the State of Illinois, on her own motion and at the request of the Illinois Environmental Protection Agency ("Illinois EPA" or "Agency"), pursuant to Sections 42(d) and (e), and 43(a) of the Illinois Environmental Protection Act ("the Act"), 415 ILCS 5/42(d) and (e), 43(a).

2. The Illinois EPA is an agency of the State of Illinois created by the Illinois General Assembly in Section 4 of the Act, 415 ILCS 5/4, and charged, *inter alia*, with the duty of enforcing the Act.

3. The Defendant Donald Irlam ("Irlam") owns and operates a swine confinement facility on Midway Road outside of Murrayville approximately one half mile east of his residence at 2067 Midwest Road, Murrayville, Morgan County (the "facility"). There are four confinement buildings at the site. Livestock waste is stored in underground pits beneath the confinement buildings.

5. On July 31, 2009, the Illinois EPA investigated a complaint of livestock waste discharging into a neighbor's pond directly downstream of the Defendant's facility and killing fish. At that time the storage pits under all four confinement buildings were completely full of liquid and solid livestock waste. Irlam stated to Illinois EPA inspector Jim Miles that the 600 finishing swine in two of the confinement buildings would be marketed in the next four to six weeks and that there were no swine in the other two buildings but those storage pits were full of waste.

6. On and after July 31, 2009, the neighbor's pond was contaminated with livestock waste and there was livestock waste in the creek and land upstream of the pond. The pond's contamination has precluded the use of the pond by the neighbor to water his cattle. The discharge of contaminants, including settleable solids, floating debris, visible oil, grease, scum or sludge solids, into the pond created a nuisance and rendered such water harmful or detrimental or injurious to public health, safety or welfare, to agricultural, recreational, or other legitimate uses, and to livestock, wild animals, birds, fish, or other aquatic life. The source of the livestock waste was swine manure stockpiled and dumped in a ravine behind the north building of the Defendant's facility. The ravine is tributary to the creek that flows into the neighbor's pond.

7. On August 4, 2009, Irlam stated to the Illinois EPA inspector that he hauled nine loads of livestock waste from the storage pits to the ravine. The amount of livestock waste deposited upon the land totaled approximately 27,000 gallons of waste. The facility consists of 7.1 acres of land, of which only 2 or 3 acres are suitable for the land application of livestock waste. The Defendant has insufficient land in his ownership and control for the proper land application of waste from his facility and is dependent upon his neighbors accepting waste for their fields. Irlam stated to the inspector that, due to wet conditions earlier in 2009, he was denied access to the neighbors' fields.

8. The Defendant does not have a National Pollution Elimination System Discharge ("NPDES") permit from the Illinois EPA for his swine confinement facility.

9. Section 42(e) of the Act, 415 ILCS 5/42(e), provides as follows:

> The State's Attorney of the county in which the violation occurred, or the Attorney General, may, at the request of the Agency or on his own motion, institute a civil action for an injunction to restrain violations of this Act.

10. Section 43(a) of the Act, 415 ILCS 5/43(a), provides as follows:

> In circumstances of substantial danger to the environment or to the public health of persons or to the welfare of persons where such danger is to the livelihood of such persons, the State's Attorney or Attorney General, upon request of the Agency or on his own motion, may institute a civil action for an immediate injunction to halt any discharge or other activity causing or contributing to the danger or to require such other action as may be necessary. The court may issue an ex parte order and shall schedule a hearing on the matter not later than 3 working days from the date of injunction.

11. The Plaintiff is hereby seeking immediate and/or preliminary injunctive relief pursuant to statutory authorization and has standing to bring this action pursuant to Sections 42(e) and 43(a) of the Act, 415 ILCS 5/42(e), 43(a).

12. Section 12 of the Act, 415 ILCS 5/12, provides, in pertinent part, as follows:

No person shall:

a. Cause or threaten or allow the discharge of any contaminants into the environment in any State so as to cause or tend to cause water pollution in Illinois, either alone or in combination with matter from other sources, or so as to violate regulations or standards adopted by the Pollution Control Board under this Act;

* * *

d. Deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard;

* * *

f. Cause, threaten or allow the discharge of any contaminant into the waters of the State, as defined herein, including but not limited to, waters to any sewage works, or into any well or from any point source within the State, without an NPDES permit for point source discharges issued by the Agency under Section 39(b) of this Act. . . .

13. Section 3.165 of the Act, 415 ILCS 5/3.165, contains the following definition:

"Contaminant" is any solid, liquid, or gaseous matter, any odor or any form of energy, from whatever source.

14. Section 3.545 of the Act, 415 ILCS 5/3.545, contains the following definition:

"Water Pollution" is such alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the State, or such discharge of any contaminant into any waters of the State, as will or is likely to create a nuisance or render such water harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or other aquatic life.

15. Section 3.550 of the Act, 415 ILCS 5/3.550, contains the following definition:

> "Waters" means all accumulations of water, surface and underground, natural, and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this State.

16. Section 309 .102(a) of the Board's Water Pollution Regulations, 35 Ill. Adm. Code 309.102(a), states, in pertinent part:

> Except as in compliance with the provisions of the Act, Board regulations, and the CWA, and the provisions and conditions of the NPDES permit issued to the discharger, the discharge of any contaminant or pollutant by any person into the waters of the State from a point source or into a well shall be unlawful.

17. Section 302.203 of the Board's Water Pollution Regulations, 35 Ill. Adm. Code 302.203, prohibits offensive conditions in waters of the State:

> Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal, color or turbidity of other than natural origin. . . .

18. Section 304.105 of the Board's Water Pollution Regulations, 35 Ill. Adm. Code 304.105, prohibits the violation of water quality standards:

> In addition to the other requirements of this Part, no effluent shall, alone or in combination with other sources, cause a violation of any applicable water quality standard. When the Agency finds that a discharge which would comply with effluent standards contained in this Part would cause or is causing a violation of water quality standards, the Agency shall take appropriate action under Section 31 or Section 39 of the Act to require the discharge to meet whatever effluent limits are necessary to ensure compliance with the water quality standards. When such a violation is caused by the cumulative effect of more than one source, several sources may be joined in an enforcement or variance proceeding, and measures for

> necessary effluent reductions will be determined on the basis of technical feasibility, economic reasonableness and fairness to all dischargers.

19. Section 304.106 of the Board's Water Pollution Regulations, 35 Ill. Adm. Code 304.106, prohibits offensive discharges to waters of the State:

> In addition to the other requirements of this Part, no effluent shall contain settleable solids, floating debris, visible oil, grease, scum or sludge solids. Color, odor and turbidity must be reduced to below obvious levels.

20. The Defendant has caused, allowed or threatened the discharge of contaminants to waters of the State so as to cause or tend to cause water pollution and offensive conditions or to violate the Board's regulations or standards through the discharge of livestock waste from his facility to a neighbor's pond.

21. The Defendant has caused or allowed contaminants to be deposited upon the land in such place and manner as to create a water pollution hazard through its proximity to a creek leading to the neighbor's pond.

22. The discharge of contaminants from the Defendant's facility have caused, threatened or allowed water pollution in that such discharges have and continue to likely rendered the waters of the State harmful or detrimental or injurious to public health, safety or welfare, or to agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish or other aquatic life and have likely created a nuisance.

23. By causing, allowing or threatening the discharge of contaminants to waters of the State so as to cause or tend to cause water pollution and offensive conditions or to violate the Board's regulations or standards, the Defendant has violated Section 12(a) of the Act, 415 ILCS

5/12(a), and Sections 302.203 and 304.106 of the Board's Water Pollution Regulations, 35 Ill. Adm. Code 302.203 and 304.106.

24. By depositing contaminants upon the land in such a place and manner as to create a water pollution hazard, the Defendant has violated Section 12(d) of the Act, 415 ILCS 5/12(d).

25. By causing or allowing the discharge of a contaminant into waters of the State from a point source without an NPDES permit, the Defendant has violated Section 12(f) of the Act, 415 ILCS 5/12(f), and 35 Ill. Adm. Code 309.102(a).

26. These violations, and the discharges and other activities causing or contributing to the danger, will continue unabated unless and until enjoined by this Court.

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, respectfully requests that this Court grant the following relief:

A. Find that the Defendant, DONALD IRLAM, has violated Sections 12(a), (d) and (f) of the Act, 415 ILCS 5/12(a), (d) and (f), and the Board's Water Pollution Regulations, and thereby created circumstances of substantial danger to the environment;

B. Immediately enjoin the Defendant to halt the activity causing or contributing to the danger and to require such other action as may be necessary to abate the nuisance;

C. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

D. Pursuant to Section 42(a) of the Act, 415 ILCS 5/42(a), impose upon the Defendant a monetary penalty of not more than the statutory maximum; and

E. Grant such other and further relief as the Court deems appropriate.

COUNT II
AGRICULTURE RELATED POLLUTION VIOLATIONS

1-16. Plaintiff realleges and incorporates by reference herein paragraphs 1 through 16 of Count I as paragraphs 1 through 16 of this Count II.

17. Section 501.404(c) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.404(c), provides in pertinent part:

> b) Temporary Manure Stacks
>
> 1) Temporary manure stacks shall be constructed or established and maintained in a manner to prevent runoff and leachate from entering surface or groundwaters.
>
> * * *
>
> c) Livestock Waste-Holding Facilities
>
> * * *
>
> 3) The contents of livestock waste-handling facilities shall be kept at levels such that there is adequate storage capacity so that an overflow does not occur except in the case of precipitation in excess of a 25-year, 24-hour storm.
>
> 4) Liquid Livestock Waste
>
> A) Existing livestock management facilities which handle the waste in a liquid form shall have adequate storage capacity in a liquid manure-holding tank, lagoon, holding pond, or any combination thereof so as not to cause air or water pollution as defined in the Act or applicable regulations. If inadequate storage time causes or threatens to cause a violation of the Act or applicable regulations, the Agency may require that additional storage time be provided. In such cases, interim pollution prevention measures may be required by the Agency.

19. Section 580.105(a) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 580.105(a), provides as follows:

Method of Reporting a Release of Livestock Waste.

a. An owner or operator of a livestock waste handling facility shall report any release of livestock waste from the livestock waste handling facility or from the transport of livestock waste by means of transportation equipment within 24 hours after the discovery of the release. Report of releases to surface waters, including to sinkholes, drain inlets, broken subsurface drains or other conduits to groundwater or surface waters, shall be made upon discovery of the release, except when such immediate notification will impede the owner's or operator's response to correct the cause of the release or to contain the livestock waste, in which case the report shall be made as soon as possible but no later than 24 hours after discovery.

20. On August 4, 2009, upon the neighbor's discovery of the fish kill in the pond, the Defendant reported the release of livestock waste to the Illinois Emergency Management Agency. This report was untimely because it was not made within 24 hours of the release.

21. By constructing or establishing temporary manure stacks in a manner that failed to prevent runoff to surface waters, the Defendant has violated Section 501.404(b) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.404(b).

22. By failing to provide adequate waste storage and maintain waste levels so as to prevent a discharge, the Defendant has violated Section 501.404(c) of the Board's Agriculture Related Pollution Regulations at 35 Ill. Adm. Code 501.404(c).

23. By failing to timely report the release of livestock waste, the Defendant has violated Section 580.105(a) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 580.105(a).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, respectfully requests that this Court grant the following relief:

A. Find that the Defendant, DONALD IRLAM, has violated the Board's Agriculture Related Pollution Regulations and thereby created circumstances of substantial danger to the environment;

B. Immediately enjoin the Defendant to halt the activity causing or contributing to the danger and to require such other action as may be necessary to abate the nuisance;

C. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

D. Pursuant to Section 42(a) of the Act, 415 ILCS 5/42(a), impose upon the Defendant a monetary penalty of not more than the statutory maximum; and

E. Grant such other and further relief as the Court deems appropriate.

Respectfully submitted,

PEOPLE OF THE STATE OF ILLINOIS,
ex rel. LISA MADIGAN,
Attorney General of the
State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement/Asbestos
Litigation Division

BY:____________________
THOMAS DAVIS, Chief
Environmental Bureau
Assistant Attorney General

OFCOUNSEL
JANE E. MCBRIDE
Senior Assistant Attorney General
500 South Second Street
Springfield, Illinois 62706
217/782-9031
Dated: 8/07/09

VERIFICATION

Upon penalties as provided by law pursuant to § 1-109 of the Code of Civil Procedure, I hereby certify that the factual statements set forth in this Complaint are true and correct, except as to any matters therein stated to be on information and belief and as to such matters that I verily believe the same to be true.

/s/ David Ginder
DAVID GINDER

Attachment 25:

Complaint, *People of the State of Illinois v. Inwood Dairy, LLC*

IN THE CIRCUIT COURT FOR THE TENTH JUDICIAL CIRCUIT
PEORIA COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS Plaintiff, v. INWOOD DAIRY, LLC, an Illinois limited liability corporation, Defendant.	)	No. 01 CH 76

AMENDED COMPLAINT FOR INJUNCTIVE AND OTHER RELIEF

The Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, *ex rel.* JAMES E. RYAN, Attorney General of the State of Illinois, on his own motion and at the request of the ILLINOIS ENVIRONMENTAL PROTECTION AGENCY, complains of the Defendant, INWOOD DAIRY, LLC, as follows:

COUNT I

WATER POLLUTION VIOLATIONS

1. This Count is brought on behalf of the People of the State of Illinois, *ex rel.* James E. Ryan, Attorney General of the State of Illinois, on his own motion and at the request of the Illinois Environmental Protection Agency ("Illinois EPA"), pursuant to Sections 42(d), 42(e) and 43(a) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e) and 43(a) (2000).

2. The Illinois EPA is an agency of the State of Illinois created by the General Assembly in Section 4 of the Act, 415 ILCS 5/4(1996), and which is charged, *inter alia*, with the duty of enforcing the Act.

3. Defendant Inwood Dairy, LLC ("Inwood") is a limited liability corporation, registered and in good standing in the State of Illinois. At the time this action was initiated,

David L. Inskeep ("Inskeep"), 201 W. Ash, Elmwood, IL 61529 was the managing member of the LLC. In approximately early May 2001, Albert Zeller ("Zeller"), 548 East High Point Road, Peoria, Illinois 61614, became the managing member. The members of the LLC are Inskeep, James R. DeBord, M.D., 420 N.E. Glen Oak Avenue, Peoria, IL 61603; Zeller; James S. Beard, 146 Prospect Hill, Nashville, TN 37205; Gerald L. Shaheen, 9708 Golden Oak Court, Peoria, IL 61615; George T. Shaheen, 86 Flood Circle, Atherton, CA 94027; Thomas G. Wessels, 639 Centerwood, Springfield, IL 62707. The registered agent is Husch Registered Agent, Inc., 401 Main Street, Suite 1400, Peoria, IL 61602.

4. Inwood Dairy is located just south of Elmwood on the western edge of Peoria County ("Inwood Dairy" or the "facility"). The facility supports a herd of 1,240 dairy cows, of which approximately 1,040 head are milked through three shifts. Structures on the site include a milking parlor, maturity barn, two freestall barns, several open dirt feedlots, commodity shed, equipment building and livestock waste/wastewater treatment/holding facilities, including an 8 acre lagoon.

5. The facility was constructed in 1997 and 1998. Cows were first brought to the facility on August 29, 1998.

6. Inwood Dairy is located in between two unnamed tributaries of the West Fork Kickapoo Creek that are the receiving waters of discharge from the dairy facility itself. One unnamed tributary flows around the east end of the lagoon and then north of the lagoon. A drainage ditch flows from the west around the south end of the lagoon into this unnamed tributary. The other unnamed tributary flow east toward the northwest end of the freestall barns and then flows north toward the West Fork Kickapoo Creek.

7. On October 14, 1998, Inwood Dairy was notified in Violation Notice W-1998-00204, that the facility was required to obtain a National Pollutant Discharge Elimination System ("NPDES") permit. On January 6, 2000, Inwood Dairy was again notified of the requirement

that it obtain an NPDES permit in a Notice of Intent to Pursue Legal Action (NIPLA). The NIPLA indicated that, because of the size and nature of the operation, and because releases had occurred from the facility on more than one occasion, the Illinois EPA required Inwood Dairy, LLC to obtain a NPDES permit. On April 13, 2000, the Illinois EPA received an NPDES permit application from Inwood Dairy. Inwood Dairy's NPDES permit application number is IL0074705. The application is under review, a permit has not yet been issued.

8. On February 14 and 15, 2001, the Illinois EPA inspected the Inwood Dairy facility and observed no available freeboard in the lagoon. The 8-acre lagoon was estimated to contain 40 million gallons of livestock waste. The contents came to the top of the berms. At the time of the February 15, 2001 inspection, the contents of the lagoon were beginning to flow on the top of the lagoon berms, but were not as yet flowing over the berms to the outside of the lagoon. The facility's workers were resorting to sandbagging the berm of the lagoon and to the application of wastewater. Under these conditions, on February 16, 2001, there was an imminent threat to the environment from releases of livestock waste from the Defendant's 8-acre lagoon and due to Defendant's land application of livestock waste. On February 16, 2001, Plaintiff filed a Verified Complaint for Preliminary Injunction and Other Relief, seeking preliminary injunctive relief pursuant to statutory authorization.

9. Section 42(e) of the Act, 415 ILCS 5/42(e) (2000), provides as follows:

> e. The State's Attorney of the county in which the violation occurred, or the Attorney General, may, at the request of the Agency or on his own motion, institute a civil action for an injunction to restrain violations of this Act.

10. Section 43(a) of the Act, 415 ILCS 5/43(a) (2000), provides as follows:

> a. In circumstances of substantial danger to the environment or to the public health of persons or to the welfare of persons where such danger is to the livelihood of such persons, the State's Attorney or Attorney General, upon request of the Agency or on his own motion, may institute a civil action for an immediate injunction to halt any

> discharge or other activity causing or contributing to the danger or to require such other action as may be necessary. The court may issue an ex parte order and shall schedule a hearing on the matter not later than 3 working days from the date of injunction.

11. An Immediate Injunction was issued on February 16, 2001. The Defendant was prohibited by the Immediate Injunction Order from releasing any wastewater from the Inwood Dairy facility.

12. On February 16 and 17, 2001, the Defendant pumped an estimated one to two million gallons of livestock waste from the lagoon to the ravine/waterway in violation of the Immediate Injunction Order. This pumping was started at approximately 4 p.m. on February 16, 2001, and continued through the night until approximately 3:30 P.M. on February 17, 2001.

13. On February 21, 2001, this Court entered a Preliminary Injunction Order against the Defendant, imposing additional requirements and specific compliance deadlines. The Defendant was required by the Preliminary Injunction Order to immediately and permanently cease all discharge or other activity causing or contributing to the discharge of livestock waste, livestock wastewater and other contaminants from all structure, properties, operations and land application activities of the facility. Pursuant to Paragraph 2 of the Preliminary Injunction Order, Inwood Dairy was required to remove all wastewater released from the facility's lagoon into the ravine/waterway located approximately 3/4 mile southwest of the facility's lagoon and directly connected to and discharging into the West Fork Kickapoo Creek. Pursuant to the Preliminary Injunction Order, Inwood Dairy was to have completed clean-up of the ravine/waterway by 8:00 P.M. Saturday, February 24, 2001.

14. Livestock wastewater continued to be discharged into the West Fork Kickapoo Creek from the ravine/waterway until the afternoon of February 28, 2001.

15. On February 24, 2001, livestock waste and wastewater discharged from the

facility west of the freestall barns, into an unnamed tributary of the West Fork Kickapoo Creek. Also on February 24, 2001, livestock waste was observed running off a separate and remote feedlot operated by Inwood Dairy. Manure had been stockpiled at this feedlot. This wastewater drained directly in the West Fork Kickapoo Creek.

16. On March 1, 2001, approximately 3 million gallons of wastewater remained in the ravine/waterway. The quantity had increased from the original amount pumped from the lagoon into the ravine/waterway due to precipitation. On March 1, 2001, an Illinois EPA inspector observed that wastewater was starting to flow across the top of the second dry dam.

17. On March 1, 2001, the facility's lagoon had only 4 inches of available freeboard.

18. On March 1, 2001, approximately one million gallons of wastewater had accumulated south and west of the freestall barns, and extended inside the southern-most freestall barn, at the Inwood facility. This accumulation was not within an approved containment structure and as such existed as a threat of water pollution and as a water pollution hazard in violation of Sections 12(a) and 12(d) of the Illinois Environmental Protection Act, 415 ILCS 5/12(a), (d) (2000).

19. On March 2, 2001, a second Immediate Injunction Order was entered by the Court, requiring immediate removal of the wastewater from the ravine/waterway, from the areas south and west of the freestall barns at the Inwood facility, and from the lagoon until 24 inches of freeboard was achieved. On March 5, 2001 and March 9, 2001, agreed modifications to the immediate injunction order were entered.

20. On March 13, 2001, an Agreed Modified Preliminary Injunction Order was entered.

21. On April 10, 2001, a status hearing was conducted in this matter. At the time of hearing the court allowed a modification of the March 13, 2001 Agreed Modified Order, so as to allow the dairy to apply waste to hayground using an Aer-way Tool.

22. The livestock waste management system utilized at the facility at the time this action was initiated consisted of the following. Wastewater and manure solids generated in the milking parlor, maturity barn, freestall barns and cattle transfer lanes were collected with an open gutter flushing system, utilizing concrete troughs/lanes and underground sewers. Fresh water from an on-site well was provided as flushwater for the milking parlor. Lagoon wastewater was recycled for flushwater in the maturity barn, freestall barns, and transfer lanes. Wastewater generated in the open dirt feedlots and other open areas flowed by gravity to inlets along the collection system. Wastewater and manure solids were transported to a duplex pump station and pumped to a solids separator (inclined screen). Solids removed from the waste stream were stockpiled near the separator. Wastewater flowed through the screen and was diverted directly to an 8-acre storage lagoon. There was an inlet line from the solids separator to the northwest corner of the storage lagoon. The inlet line was not submerged. Excess water from the separator was routed back to the lift station. Solids removed from the waste stream were stockpiled on site. Wastewater was pumped from the lagoon and applied to hay ground west and northwest of the dairy utilizing spray irrigation equipment. Irrigation was alternated with hay cutting and suspended during wet weather. The normal water usage at the Inwood Dairy required approximately ½ to 1 inch of freeboard per day in the lagoon.

23. Besides the flushing system that collected and directed wastewater and manure solids into the facility's lagoon, a significant amount of storm water from an area of approximately 1,225,000 sq.-ft. (28 acres) was diverted to a lift station and pumped to the lagoon or flowed directly into the lagoon.

24. Section 3.55 of the Act, 415 ILCS 5/3.55 (1996), provides:

> "WATER POLLUTION" is such alteration of the physical, thermal, chemical, biological or radioactive properties of any waters of the State, or such discharge of any contaminant into waters of the State, as will or is likely to create a nuisance or render such waters harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural,

recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or other aquatic life.

25. Section 3.56 of the Act, 415 ILCS 5/3.56 (1996), provides:

"WATERS" means all accumulations of water, surface and underground, natural, and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this State.

26. Section 3.06 of the Act, 415 ILCS 5/3.06 (1996), provides:

"CONTAMINANT" is any solid, liquid, or gaseous matter, any odor, or any form of energy, from whatever source.

27. Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), provides, in pertinent part:

No person shall:

a. Cause or threaten or allow the discharge of any contaminants into the environment in any State so as to cause or tend to cause water pollution in Illinois, either alone or in combination with matter from other sources, or so as to violate regulations or standards adopted by the Pollution Control Board under this Act;

* * *

d. Deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard;

* * *

f. Cause, threaten or allow the discharge of any contaminant into the waters of the State, as defined herein, including but not limited to, waters to any sewage works, or into any well or from any point source within the State, without an NPDES permit for point source discharge issued by the Agency under Section 39(b) of this Act, or in violation of any term or condition imposed by such permit, or in violation of any NPDES permit filing requirement established under Section 39(b), or in violation of any regulations adopted by the Board or of any order adopted by the Board with respect to the NPDES program.

28. Section 302.203 of the Illinois Pollution Control Board's ("Board") water pollution regulations, 35 Ill. Adm. Code 302.203 (1996), provides:

Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin.

29. Section 302.212(a) of the Board's water pollution regulations, 35 Ill. Adm. Code

302.212(a) (1996), provides, in pertinent part:

> a) Ammonia nitrogen (as N: Storet Number 00610) shall in no case exceed 15 mg/l.

30. Section 501.403(a) and (b), of the Board's agriculture related water pollution regulations, 35 Ill. Adm. Code 501.403(a), (b) (1996), provides:

> Protection of Livestock Management Facilities and Livestock Waste-Handling Facilities
>
> a) Existing livestock management facilities and livestock waste-handling facilities shall have adequate diversion dikes, walls or curbs that will prevent excessive outside surface waters from flowing through the animal feeding operation and will direct runoff to an appropriate disposal, holding or storage area. The diversions are required on all aforementioned structures unless there is negligible outside surface water which can flow through the facility or the runoff is tributary to an acceptable disposal area or a livestock waste-handling facility. If inadequate diversions cause or threaten to cause a violation of the Act or applicable regulations, the Agency may require corrective measures.
>
> b) New livestock management facilities and livestock waste-handling facilities shall have adequate diversions, dikes, walls or curbs that will prevent excessive outside surface runoff waters from flowing through the animal feeding operation and will direct runoff to an appropriate disposal, holding or storage area. The diversions are required on all aforementioned structures unless there is negligible outside surface water which can flow through the facility or the runoff is tributary to an acceptable disposal area or a livestock waste-handling facility. . . . If inadequate storage volumes cause or threaten to cause a violation of the Act or applicable regulations, the Agency may require corrective measures. In no case shall the storage volume of the containment facility be less than the 25-year 24-hour storm effluent guidelines as required by the new source performance standards of the U.S. Environmental Protection Agency for the feedlot point source category.

31. Section 501.404(c) of the Subtitle E: Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.404(c) (1996), provides, in pertinent part, as follows:

> Section 501.404 Handling and Storage of Livestock Waste
>
> * * *
>
> c) Livestock Waste-Holding Facilities
>
> * * *

2) Holding ponds and lagoons shall be impermeable or so sealed as to prevent groundwater or surface water pollution.

3) The contents of livestock waste-handling facilities shall be kept at levels such that there is adequate storage capacity so that an overflow does not occur except in the case of precipitation in excess of a 25-year 24-hour storm.

4) Liquid Livestock Waste

* * *

b) New livestock waste-handling facilities which handle the waste in a liquid form shall provide a minimum of 120-day storage with a liquid manure holding tank, lagoon, holding pond, or any combination thereof unless the operator has justifiable reasons substantiating that a lesser storage volume is adequate.

* * *

32. Section 501.405 of the Subtitle E: Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.405 (1996), provides, in pertinent part, as follows:

Section 501.405. Field Application of Livestock Waste

a) The quantity of livestock waste applied on soils shall not exceed a practical limit as determined by soil type, especially its permeability, the condition (frozen or unfrozen) of the soil, the percent slope of the land, cover mulch, proximity to surface waters and likelihood of reaching groundwater, and other relevant considerations. These livestock waste application guidelines will be adopted pursuant to Section 502.305, unless otherwise provided for by Board regulations.

* * *

33. Section 502.102 of the Subtitle E: Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 502.102 (1996), provides, in pertinent part, as follows:

An NPDES permit shall be required for an animal feeding operation which falls within the criteria set forth in Section 502.103 and Section 502.104 below; provided, however, that no animal feeding operation shall require a permit if it discharges only in the event of a 25-year 24-hour storm event.

34. Regulations promulgated under the Livestock Management Facilities Act, 510

ILCS 77/1 *et seq*. (1996), require that operators maintain 2 foot of freeboard in their lagoons. This provision, found at 35 Ill. Adm. Code 506.204 provides:

Section 506.204 Lagoon Design Standards

* * *

(g) Any livestock waste lagoon subject to the provisions of this Part shall meet or exceed the following:

4) In addition to the lagoon's total design volume, a freeboard shall be provided as follows:

A) For lagoons serving a livestock management facility with a maximum design capacity of less than 300 animal units and not collecting runoff from areas other than the exposed surface of the lagoon (including associated interior berm slopes and flat berm top areas), the top of the settled embankment shall be not less than 1 foot above the fluid surface level of the lagoon total design volume; or

B) For all other lagoons, the top of the settled embankment shall not be less than 2 feet above the fluid surface level of the lagoon total design volume.

For milking dairy cows, the number of animal units on a facility is the number of milking cows times 1.4. 35 Ill Adm. Code 506.103. Therefore, the 1,040 milking head at the Inwood Dairy facility constitute 1,456 animal units.

35. On September 4, 1997, the Illinois conducted an inspection of the Inwood facility. Earthwork construction was ongoing at the time of the inspection. Due to recent precipitation, surface water was draining from the proposed cattle feedlot/building area via a buried PVC pipe. The pipe drained to a 30 foot deep concrete sump. In an attempt to de-water the area, liquid was being pumped from the sump to a southeast storm water retention basin. At the time of the inspection, the liquid in the retention basin was turbid and brown. Brown, turbid liquid was discharging from the retention basin into an unnamed tributary of the West Fork of Kickapoo Creek. The discharge was causing the receiving stream to be brown colored and turbid. The receiving stream was also observed to be turbid and brown colored at the northeast

one-quarter, Section 19, T.9N R.5E, in Peoria County where Peabody Road crosses the stream.

36. On September 10, 1997, the Illinois EPA conducted an inspection of Inwood Dairy. Earthwork construction was ongoing at the time of the inspection. Corn silage was being chopped with the hope of filling the bunker within a matter of days. Rick Silva, general manager of the facility at the time of the inspection, indicated that 6,000 tons of silage was to be chopped and stored. The facility's bunker silo was about one quarter full at the time of the inspection. The silage stack was approximately 10 feet tall and was not covered. Several small channels of silage leachate were observed draining away from the silo. The leachate was draining to the south and east. The Illinois EPA collected samples of the silage leachate in the bunker and at the points of un-contained discharge. Test results of the leachate sample taken in the bunker silo indicated ammonia levels of 36 mg/l, biochemical oxygen demand ("BOD_5") levels of 9,240 mg/l and suspended solids levels of 700 mg/l. The Illinois EPA collected a silage leachate sample from the east side of the bunker silo. This leachate was flowing from the silo and draining to the east toward the receiving stream. Test results of this sample indicated ammonia levels of 65 mg/l, BOD_5 levels of 9,840 mg/l and suspended solids levels of 1,080 mg/l. Another silage leachate sample was collected outside the southeast corner of the bunker silo. The liquid was dark colored, turbid and contained a strong odor. Test results of this sample indicated ammonia levels of 95 mg/l, BOD_5 levels of 11,600 mg/l and suspended solid levels of 715 mg/l. Another silage leachate sample was collected from the south end of the bunker silo. The liquid was dark colored and turbid with a strong odor. Surface runoff drains to the south into a newly constructed drainage channel. Test results of this sample indicated ammonia levels of 63 mg/l, BOD_5 levels of 11,000 mg/l and suspended solids levels of 755 mg/l.

37. On September 15, 1997, the Illinois EPA conducted a compliance inspection at

the Inwood facility. At the time of the inspection, un-contained silage leachate existed at the south end of the bunker silo at the facility.

38. On October 14, 1997, the Illinois EPA conducted a compliance inspection at the Inwood facility. The silage in the bunker silo was covered with plastic except at the north end. At the time of the inspection, the plastic cover was blown apart at almost every seam, exposing the silage to rainfall. An earthen berm had been constructed diagonally across the north end of the bunker silo to impound leachate. The Illinois EPA inspector observed silage leachate inside the berm and outside of the berm, on the north end of the bunker.

39. On December 2, 1997, the Illinois EPA conducted an inspection of the Inwood Dairy. At the time of the December 2, 1997 inspection, silage leachate was draining north and east, away from the silo. It was not contained. An earthen berm had been constructed near the north end of the silo. A significant volume of leachate was impounded behind the earthen berm. However, leachate was still seeping out of the silo. A plastic cover was placed over a portion of the silage stockpile, but the plastic was ripped and silage exposed to precipitation at several locations. A sample of the silage leachate impounded behind the earthen berm was collected. The test results indicated ammonia levels of 331 mg/l, BOD_5 levels of 25,700 mg/l and suspended solid levels of 1,360 mg/l. At the time of the inspection, the southeast retention basin contained turbid, brown colored liquid. Liquid was draining from the southeast retention basin to the receiving stream. The discharge was turbid and brown colored, and was causing the receiving stream to be turbid and brown colored. At the time of the inspection, surface water from the proposed feedlot area was draining to the collection sump. In an attempt to de-water the site, this surface water was being pumped from the sump via two portable pumps. The larger pump was pumping liquid to the southeast retention basin. The second pump was pumping liquid to the drainage channel through the proposed lagoon area and into the receiving stream. The discharge from the pumps was turbid and brown colored.

40. On January 8, 1998, the Illinois EPA conducted an inspection of the Inwood Dairy. At the time of the January 8, 1998 inspection, the small earthen berm remained in place at the north end of the bunker silo containing corn silage. A dark colored leachate was impounded behind the dam to a depth of approximately one foot. Leachate had passed through the earthen dam and had accumulated in large un-contained puddles outside the dam. A sample of the silage leachate was collected from the puddles located outside the earthen berm. The liquid was black colored, turbid and contained a very strong odor. The test results indicated ammonia levels of 154 mg/l, BOD_5 levels of 16,500 mg/l and suspended solids levels of 1,585 mg/l

41. On April 9, 1998, the Illinois EPA conducted an inspection of the Inwood Dairy. At the time of the April 9, 1998 inspection, large puddles of silage leachate existed at the northern portion of the silo. These puddles were not contained. It was apparent that surface runoff was draining away from the silo to the west. A small channel directed surface runoff into the storm water diversion ditch on the west side of the silo. It was apparent that silage leachate had drained into the storm water diversion ditch and discharged off-site. A sample of the puddles at the northern portion of the silo was collected. Test results of this sample indicated ammonia levels of 201 mg/l, BOD_5 levels of 16,100 mg/l and suspended solids levels of 375mg/l. At the time of the inspection, a small flow of turbid liquid was discharging from the southeast retention basin.

42. On October 1, 1998, the Illinois EPA conducted an inspection of the Inwood Dairy. From the gravel lane on the west side of the facility, an Illinois EPA inspector observed cattle manure accumulated in a low area on the east side of the gravel road south of the barns. On October 2, 1998, a follow-up inspection was conducted by the Illinois EPA. According to workers at the facility, the pipe had detached from the sump/pump station adjacent to the lagoon on or about September 30, 1998, rendering the submersible pump useless and causing

wastewater to surcharge the sanitary sewer system and accumulate in the open area on the east side of the gravel lane. It was evident that the level of wastewater in this impounded area had recently receded about 1 foot. Wastewater had accumulated to an elevation that caused it to flow west, across the gravel lane, and enter a storm water inlet pipe located on the west side of the gravel lane. This pipe directed the livestock waste and wastewater north, into the northwest retention basin. The northwest retention basin discharges off-site. Samples were collected in areas of wastewater accumulation south of the barns. The first sample was collected near the southern-most riser pipe just east of the gravel lane at a location where cattle waste had accumulated. The liquid was turbid, dark colored and odorous. Test results of this sample indicated ammonia levels of 92 mg/l, BOD_5 levels of 10,550 mg/l and suspended solids levels of 1,070 mg/l. Another sample was collected just east of the gravel lane but closer to the southern-most barn, at a location where cattle waste had accumulated in a low area. The liquid was turbid, dark colored and contained a strong livestock odor. Test results of this sample indicated BOD_5 levels of 680 mg/l and suspended solids levels of 940 mg/l. A sample was also collected from the northwest retention basin. There was a small channel of flow in the basin at the time of sampling. The inspector observed turbid, odorous liquid in the basin at the time of sampling. Test results of this sample indicated ammonia levels of 16 mg/l, BOD_5 levels of 190 mg/l and suspended solids levels of 304 mg/l. At the time of the October 2, 1998 inspection, the Illinois EPA inspector also sampled an un-contained silage leachate puddle located on the west side of the bunker silo. Test results of this sample indicated ammonia levels of 534 mg/l, BOD_5 levels of greater than 14,040 mg/l and suspended solids levels of 935 mg/l.

43. On October 6, 1998, the Illinois EPA conducted an inspection of the Inwood Dairy. On October 6, 1998, liquid cattle manure was discharging from the west end of the north cattle barn. An apparent malfunction in the flushing system was causing the discharge.

44. On April 16, 1999, the Illinois EPA conducted an inspection of the Inwood facility.

At the time of the inspection, odors around the lagoon were prominent. The Illinois EPA inspector experienced lagoon odors at a residence approximately 1/4 mile east of Inwood.

45. On May 13, 1999, the Illinois EPA conducted an inspection of the Inwood Dairy. At the time of the May 13, 1999 inspection, the facility's lagoon contained only 8 to 10 inches of freeboard. The inspector also observed that a large area of wastewater had accumulated outside of the west side of the lagoon. A standpipe or riser pipe was located on the west side of the lagoon at the time of the May 13, 1999 inspection. The standpipe was connected to the force main which delivers wastewater from the wet well to the lagoon. The inspector observed wastewater discharging from the riser pipe. It was apparent that the force main was surcharging. The inspector also observed sludge/manure solids in the area near the riser pipe and west of the lagoon. A sample of this wastewater accumulation outside of the lagoon was taken, and the test results indicated BOD_5 levels of 705 mg/l, and total suspended solids levels of 920 mg/l.

46. At the time of the May 13, 1999 inspection, the Illinois EPA inspector observed a low flow of turbid, gray colored and odorous liquid discharging from the outlet pipe of the northwest retention basin. The basin discharged to a road ditch along Taggart Road. This road ditch flows into the unnamed tributary of the West Fork Kickapoo Creek that flows along the west and north end of the dairy facility. A sample was taken of the liquid being discharged from the retention basin. Sample test results indicated an ammonia level of 20 mg/l, a BOD_5 level of 23 mg/l and a total suspended solids level of 535 mg/l. On May 13, 1999, the inspector observed odorous sludge on the bottom of the retention basin, and a flow of liquid into the basin via an inlet pipe. A sample of the inflow into the retention basin was collected. The sample test results indicated an ammonia level of 92 mg/l, a BOD_5 level of 975 mg/l and a total suspended solids level of 9210 mg/l. Such test results and the observation of odor indicates that the inflow into the basin was not clean storm water, but rather liquid that contained livestock waste.

47. At the time of the May 13, 1999 inspection, the Illinois EPA inspector observed that surface water from an adjacent cornfield flowed onto the Inwood facility property and into the facility's lagoon. This inflow of storm water constituted a failure to divert clean water from the facility's wastewater system so as to preserve adequate capacity in the lagoon. The Illinois EPA inspector observed that it was apparent that storm water runoff from several areas in the adjacent cornfield had recently drained into the Inwood wastewater lagoon system. At the time of the May 13, 1999 inspection, Gordon Inskeep told the inspector that the storm water inflow had been discovered that morning and an earthen dam had been installed to divert the storm water.

48. At the time of the May 13, 1999 inspection, uncovered, un-contained spoiled silage remained on-site in a portion of a bunker silo. Silage leachate was draining off site. The leachate was dark colored, turbid and odorous. A liquid sample was collected from the silage leachate discharge. The sample results indicate levels of 5.6 mg/l ammonia, 1130 mg/l BOD_5, and 215 mg/l total suspended solids.

49. At the time of the May 13, 1999 inspection, the Illinois EPA inspector observed an earthen spillway at the southwest corner of the facility's lagoon. The spillway consisted of a cut in the top of the lagoon berm. The lack of adequate freeboard in the lagoon and the barren, loose soil condition of the spillway posed a threat to the structural integrity of the 8-acre, 40 million gallon wastewater lagoon. In the event that an overflow occurred through the exposed spillway, the wastewater would erode the entire section of the lagoon berm, potentially resulting in a serious lagoon breach and extensive wastewater discharge.

50. At the time of the May 13, 1999 inspection, Gordon Inskeep informed the Illinois EPA inspector that no wastewater or sludge had, since the time operations were initiated at the facility, been removed from the lagoon. Mr. Inskeep told the inspector that de-watering equipment was on order, but as yet no material had been removed from the lagoon.

51. On May 17, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the lagoon freeboard was 10 to 12 inches.

52. On May 21, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the lagoon freeboard was 8 to 10 inches. The dairy had placed geotextile fabric and stone rip-rap in the lagoon spillway in an attempt to increase the lagoon capacity.

53. On May 24, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the lagoon freeboard was 8 to 10 inches. At the time of the inspection a strong anaerobic/septic odor was experienced by the Illinois EPA inspector downwind of the lagoon. A strong offensive putrid odor was experienced by the inspector downwind of the old silage bunker, and a combination of septic and livestock odor was experienced by the inspector around the barns. The odor around the barns was much stronger during a flushing event. Lagoon wastewater was utilized to flush the barns. At the time of the inspection, a strong putrid septic odor was experienced by the Illinois EPA inspector off-site along Wiley Road near the William Wagner residence. On May 24, 1999, the Illinois EPA conducted a physical inspection at the William Wagner residence. Mr. Wagner's residence is approximately 3,300 lineal feet southeast of the Inwood lagoon. The Illinois EPA inspector experienced a strong offensive odor directly downwind of the dairy at the Wagner residence. The odor appeared to be emanating from a combination of sources at the dairy, including the lagoon, the cattle barns, feedlots, and rotten silage at the silage bunker.

54. On June 22, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. On June 21, 1999, a wastewater release had occurred during spray irrigation operations because a new hose ripped at a metal coupling. Approximately 2,000 gallons of wastewater discharged into a roadside ditch along Taggart Road just west of the dairy. The rip was discovered when the irrigation pumping rate suddenly dropped from 650 gallons per minute

("gpm") to 450 gpm. Irrigation operations were suspended when the leak was discovered. The dairy placed rice hulls along the ditch to absorb the spilled wastewater, but a portion of the discharge drained into an unnamed tributary of the West Fork Kickapoo Creek.

55. On July 2, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the Illinois EPA inspector experienced a strong anaerobic odor at the northwest corner of the lagoon. A significant amount of biological activity/gasification was occurring in the lagoon. The Illinois EPA inspector advised David Inskeep that serious odor conditions existed at the facility. The Illinois EPA inspector experienced a strong anaerobic odor from the facility off-site, downwind of the facility.

56. On August 3, 1999, the Illinois EPA conducted an inspection at the facility. At the time of the inspection approximately 12 inches of freeboard was available in the lagoon. During a significant storm event or prolonged periods of wet weather, irrigation operations to remove wastewater from the lagoon and land apply it were suspended. During such a time, all wastewater and storm water would be diverted to the lagoon or to limited collection system storage. The spray irrigation system in use at the time of the August 3, 1999 inspection was not providing sufficient storage capacity in the facility's lagoon even during recent dry hot weather. At the time of the August 3, 1999 inspection, the lagoon did not have sufficient capacity to contain a 25-year, 24-hour storm.

57. On August 13, 1999, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, the lagoon had 10 to 12 inches of available freeboard. The wastewater level in the lagoon was at the same elevation as the emergency spillway overflow. David Inskeep stated that sand bags supported by concrete blocks would be placed across the emergency spillway to increase the holding capacity of the lagoon.

58. At the time of the August 13, 1999 inspection, the spray irrigation equipment used to land apply wastewater from the facility's waste management system was not being

utilized due to recent wet weather. Irrigation at the facility is alternated with hay-cutting and suspended during wet weather. Land application from the waste management system, at the time of the inspection, had also been limited by the hydraulic capacity of the irrigation equipment available for use at the facility.

59. At the time of the August 13, 1999 inspection, the lagoon did not have adequate storage to prevent a discharge during a significant storm event or during prolonged periods of wet weather. At the time of the inspection the lagoon had approximately 10 inches of available freeboard. A 25-year, 24-hour storm could have increased the wastewater level in the lagoon as much as 16 inches. At the time of the inspection, the inspector recommended that additional storm water diversion improvements be installed at the facility.

60. At the time of the August 13, 1999 inspection, the surface of the facility's lagoon was covered with scum/sludge and a septic odor was present.

61. At the time of the August 13, 1999 inspection, gutters and downspouts previously installed on the barns were finally connected to the storm sewer system. David Inskeep stated that the dairy received 1.25 inches of rainfall on August 12, 1999, and the lagoon water level rose approximately 2 inches. The lagoon level increased approximately 3 inches for every one inch of rainfall prior to the connection of these downspouts.

62. On August 24, 1999, the Illinois EPA conducted a compliance inspection at the facility. A dam had been constructed across the wastewater lagoon emergency spillway. The wastewater elevation had risen to the base of this dam, indicating the dam was preventing a discharge.

63. At the time of the August 24, 1999, inspection, total available lagoon freeboard was about 12 inches. The lagoon irrigation pump was not in service.

64. At the time of the August 24, 1999 inspection, wastewater was ponded in an un-contained manner on both sides of the road on the Inwood property south of the freestall barns

at the facility.

65. At the time of the August 24, 1999 inspection, the silage bag near the office at the facility was very odorous and un-contained leachate was ponded around the open end of the bag in a manner that would allow it to drain into the adjacent road ditch.

66. At the time of the August 24, 1999 inspection, the Illinois EPA inspector observed a large amount of gasification occurring in the facility's lagoon. The lagoon contents had a strong putrid odor. The wind was from the west. At the time of the August 24, 1999 inspection, stockpiles of manure solids located under the solids separator were very odorous.

67. On September 8, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the wind was from the west/northwest and a strong putrid odor was experienced by the Illinois EPA inspector on the east and south sides of the lagoon. Silage stored by the office was odorous.

68. On September 29, 1999, the Illinois EPA conducted a compliance inspection at the facility. At the time of the September 29, 1999 inspection, contaminated storm water was ponded and not contained on the west side of the lagoon. The area was receiving runoff from the area where solid manure was stockpiled under the solids separator and from the feed bunker.

69. At the time of the September 29, 1999 inspection, the wind was from the northwest and a strong putrid odor was experienced by the Illinois EPA inspector on the southeast side of the lagoon. At the time of the inspection, the Illinois EPA inspector informed David Inskeep that the lagoon would remain anaerobic and odorous as long as organic loading stayed at current levels and that any increase in loadings would result in increased odor emissions. At the time of the inspection, the Illinois EPA inspector advised David Inskeep that lagoon odors could be controlled by maintaining aerobic conditions which would require reducing organic loading to the lagoon. The inspector also discussed with Mr. Inskeep

controlling odors by covering the anaerobic lagoon and collecting the gaseous emissions. At the time of the inspection, silage stored by the facility's office was very odorous. Also at the time of the inspection, the facility's solids separator was in use at the time of the September 29, 1999 inspection, and the stockpile of manure solids under the separator was odorous.

70. On November 19, 1999, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the solids separator was in use and the manure solids stockpiled under the separator were odorous. The wind was from the west and a strong putrid odor was experienced by the Illinois EPA inspector on the east side of the lagoon. At the time of the inspection, strong odors were experienced off-site to the east of the dairy on a public road in front of the closest residence to the dairy to the east, that being the home of Jeff and Bonny Azure. These odors were also experienced on the public road north and south of the same residence. The nature of the off-site odors was the same as the nature of the odors experienced on the east side of Inwood's lagoon.

71. On December 2, 1999, the Illinois EPA conducted an inspection at the facility in response to a citizen complaint. At the time of the inspection, David Inskeep stated that livestock waste from the dairy lagoon was being applied to an agricultural field and the operator had spread liquid waste across a waterway without realizing the waterway contained a field tile. The waste entered the tile and discharged into the headwaters of the unnamed tributary of the West Fork Kickapoo Creek that flows east and then north in a location northwest of the dairy. At the time of the December 2, 1999 inspection, the Illinois EPA inspector collected a sample from the unnamed tributary near the northwest corner of the dairy property at the south edge of Taggart Road. The Illinois EPA inspector observed that the stream at this location was very turbid with a distinct livestock waste odor. Flow in the stream was estimated to be approximately 5 gpm and was exclusively composed of livestock waste. No fish were observed at this location. The field tile that was the apparent source of the discharge existed

approximately one half (½) mile upstream from the sampling location.

72. On December 21, 1999, the Illinois EPA conducted a compliance inspection of the Inwood facility. At the time of the inspection, wastewater was pooling outside of the lagoon in an un-contained manner, in a large area along the west edge of the lagoon. The 8-inch diameter force main from the wet well located near the northwest corner of the lagoon was apparently plugged, causing wastewater and sludge to accumulate along the west side of the lagoon. The ponded un-contained wastewater/sludge was odorous. The Illinois EPA inspector collected a sample of the wastewater in the ponded area west of the lagoon. Test results of this sample indicated ammonia levels of 340 mg/l, BOD_5 levels of 1,900 mg/l and suspended solids levels of 715 mg/l. At the time of the inspection, wastewater in the wet well to the lagoon was turbid and dark greenish-brown in color. The wastewater in the wet well emitted a strong and offensive, rotten egg odor. The contents of the lagoon were turbid, dark greenish-brown in color, and emitted a strong and offensive odor. The 8-inch diameter inlet pipe to the lagoon was exposed and not submerged.

73. On January 4, 2000, the Illinois EPA conducted a compliance inspection in the vicinity of the Inwood facility. In that this inspection was conducted immediately after an inspection of another livestock facility, all observations were made off-site from Wiley Road and an old unnamed access road located just southeast of the dairy. A strong septic odor was experienced by the Illinois EPA inspector approximately ½ mile southeast of the dairy. It was apparent that the odors were emanating from the facility's anaerobic lagoon. No other odor source was observed in the area. Weather conditions at the time of the inspection included cool temperatures (30 to 35 degrees F) and relatively gusting winds (15-20 mph). The lagoon appeared to have 6 to 8 inches of available freeboard at the time of the inspection and there was an ice cover developing on the lagoon.

74. On January 26, 2000, the Illinois EPA conducted a compliance inspection at the

facility. At the time of the January 26, 2000 inspection, the Illinois EPA inspector observed that a significant amount of storm water runoff at the facility still drained to the lift station and was being pumped to the lagoon. The Illinois EPA inspector observed that additional storm water improvements were needed to sufficiently divert storm water so as to ensure adequate capacity in the lagoon. The inspector specifically observed that diversion improvement should be implemented so as to eliminate unused open feedlots from the watershed flowing into the lagoon.

75. At the time of the January 26, 2000 inspection, the facility's lagoon had an ice cover with approximately 6 to 8 inches of available freeboard. An anaerobic lagoon odor was experienced by the Illinois EPA inspector downwind of the facility along Quarry Road (5/8 mile south of the dairy).

76. On February 15, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the January 26, 2000 and February 15, 2000 inspections, the Illinois EPA inspector observed that the solids separator at the facility was not in use. The separator was in use at the time of the November 19, 1999 inspection, but had not been observed in use since. The separator screens were not be used during months of cold weather. Wastewater and manure solids were being pumped directly into the lagoon. On February 15, 2000, the Illinois EPA inspector observed that the available storage capacity in the lagoon had been reduced significantly during recent weeks.

77. At the time of the February 15, 2000 inspection, an anaerobic lagoon odor was experienced by the Illinois EPA inspector around the wastewater handling facilities and a livestock/septic odor was experienced around the barns and parlor. An obvious off-site livestock waste odor was experienced by the Illinois EPA inspector off-site downwind of the facility along Peabody Road approximately ½ mile north by northwest of the dairy. This off-site odor appeared to emanate from various sources at the dairy, including the wastewater lagoon,

the solids separator area and the cattle barns. At the time of the inspection, winds were gusting 20 to 26 mph from the south by southwest and the temperature was approximately 40 degrees F.

78. On March 13, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the March 13, 2000 inspection, the facility's solids separator was in operation. A new 15-inch inlet line had recently been installed from the separator to the lagoon. An 8- inch pipe had formerly serviced both the lift station and the separator, carrying wastewater to the lagoon.

79. At the time of the March 13, 2000 inspection, an anaerobic lagoon odor was experienced by the Illinois EPA inspector around the wastewater handling facilities and livestock/septic odor was experienced around the barns and parlor. An obvious off-site livestock odor was experienced by the Illinois EPA inspector downwind of the facility along Wiley Road. This off-site odor appeared to emanate from various sources at the dairy, including, the wastewater lagoon, the solids separator area and the cattle barns. These same odors were experienced by the Illinois EPA inspector at the residences of William Wagner and Jeff and Bonny Azure. At the time of the inspection, winds were 4 to 6 mph from the west and the temperature was 44 to 46 degrees F. At the time of the inspection, the Illinois inspector contacted Julie Wagner, whose residence is directly south of the dairy on Quarry Road. Ms. Wagner indicated that offensive off-site odors from the dairy had been experienced at her home on March 11 and March 12, 2000.

80. On March 27, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the March 27, 2000 inspection, both screens of the solids separator were being utilized to remove manure solids. Wastewater was being diverted from the screens into the lagoon through the new 15-inch inlet line. The wastewater lagoon had only approximately 20 inches of available freeboard to the spillway invert elevation. At the time of the March 27,

2000 inspection, the Illinois EPA inspector observed that, despite extremely dry weather during recent months, the lagoon was full.

81. At the time of the March 27, 2000 inspection, the facility's lagoon was black and septic. Gas bubbles and floating sludge were observed on the entire surface of the 8-acre lagoon. An anaerobic/septic odor was experienced by the Illinois EPA inspector around the lagoon and the solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector around the barns and parlor. At the time of the inspection, an off-site odor that appeared to emanate from various sources at the dairy, including, the wastewater lagoon, the solids separator area and the cattle barns, was experienced by the Illinois EPA inspector downwind of the dairy along Wiley Road. At the time of the inspection, winds gusted 10 to 18 mph from the west by northwest and the temperature was approximately 55 degrees F.

82. On April 4, 2000, the Illinois EPA conducted a compliance inspection at the facility. The solids separator was in use at the time of this inspection. The lagoon had approximately 20 inches to 24 inches of freeboard to the spillway invert elevation. At the time of the April 4, 2000 inspection, the Illinois EPA inspector told David Inskeep that the lagoon was full despite extremely dry weather and that these conditions had existed for several months. Typical spring wet weather could still overload the lagoon. Mr. Inskeep indicated he might cut back the amount of fresh water used in the milking parlor to reduce hydraulic loading on the lagoon. Also at the time of the April 4, 2000 inspection, the Illinois EPA inspector observed that the unused cattle feedlot south of the freestall barns should be cleaned and removed from sanitary collection system, so as to divert this area from the watershed of the lagoon.

83. At the time of the April 4, 2000 inspection, the contents of the facility's lagoon were black and septic and gas bubbles and floating sludge were observed floating on the surface.

84. On April 20, 2000, the Illinois EPA conducted a compliance inspection at the

facility. At the time of the April 20, 2000 inspection, livestock waste generated at the facility was not being diverted through the solids separator. The Illinois EPA inspector observed that the separators had only been in use for one brief period during the past six months. The lagoon had approximately 24 inches of freeboard to the spillway invert elevation.

85. At the time of the April 20, 2000 inspection, the contents of the facility's lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. The Illinois EPA inspector experienced an anaerobic odor from the lagoon and the solids separator and also experienced livestock odor from the barns. At the time of the inspection, there were light winds of approximately 8 mph from the east and the temperature was approximately 59 degrees F. At the time of the inspection, the Illinois EPA had continued to received complaints that offensive odors from the dairy were unreasonably interfering with the enjoyment of life and property at the residences of neighbors. William Wagner indicated the odors were particularly bad during the prior three weeks, especially during times of irrigation operations. Dave and Julie Wagner, who resided to the south of the dairy, also reported strong offensive odors.

86. On May 2, 2000, the Illinois EPA conducted an off-site inspection of the Inwood facility. The Illinois EPA inspectors experienced an offensive odor downwind of the dairy, and identified the odor to be coming from the dairy. The off-site odor was experienced approximately 3/4 mile north-northwest of the dairy on Peabody Road, located in the east one-half of Section 19, Elmwood Township in Peoria County.

87. On May 18, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the May 18, 2000 inspection, the solid separator was in use. The lagoon had only 12 inches of freeboard to the spillway invert elevation. At the time of the May 18, 2000 inspection, the lagoon did not have sufficient capacity to contain a 24-hour, 25-year storm event.

88. At the time of the May 18, 2000 inspection, the facility's anaerobic lagoon was black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. An anaerobic odor from the lagoon and solids separator and a livestock odor from the barns were experienced by the Illinois EPA inspector on site at the facility and approximately 3/4 mile downwind, north, of the dairy, along Wiley Road, and approximately 1 mile from the dairy on Graham Chapel Road. A particularly strong septic odor was experienced by the Illinois EPA inspector in the barns during flushing operations due to the anaerobic condition of the lagoon wastewater utilized to flush the barns. At the time of this inspection, there was a misty, light rain, there were strong winds of 14 to 21 mph from the south and temperatures of 60 to 64 degrees F.

89. On May 23, 2000, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the Illinois EPA inspector experienced a strong, offensive hydrogen sulfide odor emanating from the wet well to the lagoon. A significant amount of anaerobic activity was observed in the lagoon. Large "sludge turtles" were observed rising to the surface. A very strong and offensive odor was experienced by the Illinois EPA inspector at the south end of the lagoon. The contents of the lagoon were black colored and turbid. At the time of the inspection, the lagoon had 16 inches of freeboard.

90. On May 30, 2000, the Illinois EPA conducted a compliance inspection at the facility. The lagoon had 12 inches of available freeboard to the spillway invert elevation. Wastewater was not being pumped from the lagoon and applied to crop land due to wet fields. Due to inadequate freeboard at the time of the May 30, 2000 inspection, additional rain could flood the facility or result in an overflow from the lagoon. At the time of the May 30, 2000 inspection, the lagoon did not have sufficient capacity to contain a 24-hour, 25-year storm event.

91. At the time of the May 30, 2000 inspection, the contents of the facility's

anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector downwind, that being west by northwest, of the lagoon. An anaerobic/septic odor was experienced by the Illinois EPA inspector downwind of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector downwind of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector downwind, that being west by northwest, of the facility along the access road.

92. On June 12, 2000, the Illinois EPA conducted a compliance inspection at the facility. The lagoon had 12 inches of available freeboard to the spillway invert elevation. At the time of the June 12, 2000 inspection, the lagoon did not have sufficient capacity to contain a 24-hour, 25-year storm event.

93. At the time of the June 12, 2000 inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector downwind of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector downwind of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector downwind, that being east, of the facility along Wiley Road. A strong odor was also experienced by the Illinois EPA inspector in the Inwood fields near stockpiled feed.

94. On June 26, 2000, the Illinois EPA conducted a compliance inspection at the facility. The lagoon had 6 inches of available freeboard to the spillway invert elevation. The spillway had recently been filled with concrete blocks and a lime/soil fill to increase the lagoon capacity. Wastewater was not being pumped from the lagoon and applied to crop land due to

wet fields. Due to inadequate freeboard at the time of the June 26, 2000 inspection, additional rain could flood the facility or result in an overflow from the lagoon. At the time of the June 26, 2000 inspection, the lagoon did not have sufficient capacity to contain a 24-hour, 25-year storm event.

95. At the time of the June 26, 2000 inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector downwind of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector downwind of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector downwind, that being east, of the facility along Wiley Road.

96. On June 28, 2000, the Illinois EPA conducted a compliance inspection at the facility. The lagoon had 8 inches of available freeboard to the spillway invert elevation. At the time of the June 28, 2000 inspection, the lagoon did not have sufficient capacity to contain a 24-hour, 25-year storm event.

97. At the time of the June 28, 2000 inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector downwind of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector downwind of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector downwind, that being east, of the facility along Wiley Road.

98. On July 7, 2000, the Illinois EPA conducted an inspection in response to a complaint that livestock waste and wastewater were flowing off a land application site into roadside ditches. At the time of the inspection, the Illinois EPA inspector observed wastewater

accumulated in the ditch on the east side of Illinois Rt. 78 and in the ditch on the north side of Taggart Road. Samples were collected. Test results of a sample collected from pooled wastewater in the ditch along Taggart Road indicated ammonia levels of 146 mg/l, BOD_5 levels of 300 mg/l and suspended solids levels of 405 mg/l.

99. On July 14, 2000, the Illinois EPA conducted a compliance inspection at the facility. The 8-acre lagoon had only approximately 12 inches of available freeboard to the spillway invert elevation. At the time of the July 14, 2000 inspection, the lagoon did not have sufficient capacity to contain a 24-hour, 25-year storm event.

100. At the time of the July 14, 2000 inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector along the southeast side of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector southeast of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector southeast of the facility. The wind was from the northwest.

101. On July 26, 2000, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector along the northeast side of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector northeast of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector northeast of the facility along Wiley Road.

102. On August 18, 2000, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the contents of the facility's anaerobic lagoon

were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector along the south side of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector south of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector south of the facility near the Dave and Julie Wagner residence.

103. On September 15, 2000, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong septic/putrid odor was experienced by the Illinois EPA inspector along the south side of the lagoon and solids separator, and a livestock/septic odor was experienced by the Illinois EPA inspector south of the cattle barns and parlor. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector south of the facility near the Dave and Julie Wagner residence. The anaerobic lagoon appeared to be the main source of odor.

104. On September 26, 2000, the Illinois EPA conducted a inspection at the facility in response to complaints regarding wastewater being discharged from the southeast storm water retention basin. At the time of the September 26, 2000, haylage was stored in Ag-bags in an open area just east of the milking parlor. Ponded leachate from this haylage was observed along the drainage path to the southeast retention basin. Observation and discussions with David Inskeep indicated that recent rainfall flushed the leachate into the retention basin. The leachate was dark reddish brown in color, very turbid, and odorous. Storm water runoff containing the haylage leachate entered the southeast retention basin through an inlet riser pipe. The contents of the retention basin were discharged from a 12-inch PVC outlet pipe to an adjacent stream. At the time of the inspection, the contents of the basin were reddish brown in

color, turbid and odorous. Recent rains had apparently produced a significant discharge from this basin. At the time of the inspection, leachate runoff was entering the basin and the basin was discharging at a rate of approximately 2 to 3 gpm. Samples were collected. Test results of a sample of the retention basin discharge indicated ammonia levels of 35 mg/l, BOD5 levels of 315 mg/l and suspended solids levels of 160 mg/l. Test results of a sample of ponded leachate collected at the retention basin inlet indicated ammonia levels of 73 mg/l, BOD5 levels of 635 mg/l and suspended solids levels of 158 mg/l.

105. At the time of the September 26, 2000 inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. A strong anaerobic/putrid odor was experienced by the Illinois EPA inspector around the lagoon and solids separator, a strong rotten haylage odor was experienced in the Ag-bag storage area, and a livestock/septic odor was experienced by the Illinois EPA inspector downwind of the cattle barns. At the time of the inspection, an obvious offensive off-site odor was experienced by the Illinois EPA inspector southeast of the facility near William Wagner's residence.

106. On September 28, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, a strong off-site odor was experienced by the Illinois EPA inspector northeast of the dairy.

107. On October 2, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, a strong off-site odor was experienced by the Illinois EPA inspector northeast of the dairy along Wiley Road.

108. On October 25, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. The Illinois EPA inspector experienced a strong septic odor along

the northwest side of the lagoon. At the time of the inspection, a strong off-site odor was experienced by the Illinois EPA inspector northwest of the dairy along the access road.

109. On November 29, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, the contents of the facility's anaerobic lagoon were black and septic and gas bubbles and floating sludge were observed by the Illinois EPA inspector on the surface of the lagoon. The Illinois EPA inspector experienced a strong septic odor downwind of the lagoon. At the time of the inspection, a strong off-site odor was experienced by the Illinois EPA inspector downwind, east by southeast, of the dairy along Wiley Road.

110. On November 30, 2000, the Illinois EPA conducted a compliance inspection in the vicinity of the facility. At the time of the inspection, the Illinois EPA inspector experienced an offensive odor downwind of the Inwood facility, emanating from the dairy, while on North Wiley Road near the Azure residence.

111. On December 1, 2000, the Illinois EPA conducted an inspection to follow-up regarding stream observations made the previous day. The Illinois EPA inspector observed the small, intermittent stream that flows along the west side of the dairy where it flowed under Taggart Road. The stream was slightly turbid with a dark color and contained some foam. The Illinois EPA inspector walked upstream and at a distance of nearly ½ mile southwest of Taggart Road observed orange/rust colored sludge deposits approximately 12 inches thick in the stream. Slightly further upstream, the Illinois EPA inspector observed a portion of the stream where rice hulls had been dumped. The stream had cut a channel through the rice hulls. Further upstream, the Illinois EPA observed surface drainage leaving an agricultural field. At that point, the tributary connected with crop land that was used for manure disposal by Inwood Dairy. The field appeared to contain approximately 50 to 100 acres of waste application area and was part of the headwaters of the stream. The application field contained dairy manure,

waste bedding material, waste haylage, corn silage, remains of large hay bales and grain. Runoff from the manure application field was black colored, turbid and contained a strong dairy waste odor. The runoff liquid contained foam. The application field is located near the center of Section 30, T9N, R5e (Elmwood Township), Peoria County. At the time of the inspection, the Illinois EPA inspector observed the flow of waste liquid draining off the manure application field and entering the unnamed tributary to West Fork Kickapoo Creek at a rate of several gallons per minute. Samples were collected. Test results of a sample of surface runoff from the manure application field indicated ammonia levels of 26 mg/l and BOD_5 levels of 170 mg/l. At this sampling point, the Illinois EPA inspector observed a black colored, very turbid liquid draining away from the manure application field. The drainage contained a strong dairy waste odor. The surface drainage contained foam in some areas. Test results of a sample collected downstream from the manure application field indicated ammonia levels of 6.2 mg/l and BOD_5 levels of 44 mg/l. At this sample point, the stream was turbid and dark colored and contained foam is some areas.

112. On December 18, 2000, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, the contents of the facility's anaerobic lagoon were black and septic and a septic odor was experienced by the Illinois EPA inspector downwind of the lagoon. The lagoon was covered with ice and snow. The inspector observed that the odor intensity appeared to be somewhat reduced due to the ice cover. At the time of the inspection, a distinctive off-site odor was experienced by the Illinois EPA inspector northwest, downwind, of the dairy along Taggart Road.

113. On January 11, 2001, the Illinois EPA conducted an inspection of a manure application site utilized by Inwood Dairy. At the time of the inspection, dairy personnel were removing manure that had been stockpiled along Korth Road in the southern ½ of Section 30, T9N, R5E (Elmwood Township), Peoria County, and the waste was being land applied

immediately north of Korth Road. A thick cover of snow existed on the application field; waste was being applied on frozen and snow covered ground. There existed a ravine/waterway just north of the application field. The waterway drained west into a pond, which discharged directly into West Fork Kickapoo Creek. At the time of the inspection, the application fields were blackened with manure and the field north of the waterway was darkened. Given the quantity of the manure applied, the slope of the land and the close proximity of the waterway, snow melt/precipitation conditions would result in manure runoff to the waterway and West Fork Kickapoo Creek.

114. On January 24, 2001, the Illinois EPA conducted an inspection of the facility. At the time of the inspection, the open gutter flush system was not in operation. Moisture in the air lines used to activate the flush valves had been freezing, which prevented the valves from closing. All manure and bedding was currently being scraped and stockpiled along the access road just west of the barns. This stockpiled waste was being disposed of by loading it into trucks and applying it to crop lands. In the event of snow melt or precipitation, runoff from this stockpile would drain off-site. It was not contained. Also at the time of the inspection, the sensor on a well water storage tank, located next to the milking parlor, was defective and the tank was overflowing. The overflow ran into several 55-gallon waste oil drums stockpiled at the base of the storage tank. One of the drums was leaking at a rate of 2 to 3 gpm. The spilled oil was mixing with the overflow well water and ponding in an un-contained manner. In that this mixture was un-contained, it could runoff and discharge off-site in the event of snow-melt or precipitation.

115. At the time of the January 24, 2001 inspection, the contents of the facility's anaerobic lagoon were black and septic and a septic odor was experienced by the Illinois EPA inspector downwind of the lagoon. The lagoon was covered with ice and snow. The inspector observed that the odor intensity appeared to be somewhat reduced due to the ice cover. At the

time of the inspection, a distinctive off-site odor was experienced by the Illinois EPA inspector downwind of the dairy along Korth Road.

116. On January 29, 2001, the Illinois EPA conducted an inspection of a land application area upon which Inwood Dairy had recently applied livestock waste. This inspection was conducted in response to a complaint of runoff. It was raining at the time of the inspection. The rainfall event measured 2 inches. There were two locations where runoff from the field flowed to a neighbor's lake. The first location was on the west side of Route 78 where a culvert was discharging runoff from the application field. The Illinois EPA inspector observed flow through the culvert at an estimated rate of 50 to 75 gpm. The water flowing through the culvert had a tan color and had a slight musty odor. The second location was approximately 200 yards south, at another culvert. The culvert transported runoff from the same field, at which point the runoff flowed into the same lake. The runoff at this location had a tan color and no odor was detected by the Illinois EPA inspector.

117. On January 31, 2001, the Illinois EPA conducted an inspection of Inwood Dairy in response to a complaint. Prior to arriving at the dairy, the inspectors conducted initial observations at stream locations downstream from the dairy. There were foam accumulations in an unnamed tributary to West Fork Kickapoo Creek at a point approximately 1 1/4 miles downstream of the dairy. At the dairy, ongoing manure discharges from the northwest retention basin were observed. The discharging was occurring at a rate of approximately 5 gpm. The discharge was black colored, turbid and contained a strong cattle manure odor. The basin was receiving livestock wastewater from the 30 inch diameter PVC pipe located in the southwest corner of the basin. The basin was designed to receive clean storm water only from the dairy's buried storm water collection system. At the time of the inspection, there was a significant accumulation of manure at the west end of the freestall barns along the gravel lane. The manure accumulation was especially prominent west and south of the southernmost freestall

barn. Wastewater and manure/sludge were draining into an open manhole located south of the southernmost freestall barn. Also at the time of the inspection, the Illinois EPA inspectors observed that a downspout was missing from the northwest corner of the northernmost freestall barn. The purpose of the downspout was to direct clean roof water into the storm water system and away from the wastewater lagoon. Without this diversion, the clean water running off the barn flows into the wastewater lagoon watershed. Also at the time of the inspection, the Illinois EPA inspectors observed cattle manure flowing out the west end of the middle freestall barn and passing across the gravel lane where it was accumulating off-site on a neighboring property. Water samples were collected at the time of the inspection. Test results of a sample of the discharge from the northwest retention basin indicated ammonia levels of 216 mg/l, BOD_5 levels of 980 mg/l and suspended solids levels of 1,080 mg/l. Test results of a sample collected immediately downstream from the northwest retention basin indicated ammonia levels of 199 mg/l, BOD_5 levels of 810 mg/l and suspended solids levels of 420 mg/l.

118. At the time of the January 31, 2001 inspection, a strong, offensive odor was experienced by the Illinois EPA inspector at the lagoon. At the time of the inspection, a distinctive off-site odor was experienced by the Illinois EPA inspector east of the dairy along Wiley Road near the Azures' residence.

119. On February 14, 2001, the Illinois EPA conducted an inspection of Inwood Dairy. At the time of the inspection, there was only 2 to 3 inches of freeboard available in the wastewater lagoon. The flushing system was in operation and the barns and parlor were being flushed and the wastewater was being pumped into the lagoon. The solids separator was not in use. At the time of the inspection, wastewater was being pumped from the lagoon to a land application site. Application operations were suspended when a tractor damaged (severely rutted) the field. At the time of the inspection, David Inskeep verbally agreed that the dairy should stop pumping wastewater/solids into the lagoon. He also agreed that the dairy should

switch from flushing to scraping the barns until adequate freeboard was available to prevent an overflow of the lagoon. At the time of the February 14, 2001 inspection, dairy employees were sandbagging the lagoon berm in an attempt to stop an overflow.

120. On February 15, 2001, the Illinois EPA conducted an inspection in response to a citizen complaint and due to the lack of adequate freeboard in the lagoon observed the previous day. Mr. Inskeep indicated that the dairy had made an attempt to land apply wastewater from the lagoon that morning but field conditions were too wet. At the time of the inspection Mr. Inskeep acknowledged that the facility was still flushing both the milking parlor and the freestall barns. Mr. Inskeep also acknowledged that he did not know the volume of water utilized in the flushing process. The frequency of flushing and volume per flush was apparently left to the discretion of the individual operator(s). The system operated on a manual basis and was not automated nor was it assisted by an automated timer. At the time of the inspection, Mr. Inskeep said that cessation of flushing was not practical, and could not be done. He indicated that the alternative method, scraping of solids, resulted in solids settling into pipes, which required that a contractor be retained to clear the pipes. The Illinois EPA again advised Mr. Inskeep that the facility should not place any more waste into the lagoon. At the time of the February 15, 2001 inspection, there was no freeboard available in the lagoon. Wastewater was beginning to flow east, over the top of the berm. Further, there continued to be an accumulation of livestock waste and wastewater south and west of the southernmost barns, contained only because the land was depressed in that area. The area was not an approved or authorized waste containment structure. Also at the time of the inspection, cattle manure flowed west from the west end of the center freestall barn and passed across the gravel road where it accumulated on neighboring property. A sample was collected from this accumulation on neighboring property. Test results of this sample indicated ammonia levels of 32 mg/l, BOD_5 levels of 860 mg/l and suspended solids of 135,000 mg/l. A significant accumulation of cattle

manure existed outside the west end of all the freestall barns and in between the barns.

121. On February 16, 2001, the Illinois EPA conducted an inspection of the facility. There was no freeboard available in the lagoon. Wastewater was ponded along the top of the east berm. The Illinois EPA inspector obtained information that additional wastewater had been pumped to the lagoon throughout the night. Gordon Inskeep shut off the pumps at the lift station where the waste was pumped into the lagoon early in the morning of February 16, 2001. The barns and milking parlor were still being flushed. The wastewater and manure generated in the barns and milking parlor were being diverted to the low area south of the southernmost freestall barn by allowing the sewer system to surcharge.

122. On February 17, 2001, the Illinois EPA conducted an inspection. At the time of the inspection, the facility continued to pump wastewater from the lagoon into a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon. Upon learning that the facility was continuing to pump, the Illinois EPA inspector demanded the pumping be stopped. David Inskeep, owner/manager of the facility, refused to stop the pumping. Mr. Inskeep accompanied the inspectors to the location of the ravine/waterway. A hose was observed discharging lagoon wastewater into a large waterway, a significant accumulation of foam was observed at the end of the hose, and the liquid in the waterway was turbid, greenish brown in color and contained a strong livestock waste odor. There were two discharge pipes in the first dry dam in the ravine. At the time of the inspection, wastewater was being discharged through the lower of the two pipes at a rate of approximately 60 to 100 gpm. This wastewater was flowing into a second impoundment. The drain pipes in the second dry dam were not plugged. Wastewater was discharging through the pipes of the second dry dam at an estimated flow of 60 to 100 gpm. The wastewater that discharged through the second dry dam flowed into a pond. Liquid in the pond was turbid, greenish-brown in color and had a strong livestock waste odor. Dead and distressed fish were observed in the pond. The pond was

discharging, via an approximately 30-inch diameter corrugated metal pipe, into a waterway that flowed directly into the West Fork Kickapoo Creek. Following the observations of the discharge through the dry dams, the Illinois EPA inspectors again demanded that Mr. Inskeep stop pumping wastewater from the lagoon into the ravine/waterway. Mr. Inskeep then agreed to do so, and at approximately 3:40 P.M. the inspectors verified that the pump was shut off. Water samples were collected. Test results of a sample of the wastewater behind the first dry dam indicated ammonia levels of 310 mg/l, BOD_5 levels of 870 mg/l and suspended solids levels of 350 mg/l. Test results of a sample of the wastewater discharge from the pond indicated ammonia levels of 27 mg/l, BOD_5 levels of 51 mg/l and suspended solids levels of 120 mg/l.

123. At the time of the February 17, 2001 inspection, the Illinois EPA inspector observed frozen livestock wastewater outside the lagoon in the emergency spillway. The inspector observed an eroded channel leading away from the emergency spillway in a southeasterly direction and continuing into a nearby receiving stream. The inspector observed a low flow of wastewater in a portion of the eroded channel. The liquid in the eroded channel contained a strong livestock waste odor similar to the lagoon wastewater. These conditions indicated that livestock wastewater had recently seeped through the emergency spillway and discharged from the lagoon.

124. At the time of the February 17, 2001 inspection, an accumulation of liquid waste existed south and west of the southernmost freestall barn. It consisted of wastewater and manure generated in the barns and parlor that was surcharging from the facility's waste collection system. This accumulation existed in a low-lying area south of the barns that was not an authorized waste containment structure.

125. On February 18, 2001, the Illinois EPA conducted an inspection of the Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon. At the time of the February 18, 2001 inspection, there was 8 to 9 inches of freeboard in

the lagoon, measured from the top of the east berm. Wastewater and manure generated in the barns and parlor was surcharging from the sanitary collection system to the low lying area south of the barns that was not an authorized waste containment structure. This wastewater accumulation was rising and entered the south barn.

126. At the time of the February 18, 2001 inspection, wastewater that had been pumped from the lagoon on the previous two days remained impounded behind the two dry dams in the ravine/waterway. There was 2 to 3 feet of freeboard behind the first dry dam and 3 to 4 feet of freeboard behind the second dry dam. Dead fish were observed along the banks of the pond at the west end of the ravine/waterway. The impounded liquid, contents of the pond, and discharge from the pond emitted a livestock waste odor and was dark brown in color. The pond was discharging at a rate of approximately 30 to 60 gpm to a waterway that led directly into the West Fork Kickapoo Creek. Foam was present in the pond discharge and in the West Fork Kickapoo Creek downstream from where the pond discharge entered the creek. Samples were collected from the waterway/ravine area. Test results from the sample of wastewater impounded behind the first dry dam indicated ammonia levels of 220 mg/l, BOD_5 levels of 730 mg/l and suspended solids levels of 390 mg/l. Test results from the sample of wastewater impounded behind the second dry dam indicated ammonia levels of 310 mg/l, BOD_5 levels of 1,100 mg/l and suspended solids levels of 650 mg/l. Test results of the sample of the discharge from the pond indicated ammonia levels of 27 mg/l, BOD_5 levels of 55 mg/l and suspended solids levels of 50 mg/l.

127. At the time of the February 18, 2001 inspection, the lagoon had 8 to 9 inches of freeboard, measured from the top of the east berm.

128. On February 19, 2001, the Illinois EPA conducted an inspection of the Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon. At the time of the February 19, 2001 inspection, the lagoon had 8 to 9 inches of

freeboard, measured from the top of the east berm. The barns and parlor were still being flushed, and wastewater and manure generated in the barns and parlor were being surcharged from the sanitary system into the low-lying area south of the barns that was not an authorized waste containment structure.

129. At the time of the February 19, 2001 inspection, the wastewater from the pond at the west end of the ravine/waterway was discharging into a waterway that led directly into the West Fork Kickapoo Creek. Dead fish were observed along the banks of the pond. Samples were collected at the time of the February 19, 2001 inspection. Test results of the sample of the discharge from the pond indicated ammonia levels of 27 mg/l, BOD_5 levels of 33 mg/l and suspended solids levels of 69 mg/l.

130. On February 20, 2001, the Illinois EPA conducted an inspection of the Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon. The lagoon had 8 to 9 inches of freeboard at the time of the inspection, measured from the top of the east berm. Wastewater and manure generated in the barns and parlor was surcharging from the sanitary collection system to the low-lying area south of the barns that was not an authorized waste containment structure. This accumulation of wastewater continued to rise in elevation. At the ravine/waterway, there was 2 to 3 foot of freeboard in the impoundment behind the first dry dam and 3 to 4 feet of freeboard in the impoundment behind the second dry dam. The pond at the west end of the ravine/waterway was discharging into a waterway that led directly into the West Fork Kickapoo Creek. Dead fish were observed on the banks of the pond. Samples were collected at the time of the February 20, 2001 inspection. Test results of the sample of the discharge from the pond indicated ammonia levels of 22 mg/l, BOD_5 levels of 36 mg/l and suspended solids levels of 31 mg/l. At the time of the February 20, 2001 inspection, the Illinois EPA inspector experienced a strong anaerobic odor at the southeast corner of the facility's lagoon. This location was downwind.

131. On February 21, 2001, the Illinois EPA conducted two inspections of the Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon, one in the morning and one in the afternoon. At the time of the morning inspection, the lagoon freeboard was 8 to 9 inches, measured from the top of the east berm. Wastewater and manure generated in the barns and parlor were surcharging to the low-lying area to the south of the barns that was not an authorized waste containment structure. The elevation and surface area of this accumulation had continued to increase. At the time of the morning inspection, the pond at the west end of the ravine/waterway was discharging into a waterway that led directly to the West Branch Kickapoo Creek. At the time of the afternoon inspection, the pond at the west end of the ravine/waterway was discharging into a waterway and flowed directly into the West Branch Kickapoo Creek. The discharge was brown and turbid and emitted a cattle manure odor. A sample of the discharge was collected. Test results of this sample indicated ammonia levels of 30 mg/l, BOD_5 levels of 54 mg/l and suspended solids levels of 137 mg/l. At the time of the afternoon inspection, the Illinois EPA also investigated a complaint regarding the land application of livestock waste by Inwood personnel on a field north of Taggart Road in Section 19, T.9N.-R.5E, Elmwood Township. Livestock waste had been applied in and near a waterway in Section 19, and it was apparent that solid waste had previously been applied in the same waterway at an earlier date.

132. At the time of the February 21, 2001 inspection conducted in the morning, there was a strong anaerobic odor emanating from the facility's lagoon. At the time of the February 21, 2001 inspection conducted in the afternoon, Illinois EPA inspectors experienced cattle barn odors west of the dairy along Taggart Road and in the ravine/waterway area. The wind was out of the east.

133. On February 22, 2001, the Illinois EPA conducted an inspection of the Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's

lagoon. The facility's lagoon had a freeboard of 8 to 9 inches, measured from the top of the east berm. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. The elevation and surface area of this accumulation was continuing to increase. At the time of the inspection, the pond on the west end of the ravine/waterway was discharging to a waterway that flowed directly into the West Fork Kickapoo Creek. A sample of the pond discharge was collected. Test results of the sample of liquid discharged from the pond at the time of the inspection indicated ammonia levels of 29 mg/l, BOD_5 levels of 53 mg/l, and suspended solids levels of 112 mg/l. At the time of the February 22, 2001 inspection, a strong anaerobic odor was experienced around the lagoon.

134. On February 23, 2001, the Illinois EPA conducted an inspection of the Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon. At the time of the inspection, liquid from the pond was discharging at a rate of approximately 30 gpm to a waterway that flowed directly into the West Fork Kickapoo Creek. The discharging liquid was greenish brown in color, and emitted a livestock waste odor. Foam was observed at the outfall. Samples were collected at the ravine/waterway area. Test results of the sample of the pond discharge indicated ammonia levels of 34 mg/l, BOD_5 levels of 63 mg/l and suspended solids levels of 70 mg/l. At the time of the inspection, wastewater and manure generated in the barns and parlor were surcharging from the sanitary collection system to the low-lying area south of the barns that was not an authorized waste containment structure. This accumulation continued to increase in elevation and surface area. At the time of the inspection, there was approximately 8 inches of freeboard in the facility's lagoon, measured from the top of the east berm. The inspectors observed a strong anaerobic odor around the facility's lagoon.

135. On February 24, 2001, the Illinois EPA conducted a compliance inspection at the

Inwood facility and the watershed of a ravine/waterway approximately 3/4 mile southwest of the facility's lagoon. The facility's lagoon had about 6 inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. The elevation and surface area of this accumulation was continuing to increase. Wastewater from this accumulation was entering the storm sewer system through downspout inlets. This wastewater was discharging from the northwest storm water retention basin. At the time of the inspection, wastewater and storm water were also seeping through the berm along the west access road. This berm was a makeshift structure consisted of dirt, old bedding and waste feed. The discharge through the makeshift berm entered a drainage stream located on the west side of the dairy. At approximately 8:20 P.M. on February 24, 2001, the northwest retention basin was discharging to a road ditch along Taggart Road. The road ditch flows into the unnamed tributary of the West Fork Kickapoo Creek that flows south to north along the west side of the dairy. The discharge was turbid. The unnamed tributary was turbid and odorous with large accumulations of billowing foam.

136. By approximately 4:00 P.M. on February 24, 2001, wastewater had accumulated on the west side of the dairy between the north and central freestall barns and covered the gravel lane on the west side of the freestall barns. The wastewater was draining down a slope on the west side of the gravel land. The wastewater was very turbid, greenish brown in color and emitted a strong livestock waste odor. The wastewater flowed west into an adjoining field and then flowed north where it entered the unnamed tributary of West Fork Kickapoo Creek that flows from south to north along the west side of the dairy. A significant amount of foam was in the discharge path.

137. At the time of the February 24, 2001 inspection, the Illinois EPA inspector

observed runoff that was greenish brown to brown in color, produced a white foam and emitted a livestock waste odor to be coming off the dairy's land application fields in Sections 19, 30 and 31, T.9N.-R.5E, Elmwood Township. At the time of the inspection, liquid from the pond located at the west end of the ravine/waterway that contained wastewater from the dairy was discharging to a waterway that flowed directly into the West Fork Kickapoo Creek. This discharge was again observed at approximately 5:00 P.M. and 8:45 P.M., at a rate of approximately 100 gpm.

138. At approximately 5:45 P.M. on February 24, 2001, runoff was discharging from a dirt feedlot that contained a large stockpile of manure on a slope, located south of Korth Road on a hillside above the West Fork Kickapoo Creek in the Northwest 1/4, Section 31, T9N, R5E, Elmwood Township. Runoff from the feedlot ran directly into the West Fork Kickapoo Creek and also into a private pond that had an unimpeded outlet to the West Fork Kickapoo Creek.

139. On February 25, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, there was 4 inches of freeboard in the facility's lagoon. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. The elevation and surface area of this accumulation was continuing to increase. The dairy was placing additional waste feed along the west access road to contain the wastewater in this accumulation. Wastewater continued to enter the storm sewer system through downspout inlets and discharge from the northwest storm water retention basin. At the time of the inspection, liquid from the pond located at the west end of the ravine/waterway that contained wastewater from the dairy was discharging to a waterway that flowed directly into the West Fork Kickapoo Creek. The impoundment in the ravine/waterway behind the first dry dam had 2 ½ feet of freeboard. The impoundment behind the second dam had 2 to 3 inches of

freeboard.

140. On February 26, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. The facility lagoon had approximately 4 inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater continued to enter the storm sewer system through downspout inlets and discharge from the northwest storm water retention basin. At the time of the inspection, liquid from the pond located at the west end of the ravine/waterway that contained wastewater from the dairy was discharging to a waterway that flowed directly into the West Fork Kickapoo Creek. The impoundment of wastewater in the ravine behind the second dry dam contained no freeboard.

141. On February 27, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater continued to enter the storm sewer system through downspout inlets. A riser pipe had been installed on the outlet pipe in the northwest storm water retention basis in an attempt to stop the wastewater discharge. Surcharging problems along the sewer system were producing back-ups in the milking parlor basement.
At the time of the inspection, liquid from the pond located at the west end of the ravine/waterway that contained wastewater from the dairy was discharging to a waterway that flowed directly into the West Fork Kickapoo Creek. The impoundment of wastewater in the ravine behind the second dry dam contained no freeboard.

142. On February 28, 2001, the Illinois EPA conducted a compliance inspection at the

Inwood facility. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater continued to enter the storm sewer system through downspout inlets. Surcharging problems along the sewer system were producing back-ups in the milking parlor basement. At the time of the inspection, the dairy was not milking due to the ponding of wastewater in the milking parlor basement. At the time of the inspection, liquid from the pond located at the west end of the ravine/waterway that contained wastewater from the dairy was discharging to a waterway that flowed directly into the West Fork Kickapoo Creek. David Inskeep reported that the pond discharge was stopped at 5:00 P.M. on February 28, 2001.

143. On March 1, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon. The facility's barns were being scraped to remove manure. Manure from the north and central barns was being pushed to the west for loading and hauling to fields. Manure from the south barn was being pushed directly into the un-contained wastewater accumulation that existed in a low-lying area south of the south barn. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater continued to enter the storm sewer system through downspout inlets. Brown, turbid and odorous wastewater was present in the northwest retention basin, and at the time of the inspection there was a small seepage of discharge from this basin to the adjacent road ditch. Bedding and other barn solids, including manure, were present in the south bunker silo. Leachate was leaving this site and collecting in

an un-contained "pool" area to the south.

144. On March 2, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater and manure generated in the barns were being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon.

145. On March 3, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater generated in the parlor was being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon.

146. On March 4, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater in the parlor was being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater from the flush pits in the barns and a manhole near the parlor was hauled to the low-lying area south of the barns. At the time of the inspection, this accumulation was on the verge of overflow to the stream on the west side of the dairy. Wastewater seeped through the makeshift berm along the west access road and was ponded in a field west of the facility. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon.

147. On March 4, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the dairy continued to remove wastewater from

the ravine/waterway into which lagoon wastewater had been released by the dairy, located about 3/4 mile south of the lagoon. The wastewater was being pumped from the waterway and land applied to adjacent fields. Considerable runoff was coming from the fields back to the impoundment behind the second dry dam in the ravine. There was sheet flow of wastewater over the dam.

148. On March 5, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater in the parlor was being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater from the flush pits in the barns and a manhole near the parlor was hauled to the low-lying area south of the barns. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon.

149. On March 6, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater from the parlor was being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater from the flush pits in the barns and a manhole near the parlor was hauled to the low-lying area south of the barns. The facility lagoon had approximately 4 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon.

150. On March 7, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater generated in the parlor was being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater from the flush pits in the barns and a manhole near the parlor was hauled to the low-lying area south of the barns. At the time of the inspection, this accumulation extended to the west edge of the property, and wastewater was backed up into

the west end of the southernmost barn. Thick manure solids were present in the accumulation and this waste area was odorous. Manure runoff was observed by the Illinois EPA inspectors along the west side of the dairy. Manure drained across the gravel lane at the west end of the barns and was deposited in the drainage path along the west side of the facility. Wastewater from this accumulation continued to enter the storm sewer system. Wastewater continued to seep from the northwest retention basin. A dark colored, turbid liquid with a strong livestock waste odor was draining out of the northwest retention basin. The dairy was taking solid wastes, such as bedding, to the bunker silo. At the time of the inspection, the facility lagoon had approximately 4 inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor around the lagoon.

151. On March 8, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. Wastewater generated in the parlor was being surcharged from the sanitary collection system to a low-lying area south of the barns that was not an authorized waste containment structure. Wastewater from the flush pits in the barns and a manhole near the parlor was hauled to the low-lying area south of the barns. The facility lagoon had approximately 5 inches of freeboard at the time of the inspection. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon. The Illinois EPA inspector also experienced an offensive putrid odor from the dairy along Wiley Road near the Azure and Wagner residences.

152. On March 9, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the Illinois EPA inspectors observed wastewater pooled in a waterway on a field located in the southwest one quarter of Section 22, Elmwood Township. The waterway drained to a nearby stream via a 10- to 12-inch diameter corrugated metal pipe. This release was reported and received the following incident number: H 2001 0407. At the time of the March 9,

2001 inspection, the facility lagoon had approximately 6 inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon. At the time of the inspection, there was a trickle discharge of green colored, turbid liquid from the northwest retention basin.

153. On March 10, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. A field tile located in a field in the southwest one quarter of Section 22, Elmwood Township, an area where Inwood was land applying waste, was flowing about 50 percent full with green-brown water that had a cattle waste/manure odor. The wastewater drained from the field tile to an adjacent stream. This was the same field and field tile where a livestock waste release had occurred on March 9, 2001. At the time of the March 10, 2001 inspection, the facility's lagoon had about 7 inches of freeboard.

154. On March 11, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 7 inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon. At the time of the inspection, the Illinois EPA inspector observed that the dairy was pumping into the lagoon from two waste steams: the dairy was pumping wastewater into the facility's lagoon from the accumulation south of the southernmost barn and also from the ravine/waterway. Pursuant to court order, the dairy was allowed to pump into the lagoon from only one waste stream. Also at the time of the inspection, the dairy was land applying waste on an area outside of the watershed of the ravine/watershed, contrary to the requirements of a court order then in effect.

155. On March 12, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 6 inches of freeboard.

156. On March 13, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 7 ½ inches of freeboard.

157. On March 15, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 11 to 12 inches of freeboard. Solids from the low-lying area south of the barns were being stockpiled in the leachate pool and bunker silo area at the south end of the facility. Daily dairy wastewater generation from the milking parlor/holding pen area was flowing down the facility's gutter to the lift station sump, and some wastewater was surcharging back into the un-contained low-lying area due to apparent partial plugging in the sump. At the time of the inspection, runoff was occurring from manure stockpiled by Inwood south of Korth Road, Section 31, Elmwood Township.

158. On March 16, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 12 inches of freeboard.

159. On March 17, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. Daily dairy wastewater generation from the milking parlor/holding pen area was surcharging into the un-contained low-lying area south of the barns. At the time of the inspection, the facility's lagoon had about 9 inches of freeboard.

160. On March 19, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. Daily dairy wastewater generation from the milking parlor/holding pen area was surcharging into the un-contained low-lying area south of the barns. A large volume of manure solids existed in the un-contained low-lying area at the time of the inspection. At the time of the inspection, the

facility's lagoon had about 9 inches of freeboard. The Illinois EPA inspector experienced a septic-putrid odor on all sides of the lagoon. Dark brown and odorous wastewater existed in the northwest retention basis and was seeping through the discharge pipe. At the time of the inspection, accumulations of manure existed in the gutter area and around the east end of the center and south barns. Some of this manure also flowed onto the open lot area between the north and center barns. Manure had not been hauled after scraping over the weekend due to lack of adequate staffing at the dairy. Over the weekend the manure had been pushed to the east end of the barns and allowed to accumulate.

161. At the time of the March 19, 2001 inspection, the wastewater collected in the un-contained "leachate pool" to the south of the south bunker silo area appeared to be seeping to the adjacent ditch on the west side of the pool.

162. On March 22, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 10 inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon.

163. On March 23, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the facility's lagoon had about 12 ½ inches of freeboard. The Illinois EPA inspector experienced a strong anaerobic odor downwind of the lagoon. Wastewater from the barns was draining to the un-contained low-lying area south of the barns, and milking parlor wastewater was accumulating in the sanitary sewers.

164. On March 24, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. The facility's lagoon had 14 inches of freeboard. Daily dairy wastewater generation from the milking parlor and barn watering troughs was surcharging into the un-contained low-lying area south of the barns.

165. On March 25, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. The facility's lagoon had 17.7 inches of freeboard. Wind was out of the northwest. The Illinois EPA inspector experienced strong dairy odors off-site at the Wagner and Azure residences.

166. On March 26, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. The facility's lagoon had about 22 inches of freeboard. The Illinois EPA inspector experienced strong odors from Inwood off-site along Wiley Road near the Azure and Wagner residences.

167. On March 27, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. An area of land application in the west portion of Section 19 along Route 78 had solids that were at least a day old that had not been incorporated. These solids were very odorous. Other areas had been incorporated by chisel and these areas were also odorous. Some solids had been applied on top of previously chiseled ground. Solids were stockpiled along the east side of the chiseled area. Solids were also stockpiled to the north of this area in a waterway tributary to two lakes.

168. At the time of the March 27, 2001 inspection, the dairy's northwest retention basin contained black septic wastewater. Some seepage from the retention basin was entering the adjacent road ditch that was tributary to an unnamed tributary of West Fork Kickapoo Creek. At the time of the inspection, a large pool of odorous milk wastewater was present in the west end of the north feedlot due to surcharging at the sanitary manhole northwest of the north barn. Daily dairy wastewater generation from the parlor was also surcharging into the un-contained low-lying area south of the barns. Manure solids from the milking parlor/holding pen areas and center and south barns had overflowed the gutter area onto the adjacent ground surface.

169. At the time of the March 27, 2001 inspection, the Illinois EPA inspector

experienced strong anaerobic odors at the facility's lagoon, especially on the downwind east side.

170. On March 29, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the wind was out of the east. Lagoon odors were noted in the ravine/waterway area approximately 3/4 mile south of the lagoon. Lagoon odors were also experienced by the Illinois EPA inspector as he was driving on Route 78 west of the ravine. The Illinois EPA inspector experienced strong odors from Inwood's Section 19, Elmwood Township, solids application area along Route 78. At the time of the inspection, solids were being spread on chiseled ground. Manure solids stockpiles existed in several areas on the field.

171. On April 4, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility. At the time of the inspection, the sanitary sewer system remained plugged. The dairy had set up a portable pump with hose at the south freestall barn in an attempt to pump around the blockage. At the time of the inspection, fresh manure was on top of the 8-inch curb of the freestall barns and extended outside of the barns. Storm water continued to mix with manure at the site. A significant accumulation of manure existed in an un-contained manner along the alley/transfer lane at the east end of the freestall barns. At the time of the inspection, the Illinois EPA inspector experienced a strong, offensive odor at the facility's lagoon. Anaerobic activity/gasification was occurring in the lagoon. A significant sludge accumulation existed at the southwest portion of the lagoon.

172. On April 9, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the Illinois EPA inspector experienced a strong anaerobic odor downwind of the facility's lagoon. Neighbors William Wagner and Jeff Azure reported that the off-site lagoon odors had been particularly strong and offensive in recent weeks. At the time of the inspection,

a contractor was continuing to attempt to clean sanitary sewer lines. Wastewater was being pumped from the un-contained wastewater accumulation south of the freestall barns into the lagoon with a portable pump. At the time of the inspection, the Illinois EPA inspector observed that wastewater, manure solids and other livestock wastes had not been contained by the shallow gutters in the barns and along the east transfer alley. This waste ultimately flowed into the newly designated clean storm water areas and polluted these areas.

173. On April 11, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection runoff was occurring from a stockpile of manure solids, rice hulls and haylage in the northeast one quarter of Section 19, Elmwood Township, along Peabody Road. The runoff was discharging to an unnamed tributary of West Fork Kickapoo Creek. The discharge was brown in color, turbid, contained foam and emitted odor. At the time of the inspection, the Illinois EPA inspectors experienced strong offensive putrid odor at the location of the stockpile runoff on Peabody Road. This location was about 3/4 mile north-northwest of the dairy and the facility's lagoon. The wind was out of a southerly direction. The similar but much stronger odor was experienced by the inspectors about one hour later at the north end of the lagoon.

174. At the time of the April 11, 2001 inspection, both solid and liquid manure existed on the outside of the freestall barns, in an un-contained manner, along the north and south sides of the buildings. An accumulation of manure extended west from the transfer alley between the central and southern barn. Liquid manure was observed by the inspectors to be flowing out of the west end of the center barn and draining south. At the time of the inspection, roof water was draining out of broken and damaged roof gutters and was being blown back into the barns by the wind. At the time of the inspection, the inspectors observed large accumulations of manure solids in the southern portion of the transfer lane extending from the south barn toward the facility's lagoon.

175. On April 16, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the facility's lagoon. The same strong putrid odor was experienced by the Illinois EPA inspector off-site along Wiley Road near the Azure and Wagner residence and also along Korth Road. At the time of the inspection, the Illinois EPA inspector observed that wastewater and manure solids were not being contained by the shallow gutters in the barns and along the east transfer alley. The waste flowed into the newly designated clean storm water areas. At the time of the inspection, dairy employees were land applying solids that had been stockpiled on the Patterson farm in Section 31, Elmwood Township. Several stockpiles of manure solids from the Inwood facility remained on fields in Sections 19 and 22, Elmwood Township, that needed to be properly land applied before the next rain event.

176. On April 19, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the facility's lagoon. The odor was also experienced off-site along Peabody Road near Graham Chapel Road. At the time of the inspection, dairy employees were land applying stockpiled solids on the Patterson farm in Section 31, Elmwood Township, and were beginning to land apply solids stockpiled in fields in Section 19, Elmwood Township. At the time of the inspection, several stockpiles of manure solids from the Inwood facility remained on fields in Sections 19 and 22, Elmwood Township.

177. On April 23, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the facility's lagoon. At the time of the inspection, several stockpiles of manure solids from the Inwood facility remained on fields in Sections 19 and 22, Elmwood Township.

178. On April 26, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection, a considerable accumulation of manure solids existed at the facility. A significant accumulation of manure/bedding solids existed along the east transfer alley and the adjacent roadway. At the time of the inspection, manure solids were also stockpiled on the solids separator load-out pad, on the concrete slab near the south silage bunker and on fields in sections 19 and 22, Elmwood Township. The Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the facility's lagoon and east transfer alley. The Illinois EPA inspector also experienced this odor off-site along Wiley Road near the intersection with Foster Road.

179. On April 30, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection, a significant amount of livestock waste and manure solids was accumulated along the east transfer alley. Manure solids were also stockpiled on the solids separator load-out pad, on the concrete slab near the south silage bunker and on fields in Section 19, Elmwood Township. At the time of the inspection, the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the lagoon and east transfer alley. The Illinois EPA inspector experienced the same odor off-site along Wiley Road near the intersection with Foster Road.

180. On May 3, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection, a significant amount of manure solids had accumulated along the east transfer alley. Solids were stockpiled on the solids separator load-out pad, on the concrete slab near the south silage bunker, in the leachate pond area south of the silage bunkers and on fields in Section 19, Elmwood Township. At the time of the inspection, the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the lagoon and east transfer alley. This anaerobic/septic odor was also experienced off-site along Wiley Road, north by northeast of the facility.

181. On May 7, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection, there was a significant accumulation of solids along the east transfer alley. Manure solids were stockpiled on the solids separator load-out pad, on the concrete slab near the south silage bunker, in the leachate pond area south of the silage bunkers, and on fields in Section 19, Elmwood Township. At the time of the inspection, the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the lagoon and east transfer alley. This odor was also experienced off-site along Wiley Road, northeast of the facility.

182. On May 10, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection, manure solids were stockpiled on the solids separator load-out pad, on the concrete slab near the south silage bunker, in the leachate pond area south of the silage bunkers, in the north exercise lot, and on fields in Section 19, Elmwood Township. At the time of the inspection, the Illinois EPA inspector experienced a strong anaerobic/septic odor downwind of the lagoon and east transfer alley. The Illinois EPA inspector also experienced the same anaerobic/septic odor off-site along Peabody Road near Wiley Road.

183. On May 13, 2001, a manure release occurred at the Inwood facility. Livestock wastewater drained east from the transfer alley and flowed between the two new temporary basins. It entered the southeast storm water retention basin on the property and discharged to the unnamed tributary to West Fork Kickapoo Creek.

184. On May 14, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. At the time of the inspection, manure solids were stockpiled on the solids separator load-out pad, on the concrete slab near the south silage bunker, in the leachate pond area south of the silage bunkers, in the north exercise lot, and on fields in Section 19, Elmwood Township. At the time of the inspection, the Illinois EPA

inspector experienced a strong anaerobic/septic odor downwind of the lagoon and east transfer alley. The Illinois EPA inspector also experienced the same anaerobic/septic odor off-site along Wiley Road.

185. On May 15, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. Liquid in the northwest retention basin at the facility was greenish-brown colored and turbid. A turbid, greenish-brown liquid was discharging from the basin through the principal spillway at a rate of less than 5 gpm. Light foam was observed at the outfall. At the time of the inspection, the Illinois EPA inspector observed that the north temporary manure basin was not seeded or vegetated, and erosion from the area was resulting in significant siltation and sedimentation in the southeast retention basin and in the discharge from that basin.

186. On May 23, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. The contents of the facility's lagoon were black and very turbid. The Illinois EPA inspector experienced an anaerobic/septic odor at the lagoon. The contents of the temporary waste storage basins were black and very turbid, and emitted an anaerobic/septic odor. The Illinois EPA inspector experienced an off-site anaerobic/septic odor downwind of the facility on Wiley Road. At the time of the inspection, manure solids were accumulated along the east transfer alley, and stockpiled on the solids separator load-out pad, on the maturity barn load-out pad, and in the north exercise lot. Old manure and clean-up solids were stored in the leachate pond area south of the silage bunkers, in the north exercise lot, and on fields in Section 19, Elmwood Township. The Illinois EPA inspector experienced some odor downwind of the manure solids storage areas.

187. On May 30, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and land application sites. The contents of the facility's lagoon were black and very turbid. The Illinois EPA inspector experienced an anaerobic/septic odor at the lagoon.

The contents of the temporary waste storage basins were black and very turbid, and emitted an anaerobic/septic odor. The Illinois EPA inspector experienced an off-site anaerobic/septic odor downwind of the facility, west by northwest, along Taggart Road. At the time of the inspection, manure solids were accumulated along the east transfer alley and stockpiled on the solids separator load-out pad. Old manure and clean-up solids were stored on fields in Section 19, Elmwood Township. The Illinois EPA inspector experienced some odor downwind of the manure solids storage areas.

188. On June 4, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and fields utilized by Inwood for the application of waste. The contents of the facility's lagoon were black and turbid. The Illinois EPA inspector experienced an anaerobic/septic odor at the lagoon. The contents of the temporary waste storage basins were black and turbid, and emitted an anaerobic/septic odor. The Illinois EPA inspector experienced an off-site anaerobic/septic odor west, downwind, of the facility. The Illinois EPA inspector experienced odors emanating from Inwood's application fields and observed some runoff from the application fields in Section 19, Elmwood Township. The area had been subject to recent rains. Old manure and bedding solids were still stockpiled in application fields in Section 19, Elmwood Township. At the time of the inspection, manure was pushed over the top of the shallow concrete curbs along the alleys in the barns and the east transfer alley. Manure overflow from the alleys in the barns is a potential source of contamination during wet weather.

189. On June 11, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and fields utilized by Inwood for the application of waste. At the time of the inspection, the lagoon freeboard was 22 inches. The contents of the facility's lagoon were black and turbid. The Illinois EPA inspector experienced an anaerobic/septic odor at the lagoon. The contents of the temporary waste storage basins were black and turbid, and emitted an anaerobic/septic odor. The Illinois EPA inspector experienced anaerobic/septic and

livestock odors off-site, downwind, west, of the facility. At the time of the inspection, some old manure and bedding solids were still stockpiled in Section 19, Elmwood Township. At the facility, manure solids were stored on the east transfer alley and the solids separator load-out pad. Odors were experienced by the Illinois EPA inspector downwind of the stockpiles at the facility. At the time of the inspection, manure was pushed over the top of the shallow concrete curbs along the alleys in the barns and the east transfer alley. Manure overflow from the alleys in the barns is a potential source of contamination during wet weather.

190. On June 13, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and fields utilized by Inwood for the application of waste. At the time of the inspection, the lagoon freeboard was 22 inches. The contents of the facility's lagoon were black and turbid. The Illinois EPA inspector experienced an anaerobic/septic odor at the lagoon. The contents of the temporary waste storage basins were black and turbid, and emitted an anaerobic/septic odor. The Illinois EPA inspector experienced anaerobic/septic and livestock odors off-site, downwind, north by northeast of the facility along Wiley Road. At the time of the inspection, old manure and bedding solids were still stockpiled in Section 19, Elmwood Township. At the facility, manure solids were stored on the east transfer alley and the solids separator load-out pad. Odors were experienced by the Illinois EPA inspector downwind of the stockpiles at the facility.

191. On July 5, 2001, the Illinois EPA conducted a compliance inspection at the Inwood facility and at fields utilized by Inwood for the application of waste. At the time of the inspection, the lagoon contents were dark and septic in appearance with considerable activity of gasification and rising sludge. The southwest corner of the lagoon was covered with scum, and the lagoon emitted a strong septic-putrid odor. The wind was from the north-northeast. Odors were present on all sides of the lagoon. The north temporary basin emitted a strong manure odor and had a 90 percent cover of thin scum. The south temporary basin emitted the same

type of odor as the facility's large lagoon. About 40 percent of the south temporary basin's surface was covered with scum. The Illinois EPA inspectors experienced strong odor emanating from the waste in the bunker areas on the south end of the facility. The Illinois EPA inspectors experienced lagoon and silage odors from Inwood about 3/4 mile south of the dairy on Korth Road near Dave and Julie Wagner's residence.

192. On December 16, 1997, June 3, 1998, October 14, 1998, August 17, 1999 and December 6, 1999, the Illinois EPA issued Inwood Dairy Violation Notices, pursuant to Section 31 of the Act, 415 ILCS 5/31 (1996). These violation notices set forth in detail the dates and nature of violations that had occurred at the dairy. Further, Section 31 of the Act requires the Illinois EPA to allow the alleged violator opportunities to meet with Illinois EPA personnel to discuss the allegations and required compliance measures. These opportunities were extended to the Defendant. Further, if dairy management was available at the time of the inspection, the Illinois EPA inspectors discussed all compliance problems with such personnel at the time of the inspection. Despite such notice and opportunity to correct compliance problems, Inwood Dairy knowingly continued to violate the Act and applicable environmental regulations.

193. By causing, threatening or allowing the discharge of construction runoff, cattle manure, livestock waste, livestock wastewater, silage leachate, soured milk, oil and other contaminants into the environment so as to cause or tend to cause water pollution, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996).

194. By depositing construction runoff, cattle manure, livestock waste, livestock wastewater, silage leachate, soured milk, oil and other contaminants upon the land in such place and manner so as to create a water pollution hazard, Defendant Inwood Dairy LLC has violated Section 12(d) of the Act, 415 ILCS 5/12(d) (1996).

195. By causing, threatening and allowing the discharge of construction runoff, cattle

manure, livestock waste, livestock wastewater, silage leachate, soured milk, oil and other contaminants into waters of the State, without an NPDES permit or in violation of the conditions of the facility's construction storm water NPDES permit, Defendant Inwood Dairy LLC has violated Section 12(f) of the Act, 415 ILCS 5/12(f) (1996).

196. By failing to keep waters of the State free from sludge, bottom deposits, floating debris, odor, color or turbidity of other than natural origins, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 302.203 (1994).

197. By causing or allowing ammonia nitrogen levels that exceeded 15 mg/l in waters of the State, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 302.212(a) (1994).

198. By failing to have adequate diversions, dikes, walls or curbs that will prevent excessive outside surface runoff waters from flowing through its animal feeding operation, and by failing to direct runoff to an appropriate disposal, holding or storage area, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996) and 35 Ill. Adm. Code 501.403 (a) and (b) (1994).

199. By failing to keep wastewater levels in the lagoon such that there is adequate storage capacity so that an overflow does not occur except in the case of precipitation in excess of a 25-year 24-hour storm event, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 501.404(c) (1994).

200. By failing to construct and maintain holding ponds and lagoons in such a manner so that they are impermeable or so sealed as to prevent surface water pollution, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 501.404(c)(1994).

201. By failing to failing to provide a minimum of 120-day storage with a liquid manure

holding tank, lagoon, holding pond, or any combination thereof, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 501.404(c)(1994).

202. By causing, threatening or allowing the land application of livestock waste in such a manner as to cause water pollution in waters of the State, the Defendant has violated Sections 12(a) and (d) of the Act, 415 ILCS 5/12(a), (d) (2000) and 35 Ill. Adm. Code 501.405.

203. By failing to apply for an NPDES permit from October 15, 1998 until April 3, 2000, Defendant Inwood Dairy LLC violated Section 12(f) of the Act, 415 ILCS 5/12(f) (1998), and 35 Ill. Adm. Code 502.102 (1996).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that this Court grant the following relief:

A. Find that the Defendant Inwood Dairy LLC has violated Sections 12(a), (d) and (f) of the Act, 415 ILCS 5/12(a), (d), (f) (1996), and 35 Ill. Adm. Code 302.203, 302.212(a), 501.403(a) and (b), 501.404(c) (2), (3) and (4), 501.405(1), and 502.102 (1994)..

B. Permanently enjoin the Defendants from further violations of the Act and associated regulations;

C. Assess against the Defendants a civil penalty of fifty thousand ($50,000) for each violation of the Act not relating to the NPDES program, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation not relating to the NPDES program has continued thereafter; and a civil penalty of ten thousand $10,000 per day for each violation of Section 12(f) of the Act or any term or condition of the facility's NPDES permit.

D. Pursuant to Section 42(f) of the Act, 415 ILCS 5/42(f)(1998), award the Plaintiff its costs in this matter, including reasonable attorney's fees and expert witness costs; and

E. Grant such other and further relief as the Court deems appropriate.

COUNT II
ODOR AIR POLLUTION VIOLATIONS

1-23. Plaintiff realleges and incorporates by reference herein paragraphs 1 through 23 of Count I as paragraphs 1 through 23 of this Count II.

24. Section 3.02 of the Act, 415 ILCS 5/3.02 (1998), provides:

"AIR POLLUTION" is the presence in the atmosphere of one or more contaminants in sufficient quantities and of such characteristics and duration as to be injurious to human, plant, or animal life, to health, or to property, or to unreasonably interfere with the enjoyment of life or property.

25. Section 3.06 of the Act, 415 ILCS 5/3.06 (1998), provides:

"CONTAMINANT" is any solid, liquid, or gaseous matter, any odor, or any form of energy, from whatever source.

26. Section 9(a) of the Act, 415 ILCS 5/9(a) (1998), provides, in pertinent part, as follows:

No person shall

a) Cause or threaten or allow the discharge or emission of any contaminant into the environment in any State so as to cause or tend to cause air pollution in Illinois, either alone or in combination with contaminants from other sources, or so as to violate regulations or standards adopted by the Board under this Act;

* * *

27. Section 501.405(b) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.405(b) (1996), provides, in pertinent part, as follows:

Field Application of Livestock Waste

(b) Operators of livestock waste handling facilities shall practice odor control methods during the course of manure removal and field application so as not to affect a neighboring farm or non-farm residence or populated area by causing air pollution as described in Section 501.102(d).

28. Section 501.401(a) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.401(a) (1996), provides, in pertinent part, as follows:

General Criteria

a) Besides the regulations contained within this Chapter, every person shall also comply with provisions of the Act and Board regulations.

* * *

29. Section 501.402(c) (1) and (3) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.402(c)(1), (3) (1996), provides, in pertinent part, as follows:

Location of New Livestock Management Facilities and
New Livestock Waste-Handling Facilities

c) 1) Upon July 15, 1991, new or expanded livestock management facilities and new or expanded livestock waste-handling facilities shall not be located within ½ mile of a populated area or within 1/4 mile of a non-farm residence.

* * *

3) Adequate odor control methods and technology shall be practiced by operators of new and existing livestock management facilities and livestock waste-handling facilities so as not to cause air pollution.

30. Section 35 of the Illinois Livestock Management Facilities Act ("LMFA"), 510 ILCS 77/35 (1996), provides, in pertinent part:

(c) New livestock management or livestock waste handling facilities. Any new facility shall comply with the following setbacks:

* * *

(4) For a livestock management facility or livestock waste handling facility serving 1,000 or greater but less than 7,000 animal units, the setback is as follows:

* * *

(B) For any occupied residence, the minimum setback shall be increased 220 feet over the minimum setback of 1/4 mile for each additional 1,000 animal units over 1,000 animal units.

For milking dairy cows, the number of animal units on a facility is the number of milking cows times 1.4. 35 Ill Adm. Code 506.103. Therefore, the 1,040 milking head at the Inwood

Dairy facility constitute 1,456 animal units.

31. Section 100 of the LMFA, 510 ILCS 77/100 (1996), provides:

> Limitation or preemption. Nothing in this Act shall be construed as a limitation or preemption of any statutory or regulatory authority under the Illinois Environmental Protection Act.

32-188. Plaintiff realleges and incorporates by reference herein paragraphs 35 through 191 of Count I as paragraphs 32 through 188 of this Count II.

189. On numerous occasions, beginning in March 1999 and continuing through the present, the Defendant has caused or allowed the emission of offensive livestock and feed odors from the facility and has caused or allowed the emission of offensive odors during times of land application of livestock waste. Defendants have continually and repeatedly failed to correct the odor emissions problems at the facility and when land applying waste. These odors have unreasonably interfered with the enjoyment of life and property by neighboring residents by preventing or disrupting outdoor activities and by invading or penetrating their homes causing physical discomfort, including, but not limited to, a burning sensation in their noses and eyes, headaches and nausea. Such physical discomfort has included the physical and emotional revulsion an individual might experience when subjected to highly offensive odors.

190. Most of the complaining neighbors owned their property and lived in their current residences, that now neighbor Inwood Dairy, since a time prior to the completion of construction of Inwood Dairy.

191. On March 8, 2001, William and Kay Wagner left their property in order to get away from the odor emanating from Inwood Dairy. The Wagners live approximately 3300 feet from the Inwood facility's lagoon. They have lived in their current residence since 1968. The Wagners left their home at 6:00 P.M. and returned home approximately 9:30 P.M. or 10:00 P.M. The odor was still present in the house at the time of their return. The Wagners noticed that the offensive odor remained in their drapes inside their residence. The Wagners' home is

well built, with good quality windows and doors, and is well insulated, yet offensive odors from Inwood Dairy permeate the structure. A few days after March 8, 2001, Mrs. Wagner took down the drapes and delivered them to a professional dry cleaner. The Wagners reported the following additional offensive odor days in March 2001: March 2, 3, 5, 6, 7, 13, 23, 24, and 25, 2001. William and Kay Wagner have complained of repeated incidences of offensive odors from Inwood dairy at their home since June 1999 and continuing to the present, often indicating that the odor caused a burning sensation in their nose and eyes.

192. David and Julie Wagner live approximately ½ mile south of the Inwood Dairy lagoon and have complained of offensive odors at their residence emanating from the dairy since July of 1999. They have lived in their current residence approximately 10 years. More recently, they have complained of offensive odor events on June 16, 20, 21 and 22, 2001. David and Julie Wagner indicate that odors from Inwood Dairy penetrate their home even when the windows are closed. The Wagners have indicated that the odors caused them to abandon outdoor activities, caused them to become nauseous while working outdoors, have caused a burning sensation in their noses, have woken them at 3:00 A.M. and caused them to light candles and ventilate the house to relieve the offensiveness, and have caused their three-year-old child to complain while playing outdoors.

193. Jeff Azure owns a home and resides with his family approximately 1300 feet southeast of the Inwood facility's lagoon. The family has lived in the residence since 1995. The Azures live in the basement portion of their home. Mr. Azure has not built the home up to grade due to odors emanating from Inwood Dairy. If he built an additional height of 12 feet to his home, the family would be subject to odors from Inwood more frequently than they are now. The home is presently below the elevation of the lagoon. Mr. Azure originally planned to built out the home, but has not done so due to the odors coming from Inwood. The odor from Inwood has prevented friends from visiting the Azures, it has caused the Azures to keep their

air conditioning running in order to keep the odor out, and the odor has prevented the Azures from utilizing their outdoor pool. Mr. Azure has gotten headaches from the odor. The odor from Inwood has prevented him from working in his garage.

194. Tim and Malana Dunne live at 240 Illinois Hwy 78, directly across the road from fields Inwood Dairy utilizes for livestock waste land application in Section 19, Elmwood Township. On March 26, 27, 28, and 29, 2001, Tim Dunne reported that he was subject to very offensive odors emanating from Inwood's land application activities at his home while he was attempting to entertain guests. Mr. Dunne has owned his property for five years, and built a home on the property in June of 2000. The property is 1.25 miles west of the dairy. While constructing the home, workers got sick from the dairy odor. Odors emanating from the dairy have caused Mr. and Mrs. Dunne to become nauseous. The dairy odors have prevented Mr. Dunne from fishing on the 30-acre lake on his property. The odors have prevented the Dunnes from having family functions at their home. On Thanksgiving in the Year 2000, Mr. Dunne attempted to cook outdoors. Odors from the dairy caused the Dunnes to take all holiday activities indoors. At times when Inwood is land applying waste in Section 19, the Dunnes cannot have their windows open and they must run their air conditioner in an attempt to keep the odors out of their home. Land application events have been frequent due to the waste handling system and methods utilized at the dairy.

195. The odor emanating from Defendant's facility is a "contaminant" as that term is defined in Section 3.06 of the Act, 415 ILCS 5/3.06 (1996).

196. On August 17, 1999 and December 6, 1999, the Illinois EPA issued Inwood Dairy Violation Notices, pursuant to Section 31 of the Act, 415 ILCS 5/31 (1996). These violation notices set forth in detail the dates and nature of violations that had occurred at the dairy. Further, Section 31 of the Act requires the Illinois EPA to allow the alleged violator opportunities to meet with Illinois EPA personnel to discuss the allegations and required

compliance measures. These opportunities were extended to the Defendant. Further, if dairy management was available at the time of the inspection, the Illinois EPA inspectors discussed all compliance problems with such personnel at the time of the inspection. Despite such notice and opportunity to correct compliance problems, Inwood Dairy knowingly continued to violate the Act and applicable environmental regulations.

197. By causing or allowing strong, persistent and unreasonably offensive livestock odors to emanate from its dairy and interfere with the use and enjoyment of the neighbors' property, Defendant Inwood Dairy, LLC has caused air pollution, thereby violating Section 9(a) of the Act, 415 ILCS 5/9(a)(1998).

198. By failing to take into consideration and incorporate adequate odor control methods and technology at its new livestock management facility and livestock waste-handling facility, thereby causing air pollution, Defendant Inwood Dairy, LLC has violated Section 9(a) of the Act, 415 ILCS 5/9(a)(1998), and 35 Ill. Adm. Code 501.402(c)(3)(1996).

199. By failing to practice odor control methods during manure removal and field application, thereby affecting its neighbors by causing air pollution and unreasonable interference with the use of their property, Defendant Inwood Dairy, LLC has violated Section 9(a) of the Act, 415 ILCS 5/9(a)(1998) and 35 Ill. Adm. Code 501.405(b)(1996).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, the People of the State of Illinois, respectfully requests that this Court grant the following relief:

A. Find that the Defendant Inwood Dairy, LLC has violated Section 9(a) of the Act, 415 ILCS 5/9(a) (1998), and 35 Ill Adm. Code 501.402(c)(3)(1996) and 501.405(b)(1996).

B. Enjoin the Defendant from further violations of the Act and associated regulations;

C. Assess against the Defendant a civil penalty of fifty thousand ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter;

D. Pursuant to Section 42(f) of the Act, 415 ILCS 5/42(f) (1996), award the Plaintiff its costs in this matter, including reasonable attorney's fees and expert witness costs; and

E. Grant such other and further relief as the Court deems appropriate.

Respectfully submitted,

PEOPLE OF THE STATE OF ILLINOIS,
ex rel. JAMES E. RYAN,
Attorney General of the State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement/Asbestos
Litigation Division

BY: James L Morgan
for THOMAS DAVIS, Chief
Environmental Bureau
Assistant Attorney General

Of Counsel
JANE E. MCBRIDE
Assistant Attorney General
500 South Second Street
Springfield, Illinois 62706
217/782-9031
Dated: August 2, 2001

People v. Inwood Dairy, LLC
Peoria Co. No. 01-CH-76

CERTIFICATE OF SERVICE

I hereby certify that I did on August 2, 2001, send by Federal Express Mail a true and correct copy of the foregoing instrument entitled AMENDED COMPLAINT FOR INJUNCTIVE AND OTHER RELIEF upon:

Mr. Roy Harsch, Esq.
Gardner, Carter & Douglas
Quaker Tower
321 N. Clark Street
Chicago, IL 60610-4795

Mr. Jeffrey Ryva, Esq.
Husch & Eppenberger, LLC
401 Main Street, Suite 1400
Peoria, IL 61602-1241

Jane E. McBride
Assistant Attorney General

Attachment 26:

Order, *People of the State of Illinois v. Inwood Dairy, LLC*

IN THE CIRCUIT COURT FOR THE TENTH JUDICIAL CIRCUIT
PEORIA COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS)
Plaintiff,)
v.) No. 01 CH 76
INWOOD DAIRY, LLC, an Illinois limited liability corporation,)
Defendant.)

CONSENT ORDER

This action was commenced on behalf of the PEOPLE OF THE STATE OF ILLINOIS, *ex rel.* JAMES E. RYAN, Attorney General of the State of Illinois, on his own motion and at the request of the Illinois Environmental Protection Agency. The Plaintiff and the Defendant, INWOOD DAIRY, LLC, having agreed to the making and entry of this Consent Order, do hereby stipulate and agree as follows:

I.

STIPULATION OF USE AND AUTHORIZATION

The parties stipulate that this Consent Order is entered into for the purposes of settlement only, and that neither the fact that a party has entered into this Consent Order, nor any of the facts stipulated herein, shall be used for any purpose in this or any other proceeding except to enforce the terms hereof by the parties to this agreement. Notwithstanding the foregoing, this Consent Order may be used in any future permitting or enforcement action as evidence of a past adjudication of violation of the Illinois Environmental Protection Act ("Act") for purposes of Sections 39(i) and 42(h) of the Act, 415 ILCS 5/39(i), 42(h) (2000). The undersigned representative for each party certifies that he is fully authorized by the party whom he represents to enter into the terms and conditions of this Consent Order and to bind legally the party he represents to the Consent Order. Plaintiff contends that the violations alleged in the Amended Complaint are true. Defendant denies the violations alleged in the Amended Complaint.

II.

STATEMENT OF FACTS

1. The Attorney General of the State of Illinois brings this action on his own motion, as well as at the request of the Illinois Environmental Protection Agency ("Illinois EPA"), pursuant to the statutory authority vested in him under Section 42 of the Act, 415 ILCS 5/42 (2000).

2. The Illinois EPA is an agency of the State of Illinois created pursuant to Section 4 of the Act, 415 ILCS 5/4 (2000), and charged, *inter alia*, with the duty of enforcing the Act.

3. Defendant Inwood Dairy, LLC ("Inwood") is a limited liability corporation, registered and in good standing in the State of Illinois. At the time this action was initiated, David L. Inskeep ("Inskeep"), 201 W. Ash, Elmwood, IL 61529 was the managing member of the LLC. In approximately early May 2001, Albert Zeller ("Zeller"), 548 East High Point Road, Peoria, Illinois 61614, became the managing member. The members of the LLC are Inskeep, James R. DeBord, M.D., 420 N.E. Glen Oak Avenue, Peoria, IL 61603; Zeller; James S. Beard, 146 Prospect Hill, Nashville, TN 37205; Gerald L. Shaheen, 9708 Golden Oak Court, Peoria, IL 61615; George T. Shaheen, 86 Flood Circle, Atherton, CA 94027; Thomas G. Wessels, 639 Centerwood, Springfield, IL 62707. The registered agent is Husch Registered Agent, Inc., 401 Main Street, Suite 1400, Peoria, IL 61602.

4. Inwood Dairy is located just south of Elmwood on the western edge of Peoria County ("Inwood Dairy", the "facility" or the "dairy"). The facility supports a herd of 1,240 dairy cows, of which approximately 1,040 head are milked through three shifts. Structures on the site include a milking parlor, maturity barn, two freestall barns, several open dirt feedlots,

commodity shed, equipment building and livestock waste/wastewater treatment/holding facilities, including a 7-acre lagoon.

5. The facility was constructed in 1997 and 1998. Cows were first brought to the facility on August 29, 1998.

6. Inwood Dairy is located in between two unnamed tributaries of the West Fork Kickapoo Creek that are the receiving waters of discharge from the dairy facility itself. One unnamed tributary flows around the east end of the lagoon and then north of the lagoon. A drainage ditch flows from the west around the south end of the lagoon into this unnamed tributary. The other unnamed tributary flows east toward the northwest end of the freestall barns and then flows north toward the West Fork Kickapoo Creek.

7. Plaintiff alleges that on October 14, 1998, Inwood Dairy was notified in Violation Notice W-1998-00204 that the facility was required to obtain a National Pollutant Discharge Elimination System ("NPDES") permit. On January 6, 2000, Inwood Dairy was again notified of the requirement that it obtain an NPDES permit in a Notice of Intent to Pursue Legal Action ("NIPLA"). The NIPLA indicated that, because of the size and nature of the operation, and because releases had occurred from the facility on more than one occasion, the Illinois EPA required Inwood Dairy, LLC to obtain a NPDES permit. On April 13, 2000, the Illinois EPA received a NPDES permit application from Inwood Dairy. Inwood Dairy's NPDES permit application number is IL0074705. The application is under review; a permit has not yet been issued.

8. Plaintiff alleges that on February 14 and 15, 2001, the Illinois EPA inspected the Inwood Dairy facility and observed no available freeboard in the lagoon. The 7-acre lagoon was estimated to contain 40 million gallons of livestock waste. The contents came to the top of the berms. At the time of the February 15, 2001 inspection, the contents of the lagoon were beginning to flow on the top of the lagoon berms, but were not as yet flowing over the berms to

the outside of the lagoon. The facility's workers were resorting to sandbagging the berm of the lagoon and to the land application of wastewater. Under these conditions, on February 16, 2001, there was an imminent threat to the environment from releases of livestock waste from the Defendant's 7-acre lagoon and due to Defendant's land application of livestock waste. On February 16, 2001, Plaintiff filed a Verified Complaint for Preliminary Injunction and Other Relief, seeking preliminary injunctive relief pursuant to statutory authorization.

9. An Immediate Injunction was issued on February 16, 2001. The Defendant was prohibited by the Immediate Injunction Order from releasing any wastewater from the Inwood Dairy facility.

10. Plaintiff alleges that on February 16 and 17, 2001, the Defendant pumped an estimated one to two million gallons of livestock waste from the lagoon to the ravine/waterway in violation of the Immediate Injunction Order. This pumping was started at approximately 4 p.m. on February 16, 2001, and continued through the night until approximately 3:30 P.M. on February 17, 2001.

11. On February 21, 2001, this Court entered a Preliminary Injunction Order against the Defendant, imposing additional requirements and specific compliance deadlines. The Defendant was required by the Preliminary Injunction Order to immediately and permanently cease all discharge or other activity causing or contributing to the discharge of livestock waste, livestock wastewater and other contaminants from all structures, properties, operations and land application activities of the facility. Pursuant to Paragraph 2 of the Preliminary Injunction Order, Inwood Dairy was required to remove all wastewater released from the facility's lagoon into the ravine/waterway located approximately 3/4 mile southwest of the facility's lagoon and directly connected to and discharging into the West Fork Kickapoo Creek. Pursuant to the Preliminary Injunction Order, Inwood Dairy was to have completed clean-up of the ravine/waterway by 8:00 P.M. Saturday, February 24, 2001.

12. Plaintiff alleges that livestock wastewater continued to be discharged into the West Fork Kickapoo Creek from the ravine/waterway until the afternoon of February 28, 2001.

13. Plaintiff alleges that on February 24, 2001, livestock waste and wastewater discharged from the facility west of the freestall barns, into an unnamed tributary of the West Fork Kickapoo Creek. Also on February 24, 2001, livestock waste was observed running off a separate and remote feedlot operated by Inwood Dairy. Manure had been stockpiled at this feedlot. This wastewater drained directly into the West Fork Kickapoo Creek.

14. Plaintiff alleges that on March 1, 2001, approximately 3 million gallons of wastewater remained in the ravine/waterway. The quantity had increased from the original amount pumped from the lagoon into the ravine/waterway due to precipitation. On March 1, 2001, an Illinois EPA inspector observed that wastewater was starting to flow across the top of the second dry dam.

15. Plaintiff alleges that on March 1, 2001, the facility's lagoon had only 4 inches of available freeboard.

16. Plaintiff alleges that on March 1, 2001, approximately one million gallons of wastewater had accumulated south and west of the freestall barns, and extended inside the southern-most freestall barn, at the Inwood facility. Plaintiff alleges that this accumulation was not within an approved containment structure and as such existed as a threat of water pollution and as a water pollution hazard in violation of Sections 12(a) and 12(d) of the Illinois Environmental Protection Act, 415 ILCS 5/12(a), (d) (2000).

17. On March 2, 2001, a second Immediate Injunction Order was entered by the Court, requiring immediate removal of the wastewater from the ravine/waterway, from the areas south and west of the freestall barns at the Inwood facility, and from the lagoon until 24 inches of freeboard was achieved. On March 5, 2001 and March 9, 2001, agreed modifications to the immediate injunction order were entered.

18. On March 13, 2001, an Agreed Modified Preliminary Injunction Order was entered.

19. On April 10, 2001, a status hearing was conducted in this matter. At the time of hearing the court allowed a modification of the March 13, 2001 Agreed Modified Order, so as to allow the dairy to apply waste to hayground using an Aer-way Tool.

20. Plaintiff alleges that the livestock waste management system utilized at the facility at the time this action was initiated consisted of the following: wastewater and manure solids generated in the milking parlor, maturity barn, freestall barns and cattle transfer lanes were collected with an open gutter flushing system, utilizing concrete troughs/lanes and underground sewers; fresh water from an on-site well was provided as flushwater for the milking parlor; lagoon wastewater was recycled for flushwater in the maturity barn, freestall barns, and transfer lanes; wastewater generated in the open dirt feedlots and other open areas flowed by gravity to inlets along the collection system; wastewater and manure solids were transported to a duplex pump station and pumped to a solids separator (inclined screen); solids removed from the waste stream were stockpiled near the separator; wastewater flowed through the screen and was diverted directly to an 7-acre storage lagoon; there was an inlet line from the solids separator to the northwest corner of the storage lagoon; the inlet line was not submerged; excess water from the separator was routed back to the lift station; solids removed from the waste stream were stockpiled on site; wastewater was pumped from the lagoon and applied to hay ground west and northwest of the dairy utilizing spray irrigation equipment; irrigation was alternated with hay cutting and suspended during wet weather; the normal water usage at the Inwood Dairy required approximately ½ to 1 inch of freeboard per day in the lagoon.

21. Plaintiff alleges that besides the flushing system that collected and directed wastewater and manure solids into the facility's lagoon, a significant amount of storm water

from an area of approximately 1,225,000 sq.-ft. (28 acres) was diverted to a lift station and pumped to the lagoon or flowed directly into the lagoon.

22. On August 3, 2001, an Amended Complaint was filed in this matter. From September 4, 1997 through July 5, 2001, the Illinois EPA conducted compliance inspections at and in the vicinity of Inwood Dairy. Plaintiff alleges that these inspections constitute the basis of the factual allegations set forth in paragraphs 35 through 191 of Count I of the Amended Complaint, and paragraphs 32 through 188 of Count II of the Amended Complaint.

23. Plaintiff alleges that on numerous occasions, beginning in March 1999 and continuing through the present, the Defendant has caused or allowed the emission of offensive livestock and feed odors from the facility and has caused or allowed the emission of offensive odors during times of land application of livestock waste. Plaintiff alleges that defendants have continually and repeatedly failed to correct the odor emissions problems at the facility and when land applying waste. Plaintiff alleges that these odors have unreasonably interfered with the enjoyment of life and property by neighboring residents by preventing or disrupting outdoor activities and by invading or penetrating their homes causing physical discomfort, including, but not limited to, a burning sensation in their noses and eyes, headaches and nausea. Plaintiff alleges that such physical discomfort has included the physical and emotional revulsion an individual might experience when subjected to highly offensive odors.

24. On December 16, 1997, June 3, 1998, October 14, 1998, August 17, 1999 and December 6, 1999, the Illinois EPA issued Inwood Dairy Violation Notices, pursuant to Section 31 of the Act, 415 ILCS 5/31 (1996). These violation notices set forth in detail the dates and nature of the water pollution violations that Plaintiff's Amended Complaint alleges occurred at the dairy. Further, Section 31 of the Act requires the Illinois EPA to allow the alleged violator opportunities to meet with Illinois EPA personnel to discuss all allegations and required compliance measures. These opportunities were extended to the Defendant. Further, if dairy

management was available at the time of the inspection, the Illinois EPA inspectors discussed perceived compliance problems with such personnel at the time of the inspection. Despite such notice and opportunity to correct perceived compliance problems, Plaintiff alleges that Inwood Dairy knowingly continued to violate the Act and applicable environmental regulations.

25. On August 17, 1999 and December 6, 1999, the Illinois EPA issued Inwood Dairy Violation Notices, pursuant to Section 31 of the Act, 415 ILCS 5/31 (1996). These violation notices set forth in detail the dates and nature of odor air pollution violations that Plaintiff's Amended Complaint alleges occurred at the dairy. Further, Section 31 of the Act requires the Illinois EPA to allow the alleged violator opportunities to meet with Illinois EPA personnel to discuss the allegations and required compliance measures. These opportunities were extended to the Defendant. Further, if dairy management was available at the time of the inspection, the Illinois EPA inspectors discussed perceived compliance problems with such personnel at the time of the inspection. Despite such notice and opportunity to correct perceived compliance problems, Inwood Dairy knowingly continued to violate the Act and applicable environmental regulations.

26. Plaintiff alleges that by causing, threatening or allowing the discharge of construction runoff, cattle manure, livestock waste, livestock wastewater, silage leachate, soured milk, oil and other contaminants into the environment so as to cause or tend to cause water pollution, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996).

27. Plaintiff alleges that by depositing construction runoff, cattle manure, livestock waste, livestock wastewater, silage leachate, soured milk, oil and other contaminants upon the land in such place and manner so as to create a water pollution hazard, Defendant Inwood Dairy LLC has violated Section 12(d) of the Act, 415 ILCS 5/12(d) (1996).

28. Plaintiff alleges that by causing, threatening and allowing the discharge of

construction runoff, cattle manure, livestock waste, livestock wastewater, silage leachate, soured milk, oil and other contaminants into waters of the State, without an NPDES permit or in violation of the conditions of the facility's construction stormwater NPDES permit, Defendant Inwood Dairy LLC has violated Section 12(f) of the Act, 415 ILCS 5/12(f) (1996).

29. Plaintiff alleges that by failing to keep waters of the State free from sludge, bottom deposits, floating debris, odor, color or turbidity of other than natural origins, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 302.203 (1994).

30. Plaintiff alleges that by causing or allowing ammonia nitrogen levels that exceeded 15 mg/l in waters of the State, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 302.212(a) (1994).

31. Plaintiff alleges that by failing to have adequate diversions, dikes, walls or curbs that will prevent excessive outside surface runoff waters from flowing through its animal feeding operation, and by failing to direct runoff to an appropriate disposal, holding or storage area, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996) and 35 Ill. Adm. Code 501.403 (a) and (b) (1994).

32. Plaintiff alleges that by failing to keep wastewater levels in the lagoon such that there is adequate storage capacity so that an overflow does not occur except in the case of precipitation in excess of a 25-year 24-hour storm event, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 501.404(c) (1994).

33. Plaintiff alleges that by failing to construct and maintain holding ponds and lagoons in such a manner so that they are impermeable or so sealed as to prevent surface water pollution, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 501.404(c)(1994).

34. Plaintiff alleges that by failing to provide a minimum of 120-day storage with a liquid manure holding tank, lagoon, holding pond, or any combination thereof, Defendant Inwood Dairy LLC has violated Section 12(a) of the Act, 415 ILCS 5/12(a) (1996), and 35 Ill. Adm. Code 501.404(c)(1994).

35. Plaintiff alleges that by causing, threatening or allowing the land application of livestock waste in such a manner as to cause water pollution in waters of the State, the Defendant has violated Sections 12(a) and (d) of the Act, 415 ILCS 5/12(a), (d) (2000) and 35 Ill. Adm. Code 501.405.

36. Plaintiff alleges that by failing to apply for an NPDES permit from October 15, 1998 until April 3, 2000, Defendant Inwood Dairy LLC violated Section 12(f) of the Act, 415 ILCS 5/12(f) (1998), and 35 Ill. Adm. Code 502.102 (1996).

37. Plaintiff alleges that by causing or allowing strong, persistent and unreasonably offensive livestock odors to emanate from its dairy and interfere with the use and enjoyment of the neighbors' property, Defendant Inwood Dairy, LLC has caused air pollution, thereby violating Section 9(a) of the Act, 415 ILCS 5/9(a)(1998).

38. Plaintiff alleges that by failing to take into consideration and incorporate adequate odor control methods and technology at its new livestock management facility and livestock waste-handling facility, thereby causing air pollution, Defendant Inwood Dairy, LLC has violated Section 9(a) of the Act, 415 ILCS 5/9(a)(1998), and 35 Ill. Adm. Code 501.402(c)(3)(1996).

39. Plaintiff alleges that by failing to practice odor control methods during manure removal and field application, thereby affecting its neighbors by causing air pollution and unreasonable interference with the use of their property, Defendant Inwood Dairy, LLC has violated Section 9(a) of the Act, 415 ILCS 5/9(a)(1998) and 35 Ill. Adm. Code 501.405(b)(1996).

40. Defendant has ceased to handle waste by flushing. The dairy has initiated and

maintained a manure scraping system. A mechanical alley scraper system will be installed in all three freestall barns. The existing flush collection system is to be plugged with concrete. Only parlor wastewater, not manure, is currently stored in the facility's 7-acre lagoon. A new collection and pumping system has been designed and is to be installed on the west side of the freestall barns to handle scraped manure. The system consists of a covered concrete drop structure at the end of each barn alley, pvc pipe, and covered concrete lift sump tanks. The system is designed to be an all weather system which can pump manure to a tanker or digester. Bed pack manure is to be retained in the barn's bed pack for 4 to 6 months with new bedding added as needed. This practice is anticipated to reduce manure land application frequency and also reduce the need for temporary manure stacks.

41. Defendant has hired professional waste applicators to land apply all manure by injection.

42. Defendant has begun to implement a stormwater plan and is also implementing well water conservation strategies. The Defendant has continued to implement its Revised Stormwater Plan dated November 6, 2001, drafted by Terry Feldmann, the dairy's consulting engineer. The dairy has implemented well water conservation strategies pursuant to a groundwater/fresh water report and plan approved by the Illinois EPA.

III.

APPLICABILITY

This Consent Order shall apply to and be binding upon the State, the Defendant, and the Defendant's successors and assigns, and all officers, agents and employees thereof. The Defendant shall not raise, as a defense to any action to enforce this Consent Order, the failure of any of its agents or employees to take such action as shall be required to comply with the provisions of this Consent Order.

IV.

COVERED MATTERS

This Consent Order covers all claims asserted in the Plaintiff's Amended Complaint concerning violations of the Act, 415 ILCS 5/1 *et seq*. (2000), and the regulations promulgated thereunder. Covered matters do not include:

i) Criminal liability;

ii) Claims based on the Defendant's failure to meet the requirements of this Consent Order;

iii) Liability for future violation of state, local, federal, and common laws and/or regulations; and

iv) Any future liability for natural resource damage or for removal, cleanup, or remedial action as a result of a release of hazardous substances or the liability of the Defendant under Section 22.2(f) of the Act, 415 ILCS 5/22.2(f) (1994), or under the Comprehensive Environmental Response, Compensation and Liability Act, 42 U.S.C. Sections 9601-9675.

V.

COMPLIANCE WITH OTHER LAWS AND REGULATIONS

This Consent Order in no way affects the responsibility of the Defendant to comply with any other federal, state or local statutes and regulations, including but not limited to the Act, 415 ILCS 5/1 *et seq.* (2000), and the Board's rules and regulations, 35 Ill. Adm. Code Subtitles A through H.

VI.

VENUE

The parties agree that the venue of any action commenced in circuit court for the purposes of interpretation, implementation and enforcement of the terms and conditions of this Consent Order shall be in Peoria County.

VII.

SEVERABILITY

It is the intent of the parties hereto that the provisions of this Consent Order shall be severable and should any provisions be declared by a court of competent jurisdiction to be unenforceable, the remaining clauses shall remain in full force and effect.

VIII.

FINAL JUDGMENT ORDER

This Court having jurisdiction over the parties and subject matter, the parties having waived appearance, the Court having considered the Plaintiff's Amended Complaint and being advised in the premises, the Court finds the following relief appropriate:

IT IS HEREBY ORDERED AND ADJUDGED:

A. MONETARY PAYMENT

1. The Defendant, INWOOD DAIRY, LLC, shall make a penalty payment of Fifty Thousand Dollars ($50,000.00) to the Environmental Protection Trust Fund, within thirty (30) days of the Circuit Court's entry of this Consent Order. This amount shall be paid by certified check or money order, payable to: "The Illinois Environmental Protection Agency, for deposit in the Environmental Protection Trust Fund," and be delivered to:

Illinois Environmental Protection Agency
Fiscal Services Section
1021 North Grand Avenue East
Post Office Box 19276
Springfield, Illinois 62794-9276

A copy of the penalty transmittal and check shall be simultaneously submitted to:

Illinois Attorney General's Office
c/o Donna Lutes, Environmental Bureau

500 South Second Street
Springfield, Illinois 62706

The name and court number of this case and the Federal Employer Identification Number ("FEIN") of the Defendant shall appear on the certified check or money order. For purposes of payment and collection, the Defendant may be reached at the following address:

Albert Zeller
Inwood Dairy, LLC
4711 Rockwood Road
Peoria, Illinois 61615

The FEIN for the Defendant: 36-4121805.

2. In the event the penalty is not paid in a timely fashion, interest shall accrue and be paid by the Defendant at the rate set forth in Section 1003(a) of the Illinois Income Tax Act, 35 ILCS 5/1003(a) (2000), pursuant to Section 42(g) of the Act, 415 ILCS 5/42(g) (2000).

B. COMPLIANCE

1. The Defendant shall diligently comply with, and shall cease and desist from violation of the Act, 415 ILCS 5/1 *et seq.* (2000), the Board's rules and regulations (35 Ill. Adm. Code Subtitles A through H (1998)) and any and all federal laws and regulations.

2. The Defendant shall revise its application for an NDPES permit, which shall include appropriate stormwater provisions, and submit the revised application to the Illinois EPA within 60 calendar days of entry of this consent decree.

3. In all areas except the milking parlor, holding pen and east cow transfer lane, the Defendant shall continue to maintain a manure scraping waste handling system and shall not return to handling waste by flushing. The Defendant may use a hose-type flushing system utilizing fresh or grey water for cleaning of the holding pen, transfer lane and other specific locations servicing or otherwise within the parlor. Best management practices shall be used to minimize the volume of wastewater generated.

4. Dairy management and employees or professional waste applicators retained by the Defendant shall handle all wastes. For Sections 19, 30 and 31 of Elmwood Township, liquids shall be injected and solid wastes shall be incorporated within 3 hours after application and all in a manner that prevents runoff and odor. Alternative application methods may be used when approved by the Illinois EPA in writing prior to such practice. In Section 30, the Defendant shall not apply waste within ¼ mile of Route 78. In Section 19, the Defendant shall not apply waste within 900 feet of Route 78 and within ¼ mile of the intersection of Route 78 and Taggart Road. All land application of waste shall be performed in a manner that prevents runoff and odor and in accordance with all applicable regulations and the NPDES Permit.

5. The Defendant shall implement all remaining stormwater pollution prevention measures for uncontaminated stormwater per the Revised Stormwater Plan dated November 6, 2001, submitted by Terry Feldmann. All remaining work, including roof gutter repair and installation, shall be completed within 30 calendar days of entry of this consent decree. All stormwater pollution prevention measures and associated operational controls and practices shall be incorporated into a stormwater pollution prevention plan for the dairy that will be submitted as part of, and included in, the NPDES Permit application. Further, within 90 calendar days of entry of this order, the Defendant shall restore and reseed barren acreage including but not limited to areas located south of the wastewater lagoon and all areas designated as clean areas in the November 6, 2001 Revised Stormwater Plan between the barns and north and south of the barns as well as the area along and east of the east road. Said area consists of several acres and shall be reseeded and a permanent grass cover shall be established and maintained. A stable layer of topsoil shall first be applied to this area to aid in vegetative cover establishment. All other barren areas, including areas around the temporary manure storage basins, shall be seeded for permanent grass cover establishment within 90 days of entry of this order. Further, within 90 days of entry of this order, Defendant shall provide for the proper

design and construction of all outfall structures for the southeast and northwest detention basins at the facility, so as to maximize detention prior to discharge. Defendant shall drain the detention ponds in between storm events and routinely clean out all silt collected in the ponds.

6. In order to eliminate unnecessary hydraulic loading to the wastewater handling facilities, Defendant shall continue to implement well water conservation strategies pursuant to the groundwater/fresh water report and plan approved by the Illinois EPA ("Water Use Plan").

7. By September 30, 2002, the Defendant shall clean the facility's 7-acre wastewater lagoon by removing wastewater and sludge. Waste shall be removed to a depth of 1 foot or less as measured from the lagoon floor. The Illinois EPA shall be notified when the lagoon cleaning is complete so that it might conduct an inspection. This lagoon clean-out is subject to approval of the Illinois EPA and shall not be considered complete until the Illinois EPA has approved the work. Defendant shall submit a plan outlining a schedule for future, routine removal and disposal of sludge from the lagoon, for Illinois EPA review and approval ("Sludge Removal Plan"). Sludge removal in the future from the lagoon shall be sufficient to prevent exceedence of the volatile solids loading rate per item Paragraph 8 below. The Defendant shall implement an annual sludge monitoring plan to determine the volume and depth of sludge accumulation in the lagoon ("Sludge Monitoring Plan").

8. The Defendant shall install new waste handling/treatment facilities to reduce organic loading to the wastewater lagoon sufficient to eliminate offensive off-site odor nuisance conditions and complaints. New waste handling/treatment facilities will be completed and on line within 180 days of entry of this order. Design of these will be based on a specified maximum herd size and a total organic loading from all sources not to exceed 3.75 pounds of volatile solids per day per 1000 cubic feet of lagoon treatment volume if 90 percent of livestock waste is treated in an anaerobic digester or 1.5 pounds of volatile solids per day per 1000 cubic feet of lagoon treatment volume if less than 90 percent of the livestock waste is treated in an

anaerobic digester. If off-site odor conditions, as verified by the Illinois EPA, continue after this work is completed, Defendant shall provide supplemental aeration as needed in the lagoon and maintain at least 2 parts per million ("ppm") dissolved oxygen throughout the upper 2 feet of the lagoon at all times. Aerobic conditions of at least 2 ppm dissolved oxygen shall be achieved no later than six months following notice by the Illinois EPA that additional aeration is required. In lieu of maintaining aerobic conditions in this lagoon, to prevent and/or address off-site odor conditions Defendant may opt to cover this lagoon and collect and use or treat odorous gases or implement other Illinois EPA approved technologies to prevent air pollution that may or may not require the above-described treatment volume.

9. The Defendant shall maintain a minimum freeboard of 2 feet in the wastewater lagoon at all times. Within 90 days of entry of this order, the Defendant shall install an easily visible and accurate permanent freeboard marker (delineated in inches) in its lagoon. The freeboard marker shall be selected and installed with the oversight and approval of the Defendant's engineer and the Illinois EPA. The benchmark for freeboard measurement shall be from the low point of the emergency spillway. In addition, a marker shall be installed and maintained that indicates the minimum level of the lagoon contents that provides the treatment volume to prevent exceedence of the volatile solids loading rate of 3.75 pounds of volatile solids per day per 1000 cubic feet of lagoon treatment volume if 90 percent of livestock waste is treated in an anaerobic digester or 1.5 pounds of volatile solids per day per 1000 cubic feet of lagoon treatment volume if less than 90 percent of the livestock waste is treated in an anaerobic digester.

10. The Defendant shall operate the wastewater lagoon such that at least 6 months of storage capacity, in addition to the minimum 2 feet of freeboard, is available by December 1 of each year.

11. Within 180 days of entry of this order, the Defendant shall permanently cease

usage of the two temporary manure storage basins for waste storage. Within 180 days of entry of this order, these two basins shall be thoroughly cleaned, removing all wastewater and sludge per Illinois EPA oversight and approval. Interim odor control measures, such as straw covers, shall be maintained during the waste storage period. Within 90 days of entry of this order, a plan for proposed future use of these structures shall be submitted to the Illinois EPA for approval ("Temporary Storage Basins Future Use Plan").

12. The Defendant shall provide odor control systems, such as covers, complete containment and gas collection, for all anaerobic processes conducted by and/or under the control of the dairy as needed to prevent offensive off-site odor or nuisance conditions.

13. The Defendant shall design and construct additional waste handling/treatment facilities sufficient to eliminate all wastewater discharges from the dairy and off-site odor emissions that cause nuisance conditions. This work may include measures such as anaerobic digestion, solids separation/dewatering, covering of all anaerobic waste storage and the utilization or flaring of gaseous emissions, or maintaining aerobic conditions in all uncovered waste storage structures as described in Paragraph VIII.B.8. This work shall be completed within 180 days of entry of this order. The Defendant has agreed to design and install a heated anaerobic digester and solids separator system at the facility. Methane recovery and facilities for utilizing the methane as energy shall be provided. Aeration shall be installed and operated in the lagoon as needed to control off-site odor, as described in Paragraph VIII.B.8.

14. The Defendant shall provide odor and runoff controls for all silage and waste storage areas created by, generated by, accumulated at, and/or under control of, the Defendant.

15. The Defendant shall adopt and implement a year-round manure management plan ("Manure Management Plan") that shall include sufficient land base, manpower, and equipment immediately available at all times so that all handling, land application and disposal

of wastewater, liquid and solid manure, and other liquid and solid wastes generated or accumulated at the dairy is done in a manner that complies with all applicable laws and regulations. Said Manure Management Plan shall be completed within 60 calendar days of entry of this consent decree and submitted to the Illinois EPA for approval. The Defendant's Manure Management Plan shall include permanent covered storage containment facilities for manure and all wastes and provide for at least 6 months of storage capacity. Said containment facilities shall provide for complete containment, that is, each shall be a building or structure with sidewalls and roof, except that Defendant may use plastic agricultural storage bags for storage of separated manure solids. It is expected that this Manure Management Plan will include all information necessary to meet the waste management plan requirements of the Livestock Management Facilities Act, 510 ILCS 77/1 *et seq.*, and regulations promulgated thereunder.

16. The Defendant shall control odors and runoff from the permanent storage facilities. The Defendant shall develop a plan for the control of odors and runoff for all permanent waste storage, including storage in plastic agricultural storage bags, and silage storage facilities at the dairy ("Odor and Runoff Control Plan"), and submit it to the Illinois EPA for approval within 60 calendar days of entry of this Order. The Defendant shall implement the approved Odor and Runoff Control Plan for all permanent waste and silage storage facilities within 180 days of entry of this order. This Odor and Runoff Control Plan shall be submitted as part of and included in the NPDES Permit application.

17. The Defendant shall continue to monitor, record and submit reports (on similar forms currently being used) to the Illinois EPA on a monthly basis by fax (309.693.5467) or mail or delivery (5415 N. University, Peoria, IL 61614) as follows:

a. Lagoon freeboard shall be monitored and recorded twice weekly and within 24 hours after each precipitation event.

b. Precipitation shall be monitored and recorded promptly following each event.

c Fresh water usage (total and barn) shall be monitored and recorded daily.

d. Land application of waste shall be monitored and recorded on the day of application, including location, acres, volume applied, name of applicator, and date of application.

If lagoon freeboard is ever less than 3 feet, freeboard readings shall be taken daily and the frequency of submission shall be weekly via facsimile. In the event that freeboard is less than one foot, Defendant shall monitor freeboard at least twice daily with a minimum interval of eight (8) hours between readings, and submit daily reports, including time of recording, via facsimile to the Illinois EPA. When reporting monthly, Defendant shall submit reports to the Illinois EPA by delivery or facsimile by the first working day of each month.

18. The Defendant is aware that waste handling modifications set forth in this Section VIII.B may result in the installation of structures or technology applications that meet the definition of an emission source pursuant to the Illinois Pollution Control Board's ("Board") air pollution regulations. Defendant shall take all steps required by the Board's air pollution regulations to assess the need for and obtain all necessary air pollution control permits.

C. STIPULATED PENALTIES

1. If the Defendant fails to complete any activity by the date specified in Section VIII.B. of this Consent Order, the Defendant shall provide notice to the Plaintiff of each failure to comply with this Consent Order. In addition, the Defendant shall pay to the Plaintiff, for payment into the Environmental Protection Trust Fund ("EPTF"), stipulated penalties per violation for each day of violation in the amount of one hundred dollars ($100.00) per day of noncompliance until such time that compliance is achieved.

2. Following the Plaintiff's determination that the Defendant has failed to complete performance of any task or other portion of work, or failed to provide a required submittal, including any report or notification, Plaintiff may make a written demand for stipulated penalties upon Defendant for its noncompliance with this Consent Order. Failure by the Plaintiff to make this demand shall not relieve the Defendant of the obligation to pay stipulated penalties.

3. All stipulated penalties owed the Plaintiff under this section of this Consent Order that have not been paid shall be payable within thirty (30) days of the date the Plaintiff makes a written demand for stipulated penalties to Defendant.

4. a. All stipulated penalties shall be paid by certified check payable to the Illinois EPA for deposit in the EPTF and delivered to:

Illinois Environmental Protection Agency
Fiscal Services
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

b. The name and number of the case and the Defendant's FEIN shall appear on the face of the check. A copy of the check(s) and the transmittal letter shall be sent to:

Illinois Attorney General's Office
c/o Donna Lutes, Environmental Bureau
500 South Second Street
Springfield, Illinois 62706

5. The stipulated penalties shall be enforceable by the Plaintiff and shall be in addition to, and shall not preclude the use of, any other remedies or sanctions arising from the failure to comply with this Consent Order.

D. DISPUTE RESOLUTION

1. The Consent Order and its terms, any application, plan, record or report required thereunder, or with respect to any party's compliance herewith or any delay thereunder shall in the first instance be the subject of informal negotiations during which the parties make a good

faith attempt to resolve any dispute. If the Plaintiff and the Defendant cannot resolve the dispute in thirty (30) calendar days, however, it may then be presented to the court for appropriate resolution upon written notice by any party (the period for negotiations may be extended by mutual agreement among the parties). Where the Defendant has violated any payment or compliance deadline within this Consent Order, the Plaintiff may elect to pursue contempt sanctions to enforce this Consent Order.

2. It shall be the responsibility of the Defendant to file the documents necessary to notify the Court of the dispute, and thereafter the Court may order the parties to file such pleadings as the Court deems necessary and proper. The Defendant shall bear the burden of proof. The Defendant shall file any petition with the Court within forty-five (45) calendar days after the informal negotiation period (or any extension) has expired.

E. FORCE MAJEURE

1. Any failure by the Defendant to comply with any requirement of the Consent Order shall not be a violation if such failure is the direct result of actions by persons or events beyond the reasonable control of the Defendant, including, but not restricted to, acts of God, acts of other parties, fires, floods, strikes, freight embargoes, or delays of contractors due to such causes.

2. When, in the opinion of the Defendant, circumstances have occurred which cause or may cause a violation of any provision of the Consent Order, the Defendant shall notify the Agency in writing as soon as practicable but not later than five (5) calendar days after the claimed occurrence. Failure to so notify the Agency shall constitute a waiver of any defense under this Paragraph E arising from said circumstances.

3. If the Plaintiff agrees that the violation has been or will be caused by circumstances beyond the control of the Defendant, the parties may request that this Court

extend the time for performance hereunder for a period equal to the delay resulting from such circumstances or enter such order as is appropriate. If parties cannot agree whether the reasons for the delay or noncompliance were beyond the reasonable control of the Defendant, such dispute shall be resolved pursuant to the dispute resolution provisions appearing in Paragraph D above. The Defendant shall have the burden of going forward and proving that the circumstances alleged to be causing the delay of noncompliance were beyond its reasonable control.

4. Increased costs associated with implementing the measures required by the Consent Order shall not, by itself, excuse the Defendant from a failure to comply under the provisions of this Paragraph E.

F. RELEASE

In consideration of Defendant's payment of a $50,000 civil penalty, and commitment to perform the actions set forth herein, Plaintiff releases, waives and discharges Defendant from any further liability or penalties resulting from alleged violations of the Act which were the subject of the Amended Complaint in this matter.

G. JURISDICTION

This Court shall retain jurisdiction of this matter for the purpose of amending, interpreting, implementing and enforcing the terms and conditions of this Consent Order, and for the purpose of adjudicating all matters of dispute among the parties. The Defendant agrees that notice of any subsequent proceeding to enforce this Consent Order may be made by mail and waives any requirement of service of process.

WHEREFORE, the parties, by their representatives, enter into this Consent Order and submit it to the Court that it may be approved and entered.

Respectfully submitted,

PEOPLE OF THE STATE OF ILLINOIS,
ex rel. JAMES E. RYAN, Attorney
General of the State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement/
Asbestos Litigation Division

DATED: 4/29/02 BY: ____________________
THOMAS DAVIS, Chief
Environmental Bureau
Assistant Attorney General

ILLINOIS ENVIRONMENTAL PROTECTION AGENCY

DATED: 4/18/02 BY: ____________________
JOSEPH E. SVOBODA
Chief Legal Counsel
Division of Legal Counsel

INWOOD DAIRY LLC.

DATED: 4-25-02 BY: ____________________
Albert Zeller
Managing Member

ENTERED: 5-1-02 ____________________
JUDGE

FILED
CLERK OF CIRCUIT COURT
MAY 1 2 27 PM '02
REGINA M. SPEARS

Attachment 27:

Complaint, *People of the State of Illinois v. Ed Malone, d/b/a Malone Farms and Feedlot, and Galesburg Livestock Sales, Inc.*

IN THE CIRCUIT COURT FOR THE NINTH JUDICIAL CIRCUIT

KNOX COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS,
***ex rel.* LISA MADIGAN, Attorney**
General of the State of Illinois

Plaintiff,

v. **No. 09 - L - 07**

ED MALONE, d/b/a
MALONE FARMS AND FEEDLOT, and
GALESBURG LIVESTOCK SALES, INC.,
an Illinois corporation

Defendants

MOTION FOR LEAVE TO SUPPLEMENT COMPLAINT

NOW COMES Plaintiff, People of the State of Illinois, *ex rel* Lisa Madigan, Attorney General of the State of Illinois, and moves for leave to supplement the Complaint in this matter, stating the following in support of its motion:

1. On February 20, 2009, the original Complaint was filed and entered in this matter.

2. On June 1, 2010, an Agreed Injunction Order with Defendant Ed Malone was filed and entered in this matter.

3. On January 14, 2011, a Preliminary Injunction Order against Defendant Ed Malone was entered in this matter.

4. On January 21, 2011, a second Agreed Injunction Order with Defendant Ed Malone was entered in this matter.

5. Neither Defendant has answered the complaint. The Plaintiff is in settlement negotiations with Defendant Galesburg Livestock Sales, Inc. The Plaintiff was in settlement discussions with Defendant Ed Malone until February 20, 2010.

6. None of the parties have initiated discovery.

7. Since this matter was originally filed, there have been numerous documented instances of discharges and conditions that existed as a threat of pollution to waters of the State at the Malone site in violation of Sections 12(a), (d) and (f) of the Illinois Environmental Protection Act and regulations promulgated thereunder. With this motion, the State seeks to supplement the complaint so as to include all outstanding allegations of violation at the Malone site in this existing enforcement matter.

8. Section 2-609 of the Illinois Code of Civil Procedure, 735 ILCS 5/2-609, provides:

> Supplemental pleadings. Supplemental pleadings, setting up matters which arise after the original pleadings are filed, may be filed within a reasonable time by either party by leave of court and upon terms.

* * *

9. An Amended Complaint is submitted in conjunction with this Motion.

WHEREFORE, Plaintiff respectfully requests leave to supplement the original Complaint and that the Amended Complaint submitted in conjunction with this Motion be filed and entered.

Respectfully submitted,

PEOPLE OF THE STATE OF ILLINOIS,
ex rel. LISA MADIGAN, Attorney General
of the State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement Division

BY: ____________________
JANE E. MCBRIDE
Assistant Attorney General

500 South Second Street
Springfield, Illinois 62706
(217) 782-9031

STATE OF ILLINOIS)
) ss
COUNTY OF SANGAMON)

AFFIDAVIT

I, JANE MCBRIDE, after being duly sworn and upon oath, states as follows:

1. I am the Senior Assistant Attorney Generals assigned to handle the matter of *People v. Ed Malone, d/b/a Malone Farms and Feedlot and Galesburg Livestock Sales, Inc*, Knox County Case No. 09 L 07, and have been involved with the matter since it was originally referred by the Illinois Environmental Protection Agency.

2. I am executing this Affidavit to accompany Plaintiff's Motion for Leave to Supplement the Complaint.

3. The assertions set forth in Plaintiff's Motion for Leave to Supplement are correct and accurate, to the best of Affiant's knowledge and belief.

Further, Affiant sayeth not.

JANE E. MCBRIDE

STATE OF ILLINOIS)
) ss
COUNTY OF PEORIA)

AFFIDAVIT

I, ERIC O. ACKERMAN, after being duly sworn and upon oath, state as follows:

1. I am employed by the Illinois Environmental Protection Agency ("Illinois EPA") as a field inspector and environmental protection engineer.

2. As part of my duties with the Illinois EPA, I perform site investigations to assess whether environmental and/or public health threats exist. Upon formal request, I also review pleadings to be filed by the Attorney General's Office to ensure veracity and accuracy with the records of the Illinois EPA as well as my own personal observations and knowledge.

3. I am executing this Affidavit to accompany Plaintiff's Motion for Leave to Supplement the Complaint.

4. The assertions set forth in Paragraph 7 of Plaintiff's Motion for Leave to Supplement the Complaint, and Paragraphs 31 through 65, 75 through 90, 97 through 102, 126 through 133 and 135 through 138 of the Amended Complaint are correct and accurate, to the best of Affiant's knowledge and belief.

Further, Affiant sayeth not.

Eric Ackerman
ERIC O. ACKERMAN

STATE OF ILLINOIS)
) ss
COUNTY OF PEORIA)

AFFIDAVIT

I, TODD HUSON, after being duly sworn and upon oath, state as follows:

1. I am employed by the Illinois Environmental Protection Agency ("Illinois EPA") as a field inspector and environmental protection engineer.

2. As part of my duties with the Illinois EPA, I perform site investigations to assess whether environmental and/or public health threats exist. Upon formal request, I also review pleadings to be filed by the Attorney General's Office to ensure veracity and accuracy with the records of the Illinois EPA as well as my own personal observations and knowledge.

3. I am executing this Affidavit to accompany Plaintiff's Motion for Leave to Supplement the Complaint.

4. The assertions set forth in Paragraph 7 of Plaintiff's Motion for Leave to Supplement the Complaint, and Paragraphs 66 through 69, 71 through 74, 91 through 96, 103 through 118 and 120 through 125 of the Amended Complaint are correct and accurate, to the best of Affiant's knowledge and belief.

Further, Affiant sayeth not.

Todd R Huson
TODD HUSON

IN THE CIRCUIT COURT FOR THE NINTH JUDICIAL CIRCUIT

KNOX COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS, *ex rel.* LISA MADIGAN, Attorney General of the State of Illinois	)	
Plaintiff,	)	
	)	**No. 09 - L - 07**
v.	)	
ED MALONE, d/b/a MALONE FARMS AND FEEDLOT, and GALESBURG LIVESTOCK SALES, INC., an Illinois corporation	)	
Defendants	)	

AMENDED COMPLAINT

The PEOPLE OF THE STATE OF ILLINOIS, by Lisa Madigan, Attorney General of the State of Illinois, complain of Defendants ED MALONE, d/b/a MALONE FARMS AND FEEDLOT, and GALESBURG LIVESTOCK SALES, INC., as follows:

COUNT I

MALONE SITE WATER POLLUTION

1. This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2. The Illinois EPA is an agency of the State of Illinois created by the General Assembly in Section 4 of the Act, 415 ILCS 5/4, and which is charged, inter alia, with the duty of enforcing the Act.

3. Defendant Ed Malone ("Malone"), d/b/a Malone Farms and Feedlot, owns and operates a cattle feedlot facility located approximately two miles northwest of Abingdon, Illinois

which is approximately 10 miles south of Galesburg, IL ("Malone facility" or "Malone site"). The legal description is S ½, SW 1/4, Section 30, T10N, R1E (Cedar Township), Knox County, IL. The operation includes open dirt feedlots encompassing several acres that were, at times relevant to this complaint, populated with up to 2800 head of cattle. The facility is in the watershed of Latimer Creek which is tributary to Cedar Fork. At the time of the filing of the original complaint in this matter, February 20, 2009, an inadequate, undersized wastewater holding pond was the sole storage for waste on the site and was located near the north edge of the site near a tributary of Latimer Creek.

4. Defendant Galesburg Livestock Sales, Inc. ("Galesburg Livestock Sales") is a 23-acre cattle feedlot facility engaged in weekly public livestock auctions. The site consists of barns, a concrete feedlot, earthen feedlots and pasture and is located near and northwest of the intersection of Knox County Routes 7 and 9, two miles northeast of Galesburg, Knox County, Illinois (the "Galesburg Livestock Sales facility" or "Galesburg Livestock Sales site"). The address is 1714 Knox Highway #9, Galesburg, IL 61401. The facility is located in the watershed of Rice Lake, which is tributary to Court Creek. Richard M. Anderson, 2135 U.S. Highway 150 N., Wataga, IL 61488, is manager/owner and president of the facility. The registered agent is Kurt Horberg, 124 West Exchange, PO Box 179, Cambridge, IL 61238.

5. At the time of site inspections at the Malone facility, Defendant Malone informed the Illinois EPA that some if not all of the cattle on site belonged to Defendant Galesburg Livestock Sales.

6. On March 30, 2009, an original design and construction plan was submitted to the Illinois EPA and Illinois Department of Agriculture to construct and upgrade waste handling and storage structures at the Malone site as well as clean water diversion. The plan received final approval in September of 2009. In late October 2009, construction was initiated at the

Malone site.

7. On December 15, 2009, the Illinois EPA conducted an inspection at the Malone site. The status of the construction was documented in the Illinois EPA's inspection report. Per agreement of the parties, construction and installation called for in the approved plan not yet completed were due to be completed by the end of March 2010.

8. According to Defendant Galesburg Livestock's records, as of February 20, 2010, 2,851 head of cattle owned by Galesburg Livestock were to be alive and on hoof at the Malone site. In addition, Defendant Malone has informed Galesburg Livestock that another 265 head were on the Malone site and were in payment to Galesburg for money lent by Defendant Galesburg Livestock to Defendant Malone.

9. On February 20, 2010, Richard Anderson, principal for Galesburg Defendant Livestock, visited the Malone site and observed that far fewer animals were on site than his records indicated should have been on site. On that date, an employee of Malone stated there were 440 cattle on the site.

10. On March 10, 2010, the Illinois EPA conducted a reconnaissance inspection at the site. At the time of the inspection, there were only a few head of cattle on site. The outstanding compliance work that was to be completed by March 15, 2010, was yet to be done.

11. On May 10, 2010 Defendant Malone filed a Chapter 11 petition in the United States Bankruptcy Court. As of the date of filing of this Amended Complaint, Defendant Malone is Debtor in Possession of the site and as such exercises control over the premises of the facility.

12. On May 17, 2010, Defendant Galesburg Livestock sued Defendant Malone for conversion, breach of contract and fraud in state court. On June 8, 2010, Defendant Galesburg Livestock filed a Complaint to Determine Dischargeability pursuant to 11 USC §523(a)(2)(A)

and 11 USC §523(a)(4) in Defendant Malone's bankruptcy matter, contesting, on the basis of assertions of conversion, fraud, deception and misrepresentation set forth in the State case, Defendant Malone's claims of dischargeability.

13. On May 25, 2010, the Illinois EPA conducted an inspection of the Malone site. At the time of the inspection, the inspector documented the following: "Unless prompt action is taken to reduce hydraulic pressure, the earthen dam serving the West Holding Pond will likely fail, releasing a significant volume of wastewater to Latimer Creek." At the time of the inspection, a significant accumulation of stacked cattle manure and waste feed and leaching stockpiled silage remained at various onsite, un-contained locations contributing contaminated runoff to the wastewater impoundments on site. Gutters and downspouts had not yet been installed on the cattle barns. Guttering is essential to divert clean surface water away from the feedlots and wastewater holding ponds. On June 11, 2010, Defendant inadvertently created a spillway that allowed continuous discharge from the West Holding Pond. On June 22, 2010, the north berm of the site's East Livestock Waste Holding Pond failed.

14. Section 3.545 of the Act, 415 ILCS 5/3.545, provides:

> "WATER POLLUTION" is such alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the State, or such discharge of any contaminant into any waters of the State, as will or is likely to create a nuisance or render such water harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or other aquatic life.

15. Section 3.550 of the Act, 415 ILCS 5/3.550, provides:

> "WATERS" means all accumulations of water, surface and underground, natural, and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this State.

16. Section 3.165 of the Act, 415 ILCS 5/3.165, provides:

"CONTAMINANT" is any solid, liquid, or gaseous matter, any odor or any form of energy, from whatever source.

17. Section 12 (a) of the Act, 415 ILCS 5/12(a), provides, in pertinent part, as follows:

No person shall:

a. Cause or threaten or allow the discharge of any contaminants into the environment in any State so as to cause or tend to cause water pollution in Illinois, either alone or in combination with matter from other sources, or so as to violate regulations or standards adopted by the Pollution Control Board under this Act;

18. On August 23, 2005, the Illinois EPA conducted an inspection of the Malone site. At the time of the inspection, approximately 600 to 700 head of cattle were present at the facility. Defendant Malone was present at the time of the inspection. He indicated that he had been raising cattle at the site for approximately three years. The maximum number of cattle confined to the facility was reported to be 900 to 1,000 head at that time. Defendant Malone indicated that he owned and managed the feedlots but did not own the cattle. The cattle were owned by Richard Anderson, manager of Galesburg Livestock Sales, Inc.

19. At the time of the August 23, 2005 inspection of the Malone site, Defendant Malone was not a Certified Livestock Manager. Pursuant to the Illinois Livestock Management Facilities Act ("LMFA"), 510 ILCS 77/ and 8 Ill. Admin. Code 900.901, a livestock waste handling facility serving 300 or greater animal units shall be operated only under the supervision of a certified livestock manager. An individual animal grown for slaughter is one animal unit, pursuant to the LMFA. As of December 31, 2008, Defendant Malone had not obtained his state livestock manager certification.

20. At the time of the August 23, 2005 inspection of the Malone site, there were no liquid livestock waste collection or containment structures at the facility. It was apparent from

the location and condition of the cattle lots that feedlot runoff would occur during rainfall events. Defendant Malone informed the inspector that his general practice was to haul solid manure during the fall and winter months. At the time of the inspection, the facility was without a manure spreader for the handling of solid manure. At the time of the inspection, Defendant Malone was advised of the need to properly control feedlot runoff and comply with environmental requirements.

21. On September 20, 2005, the Illinois EPA sent Defendant Malone a Noncompliance Advisory Letter, reiterating the need for additional controls to ensure proper containment of all livestock waste at the site. The letter included a list of recommendations. The recommendations included the need for a comprehensive professional study of the facility, and the need to develop a waste management plan. The plan was to include the installation of appropriate waste management structures. Also, as discussed at the time of the site visit; Defendant Malone was advised to abandon lots that were not suitable for runoff control and reseed the abandoned lots so as to create a thick vegetative cover. Defendant Malone was advised to divert all clean water away from the livestock feedlot areas, and to install grass buffers around the cattle lots. Defendant Malone was also advised to create suitable covered manure stacking structures for the storage of solid livestock waste so that it was not subject to precipitation resulting in runoff.

22. On May 3, 2007, the Illinois EPA conducted an inspection of the Malone site. At the time of the inspection, a significant accumulation of un-contained, uncovered solid manure existed on the feedlots at the facility. The inspectors observed drainage channels that, at times of precipitation events, would result in contaminated surface runoff discharge from the cattle lots. A wastewater pond was located in a ravine on the north side of the cattle operation. At the time of the inspection, wastewater was discharging from the wastewater pond.

Contaminated surface runoff was also observed coming from the cattle feed storage piles on site, including a gluten stockpile. At the time of the inspection, there were approximately 1300 to 1400 head of cattle on the Malone site.

23. At the time of the May 3, 2007 inspection of the Malone site, liquid samples were collected at four locations on the site. A sample was collected from a small stream at the facility that is an unnamed tributary to Latimer Creek. The stream sample was taken immediately downstream from the wastewater pond that was discharging at the time of the inspection. At the location where the sample was collected, the stream was turbid, black colored with a strong odor. Upon analysis the sample exhibited the following parameter levels: ammonia, 56.9 milligrams per liter ("mg/l"); Biological Oxygen Demand ("BOD"), 450 mg/l; total suspended solids ("TSS"), 408 mg/l; and fecal coliform, 180 per 100 milliliter ("ml"). A sample collected from another unnamed tributary to Latimer Creek that flows south to north along the east side of the cattle facility was odorous. A sample collected from an accumulation of wastewater in the south lot of the cattle facility, which was un-contained and susceptible to becoming a runoff discharge in the event of precipitation, upon analysis exhibited the following parameter levels: ammonia, 279 mg/l; BOD, 4000 mg/l; TSS, 4,490 mg/l; fecal coliform, 61,300 per 100 ml. This sample was dark colored, turbid and contained a strong waste odor. Drainage from the location of the sample flows east into an unnamed tributary to Latimer Creek. A fourth sample was collected from an accumulation of wastewater near a manure stockpile and a gluten storage area. This ponded liquid was light brown in color, turbid and contained an odor. Drainage from the area of this fourth sample flows to the wastewater pond on-site that was discharging the day of the inspection. Analysis of this fourth sample indicated the following parameter levels: ammonia, 1,470 mg/l; BOD, 15,000 mg/l; TSS, 410 mg/l; fecal coliform, 470,000 per 100 ml.

24. Immediately following the inspection, the IEPA inspectors advised Defendant Malone that he must stop the manure discharge from the holding pond at his cattle operation. The inspectors further advised Defendant Malone to report the manure release pursuant to the livestock discharge reporting requirements to the Illinois Emergency Management Agency ("IEMA"). The inspectors recommended that Defendant Malone promptly plug the discharge pipe and begin removing wastewater from the holding pond, to be sprayed/irrigated on grass application sites at an agronomic rate.

25. On May 8, 2007, the Illinois EPA conducted a follow-up inspection at the Malone site. At the time of the inspection, approximately 1500 to 1600 head of cattle existed on the site. At the time of the inspection, wastewater discharged from the holding pond on-site to an unnamed tributary to Latimer Creek. Defendant Malone indicated, at the time of the inspection, that he had been unable to plug the leak because the wastewater was seeping through the porous, earthen/broken concrete dam that served as a berm for the holding pond. At the time of the inspection, waste feed had been deposited in a field just southwest of the wastewater pond. Surface runoff from the waste feed was in the drainage pattern to the pond in the event of a precipitation event.

26. At the time of the inspection, a significant accumulation of solid manure existed at the Malone facility. It was apparent from the inspectors' observation of drainage channels at the time of the inspection that contaminated surface runoff discharges from the cattle lots during precipitation events. A significant volume of cattle manure was stored on the south lot. This manure drains to the east and discharges into an unnamed tributary to Latimer Creek.

27. At the time of the May 8, 2007 inspection of the Malone site, dead cattle were observed by the inspectors at various locations on the feedlot site. Some of the dead livestock were located in and/or near the stream. The inspectors observed that the animals had been

dead for a long period of time.

28. At the time of the May 8, 2007 inspection, liquid samples were collected at eight locations on the Malone site. A sample collected from the wastewater pond, which was discharging at the time of the inspection, exhibited the following parameter levels upon analysis: ammonia, 61.2 mg/l; BOD, 690 mg/l; total suspended solids ("TSS"), 396 mg/l; and fecal coliform, 600,000 per 100 ml. A sample collected from a small stream on the site immediately downstream of the wastewater pond and flowed from the wastewater pond at a rate of approximately 3 gallons per minute. The liquid was turbid, black in color and had a strong livestock waste odor. Upon analysis, the sample exhibited the following parameter levels: ammonia, 53.5 mg./l; BOD, 280 mg/l; TSS, 268 mg/l; fecal coliform, 310,000 per 100 ml. A sample collected from a stream on the property that is an unnamed tributary to Latimer Creek and is downstream of the two prior samples described in this paragraph, upon analysis exhibited the following parameter levels: ammonia, 34.2 mg/l; BOD, 70 mg/l; TSS, 156 mg/l; fecal coliform, 5,500 per 100 ml. A dead cow was in the stream near the location where this sample was collected. At the sample location, the stream was odorous, slightly turbid and had a brownish color.

29. On October 3, 2007, the Illinois EPA conducted an inspection at the Malone facility. Approximately 1600 head were on site at the time of the inspection. At the time of the inspection, leachate discharging from a storage pad holding modified wet distillers grain and wet gluten had pooled outside of the storage pad structure, un-contained, on the ground. At the time of the inspection, the facility lacked manure collection structures to adequately contain and manage waste.

30. On April 29, 2008, Defendant Malone met with the Illinois EPA regarding the compliance issues at the site. At the time of the meeting, the Defendant indicated that he had

2000 head on site.

31. On December 29, 2008, the Illinois EPA conducted an inspection at the Malone site. At the time of the inspection, Defendant Malone indicated there were 3,000 head of cattle on site. At the time of the inspection, the single large waste holding cell in existence on the site at the time, was full. The Illinois EPA inspection observed manure runoff draining east, off the surface of cattle lots located on the east side of the Malone site. The runoff drains into an unnamed tributary to Latimer Creek.

32. At the time of the December 29, 2008 inspection, a large silage stockpile existed on the south side of the gravel lane at the Malone site. The stockpile was approximately 20 feet tall and measured slightly less than 80 feet by 180 feet. A dark colored, turbid liquid was observed draining away from the silage stockpile. The dark liquid was not contained and its drainage path was south and east to an unnamed tributary to Latimer Creek.

33. On January 8, 2009, the Illinois EPA conducted an inspection of the Malone site. At the time of the inspection, Defendant Malone indicated that approximately 2800 head of cattle were on site.

34. During 2008, three new cattle barns were built at the Malone facility. All of the barns have a concrete floor as well as a concrete pad extending in the front of the building for approximately 40 feet. At the time of the inspection, Defendant Malone indicated that his method of manure management was to scrape cattle manure off the concrete portion of the cattle lots every 10 days to two weeks and stockpile the manure. The solid manure was later removed with a semi-trailer or in a conventional manure spreader and land applied. At the time of the January 8, 2009 inspection, manure from an area known as the Holding Lot was draining north and entering the small, intermittent stream located between the Holding Lot and Pasture Lot on the site. At the time of the inspection, there were 400 head of cattle in the Pasture Lot.

At the time of the inspection, the Illinois EPA inspector advised Defendant Malone to construct a temporary holding pond at the Holding Lot to collect and contain liquid manure and manage it by regularly applying it to cropland.

35. At the time of the January 8, 2009 inspection, the Illinois EPA inspector observed that the single wastewater holding pond in existence on the site at the time was frozen. An eroded overflow channel was observed at the west end of the earthen dam that created the wastewater holding pond. Wastewater was frozen in the eroded overflow channel, discharging from the wastewater pond.

36. On February 25, 2009, the Illinois EPA conducted an inspection at the Malone site. At the time of the inspection, there was a significant accumulation of cattle manure at the Holding Lot. At the time of the inspection, adequate manure collection, containment or storage structures had not yet been installed at this location at the facility. The manure at this location existed in a manner that would result in manure run-off to an intermittent stream during precipitation events.

37. At the time of the February 25, 2009 inspection, the Illinois EPA inspector observed that earthen fill was recently placed along the west end of the waste hold cell dam, backfilling the eroded overflow channel.

38. On September 25, 2009, the Illinois EPA conducted an inspection at the Malone site. At the time of the inspection, Defendant Malone indicated there were approximately 2200 head of cattle on-site. At the time of the inspection, the design and construction plan developed for the site had been approved by the Illinois EPA and the Illinois Department of Agriculture. Defendant Malone was attempting to secure federal assistance in the form of USDA/NRCS EQIP funding. The federal assistance application process caused a construction delay.

39. At the time of the September 25, 2009 inspection, the Illinois EPA inspector

observed that the lots in the south eastern portion of the site has been significantly decreased in size and paved in concrete. Approximately 71 head of cattle were in one pen, and 20 were in another. Surface runoff from the new concrete feedlot drains off the south side and east site of the lots. Feedlot runoff draining off the south side of one of the pens discharges to a small stream on the east side of the site. At the time of the inspection, wastewater was flowing away from the south lot. The inspector collected a sample of the runoff. The liquid from which the sample was collected was brown colored, turbid and odorous. Analytical results indicated a biological oxygen demand ("BOD") of 335 mg/l and total suspended solids of 764 mg/l.

40. At the time of the September 25, 2009 inspection, a small earthen berm existed in a north/south manner along a portion of the east side of the newly paved lots in the southeast corner of the site. A portion of the runoff from the concrete lots ponded on the west side of the berm. The Illinois EPA inspector observed an eroded channel cut through the berm and wastewater was flowing from the concrete lots to the berm and then continued east as is flowed through the eroded channel to the nearby stream. This wastewater discharge was turbid with foam and the flow was estimated at 5 gallons per minute.

41. At the time of the September 25, 2009 inspection, the discharge pipe and valve were still in place, in the berm of the existing large holding cell that would come to be known as the East Holding Cell on the site. Defendant Malone indicated he intended to remove the pipe and valve when construction got underway and improvements were made to the holding cell.

42. At the time of the September 25, 2009 inspection, only a portion of the manure runoff from what was known as the Holding Lot was being captured in a temporary waste holding cell. At the time of the inspection, the waste holding cell had about 3 foot of freeboard. The contents of the cell will black and turbid with gas bubbles rising to the surface. Runoff from the eastern half of the Holding Lot drained directly into a nearby receiving stream that is an

unnamed tributary to Latimer Creek.

43. At the time of the September 25, 2009 inspection, an accumulation of wastewater was ponded along the east boundary of what was known as the Stockfield East cattle lot on the site. Surface runoff from this lot was not contained and drained to the nearby receiving stream, which is an unnamed tributary of Latimer Creek. At the time of the inspection, the Illinois EPA inspector observed a drainage channel leading away from the Stockfield East lot.

44. At the time fo the September 25, 2009 inspection, gutters and downspouts still had not been installed on the cattle barns built on site in 2008. The large barns contribute a significant amount of roof water to the surface of the feedlots. Uncontrolled roof water flushes manure off the feedlots and conveys the manure to the stream. Thus, it is essential that clean water be diverted away from the feedlots and the waste management system.

45. At the time of the September 25, 2009 inspection, the silage stockpile consisting of seed corn kernels and shucks from the 2008 harvest, continued to exist on the south side of the gravel lane at the site. At the time of the inspection, the Illinois EPA inspector observed black colored, turbid liquid with a strong odor ponded around the stockpile – leachate from the silage. A small limestone berm has been constructed on three sides of the stockpile. The limestone berm was eroded at the southeast corner of the stockpile, releasing leachate and allowing it to drain to a nearby stream. The Illinois EPA inspector collected a sample of the liquid draining from the stock pile. Analytical results indicated the following parameter levels: ammonia, 68.9 mg/l; BOD 774 mg/l; total suspended solids, 808 mg/l.

46. On December 15, 2009, the Illinois EPA conducted an inspection of the Malone site. At the time of the inspection, Defendant Malone indicated there were approximately 2400 head of cattle on site. Construction activities to implement the design and construction plan

recently approved by the Illinois EPA and Illinois Department of Agriculture had begun on site. An earthen berm has been constructed along the south and east side of concrete lots in the southeast corner of the site. The berm is designed to capture feedlot runoff. A transfer pipe to direct wastewater diverted by the berm to the nearby east holding pond had yet to be installed at the time of the inspection. Without the transfer pipe that was to drain wastewater ponded behind the berm and properly dispose of it in the East Holding Cell, wastewater became improperly impounded behind, that is, west of, the berm. The area was not designed or constructed as a waste holding structure.

47. At the time of the December 15, 2009 inspection, construction to improve the existing waste holding cell on the site, which would come to be known as the East Holding Cell, was underway. Limited excavation has been completed at the southern portion of the cell. The plan called for removal of the valve and drain pipe in the cell berm. Said removal was yet to be completed. The size and elevation of the existing berm was to be increased, and this work was not completed as of the time of the inspection either.

48. At the time of the December 15, 2009 inspection, a large holding pond in the east/west drainage channel located between the Holding Lot and Pasture Lot was under construction. an earthen dam had been constructed in a north/south direction across the drainage channel, to capture feedlot runoff. This dam was constructed below the location of the existing temporary holding pond serving the Holding Lot. The temporary holding pond remained in place, and was upstream of and flowed into the new large cell. The temporary holding pond was full at the time of the inspection. This new large cell is north and west of the existing East Holding Cell on the site. The new large cell came to be known as the West Holding Cell. The contents of the new large cell were frozen at the time of the inspection.

49. At the time of the December 15, 2009 inspection, the Illinois EPA inspector

observed that the size of the Pasture Lot had been reduced, consistent with the approved design plan. New fencing had been installed.

50. At the time of the December 15, 2009 inspection, gutters and downspouts had not yet been installed on the cattle buildings.

51. As of the time of the December 15, 2009 inspection, an earthen berm had recently been constructed along the west side of the Malone site. The berm is oriented in a north/south manner and is equipped with a riser and buried tile line. The berm and riser pipe collect clean stormwater from the pasture area west of the Malone site, therefore preventing the stormwater from flowing onto the feedlot, becoming contaminated and adding to the amount of wastewater that needed to be managed on site.

52. At the time of the December 15, 2009 inspection, a silage stockpile continued to exist along the south side of the gravel lane on the site. Leachate from the stockpile was frozen next to the pile.

53. On May 25, 2010, the Illinois EPA conducted an inspection of the Malone site. At the time of the inspection, there were five head of cattle on site.

54. At the time of the May 25, 2010 inspection, the area between the concrete lots in the southeast portion of the site and the berm constructed to retain and divert runoff from the lots to the East Holding Cell, was improperly full of wastewater. The Illinois EPA inspector observed that wastewater had overflowed the berm at the north end of the improperly ponded wastewater and flowed east down a hillside to an unnamed tributary to Latimer Creek. Design plans called for installation of a drain transfer pipe from this impoundment to the East Holding Cell. This transfer pipe had not been installed. The inspector collected a sample of the contents of the ponded wastewater. The liquid was brown colored, very turbid and odorous. Analytical results indicated the following parameter levels: BOD, 343 mg/l; total suspended

solids, 1960 mg/l; fecal coliform, 90,000 per 100 ml; fecal streptococcus, 90,000 per 100 ml.

55. At the time of the May 25, 2010 inspection, the East Holding Cell contained approximately 1 foot of freeboard. The outer slope of the berm creating this impoundment was eroded evidencing past overflows. Eroded channels approximately one foot deep were observed on the outer slope of the berm. The East Holding Cell receives contaminated surface runoff from the east portion of the facility.

56. The earthen dam that serves as the restraining berm for the East Holding Cell contains a 4-inch diameter drain pipe with valve. This drain pipe and valve, pursuant to the design plans, were to be removed. At the time of the May 25, 2010 inspection, the pipe and valve remained in the berm. At the time of the inspection, it was apparent the pipe had recently been used. Sheet metal directly under the pipe outlet was stained. There was liquid puddled in a drainage channel leading from the pipe outlet. This drainage channel flows to the north, to an unnamed tributary of Latimer Creek. A significant amount of work remained to be performed at the East Holding Cell. Besides removal of the pipe and valve, the size and elevation of the existing dam were to be increased. The inspector collected a sample of the contents of the East Holding Cell. The liquid was brown colored, turbid and odorous. Analytical results indicated the following parameter levels: total suspended solids, 126 mg/l; fecal coliform, 5,900 per 100 ml; fecal streptococcus, 450 per 100 ml.

57. At the time of the May 25, 2010 inspection, a significant accumulation of cattle manure and waste feed remained stockpiled at various lots on the site, contributing contaminated runoff to the wastewater impoundments. In addition, gutters and downspouts had not yet been installed. The guttering is essential to diverting clean water from the feedlots and wastewater holding ponds. The inspector collected a sample of uncontained runoff north of a gluten stockpile on site. The liquid was black colored, turbid and odorous. The area drains

to the East Holding Cell. Analytical results indicated the following parameter levels: total suspended solids, 2,220 mg/l; fecal coliform, 10,000 per 100 ml; fecal streptococcus, 600,000 per 100 ml.

58. At the time of the May 25, 2010 inspection, the West Holding Cell was completely full of black, turbid and odorous liquid. Wastewater was overflowing the restraining berm, an earthen dam constructed in a north/south direction across an east/west drainage channel between the Holding Lot and Pasture Lot. Wastewater was overflowing the dam at a trickle rate at the north end of the dam. Wastewater was also seeping through the dam near the center of the dam. Two distinct seepage locations were noted through the dam. Flow due to seepage was estimated at approximately one gallon per minute. The seepage was at a horizontal seam approximately two feet below the top of the dam. The top of the dam was approximately two feet wide at its narrowest point. Severely eroded channels existed on the outer (east) slope of the earthen dam. The eroded channels were approximately 6 feet wide and 5 feet deep. The inspector collected a sample of the contents of the West Holding Pond. The liquid was black colored, turbid and odorous. Analytical results indicated the following parameter levels: ammonia, 15.4 mg/l; fecal coliform, 3,500 per 100 ml; fecal streptococcus, 3,000 per 100 ml.

59. At the time of the May 25, 2010 inspection, a silage stockpile continued to exist south of the gravel lane on the site. Leachate was being formed by the stockpile and was impounded. The Illinois EPA inspector collected a sample of the impounded liquid. It was reddish in color, turbid and odorous. Analytical results indicated the following parameter levels: total suspended solids, 672 mg/l; fecal coliform, 50,000 per 100 ml; fecal streptococcus, 6,100 per 100 ml.

60. On May 27, 2010, the Illinois EPA conducted an inspection of the Malone facility.

At the time of the inspection, the Illinois EPA inspector observed that the West Holding Cell was completely full of black, turbid, odorous wastewater. Septic conditions were evident with gas bubbles rising to the surface of the impoundment. Severely eroded gullies existed on the outer slope of the earthen retention dam. The erosion was approximately 9 feet wide by 4 feet deep in one location on the outer slope of the dam. The top of the dam was approximately 2 feet wide at its narrowest point. There was evidence of recent overflow across the top of the earthen dam at three individual locations.

61. At the time of the May 27, 2010 inspection, seepage was occurring through the West Holding Cell earthen dam at five distinct locations. The seepage flow was estimated to be less than one gallon per minute. A liquid sample was collected from the West Holding Cell and from the seepage through the dam. The surface of the dam was barren in many places and did not contain sufficient vegetation to hold soil in place. Analytical results for the sample collected from the West Holding Cell indicated the following parameter levels: biological oxygen demand, 77.2 mg/l; total suspended solids, 127 mg/l; fecal coliform, 3,100 per 100 ml; fecal streptococcus, 3,600 per 100 ml. Analytical results for the sample collected from the seepage flowing through the West Holding Cell dam indicated the following parameter levels: ; total suspended solids, 173 mg/l; fecal coliform, 1,600 per 100 ml; fecal streptococcus, 570 per 100 ml.

62. At the time of the May 27, 2010 inspection, the Illinois EPA inspector collected a sample result from the temporary waste holding pond at the Malone site that was located immediately west and upstream of the West Holding Cell. At the time of the May 27, 2010 inspection, liquid in the temporary pond was black, turbid and contained a strong livestock waste odor. Gas bubbles were observed rising to the surface of this impoundment. The overflow from this structure drains into the nearby West Holding Cell. Analytical results for the

sample collected from the seepage flowing through the West Holding Cell dam indicated the following parameter levels: ammonia, 31.0 mg/l; biological oxygen demand, 69.4 mg/l; total suspended solids, 205 mg/l; fecal coliform, 1,200 per 100 ml; fecal streptococcus, 4,300 per 100 ml.

63. At the time of the May 27, 2010 inspection, the area west of the retention berm east of the lots on the southeast portion of the Malone facility was full of wastewater.

64. At the time of the May 27, 2010 inspection, the Illinois EPA inspector observed that gutters and downspouts had not been installed on the various cattle barns existing on site. Without the gutters and downspouts, a significant volume of rainfall resulting in extraneous clean water is directed into the wastewater holding ponds at the site, contributing to the waste cells' overflow.

65. At the time of the May 27, 2010 inspection, the Illinois EPA inspector observed that unless prompt action was taken to reduce hydraulic pressure, the earthen dam serving the West Holding Cell would likely fail, releasing a significant volume of wastewater to Latimer Creek.

66. On May 28, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site to determine the current condition of the wastewater storage structures.

67. At the time of the May 28, 2010 inspection, the Illinois EPA inspector observed that several eroded channels continued to exist on the outside slope of the retaining dam, and a significant amount of seepage was coming through the dam along a seam approximately two feet from the top of the berm. The inspector observed that the berm would undoubtedly fail if corrective actions were not taken. The West Holding Cell impounds runoff from cattle feedlots on the west side of the Malone facility.

68. At the time of the May 28, 2010 inspection, the Illinois EPA inspector observed

that wastewater needed to be removed from the East Holding Cell to prevent an overflow and possible berm failure. The East Holding Cell was scheduled to be enlarged significantly, but the work had not been performed to do so. At the time of the May 28, 2010 inspection, the East Holding Cell was almost full with only a few inches of available freeboard.

69. At the time of the May 28, 2010 inspection, the impoundment behind the berm constructed to retain runoff from cattle lots in the southeast portion of the Malone facility, was full of wastewater. This berm was to be installed in conjunction with a drain line, to drain the impounded wastewater to the East Holding Cell. The drain line was not installed and thus the impoundment formed consisting of cattle lot runoff.

70. On June 1, 2010, Defendant Malone entered into an Agreed Order with Plaintiff. The order required the following

a. Cease and desist from all discharges of livestock manure, livestock waste, waste feed, silage leachate and/or wastewater from the facility.

b. Defendant Malone shall immediately relieve pressure on the partially constructed earthen dam that creates a wastewater holding cell on the west portion of the facility site by irrigating or otherwise properly removing and utilize wastewater from the west holding pond

c. Defendant Malone small make necessary temporary repairs to maintain the structural integrity of the top and outer slope fo the earthen dame of the west holding pond. Said repairs shall be made after the wastewater level is sufficiently reduced to all safe access.

d. Defendant Malone shall maintain a minimum of three feet of freeboard in the west holding pond at all times.

e. Defendant Malone shall monitor and report freeboard daily until it reaches 3 feet.

f. Defendant Malone shall, at all times, cause the value in the pipe in the berm of the east holding pond to be closed.

g. Defendant Malone shall maintain 3 foot of freeboard in the east holding cell.

Defendant Malone has never submitted the freeboard records required by the agreed order.

71. On June 2, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, the Illinois EPA inspector was told that on June 1, 2010, Defendant Malone placed additional fill on top of the West Holding Cell's eroded berm.

72. At the time of the June 2, 2010 inspection, the Illinois EPA inspector observed that the top of the West Holding Cell berm was soft. The placement of the fill was only a temporary measure. The West Holding Cell had two inches of available freeboard at the time of the June 2, 2010 inspection. At the time of the inspection, the Illinois EPA inspector documented that in his professional opinion the West Holding Cell berm would fail if additional actions were not taken. Such actions would entail lowering the level of wastewater in the cell, the berm fill above the point of seepage needed to be removed, the surface scarified before replacing the fill in properly compacted lifts..

73. At the time of the June 2, 2010 inspection, the East Holding Cell had 2 inches of available freeboard. The Illinois EPA inspector documented that the level of wastewater in the East Holding Cell needed to be lowered to prevent an overflow.

74. At the time of the June 2, 2010 inspection, the Illinois EPA inspector observed that Defendant Malone was pumping wastewater ponded between the concrete lots in the southeastern portion of the site and the berm constructed east of these lots to retain and divert runoff from the lots. He was pumping the wastewater to a grassy hill just north of the feedlots.

75. On June 9, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, wet field conditions existed. Weather conditions were sunny, hot and humid.

76. At the time of the June 9, 2010 inspection, the Illinois EPA inspector observed that the West Holding Cell was full of wastewater and contained zero freeboard. Wastewater in the holding cell was black, turbid and odorous. The inspector collected a sample of the

wastewater in the holding cell. Analysis of the sample indicated the following parameter levels: BOD, 53.3 mg/l; TSS, 147 mg/l. Severely eroded channels existed on the barren outer slope of the west holding cell earthen dam. The most severe erosion was located near the center of the dam. It was obvious from the wet condition on top of the earthen dam that wastewater had very recently overflowed the West Holding Cell and drained to the receiving stream. The inspector also observed seepage through the dam in an eroded channel. The inspector again opined that prompt corrective action was need at the West Holding Cell in order to prevent failure of the earthen dam. A tractor and PTO pump were positioned at the West Holding Cell at the time of the inspection, but were not operation.

77. At the time of the June 9, 2010 inspection, the small impoundment located west of the West Holding Cell was sampled. The temporary impoundment contain a black, turbid and odorous liquid. Wastewater was draining from the temporary impoundment into the West Hold Cell at the time of the inspection. The inspector collected a sample of the wastewater contained in the temporary impoundment. Analysis of the sample indicated the following parameter levels: ammonia, 25.1 mg/l; BOD, 68.7 mg/l; TSS, 103 mg/l. At the time of the inspection, the Illinois EPA inspector also collected a sample of the wastewater contained in the drainage channel located between the temporary waste holding pond and the West Holding Cell. Flow in the channel was estimated at 2 to 3 gallons per minute. The liquid was black colored, turbid and odorous. Analysis of the sample indicated the following parameter levels: ammonia, 20.2 mg/l; BOD, 68.6 mg/l; TSS, 168 mg/l.

78. At the time of the June 9, 2010 inspection, the East Holding Cell was overflowing and discharging wastewater to the receiving stream. The discharging liquid was brownish, colored, turbid and odorous. The discharge rate was approximately 6 gallons per minute. The inspector collected a sample of the wastewater contained in the East Holding Cell. Analysis of

the sample indicated the following parameter levels: BOD, 88.1 mg/l; TSS, 213 mg/l. The inspector observed severe erosion cutting ruts in the outer slope of the East Holding Cell's earthen dam. Although the dam contained some stabilizing vegetation, the inspectors opined that the earthen structure would fail unless prompt corrective action was taken.

79. At the time of the June 9, 2010 inspection, the Illinois EPA inspector examined the 4-inch diameter drain pipe located through the dam of the East Holding Cell. It was apparent that the discharge pipe had recently been used to release wastewater in that there was liquid inside the outlet end of the pipe and liquid at the base of the pipe just below the sheet metal splash pad.

80. At the time of the June 9, 2010 inspection, the impoundment for the southeast lots was full of manure and wastewater and was overflowing at the north end at a rate of approximately 1 gallon per minute. The overflow entered a small stream tributary to Latimer Creek. The inspector collected a sample of the wastewater contained by this impoundment. Analysis of the sample indicated the following parameter levels: ammonia, 29.2 mg/l; BOD, greater than 222 mg/l; TSS, 404 mg/l. At the time of the inspection, approximately five cows/heifers and two bulls were confined in the east area of these southeast lots. A cattle waterer was overflowing in the lots at the time of the inspection, creating a water source that mixed with manure as it ran off the lots and added to the wastewater already overflowing in the impoundment.

81. On June 14, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. Rainfall has occurred at the site approximately 6 hours prior to the inspection. Surface runoff was observed draining into the wastewater holding ponds during the inspection.

82. At the time of the June 14, 2010 inspection, the West Holding Cell was full. The wastewater in the holding cell was dark colored, turbid and odorous. A tractor and pump was

positioned near the west end of the West Holding Cell but were not operating. A significant flow of wastewater was entering the West Holding Cell from the temporary waste holding pond upstream.

83. At the time of the June 14, 2010 inspection, the Illinois EPA inspector observed that additional clay soil had recently been placed on top of the earthen dam serving the West Holding Cell. This fill material raised the elevation of the dam and thus allowed for an increased volume of liquid to be contained behind the dam. This additional volume results in additional pressure on the compromised structure. The additional clay soil on the top of the dam created a spillway (overflow channel) at the north end of the dame. Wastewater was discharging out of the West Holding Cell via the spillway at the time of the inspection. The rate of overflow was estimated at 70 gallons per minute. The wastewater discharging via the spillway drained into a stream that is an unnamed tributary to Latimer Creek. The Illinois EPA inspector collected a sample of the wastewater contained in the West Holding Cell. Analysis of the sample indicated the following parameter levels: BOD, 105 mg/l; TSS, 124 mg/l.

84. At the time of the June 14, 2010 inspection, the Illinois EPA inspector observed that the East Holding Cell was overflowing and discharging wastewater to the receiving stream. The discharging liquid was black colored, turbid and odorous. The discharge rate was approximately 50 to 100 gallons per minute. Severe erosion had occurred on the outer slope of the dame due to the uncontrolled overflow of wastewater. An eroded channel approximately 4 feet deep by 8 feet wide was created in the earthen dam. The dam is approximately 10 feet to 15 feet high. The top of the dam width is about 6 feet. It was apparent to the Illinois EPA inspector from the deteriorating condition of the dam that the earthen structure would fail if prompt corrective action was not taken. The Illinois EPA inspector collected a sample of the wastewater contained in the East Holding Cell. Analysis of the sample indicated the following

parameter levels: BOD, 41.5 mg/l; TSS, 214 mg/l.

85. At the time of the June 14, 2010 inspection, the Illinois EPA inspector observed that the impoundment for the southeast lots was full. The Illinois EPA inspector collected a sample of the wastewater contained in the this impoundment. Analysis of the sample indicated the following parameter levels: BOD, 96 mg/l; TSS, 646 mg/l.

86. At the time of the June 14, 2010 inspection, the Illinois EPA inspector observed the contents of the temporary wastewater impoundment that existed on the facility upstream of the West Hold Cell, to be black, turbid and odorous. Wastewater from the temporary impoundment was flowing into the West Holding Cell, which, itself, was discharging to an unnamed tributary to Latimer Creek. The inspector collected a sample of the wastewater contained in the temporary impoundment. Analysis of the sample indicated the following parameter levels: BOD, 43.1 mg/l; TSS, 224 mg/l.

87. At the time of the June 14, 2010 inspection, the Illinois EPA inspector collected samples of feedlot runoff that was entering the discharging waste holding cells, runoff from the gluten feed stockpile that was also entering the discharging waste holding cells, as well as a downstream sample. Analysis of the feedlot runoff sample indicated the following parameter levels: ammonia, 108 mg/l; BOD, 1650 mg/l; TSS, 2440 mg/l. Analysis of the gluten feed stockpile runoff sample indicated the following parameter levels: ammonia, 24.9 mg/l; BOD, 1780 mg/l; TSS, 4730 mg/l. Analysis of the downstream sample indicated the following parameter levels: BOD, 33.8 mg/l; TSS, 666 mg/l.

88. On June 15, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, very wet field conditions existed. Rainfall occurred at the site during the inspection.

89. At the time of the inspection, the West Holding Cell was full of wastewater and

overflowing. Wastewater was discharging from the West Holding Cell via the spillway at the north end of the earthen dam into an unnamed tributary to Latimer Creek. The wastewater in the holding cell was dark colored and turbid. The inspector collected a sample of the wastewater contained in the West Holding Cell. Analysis of the sample indicated the following parameter levels: BOD, 36.0 mg/l; TSS, 77 mg/l.

90. At the time of the June 15, 2010 inspection, the East Holding Cell was overflowing and discharging wastewater to the receiving stream. The discharging liquid was black colored, turbid and odorous. The discharge rate was estimated at approximately 100 gallons per minute. Severe erosion was occurring on the outer slope of the dam due to uncontrolled overflow of wastewater. The extent of erosion on the dam was greater than the erosion observed at the time of the June 14, 2010 inspection. An eroded channel approximately 4 feet deep by 12 feet wide existed in the earthen dam. The dam was approximately 10 feet to 15 feet high. The top of dam width was about 5 feet. The Illinois EPA inspector observed that it was apparent from the deteriorating condition of the dam that it would fail if prompt corrective action was not taken. The inspector collected a sample of the wastewater contained in the East Holding Cell. Analysis of the sample indicated the following parameter levels: BOD, 38.5 mg/l; TSS, 188 mg/l.

91. On June 21, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, the rate of wastewater discharge from the West Holding Cell via the spillway was approximately 15 gallons per minute. The Illinois EPA inspector collected a sample of the discharge. Analytical results indicated a BOD level of 24.7 mg/l and total suspended solids of 305 mg/l. At the time of the June 21, 2010 inspection, the Illinois EPA inspector observed that recent rainfalls had resulted in erosion of the additional fill placed on the berm.

92. At the time of the June 21, 2010 inspection, overflow from the East Holding Cell was discharging at a rate of approximately 20 gallons per minute. The Illinois EPA inspector collected a sample of the discharge. Analytical results indicated a BOD level of 31.4 mg/l and total suspended solids of 81 mg/l. The overflow from the East Holding Cell was eroding a channel through the restraining berm. At the time of the inspection, the eroded channel extended completely through the berm to the interior slope of the holding cell. The Illinois EPA inspector indicated to Defendant Malone that any additional erosion would result in the release of a significant amount of wastewater through the breach.

93. At the time of the June 21, 2010 inspection, the area between the concrete lots in the southeast portion of the site and the restraining berm was full of ponded wastewater but the ponded wastewater was not discharging.

94. On June 23, 2010, the Illinois EPA conducted a reconnaissance inspection. At the time of the inspection, the West Holding Cell was discharging through the earthen spillway at the north end of the berm at a rate of approximately 25 gallons per minute. The Illinois EPA inspector collected a sample of the discharge. The sample was amber to dark brown in color and odorous. Analytical results indicated the following parameter levels: BOD-5 day, 32.3 mg/l; total suspended solids, 88 mg/l.

95. At the time of the June 23, 2010 inspection, the Illinois EPA inspector observed that the restraining berm of the East Holding Cell recently failed. The inspector observed a major breach in the berm that was several feet wide. The wastewater level in the cell had dropped six feet. The breach in the berm was 6 to 8 feet deep. The berm reportedly failed on Tuesday, June 22, 2010 following an intense rainfall. At the time of the inspection, the rate of discharge through the breach was approximately 15 gallons per minute. The Illinois EPA inspector collected a sample of the discharge. The sample was amber to dark brown in color

and odorous. Analytical results indicated the following parameter levels: BOD-5 day, 34.5 mg/l; ammonia, 13.7 mg/l; total suspended solids, 161 mg/l.

96. At the time of the June 23, 2010 inspection, runoff from manure stockpiles and the commodity storage area continued to drain to the East and West Holding Cells. Both cells were discharging to an unnamed tributary of Latimer Creek. At the time of the inspection, Latimer Creek had a significant flow rate due to recent rains. The stream was brown and turbid. The Illinois EPA inspector collected a sample from Latimer Creek. Analytical results indicated the following parameter levels: total suspended solids, 109 mg/l.

97. On June 28, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the June 28, 2010 inspection, the Illinois EPA inspector observed that the West Holding Cell was full of wastewater that was dark colored and turbid. Wastewater was discharging out of the West Holding Cell at the time of the inspection. The rate of overflow was estimated at approximately 5 to 10 gallons per minute. The discharging wastewater was draining into an unnamed tributary to Latimer Creek.

98. At the time of the June 28, 2010 inspection, several deeply eroded channels were observed on the exterior slope of the earthen dam serving the West Holding Cell. A 43-inch tall sheer vertical face was measured at one location on the outer wall/slope of the earthen dam. The top of the earthen dam was approximately 5 feet wide at its narrowest point.

99. At the time of the June 28, 2010 inspection, a tractor and pump previously observed at the West Holding Cell were absent. The Defendant indicated the pump, irrigation gun and hose were removed from the site. At the time of the inspection, wastewater was draining from the upstream temporary waste impoundment into the West Holding Cell.

100. As of the time of the June 28, 2010 inspection, the East Holding Cell dam had failed. The East Holding Cell was discharging wastewater at a rate of approximately 5 to 10

gallons per minute to the receiving stream. The discharging liquid was black colored and turbid. An eroded 8-foot-deep cut existed through the center of the dam. The cut measured 16 feet across. The level of wastewater in the East Holding Cell was significantly lower than the level observed during previous inspections. It was apparent to the Illinois EPA inspector that from the size of the cut in the dam, a significant volume of wastewater had recently discharged from the East Holding Cell and drained into the nearby receiving stream. The volume of liquid discharged to the nearby receiving stream due to the dam failure represented several hundred thousand gallons of wastewater. At the time fo the June 28, 2010 inspection, the Illinois EPA inspector collected a sample from wastewater contained in the East Holding Cell. Analytical results indicated the following parameter levels: BOD, 77.6 mg/l; total suspended solids, 367 mg/l.

101. At the time of the June 28, 2010 inspection, a dark colored waste material was stockpiled in the gluten feed storage area located upstream of the East Holding Cell. Leachate was draining from this waste stockpile. The leachate drained into a small impoundment prior to entering the East Holding Cell. The Illinois EPA inspector collected a sample from this small impoundment. Analytical results indicated the following parameter levels: ammonia, 53.2 mg/l; BOD, 658 mg/l; total suspended solids, 664 mg/l.

102. At the time of the June 28, 2010 inspection, the impoundment for the southeast lots was full of a black colored, turbid wastewater. Manure solids were stockpiled on the lots, susceptible to contributing additional run off to the impoundment in the event of precipitation. The Illinois EPA inspector collected a sample from this impoundment. Analytical results indicated the following parameter levels: ammonia, 19.8 mg/l; BOD, 51 mg/l; total suspended solids, 524 mg/l.

103. On June 29, 2010, Defendant Ed Malone twice verbally contacted the Illinois

EPA to review required corrective action and clean-up activities for the site. Defendant Malone was meeting with the auctioneer who was handling disposition of the property and a representative of the bank who held the mortgage for the property. He was calling indicating that he intended to clean up the site in anticipation of the sale of the property. The desire was to obtain Illinois EPA approval of the clean up and corrective action so that the site could be marketed as in compliance with environmental regulations. Defendant Malone was told the following by the Illinois EPA inspector:

a. Properly dispose of manure solids, waste feed, and silage from the facility. This waste reportedly was to be land applied with a manure spreader on adjacent fields.

b. Properly dispose of wastewater from the West Holding Cell and stop the discharge. Runoff from the west feedlots drain to this West Holding Cell and are discharged through the spillway. The wastewater level must be lowered sufficiently to allow for safe repair of the earthen berm. The loose fill placed on top of the berm was to be replaced with properly compacted fill, if the structure was to be used in the future. Any sludge accumulation in the cell had to be addressed if the cell was to be abandoned.

c. Repair the breach in the berm of the East Holding Cell and stop the discharge. Runoff from the commodity storage areas and east central feedlots drain to this Holding Cell and are discharged through the exiting breach. After the berm is repaired, the wastewater diverted into this cell needs to be properly disposed. Any sludge accumulation in the cell must be addressed if the cell is to be abandoned.

d. Stop the discharge from the ponded wastewater behind the berm restraining runoff from the concrete lots in the southeast portion of the site. Defendant Malone represented that the ponded wastewater would be pumped to the East Holding Cell, when that cell's berm is repaired and then ultimately disposed. Any sludge accumulation in the ponded are also must be addressed. Wastewater is several small ponds formed in the feedlots needed to be addressed.

104. On July 6, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, the Illinois EPA inspector observed that manure piles continued to exist on the western parts of the facility, susceptible to creating additional

wastewater runoff drainage into the discharging West Holding Cell. At the time of the inspection, the West Holding Cell was discharging via the spillway at a rate of approximately 3 gallons per minute. The discharge was amber to dark brown in color and odorous. Erosion was continuing on the berm of the West Holding Cell.

105. At the time of the July 6, 2010 inspection, manure piles continued to exist on the central portions of the feedlot, susceptible to creating additional wastewater runoff drainage into the breached East Holding Cell. The breach was several feet wide and 6 to 8 inches deep.

106. On July 19, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. It was raining at the time of the inspection, but recent weather had been dry. At the time of the inspection, the West Holding Cell was not discharging. There was 1 inch of freeboard at the location of the spillway. Corrective action had not been taken to remove sufficient wastewater from the cell and repair the berm, eliminating the spillway. Manure stockpiles on the western feedlots continued to exist in an un-contained manner, allowing runoff from these stockpiles to drain into the West Holding Cell. The wastewater contents of the West Holding Cell were amber brown and odorous.

107. At the time of the July 19, 2010 inspection, the breach in the East Holding Cell restraining berm remained several feet wide and approximately 8 feet deep. The East Holding Cell was not discharging at the time of the inspection, mostly due to recent dry weather. The ponded wastewater at the bottom of the East Holding Cell had one inch of freeboard at the breach. The ponded wastewater at the bottom of the East Holding Cell appeared green/brown in color and odorous.

108. At the time of the July 19, 2010 inspection, runoff wastewater from the concrete lots in the southeastern portion of the site, restrained by a berm, was ponded behind the berm with 5 inches of freeboard. It was green/brown in color.

109. On August 26, 2010, the Illinois EPA conducted at reconnaissance inspection at the Malone site. The area had received 2 ½ inches of rain on August 20, 2010.

110. At the time of the August 26, 2010 inspection, runoff from several central feedlots on the site and the commodity storage areas continued to drain into the East Holding Cell. At the time of the inspection, the East Holding Cell was discharging through the 8-foot-deep breach in the restraining berm. The discharge flowed to an unnamed tributary to Latimer Creek. The Illinois EPA inspector collected a sample of the discharge. Analytical results indicated the following parameter levels: BOD 5-day, 87.6 mg/l; total suspended solids, 220 mg/l.

111. At the time of the August 26, 2010 inspection, runoff form central and western lots at the site continued to drain to the West Holding Cell. The West Holding Cell was not discharging at the time of the inspection, however there was only 1 inch of freeboard at the location of the spillway. The contents of the West Holding Cell appeared green/brown in color, and were turbid with a slight odor. The Illinois EPA inspector collected a sample of the holding cell contents. Analytical results indicated the following parameter levels: BOD 5-day, 23.1 mg/l; total suspended solids, 173 mg/l.

112. At the time of the August 26, 2010 inspection, the Illinois EPA inspector collected a sample from the small temporary waste holding cell that received runoff from the northwest lots on the site, and which drained to the West Holding Cell. The contents of the small temporary waste holding cell were black and turbid with a strong septic odor. Gasification bubbles were observed at the surface. Analytical results indicated the following parameter levels: BOD 5-day, 56.5 mg/l; ammonia, 87.1 mg/l; total suspended solids, 472 mg/l.

113. In anticipation of a bankruptcy sale of the property, Defendant Malone was disposing of stockpiled solids, by spreading them on pasture grounds at the site. Manure solids

and bedding remained stored under roof in all three cattle barns on the site. A mixture of old feed and bedding remained stockpiled in the site commodity area. Some manure solids and ponded wastewater runoff was observed along a drainage path leading from several concrete feedlots.

114. On September 8, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, runoff from several central feedlots and the commodity storage area on the site continued to drain to the East Holding Cell. The breach in the restraining berm of this cell continued to exist. It was several feet wide and approximately 8 feet deep. The cell was not discharging at the time of the inspection. There was 1 inch of freeboard at the location of the breach. The contents of the East Holding Cell were green and turbid with a slight odor.

115. At the time of the September 8, 2010 inspection, runoff from central and western feedlots on the site continued to drain to the West Holding Cell. At the time of the inspection, the cell was not discharging through the spillway. There was 1 inch of freeboard at the location of the spillway. The contents of the cell appeared green/brown in color and were turbid with a flight odor.

116. At the time of the September 8, 2010 inspection, the contents of the small temporary holding pond upstream and to the west of the West Holding Cell were black and turbid with a septic odor and gasification bubbles on the surface. This temporary cell is tributary to the West Holding Cell.

117. At the time of the September 8, 2010 inspection, the wastewater ponded behind the berm restraining runoff from the concrete lots in the southeast portion of the site was green/brown in color and there was 1 inch of freeboard.

118. At the time of the September 8, 2010 inspection, manure solids and bedding

were still stored under roof in the three cattle barns. A mixture of old feed and bedding was still stockpiled in the commodity area. Some manure solids and ponded wastewater runoff were observed along the drainage paths from several of the concrete feedlots on site.

119. A bankruptcy auction was conducted on September 8, 2010. After the auction, Defendant Malone remained Debtor in Possession of the site. In early 2011, it was determined the successful bid for the site would not be able to close the sale. During all relevant times to this Amended Complaint, Defendant Malone continuously remained in possession and control of the site

120. On September 22, 2010, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the site, the Illinois EPA inspector met with Defendant Malone and a contractor Defendant Malone had hired to repair and complete earthwork at the site.

121. At the time of the September 22, 2010 inspection, runoff from several central feedlots and the commodity storage areas continued to drain to the East Holding Cell. The breach remained in the restraining berm of the cell. The cell was not discharging at the time of the inspection. There was 1 inch of freeboard at the location of the breach. The contents of the cell appeared to be green and turbid and had a slight odor.

122. At the time of the September 22, 2010 inspection, runoff from central feedlots and western feedlots at the site continued to drain to the West Holding Cell. The cell was not discharging at the time of the inspection. There was 1 inch of freeboard at the location of the spillway. The contents of the cell appeared green/brown in color, were turbid and had a slight odor.

123. At the time of the September 22, 2010 inspection, the small temporary holding cell west of the West Holding Cell was black and turbid with a septic odor and gasification bubbles on the surface. This temporary cell discharges to the West Holding Cell.

124. At the time of the September 22, 2010 inspection, the ponded wastewater behind a berm that restrains runoff coming from concrete lots in the southeast portion of the site, was not discharging. It was green in color. There was 1 inch freeboard.

125. At the time of the September 22, 2010 inspection, manure solids and bedding were still stored under roof in the three barns on the site. A mixture of old feed and bedding was still stockpiled in the commodity area. Manure solids and ponded wastewater runoff was noted along the drainage paths from several feedlots.

126. On January 5, 2011, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, Defendant Malone had not received final approval of feedlot modification construction from the Illinois Department of Agriculture. Cattle had not been observed on the feedlot since May of 2010. At the time of the January 5, 2011 inspection, 120 to 130 head were present on the feedlot. According to Defendant Malone, he began bringing cattle onto the site on December 30, 2010. He indicated that the cattle did not belong to him. Defendant Malone would not tell the inspector who owned the cattle.

127. At the time of the January 5, 2011 inspection, the West Holding Cell contained approximately 4 feet of freeboard. Defendant Malone told the inspector that the last time he hauled or pumped wastewater from the West Holding Cell was in September and/or October 2010. At the time he used a one-cylinder trash pump and he pumped to the pasture located west of the site. Therefore, wastewater was pumped to the filed and discharged out the end of an open pipe rather than being appropriately distributed at agronomic rates.

128. At the time of the January 5, 2011 inspection, additional clay fill material had been placed on the earthen dam. Very steep slopes of loose soil/clay existed as the outer slope of the dam. Defendant Malone indicated that he planned to reduce the slope on the exterior side of the dam when weather permitted. The earthen dam consisted of barren clay

soil, subject to erosion. With the presence of cattle at the facility, these structures were being placed into use in this incomplete and inappropriate condition.

129. At the time of the January 5, 2011 inspection, the Illinois EPA inspector observed that a crude drainage channel had been installed between the West and East holding cells.

130. At the time of the January 5, 2011 inspection, a significant amount of earthwork had been performed at the East Holding Cell. The impoundment was excavated and reshaped and a new earthen dam constructed. The dam was much taller than the previous version, thus potentially allowing additional wastewater to be impounded. It was not apparent that Defendant Malone had adequate equipment on site to manage accumulated wastewater. Approximately 10 to 15 feet of freeboard existed in the East Holding Pond. Barren slopes existed and were in need of vegetative cover to prevent erosion. The outer slope of the dam was too steep to maintain or mow. Soil erosion problems were noted. Trees had been bulldozed into the small stream north of the dam. Silt and sediment were draining into the small stream as a result of the earthwork. Defendant Malone reported that the earthwork on the East Holding Cell was done during the fall of 2010. He indicated he did most of the work himself using a bull dozer and hydraulic excavator.

131. At the time of the January 5, 2011 inspection, the Illinois EPA inspector observed that wastewater impounded in the impoundment that received runoff from the southeast lots was level with a drain pipe in the north berm of the impoundment. The drain pipe was installed in the impoundment in November 2010 to drain the impoundment into the East Holding Cell.

132. At the time of the January 5, 2011 inspection, the Illinois EPA inspector observed wastewater seeping through the southeast lots runoff impoundment. The wastewater was leaking through the berm at the northeast corner of the impoundment. The drainage path for the seepage led directly into an unnamed tributary to Latimer Creek along the east side of the

facility.

133. At the time of the January 5, 2011 inspection, the cattle barns lacked gutters and downspouts to divert clean surface water away from the wastewater holding cells. The continued contribution of clean, extraneous stormwater into the livestock waste collection system impairs the operation of the system. The waste management system, including installation of building gutters and downspouts, was to be complete and operation before the site was repopulated with cattle pursuant to the requirements of the Illinois Livestock Management Facilities Act, 510 ILCS 77/1 *et seq.*

134. On January 14, 2011, an Immediate Injunction Order was entered in this matter, requiring that all cattle be removed from the feedlot.

135. On May 10, 2011, the Illinois EPA conducted a reconnaissance inspection at the Malone site. At the time of the inspection, earthwork was on going at the site. Defendant Malone and two other individuals were doing the work. A scraper, bull dozer and hydraulic excavator were on site but no compaction equipment.

136. At the time of the May 10, 2011 inspection, the West Holding Cell contained odorous, turbid liquid. There was approximately 7 feet of freeboard. The dam was under construction. The height of the earthen dam had been raised with clay soil. Fill material was placed on the dam with a scraper. The dam was soft and did not appear to be adequately compacted. Steep slopes were noted on the exterior side of the dam.

137. At the time of the May 10, 2011 inspection, wastewater contained in the East Holding Cell was dark colored and turbid. It had approximately 5 feet of freeboard.

138. At the time of the May 10, 2011 inspection, the impoundment that captured runoff from the southeast lots had approximately 1 foot of freeboard. The Illinois EPA inspector observed seepage through the earthen berm near the north end of the impoundment. A trickle

flow of less than 1 gallon per minute was seeping through the structure. This discharge flowed to the east into a small stream tributary to Latimer Creek.

139. The Defendants have caused or allowed the discharge of contaminants to waters of the State at the Malone site as will or is likely to create a nuisance or render such water harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses.

140. By causing, allowing or threatening the discharge of contaminants to waters of the State at the Malone site so as to cause or tend to cause water pollution in Illinois at all times relevant to this Amended Complaint prior to February 20, 2010, the Defendants Malone and Galesburg Livestock have violated Section 12(a) of the Act, 415 ILCS 5/12(a).

141. By causing, allowing or threatening the discharge of contaminants to waters of the State at the Malone site so as to cause or tend to cause water pollution in Illinois at all times relevant to this Amended Complaint after February 20, 2010, Defendant Malone has violated Section 12(a) of the Act, 415 ILCS 5/12(a).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Ed Malone, d/b/a Malone Farms and Feedlot, and Defendant Galesburg Livestock Sales, Inc. have violated Sections 12(a) of the Act, 415 ILCS 5/12(a);

B. Permanently enjoin the Defendants from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendants a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT II

MALONE SITE WATER POLLUTION HAZARD VIOLATION

1 . This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-16. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 16 of Count I as paragraphs 2 through 16 of this Count II.

17. Section 12(d) of the Act, 415 ILCS 5/12(d), provides, in pertinent part, as follows:

> No person shall:
>
> * * *
>
> d. Deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard.
>
> * * *

18-141. Plaintiff re-alleges and incorporates by reference herein paragraphs 18 through 141 of Count I as paragraphs 18 through 141 of this Count II.

142. The Defendants have caused or allowed contaminants to be deposited upon the land in such place and manner as to create a water pollution hazard by causing contaminants to remain on the land and subject to surface drainage or leaching into waters of the State.

143. By depositing contaminants upon the land in such place and manner as to create a water pollution hazard at the Malone site prior to February 20, 2010, the Defendants have

violated Section 12(d) of the Act, 415 ILCS 5/12(d).

144. By depositing contaminants upon the land in such place and manner as to create a water pollution hazard at the Malone site after February 20, 2010, Defendant Malone has violated Section 12(d) of the Act, 415 ILCS 5/12(d).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Ed Malone, d/b/a Malone Farms and Feedlot, and Defendant Galesburg Livestock Sales, Inc. have violated Section 12(d) of the Act, 415 ILCS 5/12(d);

B. Permanently enjoin the Defendants from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendants a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT III

MALONE SITE NPDES VIOLATION

1 . This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-141. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 141 of Count I as paragraphs 2 through 141 of this Count III.

142. Section 12 (f) of the Act, 415 ILCS 5/12(f), provides, in pertinent part, as follows:

> No person shall:
>
> f. Cause, threaten or allow the discharge of any contaminant into the waters of the State, as defined herein, including but not limited to, waters to any sewage works, or into any well or from any point source within the State, without an NPDES permit for point source discharges issued by the Agency under Section 39(b) of this Act, or in violation of any term or condition imposed by such permit, or in violation of any NPDES permit filing requirement established under Section 39(b), or in violation of any regulations adopted by the Board or of any order adopted by the Board with respect to the NPDES program.
>
> * * *

143. Section 309 .102 of the Board's water pollution regulations, 35 Ill . Adm. Code 309.102(a), states, in pertinent part :

> NPDES Permit Required
>
> a. Except as in compliance with the provisions of the Act, Board regulations, and the CWA, and the provisions and conditions of the NPDES permit issued to the discharger, the discharge of any contaminant or pollutant by any person into the waters of the State from a point source or into a well shall be unlawful

144. Defendant Malone did not apply for an NPDES permit until approximately on or before April 1, 2009. He did not submit a Comprehensive Nutrient Management Plan, a required portion of the application, until August 17, 2009. Defendant Malone's application remains incomplete.

145. By causing or allowing the discharge of livestock wastewater to waters of the State without an NPDES permit, Defendant Malone has violated 12(f) of the Act, 415 ILCS 5/12(f), and 35 Ill. Adm. Code 309.102(a).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the

Court grant the following relief:

A. Find that the Defendant, Ed Malone, d/b/a Malone Farms and Feedlot, has violated Section 12(f) of the Act, 415 ILCS 5/12(f), and 35 Ill. Adm. Code 309.102(a);

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of ten thousand dollars ($10,000) per day of violation, pursuant to Section 42(b)(1) of the Act, 414 ILCS 5/42(b)(1); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT IV

MALONE SITE AGRICULTURE RELATED POLLUTION VIOLATIONS

1 . This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-141. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 141 of Count I as paragraphs 2 through 141 of this Count IV.

142. Section 501.295 of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.295, provides as follows:

> Livestock Waste
> Livestock excreta and associated feed losses, bedding, wash waters, sprinkling waters from livestock cooling, precipitation polluted by falling on or flowing onto an animal feeding operation and other materials polluted by livestock.

143. Section 501.403(a) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.403(a), provides, in pertinent part, as follows:

> a. Existing livestock management facilities and livestock waste-handling facilities shall have adequate diversion dikes, walls or curbs that will prevent excessive outside surface waters from flowing through the animal

feeding operation and will direct runoff to an appropriate disposal, holding or storage area. The diversions are required on all aforementioned structures unless there is negligible outside surface water which can flow through the facility or the runoff is tributary to an acceptable disposal area or a livestock waste-handling facility. If inadequate diversions cause or threaten to cause a violation of the Act or applicable regulations, the Agency may require corrective measures.

144. Section 501.404(b)(1) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.404(b)(1), provides, in pertinent part, as follows:

> 1) Temporary manure stacks shall be constructed or established and maintained in a manner to prevent runoff and leachate from entering surface or ground waters.

145. Section 501.404(c)(2) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.404(c)(2), provides, in pertinent part, as follows:

> 2) Holding ponds and lagoons shall be impermeable or so sealed as to prevent groundwater or surface water pollution.

146. At all times relevant to this Amended Complaint, livestock manure waste and waste feed existed on the Malone site un-contained and susceptible to runoff in the event of precipitation. Discharges were occurring due to a eroded channels and breaches in the wastewater holding cells, as well as due to surface runoff from feed stockpiles and un-contained manure on the site. There are two unnamed tributaries to Latimer Creek on the site, and a discharge from the original wastewater holding cell formed a third tributary creek. Defendant Malone failed to provide sufficient diversion to keep clean storm water from contacting manure and feed stacks on the site, thus resulting in contamination discharging into the surface water tributary to Latimer Creek.

147. By failing to adequately contain livestock waste so as not to cause water pollution, by failing to adequately seal the facility's wastewater holding cells, and by failing to provide adequate diversion, Defendant Malone has violated Section 12(a) of the Act, 35 Ill. Adm. 501.403(a), 35 Ill. Adm. Code 501.404(b)(1) and 35 Ill. Adm. Code 501.404(c)(2).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant, Ed Malone, d/b/a Malone Farms and Feedlot, has violated Sections 12(a) of the Act, 415 ILCS 5/12(a), 35 Ill. Adm. 501.403(a), 35 Ill. Adm. Code 501.404(b)(1) and 35 Ill. Adm. Code 501.404(c)(2);

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT V

MALONE SITE OFFENSIVE CONDITIONS

1 . This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion and at the request of the Illinois Environmental Protection Agency ("Illinois EPA"), pursuant to Section 42(e) of the Illinois Environmental Protection Act ("the Act"), 415 ILCS 5/42(e).

2-141. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 141 of Count I as paragraphs 2 through 141 of this Count V.

142 . Section 302.203 of the Board's water pollution regulations, 35 Ill . Adm. Code 302.203, states, in pertinent part:

> Waters of the State shall be free from sludge or bottom deposits, floating debris, visible oil, odor, plant or algal growth, color or turbidity of other than natural origin. The allowed mixing provisions of Section 302.102 shall not be used to comply with the provisions of this Section.

* * *

143. Sample results from waters impacted by the May 3, 2007, May 8, 2007 and December 29, 2008 discharges from Defendant Malone's facility, indicated turbid, discolored and odor conditions in the waters of unnamed tributaries to Latimer Creek.

144. By causing or allowing the discharge of contaminants that resulted in turbid, discolored and odor conditions in the waters of unnamed tributaries to Latimer Creek, the Defendants have violated Section 12(a) of the Act, 415 ILCS 5/12(a), and Section 302.203 of the Board's Water Pollution Regulations, 35 Ill.Adm. Code 302.203.

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Ed Malone, d/b/a Malone Farms and Feedlot, and Defendant Galesburg Livestock Sales, Inc., have violated Sections 12(a) of the Act, 415 ILCS 5/12(a), and 35 Ill. Adm. 302.203;

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT VI

GALESBURG LIVESTOCK SALES INC. SITE WATER POLLUTION

1. This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-7. Plaintiff re-alleges and incorporates by reference herein paragraphs 2, 4 and 6 through 9 of Count I as paragraphs 2 through 7 of this Count VI.

8. On April 14, 1987, the Illinois EPA conducted an inspection of the site. At the time of the inspection, at the west boundary of the site, the Illinois EPA inspector observed a brown colored, very turbid liquid contain foam that had a livestock waste odor discharge from the surface of the cattle feedlots. Surface runoff from the dirt feedlot area drains to the west onto adjoining property. At the time of the April 14, 1987 inspection, brown wastewater was draining off site onto a pasture owned by the neighbor. The flow was approximately 225 gallons per minute. The inspector collected a sample at this location. Upon analysis, the sample indicated the following parameter levels: ammonia, 6.1 milligram per liter ("mg/l"); biochemical oxygen demand ("BOD"), 75 mg/l; total suspended solids ("TSS"), 136 mg/l. The inspector observed large stockpiles of livestock waste on the dirt feedlots at the site. The discharge was pooling at the location of a field tile that was tributary to an unnamed tributary of Rice Lake.

9. On December 30, 2002, the Illinois EPA conducted an inspection of the Galesburg Livestock Sales site. At the time of the inspection, there existed on the site several manure stacks exposed to the elements and therefore susceptible to precipitation resulting in runoff. Manure stockpiles were observed along the east edge of a concrete feedlot located on the east side of the barns on the Galesburg Livestock Sales site. At the time of the inspection,

surface runoff was pooled, un-contained and draining from the manure stockpiles along the edge of the concrete feedlot.

10. At the time of the December 30, 2002, the Illinois EPA collected water samples. A sample was collected from the drainage adjacent to the manure stock pile at the concrete feedlot. The liquid sampled was dark in color and turbid and had a livestock waste odor. Upon analysis, the sample parameter levels were as follows: ammonia, 148 milligrams per liter ("mg/l"); Biochemical Oxygen Demand ("BOD"), 1070 mg/l; Total Suspended Solids ("TSS"), 278 mg/l. A sample was also collected about 100 to 200 feet southeast of the concrete feedlot in an un-contained drainage path leading away from the concrete feedlots. The sample was dark in color, turbid, and was odorous. The analytical result for ammonia for this sample was 159 mg/l.

11. On January 2, 2003, the Illinois EPA inspector contacted Mr. Richard Anderson of Galesburg Livestock Sales, Inc. and advised him of the need to correct waste management problems at his facility including, but not limited to, containment of feedlot runoff and providing covered storage for manure stacks.

12. On January 7, 2003, the Illinois EPA sent a noncompliance advisory letter to Mr. Anderson. The letter indicated that based on the recent field inspection, additional controls were needed at the site to ensure proper containment of all livestock wastes. A list of recommendations was attached to the letter. The recommendations included: (1) cease all manure discharges, (2) conduct a thorough engineering study of the site and development a waste management plan, (3) promptly remove all manure stockpiles at the site, (4) divert all clean water away from the surface of the livestock feedlot areas, (5) secure the availability of suitable off-site cropland for timely land application of manure, (6) provide a suitable manure stacking structure for storage of solid livestock manure at the site.

13. On September 8, 2004, the Illinois EPA conducted an inspection of the Galesburg Livestock Sales site. There were cattle on-site at the time of the inspection. At the time of the inspection accumulations of wastewater and manure solids were observed at two locations adjacent to the concrete feedlot at the Galesburg Livestock Sales site. The wastewater and solids were not contained in a manure storage structure. At the time of the inspection, an semi-trailer operator was in the process of cleaning manure out of the livestock trailer. An accumulation of manure was observed in the area. The waste was not contained in a storage structure. Surface drainage flowed from this area to the south, into a cattle lot/pasture area.

14. At the time of the September 8, 2004 inspection, a large manure stockpile was observed in the lot southwest of the office at the Galesburg Livestock Sales site. There was a runoff channel leading in a westerly direction away from the manure stockpile. It was observed that the flow path extended west through the grass filter area, rather than being absorbed by the filter strip. The filter was in need of repair and maintenance in the area of the drainage path. Each of the dirt feedlots contained a stockpile of manure and soil.

15. On September 17, 2004, the Illinois EPA sent Mr. Anderson of Galesburg Livestock Sales, Inc. a noncompliance advisory letter. The letter indicated that based on the recent field inspection, additional controls were needed at the site to ensure proper containment of all livestock wastes. A list of recommendations was attached to the letter. The recommendations included: (1) cease all manure discharges, (2) conduct a thorough engineering study of the site and development a waste management plan, (3) promptly remove all manure stockpiles at the site, (4) divert all clean water away from the surface of the livestock feedlot areas, (5) secure the availability of suitable off-site cropland for timely land application of manure, (6) provide a suitable manure stacking structure for storage of solid livestock manure

at the site, (7) provide a suitable manure collection and storage structure for the livestock trailer clean-out activities.

16. On May 1, 2007, the Illinois EPA conducted an inspection of the Galesburg Livestock Sales site. At the time of the inspection, a large stockpile of cattle manure existed on the facility's earthen feedlot located southwest of the facility's office. The inspectors observed a runoff channel leading in a westerly direction away from the manure stockpile and extending through the grass filter at the facility. The purpose of a grass filter is to stop any potential runoff and assimilate it. When a waste accumulation becomes too voluminous, so that the quantity and strength of the manure overwhelms the grass filter, channels of manure runoff will develop through the filter. The filter is no longer able to assimilate the waste, and instead, the waste runs right through it. The benefit of the filter is lost.

17. At the time of the May 1, 2007 inspection of the Galesburg Livestock Sales site, an accumulation of dark colored wastewater was noted adjacent to the manure stockpile. The waste was not contained in a manure storage structure.

18. At the time of the May 1, 2007 inspection of the Galesburg Livestock Sales site , the inspectors observed an accumulation of solid manure and wastewater east of the main manure stockpile. This accumulation was the result of the area being used as a semi-trailer clean-out location where cattle manure is removed from livestock trailers. The truck cleaning area is located at the west edge of the driveway, west of the office. The waste was not contained in a storage structure. Surface drainage from this area flows to the south, into a cattle lot/pasture area.

19. At the time of the May 1, 2007 inspection of the Galesburg Livestock Sales site, there was an accumulation of wastewater and solid manure on the concrete feedlot just north of the office. The wastewater and solids were not contained. The inspectors experienced a

livestock odor on site.

20. At the time of the May 1, 2007 inspection of the Galesburg Livestock Sales site, the inspectors collected a sample of un-contained surface water in the truck clean out area. The liquid was dark colored, turbid and odorous. Analysis of the sample indicated the following parameter levels: ammonia, 16.3 mg/l; BOD, 260 mg/l; TSS, 620 mg/l. The inspectors collected a second sample from un-contained surface water near the large stockpile of cattle manure located at the southwest portion of the site. The liquid was dark colored, turbid and odorous. Analysis of this second sample indicated the following parameter levels: ammonia, 5.52 mg/l; BOD, 170 mg/l; TSS, 2,230 mg/l.

21. On May 31, 2007, the Illinois EPA conducted a follow-up inspection at the Galesburg Livestock Sales site. At the time of the inspection, Illinois EPA inspectors observed that manure solids were stockpiled at several locations at the facility including the concrete lots just north of the office, the truck clean-out area and the large stockpile at the southwest portion of the facility. Wastewater existed adjacent to each of the stockpiles. At the time of the inspection, surface runoff from the large stockpile drained west through the grass filter and into a neighboring pasture. The runoff was not being assimilated by the grass filter strip.

22. At the time of the May 31, 2007 inspection of the Galesburg Livestock Sales site, the Illinois EPA inspectors collected samples at three locations on the site. A sample of wastewater collected on the east side of the concrete lots where manure is stockpiled just north of the sale barn and office was dark colored, very turbid and contained a strong livestock waste odor. Analysis of the sample indicated the following parameter levels: ammonia, 113 mg/l; BOD, 52 mg/l; fecal coliform, 142,000 per 100 ml. A sample collected from surface wastewater near the truck clean-out area was brown colored, turbid and contained a strong livestock waste odor. Analysis of the sample indicated the following parameter levels: ammonia, 36.4 mg/l;

BOD, 67 mg/l; TSS, 17,300 mg/l; fecal coliform, 167,000 per 100 ml. A sample collected from a drainage channel leading to the west of the large stockpile of cattle manure at the southwest portion of the site was brown colored, turbid and odorous. Analysis of the sample indicated the following parameter levels: ammonia, 22.0 mg/l; BOD, 73 mg/l; TSS, 400 mg/l; fecal coliform, 175,000 per 100 ml.

23. On July 18, 2007, the Illinois EPA conducted an inspection of the Galesburg Livestock Sales site. At the time of the inspection, a very large manure/bedding stockpile was observed in the lots west of the buildings. It was apparent this pile had not been disturbed recently due to the growth of vegetation on the pile. A large stockpile of waste was also observed in the lots north of the buildings and a few smaller stockpiles were observed throughout the site. Ponded livestock wastewater that was seepage from the stockpiles and contaminated storm water from recent rain were observed around these stockpiles.

24. Defendant Galesburg Livestock Sales, Inc. has caused or allowed the discharge of contaminants to waters of the State as will or is likely to create a nuisance or render such water harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses.

25. By causing, allowing or threatening the discharge of contaminants to waters of the State so as to cause or tend to cause water pollution in Illinois, Defendant Galesburg Livestock Sales, Inc. has violated Section 12(a) of the Act, 415 ILCS 5/12(a).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Galesburg Livestock Sales, Inc. has violated Section 12(a) of the Act, 415 ILCS 5/12(a);

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT VII

GALESBURG LIVESTOCK SALES, INC. SITE WATER POLLUTION HAZARD VIOLATION

1. This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-7. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 7 of Count VI as paragraphs 2 through 7 of this Count VII.

8. Section 12(d) of the Act, 415 ILCS 5/12(d), provides, in pertinent part, as follows:

> No person shall:
>
> * * *
>
> d. Deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard.
>
> * * *

9-26. Plaintiff re-alleges and incorporates by reference herein paragraphs 8 through 25 of Count VI as paragraphs 9 through 26 of this Count VII.

27. Defendant Galesburg Livestock Sales, Inc. has caused or allowed contaminants

to be deposited upon the land in such place and manner as to create a water pollution hazard by causing contaminants to remain on the land and subject to surface drainage or leaching into waters of the State.

28. By depositing contaminants upon the land in such place and manner as to create a water pollution hazard at the Galesburg site, Defendant Galesburg Livestock Sales, Inc. has violated Section 12(d) of the Act, 415 ILCS 5/12(d).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Galesburg Livestock Sales, Inc. has violated Section 12(d) of the Act, 415 ILCS 5/12(d);

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT VIII

GALESBURG LIVESTOCK SALES, INC. SITE NPDES VIOLATION

1 . This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-25. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 25 of Count VI as paragraphs 2 through 25 of this Count VIII.

26-27. Plaintiff re-alleges and incorporates by reference herein paragraphs 25 and 26 Count III as paragraphs 26 and 27 of this Count VII.

28. Defendant Galesburg Livestock Sales, Inc. does not have a National Pollution Discharge Elimination System Permit ("NPDES") for the Galesburg facility, nor has the Defendant applied for one. Discharges from the feedlot are point source discharges.

29. By causing or allowing the discharge of livestock wastewater to waters of the State without an NPDES permit, the Defendant Galesburg Livestock Sales, Inc. has violated 12(f) of the Act, 415 ILCS 5/12(f), and 35 Ill. Adm. Code 309.102(a).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Galesburg Livestock Sales, Inc. has violated Section 12(f) of the Act, 415 ILCS 5/12(f), and 35 Ill. Adm. Code 309.102(a);

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of ten thousand dollars ($10,000) per day of violation, pursuant to Section 42(b)(1) of the Act, 414 ILCS 5/42(b)(1); and

D. Grant such other and further relief as the Court deems appropriate.

COUNT IX

GALESBURG LIVESTOCK SALES, INC. SITE

AGRICULTURE RELATED POLLUTION VIOLATIONS

1 . This Count is brought on behalf of the People of the State of Illinois, by Lisa Madigan, Attorney General of the State of Illinois, on her own motion pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e).

2-25. Plaintiff re-alleges and incorporates by reference herein paragraphs 2 through 25 of Count VI as paragraphs 2 through 25 of this Count IX.

26-27. Plaintiff re-alleges and incorporates by reference herein paragraphs 25 through 27 of Count IV as paragraphs 26 through 27 of this Count IX.

28. Defendant Galesburg Livestock Sales, Inc. has allowed livestock manure waste to exist on the Galesburg Livestock Sales site stockpiled, un-contained and susceptible to runoff in the event of precipitation.

29. By failing to adequately contain livestock waste so as not to cause water pollution, and by failing to provide adequate diversion, Defendant Galesburg Livestock Sales, Inc has violated Section 12(a) of the Act, 415 ILCS 5/12(a), 35 Ill. Adm. 501.403(a), 35 Ill. Adm. Code 501.404(b)(1) and 35 Ill. Adm. Code 501.404(c)(2).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, People of the State of Illinois, respectfully requests that the Court grant the following relief:

A. Find that the Defendant Galesburg Livestock Sales, Inc. has violated Section 12(a) of the Act, 415 ILCS 5/12(a), 35 Ill. Adm. 501.403(a) and 35 Ill. Adm. Code 501.404(b)(1);

B. Permanently enjoin the Defendant from further violations of the Act and associated regulations pursuant to Section 42(e) of the Act, 415 ILCS 5/42(e);

C. Assess against the Defendant a civil penalty of fifty thousand dollars ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter, pursuant to Section 42(a) of the Act, 414 ILCS 5/42(a); and

D. Grant such other and further relief as the Court deems appropriate.

Respectfully submitted,

PEOPLE OF THE STATE OF ILLINOIS,
ex rel. LISA MADIGAN,
Attorney General of the State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement/Asbestos
Litigation Division

BY:__________________________
THOMAS DAVIS, Chief
Environmental Bureau
Assistant Attorney General

Of Counsel
JANE E. MCBRIDE
Assistant Attorney General
500 South Second Street
Springfield, Illinois 62706
217/782-9031
Dated: 7/25/11

Attachment 28:

Order, *People of the State of Illinois v. Ed Malone, d/b/a Malone Farms and Feedlot, and Galesburg Livestock Sales, Inc.*

IN THE CIRCUIT COURT FOR THE NINTH JUDICIAL CIRCUIT

KNOX COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS, *ex rel.* LISA MADIGAN, Attorney General of the State of Illinois	)	
Plaintiff,	)	No. 09 - L - 07
v.	)	
ED MALONE, d/b/a MALONE FARMS AND FEEDLOT, and GALESBURG LIVESTOCK SALES, INC., an Illinois corporation	)	
Defendants	)	

IMMEDIATE INJUNCTION ORDER

THIS CAUSE coming on to be heard upon the request of the Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, and the Court being fully advised in the premises :

Defendant Ed Malone is Debtor in Possession and potential permanent manager of a cattle feedlot facility located approximately two miles northwest of Abingdon, Illinois. He owned and operated the facility at all times relevant to the Complaint in this matter. On May 10, 2010 Defendant Malone filed a Chapter 11 petition in the United States Bankruptcy Court.

The facility includes open dirt feedlots encompassing several acres that were, at times relevant to this complaint, populated with up to 2800 head of cattle. The facility is in the watershed of Latimer Creek which is tributary to Cedar Fork.

During June, July, August and September of 2010, Defendant Malone caused and allowed wastewater holding cells that were under construction yet incomplete at the site to overflow with livestock waste, discharging their contents to a small stream tributary to Latimer Creek. The earthen dam of the east waste holding cell ultimately failed, allowing a large volume of wastewater to suddenly flow into the small stream tributary to Latimer Creek. A temporary spillway in the earthen dam of the west waste holding cell prevented it from failing yet caused the wastewater impoundment to routinely and frequently discharge livestock waste to the receiving stream. Runoff from feedlot manure stockpiles and the feedlot's commodity storage area continued to drain to the two wastewater holding cells and discharge through a temporary spillway constructed in the west cell and through the breach in the east cell.

On September 8, 2010, Karita E. Hines was the successful bidder in the bankruptcy sale of the subject property. Ms. Hines is Defendant Malone's fiancé and mother of his three-year-old son. On October 12, 2010, Ms. Hines filed a motion in the bankruptcy proceeding seeking an extension of time within which to close sale of the feedlot. The sale of the feedlot to Ms. Hines has not yet closed, but the closing is imminent according to Mr. Malone's bankruptcy attorney.

On January 5, 2011, the Illinois EPA conducted an inspection of the site and observed that despite the fact Defendant Malone has not completed construction of a waste collection and containment system for the site and that wastewater was seeping out of a waste holding structure and has failed to obtain National Pollution Discharge Elimination System ("NPDES") permit coverage, he is maintaining approximately 130 cattle on site.

IT IS ORDERED, ADJUDGED AND DECREED

1. Defendant Ed Malone shall cease and desist from all discharges of livestock manure, livestock waste, waste feed, silage leachate, and/or wastewater from the facility.

2. Defendant Ed Malone shall immediately remove all livestock from the site until such time as construction of the site's waste collection, containment and management system is approved in writing by the Illinois Department of Agriculture and Illinois Environmental Protection Agency, and NPDES permit coverage is obtained for the site. The NPDES permit application originally submitted for the site must be revised to reflect current ownership and management. In addition to all measures described in the Department of Agriculture's letter dated January 7, 2011, Illinois EPA approval will

require and include, but not be limited to, installation of gutters and downspouts on all feedlot buildings to divert clean water and thereby preserve capacity for waste storage in the waste handling system.

3. Defendant Ed Malone shall not bring or allow to be brought any livestock on site at the subject feedlot until such time as this Court may schedule a hearing to ascertain and confirm compliance with this order. The Defendant shall not allow any person or entity to maintain cattle on the site. For the purposes of this order, "feedlot" means all of the area included in the design and construction plan submitted to and approved by the Illinois Department of Agriculture and the Illinois EPA including any area that has been or will be, by any means, altered pursuant to that plan.

4. The Court hereby sets this matter for ~~status hearing on~~ CMC to be set & notified ____________, ~~2011~~, ~~at~~ ________M. by the Court.

AGREED TO:

ED MALONE

BY: Ed Malone
ED MALONE

ANDREW L. YOUNGQUIST
BEAL, PRATT & PRATT
Counsel for Defendant Ed Malone

PEOPLE OF THE STATE OF ILLINOIS,
LISA MADIGAN
Attorney General State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement Division,

BY: ____________
THOMAS DAVIS, Chief
Environmental Bureau
Assistant Attorney General

ENTERED: 1/21/11

____
JUDGE

FILED
KNOX CO., IL
JAN 2 1 2011
KELLY CHEESMAN
Clerk of the Circuit Court
____________ Deputy

Attachment 29:

Complaint, *People of the State of Illinois v. James Fuhler, d/b/a Fuhler Dairy Farm*

IN THE CIRCUIT COURT FOR THE FOURTH JUDICIAL CIRCUIT

CLINTON COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS, ex rel. LISA MADIGAN, Attorney General of the State of Illinois,	)	
Plaintiff,	)	
v.	)	**No.** 05CH 89
JAMES FUHLER, d/b/a FUHLER DAIRY FARM,	)	
Defendant.	)	

COMPLAINT FOR INJUNCTIVE AND OTHER RELIEF

The Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, *ex rel.* LISA MADIGAN, Attorney General of the State of Illinois, on her own motion and at the request of the ILLINOIS ENVIRONMENTAL PROTECTION AGENCY, complains of the Defendant, JAMES FUHLER, d/b/a FUHLER DAIRY FARM, as follows:

COUNT I

WATER POLLUTION

1. This Count is brought on behalf of the People of the State of Illinois, *ex rel.* Lisa Madigan, Attorney General of the State of Illinois, on her own motion and at the request of the Illinois Environmental Protection Agency ("Illinois EPA"), pursuant to Sections 42(d) and (e) of the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/42(d), (e) (2002).

2. The Illinois EPA is an agency of the State of Illinois created by the General Assembly in Section 4 of the Act, 415 ILCS 5/4 (2002), and which is charged, inter alia, with the duty of enforcing the Act.

3. Defendant James Fuhler ("Fuhler") is an individual who owns and operates a dairy farm of approximately 200 milking cows. The farm is located in the Northwest One-quarter of Section 33; T.3 N; R. 4 W, Clinton County (the "facility" or "site"). James Fuhler's address is 8110 Wayne Road, Trenton, Illinois 62293.

4. Defendant Fuhler's facility consists of a large earthen feedlot, upon which he keeps his milking cows. Dry cows are kept on concrete feedlots with underfloor waste pits.

5. Section 3.545 of the Act, 415 ILCS 5/3.545 (2002), provides:

> "WATER POLLUTION" is such alteration of the physical, thermal, chemical, biological or radioactive properties of any waters of the State, or such discharge of any contaminant into waters of the State, as will or is likely to create a nuisance or render such waters harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate uses, or to livestock, wild animals, birds, fish, or other aquatic life.

6. Section 3.550 of the Act, 415 ILCS 5/3.550 (2002), provides:

> "WATERS" means all accumulations of water, surface and underground, natural, and artificial, public and private, or parts thereof, which are wholly or partially within, flow through, or border upon this State.

7. Section 12(a) and (d) of the Act, 415 ILCS 5/12(a), (d) (2002), provides, in pertinent part:

> No person shall:
>
> a. Cause or threaten or allow the discharge of any contaminants into the environment in any State so as to cause or tend to cause water pollution in Illinois, either alone or in combination with matter from other sources, or so as to violate regulations or standards adopted by the Pollution Control Board under this Act;
>
> * * *
>
> d. Deposit any contaminants upon the land in such place and manner so as to create a water pollution hazard;
>
> * * *

8. Section 501.403(a) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.403(a), provides:

> Section 501.403
>
> Protection of Livestock Management Facilities and Livestock Waste-Handling Facilities
>
> a) Existing livestock management facilities and livestock waste-handling facilities shall have adequate diversion dikes, walls or curbs that will prevent excessive outside surface waters from flowing through the animal feeding operation and will direct runoff to an appropriate disposal, holding or storage area. The diversions are required on all aforementioned structures unless there is negligible outside surface water which can flow through the facility or the runoff is tributary to an acceptable disposal area or a livestock waste-handling facility. If inadequate diversions cause ro threaten to cause a violation of the Act or applicable regulations, the Agency may require corrective measures.

9. Sections 501.404(c)(3) and (c)(4)(A) of the Board's Agriculture Related Pollution Regulations, 35 Ill. Adm. Code 501.404(c)(3), (c)(4)(A), provide:

> Section 501.404 Handling and Storage of Livestock Waste
>
> * * *
>
> c) Livestock Waste-Holding Facilities
>
> * * *
>
> 4) Liquid Livestock Waste
>
> A) Existing livestock management facilities which handle the waste in a liquid form shall have adequate storage capacity in a liquid manure-holding tank, lagoon, holding pond, or any combination thereof so as not to cause air or water pollution as defined in the Act or applicable regulations. If inadequate storage time causes or threatens to cause a violation of the Act or applicable regulations, the Agency may require that additional storage time be provided. In such cases, interim pollution prevention measures may be required by the Agency.

10. On April 26, 2001, the Illinois EPA conducted an inspection of the facility in response to a citizen complaint regarding land application practices. At the time of the inspection, the Illinois EPA inspector observed that the facility's earthen feedlot was large and

that all waste runoff from the earthen feedlot discharged to the adjacent creek. At the time of the inspection, the Illinois EPA inspector informed Defendant Fuhler that all liquid runoff from the earthen feedlot must be contained. The inspector indicated that Defendant Fuhler must provide containment or move the earthen feedlot away from the creek and provide a vegetative buffer between the creek and the feedlot.

11. At the time of the April 26, 2001 inspection, the Illinois EPA inspector observed that there was a large underfloor pit in the center of the main concrete feedlot at the facility. At the time of the inspection, runoff to the east of the pit was discharging off of the eastern edge of the feedlot to an earthen swale which carried it to the creek. At the time of the inspection, Defendant Fuhler indicated to the inspector that he intended to install a vegetative filter system on the east of the feedlot for waste handling. The inspector indicated that if the Defendant was going to install a filter, a settling basin should precede it otherwise manure solids would overpower the vegetative filter. The inspector further responded that vegetative filter systems are recommended for facilities limited to 300 or less animal units. In that Defendant Fuhler's facility currently consisted of close to 300 animals, the filter system would not be sufficient to accommodate growth in the operation.

12. At the time of the April 26, 2001, the Illinois EPA inspector observed that most of the facility's buildings were not equipped with guttering. The Illinois EPA inspector recommended to Defendant Fuhler that gutters be installed to divert stormwater away from the feedlot areas.

13. On May 16, 2003, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, the Illinois EPA inspector observed a large manure stack approximately 10 feet from the roadside ditch on the northern edge of the site. The Illinois EPA inspector observed leachate discharging from the stack and into the roadside ditch which flows

into Lake Branch. The Illinois EPA inspector instructed Defendant Fuhler to immediately construct an earthen dike around the stack to contain the leachate. The inspector also suggested that the contained leachate could be pumped into the existing pits under the concrete feedlots.

14. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that Defendant Fuhler had begun to install guttering on several of the buildings at the site, but had not completed this work.

15. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that construction of a proposed concrete settling basin had not begun. The settling basin was to be installed on the eastern edge of the concrete feedlot. At the time of the inspection, the Illinois EPA inspector observed that an earthen berm had been constructed along the eastern edge of the concrete feedlot to divert manure runoff south. The inspector observed that the diverted liquid manure from the concrete feedlot discharged onto the earthen feedlot which, in turn, discharged into an earthen swale that flowed east.

16. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that at the eastern edge of the farm at the creek, a large earthen berm had been constructed. At the berm, waste runoff discharging from the facility turned south and flowed along the berm to the south a couple of hundred feet and then entered the creek at a low point in the berm.

17. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that the facility's main earthen feedlot which previously extended up to the creek, had been moved about 100 feet back from the creek and a vegetated buffer had been installed between the feedlot and the creek.

18. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed a small earthen hog feedlot on the western portion of the facility. At the time of the inspection,

approximately 20 small hogs were on this feedlot. The inspector observed that the hog feedlot was constructed in such a manner, that, in the event of rain, runoff from this small feedlot would discharge off of the feedlot and flow toward Defendant Fuhler's farm ground directly south of the facility. At the time of the inspection, Defendant Fuhler indicated that after the existing hogs were finished, he was not going to raise hogs again.

19. By failing to install proper manure runoff collection and control structures and stormwater diversion structures at the facility and thereby causing or allowing feedlot runoff containing livestock and feedlot wastes to discharge from the facility so as to cause or tend to cause water pollution and create a water pollution hazard, Defendant Fuhler has violated Section 12(a) and (d) of the Act, 415 ILCS 5/12(a),(d) (2002), 35 Ill. Adm. Code 501.403(a) and 35 Ill. Adm. Code 501.404(c)(4)(A).

PRAYER FOR RELIEF

WHEREFORE, the Plaintiff, the People of the State of Illinois, respectfully requests that this Court grant the following relief:

A. Find that Defendant James Fuhler, d/b/a Fuhler Dairy Farm, has violated Sections 12(a) and (d) of the Act, 415 ILCS 5/12(a), (d) (2002), 35 Ill. Adm. Code 501.403(a), and 35 Ill. Adm. Code 501.404(c)(4)(A);

B. Enjoin Defendant James Fuhler from further violations of the Act and associated regulations;

C. Assess against Defendant James Fuhler a civil penalty of fifty thousand ($50,000) for each violation of the Act, and an additional penalty of ten thousand dollars ($10,000) for each day during which each violation has continued thereafter;

D. Pursuant to Section 42(f) of the Act, 415 ILCS 5/42(f) (2002), award the Plaintiff its costs in this matter, including reasonable attorney's fees and expert witness costs; and

E. Grant such other and further relief as the Court deems appropriate.

Respectfully submitted,

PEOPLE OF THE STATE OF ILLINOIS,
ex rel. LISA MADIGAN,
Attorney General of the State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement/Asbestos
Litigation Division

BY:____________________________
THOMAS DAVIS, Chief
Environmental Bureau
Assistant Attorney General

Of Counsel
JANE E. MCBRIDE
Assistant Attorney General
500 South Second Street
Springfield, Illinois 62706
217/782-9031
Dated: 12/21/05

Attachment 30:

Order, *People of the State of Illinois v. James Fuhler, d/b/a Fuhler Dairy Farm*

IN THE CIRCUIT COURT FOR THE FOURTH JUDICIAL CIRCUIT

CLINTON COUNTY, ILLINOIS

PEOPLE OF THE STATE OF ILLINOIS, ex rel. LISA MADIGAN, Attorney General of the State of Illinois,	)	
Plaintiff,	)	
v.	)	No. 05-CH-89
JAMES FUHLER, d/b/a FUHLER DAIRY FARM,	)	
Defendant.	)	

FILED

CONSENT ORDER

Plaintiff, PEOPLE OF THE STATE OF ILLINOIS, ex rel. LISA MADIGAN, Attorney General of the State of Illinois, the Illinois Environmental Protection Agency ("Illinois EPA"), and Defendant, James Fuhler, d/b/a Fuhler Dairy Farm, have agreed to the making of this Consent Order and submit it to this Court for approval. The parties agree that the statement of facts contained herein represents a fair summary of the evidence and testimony which would be introduced by the parties if a trial were held. The parties further stipulate that this statement of facts is made and agreed upon for purposes of settlement only and that neither the fact that a party has entered into this Consent Order, nor any of the facts stipulated herein, shall be introduced into evidence in any other proceeding regarding the claims asserted in the Complaint except as otherwise provided herein. If this Court approves and enters this Consent Order, Defendant agrees to be bound by the Consent Order and not to contest its validity in any subsequent proceeding to implement or enforce its terms. However, it is the intent of the parties to this Consent Order that it be a final judgment on the merits of this matter, subject to the provisions of Section VIII.H ("Release from Liability") and Section VIII.J ("Modification of Consent Order").

I. JURISDICTION

This Court has jurisdiction of the subject matter herein and of the parties consenting hereto pursuant to the Illinois Environmental Protection Act ("Act"), 415 ILCS 5/1 et seq. (2002).

II. AUTHORIZATION

The undersigned representatives for each party certify that they are fully authorized by the party whom they represent to enter into the terms and conditions of this Consent Order and to legally bind them to it.

III. STATEMENT OF FACTS

A. Parties

1. On December 28, 2005, a Complaint was filed on behalf of the People of the State of Illinois by Lisa Madigan, Attorney General of the State of Illinois, on her own motion and upon the request of the Illinois EPA, pursuant to Section 42(d) and (e) of the Act, 415 ILCS 5/42(d) and (e) (2004), against the Defendant.

2. The Illinois EPA is an administrative agency of the State of Illinois, created pursuant to Section 4 of the Act, 415 ILCS 5/4 (2004).

3. At all times relevant to the Complaint, Defendant James Fuhler ("Fuhler") is an individual who owns and operates a dairy farm of approximately 200 milking cows.

B. Site Description

1. At all times relevant to the Complaint, Defendant owned and operated a farm located in the Northwest One-quarter of Section 33; T.3 N; R. 4 W. Clinton County (the "facility" or "site"). James Fuhler's address is 8110 Wayne Road, Trenton, Illinois 62293.

2. Defendant Fuhler's facility consists of a large earthen feedlot, upon which he keeps his milking cows. Dry cows are kept on concrete feedlots with underfloor waste pits.

3. On April 26, 2001 inspection, the Illinois EPA conducted an inspection of the facility in response to a citizen complaint regarding land application practices. At the time of the inspection, the Illinois EPA inspector observed that the facility's earthen feedlot was large and that all waste runoff from the earthen feedlot discharged to the adjacent creek. At the time of the inspection, the Illinois EPA inspector informed Defendant Fuhler that all liquid runoff from the earthen feedlot must be contained. The inspector indicated that Defendant Fuhler must provide containment or move the earthen feedlot away from the creek and provide a vegetative buffer between the creek and the feedlot.

4. At the time of the April 26, 2001 inspection, the Illinois EPA inspector observed that there was a large underfloor pit in the center of the main concrete feedlot at the facility. At the time of the inspection, runoff to the east of the pit was discharging off of the eastern edge of the feedlot to an earthen swale which carried it to the creek. At the time of the inspection, Defendant Fuhler indicated to the inspector that he intended to install a vegetative filter system on the east of the feedlot for waste handling. The inspector indicated that if the Defendant was going to install a filter, a settling basin should precede it otherwise manure solids would overpower the vegetative filter. The inspector further responded that vegetative filter systems are recommended for facilities limited to 300 or less animal units. In that Defendant Fuhler's facility currently consisted of close to 300 animals, the filter system would not be sufficient to accommodate growth in the operation.

5. At the time of the April 26, 2001, the Illinois EPA inspector observed that most of the facility's buildings were not equipped with guttering. The Illinois EPA inspector recommended to Defendant Fuhler that gutters be installed to divert stormwater away from the

feedlot areas.

6. On May 16, 2003, the Illinois EPA conducted a compliance inspection at the facility. At the time of the inspection, the Illinois EPA inspector observed a large manure stack approximately 10 feet from the roadside ditch on the northern edge of the site. The Illinois EPA inspector observed leachate discharging from the stack and into the roadside ditch which flows into Lake Branch. The Illinois EPA inspector instructed Defendant Fuhler to immediately construct an earthen dike around the stack to contain the leachate. The inspector also suggested that the contained leachate could be pumped into the existing pits under the concrete feedlots.

7. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that Defendant Fuhler had begun to install guttering on several of the buildings at the site, but had not completed this work.

8. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that construction of a proposed concrete settling basin had not begun. The settling basin was to be installed on the eastern edge of the concrete feedlot. At the time of the inspection, the Illinois EPA inspector observed that an earthen berm had been constructed along the eastern edge of the concrete feedlot to divert manure runoff south. The inspector observed that the diverted liquid manure from the concrete feedlot discharged onto the earthen feedlot which, in turn, discharged into an earthen swale that flowed east.

9. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed that at the eastern edge of the farm at the creek, a large earthen berm had been constructed. At the berm, waste runoff discharging from the facility turned south and flowed along the berm to the south a couple of hundred feet and then entered the creek at a low point in the berm.

10. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed

that the facility's main earthen feedlot which previously extended up to the creek, had been moved about 100 feet back from the creek and a vegetated buffer had been installed between the feedlot and the creek.

11. At the time of the May 16, 2003 inspection, the Illinois EPA inspector observed a small earthen hog feedlot on the western portion of the facility. At the time of the inspection, approximately 20 small hogs were on this feedlot. The inspector observed that the hog feedlot was constructed in such a manner, that, in the event of rain, runoff from this small feedlot would discharge off of the feedlot and flow toward Defendant Fuhler's farm ground directly south of the facility. At the time of the inspection, Defendant Fuhler indicated that after the existing hogs were finished, he was not going to raise hogs again.

C. Allegations of Non-Compliance

Plaintiff contends that the Defendant has violated the following provisions of the Act and Illinois Pollution Control Board ("Board") Water Pollution Regulations:

Count I:

1. By failing to install proper manure runoff collection and control structures and stormwater diversion structures at the facility and thereby causing or allowing feedlot runoff containing livestock and feedlot wastes to discharge from the facility so as to cause or tend to cause water pollution and create a water pollution hazard, Defendant Fuhler has violated Section 12(a) and (d) of the Act, 415 ILCS 5/12(a),(d) (2002), 35 Ill. Adm. Code 501.403(a) and 35 Ill. Adm. Code 501.404(c)(4)(A).

D. Admission of Violations

The Defendant represents that it has entered into this Consent Order for the purpose of settling and compromising disputed claims without having to incur the expense of contested litigation. By entering into this Consent Order and complying with its terms, the Defendant does not affirmatively admit the allegations of violation within the Complaint and referenced within Section III.C herein, and this Consent Order shall not be interpreted as including such admission.

E. Compliance Activities to Date

The Defendant, with the assistance of a federal EQIP grant, has constructed two additional waste pits at his facility with cement covers that are utilized as feedlots for the cattle. He constructed one 70 foot by 125 foot by 8 foot reception pit west of silos at the facility. The pit cover is utilized as a feedlot and a 25 foot by 25 foot area of the cover is used as a manure stacking area. A second pit, 32 foot by 48 foot by 8 foot, has been constructed east of the silos on the facility. It too is covered and the cement cover is used as a feedlot for cattle. Curbs have been constructed to send all farm runoff into the waste pits. The barn roofs have been guttered and outlets installed to send roof runoff away from the feedlot areas. A 62 foot wide permanent grass buffer strip 1300 feet long has been installed on the west bank of Lake Branch.

F. Value of Settlement and Resulting Benefits

The structures described in Section III.E above was estimated to cost $170,030.89. Sixty percent of this cost, or $101,074.00, was covered by federal EQIP funding. The actual cost of the project is projected at $250.000.00. The Defendant paid 40 percent of the original cost estimate, as well as all cost overruns.

IV. APPLICABILITY

A. This Consent Order shall apply to and be binding upon the Plaintiff and the Defendant, and any officer, director, agent, or employee of the Defendant, as well as any successors or assigns of the Defendant. The Defendant waives as a defense to any enforcement action taken pursuant to this Consent Order the failure of any of its officers, directors, agents, employees or successors or assigns to take such action as shall be required to comply with the provisions of this Consent Order.

B. No change in ownership, corporate status or operator of the facility shall in any way alter the responsibilities of the Defendant under this Consent Order. In the event of any conveyance of title, easement or other interest in the facility, the Defendant shall continue to be bound by and remain liable for performance of all obligations under this Consent Order. In appropriate circumstances, however, the Defendant and a proposed purchaser or operator of the facility may jointly request, and the Plaintiff, in its discretion, may consider modification of this Consent Order to obligate the proposed purchaser or operator to carry out future requirements of this Consent Order in place of, or in addition to, the Defendant.

C. In the event that the Defendant proposes to sell or transfer any real property or operations subject to this Consent Order, the Defendant shall notify the Plaintiff 30 days prior to the conveyance of title, ownership or other interest, including a leasehold interest in the facility or a portion thereof. The Defendant shall make the prospective purchaser or successor's compliance with this Consent Order a condition of any such sale or transfer and shall provide a copy of this Consent Order to any such successor in interest. This provision does not relieve the Defendant from compliance with any regulatory requirement regarding notice and transfer of applicable facility permits.

V. COMPLIANCE WITH OTHER LAWS AND REGULATIONS

This Consent Order in no way affects the responsibilities of the Defendant to comply with any other federal, state or local laws or regulations, including but not limited to the Act, and the Board Regulations, 35 Ill. Adm. Code, Subtitles A through H.

VI. VENUE

The parties agree that the venue of any action commenced in the circuit court for the purposes of interpretation and enforcement of the terms and conditions of this Consent Order shall be in the Circuit Court of Clinton County, Illinois.

VII. SEVERABILITY

It is the intent of the Plaintiff and Defendant that the provisions of this Consent Order shall be severable, and should any provision be declared by a court of competent jurisdiction to be inconsistent with state or federal law, and therefore unenforceable, the remaining clauses shall remain in full force and effect.

VIII. JUDGMENT ORDER

This Court, having jurisdiction over the parties and subject matter, the parties having appeared, due notice having been given, the Court having considered the stipulated facts and being advised in the premises, this Court finds the following relief appropriate:

IT IS HEREBY ORDERED, ADJUDGED AND DECREED:

A. **Penalty**

1. a. The Defendant shall pay a civil penalty of One Thousand Dollars ($1,000.00). Payment shall be tendered at time of entry of the consent order.

b. Payment shall be made by certified check, money order or electronic funds transfer, payable to the Illinois EPA for deposit into the Environmental Protection Trust Fund ("EPTF") and shall be sent by first class mail, unless submitted by electronic funds transfer, and delivered to:

Illinois Environmental Protection Agency
Fiscal Services
1021 North Grand Avenue East
P.O. Box 19276
Springfield, IL 62794-9276

c. The name and case number shall appear on the face of the certified check or money order. A copy of the certified check, money order or record of electronic funds transfer and any transmittal letter shall be sent to:

Jane E. McBride
Assistant Attorney General
Environmental Bureau
500 South Second Street
Springfield, Illinois 62706

2. If the Defendant fails to make any payment specified within Section VIII.A.1 of this Consent Order on or before the date upon which the payment is due, the Defendant shall be in default and the remaining unpaid balance of the penalty, plus any accrued interest, shall be due and owing immediately.

3. For purposes of payment and collection, Defendant may be reached at the following address:

James Fuhler
8110 Wayne Road

Trenton, Illinois 62293.

4. In the event of default, the Plaintiff shall be entitled to reasonable costs of collection, including reasonable attorney's fees.

B. Interest on Penalties

1. Pursuant to Section 42(g) of the Act, 415 ILCS 5/42(g), interest shall accrue on any penalty amount owed by the Defendant not paid within the time prescribed herein, at the maximum rate allowable under Section 1003(a) of the Illinois Income Tax Act, 35 ILCS 5/1003(a)(2002).

2. Interest on unpaid penalties shall begin to accrue from the date such are due and continue to accrue to the date full payment is received by the Illinois EPA.

3. Where partial payment is made on any penalty amount that is due, such partial payment shall be first applied to any interest on unpaid penalties then owing.

4. All interest on penalties owed the Plaintiff shall be paid by certified check, money order or electronic funds transfer payable to the Illinois EPA for deposit in the EPTF and shall be submitted by first class mail unless submitted by electronic funds transfer, and delivered to:

Illinois Environmental Protection Agency
Fiscal Services
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

The name, case number, and the Defendant's FEIN shall appear on the face of the certified check or money order. A copy of the certified check, money order or record of electronic funds transfer and any transmittal letter shall be sent to:

C. Future Use

Notwithstanding any other language in this Consent Order to the contrary, and in consideration of the mutual promises and conditions contained in this Consent Order, including the Release from Liability contained in Section VIII.H, below, Defendant hereby agrees that this Consent Order may be used against the Defendant in any subsequent enforcement action or permit proceeding as proof of a past adjudication of violation of the Act and the Board Regulations promulgated thereunder for all violations alleged in the Complaint in this matter, for purposes of Section 39(a) and (i) and/or 42(h) of the Act, 415 ILCS 5/39(a) and (i) and/or 5/42(h). Further, Defendant agrees to waive, in any subsequent enforcement action, any right to contest whether these alleged violations were adjudicated.

D. Dispute Resolution

1. Unless otherwise provided for in this Consent Order, the dispute resolution procedures provided by this section shall be the only process available to resolve all disputes arising under this Consent Order, including but not limited to the Illinois EPA's approval, comment on, or denial of any report, plan or remediation objective, or the Illinois EPA's decision regarding appropriate or necessary response activity. The following are expressly not subject to the dispute resolution procedures provided by this section: where the Defendant has violated any payment or compliance deadline within this Consent Order, for which the Plaintiff may elect to file a petition for adjudication of contempt or rule to show cause; and, disputes regarding a substantial danger to the environment or to the public health of persons or to the welfare of persons.

2. The dispute resolution procedure shall be invoked upon the written notice by one of the parties to this Consent Order to another describing the nature of the dispute and the initiating party's position with regard to such dispute. The party receiving such notice shall acknowledge receipt of the notice; thereafter the parties shall schedule a meeting to discuss the

dispute informally not later than fourteen (14) days from the receipt of such notice.

3. Disputes submitted to dispute resolution shall, in the first instance, be the subject of informal negotiations between the parties. Such period of informal negotiations shall be for a period of thirty (30) calendar days from the date of the first meeting between representatives of the Plaintiff and the Defendant, unless the parties' representatives agree, in writing, to shorten or extend this period.

4. In the event that the parties are unable to reach agreement during the informal negotiation period, the Plaintiff shall provide the Defendant with a written summary of its position regarding the dispute. The position advanced by the Plaintiff shall be considered binding unless, within twenty (20) calendar days of the Defendant's receipt of the written summary of the Plaintiff's position, the Defendant files a petition with this Court seeking judicial resolution of the dispute. The Plaintiff shall respond to the petition by filing the administrative record of the dispute and any argument responsive to the petition within twenty (20) calendar days of service of Defendant's petition. The administrative record of the dispute shall include the written notice of the dispute, any responsive submittals, the Plaintiff's written summary of its position, the Defendant's petition before the court and the Plaintiff's response to the petition.

5. The invocation of dispute resolution, in and of itself, shall not excuse compliance with any requirement, obligation or deadline contained herein, and stipulated penalties may be assessed for failure or noncompliance during the period of dispute resolution.

6. This Court shall make its decision based on the administrative record and shall not draw any inferences nor establish any presumptions adverse to any party as a result of invocation of this section or the parties' inability to reach agreement with respect to the disputed issue. The Plaintiff's position shall be affirmed unless, based upon the administrative record, it is against the manifest weight of the evidence.

7. As part of the resolution of any dispute, the parties, by agreement, or by order of this Court, may, in appropriate circumstances, extend or modify the schedule for completion of work under this Consent Order to account for the delay in the work that occurred as a result of dispute resolution.

E. Right of Entry

In addition to any other authority, the Illinois EPA, its employees and representatives, and the Attorney General, her employees and representatives, shall have the right of entry into and upon the Defendant's facility which is the subject of this Consent Order, at all reasonable times for the purposes of carrying out inspections. In conducting such inspections, the Illinois EPA, its employees and representatives, and the Attorney General, her employees and representatives, may take photographs, samples, and collect information, as they deem necessary.

F. Cease and Desist

The Defendant shall cease and desist from future violations of the Act and Board Regulations that were the subject matter of the Complaint as outlined in Section III.C. of this Consent Order.

G. Release from Liability

In consideration of the Defendant's payment of a $1,000.00 penalty and any specified costs and accrued interest, and to Cease and Desist as contained in Sections VIII.B and F above, the Plaintiff releases, waives and discharges the Defendant from any further liability or penalties for violations of the Act and Board Regulations that were the subject matter of the

Complaint herein. The release set forth above does not extend to any matters other than those expressly specified in Plaintiff's Complaint filed on December 28, 2005. The Plaintiff reserves, and this Consent Order is without prejudice to, all rights of the State of Illinois against the Defendant with respect to all other matters, including but not limited to, the following:

a. criminal liability;

b. liability for future violation of state, federal, local, and common laws and/or regulations;

c. liability for natural resources damage arising out of the alleged violations; and

d. liability or claims based on the Defendant's failure to satisfy the requirements of this Consent Order.

Nothing in this Consent Order is intended as a waiver, discharge, release, or covenant not to sue for any claim or cause of action, administrative or judicial, civil or criminal, past or future, in law or in equity, which the State of Illinois or the Illinois EPA may have against any person, as defined by Section 3.315 of the Act, 415 ILCS 5/3.315, or entity other than the Defendant.

H. Retention of Jurisdiction

This Court shall retain jurisdiction of this matter for the purposes of interpreting and enforcing the terms and conditions of this Consent Order.

I. Modification of Consent Order

The parties may, by mutual written consent, extend any compliance dates or modify the terms of this Consent Order without leave of court. A request for any modification shall be made in writing and submitted to the following contact persons:

As to the Plaintiff

Jane E. McBride
Assistant Attorney General (or other designee)
Environmental Bureau
500 South Second Street
Springfield, Illinois 62706

Joey Logan Wilkey
Assistant Counsel
Illinois EPA
1021 North Grand Avenue East
P.O. Box 19276
Springfield, Illinois 62794-9276

Joseph Stitely
Illinois EPA
2509 W. Main
Marion, IL 62959

As to the Defendant

James Fuhler
8110 Wayne Road
Trenton, Illinois 62293

Christina L. Archer, Esq.
Greensfelder Attorneys at Law
2000 Equitable Building
10 South Broadway
St. Louis, MO 63102

Any such request shall be made by separate document, and shall not be submitted within any other report or submittal required by this Consent Order. Any such agreed modification shall be in writing, signed by authorized representatives of each party, filed with the court and incorporated into this Consent Order by reference.

J. **Enforcement of Consent Order**

1. Upon the entry of this Consent Order, any party hereto, upon motion, may reinstate these proceedings for the purpose of enforcing the terms and conditions of this

Consent Order. This Consent Order is a binding and enforceable order of this Court and may be enforced as such through any and all available means.

2. Defendant agrees that notice of any subsequent proceeding to enforce this Consent Order may be made by mail and waives any requirement of service of process.

K. Termination

1. Defendant may request that this Consent Order terminate no sooner than twelve (12) months after entry of this Consent Order, provided that Defendant has been in continuous compliance with the terms of the Consent Order for the twelve (12) months preceding the request. Such a request may be made by notice to the individuals listed as contact persons for Plaintiff in Section VIII.J of this Consent Order. The request shall include a statement that Defendant has completed all actions required by this Consent Order, that Defendant has been in continuous compliance with the terms of the Consent Order for the twelve (12) months preceding the request and a certification by a responsible corporate official of Defendant who shall state:

> I certify under penalty of law that this document was prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted based on my inquiry of those persons directly responsible for gathering the information, and that the information submitted in or accompanying this notification of final compliance is to the best of my knowledge true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and or imprisonment for knowing violations.

2. The Plaintiff shall notify Defendant of its decision on the request within forty-five (45) days of Plaintiff's receipt of the request. If the Plaintiff agrees to terminate this Consent Order, the Plaintiff and Defendant shall jointly file a notice with the Court that the Consent Order is terminated. If the Plaintiff does not agree to terminate this Consent Order, the Plaintiff shall

provide Defendant written notification stating the reasons why this Consent Order should not be terminated. Upon receipt of such notification, any party may initiate the Dispute Resolution as provided in Section VIII.E of this Consent Order. The Consent Order shall remain in effect pending resolution of any dispute by the parties or the Court concerning whether Defendant has completed its obligations under this Consent Order and is in compliance with the terms of the Consent Order.

3. The provisions of Section VIII.D "Future Use," Section VIII.G "Cease and Desist" and Section VIII.H "Release from Liability" shall survive and shall not be subject to and are not affected by the termination of any other provision(s)of this Consent Order.

L. Execution of Document

This Order shall become effective only when executed by all parties and the Court. This Order may be executed by the parties in one or more counterparts, all of which taken together, shall constitute one and the same instrument.

WHEREFORE, the parties, by their representatives, enter into this Consent Order and submit it to this Court that it may be approved and entered.

AGREED:

FOR THE PLAINTIFF:

PEOPLE OF THE STATE OF ILLINOIS
ex rel. LISA MADIGAN,
Attorney General of the
State of Illinois

MATTHEW J. DUNN, Chief
Environmental Enforcement/
Asbestos Litigation Division

BY: [signature]
THOMAS DAVIS, Chief
Environmental Bureau

DATE: 11/01/06

ILLINOIS ENVIRONMENTAL
PROTECTION AGENCY

BY: [signature: Robert A. Messina]
ROBERT A. MESSINA
Chief Legal Counsel

DATE: 10/30/06

FOR THE DEFENDANT:
JAMES FUHLER

BY: [signature: James Fuhler]
James Funier

DATE: 12-4-06

ENTERED: 12-18-06

JUDGE

DATE: S/ William J Bacher (CP)

Attachment 31:

Managing nitrate and bacteria in runoff from livestock confinement areas with vegetative filter strips
(Fajardo et al. 2001)

RESEARCH

Managing nitrate and bacteria in runoff from livestock confinement areas with vegetative filter strips

J.J. Fajardo, J.W. Bauder, and S.D. Cash

ABSTRACT: A documented source of nitrate-nitrogen contamination of surface water is livestock waste and storage facilities. A vegetative filter strip (VFS) is effective in reducing some nutrients, sediment, and suspended solids in surface runoff from feedlots; however, results are variable in controlling water-soluble nutrients and bacteria in runoff. This study assessed the role of tall fescue (Festuca arundinacea Schreb.) as a VFS in reducing contaminants from stored animal wastes. The study evaluated the extent to which livestock manure stockpiles potentially contribute to nitrate-nitrogen (NO_3-N) and coliform bacteria contamination of surface water resources. The experiment was conducted on Amsterdam silt loam (fine-silty, mixed, superactive Typic Haploboroll) soil. Tall fescue and bare soil (fallow) strips were established on a 4% slope. Treatments consisted of manure applications in the upland position for the strips. For comparision, vegetated and bare control (non treated) strips without manure in the upland position were also studied. Manure was applied annually (approximately 2 t fresh weight per strip). Runoff was achieved by applying water at the head of the treatments and forcing the applied water to pass through the manure stockpiles and into the VFS and fallow strips. Runoff water samples were collected and analyzed for NO_3-N and coliform. Concentration of NO_3-N in surface runoff from VFS with manure stockpiles in the headland was reduced up to 97% in 1997 and 99% in 1998 where a VFS was present. Coliform populations in runoff were reduced significantly by VFS in two runoff events, a 64% reduction in July 1997, and an 87% reduction in August 1998. However, the coliform counts in runoff, even from VFS treatments not receiving manure, remained substantially elevated. Dilution and residence time of water passing through the VFS appeared to be the most significant factors affecting reductions in NO_3-N and bacteria in runoff.

Keywords: Coliform bacteria, nitrate, runoff, vegetative filter strips, water quality

Point and nonpoint source pollution of surface and groundwater is a major social and environmental concern in the world. Point sources include, among other things, municipal and industrial wastes, runoff and infiltration from animal feedlots, and storm sewer outfalls from cities, and septic tanks. Nonpoint sources include runoff from agriculture (farm-site fertilizers), pasture and range, and construction sites (under 2 ha), atmospheric deposition over a water surface, and runoff from urban lands (Carey 1991; Carpenter et al. 1998; National Academy of Sciences 1972). Point sources of pollution are continuous discharges that can be relatively easily monitored and regulated, and can be controlled by treatment at the source. Nonpoint sources are more intermittent and associated with seasonal agricultural or other land use activity, or heavy precipitation; thus, they are difficult to measure and regulate (Carpenter et al. 1998).

Juan J. Fajardo is an agricultural engineer and former research associate and James W. Bauder is a soil and water quality specialist with the Department of Land Resources and Environmental Sciences at Montana State University. S. Dennis Cash is an extension agronomy specialist in the Department of Animal and Range Sciences at Montana State University.

Feedlot and livestock waste disposal areas contribute to nitrogen contamination of surface and groundwater. From a compilation of several studies of feedlot runoff in the Great Plains region, it was estimated that the average total nitrogen concentration in runoff water from feedlots ranged from a low of 50 mg L^{-1} to a high of 2,100 mg L^{-1} (Khaleel et al. 1980). Another study showed that soil NO_3-N content from feedlots abandoned for several years averaged 7,200 kg ha^{-1} in a 9.1 m soil profile while adjacent cropland had just 570 kg ha^{-1}. Nitrate-nitrogen concentration in groundwater samples from three of four study sites ranged from 0.6–77.2 mg L^{-1} (Mielke and Ellis 1976).

Runoff from feedlot operations and dairy barnyards also contaminates the receiving waters with pathogens (Miner et al. 1966; Young et al. 1980). Application and incorporation of manure in cropland and feces deposition on pastures through animal grazing contribute to pollution of surface waters when pathogens contained in the manure are carried by runoff (Faust 1982; Patni et al. 1985). These same studies reported that significant counts of fecal coliforms could be detected in runoff from areas not receiving manure applications or not being grazed. This contamination is attributed to fecal deposition by wild animals.

Vegetative filter strips (VFS) are effective in controlling point and nonpoint sources of pollution. A VFS is an area of permanent vegetation established to intercept sediment, nutrients, pesticides, and other contaminants from runoff before the runoff can enter a water body (USDA NRCS 1998a). Vegetative filter strips enhance the opportunity for runoff and pollutants to infiltrate into the soil profile; allow deposition of total suspended solids; enhance filtration of suspended sediment by vegetation; provide adsorption on soil and plant surfaces; and enhance adsorption of soluble pollutants by plants. Once pollutants are in the soil profile, they can be trapped by a series of physical, chemical, and biological processes (Dillaha et al. 1988). Filtration is probably most significant for larger soil particles, aggregates, and manure particles, while absorption is a significant factor with respect to soluble pollutant removal.

Vegetative filter strips have been used effectively to reduce pollutants from dairy liquid waste discharges (Paterson et al. 1980; Schwer and Clausen 1989; Yang et al. 1980). For example, in the Schwer and Clausen (1989) study, a 26 by 10 m VFS reduced the concentration of total suspended solids by 92%, total phosphorus by 86%, and total Kjeldahl nitrogen by 83% in surface runoff. The hydraulic loading rate of the liquid waste was the main factor that affected the effectiveness of VFS at retaining nutrients. Poor performance of VFS was achieved when the hydraulic loading rate surpassed the infiltration capacity of the VFS (Schellinger and Clausen 1992). Maximum efficiency of VFS occurred during the growing period. In addition, soils saturated during heavy summer rain and wet or frozen soils reduced the infiltration of VFS and increased the pollution potential from surface runoff. Uptake of phosphorus and nitrogen by the vegetation was not a primary removal mechanism, as suggested by Schwer and Clausen (1989).

Vegetative filter strips may be effective in reducing the concentration of nitrogen, phosphorus, and sediment in the incoming runoff from livestock confinement areas. Strips 4.6 and 9.1 m long were tested for reducing nutrients and sediment from simulated open feedlot areas to which fresh manure was applied at rates of 7,500 and 15,000 kg ha^{-1} (moist weight), equivalent to accumulations in a feedlot 7 and 14 days, respectively (Dillaha et al. 1989). Runoff was achieved by using rain simulators applying 50 mm of water per hour. The VFS removed 81% and 91% of the incoming sediment, respectively. The 4.6 and 9.1 m long filters reduced total nitrogen by an average of 67% to 74%, respectively, but soluble nitrogen concentrations were not effectively reduced. Nitrate-nitrogen reduction in the best situation was 17%. Similar results were obtained in west central Minnesota where 40 m VFS strips of corn, orchardgrass, sorghum, or oats were planted across slope (4 percent). Runoff and total solids were reduced by 67% and 79%, respectively; total N was reduced 84% and soluble P was reduced 83% (Young et al. 1980).

Bacterial contamination due to fecal coliforms is another pollutant associated with runoff from livestock confinement areas. Studies show that reductions of coliform bacteria up to 70% in runoff from a feedlot can be attained with a 36 m VFS (Young et al. 1980). However, Dickey et al. (1981) did not find significant reductions in coliform counts when runoff from four different types of feedlot passed through a VFS.

The present study assessed the role of the cool season grass, tall fescue (*Festuca arundinacea* Schreb), as a VFS in reducing contaminants (NO_3-N and bacteria contamination) in surface runoff generated by storage of animal waste from livestock confinement areas under the relatively short growing season and short duration and high rainfall intensity characteristic of southwestern Montana.

Methods and Materials

The experimental plots were located at the Montana State University Arthur Post Research Farm, about 8 km west of Bozeman, Gallatin County, Montana. The experiment was established on an Amsterdam soil series (fine-silty, mixed, superactive Typic Haploboroll) (USDA NRCS Soil Survey Division 1998b).

The experiment was based on research initiated by Oksendahl (1997) in 1994 in which four grass strips consisting of different grass species and two bare soil strips (fallow strips) were established in order to evaluate design criteria for VFS in lower rainfall areas in northern latitudes. The treatments were established in an area of approximately 2,200 m^2, subdivided in strips, each strip 3 m wide and 30 m long. The strips had a slope of 4.3% to 5.1% and a cross slope ranging from 1.8–2.2%.

The present study was conducted between 1997 and 1998 using plots established by Oksendahl (1977). Tall fescue strips with and without manure application in the upland position (TFM and TFC) and fallow (bare) strips with and without manure application in upland position (FM and FC) were used to evaluate effectiveness of tall fescue as a VFS for reducing soluble nitrate-nitrogen (NO_3-N) and bacterial contamination in runoff water from manure stockpiles. Tall fescue was used because of its adaptability and suitability to much of the Northern Great Plains, its popularity as a commonly used field border species, and the fact that tall fescue satisified the vegetation selection requirements for overland flow systems (USEPA 1984). The experimental design consisted of four treatments (TFC, TFM, FC, and FM) with four replications in a completely randomized block.

Following an initial manure application in 1995, subsequent annual applications were made in April of 1996, 1997, and 1998 in order to simulate a livestock waste disposal area or feedlot. Each year manure from the previous year was removed and replaced with fresh manure (18% dry matter) obtained from a cooperator dairy confinement facility adjacent to the study site. The annual manure application equaled approximately 2 metric tons fresh weight per treated strip.

Sampling and Analysis

Runoff water sampling and analysis. Two runoff events were created each year of the study following grass harvest. The first runoff event for 1997 was imposed between July 8 and 9 and the second on August 22. For 1998, the first runoff event was imposed between July 7 and 10 and the second between August 27 and September 10. Runoff was achieved by applying water uniformly to the manure stockpile or the bare border at the head of the treatments (with and without manure stockpile) and then forcing the applied water to pass through the VFS. Irrigation water was applied to FC and FM treatments at a rate and volume only sufficient to produce runoff. The water applied was 1,770 L in a period of 70 min for each strip (90 m^2). The volume of water applied was equivalent to 20mm of precipitation over the entire strip. This precipitation is equivalent to a 2 yr 24 hr storm for the Bozeman area (Miller et al. 1973). The volume of water applied to TFM and TFC treatment was increased to assure one hour of runoff. The application equaled a total volume of 29,880 L for a period of 180 min, which was equivalent to 330 mm of precipitation applied to each strip. The occurrence of this amount of precipitation is extremely improbable, in as much as a 100 yr 24 hr precipitation event for the Bozeman area is only 71 mm (Miller et al. 1973). Furthermore, the hypothetically probable maximum precipitation for the Bozeman area that may occur in a thousand years is about 300 mm in a 6 hr precipitation event (USDA SCS 1965). Admittedly, the water application rates represented "worst case" scenarios, intended to provide sufficient information for VFS design and planning criteria.

A sequence of runoff samples was collected from each strip during each runoff event. The first sample corresponded with the time when runoff water began to leave the filter strip (0 min); subsequent samples were collected at twenty minutes intervals: 20 min, 40 min, and 60 min. Two replicate subsamples, each approximately 200 ml were collected for each time for each treatment at each sampling. One sub-sample was analyzed for NO_3-N. The other subsample was analyzed for presence of total coliform (C_T) in 1997 and for presence of fecal coliform (C_F) in 1998.

Laboratory determination of NO_3-N in runoff was made utilizing the automated cadmium reduction colorimetric-based method, (Clesceri et al. 1989), which cannot detect concentrations of NO_3-N below 0.1 mg L^{-1}. Therefore, concentrations of NO_3-N that were less than 0.1 mg L^{-1} were assigned a value of zero (0 mg L^{-1}) in order to complete the appropriate statistical analyses

Soil sampling and analysis. Soil samples were collected in April of 1997 and 1998 from all treatments following removal of the manure stockpiles. Soil samples were collected at seven positions along the length of the VFS. The sampling locations corresponded with a position centered directly under the manure pile (or its equivalent in the control treatments), the edge of the manure stockpile, and 1, 2, 4, 8, and 26 m downslope from the edge of the manure stockpile, respectively. Soil samples were obtained in incremental depths of 0–10, 10–20, 20–40, 40–80, 80–160, and 160–200 cm, respectively, using a truck mounted hydraulic sampling probe. Each sample was placed in a prelabeled soil sample bag and transported to the laboratory for further analyses. Soil samples were air dried at 70°C for three days, ground and 2 mm sieved. Soil NO_3-N was determined by a colorimetric method (Yang et al. 1998).

Soil NO_3-N concentration for each depth increment was multiplied by its corresponding depth to obtain an estimated depth weighted nitrate load (i.e., an expression of mg NO_3-N in the soil profile). This calculation was made to facilitate analyses and interpretation of an extensive NO_3-N dataset. Bulk density was assumed uniform across the landscape and estimated as 1.3 Mg m^{-3}. A single value of NO_3-N load in the profile for each position was then obtained by summing the NO_3-N loads of the six incremental depths at each sampling position. A factorial analysis with three factors (VFS, treatment, and position) was used to complete an analysis of variance of these data. The VFS treatment had two levels, fallow (strip without grass cover) and grass (tall fescue); the treatment factor had two levels, with manure application and without (control); and position factor had seven levels corresponding to the points where sampling was completed.

Table 1. Mean NO_3–N concentration in runoff water of VFS and fallow strip treatments.

	Mean NO_3–N concentration (mg L^{-1})*†							
	July, 1997				August, 1997			
	Treatments†				Treatments†			
Time (min)	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure
0	5.60a	4.03a	0.40a	0.45a	2.25a	4.30a	0.03a	0.18a
20	2.75b	1.98b	0.25a	0.03a	1.13b	1.85b	0.00a	0.00a
40	1.53b	1.03b	0.00a	0.00a	0.73b	1.28b	0.03a	0.05a
60	1.23b	0.85b	0.00a	0.00a	0.63b	0.85b	0.00a	0.00a
	Mean NO_3–N concentration (mg L^{-1})*							
	July, 1998				August, 1998			
	Treatments*				Treatments*			
Time (min)	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure
0	1.05a	13.88a	0.00a	0.10a	0.43a	17.75a	0.00a	0.00a
20	0.23a	4.23b	0.00a	0.03a	0.23a	3.78b	0.00a	0.03a
40	0.18a	2.28c	0.00a	0.03a	0.20a	2.08b	0.00a	0.03a
60	0.18a	1.70c	0.00a	0.05a	0.18a	1.48b	0.00a	0.03a

* Concentrations of NO_3–N below 0.1 mg L^{-1} in replications were assumed equal zero.
† Means with the same letter in the same column in each year and in each month are not significantly different at $P = 0.05$.

Statistical analyses were performed using the Statistical Analysis System (SAS) version 7.0 (SAS Institute 1998). Runoff NO_3-N concentration and bacterial counts were analyzed using a split plot design considering time as a subplot. A three factorial arrangement was used for soil NO_3-N concentrations. Analysis of variance (ANOVA) tables were developed to present the significance of treatment effects and interactions.

Results and Discussion

Runoff Water Analysis: Nitrate nitrogen concentration of VFS runoff water. To create runoff within fallow treatments (FC and FM), water was applied to the upslope source area at a rate of 25 L min^{-1}. At this rate of application, runoff reached the end of the strip in 10 min. In contrast, the rate of water applied to the source area of the VFS treatments (TFC and TFM) was 166 L min^{-1}. Runoff reached the end of the strip in 120 min. Under these conditions, the total water applied to obtain 60 min runoff was equivalent to 1.77 m^3 and 30 m^3 for each fallow and VFS treatment, respectively. Because of this disparity in the water application rate, the results were analyzed independently for the runoff from the VFS treatments and fallow treatments. Comparisons were then made between the two cover conditions to estimate the impact that VFS had in mitigating NO_3-N pollution from fallowed land and manure stockpiles. The NO_3-N concentration differed significantly among the VFS treatments (TFC, TFM, FC, FM) and among the sampling times after the initiation of runoff (0, 20, 40, 60 min) (Table 1). The interaction of main treatment effects resulted in highly significant differences ($P = 0.05$) in the NO_3-N concentrations in runoff water. These differences persisted through all runoff measurements made in July and August 1997 and 1998.

The NO_3-N concentrations of runoff water from VFS and fallow treatments at four samplings periods (0, 20, 40, and 60 min) are shown in Table 1. Clearly, NO_3-N concentrations in runoff was affected by both duration and magnitude of the runoff event. The first runoff samples (0 min) in the FM treatment, for each runoff event, had the highest NO_3-N concentrations. Correspondingly, concentration of initial runoff was significantly different from the concentration of subsequent samplings. This pattern was also measured in runoff events for FC treatment in July and August 1997. Nitrate-nitrogen concentration of runoff from VFS (TFC and TFM treatments) over time did not follow the pattern observed in the fallow treatments. Nitrate-nitrogen concentration in runoff water from TFC and TFM treatments did not differ significantly among the different sampling times for any runoff event.

Vegetative filter strip runoff. The effect of VFS and fallow treatments on mean NO_3-N concentrations of runoff water is shown in Figure 1 for 1997 and

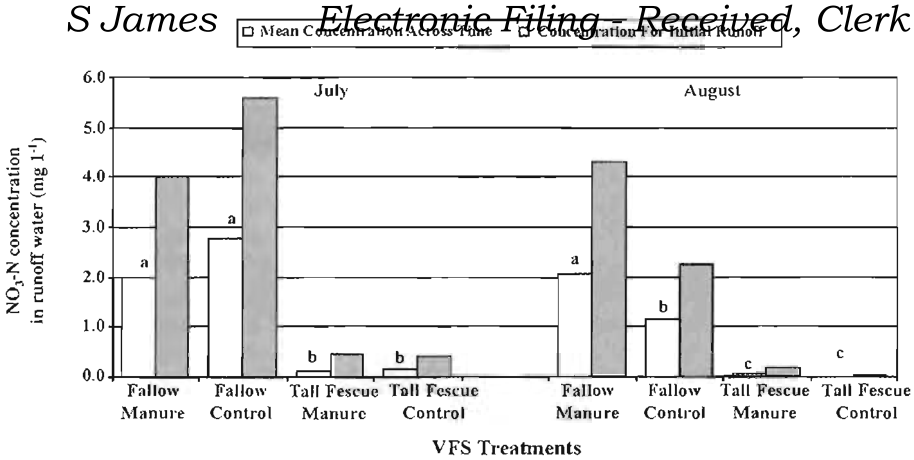

Figure 1. Mean NO_3-N concentration in runoff water versus concentration obtained at initial runoff (time = 0 min), 1997. Means were obtained by averaging nitrate nitrogen concentrations of samples collected at 0, 20, 40, and 60 min after initiation of runoff. Means followed by the same letter in each month are not significantly different at $P = 0.05$.

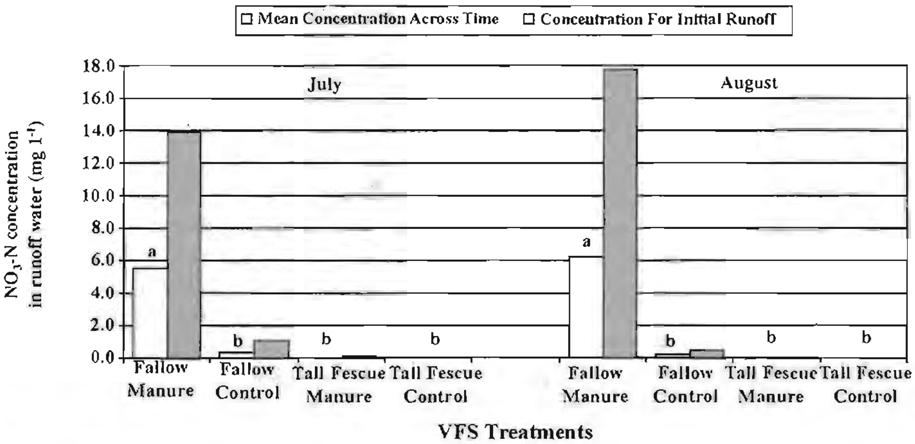

Figure 2. Mean NO_3-N concentration in runoff water versus concentration obtained at initial runoff (time = 0 min), 1998. Means were obtained by averaging nitrate nitrogen concentrations of samples collected at 0, 20, 40, and 60 min after initiation of runoff. Means followed by the same letter in each month are not significantly different at $P = 0.05$.

Figure 2 for 1998. Values for NO_3-N concentrations are averages of the concentrations of samples collected at 0, 20, 40, and 60 minutes after initiation of runoff. The July 1997 mean NO_3-N concentration of 0.12 mg L^{-1} for the TFM and 0.16 mg L^{-1} for the TFC and < 0.1 mg L^{-1} for both treatments in August were not significantly different. Neither treatment (TFM or TFC) in 1998 had significant differences in NO_3-N concentration in the runoff water. All measured NO_3-N concentrations were below the detection threshold (under 0.1 mg L^{-1}).

Several mechanisms have been proposed as being responsible for trapping sediment and nutrients in runoff through vegetated filter strips (Dillaha et al. 1988). Enhanced infiltration is a significant mechanism that improves performance of VFS in reducing nutrients in runoff (Dickey and Vanderholm 1981; Schwer and Clausen 1989; and Yang et al. 1980). Filter strips enhance infiltration and sediment deposition by reducing the velocity of runoff (Yang et al. 1980). Thus, pollutants dissolved in runoff water enter the soil as infiltration takes place. Infiltration may be the mechanism that reduced NO_3-N concentration in TFM runoff. Thus, nitrates from the manure stockpile that were carried by the runoff were mainly trapped in the soil profile as infiltration of the runoff occurred. The 30 m long VFS was able to reduce velocity of runoff for at least a 120 min period before runoff exited the VFS, prolonging the time for infiltration. In addition, concentration of NO_3-N in irrigation water used to create runoff was less than the threshold of detection. Therefore, irrigation water diluted the concentration of NO_3-N in runoff water to very low levels.

Fallow runoff. The NO_3-N concentrations in runoff from FM and FC treatments for 1997 were 1.97, 2.78 and 2.07, 1.18 mg L^{-1} for July and August, respectively. Runoff water from the FM treatment in 1998 had the highest concentration of NO_3-N. The concentrations were 5.52 and 6.27 mg L^{-1} for July and August, respectively. These values were significantly different from FC. Concentrations of NO_3-N in runoff from FC treatment in 1998 were 0.41 and 0.26 mg L^{-1} for July and August, respectively.

Although sediment concentration in runoff water was not measured, it was apparent from cursory observation that runoff from the fallow treatments (FC and FM) carried considerable sediment. Successive runoff events most likely eroded away some of the surface layer of soil. This uppermost soil layer is probably the zone where the higher concentrations of mineralized nitrogen are found in the soil profile. Comparing the runoff events after July 1997 (August 1997, and July and August 1998), the NO_3-N concentration in the runoff water for the FC treatment decreased in each subsequent runoff event. This pattern was not observed for the FM treatment, which had a constant supply of nitrates from the manure stockpile. Therefore, it may be postulated that NO_3-N measured in the runoff water from the FM treatment may be attributable to the manure application and can be assumed as the total potential NO_3-N flushed from the manure stockpile when runoff occurred.

Total and fecal coliforms from VFS runoff water. Runoff samples collected in 1997 were analyzed for total coliforms (C_T) and runoff samples collected in 1998 were analyzed for fecal coliforms (C_F). Total coliform counts differed significantly among treatments (TFC, TFM, FC, and FM) and time of sampling (0, 20, 40, and 60 min) ($P = 0.05$) in 1997. Only in August 1998 did treatment have a significant effect ($P = 0.05$) on fecal coliform counts.

The mean coliform bacteria counts in runoff water from the VFS and fallow treatments at four sampling times after the initiation of runoff (0, 20, 40, and 60 min) are shown in Table 2. Total bacteria counts in runoff water from TFM treatment were significantly different among sampling times in 1997; the highest counts of C_T occurred at time 0 min.

Bacteria counts did not differ significantly ($P = 0.05$) from time 20 through 60 min for either July or August events. Total coliforms counts from the FM treatment in August 1997 and C_F counts in July and August of 1998 differed among sampling times. The highest counts occurred at time 0 min, followed by no significant difference from time 20 min through 60 min. Significant counts were also measured in runoff from treatments that did not received manure (i.e., FC and TFC). These counts were comparable to the values obtained from the FM and TFM treatments. Populations of C_F in the order of 6 x 10^3 colony forming units (CFU) per 100 ml^{-1} were measured in the water used to force runoff. Most likely, the source of bacterial contamination in the control treatments was the irrigation water. It is possible that cross contamination of coliforms between plots due to rainfall did occur. Moreover, C_T includes species that are commonly found in unpolluted soils and vegetation (Gleeson and Gray 1997); therefore, their indigenous presence may increase the number of coliforms that were attributed to runoff originating from the manure stockpiles. In addition, wildlife can contribute significantly to coliforms in runoff from land not receiving applications of cattle manure (Faust 1982; Patni et al. 1985).

Figures 3 and 4 present the average C_T and C_F in runoff water for four times of sampling for each treatment. Concentrations of C_T in runoff from TFM in 1997 were 7.2 x 10^3 and 2.3 x 10^6 CFU per $100ml^{-1}$, for July and August sampling, respectively. In 1998, the counts were 2.7 x 10^3 and 8.3 x 10^4 CFU per $100ml^{-1}$, respectively. The counts in runoff water from TFC treatment were not significantly different from the counts in runoff water from TFM treatment either year.

The bacterial counts in runoff water from the FM treatment were not significantly different from the bacterial counts in runoff water from FC treatment in July of 1997 or July 1998. They did differ significantly in August 1997 and August 1998. Counts of coliforms in the runoff water from FM treatment were 20 x 10^3 and 5 x 10^6 CFU per $100ml^{-1}$ of C_T in July and August 1997, respectively; and 4.3 x 10^3 and 6.3 x 10^5 CFU per $100ml^{-1}$ of C_F in July and August 1998, respectively. The bacterial counts were 16 x 10^3 and 21.5 x 10^5 CFU per $100ml^{-1}$ of C_T for the FC treatments in July and August 1997, respectively; and 2.7 x 10^3 and 23 x 10^5 CFU per $100ml^{-1}$

Table 2. Total coliform and fecal coliform counts in runoff water of VFS and fallow strip treatments.

Mean total coliforms (CFU 100 ml^{-1})*

	July, 1997				August, 1997			
Time (min)	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure
0	20,000a	20,000a	17,000a	14,550a	707,500a	10,500,000a	1,775,000a	6,562,500a
20	20,000a	20,000a	10,200a	6150b	30,000a	4,625,000b	490,000a	1,587,500b
40	16,800ab	20,000a	2755b	3435b	47,500a	2,500,000b	405,000a	655,000b
60	10,075b	20,000a	1550b	4690b	75,000a	2,125,000b	602,500a	255,000b

Mean fecal coliforms (CFU 100 ml^{-1})*

	July, 1998				August, 1998			
Time (min)	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure	Fallow Control	Fallow Manure	Tall Fescue Control	Tall Fescue Manure
0	3350a	9750a	2150a	5375a	346,000a	1,387,500a	74,500a	88,000a
20	2775a	3625ab	1950a	1025a	48,500a	517,500b	337,250a	188,250a
40	800a	2400b	3075a	1500a	261,500a	422,500b	19,750a	19,500a
60	2350a	1575b	2425a	3125a	265,500a	197,500b	37,750a	36,000a

*Means with the same letter in the same column in each year and in each month are not significantly different at $P = 0.05$.

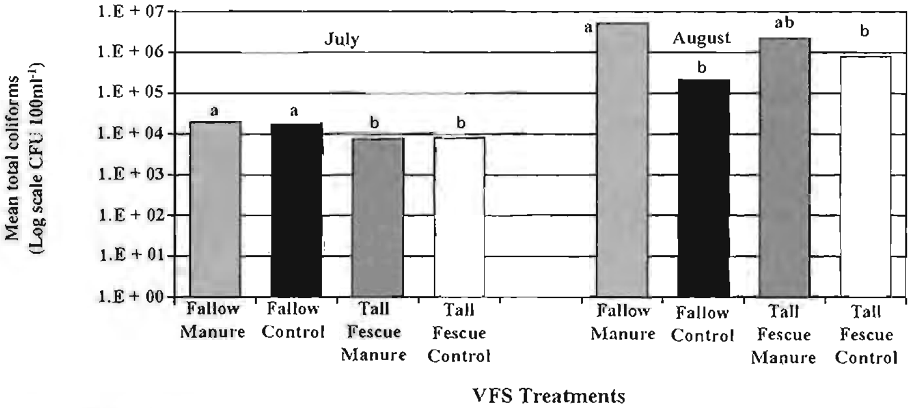

Figure 3. Mean total coliforms present in runoff water, 1997. Means were obtained by averaging bacteria counts of samples collected at 0, 20, 40, and 60 min after initiation of runoff. Means within a single sampling period followed by the same letter are not significantly different at $P = 0.05$.

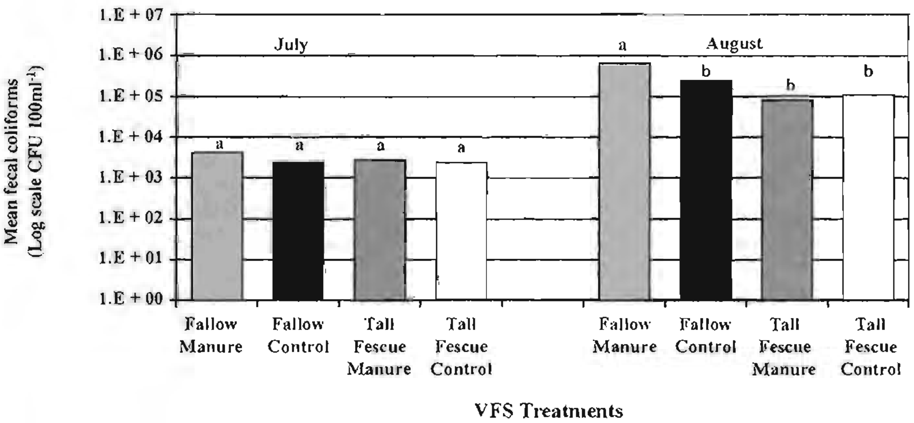

Figure 4. Mean fecal coliforms present in runoff water, 1998. Means were obtained by averaging bacteria counts of samples collected at 0, 20, 40, and 60 min after initiation of runoff. Means within a single sampling period followed by the same letter are not significantly different at $P = 0.05$.

of C_F in July and August 1998, respectively. Between the July and the August sampling each year, bacteria population counts increased by a factor of as much as a hundred fold. Presumably, the increase in bacteria counts through the summer in runoff water reflects enhancement of the growth rate of bacteria populations in manure stockpiles as summer temperatures increased.

Nitrate-nitrogen in VFS soil profile. Nitrate-nitrogen load varied significantly among VFS, treatment, and position ($P = 0.05$) for both years of sampling. Mean separations and distribution of NO_3-N load along the VFS treatments are presented in Table 3. As may be expected, the greatest soil NO_3-N loads were measured directly beneath the manure stockpiles.

There appeared to be no significant subsurface movement of NO_3-N along the downslope positions of the TFM and FM treatments beyond the direct influence of the manure stockpile (position C and 0m). Similarly, there were no significant increases in NO_3-N due to loading from the NO_3-N carried in runoff water. The greatest NO_3-N load in the soil profile for the TFM treatment was measured at position C and 0m. There were no significant differences in NO_3-N load among position 1 m and any downslope positions to 26 m in either year. The greatest NO_3-N load for FM treatment occurred at position C. There were no significant differences among position 0 m and any downslope positions to 26 m in either year. No significant differences were found between the TFC and FC treatments in 1997. However, in 1998 the differences between NO_3-N loads below TFC and FC were significant, indicating greater NO_3-N accumulation in the FC treatment soil profile than in the TFC treatment soil profile. This accumulation of NO_3-N in soil profile from the FC treatment was assumed to be due to nitrogen mineralized from soil organic matter and not subjected to leaching or plant uptake. The lack of NO_3-N accumulation in soil profile for tall fescue treatments from 1997 to 1998 was assumed to be due to the presence of the growing grass cover that continually took up the mineralized nitrogen and any nitrogen transported in runoff water.

Table 3. Mean NO_3-N load in 2 m soil depth along the fallow and VFS strip treatments. Sampling corresponds to April 1997 and 1998.

	Mean NO_3–N (mg) in 2 m soil profile, 1997 sampling*			
	Tall fescue		Fallow	
Position†	Manure	Control	Manure	Control
Center	123.78a	4.10c	102.00a	16.03c
0 m	53.93b	2.55c	15.85c	19.40c
1 m	6.33c	3.55c	19.40c	21.93c
2 m	5.15c	5.50c	16.70c	21.00c
4 m	4.08c	5.28c	12.73c	18.60c
8 m	4.43c	4.88c	13.65c	13.75c
26 m	3.98c	4.40c	9.85c	16.38c
	Mean NO_3–N (mg) in 2 m soil profile, 1998 sampling*			
	Tall fescue		Fallow	
Position	Manure	Control	Manure	Control
Center	135.59a	5.28fg	153.17a	23.14cdefg
0 m	52.50b	4.71g	41.69bc	29.08cd
1 m	8.21defg	4.32g	30.47c	32.03bc
2 m	5.62fg	3.19g	33.39bc	31.61bc
4 m	5.24fg	3.82g	28.03cd	27.33cde
8 m	5.27fg	2.88g	28.47cd	26.10cdef
26 m	6.53efg	4.23g	38.31bc	35.08bc

* Means with the same letter within and across columns in each year are not significantly different at $P = 0.05$.
† Center = under manure stockpile, 0 m = edge of manure stockpile.

Summary and Conclusion

A vegetative filter strip (VFS) is potentially a valuable tool to capture the NO_3-N losses from manure confinement areas. Based on a comparison of the data from the TFM and FM treatments, the VFS reduced NO_3-N losses in runoff by 94% and 97% for July and August, respectively, in 1997; the reduction was 99% for both the July and August events in 1998.

Concentration of NO_3-N in runoff was affected by duration of the runoff event. The greatest concentration was detected in the first runoff leaving the VFS and fallow strips. In this study, the 30 m VFS was able to reduce levels of NO_3-N in runoff below the threshold of our detection. Based on the length of time it took runoff to reach the end of the plots, the length of the VFS used in this study facilitated infiltration of the advancing runoff water. Slower water movement allowed infiltration of the nitrates dissolved in the runoff-advancing front. No detectable NO_3-N in water applied to force runoff, combined with a long flow through time of water, may have also facilitated dilution of the NO_3-N in runoff.

In the present study, bacterial contamination in runoff water was not effectively reduced by the VFS. The VFS were not as efficient for reducing bacterial contamination contained in runoff from manure stockpiles as they were for reducing nitrates. Only two of the four runoff events monitored had significant reductions in coliform counts. Assuming the coliform counts measured in runoff from the FM treatment represented the maximum coliform counts in runoff water, the VFS reduced bacterial concentration approximately 64 to 87% in the runoff of July 1997 and August 1998, respectively. In contrast, VFS treatment did not significantly affect coliform counts from FM treatment in August 1997 or July 1998. The reductions in coliform counts are comparable with values obtained by Yang et al. (1980), which were in the order of 70 percent reductions for CF and CT using a 36 m VFS. Although reductions in coliform counts were relatively acceptable, final concentrations were still greater than the standards of 200 counts per 100 ml (USEPA 1986) established for bathing waters.

Typically, presence of bacterial organisms on the soil surface is ubiquitous. The quantity of bacteria on land associated with livestock, either free ranging or confined, is a function of the type and number of livestock, as well as whether or not the livestock waste is stored prior to spreading (Walker et al. 1990). In addition, fecal coliforms can survive in the environment for several weeks or longer. Studies show that reductions of coliform bacteria up to 70% in runoff from feedlots can be attained with a 36 m

VFS (Young et al. 1980). However, Dickey et al (1981) did not find significant reductions in coliform counts when runoff from four different types of feedlot passed through a VFS.

Results from the present study suggest that high volumes of runoff water may dilute nitrates from manure to low concentrations but may actually increase the number of coliforms that escape from manure stockpiles, increasing their levels in the runoff. Since one of the purposes of the present study was to force runoff through the VFS strips and obtain sufficient information to determine design criteria for worst case scenarios, it was necessary to apply excessive amounts of water, which is not likely to be representative of a real rainstorm situations. Under natural rainfall and runoff conditions, the number of coliforms in runoff could be lower or non existent, depending on magnitude and intensity of the rainstorm event and the amount of runoff able to leave the VFS.

There appeared to be no significant redistribution of NO_3-N along the downslope positions beyond the direct influence of the manure stockpile. Very elevated loads of NO_3-N were detected under the manure stockpiles. This NO_3-N, which accumulated in the soil, may be a potential source of contamination to groundwater if the same area is used continuously to accumulate animal wastes.

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REFERENCES CITED

Carey, A.E. 1991. Agriculture, agriculture chemicals, and water quality. Pp 78–85. In: Agriculture and the environment. 1991 Yearbook of Agriculture, Washington D.C.: U.S. Government Printing Office.

Carpenter, S.R., N.F. Caraco, D.L. Correl, R.W. Howarth, A.N. Sharpley, and V.H. Smith. 1998. Nonpoint pollution of surface waters with phosphorus and nitrogen. Ecology 8:559–568.

Clesceri, L. S., A. E. Greenberg, and R. R. Trussell. 1989. Standard methods for the examination of water and wastewater. 17th ed. Washington, D.C.: American Public Health Association.

Dickey, E.C. and D.H. Vanderholm. 1981. Vegetative filter treatment of livestock feedlot runoff. Journal of Environmental Quality 10:279–284.

Dillaha, T.A., J.H. Sherrad, D. Lee, S. Mostaghimi, and V.O. Shanholtz. 1988. Evaluation of vegetative filter strips as a best management practice for feed lots. Journal of Water Pollution Control Federation 60:1231–1238.

Dillaha, T.A., R.B. Reneau, S. Mostaghimi, and D. Lee. 1989. Vegetative filter strips for agricultural nonpoint source pollution control. Transaction of the American Society of Agricultural Engineers 32 (2):513–519.

Faust, M.A. 1982. Relationship between land-use practices and fecal bacteria in soils. Journal of Environmental Quality 11:141–146.

Gleeson, C. and N. Gray. 1997. The coliform index and waterborne disease. London: E & FN SPON.

Khaleel, R., K.R. Reddy, and M.R. Overcash. 1980. Transport of potential pollutants in runoff water from land areas receiving animal wastes: a review. Water Research 14:421–436.

Mielke, L.N. and J.R. Ellis. 1976. Nitrogen in soil cores and groundwater under abandoned cattle feedlots. Journal of Environmental Quality 5:71–75.

Miller, J.F., R.H. Frederick, and R.J. Tracey. 1973. Precipitation frequency atlas of the Western United States, NOAA. Volume 1. Atlas 2. Prepared by the Office of Services, National Weather Service. Silver Spring: U.S. Department of Commerce. National Oceanic and Atmospheric Administration (NOAA).

Miner, J.R., R.I. Lipper, L.R. Fina, and J.W. Funk. 1966. Cattle feedlot runoff. Its nature and variation. Journal of Water Pollution Control Federation 38:1583–1591.

National Academy of Sciences. 1972. Accumulation of nitrate. Washington, D.C.: National Academy of Sciences.

Oksendahl. V.E. 1997. Effectiveness of grass species for nitrogen recovery from dairy waste. Master's Thesis. Montana State University-Bozeman.

Paterson, J.J., J.H. Jones, F.J. Olsen, and G.C. McCoy. 1980. Dairy liquid waste distribution in an overland flow vegetative—soil filter system. Transactions of the American Society of Agricultural Engineers 23:973–977, 984.

Patni, N.K., H.R. Toxopeus, and P.Y. Jui. 1985. Bacterial quality of runoff from manured and non manured cropland. Transactions of the American Society of Agricultural Engineers 28:1871–1877, 1884.

Statistical Analysis Software Institute, Inc. (SAS). 1998. ASA/STAT User's Guide. Version 7.0. Cary: SAS Institute.

Schellinger, G.R. and J.C. Clausen. 1992. Vegetative filter treatment of dairy barnyard runoff in cold regions. Journal of Environmental Quality 21:40–45.

Schwer, C.B. and J.C. Clausen. 1989. Vegetative filter treatment of dairy milkhouse wastewater. Journal of Environmental Quality 18:446–451.

U.S. Department of Agriculture, Soil Conservation Service. 1965. Engineering memorandum 27th Revision. Washington, D.C.: U.S. Department of Agriculture.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1998a. Montana field office technical guide. Section IV. Practice Standard 393A: Filter strip. Bozeman: Natural Resources Conservation Service.

U.S. Department of Agriculture, Natural Resources Conservation Service. 1998b. Soil Survey Division. Official soil series description. Available from: http://www.statlab.iastate.edu/soils/osd/.

U.S. Environmental Protection Agency (EPA). 1986. Quality criteria for water. Office of water Regulations and Standards, Washington, D.C.: U.S. Government Printing Office. EPA Pub. No. 440/5-86-001.

U.S. Environmental Protection Agency (EPA). 1984. Technology transfer process design manual for land treatment of municipal wastewater, supplement on rapid infiltration and overland flow. Cincinnati: Center for Environmental Research Information. EPA Pub. No. 625/1-81-013a.

Walker, S.E., S. Mostaghinmi, T.A. Dillaha, and F.E. Woeste. 1990. Modeling animal waste management practices: Impacts on bacteria levels in runoff from agricultural lands. Transactions of the American Society of Agricultural Engineers 33 (3):807–817.

Yang, S-Y., J.H. Jones, F.J. Olsen, and J.J. Paterson. 1980. Soil as a medium for dairy liquid waste disposal. Journal of Environmental Quality 9:370–372.

Yang, J.E., E.O. Skogley, B.E. Schaff, and J.J. Kim. 1998. A simple spectrophotometric determination of nitrate in water, resin, and soil extracts. Soil Science Society of America Journal 62:1108–1115.

Young, R.A., T. Huntrods, and W. Anderson. 1980. Effectiveness of vegetated buffer strips in controlling pollution from feedlot runoff. Journal of Environmental Quality 9:483–487.

Attachment 32:

Movement of Nitrogen and Phosphorus Downslope
And Beneath a Manure and Organic Waste
Composting Site
(Confesor et al. 2007)

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Movement of Nitrogen and Phosphorus Downslope And Beneath a Manure and Organic Waste Composting Site

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This observational study was conducted to assess the movement of nitrate and phosphorus into and through the soil profile beneath a compacted gravel compost pad. The accumulation of nitrate and phosphorus in the vegetated filter strip immediately downslope of the pad was also evaluated. Soil samples were taken from the composting site and the immediate surrounding area in two transects each for the Control (outside of compost pad), Old Pad (combined manure stack and compost area), and Extension pad (compost only area). Each transect was divided into three sampling zones: within the pad, in an intermediate area between the pad and the filter strip, and within the filter strip. Compost samples from windrows of different ages and mixes were also taken for laboratory leaching test to determine the potential of the composts as source of nitrogen and phosphorus. The NO_3-N concentrations in the soil beneath the compost pad of the Old Pad and Extension transects were higher than the soil NO_3-N concentrations at the same depths and locations in the control transect. These results indicate that the compacted gravel pad did not fully prevent the downward movement and accumulation of NO_3-N beneath the pad. The NO_3-N concentrations in the soil surface of the pad, intermediate between the pad and filter strip, and the filter strip areas of the Control and Old Pad transects were not statistically different; suggesting that there was negligible NO_3-N surface movement and transport from the pad area to the filter strip. The average Mehlich3-P concentration at the soil surface in the pad area was less than in the intermediate and the filter strip areas, indicating that there was surface runoff and downslope transport of phosphorus from the compost site to the filter strip. Statistical analysis showed that there was no significant difference in the Mehlich3-P concentration between the filter strip areas of the Old Pad and Control transects; suggesting that the downslope transport of phosphorus from the compost pad to the filter strip had not yet caused significant accumulation of phosphorus in the filter strip relative to the adjacent field. Leaching tests indicated that during the composting process, mature composts pose a greater potential as a source of NO_3-N leaching than the freshly-mixed composts. In contrast, the composting process and operation poses a greater potential as a source of PO_4-P during the early stages of composting than with older composts.

Introduction

In many localized farm areas in the United States, there is an accumulation of nutrients in the soil as a result of over-application of manure that exceeds crop needs (Lander *et al.* 1998; Lanyon and Thompson 1996). Excess application of nitrogen and phosphorus to the soil enhances the potential movement of nitrate to ground water and phosphate in surface runoff creating an environmental problem. Nitrate can be toxic to both humans and livestock; whereas phosphate, though not directly toxic to humans, often causes advanced eutrophication of surface waters.

There is very little research that has investigated the composting process, facilities, and sites as potential sources of pollutants. The effects of large-scale and commercial composting sites and processes on surface and ground water quality, as well as the best management practices used to mitigate these effects, have not been fully explored and are not clearly known. In Pennsylvania, the conservation practice standard for composting (PA USDA-NRCS-NHCP Code 317) requires that the runoff from a compost facility shall be collected and treated in a vegetated filter strip area or in a constructed wetland. Krogmann and Woyczechowski (2000) suggested the use of vegetative filter strips for treatment of liquid by-products from a composting facility before release to surface waters. However, little information is readily available about the performance of filter strips that are specifically used in composting sites.

Neinaber and Ferguson (1992) measured the nitrate and chloride concentration of soil below a composting pad for beef cattle manure and below an adjacent cornfield. Prior to composting, the composting pad was part of the irrigated cornfield in which manure had been spread for several years. Soil samples were not taken before the composting operation and data were collected post facto. Their results indicated that there were elevated amounts of NO_3-N (20 ppm) and chloride (35 ppm) below a portion of a beef cattle feedlot converted to a compost pad as compared to the NO_3-N (< 5 ppm) and chloride (< 10 ppm) concentrations below an adjacent cornfield (3-m and 2.4-m depths, respectively), suggesting a potential for significant leaching beneath the compost pad. However, in comparing 3-yr old and 7-yr old pads, their results were inconclusive about the length of time a compost site could be used without creating nitrate and salinity problems.

Ballestero and Douglas (1996) also monitored the leachate beneath (0.60-, 0.91-, and 1.52-m depths) an open-windrow composting site (pad was well-drained Hinckley gravelly loam) for farm wastes (manure and barn bedding) and yard wastes (grass clippings and leaves) using suction lysimeters. They measured as much as 750 mg/L of NO_3-N at 0.60 m below the compost windrow. Results from these studies indicate that nitrogen loss (i.e., NO_3-N concentration in the leachate) is a function of the type of organic carbon and the nitrogen content of the compost mixture, along with bulk density and moisture content of the waste. Garrison *et al.*, (2001) observed that high amounts of nitrogen losses at a composting site without impermeable linings were leached into the soil as indicated by high nitrogen soil accumulation beneath the pad.

The study reported herein was conducted to assess the amount of nitrogen and phosphorus that had moved beneath and downslope to an organic waste and manure composting site that had been operated for nearly 11 years. The specific objectives were to:1) assess the effectiveness of a compacted gravel compost pad in preventing the movement of nitrogen and phosphorus into and through the soil profile beneath the compost pad, and 2) evaluate the accumulation of nitrogen and phosphorus transported by surface runoff from the compost pad to a downslope filter strip. The results of this study would help identify the extent of N and P movement from a manure/composting site operated on a compacted gravel pad in the humid northeast United States. In turn, this knowledge could be helpful in the design of efficient and effective control strategies for on-farm or commercial composting operations.

Methods

Site Description

The site investigated in this study was used for composting food wastes, leaves, and manure from 1997 until summer 2001 and was operated and managed by the Organic Materials Processing and Education Center (OMPEC) at the Pennsylvania State University. The composting site was built according to USDA-NRCS standards for a waste stacking and handling pad (Houck and Graves 2001). Soil liners in composting pads should be at least 2 feet thick and compacted to achieve a permeability of no greater than 1×10^{-9} m/s (US EPA 1994). The permeability of the subsoil beneath the compost pad was not known after construction nor was measured in-situ in this present study. Prior to use for composting, the site was used for manure stacking from 1990 to the end of 1996. Nonetheless, this composting site provided an opportunity to investigate potential nitrate and phosphorus movement in a full-scale and commercial operation.

The compost pad was located in Centre County, Central Pennsylvania (approximately 40°48′50″N, 77°52′48″ W) on land owned by the Pennsylvania State University and about 1.6 kilometers northwest of the main campus. The compost pad was constructed of compacted gravel aggregate (~10-cm thick) placed on top of compacted subsoil originally mapped as Hagerstown silty loam soil). Hagerstown soils are well drained with moderate permeability (4.2×10^{-6} m/s to 2.1×10^{-5} m/s). The pad had a gentle slope (1-2%) allowing surface runoff to flow to a vegetated filter system (smooth brome grass and orchard grass) located immediately downslope (Figure 1). The vegetated filter strip (USDA-NRCS-NHCP Code 393) was designed to absorb and filter the nutrients from the surface

FIGURE 1. The vegetative filter strip and pasture areas downslope of the compost pad. (View looking upslope toward the compost pad site.)

runoff and prevent/minimize contamination of surface and groundwater (USDA-NRCS-NHCP 1999). The area adjacent to the compost pad (except the vegetated filter strip), received 168.4 kg urea fertilizer/ha in late April of each year as part of fertility program for the pasture. This adjacent area was pastured in the late summer or fall when rain or cool weather predominates. Hay was harvested from both the grass filter strip and pasture area.

Soil Sampling Design and Method

Soil samples were taken in April 2001 from the old composting site and filter strip areas along two transects each for the Control (outside of compost pad), Old Pad (manure stacking in 1990 through 1996 and compost pad from 1997 through summer 2001), and Extension pad (operated for composting from 1997 through 2001) (Figure 2). Each transect was divided into three sampling areas: within the pad, in an intermediate zone between the pad and the filter strip, and within the filter strip. In the Old Pad and Extension transects, there were six sampling points: two replicates in the pad itself, two replicates intermediate of the pad and the filter strip, and two replicates in the filter strips. During sample collection the compacted gravel (about 10-cm thick) was scraped off and was not included in the soil samples taken from the pad sampling area of the Old Pad and Extension transects. There was one sampling point in each sampling area of each of the two Control transects.

At each sampling point, hydraulically pushed soil cores were taken at four depths from the soil surface: D_1 = 0 to 10.0 cm, D_2 = 10.1 to 30.5 cm, D_3 = 30.6 to 61.0 cm, and D_4 = 61.1 to 91.4 cm. The soil core sample taken at each depth was thoroughly hand-mixed in a bucket, and samples (~100 g) were collected from the mixed soil and placed in zip-lock plastic bags during field collection. The collected soil samples were taken immediately after sampling to the Penn State Agricultural Analytical Services laboratory for physical and chemical analysis using standard soil analysis methods for nitrate (Griffin 1995), total nitrogen (Bremner 1996), and Mehlich3-phosphorus (Wolf and Beegle 1995). In October 2001, soil samples were also taken in the control and old pad transects for a separate phosphorus analysis.

The concentrations of nutrients (N and P) at the different locations, depths, and sampling times were compared, and an analysis of variance (ANOVA) was performed with the depths, sampling areas, and transects as independent variables using the SAS (Version 8) software. Tukey's test for multiple comparison of means was performed to determine significant differences between means at $\alpha = 0.05$.

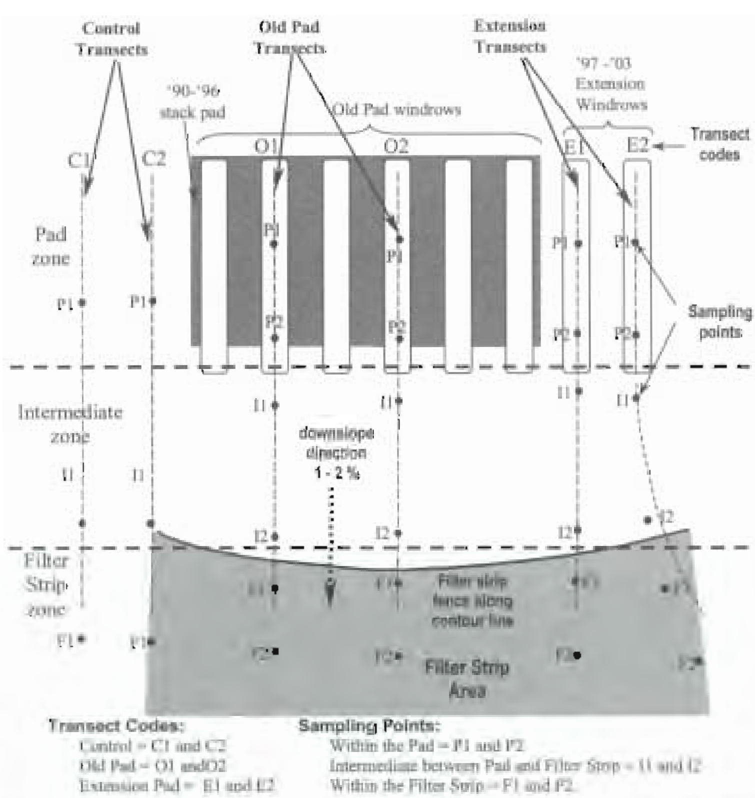


FIGURE 2. Compost site field layout and sampling design showing locations of control, original pad, extension pad transects and pad, intermediate, and filter strip sampling zones (map not drawn to scale).

Laboratory Column Leaching of Composts

To determine the potential of the composts as source of nitrogen and phosphorus, compost samples from windrows were taken in Summer 2001 for laboratory leaching test in a setup based on the modified procedure described by Sharpley and Moyer (2000) and Li *et al.* (1997). Compost samples were placed in a 15.25-cm nominal diameter and 30.50-cm long PVC pipe columns for the leaching tests. The columns were filled with compost samples to a height of 25.4 cm (10") equivalent to approximately 0.0046 m^3. The compost samples placed in the PVC pipe columns were leached using distilled and de-ionized (DDI) water. The DDI water was applied for 2.5 hours through a Mariotte bottle set at a constant flow equivalent to a 30-minute storm of 7 cm/hr (2.75 in/hr) intensity and 5-year return period in central PA (Sharpley and Moyer 2000). The windrows were made up of different ratios and mixes of compost feedstocks (food waste, manure, leaves, corn stalks, switch grass, etc.). The compost samples were not analyzed for chemical characterization immediately before the leaching test but previous analysis 2-3 weeks prior to leaching was used to characterize the samples.

Results and Discussion

Compost Leachate NO_3-N and PO_4-P Concentration

The mature compost was characterized by a low C:N ratio (~13) as compared with the high C:N ratio (~21) of the 2-week old compost (Table 1). Previous studies (i.e., Ballestero and Douglas 1996) indicated that leachate nutrient concentration is related to compost nutrient concentration. However, it was difficult to correlate the levels of nutrient in the leachate to the compost nutrient concentration since the composts were analyzed several weeks prior to leaching and no data was available for the 6-week and 14-week old composts. A forthcoming report from a related study will discuss the relationship of leachate nutrient levels to nutrient concentration of compost of different mixes and ages.

Results from the column leaching tests showed that NO_3-N and PO_4-P readily leach from compost and the concentrations in leachate vary for composts of different ages (Figure 3). The leachate NO_3-N concentration from the fresh (2-week old) compost was 2.17 mg/L and increased to 1300 mg/L from the mature compost. On the other hand, the PO_4-P concentration (135.2 mg/L) of leachate was highest from the fresh compost compared with the PO_4-P concentration of leachate from older composts (17.6 to 39.4 mg/L). These results indicate that during the composting process mature compost poses a greater potential as a source of NO_3-N leaching than does the freshly mixed compost. In contrast, the composting process and operation poses a greater potential as a source of PO_4-P during the early stages of composting than with older composts. Furthermore, leachate is

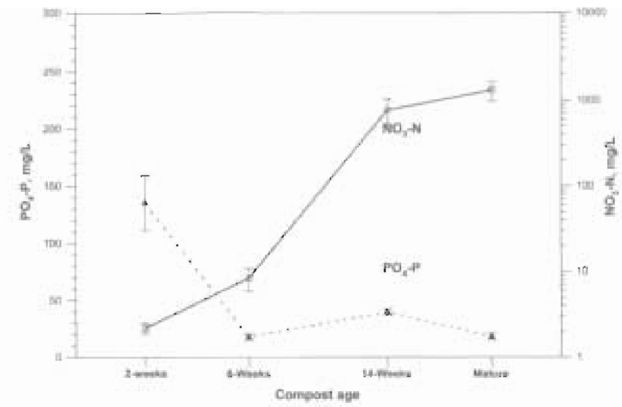


FIGURE 3. Concentrations of PO_4-P and NO_3-N in leachate from composts of different mix and ages. Vertical bars indicate standard error of the means for 3 samples.

usually produced when water percolates through the compost material and it is not uncommon that more leachate is produced during high intensity rainfall. These findings therefore should be considered in the control strategies for composting operations.

Soil Nitrate and Total Nitrogen in the Surrounding the Compost Pad

In the Control transect, the average soil NO_3-N concentration at the soil surface was significantly greater ($p = 0.02$) than soil NO_3-N concentration at all the other depths across sampling locations, whereas there were no differences ($p = 0.99$) in soil NO_3-N concentrations among the three lower depths (10.1 to 30.5 cm, 30.6 to 61.0 cm, and 61.1 to 91.4 cm) (Figure 4). These results suggest that there was little accumulation of NO_3-N in the soil profile in the area surrounding the compost pad. The relatively high concentration of available NO_3-N at the soil surface compared with the amount of NO_3-N in the lower soil depths was most likely the result of organic nitrogen mineralization at the soil surface. The percent total nitrogen (Tot N) at the soil surface of the areas surrounding the compost pad was significantly higher ($p < 0.01$) than the Tot N in the lower depths (Figure 5). The total soil nitrogen is composed mostly of organic nitrogen since

TABLE 1.
Characterization of composts used in the leaching test.[1,2]

Compost Age	Moisture Content (%)	Total N (g/kg)	NH_4 (g/kg)	Organic N (g/kg)	P (P_2O_5) (g/kg)	K (K_2O) (g/kg)	pH	Total N (%)	Total Org C (%)	C:N Ratio	Soluble Salts (mmhos/cm)
2-weeks	52.1	3.3	2.38	10.9	14.1	24.9	8.2	1.34	27.4	20.6	4.0
Mature	52.6	17.3	0.03	17.3	7.6	11.1	8.7	1.73	23.2	13.4	2.5

[1]The mature compost was analyzed 3 weeks prior to the leaching test and the 2-week old compost was analyzed 2 weeks prior to the leaching test. [2]No data was available for the 6-week and 14-week old composts.

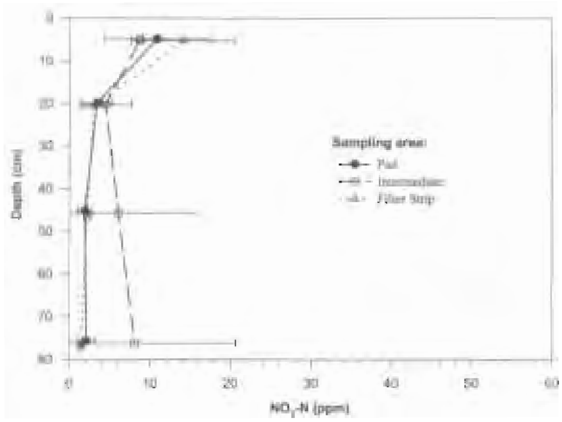


FIGURE 4. Soil NO_3-N nitrogen concentrations at different depths and sampling zones along the control transect. Horizontal lines indicate range for 2 samples (1 sampling location x 2 transects).

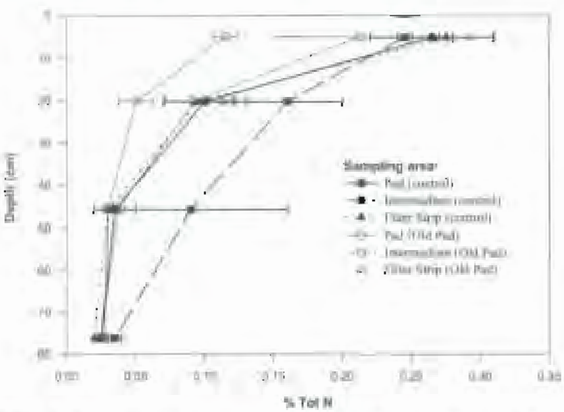


FIGURE 5. Percent total nitrogen (% Tot N) of soils at different depths and sampling zones along the Old Pad and Control transects. Horizontal lines indicate standard error of the mean (4 samples for the Old Pad and 2 samples for Control).

the NO_3 and ammonium (NH_4) concentrations of the soil samples were less than 100 ppm (0.01 %). Manure and fertilizer application on the pasture area during the spring season of each year could have also elevated the NO_3-N concentration at soil surface.

Soil NO_3-N concentrations were not significantly different ($p = 0.50$) between the locations in the Control transect across all depths, thereby showing the homogeneity of the soil around the pad (Figure 4). The amount of NO_3-N (7.6 to 17.4 ppm) at the soil surface (0 to 10 cm) at this study site was slightly less than the surface soil NO_3-N content (12.5 to 50 ppm) normal for pasture areas in Pennsylvania (L. E. Lanyon, personal communication, University Park, Pennsylvania, 13 January 2003).

There was no significant difference ($p = 0.20$) in the soil NO_3-N concentrations in the soil surface layer between the pad, intermediate, and filter strip areas of the Old Pad, Extension, and Control transects. No difference in NO_3-N concentrations suggests that there was little or no NO_3-N surface movement from the pad to the filter strip area in the Old Pad and Extension transects. Rather, it appears that most leachate nitrate from the compost likely infiltrated through the gravel pad and entered the soil beneath the pad.

Soil Nitrate and Total Nitrogen Beneath the Compost Pad

Soil NO_3-N concentrations under the Old Pad were greater than the soil NO_3-N concentrations at the same depths under the Control (Figure 6). The average soil NO_3-N concentration at D_3 (38 ppm in the 30.6 to 61.0 cm layer) and D_4 (44 ppm in the 61.1 to 91.4 cm layer) of the Old Pad transect were significantly greater (D_3: $p = 0.019$ and D_4: $p = 0.004$) than the average soil NO_3-N contents (about 2 ppm) in the same depth layers of the Control transect. These results were obtained despite the lower total nitrogen percentage (and consequently organic N) of the soils at lower depths (Figure 5); and the effect of organic nitrogen mineralization can be neglected.

This result was similar with the findings of Neinaber and Ferguson (1992) where they measured elevated amounts of soil NO_3-N (20 ppm) three meters below a compost pad for beef cattle manure as compared to less than 5 ppm NO_3-N for a control area. These results indicate that there was downward movement and accumulation of NO_3-N beneath the manure/composting pad area. Previous studies by Richard and Chadsey (1990), Neinaber and Ferguson (1992), and Douglas and Ballestero (1995) also indicated the downward movement of NO_3-N below open windrow composting sites without gravel pads.

The soil NO_3-N concentrations within the soil profile in the Extension transect (7.0 to 14.5 ppm) were greater than the soil NO_3-N concentration for the same depths in the Control transects (2.0 to 10.9 ppm) (Figure 6), but the difference was not statistically signifi-

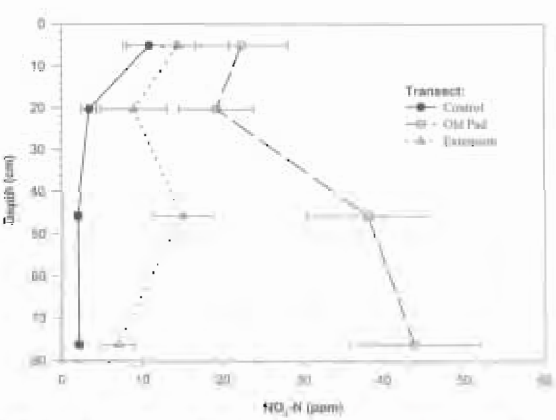


FIGURE 6. Soil nitrate nitrogen (NO_3-N) concentrations at various depths beneath the composting/manure pad in the Old Pad, Extension, and Control transects. Horizontal lines indicate standard error of the mean for 4 samples (2 sampling locations x 2 transects).

cant ($p = 0.95$). Furthermore, in the Extension transect, the average soil NO_3-N concentration (15.0 ppm) at D_3 (30.6 to 61.0 cm layer) was slightly but not significantly greater ($p = 0.88$) than the average soil NO_3-N concentrations at the other depths (14.5 ppm, 9.0 ppm, and 7.0 ppm for D_1, D_2, and D_4, respectively). In the Extension pad area the soil nitrates showed concentrations (15 ppm) at the D_3 depth that were comparable to concentrations in the surface layer (14.5 ppm). D_2 and D_4 also showed concentrations (9.0 ppm and 7.0 ppm, respectively) that were greater than the concentrations (3.5 ppm and 2.2 ppm) in the Control transect at the respective depths. These observations indicate that there was downward movement of NO_3-N beneath the Extension pad but this downward movement had not yet caused significant accumulation of soil NO_3-N beneath the extension transect relative to the control transect.

The difference in soil NO_3-N concentrations below the extension and the Old Pad transects was likely due to the length of time that each portion of the pad was used and the type of operation employed on the pad. It should be noted that the extension pad had been used for composting for about 4 years prior to soil sampling and the Old Pad had been used for manure stacking (7 years) and composting (4 years) prior to soil sampling. Based on these observations, it is apparent that if the composting operation continued in a manner similar to that used during the 1997 through 2001 period significant accumulation of NO_3-N beneath the Extension pad would occur after a few years. Results obtained by Neinaber and Ferguson (1992) showed that there was accumulation of NO_3-N from the soil surface down to the 3.0 m depth with increasing composting operation time (3- and 7 years).

Soil Test Phosphorus (STP) Along the Old Pad Transect

For the Old Pad transects the STP (Mehlich3-P) mean concentration (97.7 ppm) at the soil surface (0 to 10 cm) was significantly greater ($p < 0.001$) than the mean STP concentrations for all the other depths (greatest mean concentration of 26.3 ppm) across sampling areas (Figure 7). Furthermore, there was no significant difference ($p = 0.57$ to 0.99) in the mean STP concentrations between the three deeper samples (10.1 to 30.5 cm, 30.6 to 61.0 cm, and 61.1 to 91.4 cm). This indicates that, unlike NO_3-N, there was little movement or accumulation of phosphorus into and within the soil profile. According to Hansen *et al.* (2002), the most common pathway of phosphorus transport is through soil erosion and surface runoff. Phosphorus is readily adsorbed to soil and is not nearly as mobile in solution as is NO_3-N. The concentration of STP (~ 40 ppm) at the soil surface (0 to 10 cm) in the pad area was less than in the intermediate (~120 ppm, $p = 0.029$) and the filter strip (~ 140 ppm, $p = 0.002$) areas.

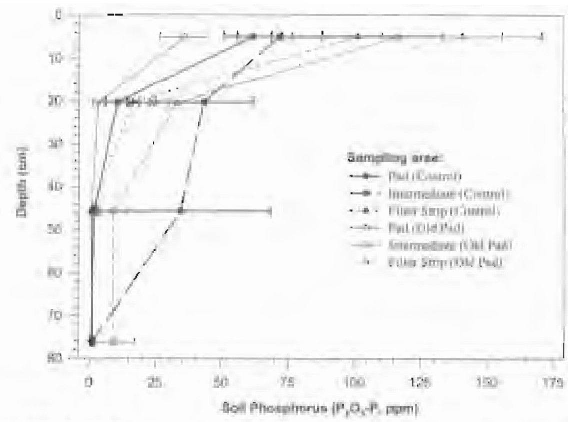


FIGURE 7. Soil test phosphorus concentrations using the Mehlich3 method at different depths and sampling zones along the Old Pad and Control transects, April 2001. Horizontal lines indicate standard error of the mean (4 samples for the Old Pad and 2 samples for Control).

These results suggest that there was accumulation of phosphorus due to surface transport and movement of phosphorus from the compost pad downslope to the intermediate area and to the filter strip. However, statistical analysis showed that there's no significant difference in the STP between the filter strip areas of the Old Pad and Control transects. The same results were found between the intermediate areas of the Old pad and Control transects. These findings further suggest that there was downslope transport of phosphorus from the compost pad to the filter strip but this downslope movement had not yet caused statistically significant accumulation of phosphorus in the filter strip relative to the control transect.

The STP concentrations of the surface soil samples taken in October 2001 from the area immediately upslope from the compost pad ranged from 11 to 28 ppm. The phosphorus concentrations (< 30 ppm) at this location represent the background (without manure and fertilizer application) phosphorus levels and were comparable with the STP (~ 35 ppm) at the surface of the compost pad (Figure 8). These comparable STP concentrations indicate that there was little or no accumulation of phosphorus in the soil profile beneath the compost pad area.

Soil samples obtained from the intermediate area in October 2001 (mean = 219 ppm) were higher in STP concentrations than samples from the same area obtained in April 2001 (mean = 116 ppm). This difference was not significantly different ($p = 0.54$) because of the large variances in October samples. Thus, we could not determine whether the difference was due to con-

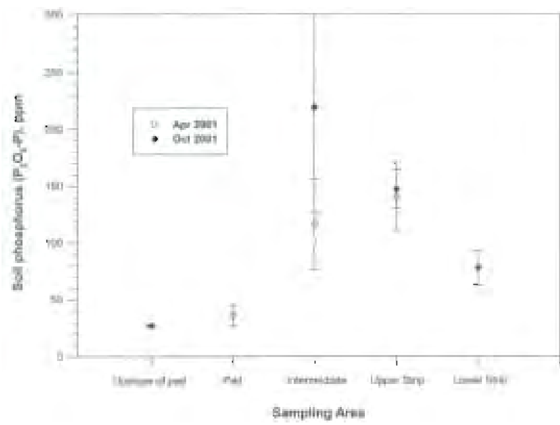


FIGURE 8. Soil test phosphorus concentrations using the Mehlich3 method at the soil surface of the Old Pad transect for samples collected in April and October 2001. Vertical lines indicate standard error of the mean for 4 samples.

tinued surface transport of phosphorus from the pad to the intermediate area, or due to sampling and spatial variability. It should be noted that the "intermediate" area does not receive fertilizer; while the pasture area adjacent to the compost pad site does.

Summary and Conclusions

This study was conducted to evaluate the potential movement of nitrogen and phosphorus from an un-covered manure stacking and composting site in operation from 1990 to 2001. The movement and accumulation of NO_3-N beneath the old composting pad (compost operation from 1997 to 2001) could not be fully attributed to the composting process because the manure stacking operations (1990-1996) on the pad preceding the composting operation undoubtedly contributed to the movement and accumulation of NO_3-N.

The data indicate that a conventionally-designed and compacted gravel pad (as commonly used for a manure stacking and/or composting operation) does not prevent downward leaching of NO_3-N. Leaching of NO_3-N under the extension pad was evident (elevated soil NO_3-N as compared to the control transect but not statistically significant at $\alpha = 0.05$) and suggests that continued composting operations will, at some point in time, result in significant accumulation of NO_3-N nitrogen beneath a compacted gravel pad.

The NO_3-N concentrations at the soil surface for the sampling locations of the Old Pad and extension transects were similar. There was no significant difference ($p > 0.95$) in the NO_3-N concentrations among the four depths at each of the intermediate and filter strip areas (downslope of the pad) of the Old Pad transects. Similar results were also found in the Extension transects. Results indicate that there was little or no accumulation in the filter strip areas of the Old Pad and Extension transects, suggesting little surface movement and transport of NO_3-N from the pad downslope to the filter strip.

The Melich3-P concentrations of the soil upslope of the pad area were comparable with the soil Melich3-P concentrations in the pad area for the various soil depths. This result showed that there was little or no phosphorus accumulation in the soil profile beneath the compost pad. The amount of available phosphorus along the soil surface of the Old Pad transect was greater in the filter strip and intermediate area than in the pad zone indicating that surface runoff and downslope transport of phosphorus from the compost site occurred. However, this downslope transport of phosphorus from the compost pad to the filter strip had not yet caused statistically significant accumulation of phosphorus in the filter strip relative to the Control transect.

Leaching tests indicated that during the composting process, mature composts pose a greater potential as a source of NO_3-N leaching than the fresh composts. In contrast, the composting process and operation poses a greater potential as a source of PO_4-P during the early stages of composting than with older composts. It was difficult to correlate the levels of nutrient in the leachate to the compost nutrient concentration. A forthcoming report from a related study will discuss the relationship of leachate nutrient levels to nutrient concentration of compost of different mixes and ages. Another limitation of this study was that the permeability of the compacted subsoil was not measured. While the pad was constructed according to standards, the results would have been more useful if the permeability of the subsoil for the different sampling points were known.

References

Ballestero, T. P. and E. M. Douglas. 1996. Comparison between nitrogen fluxes from composting farm wastes and composting yard waste. *Transactions of the ASAE* 39(5): 1709-1715.

Bremner, J.M. 1996. Nitrogen-Total. p. 1085-1121. In *Methods of Soil Analysis, Part 3. Chemical Methods. Soil Science Society of America Book Series #5*, ed. D.L. Sparks. Madison, WI: American Society of Agronomy.

Douglas, E.M. and T.P. Ballestero. 1995. Nitrogen transport and fate at farm and yard waste composting facility. NABEC Paper No. 9507. Presented at the annual Northeast Department of Agricultural and Biosystems Engineering/Bio-Engineering Conference (NABEC), July 30- August 2 1995. Bar-Harbour, Maine: American Society of Agricultural Engineers.

Garrison, M.V., T.L. Richard, S.M. Tiquia, and M.S. Honeyman. 2001. Nutrient losses from unlined bedded swine hoop structures and an associated windrow composting site. ASAE Paper No. 012238. ASAE, St. Joseph, Michigan.

Griffin, G. 1995. Recommended soil nitrate-N tests. In *Recommended Soil Testing Procedures for the Northeastern United States, Northeast Regional Bulletin #49*, eds. J. Thomas Sims and A. Wolf, 17-24. Newark, Delaware: Agricultural Experiment Station, University of Delaware.

Hansen, N.C., T.C. Daniel, A.N. Sharpley, and J.L. Lemunyon. The fate and transport of phosphorus in agricultural systems. *Journal of Soil and Water Conservation* 57(6): 408-416.

Houck, N.J. and R.E. Graves. 2001. Composting Operations. Project Report No 01-01. University Park, PA: Pennsylvania State University - Organic Materials Processing and Education Center. Available at http://www.age.psu.edu/extension/ompec/CompostingOps0101.pdf. Accessed on October 27, 2006.

Krogmann, U. and H. Woyczechowski. 2000. Selected characteristics of leachate, condensate and runoff released during composting of biogenic waste. *Waste Management and Research* 18(3): 235-248.

Lander, C.H., D. Moffitt, and K. Alt. 1998. Nutrients available from livestock manure relative to crop growth requirements. Resource Assessment and Strategic Planning Working Paper 98-1. Washington, DC: USDA, Natural Resources Conservation Service. Available at http://www.nrcs.usda.gov/technical/land/pubs/nlweb.html. Accessed on October 27, 2006.

Lanyon, L.E. and P.B. Thompson. 1996. Changes in farm production. In *Proceedings, Animal Agriculture and the Environment Conference*, ed. M. Sailus, 15-23. Ithaca, New York: NRAES.

Neinaber, J.A. and R. B. Ferguson. 1992. Nitrate movement beneath a beef cattle manure composting site. ASAE Paper No. 92-2619. St. Joseph, Michigan: ASAE.

Richard, T. and M. Chadsey. 1990. Environmental impacts of yard waste composting. *Biocycle* 31(4): 42-46.

SAS. 2001. SAS Version 8. Documentation available at http://v8doc.sas.com/sashtml. Accessed on October 27, 2006.

USDA-NRCS-NHCP. 1999. National Handbook of Conservation Practices, Conservation Practice Standard Code 393 (Filter Strip). Washington, DC: USDA Natural Resources Conservation Service. Available at ftp://ftp-fc.sc.egov.usda.gov/NHQ/practice-standards/standards. Accessed on October 27, 2006.

U.S. EPA. 1994. Composting yard trimmings and municipal solid waste. EPA530-R-94-003. Washington, DC: U.S. Environmental Protection Agency. Available at http://www.epa.gov/epaoswer/non-hw/compost/cytmsw.pdf. Accessed on October 27, 2006.

Wolf, A.M. and D.B. Beegle. 1995. Recommended soil tests for macronutrients: phosphorus, potassium, calcium, and magnesium. In *Recommended Soil Testing Procedures for the Northeastern United States, Northeast Regional Bulletin #49*, eds. J. Thomas Sims and A. Wolf, 25-34. Newark, DE: Agricultural Experiment Station, University of Delaware.

Attachment 33:

The North Central Regional Extension Publication 522 “This Land – 50 Ways Farmers Can Protect Their Groundwater”

▶ Nitrogen

▶ Scouting

▶ Insecticides

▶ Herbicides

▶ Pesticide Selection

▶ Pesticide application

▶ Pesticide disposal and storage

▶ Site conditions, wells, and septic systems

▶ Water testing & treatment

▶ Miscellaneous

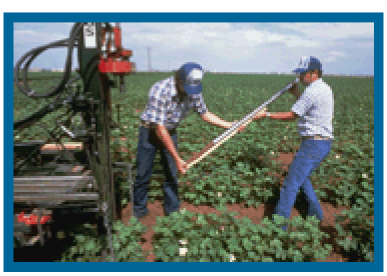
46. Store Livestock Waste Properly

It's not a pleasant statistic: A 100-cow dairy herd can produce as much waste as 2,400 people. But that's not the only unpleasant fact: In certain types of soil, this waste can seep through the ground and reach groundwater, contaminating it with nitrate and bacteria.

If you store animal waste on the feedlot, locate the lot far away and downhill from any wells, sinkholes, or surface water. Make provisions to collect runoff water from the feedlot for proper disposal and remove new waste deposits every few days.

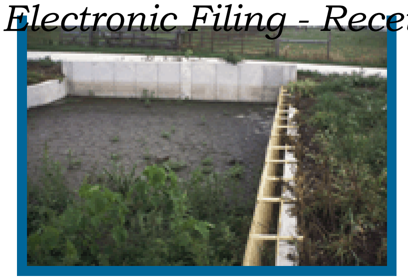
Just as with a feedlot, waste storage structures should not be located near surface water or wells. Also, take special precautions when storing waste in earthen structures to prevent wastes from seeping through the bottom of the basin to groundwater.

When the bottom of the structure is something other than clay—sandy soil, gravelly soil, or fractured rock, for instance—you must seal it. Sealing can be done with compacted clay, plastic lining, or any other material that keeps water from seeping through the ground



For lagoons, Illinois requires that soil borings be made to determine the composition of the soil and evaluate the risk of seepage. The state also requires that the lagoon design be approved by a licensed professional engineer.

If your operation is smaller than 300 animal units, another option in Illinois is to use a



vegetative filter to handle runoff water from livestock operations. However, the vegetative filter must be preceded by a settling basin.

To prevent leaching to groundwater with solid-manure storage, stack manure solids on a concrete pad. In addition, cover the storage area with a roof to prevent rain and snow from causing the manure to run off.

NEXT ▶

University of Illinois Extension

College of Agricultural, Consumer and Environmental Sciences

Attachment 34:

Virginia Cooperative Extension: Livestock Manure
Storage and Treatment Facilities

Virginia Farmstead Assessment System: Livestock Manure Storage and Treatment Facilities

442-909

*Overview of the Virginia Farm Assessment System

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Available as:
- PDF (770 KB)

Other resources in:
- Natural Resources & Environmental Quality

Other resources by:
- Eldridge R. Collins, Jr.
- Tamim Younos

Other resources from:
- Biological Systems Engineering

Introduction

Storage of livestock wastes involves accumulating manure and wastewater in an environmentally sound manner until they can be applied to land or otherwise utilized. Manure storage facilities allow farmers to spread manure when conditions are right for nutrient use by crops. Storing manure in a concentrated area, however, increases risk to the environment and to human and animal health. Fecal bacteria in livestock waste can contaminate groundwater, causing such infectious diseases as dysentery, typhoid and hepatitis.

Livestock wastes if not properly managed can become a source of nitrate and disease-causing organisms to both surface water and groundwater. Nitrate-nitrogen levels above 10 milligrams per liter (mg/l; equivalent to parts per million for water measure) can pose health problems for infants under 6 months of age, including the condition known as blue baby syndrome (methemoglobinemia). Young livestock are alsosusceptible to health problems from high nitrate-nitrogen levels. Levels of 20-40 mg/l in the water supply may prove harmful, especially in combination with high levels (1,000 ppm) of nitrate-nitrogen from feed sources.

Dry manure can be stored in solid form in stockpiles, and liquid manure can be stored in tanks or earthen basins, or stored and treated in anaerobic lagoons. Manure storage facilities, if not designed or managed properly, can be potential sources of nitrate leaching to groundwater. For example, facilities for liquid manure storage sometimes leak or burst. Seasonal filling and emptying of earthen manure storage pits can cause damage to the organic and physical seal on the bottom and sides of the pit. Short-term solid manure storage and abandoned storage areas can also be sources of groundwater contamination by nitrates.

Regulations of the Virginia Department of Environmental Quality/Water Division (DEQ) apply to storage locations and to minimum standards for seepage control from storage/treatment facilities.

The environmental safety of storing large amounts of manure in one place for an extended period depends on the following:

- location of the storage site with respect to physical and chemical characteristics of the soil.
- subsurface geologic materials.
- design and construction of the storage site or facility including control of seepage.

proper land application and utilization of the manure once it leaves the storage site or facility at a rate and time compatible with nutrient uptake by crops.

If improper animal waste storage causes water contamination, the DEQ can impose a fine and require corrective measures.

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I. Long-Term Storage

Livestock wastes can be stored long-term (for 180 days or more) either in solid, semi-solid or liquid form.

- Solid storage facilities use walls and slabs for stacking of heavily-bedded manure.
- Semi-solid storage facilities use pumps or scrapers to move manure into containment areas and may separate solids from liquids.
- Liquid storage facilities hold manure in tanks, pits or bermed areas.

Liquid and semi-solid storage systems are self-contained. Groundwater contamination can occur if the facility is not structurally sound, allowing waste materials to seep through the soil. A threat to surface water exists if pits are not emptied frequently enough to prevent wastes from flowing over the top of the structure. Liquid storage systems require the use of pipes and/or pumps for moving wastes from the barn to the storage structure. These must be carefully installed and maintained to ensure that they do not leak. Each time a pit is emptied, carefully check steel and concrete structures for cracks or the loss of watertight seals. If any breaks are apparent, repair them immediately. Likewise, check the bottom and sides of earthen waste storage pits and lagoons to be certain the liner materials have not been eroded away by agitation and pumping. Fine textured soil materials become "self-sealed" to a limited degree through clogging of soil pores. However, this seal can be destroyed through mechanical cleaning processes.

After a period of years, weathering, wave action, or wetting and drying cycles may cause the side walls of earthen pits to crack and erode, allowing wastes to seep into the underlying soil or subsurface geologic material. Groundwater contamination will result if the subsurface materials do not prevent leaching of contaminants.

While seepage from earthen waste storage facilities is not always easy to recognize, there are some tell-tale signs:

1. A properly designed structure has the capacity to handle wastes from a specific number of animals for a known number of days. For example, if a pit or pond is designed for 180 days of storage and has received designated waste amounts, but has not needed pumping for a year or more, the structure is probably leaking.

2. Evaporation from a liquid manure storage pit is minimal if a crust is formed. If additional liquids need to be added before the pit can be agitated and pumped, the pit may be leaking.

Some facilities for storage of semi-solid manure are designed to allow seepage from the waste stack. In these instances, the structure design must include collection and treatment of the wastes that seep out. These systems should not be considered on sites with coarse-textured soils, fractured bedrock, karst formations, or shallow water tables. The best way to handle seepage is to channel it into a watertight holding pond or storage tank.

If construction of a holding pond or concrete/steel tank is not feasible, another option is to build a covered semi-solid manure storage structure to protect the manure stack from precipitation. Roofed storage systems require adequate bedding to absorb and retain the liquid portion of the waste.

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II. Short-Term Storage

Short-term storage (usually 60-90 days and in some cases up to 180 days) is an important option available to farmers. It allows the farmer to hold livestock wastes during periods of bad weather when daily spreading may not be feasible, when land to be planted in crops is not available for applying manure, or when there is a shortage of crop acres to accommodate daily hauling and spreading of manure without the threat of runoff.

Short-term storage, which is restricted primarily to solid or semi-solid manure, has the disadvantage of requiring that the manure be handled often. Designs are available for short-term storage structures that facilitate handling and provide effective protection for surface water and groundwater.

Short-term storage systems may be applicable for those operations, such as small dairies, which often have to stack manure in fields, particularly during periods of bad weather or between cropping cycles. Field stacking is not a recommended practice. No matter how it is done, it may pose a contamination threat to surface water and groundwater. If manure is frequently stacked in fields, cover it with plastic sheets or consider constructing a short-term runoff detention pond at the storage site.

Likewise, many farmers and livestock feeders will scrape manure into piles in the open lots as temporary storage during bad weather or busy work periods. Mounds are constructed from dry manure materials that are shaped to accommodate cattle comfort. Regulations governing milk production require frequent manure collection and removal and do not allow milking cows to come in contact with stacked manure.

Many farmers have open housing for young livestock, such as pole sheds, where wastes are allowed to accumulate for extended periods of time. Roofs on these structures keep rain and snow off the manure. These structures are relatively effective for water quality protection if they are isolated from surface water runoff, and if adequate bedding is provided to absorb liquids in the wastes. To minimize water quality impacts, provide adequate bedding to reduce seepage, and clean these sheds as frequently as possible.

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III. Waste Storage Location

The location of livestock waste storage in relation to water wells or springs is an important factor in protecting the farm water supply. For temporary manure stacks and earthen storage facilities, the minimum separation distance for wells in Virginia is 150 feet.

Minimum separation distances regulate new well installation or the distance from existing wells to new waste storage facility construction. Existing wells are required by law only to meet separation requirements in effect at the time of well construction. However, for your own benefit make every effort to exceed "old regulations," and strive to meet current regulations whenever possible.

Observing these separation distances when siting a new facility is a good way to help protect your drinking water. Locating manure storage sites or facilities downslope from wells or springs is also important for protection of your water supply. (For more information about separation distances, and how the condition of your well or spring might affect the potential for contamination, see Fact/ Worksheet Sheet No. 2, Well and Spring Management.) Depth to seasonal high water table or fractured bedrock, along with soil type at the waste storage location, is another important factor. These characteristics are described in Fact/ Worksheet No. 1.

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IV. Lining Materials on Lagoons, Detention Ponds, or Storage Pits

The Virginia Department of Environmental Quality has responsibility for implementing water quality regulations that govern confined, concentrated livestock operations. In order to protect groundwater from seepage from manure storage facilities, lagoons and holding ponds, DEQ regulations require that all waste retention facilities be constructed of compacted or in-situ soil materials at least 12 inches thick and with a maximum permeability rating of 0.0014 inches per hour. Synthetic liner materials must be of at least 20 mils thickness. If these standards for lagoons and manure holding facilities are met, combined with the benefit of self-sealing caused by manure storage, groundwater can be adequately protected.

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V. Land Application of Manure

Use of manure in combination with row crop production and improved pastures is designed to remove accumulated nutrients through the cropping system. Animal waste is a valuable fertilizer and soil conditioner. When managed properly, the nutrients in manure can be substituted for commercial fertilizers while saving money and protecting groundwater and surface water.

Solid manure can be incorporated by tillage immediately following its application, and liquid manure slurry can be injected into the soil. Manure application should be applied near the time that planting will occur to maximize nitrogen uptake by crops and minimize the loss of nitrogen through runoff or leaching through the soil profile. Liquid manure and lagoon effluent can also be applied to land areas by irrigation over growing crops. Care must be taken, however, to prevent burning of some plants by the waste materials and to avoid excessive runoff.

Stored manure, prior to land application, should be sampled and tested to determine how much nitrogen, phosphorus and potassium it contains. When sampling manure, be sure to obtain as representative a sample as possible. This usually involves taking a number of subsamples (e.g. 10 or more) and mixing the subsamples into one or more combined samples to be analyzed. This information, along with a knowledge of the amount of manure applied per acre, enables a farmer to determine whether or not additional commercial fertilizer is needed to meet crop production goals. A farm nutrient management plan will take all of these factors into consideration.

Land application should not be carried out during extended periods of bad weather which make application impractical or illegal. Virginia Department of Environmental Quality rules discourage application of wastes when the ground is frozen or saturated.

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VI. Abandoned Pits

Abandoned waste storage pits, especially earthen ones, can pose significant water quality as well as safety problems. Any abandoned structure should be completely emptied and the contents utilized. In the case of earthen waste storage facilities, liner materials (to a depth of about two feet) should be removed and spread over croplands. The remaining hole should be filled and leveled. Manure packs from pole barns or sheds no longer in use should also be removed and the wastes applied to cropland. If manure is stacked in fields, it should be appropriately spread as soon as conditions permit.

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Glossary

Concrete stave storage - A type of liquid-tight animal manure storage structure. Located on a concrete foundation, it consists of concrete panels bound together with cable or bolts and sealed between panels.

Earthen basin or pit - Clay-lined manure or wastewater storage facility constructed according to specific engineering standards. Not simply an excavation.

Engineering standards - Design and construction standards available at Natural Resources Conservation Service (NRCS) or Virginia Cooperative Extension offices. These standards may come from NRCS technical guides, state regulations, or land grant university engineering handbooks or publications.

Filter strip - A gently sloping grass plot used to filter and settle solids from runoff from the livestock yards and some types of solid manure storage systems. Influent waste is distributed uniformly across the high end of the strip and allowed to flow down the slope. Nutrients and suspended material remaining in the runoff water are filtered through the grass, absorbed by the soil and ultimately taken up by plants. Filter strips must be designed and sized to match the characteristics of the livestock yard or storage system, and the expected quantity of runoff.

Glass-lined steel storage - A type of liquid-tight, above-ground animal manure storage structure. Located on a concrete foundation, it consists of steel panels bolted together and coated inside and outside with glass to provide corrosion protection.

Poured concrete storage - A type of liquid-tight animal manure storage structure. Located on a concrete foundation, it consists of poured concrete reinforced with steel.

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Contacts and References

For additional information consult the VirginiaFarm*A*Syst Resource Directory. Contact your local Virginia Cooperative Extension agent, Natural Resources Conservation Service office, or the Virginia Department of Conservation and Recreation for information about local ordinances, state regulations, cost-sharing funds, and nutrient management programs.

Acknowledgements.

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Worksheet 9 "Livestock Manure Storage and Treatment Facilities."

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View a list of the Virginia Farmstead Assessment System publications.

Reviewed by Bobby Grisso, Extension Specialist, Biological Systems Engineering

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Issued in furtherance of Cooperative Extension work, Virginia Polytechnic Institute and State University, Virginia State University, and the U.S. Department of Agriculture cooperating. Alan L. Grant, Dean, College of Agriculture and Life Sciences; Edwin J. Jones, Director, Virginia Cooperative Extension, Virginia Tech, Blacksburg; Jewel E. Hairston, Administrator, 1890 Extension Program, Virginia State, Petersburg.

May 1, 2009

Attachment 35:

Illinois Agronomy Handbook, Chapter 8

8

Managing Soil pH and Crop Nutrients

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The inherent complexity of crop production systems requires integrating many factors to ensure maximum crop yields with the least risk to the environment. Assessing present- and reserved-nutrient status of the soil, understanding its nutrient-release and nutrient-holding capacity, and knowing the plant and environmental factors that impact nutrient availability are necessary to guide fertilization rates, sources, and method of application of additional nutrients. The information here is intended to provide fundamental principles to help the reader understand what to do, and why, when making management decisions related to **phosphorus** (P), **potassium** (K), **secondary macronutrients** (calcium [Ca], magnesium [Mg], and sulfur [S]), **micronutrients** (boron [B], chlorine [Cl], copper [Cu], iron [Fe], manganese [Mn], molybdenum [Mo], and zinc [Zn]), and **pH**.

Factors Impacting Plant-Nutrient Availability

Nutrient availability can be impacted by soil chemical and physical properties, including parent material and naturally occurring minerals; amount of organic matter; depth to bedrock, sand, or gravel; and permeability, water holding capacity, and drainage. In addition, environmental conditions and crop characteristics have an important impact on nutrient availability. It is not unusual for crops in fields or portions of fields to show nutrient deficiencies during periods of the growing season, even where an adequate nutrient management plan is followed. The fact that nutrients are applied does not necessarily mean they are available. Plants obtain most of their nutrients and water from the soil through their root system. Any factor that restricts root growth and activity has the potential to restrict nutrient availability. This is not because nutrients are not plant-available in the soil, but because the ability of the crop to take up those nutrients is restricted. Understanding how these factors can cause nutrient deficiency in crops is important to avoiding excessive concern about the need for additional fertilization when a sound nutrient program is already in place.

Soil compaction can limit or completely restrict root penetration and effectively reduce the volume of soil, including nutrients and water, which can be accessed by the plant. To limit soil compaction, avoid entering fields that are too wet, and minimize the weight per axle by decreasing load weight and/or increasing tire surface area in contact with the soil. Planting when soils are wet can create a compacted wall next to the seed that will prevent the seedling from developing an adequate root system. Tilling wet soils will result in clods that become hard and dry out quickly on the surface, preventing roots from accessing resources inside the clod.

Soil water content is critical not only to supply the water needs of the crop but also to dissolve nutrients and make them available to the plant. Excess water in the soil, however, depletes oxygen (O_2) and builds up carbon dioxide (CO_2) levels. While O_2 is needed by roots to grow and take up nutrients, high CO_2 levels are toxic.

Temperature is important in regulating the speed of soil chemical processes that make nutrients available. Under cool soil temperatures, chemical reactions and root activity decrease, rendering nutrients less available to the crop. Portions of the plant nutrients are taken up as roots extract soil water to replenish water lost through the leaves. Cool air temperatures can lower evapotranspiration and reduce the convective flow of water and nutrients from the soil to the root.

Light intensity is low on cloudy days. Low light intensity reduces photosynthetic rates and nutrient uptake by the crop. Since low light intensity sometimes occurs when soils are waterlogged or temperatures are cool, cloud cover can exacerbate the capacity of the crop to take nutrients.

Diseases and pests can have an important impact on crop-nutrient uptake by competing for nutrients, affecting physiological capacity (such as reduction in photosynthesis rates), and diminishing root parameters through root pruning or tissue death.

Estimating Nutrient Availability

Soil Analysis

Soil tests are not perfect, so a soil test value should be considered not a single value, but rather a value within a range. There are multiple reasons why soil tests are not perfect: a soil test represents a measurement at one point in time, while a crop takes nutrients through an extended period, and typically under very different soil-water and temperature conditions than at the time of sampling; the information generated typically comes from a sample from the plow layer, but the crop roots extract nutrients below that layer; laboratory precision is typically within 5% to 10% of the true value. Despite these imperfections, soil testing is the most important guide to profitable application of phosphorus, potassium, and lime because it provides a framework for determining the fertility status of a field. In contrast, plant tissue analysis is typically more reliable than soil testing for secondary macronutrients and micronutrients. Since crop yield response to application of these nutrients has been very limited in Illinois, there is not a large enough database to correlate and calibrate soil-test procedures. Ratings in **Table 8.1** can provide a perspective on the reliability, usefulness, and cost effectiveness of soil tests as a basis for planning a soil fertility and liming program for Illinois field crops.

Traditionally, soil testing has been used to decide how much lime and fertilizer to apply to a field. With increased emphasis on precision agriculture, economics, and the environment, soil tests are also a logical tool to determine areas where adequate or excessive fertilization has taken place. In addition, they are used to monitor the impact of past fertility practices on changes in a field's nutrient status. Of course a soil test report can only be as accurate as the sample sent for analysis. In fact, the spatial variability of available nutrients in a field makes soil sampling the most common and greatest source of error in a soil test. To collect samples that provide a true measurement of the fertility of an area, one must determine the sampling distribution; collect samples to the proper depth; collect samples from precisely the same areas of the field that were sampled in the past; and collect samples at the proper time.

Table 8.1. Ratings of soil tests.

Test	Rating[a]
Water pH	100
Salt pH	30
Buffer pH	30
Exchangeable H	10
Phosphorus	85
Potassium	60
Boron: alfalfa	60
Boron: corn and soybeans	10
Iron: pH > 7.5	30
Iron: pH < 7.5	10
Organic matter	75
Calcium	40
Magnesium	40
Cation-exchange capacity	60
Sulfur	40
Zinc	45
Manganese: pH > 7.5	40
Manganese: pH < 7.5	10
Copper: organic soils	20
Copper: mineral soils	5

[a]On a scale of 0 to 100, 100 indicates a very reliable, useful, and cost-effective test, and 0 indicates a test of little value.

Field soil. A soil probe is the best implement for taking soil samples. An auger or a spade can also be used as long as care is taken to collect an exact depth with a constant slice thickness (**Figure 8.1**). A soil sample, or sampling point in the field, should be a composite of at least five soil cores taken with a probe from within a 10-foot radius around the sampling point. Composite samples should be placed in bags with labels identifying the places where the samples were collected.

Sampling distribution. The number of soil samples taken from a field is a compromise between what should be done (information) and what can be done (cost). The most common mistake is taking too few samples to represent a field adequately. Shortcuts in sampling may produce unreliable results and lead to higher fertilizer costs, lower returns, or both. Determine a soil sampling strategy by first evaluating cost, equipment to be used, past fertilization practices used, and the potential response to fertilizer application. Possible strategies include sampling for the following:

- *Whole-field uniform fertilizer applications*. For this approach, sampling at the rate of one composite from each 2-1/2-acre area is suggested (see **Figure 8.2**, diagram a, for sampling directions).

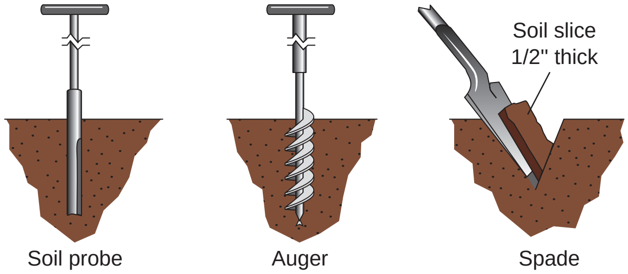


Figure 8.1. How to take soil samples with a soil probe, an auger, and a spade.

- *Site-specific applications for fields where large variations in test values over a short distance are suspected.* Under these conditions, collecting one sample from each 1.1-acre area (**Figure 8.2**, diagram b) will provide a better representation of the actual field variability. The greater sampling intensity will increase cost of the base information but allows for more complete use of technology in mapping soil fertility patterns and thus more appropriate fertilizer application rates.
- *Zones with common characteristics.* This is a directed sampling approach that is also known as "smart" or zone sampling. This method integrates information including such details as yield maps, crop canopy data, soil type or other characteristics, past management history, and the like. It defines sampling zones with common characteristics that may influence crop productivity and nutrient and water supplies. The size of such zones varies depending on field characteristics, but it seldom exceeds 10 acres.
- *Conservation tillage fields with fertilizer band applications.* There is not presently enough research data to define an accurate method for sampling these fields, so the following methods are given as suggestions. When the location of the band is known, collect the regular 7-inch depth sample 6 inches off the side of the band. Another approach would be to multiply a factor (0.67) by the distance (in inches) between bands to determine how many cores need to be collected from outside the band for each sample collected in the band. For example, in a 30-inch band distance, collect 20 cores from outside the band for each sample collected in the band. If the location of the band is not known, the best approach is to increase the number of samples (20 to 30) and to vary sampling position in relation to the row so the band does not bias test results.

Sampling depth. The proper sampling depth for pH, phosphorus, and potassium is 7 inches. This is because the fertilizer recommendation system in Illinois is based on crop response to fertility levels in the top 7 inches of the soil. For fields where conservation tillage has been used,

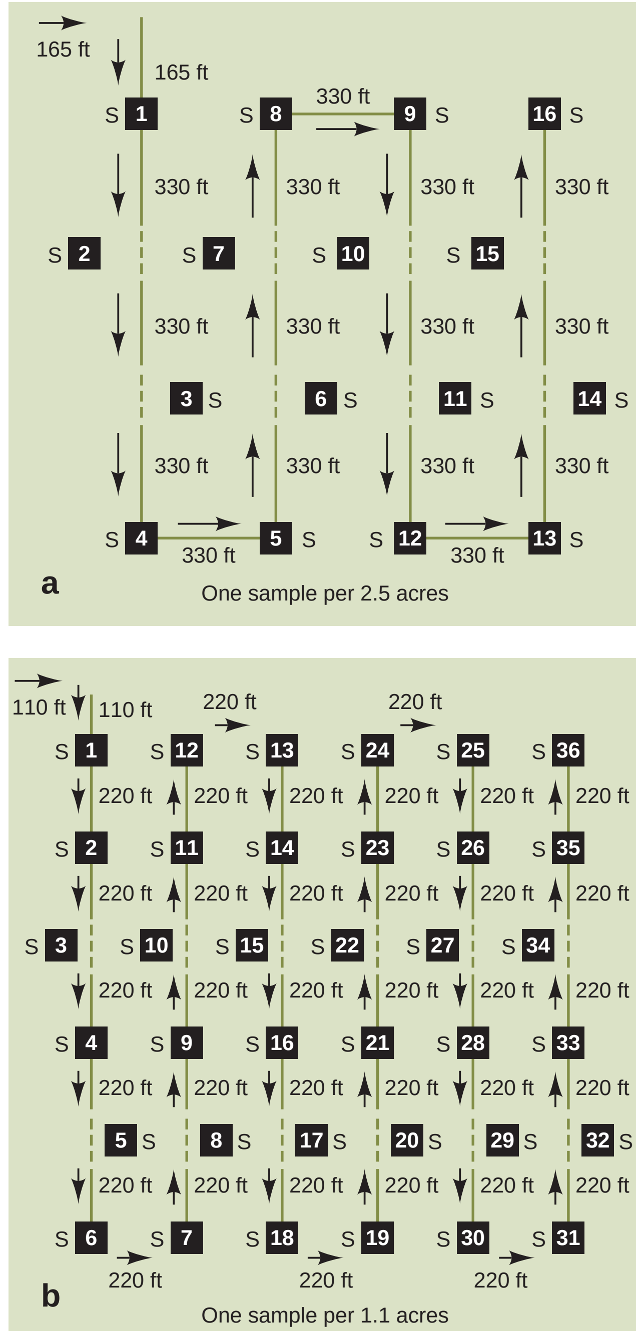


Figure 8.2. How to collect soil samples from a 40-acre field. Each sample (diagram a) should consist of five soil cores, 1 inch in diameter, collected to a 7-inch depth from within a 10-foot radius around each point. Higher frequency sampling (diagram b) is suggested for those who can use computerized spreading techniques on fields suspected of having large variations in test values over short distances.

accurate sampling depth is especially important, as such tillage results in less thorough mixing of lime and fertilizers than a tillage system that includes a moldboard plow. This stratification has not adversely affected crop yield, but misleading soil test results may be obtained if samples are not taken to the proper depth. Shallow samples will overestimate actual soil status, leading to underapplication of lime or fertilizers, while samples that are too deep or where some part of the top portion falls off during sampling will underestimate current soil status, causing overapplication of lime or fertilizers.

If surface soil pH is too high or too low, the efficacy of some herbicides and other chemical reactions may be affected. Thus, in addition to the regular 7-inch depth sampling, if either limestone (which raises pH) or nitrogen (which lowers pH) is applied to the soil surface and not incorporated with tillage, it is important to monitor surface soil pH by collecting samples to a depth of 2 inches from at least three areas in a 40-acre field. These areas should represent the low, intermediate, and high ground of the field.

Precise sample locations. Variations in values are often observed across soil tests in the same field. Given the inherent variability of soils over even short distances (related to soil forming factors) and management effects for which there is no record (such as non-uniform distribution of fertilizer), it is important to collect samples from precisely the same points each time a field is tested. Sample locations can be identified using a global positioning system (GPS) unit or by accurately measuring the sample points with a device such as a measuring wheel.

When to sample. Sampling every 4 years is strongly suggested when soils are at an optimum level of fertility. When maintenance levels are not being applied in cropping systems that remove large quantities of nutrients, such as hay or corn silage, soil testing should be done every other year. To improve the consistency of results, collect samples at the same time of year and, if possible, under similar soil-water conditions. Sampling done within a few months of lime or fertilizer treatment will be more variable than after a year.

Late summer and fall are the best seasons for collecting soil samples, because K test results are most reliable then. Results of the K test tend to be cyclic, with low levels in late summer and early fall and high levels in late January and early February. Phosphorus and pH levels are typically not seasonally affected in most soils in Illinois. In coarse-textured (sandy) soils with low buffer capacity, pH levels can increase as much as one unit under wet conditions.

Sending soils for analysis. Find information about commercial testing services available in your area at www.soiltesting.org, or contact an Extension office or a fertilizer dealer.

The best fertilizer recommendations are based on both soil test results and knowledge of field conditions that will affect nutrient availability. Because the person making the recommendation does not know the conditions in each field, it is important to provide adequate information with each sample.

The information needed includes cropping intentions for the next 4 years; the name of the soil type or, if not known, the nature of the soil (clay, silty, or sandy; light or dark color; level or hilly; eroded; well drained or wet; tiled or not; deep or shallow); fertilizer used (amount and grade); lime applied in the past 2 years; and proven yields or yield goals for all proposed crops.

The following tests should be performed:

- *pH*: The water pH test.
- *Phosphorus*: The Bray P_1 test for plant-available soil P. This test has been used to measure P availability in Illinois since it was developed in the 1940s. It was not developed to test alkaline soils, so it should be restricted to soils with pH less than 7.3. The Mehlich-3 test was developed in North Carolina for routine analysis of P, K, Ca, Mg, and several micronutrients. Research in Iowa has shown that the P results obtained with this test are nearly identical to those obtained with the Bray P_1 test on neutral-to-acid soils as long as the analysis is done by the colorimetric procedure. In soils or portions of a field where pH is above 7.3, the Bray P_1 test results in high test values. Under those soil conditions, yield response to P may be better correlated with the Mehlich-3 procedure. Samples extracted by the Mehlich-3 procedure and analyzed by inductively coupled plasma emission spectroscopy (ICP) result in higher values than those analyzed by the colorimetric procedure. The values obtained from ICP analysis cannot be adjusted to colorimetric values by a numerical conversion. A third procedure, referred to as the Olsen or sodium bicarbonate test, was developed for high-pH soils in western states and should not be used for acid soils. The results obtained with this test on high-pH soils are lower than those obtained with the Mehlich-3 procedure.
- *Potassium:* The ammonium acetate test has been the recommended test. Research in Iowa has shown that results from the Mehlich-3 extractable K test are similar to the ammonium acetate test.
- *Secondary nutrients and micronutrients:* Tests are available for most secondary nutrients and micronutrients, but interpretation is less reliable than with tests for lime, P, and K. Complete field history and soil information are especially important in interpreting results. Even though these tests are less reliable, they may be useful in two ways. First is troubleshooting, or diagnosing symptoms of abnormal growth; paired samples representing areas of good and poor growth are needed for analyses. Second

is "hidden-hunger checkup," or identifying deficiencies before symptoms appear. Soil tests are of little value in indicating marginal levels of secondary nutrients and micronutrients when crop growth is apparently normal. For this purpose, plant analysis may yield more information.

Interpreting soil test results and formulating soil treatment programs. A soil pH test reports soil reaction as pH units; phosphorus and K tests are typically reported in pounds of element per acre. Formulate a soil treatment program by preparing field soil test maps to observe areas of similar test levels that will benefit from similar applications. Areas with differences in soil test pH of 0.2 unit, P test of 10 pounds of P per acre, and K test of 30 pounds of K per acre are reasonable to designate for separate treatment. See page 96 for suggested pH goals, page 100 for P information, and page 103 for K information.

Spatial variability in soil test results. When soil test values vary across a field, there are two patterns and two possible ways to address the issue:

- *A definite pattern* of distinct high- and low-test values in different parts of the field. This likely indicates different soil types or different past management practices. Split the fertilizer or lime application to treat each area differently to meet the specific needs.
- *No consistent pattern* of high- and low-test values. Select the median test (the one that falls in the middle of a ranking from low to high). If no explanation for large differences in tests is found, consider taking a new set of samples.

Cation exchange capacity. Chemical elements exist in solution as cations (positively charged ions) or anions (negatively charged ions). In the soil solution, the plant nutrients hydrogen (H), Ca, Mg, K, ammonium (NH_4), Fe, Mn, Zn, and Cu exist as cations. The same is true for non-plant nutrients such as sodium (Na), barium (Ba), and metals of environmental concern, including mercury (Hg), cadmium (Cd), chromium (Cr), and others. Cation exchange capacity (CEC) is a measure of the amount of attraction for the soil with these chemical elements.

In soil, a high CEC is desirable, but not necessary, for high crop yields, as it is not a direct determining factor for yield. CEC facilitates retention of positively charged chemical elements from leaching, yet it gives nutrients to a growing plant root by an exchange of H. Cation exchange capacity in soil arises from negatively charged electrostatic charges in minerals and organic matter. The CEC of organic residues is low but increases as the residues convert to humus, which requires from 5 years to centuries. Thus, farming practices that reduce soil erosion and maintain soil humus favor the maintenance of CEC. It is influenced very little by fertilization, slightly decreased with soil acidification, and slightly increased with liming.

Depending on the amount of clay and humus, soil types have the following characteristic amounts of cation exchange (in units of milliequivalent per 100 grams of soil):

- Sandy soils: less than 4
- Light-colored silt-loam soils: 8 to 12
- Dark-colored silt-loam soils: 15 to 22
- Clay soils: 18 to 30

Plant Analysis

Plant analyses can be useful in diagnosing nutrient problems, identifying hidden hunger, and determining whether current fertility programs are adequate. Critical tissue-nutrient level (below which deficiency occurs) is the concentration needed for a crop to complete its life cycle. These concentrations are largely independent of soil or growing conditions, so the values typically apply across environments and provide a more reliable measurement for micronutrients and secondary nutrients than do soil tests.

How to sample. When diagnosing a fertility problem through plant analysis, select paired samples of comparable plant parts representing the abnormal and normal plants. Abnormal plants selected should represent the first stages of a problem. Samples taken at stages other than those described in **Table 8.2** might not correlate with the suggested critical nutrient levels.

After collecting the samples, deliver them immediately to the laboratory. Samples should be air-dried if they cannot be delivered immediately or if they are going to be shipped. Soil factors (fertility status, temperature, and moisture) and plant factors (cultivar and development stage) may complicate the interpretation of plant analysis data. The more information provided concerning a particular field, the more reliable the interpretation will be.

Soil pH

Effect of Soil Acidity on Plant Growth

Soil pH is a measure of the acidity or alkalinity of soil. Since pH is measured using a logarithmic scale, a decrease of 1 unit of pH means that the acidity increases by a factor of 10, so small changes in pH values can have important consequences. For most of Illinois, soil acidification is a concern, as acidity is created by removal of bases by harvested crops, leaching, and an acid residual left in the soil from N fertilizers. If surface soil pH is too high or too low, the efficacy of some herbicides and other chemical reactions may be affected. Also, soil acidity affects plant

Table 8.2. Suggested critical plant nutrient levels for various crops and stages of sampling.

Crop	Plant part	N (%)	P (%)	K (%)	Ca (%)	Mg (%)	S (%)	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)	B (ppm)
Alfalfa	Upper 6 in. at early bloom	—	0.25	2.00	1.00	0.25	0.22	15	25	20	7	25
Corn	Leaf opposite and below the ear at tasseling	2.9	0.25	1.90	0.40	0.15	0.15	15	25	15	5	10
Soybean	Fully developed leaf and petiole at early podding	—	0.25	2.00	0.40	0.25	0.15	15	30	20	5	25
Wheat	Entire aboveground portion at tillering	4.7	0.22	3.20	0.36	0.12	0.15	15	25	25	5	10

N—nitrogen; P—phosphorus; K—potassium; Ca—calcium; Mg—magnesium; S—sulfur; Zn—zinc; Fe—iron; Mn—manganese; Cu—copper; B—boron.

growth in several ways. Whenever soil pH is low (and acidity is high), several situations may exist:

- The concentration of soluble metals, especially aluminum and Mn, may be toxic.
- Populations and the activity of the organisms responsible to transform N, S, and P to plant-available forms may be reduced.
- Calcium may be deficient. Usually this occurs only when the CEC of the soil is extremely low.
- Symbiotic N fixation in legume crops is greatly impaired. The symbiotic relationship requires a narrower range of soil reaction than does the growth of plants not relying on N fixation.
- Acidic soils—particularly those low in organic matter—are poorly aggregated and have poor tilth.
- The availability of mineral elements to plants may be affected. **Figure 8.3** shows the relationship between soil pH and nutrient availability (the wider the dark bar, the greater the nutrient availability). For example, the availability of P is greatest in the pH range between 5.5 and 7.5, dropping off below 5.5. In other words, for a given soil, if P is applied at pH 6, there will be more of it available than if the same amount is applied when the soil pH is below 5.5. Because the availability of Mo is increased greatly as soil acidity is decreased, Mo deficiencies usually can be corrected by liming.

Suggested pH goals. A soil test every 4 years is the best way to check pH levels. For cash grain systems and pasture grasses (not alfalfa or clover), maintaining a pH of at least 6.0 is a realistic goal. If the soil test shows that the pH is 6.0 or less, apply limestone. After the initial investment, it costs little more to maintain a pH at 6.5 than at 6.0. The profit over 10 years will be little affected because the increased yield will approximately offset the cost of the extra limestone plus interest. In contrast, a profitable yield response from raising the pH above 6.5 in cash grain systems is unlikely.

For cropping systems with alfalfa, clover, or lespedeza, aim for a pH of 6.5 or higher unless the soils have a pH of 6.2 or higher without ever being limed. In those soils, neutral soil is just below plow depth; it probably will not be necessary to apply limestone.

Raising soil pH (liming). In addition to soil test value and cropping system, liming rates are determined based on soil type, depth of tillage, and limestone quality. Suggested limestone rates for different soil types in **Table 8.3** are based on typical limestone quality and a tillage depth of 9 inches. For details on adjusting rates to specific conditions, see table footnotes.

Limestone quality is defined by its effective neutralizing value (ENV), a measurement of the neutralizing value and the fineness of grind. The neutralizing value of limestone is determined by its calcium carbonate ($CaCO_3$) equiva-

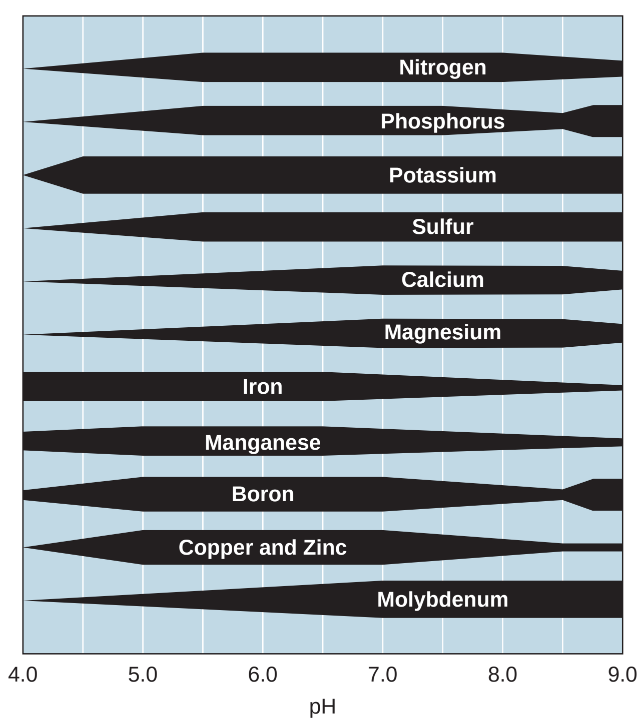


Figure 8.3. Available nutrients in relation to pH.

Table 8.3. Suggested limestone rates based on soil type, pH, cropping system, and 9-inch depth of tillage.

Soil type[a]	Soil pH value																					
	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	7.0
Tons of typical limestone[b] to apply to grain farming systems																						
A	8.0	8.0	8.0	8.0	8.0	8.0	7.8	7.0	6.3	5.5	4.8	4.0	3.3	2.5	1.8	1.0	Optional					
B	8.0	8.0	7.5	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	Optional					
C	6.6	6.3	5.9	5.5	5.1	4.8	4.4	4.0	3.6	3.3	2.9	2.5	2.1	1.8	1.4	1.0	Optional					
D	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	Optional					
E	4.0	3.6	3.2	2.8	2.4	2.0																
Tons of typical limestone[b] to apply to forage farming systems (alfalfa, clover, lespedeza)																						
A	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.3	9.6	8.9	8.1	7.4	6.7	6.0	5.3	4.6	3.9	3.1	2.4	1.7	1.0	Optional
B	11.0	11.0	11.0	10.4	9.9	9.3	8.8	8.2	7.7	7.1	6.6	6.0	5.4	4.9	4.3	3.8	3.2	2.7	2.1	1.6	1.0	Optional
C	10.0	9.6	9.1	8.7	8.2	7.8	7.3	6.9	6.4	6.0	5.5	5.1	4.6	4.2	3.7	3.3	2.8	2.4	1.9	1.5	1.0	Optional
D	6.0	5.8	5.5	5.3	5.0	4.8	4.5	4.3	4.0	3.8	3.5	3.3	3.0	2.8	2.5	2.3	2.0	1.8	1.5	1.3	1.0	Optional
E	6.0	5.4	4.9	4.3	3.8	3.2	2.7	2.1	1.6	1.0												

Note: If plowing is less than 9 in., reduce the amount; if it is more than 9 in., increase it. A chisel plow, disk, or field cultivator rather than a moldboard plow may not mix limestone deeper than 4 to 5 in.; for no-till or pasture systems, use the equivalent of a 3-in. tillage depth (one-third of the amount suggested).

[a]Soil A: Dark-colored silty clays and silty clay loams (CEC > 24). Soil B: Light- and medium-colored silty clays and silty clay loams; dark-colored silt and clay loams (CEC 15–24). Soil C: Light- and medium-colored silt and clay loams; dark- and medium-colored loams; dark-colored sandy loams (CEC 8–15). Soil D: Light-colored loams; light- and medium-colored sandy loams; sands (CEC < 8). Soil E: Muck and peat. Soil color is usually related to organic matter.Light-colored soils <2.5% organic matter; medium-colored soils 2.5–4.5% organic matter; dark-colored soils >4.5% organic matter.

[b]Typical limestone: 10% of the particles are greater than 8-mesh; 30% pass an 8-mesh and are held on 30-mesh; 30% pass a 30-mesh and are held on 60-mesh; and 30% pass a 60-mesh. A calcium carbonate equivalent (total neutralizing power) of 90%. Effective neutralizing value (ENV) of this material is 46.35 for 1 year after application, and 67.5 for 4 years after application. To correct the rate of application based on the ENV of the material available, follow calculations in the worksheet on page 98.

lent: the higher this value, the greater the limestone's ability to neutralize soil acidity. The fineness of grind determines the rate of reaction: finer limestone will neutralize soil acidity faster. Relative efficiency factors have been determined for various particle sizes (**Table 8.4**). If you are liming an acid soil just before seeding alfalfa, it is important to have highly reactive particles; the figures for 1 year are the best guide. If you apply lime before corn, the 4-year values are adequate.

The ENV can be calculated for any liming material by using the efficiency factors in **Table 8.4** and the $CaCO_3$ equivalent for the limestone in question. The Illinois Department of Agriculture, in cooperation with the Illinois Department of Transportation, collects and analyzes limestone samples from quarries that wish to participate in the Illinois Voluntary Limestone Program. These analyses, along with the calculated correction factors, are available from the Illinois Department of Agriculture, Bureau of Agricultural Products Inspection, P.O. Box 19281, Springfield, IL 62794-9281, in the annual publication *Illinois Voluntary Limestone Program Producer Information*. To calculate the ENV and the correction factor needed to determine rate of application for materials not reported in that publication, obtain the analysis of the material in question from the supplier and use the worksheet for lime-rate calculation on page 98 (or online at iah.ipm.illinois.edu/limestone_rate).

Table 8.4. Efficiency factors for various limestone particle sizes.

Particle sizes	Efficiency factor: 1 yr after application	Efficiency factor: 4 yr after application
Greater than 8-mesh	5	15
8- to 30-mesh	20	45
30- to 60-mesh	50	100
Passing 60-mesh	100	100

Examples of Rate Calculation

As an example, consider a limestone that has a $CaCO_3$ equivalent of 86.88% and a sample with 13.1% of the particles greater than 8-mesh, 40.4% that pass 8-mesh and are held on 30-mesh, 14.9% that pass 30-mesh and are held on 60-mesh, and 31.6% that pass 60-mesh. Assume that 3 tons of typical limestone are needed per acre (according to **Table 8.3**). The amounts of limestone with these characteristics that would be needed to meet the 3-ton recommendation would be 3.36 and 3.51 tons on a 1- and

Worksheet for Lime-Rate Calculation Based on ENV of Material

AFTER 1 YEAR

	Formulas	Completed Examples
1	% of particles greater than 8-mesh = $\frac{\quad}{100}$ x 5 = ... ☐	$\frac{13.1\%}{100}$ x 5 = ... 0.65
	% of particles that pass 8-mesh and are held on 30-mesh = $\frac{\quad}{100}$ x 20 = ... + ☐	$\frac{40.4\%}{100}$ x 20 = ... + 8.08
	% of particles that pass 30-mesh and are held on 60-mesh = $\frac{\quad}{100}$ x 50 = ... + ☐	$\frac{14.9\%}{100}$ x 50 = ... + 7.45
	% of particles that pass 60-mesh = $\frac{\quad}{100}$ x 100 = ... + ☐	$\frac{31.6\%}{100}$ x 100 = ... + 31.60
	Total fineness efficiency........ ☐	**Total fineness efficiency**........ **47.78**
2	ENV = total fineness efficiency x $\frac{\text{\% calcium carbonate equivalent}}{100}$	ENV = 47.78 x $\frac{86.88}{100}$ = 41.51
3	Correction factor = $\frac{\text{ENV of typical limestone (46.35)}}{\text{ENV of sampled limestone (\_\_\_)}}$	$\frac{46.35}{41.51}$ = 1.12
4	Correction factor x limestone requirement (from Table 8.3) = ______ tons of sampled limestone needed per acre	1.12 x 3 = 3.4 tons per acre

AFTER 4 YEARS

	Formulas	Completed Examples
1	% of particles greater than 8-mesh = $\frac{\quad}{100}$ x 15 = ... ☐	$\frac{13.1\%}{100}$ x 15 = ... 1.96
	% of particles that pass 8-mesh and are held on 30-mesh = $\frac{\quad}{100}$ x 45 = ... + ☐	$\frac{40.4\%}{100}$ x 45 = ... + 18.18
	% of particles that pass 30-mesh and are held on 60-mesh = $\frac{\quad}{100}$ x 100 = ... + ☐	$\frac{14.9\%}{100}$ x 100 = ... + 14.90
	% of particles that pass 60-mesh = $\frac{\quad}{100}$ x 100 = ... + ☐	$\frac{31.6\%}{100}$ x 100 = ... + 31.60
	Total fineness efficiency........ ☐	**Total fineness efficiency**........ **66.64**
2	ENV = total fineness efficiency x $\frac{\text{\% calcium carbonate equivalent}}{100}$	ENV = 66.64 x $\frac{86.88}{100}$ = 57.9
3	Correction factor = $\frac{\text{ENV of typical limestone (67.5)}}{\text{ENV of sampled limestone (\_\_\_)}}$	$\frac{67.5}{57.9}$ = 1.17
4	Correction factor x limestone requirement (from Table 8.3) = ______ tons of sampled limestone needed per acre	1.17 x 3 = 3.5 tons per acre

4-year basis, respectively (see the sample calculation in the worksheet).

How to apply limestone. Since limestone does not react with acidic soil very far from the particle, adjust application rates proportionally to the depth of tillage as explained in the footnote of **Table 8.3**. For pastures and no-till systems, when lime is broadcast on the soil surface, apply one-third of the needed rate to avoid creating extremely high pH at the soil surface. Consequently, liming may be required more often (but at lower rates) in these systems than in cultivated fields.

Similarly to a broadcast application of nutrients, make sure limestone is spread evenly throughout the soil surface by avoiding overlaps. If a mistake was made and very high rates were applied, scraping the material out of the field or increasing the amount of mixing by tillage would be a practical way to reduce negative effects. Limestone can be applied at any time, but fall applications are preferred to avoid soil compaction and concerns about spring planting delays. Fall application also allows more time for limestone to neutralize soil acidity.

If high initial cost is not a deterrent, rates up to 6 tons per acre may be applied at one time. If cost is a factor and the amount of limestone needed is 6 tons or more per acre, apply it in split applications of about two thirds the first time and the remainder 3 or 4 years later.

In no-till fields where lime is not incorporated in the soil, surface applications eventually neutralize acidity below the surface. However, this process is slow, so it is recommended to always maintain surface pH levels at adequate ranges. If pH levels in the surface are allowed to drop, lime applications will take a long time to start to neutralize acidity below the soil surface.

For hay and pastures, apply limestone several months ahead of seeding to allow time for the acidity to be neutralized. If rate requirements exceed 5 tons per acre, apply half the rate before the primary or intensive tillage and half before the secondary tillage (harrowing or disking). For rates of less than 5 tons, make a single application, preferably after primary tillage.

Fluid lime suspensions (liquid lime). Liquid lime products are created by suspending very finely ground limestone in water. Several industrial byproducts with liming properties also are being land-applied as suspensions, either because they are too fine to be spread dry or because they are already in suspension. These byproducts include residue from water treatment plants, cement plant stack dusts, paper mill sludge, and other waste products. These materials may contain as much as 50% water.

The chemistry of liquid liming materials is the same as that of dry materials. The rate of reaction and the neutralizing power for liquid lime are the same as for dry materials when particle sizes are the same. Application of liquid lime during the first few months after application will provide a more rapid increase in pH than will typical lime, but after that the two materials will provide equivalent pH levels in the soil. The rate of application calculated by using the equation below is adequate to maintain soil pH for at least 4 years at the same level as typical lime.

As an example, assume a lime need of 3 tons per acre (based on **Table 8.3**) and liquid lime that is 50% dry-matter and has a $CaCO_3$ equivalent of 97% on a dry-matter basis. The rate of liquid lime needed would be calculated as shown in the sample below.

Lowering Soil pH (Acidifying)

While soils with high pH (>7.4) result in reduced availability of several nutrients, particularly P, Zn, Fe, and Mn, decreasing soil pH has not been shown to be economical for producing agronomic crops. Acidifying soils to produce crops such as blueberries and cranberries is essential if the pH is high. Acidification can be accomplished by applying elemental S, aluminum sulfate, or iron sulfate. The amount of elemental S needed to reduce soil pH depends on the initial pH and the desired pH (see **Table 8.5**).

Calculating the Application Rate for Liquid Lime

$$\frac{\text{ENV of typical limestone [use 46.35]}}{\text{100 (fineness efficiency factor)} \times \frac{\text{\% calcium carbonate, equivalent, dry matter basis}}{100} \times \frac{\text{\% dry matter}}{100}} \times \text{tons of limestone needed per acre} = \text{tons of liquid lime needed per acre}$$

Sample calculation:

$$\frac{46.35}{100 \times \frac{97}{100} \times \frac{50}{100}} \times 3 = 2.87 \text{ tons of liquid lime needed per acre}$$

Table 8.5. Amount of elemental sulfur needed to reduce soil pH.

Soil pH	Soil group[a]			
	A	B	C	D
Elemental sulfur (lb/A) needed to reach pH 5.0				
6.4	2,700	2,100	1,400	700
6.2	2,400	1,800	1,200	600
6.0	2,150	1,625	1,075	550
5.8	1,925	1,450	950	475
5.6	1,700	1,275	850	425
5.4	1,225	925	625	300
5.2	775	575	375	200
Elemental sulfur (lb/A) needed to reach pH 4.5				
6.4	4,000	3,000	2,000	1,000
6.2	3,800	2,800	1,900	950
6.0	3,525	2,650	1,775	925
5.8	3,300	2,475	1,650	825
5.6	3,075	2,300	1,525	775
5.4	2,600	1,950	1,300	650
5.2	2,150	1,625	1,075	550
5.0	1,375	1,050	700	350

[a]Soil A: Dark-colored silty clays and silty clay loams (CEC > 24). Soil B: Light- and medium-colored silty clays and silty clay loams; dark-colored silt and clay loams (CEC 15–24). Soil C: Light- and medium-colored silt and clay loams; dark- and medium-colored loams; dark-colored sandy loams (CEC 8–15). Soil D: Light-colored loams; light- and medium-colored sandy loams; sands (CEC < 8).

Calcium–Magnesium Balance in Illinois Soils

Soils in northern Illinois usually contain more Mg than those in central and southern Illinois, both because of the high Mg content in the rock from which the soils developed and because northern soils are geologically younger. This relatively high level of Mg has caused speculation: is the level too high? Although there have been reported suggestions that either gypsum or low-Mg limestone should be applied, no research data have been put forth to justify concern over a too-narrow ratio of Ca to Mg.

On the other hand, concern is justified over a soil Mg level that is low, because of its relationship with hypomagnesaemia, a prime factor in grass tetany or milk fever in cattle. This concern is more relevant to producing forage than grain. Very high K levels (more than 500 pounds per acre) combined with low soil Mg levels contribute to low-Mg grass forages. Research data to establish critical Mg levels are very limited, but levels of soil Mg less than 60 pounds per acre on sands and 150 pounds per acre on silt-loams are considered low.

Ca and Mg levels of agricultural limestone vary among quarries in the state. Dolomitic limestone (material with appreciable Mg content, as high as 21.7% MgO or 46.5% $MgCO_3$) occurs predominantly in the northern three tiers of Illinois counties, in Kankakee County, and in Calhoun County. Limestone occurring in the remainder of the state is predominantly calcitic (high Ca), although it is not uncommon for it to contain 1% to 3% $MgCO_3$.

There are no agronomic reasons to recommend either that grain farmers in northern Illinois bypass local limestone sources, which are medium to high in Mg, and pay a premium for low-Mg limestone from southern Illinois or that grain farmers in southern Illinois order limestone from northern Illinois quarries because of Mg content.

For farmers with a livestock program or who produce forages in the claypan and fragipan regions of the south, where soil Mg levels may be marginal, it is appropriate to use a soil test to verify conditions and to use dolomitic limestone or Mg fertilization or to add Mg to the feed.

Phosphorus

Regional differences in P-supplying power shown in **Figure 8.4** were broadly defined primarily by parent material and degree of weathering factors. Within a region, variability in parent material, degree of weathering, native vegetation, and natural drainage cause differences in the soil's P-supplying power. For example, soils developed under forest cover appear to have more available subsoil P than those developed under grass.

High supplying power. The "high" region is in western Illinois, where the primary parent material was more than 4 to 5 feet of loess that was high in P content. The soils are leached of carbonates to a depth of more than 3-1/2 feet, and roots can spread easily in the moderately permeable profiles.

Medium supplying power. The "medium" region is in central Illinois, with arms extending into northern and southern Illinois. The primary parent material was more than 3 feet of loess over glacial till, glacial drift, or outwash. Some sandy areas with low P-supplying power occur. In comparison with the high-P region, more soils are poorly drained and have less available P in the subsoil and substratum horizons. Carbonates are likely to occur at shallower depths than in the high region. The soils in the northern and central areas are generally free of root restrictions, whereas soils in the southern arm are more likely to have root-restricting layers in the profile. The P-supplying power of soils of the region is likely to vary with natural drainage. Soils with good internal drainage are likely to have higher levels of available P in the subsoil and substratum. If

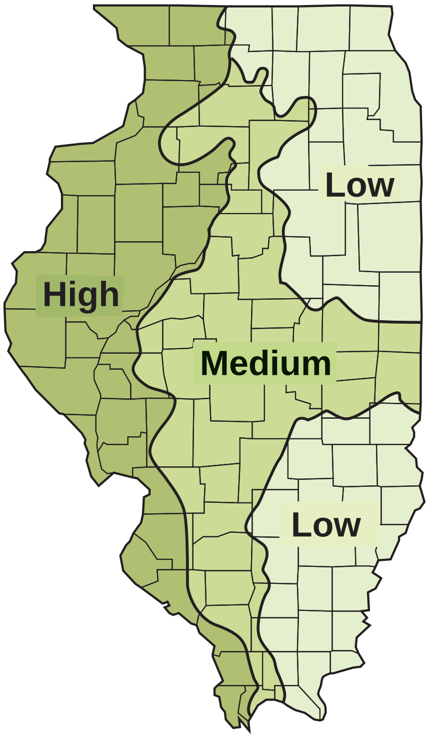
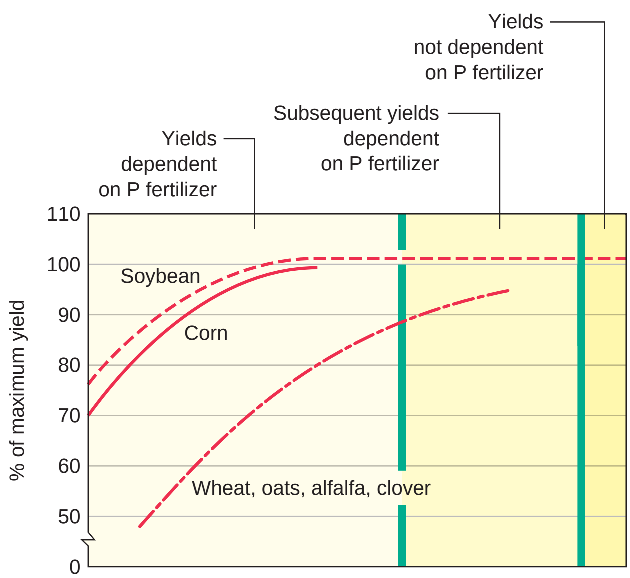


Figure 8.4. Subsoil phosphorus-supplying power in Illinois.



P test (lb/A) for different subsoil phosphorus-supplying power regions

High	7	15	20	40	60
Medium	10	20	30	45	65
Low	20	30	38	50	70

Figure 8.5. Relationship between expected yield and soil P, measured colorimetrically by the Bray P_1 or Mehlich-3 procedures on neutral-to-acid soils, or by the Mehlich-3 procedure on soils with pH > 7.3. These values should not be used for the Olsen (soil bicarbonate) test or for Mehlich-3 extractions analyzed by inductively coupled plasma emission spectroscopy (ICP).

internal drainage is fair or poor, P levels in the subsoil and substratum are likely to be low or medium.

Low supplying power. Soils in the "low" region in southeastern Illinois were formed from 2-1/2 to 7 feet of loess over weathered Illinoisan till. The profiles are more highly weathered than in the other regions and are slowly or very slowly permeable. Root development is more restricted than in the high or medium regions. Subsoil levels of P may be rather high by soil test in some soils of the region, but this is partially offset by conditions that restrict rooting.

Soils in the low region in northeastern Illinois were formed from thin loess (less than 3 feet) over glacial till. The glacial till, generally low in available P, ranges in texture from gravelly loam to clay in various soil associations of the region. In addition, shallow carbonates further reduce the P-supplying power of the soils of the region. Further, high bulk density and slow permeability in the subsoil and substratum restrict rooting in many soils of the region.

Phosphorus Recommendations

Minimum soil test levels required to produce optimal crop yields vary depending on the crop to be grown and the soil's P-supplying power (**Figure 8.5**). Near-maximal yields of corn and soybeans are obtained when levels of available P are maintained at 30, 40, and 45 pounds per acre for soils in the high, medium, and low P-supplying regions, respectively. Since these are minimal values, to ensure soil P availability will not restrict crop yield it is recommended that soil test results be built up to 40, 45, and 50 pounds per acre for soils in the high, medium, and low P-supplying regions, respectively. This is a practical approach because P is not easily lost from the soil, other than through crop removal or soil erosion.

Phosphorus soil test level required for optimal yields of wheat and oats is considerably higher than that required for corn and soybean yields (**Figure 8.5**), partly because of difference in uptake patterns. Wheat requires a large amount of readily available P in the fall, when the root system is feeding primarily from the upper soil surface. Phosphorus is taken up by corn until the grain is fully developed, so subsoil P is more important in interpreting the P test for corn than for wheat. To compensate for the higher P requirements of wheat and oats, it is suggested that 1.5 times the amount of expected P removal be applied prior to seeding these crops. This correction has already been included in the maintenance values listed for wheat and oats in **Table 8.6**.

No fertilization needed. There is no agronomic advantage in applying P when P_1 values are higher than 60, 65, and 70 for soils in the high, medium, and low P-supplying regions, respectively.

Maintenance fertilization needed. When soil test levels are between the minimum and 20 pounds above the minimum (40 to 60, 45 to 65, and 50 to 70 for the high, medium, and low P-supplying regions, respectively), apply enough to replace expected removal by the crop (and 1.5 times the removal for wheat and oats) using values from **Table 8.6**. At this test level, the yield of the current crop may not be affected by the fertilizer addition, but the yield of subsequent crops will be adversely affected if P is not applied to maintain soil test levels.

Buildup plus maintenance fertilization needed. When soil test levels are below the desired values (40, 45, and 50 for the high, medium, and low P-supplying regions, respectively), it is suggested that enough fertilizer be added to build the test to the desired goal and to replace what the crop will remove (as described in the previous paragraph). At this test level, the yield of the crop will be affected by the amount of P applied that year.

For perennial forage crops, broadcast and incorporate all of the buildup and as much of the maintenance as economically feasible after primary tillage and before seeding. On soils with low fertility, reserve 30 pounds of P_2O_5 per acre for band seeding. Warm-season perennial grasses prefer fertile soils but grow well in moderate fertility conditions.

Table 8.6. Maintenance fertilizer required for various crops.

	P_2O_5	K_2O
Grains		
Corn	0.43 lb/bu	0.28 lb/bu
Oats	0.38 lb/bu[a]	0.20 lb/bu
Soybean	0.85 lb/bu	1.30 lb/bu
Grain sorghum	0.42 lb/bu	0.21 lb/bu
Wheat	0.90 lb/bu[a]	0.30 lb/bu
Biomass		
Alfalfa, grass, or alfalfa–grass mixes	12.0 lb/ton	50.0 lb/ton
Corn silage	2.7 (0.53)[b] lb/ton	7.0 (1.4)[b] lb/ton
Corn stover	7.0 lb/ton	30 lb/ton[c]
Wheat straw	4.0 lb/ton	30 lb/ton[c]

To obtain total nutrient removal by the crop (maintenance rate), multiply value by the expected yield.
[a]Values given are 1.5 times actual P_2O_5 removal for oats and wheat.
[b]Values in parentheses correspond to pounds per bushel.
[c]Value will vary depending on amount of precipitation received between the time of physiological maturity and the time the material was baled and by the potassium fertility level of the soil.

For establishment, fertilize with 24 to 30 pounds of P_2O_5. For these cropping systems, P rates beyond the year of establishment follow the regular maintenance or buildup plus maintenance program already described.

On average, Illinois soils require 9 pounds of P_2O_5 per acre to increase the P_1 soil test by 1 pound. The recommended rate of buildup for P is thus nine times the difference between the soil test goal and the actual soil test value. For a typical 4-year buildup program, divide the rate by 4 to determine the annual rate. Because the 9-pound rate is an average for Illinois soils, some soils will fail to reach the desired goal in 4 years with P_2O_5 applied at this rate, and others will exceed the goal.

Consequences of omitting fertilizer. The impact on yield and soil test level of eliminating P fertilizer will depend on the initial soil test and the number of years that applications are omitted. In a study in Iowa, eliminating P application for 9 years decreased soil test levels from 136 to 52 pounds per acre, but yields were not adversely affected in any year as compared to plots where soil test levels were maintained (**Figure 8.6**). In the same study, eliminating P for the 9 years when the initial soil test was 29 resulted in a decrease in soil test level to 14 and a decrease in yield to 70% of that obtained when adequate fertility was supplied. Eliminating P at an intermediate soil test level had little impact on yield but decreased the soil test level from 67 to 26 pounds per acre over the 9 years. These as well as similar Illinois results indicate little if any potential for a yield decrease if P application was eliminated for 4 years on soils that have a P test of 60 pounds per acre or higher.

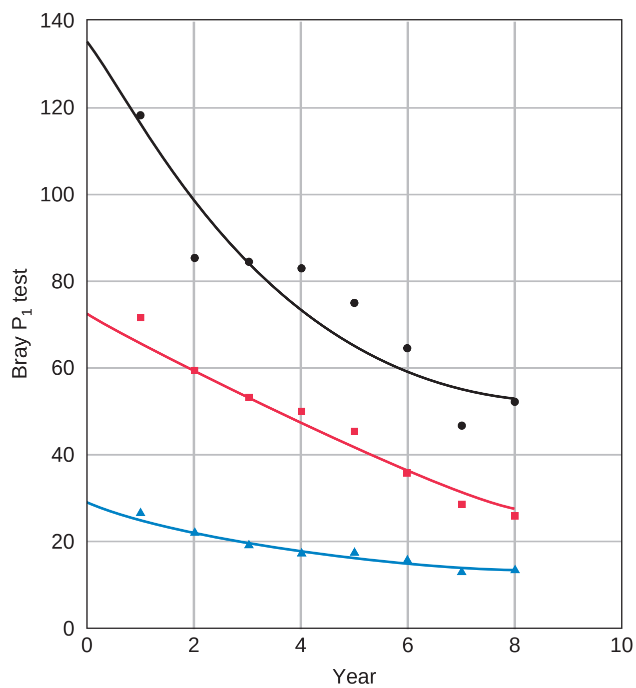


Figure 8.6. Effect of elimination of P fertilizer on P_1 soil test.

Potassium

Illinois is divided into two general regions for K, based on CEC (**Figure 8.7**). Soils with a CEC less than 12 milliequivalents per 100 grams are classified as having low capacity, while soils with values equal to or greater than 12 milliequivalents per 100 grams are considered to have high capacity. Important differences exist, however, among soils within these general regions because of differences in these factors:

- The amounts of clay and organic matter, which influence the exchange capacity of the soil.
- The degree of weathering of the soil material, which affects the amount of K that has been leached out.
- The kind of clay mineral.
- Drainage and aeration, which influence uptake of K.
- The parent material from which the soil was formed.

Low capacity includes sandy soils, because minerals from which they were developed are inherently low in K. Sandy soils also have very low cation exchange capacities and thus do not hold much reserve K.

Silt-loam soils in the "low" area in southern Illinois (claypans) are relatively older in terms of soil development; consequently, much more of the K has been leached out of the rooting zone. Furthermore, wetness and a platy structure between the surface and subsoil may interfere with rooting and with K uptake early in the growing period, even though roots are present.

Potassium Recommendations

Tests on soil samples that are taken before May 1 or after September 30 should be adjusted downward as follows: subtract 30 for the dark-colored soils in central and northern Illinois; subtract 45 for the light-colored soils in central and northern Illinois and for fine-textured bottomland soils; subtract 60 for the medium- and light-colored soils in southern Illinois.

Minimum soil test levels required to produce optimal crop yields vary depending on the crop to be grown and the soil's CEC (**Figure 8.8**). As with P, the only significant loss of soil-applied K is through crop removal or soil erosion, so to ensure that K availability will not limit crop yields it is recommended that soil test levels be slightly higher than that required for maximum yield. For corn and soybean it is recommended to have 260 and 300 pounds of exchangeable K per acre for soils in the low and high CEC regions, respectively.

Wheat is not very responsive to K unless the soil test value is less than 100 pounds per acre. Because wheat is usually grown in rotation with corn and soybeans, it is suggested that the soils be maintained at the optimal available K level for corn and soybeans.

No fertilization needed. No K additions are suggested if test levels are above 360 and 400 for the low and high CEC regions, unless crops that remove large amounts of K (such as alfalfa or corn silage) are being grown. When soil test levels are between 400 and 600 pounds of K per acre and corn silage or alfalfa is being grown, the soil should be tested every 2 years instead of every 4, or maintenance levels of K should be added to ensure that soil test levels do not fall below the point of optimal yields. Having adequate K in these systems is important to producing high-quality forage (K is important for the conversion of N to protein) and maintaining a vigorous stand (winter survival of legumes and stand longevity in grass-legume stands).

Maintenance fertilization needed. When soil test levels are between the minimum and 100 pounds above the minimum (260 to 360 and 300 to 400 for the low and high capacity, respectively), apply enough to replace what the crop to be grown is expected to remove using values from **Table 8.6**. At this test level the yield of the current crop may not be affected by the fertilizer addition, but the yield of subsequent crops will be adversely affected if K is not applied to maintain soil test levels.

Buildup plus maintenance fertilization needed. When soil test levels are below the desired values (260 and 300 for the low and high capacity, respectively), it is suggested that enough fertilizer be added to build the test to the desired goal and to replace what the crop will remove (as described in the previous paragraph). At this test level, the yield of the crop will be affected by the amount of K applied that year.

For perennial forage crops, broadcast and incorporate all of the buildup and as much of the maintenance as economically feasible before seeding. On soils with low fertility, it is safe to apply a maximum of 30 to 40 pounds of K_2O per acre along with the P band. Up to 600 pounds of K_2O per acre can be safely broadcast in the seedbed without damaging seedlings. Warm-season perennial grasses prefer fertile soils but grow well in moderate fertility conditions. For establishment, fertilize with 40 to 60 pounds of K_2O per acre. For these cropping systems, K rates beyond the year of establishment follow the regular maintenance or buildup plus maintenance program already described.

On average most Illinois soils require 4 pounds of K_2O per acre to increase the K exchangeable soil test by 1 pound. The recommended rate of buildup for K is thus 4 times the difference between the soil test goal and the actual soil test value. For a typical 4-year buildup program, divide the rate by 4 to determine the annual rate. In some soils, soil

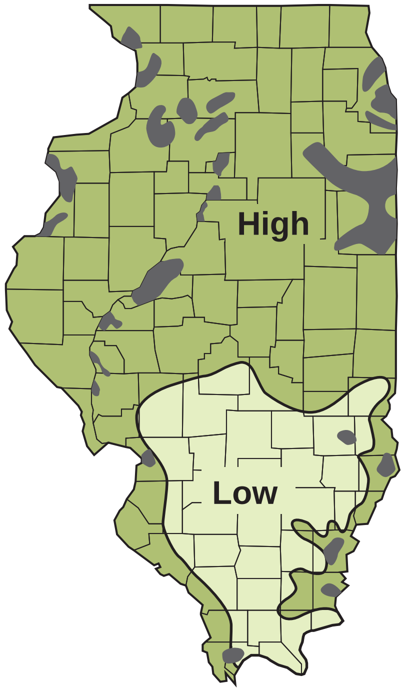


Figure 8.7. Cation-exchange capacity of Illinois soils. The darkest areas are sands with low capacity.

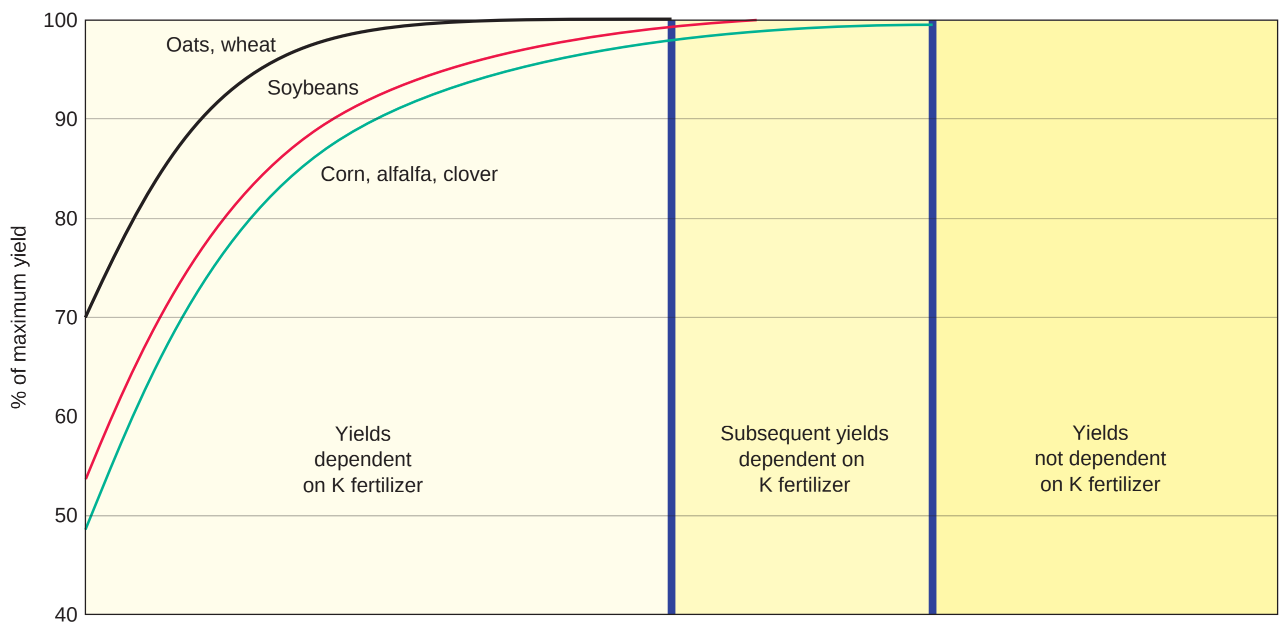
test levels do not build up as expected. Under the following conditions, an annual application approach (rather than buildup and maintenance) should be used:

- Soils for which past records indicate that soil test K does not increase when buildup applications are applied.
- Sandy soils that do not have a capacity large enough to hold adequate amounts of K.

Annual applications. When one of these conditions exists, or the land's expected tenure is short or unknown, continued monitoring of the level of K through soil testing every 4 years is recommended, along with the following:

- If soil test levels are below the desired buildup goal, multiply the maintenance value (K content in the harvested portion of the expected yield calculated from **Table 8.6**) by 1.5 and apply that rate annually.
- If levels are within the maintenance range, or only slightly below desired buildup levels (buildup and maintenance are less than 1.5 times removal), apply K maintenance amounts for the expected yield (**Table 8.6**).

There are advantages and disadvantages to buildup plus maintenance vs. annual application. In the short run, the annual option will likely be less costly. In the long run, the buildup approach may be more economical. In years of high income, tax benefits may be obtained by applying high rates of fertilizer. Also, in periods of low fertilizer prices, the soil can be built to higher levels that in essence



K test (lb/A) for different cation exchange capacity regions

Low	40	100	200	260	360	500
High	60	120	240	300	400	540

K test (lb/A)

Figure 8.8. Relationship between expected yield and soil K, measured by the ammonium acetate or Mehlich-3 extractable K tests.

bank the materials in the soil for use at a later date when fertilizer prices are higher. Producers using the buildup system are insured against yield loss that may occur in years when weather conditions prevent fertilizer application or fertilizer supplies are not adequate. The primary advantage of the buildup concept is the slightly lower risk of potential yield reduction that may result from lower annual fertilizer rates. This is especially true in years of exceptionally favorable growing conditions. The primary disadvantage of the buildup option is the high cost of fertilizer in the initial buildup years.

Consequences of omitting fertilizer. The impact of eliminating K fertilizer on yield and soil test level will depend on the initial soil test and the number of years that applications are omitted. Although test levels tend to decline more rapidly for K than for P, there is little potential, if any, for a yield decrease if K application is eliminated for 4 years on soils that have a K test of at least 360 pounds per acre.

Applications of Phosphorus and Potassium

The following are examples of how to calculate P and K fertilizer rates for a 4-year program.

Example 1: Buildup plus maintenance needed

Continuous corn with a yield goal of 180 bushels per acre grown in a region of soils with high P-supplying power and high CEC. The soil test levels were 32 pounds of P and 250 pounds of K.

- Step 1: Calculate buildup rate.

  Phosphorus:

  The soil is 8 pounds below the desired level of 40 pounds per acre (**Figure 8.5**) (40 – 32 = 8).

  It takes 9 pounds of P_2O_5 to build the soil test level by 1 pound. 8 x 9 = 72 pounds of P_2O_5 over 4 years to bring soil P to the desired level, or 72 ÷ 4 = **18 pounds of P_2O_5** per year.

  Potassium:

  The soil is 50 pounds below the desired level of 300 pounds per acre (**Figure 8.8**) (300 – 250 = 50).

  It takes 4 pounds of K_2O to build the soil test level by 1 pound. 50 x 4 = 200 pounds of K_2O over 4 years to bring soil K to the desired level, or 200 ÷ 4 = **50 pounds of K_2O** per year.

- Step 2: Calculate maintenance (from **Table 8.6**).

  Phosphorus:

  0.43 pounds of P_2O_5 per bushel of corn x 180 bushels = **77 pounds of P_2O_5** per year.

  Potassium:

  0.28 pounds of K_2O per bushel of corn x 180 bushels = **50 pounds of K_2O** per year.

- Step 3: Sum buildup and maintenance values to determine yearly application rate.

  Phosphorus: 18 + 77 = **95 pounds of P_2O_5**

  Potassium: 50 + 50 = **100 pounds of K_2O**

Example 2: Maintenance-only needed

Corn and soybean with a yield goal of 180 bushels of corn per acre and 50 bushels of soybean per acre grown in a region of soils with medium P-supplying power and low CEC. The soil test levels were 55 pounds of P and 320 pounds of K.

- Step 1: Calculate maintenance (from **Table 8.6**).

  Phosphorus:

  0.43 pounds of P_2O_5 per bushels of corn x 180 bushels = **77 pounds of P_2O_5** for corn year.

  0.85 pounds of P_2O_5 per bushels of soybean x 50 bushels = **43 pounds of P_2O_5** for soybean year.

  Potassium:

  0.28 pounds of K_2O per bushel of corn x 180 bushels = **50 pounds of K_2O** for corn year.

  1.30 pounds of K_2O per bushel of soybean x 50 bushels = **65 pounds of K_2O** for soybean year.

  If a biennial application is preferred, sum the P and K rates for both crops to determine the rate of application.

Example 3: No fertilization needed

Corn and soybean with a yield goal of 180 bushels of corn per acre and 50 bushels of soybean per acre grown in a region of soils with high P-supplying power and high CEC. Soil test levels were 90 pounds of P and 450 pounds of K.

Example 4: Annual application

Corn and soybean with a yield goal of 160 bushels of corn per acre and 40 bushels of soybean per acre grown in a region of soils with low P-supplying power and low CEC. The soil test levels were 75 pounds of P and 180 pounds of K. The K test levels fail to increase as expected.

Since P levels are high, there is no need to apply P. The soil does not respond to buildup rates, so following an annual application approach is recommended.

- Step 1: Calculate maintenance (from **Table 8.6**).

  0.28 pounds of K_2O per bushel of corn x 160 bushels = **45 pounds of K_2O** for corn year.

  1.30 pounds of K_2O per bushel of soybean x 40 bushels = **52 pounds of K_2O** for soybean year.

- Step 2: Adjust for annual application approach.

  45 pounds of K_2O x 1.5 = **68 pounds of K_2O** for corn year.

  52 pounds of K_2O x 1.5 = **78 pounds of K_2O** for soybean year.

Determining Removal in Forage Systems

As mentioned, P and K needs are assessed by soil testing. If testing is not being done in a pasture system, the second best option is to apply what is removed by the crop using values from **Table 9.6**. Very productive pastures yield 5 to 6 tons of dry matter per acre, moderately productive pastures 3 to 5 tons, and less productive pastures 1 to 3 tons. Recycling of nutrients from urine and manure reduces the total nutrients removed from a pasture by 60% to 80%, varying with the intensity of grazing management (continuous vs. rotational vs. management-intensive) and the resulting distribution of manure. Managed grazing improves the distribution and utilization of P and K. Thus, usually less of these two nutrients is needed on pastures than on hay fields. It is important to test soil every 4 years to monitor changes in the fertility status of pastures.

Determining Removal by Baled Stover or Straw

Baling corn stover and wheat straw has a direct impact on P and K removal from the field. This removal needs to be included in fertilization plans for the following crop. The best method to determining nutrient removal is by directly measuring tons of residue baled and chemically analyzing samples collected from those bales.

If that method is not feasible, follow these guidelines to determine nutrient removal through an indirect approach: The amount of residue produced depends on several factors, but for corn and wheat typically a general value is 1 pound of residue per pound of grain produced (dry weight basis). The amount of actual removal will depend on harvest method. Traditional harvest methods remove anywhere from 50% to 80% of the total residue. To determine the amount of P and K removed with the residue, multiply the values in **Table 8.6** by the tons of residue removed.

The actual amount of nutrients present in the residue can vary significantly from the table values dependent on several factors such as growing-season conditions, hybrid, and general fertility of the soil. Further, while P has low mobility because it is present in organic forms, K is present in a highly soluble inorganic form. Thus, K amounts can be largely influenced by the amount and frequency of precipitation in the time elapsed since the crop reached maturity and the time the residue was removed from the field.

In determining nutrient removal and the actual value of crop residue, it is important to realize that there are components in addition to P and K. Crop residue also includes N, secondary macronutrients, and micronutrients, as well as organic carbon. The impacts of increased removal of these nutrients and organic carbon from residue removal are not as obvious in the short term as for P and K, but they will definitely carry consequences in the long term. While secondary macronutrients and micronutrients are not typically provided through fertilization in Illinois, greater removal can accelerate deficiency of these nutrients in the soil. Removal of basic cations (such as K, Ca, and Mg) can lead to an increase in the need to lime soils to maintain adequate pH levels. Nitrogen reserves, as well as organic matter depletions, can lead to less crop availability of N through the process of mineralization (conversion of organic N to inorganic forms). Diminishing organic carbon contents can also result in negative impacts on soil physical, chemical, and biological properties. Thus, all factors, including nutrient removal and soil resources, should be carefully considered when estimating the actual cost of crop residue removal.

Fertilizer Sources

MAP vs. DAP. Monoammonium phosphate (MAP) and diammonium phosphate (DAP) are the most common P sources. The main difference between these two products is the amount of P and N present in the fertilizer and the initial chemical reaction that takes place in the soil when they are applied. Both products are made by ammoniation of phosphoric acid. The grade for MAP varies (11-51-0, 10-50-0, 11-55-0, etc.) because the phosphoric acid quality for MAP is lower than for DAP (which can be sold only as 18-46-0). As phosphate rock quality declines in the mines, MAP production is favored. When applied in the soil, MAP produces an acidifying reaction that can prevent the formation of toxic levels of ammonia, while DAP produces an alkaline reaction and the formation of ammonia. However, these initial differences diminish within a month or two, and no agronomic differences are typically observed between the two P sources.

Solubility of phosphorus. The water solubility of the P_2O_5 listed as available on the fertilizer label is of little importance under typical field crop and soil conditions on soils with medium to high levels of available P when recommended rates of application and broadcast placement are used. Due to rapid interaction of P fertilizer with iron and aluminum, P is tightly bound in the soil, so water solubility does not imply great movement or leaching.

For some situations, water solubility is important:

- For band placement of a small amount of fertilizer to stimulate early growth, at least 40% of the P should be water-soluble for application to acidic soils, and preferably 80% for calcareous soils. As shown in **Table 8.7**, the P in nearly all fertilizers commonly sold in Illinois is highly water-soluble. Phosphate water solubility above 80% has not been shown to increase yield any further than water solubility of at least 50%.
- For calcareous soils, a high degree of solubility in water is desirable, especially on soils that are shown by soil test to be low in available P.

White vs. red potash. Both red and white potash are muriate of potash (potassium chloride, or KCl). When the ore is mined it is reddish in color due to iron impurities. Depending on the processing and recovery method, the iron impurities are either removed or are left on the final product. Red potash is produced by grinding and flotation, while white potash is produced by dissolution and recrystallization in which iron is removed from the final product. Red potash is 0-0-60, and white potash is slightly more pure 0-0-62. Both forms are highly soluble and contain approximately 47% chloride. The difference in the amount of sodium is significant enough to produce any differences in the crops. Red potash contains approximately 4% sodium and white potash about 1%; there are no agronomic differences between the two products.

Noncommercial fertilizer sources. Livestock manure, sewage sludge, and some industrial waste materials are effective sources of plant nutrients. Since many of the nutrients in these materials are in the organic form and since the ratio of N to P is often not in the same proportion as removed by the plants, these materials require special management to ensure that an adequate supply of plant nutrients will be available. Whenever possible, the allocation of these products should be based on P, not N, needs of the crop to minimize the potential for long-term buildup of P in the soil. The amount of nutrients present in these products is animal- and management-specific. In order to apply adequate nutrient rates, the quantities contained in these materials need to be determined through chemical analysis, if details are not already provided by the supplier. Table 9.6 (p. 132) shows average nutrient values that can be used as a general reference for different materials. In equivalent bases of commercial fertilizer, P and K availability from these sources is normally 80% and 85%, respectively. A large percentage of both P and K will be available the first year after application, and approximately 10% of the original amount will be available the second year.

Table 8.7. Water solubility of some common processed-phosphate materials.

Material	% P_2O_5	% water-soluble
Ordinary superphosphate 0-20-0	16–22	78
Triple superphosphate	44–47	84
Mono-ammonium phosphate 11-48-0	46–48	100
Di-ammonium phosphate 18-46-0	46	100
Ammonium polyphosphate 10-34-0, 11-37-0	34–37	100

Placement of Fertilizers

Selecting the proper application technique for a particular field depends at least in part on the inherent fertility level, the crop to be grown, the land tenure, and the tillage system. On fields where the fertility level is at or above the desired goal, method of placement is often irrelevant. In contrast, on low-testing soils and in soils with high P- and K-fixing capacity, placement of the fertilizer within a concentrated band can be beneficial, particularly at low rates of application. On higher-testing soils, plant recovery of applied fertilizer in the year of application is usually greater from a band than a broadcast application, though yield differences are unlikely. Finally, there is no evidence suggesting that fertility levels can be maintained if fertilizer rates are reduced in a band application.

Broadcast fertilization. Broadcast and incorporation by plow or disk is an effective method to apply buildup and maintenance rates of P and K on soils with adequate fertility. This system, particularly when the tillage system includes a moldboard plow every few years, distributes nutrients uniformly throughout the entire plow depth. As a result, roots growing within that zone have access to high levels of fertility. Because the nutrients are intimately mixed with a large volume of soil, opportunity exists for increased nutrient fixation on soils having high fixation ability. Fortunately, most Illinois soils do not have high fixation rates for P or K.

Relatively immobile materials such as limestone, P, and K move slowly in most soils unless they are physically mixed by tillage operations. Broadcast applications of these materials in no-till or other forms of conservation tillage (including chisel plow) cause vertical stratification of nutrients, with higher concentrations developing near the surface. Such stratification has not been shown to reduce yields of corn or soybeans in Illinois. Among other factors, this is likely because crops develop more roots near the soil surface in conservation tillage systems, due apparently to both the improved soil-water conditions caused by the surface mulch of crop residues and the higher levels of available nutrients.

When doing a broadcast application it is important to maintain uniformity across the application width, do the correct amount of overlap, and have an applicator control system that maintains application rate per unit of soil surface constant independent of ground speed. When using dry bulk blends, ensure that materials are as uniform as possible in size, density, and distribution in the fertilizer bin. For liquids, maintain solution well mixed in the tank, and check nozzles for clogging.

Starter or row fertilization. This is an application below and to the side of the seed (typically 2 inches below and 2 inches to the side, also known as 2x2 placement). Other techniques to attain a starter response include application in direct contact with the seed ("pop-up" fertilization, described later) and placement on the soil surface near the seed row. These methods have not shown the consistency of crop response observed for the 2x2 technique. On soils of low fertility, 2x2 placement of fertilizer has been shown to be an efficient method of application, especially when the rate of application is markedly less than that needed to build the soil to the desired level. Producers who are not assured of having long-term tenure on the land may wish to consider this option. The major disadvantages of row fertilization are the additional time and labor required at planting time, limited contact between roots and fertilizer, and inadequate rate of application to increase soil levels for future crops.

Wet and cool soil conditions early in the season can limit plant growth and nutrient uptake. This is typically a greater concern in no-till fields where the high surface residue content has a mulching effect. Row fertilization promotes rapid and uniform corn growth when cool and wet soil conditions are present, even in soils with high fertility. At high soil test levels, the early growth response to starter seldom results in increased yield at harvest. This early growth response to starter occurs because the fertilizer band provides a high nutrient concentration when uptake demands are high relative to the small size of a root system with reduced growth and nutrient uptake capacity due to unfavorable soil conditions. For this reason, even when a large amount of fertilizer is being added by broadcast, starter applications are recommended on soils with low to medium fertility to ensure adequate nutrient supply to corn seedlings.

The greatest response to starter in corn is given by N, followed by P. Potassium produces the smallest response, and typically only when K test levels are low or when soil conditions are limiting nutrient uptake. Nitrogen in the band can increase P uptake by maintaining this nutrient in a more available form. Also, roots proliferate in response to N and P, so a band containing these two nutrients can increase nutrient availability by producing more roots to absorb the nutrients. The use of urea in the band, however, is not recommended since its hydrolysis produces ammonia, which inhibits root growth and thus negatively impacts P uptake. Since salt content can also injure roots, it is recommended not to exceed 75 and 100 pounds of salt (N plus K_2O) per acre in a starter application for soybean and corn, respectively. However, research has shown that under some conditions as much as 200 pounds of N per acre can be applied in a 2x2 placement without injuring corn. Although rarely done, a 2x2 placement can supply all the P and K maintenance for one crop.

In contrast to corn, soybean response to starter is unlikely if soil fertility is medium to high or if an adequate broadcast application of P and K was done in a low-testing soil. The difference is likely related to the distinct root system of both crops and the fact that soybeans are planted later, when soil conditions are less limiting for nutrient uptake.

Seed placed, or "pop-up," fertilization. With this method a small amount of fertilizer is applied directly with the seed. The term "pop-up" is misleading. Corn does not emerge sooner; in fact, it may be delayed a few days with this kind of application. While corn may grow more rapidly during the first 1 to 2 weeks after emergence, seldom will there be a yield difference compared to a 2x2 placement.

Some advantages for this placement method include lower equipment cost, faster planting (fewer fertilizer fill-up stops during planting), and the possibility for early cultivation for weed control due to faster growth of the crop. However, seed-placed fertilization is a risky operation. Under normal moisture conditions, the maximum safe amount of salt (N plus K_2O) for pop-up placement is about 10 or 12 pounds per acre. In excessively dry springs, or sandy soils with very low CEC (less than 8), even these low rates may result in damage to seedlings and/or reduction in germination. Urea or urea-containing fertilizers as well as micronutrients should not be used in direct contact with the seed.

Soybean is more sensitive to salt than is corn, so pop-up fertilization is not recommended for soybean.

Wheat is very responsive to P, especially under low-test levels. Because of narrow rows in wheat, there are fewer options for starter fertilizers than in corn. For this reason, starter P (normally 10-34-0, 18-46-0, or 11-52-0) is often placed with the seed. The small amount of N in the fertilizer can also help the crop when no pre-plant N was applied or when little carryover N is available from the previous crop.

For perennial forage crops, 30 pounds of P_2O_5 and up to 30 to 40 pounds of K_2O per acre can be applied safely when using a band seeder. This large amount of K is safe because the rate per acre is distributed over more rows (less fertilizer in direct contact with the seed) compared to a wider 30-inch row planter.

Strip application. With this technique, P, K, or both are applied in narrow bands on approximately 30-inch centers on the soil surface, in the same direction as the primary tillage. The theory behind this technique is that, after moldboard plowing, the fertilizer will be distributed in a narrow vertical band throughout the plow zone. This system reduces the amount of soil-to-fertilizer contact as compared with a broadcast application and thus reduces the potential for nutrient fixation. Because the fertilizer is distributed through a larger soil volume than with a band application, the opportunity for root-fertilizer contact is greater.

Deep fertilizer placement. Several terms have been used to define this technique, including root-zone banding, dual placement, knife injection, and deep placement. With this system any combination of N, P, and K can be injected at a depth of 4 to 8 inches. The knife spacing varies, but generally it is 15 to 18 inches apart for close-grown crops such as wheat and 30 inches for row crops. This placement technique is often used in combination with strip-tillage operations. With this tillage system, greater early growth and increase in corn yield, compared to a no-till system, often is the result of tillage in strip-till and not the method of nutrient placement. Under low-testing soils, when surface soil conditions are dry and subsurface water content is still adequate, subsurface placement (especially for K) can be advantageous for corn in reduced tillage systems. However, the small yield increase that can be expected is not cost-effective in light of the added cost of deep placement. It is important to realize that if the application is deep, it takes a longer time for the roots to reach the fertilizer. This can be a problem in years when growing conditions limit root development. If a deep placement is chosen in low-fertility soils, applying a starter fertilizer is recommended. Another situation in which subsurface applications may be beneficial (as long as the subsurface band application does not create a channel for water and soil movement) is when the potential for surface water runoff is high.

Site-specific or variable-rate application. This application method uses several remote sensing technologies, yield monitors, global positioning systems (GPS), geographical information systems (GIS), and variable-rate technology (VRT). These technologies can improve the efficacy of fertilization and promote more environmentally sound placement of fertilizer compared to single-rate applications derived from the conventional practice of collecting a composite soil sample to represent a large area of the field. Research has shown that this technology often reduces the amount of fertilizer applied over an entire field. However, one of the drawbacks of this placement method is the expense associated with these technologies. Also, VRT can only be as accurate as the soil test information used to guide the application rate. At this point, due to the inherent high variability in soil testing over small distances and the fact that most soils where these technologies are being used have been managed to have reserved P and K levels, the technology has seldom produced significant yield increases.

Foliar fertilization. It is well known that plant leaves absorb and utilize nutrients sprayed on them. Foliar fertilization can be effective for nutrients required in small amounts by plants. Nutrients required in large amounts, such as N, P, and K, are recommended to be soil-applied rather than foliar-applied. Foliar applications can only supply very small amounts of the total nutrients needed by crops. Because it would take many applications to supply the needed amounts without burning leaves, foliar application of major nutrients is neither practical nor cost-effective.

Environmental Considerations

Phosphorus has been identified as an important pollutant to surface waters. At very low concentrations, it can increase eutrophication of lakes and streams, which leads to problems with their use for fisheries, recreation, industry, and drinking water. Although eutrophication is the natural aging process of lakes and streams, human activities can accelerate the process by increasing the concentration of nutrients flowing into water systems. Since P is the element most often limiting eutrophication in natural water bodies, controlling its input into lakes and streams is very important.

There are concerns that agricultural soils may be important contributors to eutrophication. Normally about 5% of the soil P is soluble or easily soluble (labile) and can be lost in surface water runoff; the remaining 95% is tightly bound to soil particles. When the soil particles end up in the water, chemical equilibrium reactions release some of the absorbed P into the water. Thus, erosion control and reduction of P levels in the very surface of the soil are the best ways to minimize P loss. The following practices can help minimize P loss from agricultural fields:

1. Do not maintain excessively high-P soil test levels. While soil test procedures were designed to predict where P was needed, not to predict environmental problems, the likelihood of P loss increases with high-P

test levels. Of course, environmental decisions regarding P applications should not be made solely on P soil test levels. Rather, decisions should also include such factors as distance from a significant lake or stream, infiltration rate, slope, and residue cover. One possible problem with using soil test values to predict environmental problems is in sample depth. Normally samples are collected to a 7-inch depth for predicting nutritional needs. For environmental purposes, it would often be better to collect the samples from a 1- or 2-inch depth, which is the depth that will influence P runoff. Another potential problem is variability in soil test levels within fields in relation to the dominant runoff and sediment-producing zones.

2. Maintain buffer strips (grassy waterways, vegetative filter strips, or constructed wetlands) at the point where water leaves the field.
3. Minimize soil erosion and surface water runoff by protecting soils with residue cover, conservation tillage, the use of cover crops, farming on contours and having contour buffer strips, reducing soil compaction and increasing soil-water permeability, and maintaining subsurface drainage systems, which allow excess water to move out of the field in the tiles and not on the surface. Although some of these practices may not reduce the potential for loss of dissolved P, they will reduce the potential for loss of total P.
4. Do not leave manure or P fertilizers on the soil surface. Incorporating or injecting these products not only reduces the potential for P runoff, it also reduces the potential for N volatilization and reduces odor of manure applications.
5. Match nutrient applications to crop needs. This will minimize the potential for excessive buildup of P soil tests and reallocate P sources to fields or areas where they can produce agronomic benefits.
6. Where possible, grow high-yielding, high-P-removing crops on fields that have excessively high-P soil test levels. Even when this is done, it may take several years to lower very high levels.

Time of Application

While an annual application of P and K in a corn–soybean rotation is effective, it is possible to apply enough nutrients in any one year to meet the needs of the crops to be grown in the succeeding 2 to 3 years. Biennial applications are often preferred to reduce application costs. With biennial applications, it is recommended that you apply the fertilizer required for both crops before the corn crop and make soybean a residual feeder in the rotation.

P and K fertilizers may be applied in the fall to fields that will not be fall-tilled, provided that the slope is less than 5%. Do not apply fertilizer in fall to fields that are subject to rapid runoff. When the probability of runoff loss is low, soybean stubble need not be tilled solely for the purpose of incorporating fertilizer. This statement holds true when ammoniated phosphate materials are used as well, because the potential for volatilization of N from ammoniated phosphate materials is insignificant. P and K applications are preferred in the fall because normally there is more time available than during the spring planting season, and soil conditions tend to be less conducive to compaction. One drawback of fall P application is that the small amounts of N accompanying ammoniated phosphate fertilizers are subject to nitrification and potential loss. A three-year study in Urbana showed total N recoveries at the end of May to be 17% and 45%, respectively, for fall- and spring-applied ammoniated phosphates (MAP and DAP).

For double-crop soybeans after wheat, it is suggested that P and K fertilizer required for both crops be applied before seeding wheat. This practice reduces the number of field operations at planting time and hastens soybean planting. Also, wheat can benefit by having abundant P available during early establishment.

For perennial forage crops, broadcast and incorporate all of the P and K buildup and as much of the maintenance as economically feasible before seeding. After establishment, top-dressed applications of P and K may be made at any convenient time. Usually this will be after the first harvest or in September.

Secondary Nutrients

As previously mentioned, since response to application of secondary nutrients is uncommon in Illinois, there is not a large database to correlate and calibrate soil test procedures; thus, low confidence can be placed in the suggested soil test levels offered in **Table 8.8**.

Calcium deficiencies in Illinois have not been observed for soils with pH at or above 5.5. Calcium deficiency associated with acidic soils can be corrected by adjusting soil pH with limestone.

Table 8.8. Suggested soil-test levels for secondary nutrients.

Soil type	Levels adequate for crop production (lb/A)		Rating	Sulfur (lb/A)
	Calcium	Magnesium		
Sandy	400	60–75	Very low	0–12
Silt loam	800	150–200	Low	12–22
			Response unlikely	22

Magnesium deficiency has been recognized in isolated situations in Illinois. The soils most likely to be deficient in Mg include acidic and sandy soils throughout Illinois and low CEC soils in southern Illinois. Deficiency is more likely where calcitic limestone ($CaCO_3$) rather than dolomitic limestone ($CaMg[CO_3]_2$) has been used.

The number of incidents with sulfur-deficient crops in the Midwest has increased, probably the result of increased use of S-free fertilizer; decreased use of S as a fungicide and insecticide; increased crop yields, resulting in increased requirements for all of the essential plant nutrients; and decreased atmospheric S supply. Despite the increasing frequency of S deficiency reports, crop responses to S applications in Illinois have been inconsistent. Routine application of S fertilizer is thus not recommended.

If an S soil test is performed, evaluate whether an S response is likely by also considering organic matter level, potential atmospheric S contributions, subsoil S content, and soil-water conditions just before soil samples were taken. Since soil organic matter is the primary source of S, soils low in organic matter are more likely to be deficient than soils with higher organic matter (>2.5%). Early-season S symptoms may disappear as rainfall contributes some S (especially downwind from industries emitting significant S amounts) and as root systems develop to exploit greater soil volume. Sulfur is also a very mobile nutrient. In sandy soils under excess precipitation, leaching may result in low test values of samples collected from the soil surface. Conversely, if the soil surface is dry and hot at the time of sampling, test results can overestimate the capacity of the soil to supply this nutrient during the entire growing season. For these reasons, if a soil test is unexpectedly low, use S only on a trial basis.

Micronutrients

Boron (B), chlorine (Cl), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), and zinc (Zn) are the seven essential micronutrients (also known as minor or trace elements). Although these nutrients are required only in small (micro) amounts, if any of them is deficient, it can result in severe yield reduction. Deficiencies of these nutrients are not common, making it challenging to study and to correlate and calibrate soil tests. Micronutrient tests thus have very low reliability and usefulness. Suggested levels for each test are provided in **Table 8.9**. In most cases, however, plant analysis will provide a better estimate of micronutrient needs than the soil test. **Table 8.2** shows critical plant-nutrient levels for various crops.

In general, deficiencies of most micronutrients are accentuated by one of five situations: strongly weathered soils, coarse-textured soils, high-pH soils, organic soils, and soils low in organic matter, either inherently or because erosion or land-shaping processes have removed the topsoil.

The use of micronutrient fertilizers should be limited to areas of known deficiency, and only the deficient nutrient should be applied. An exception to this guideline would be situations in which farmers already in the highest yield bracket try micronutrients experimentally in fields that are yielding less than would be expected under good management, which includes an adequate N, P, and K fertility program and a favorable pH.

Confirmed deficiencies of micronutrients in Illinois have been limited to B deficiency of alfalfa, Zn deficiency of corn, and Fe and Mn deficiencies of soybean. To identify areas before micronutrient deficiencies become important, continually observe the most sensitive crops in soil situations in which the elements are likely to be deficient (**Table 8.10**).

Boron deficiency in alfalfa results in shorter internodes and bunching of top leaves that are typically yellow-reddish. Some plants might not flower, and under severe deficiency, growing points may die. Deficiency symptoms typically appear on the second and third cuttings of alfalfa and are especially pronounced during droughty periods in some areas of Illinois. Application of B on soils with less than 2% organic matter is recommended for areas of high alfalfa production. If you suspect B deficiency, a simple test is to apply 30 pounds per acre of household borax (3.3 lb of B) to a strip. To make application easier, B can be added to the P–K fertilizer. Generally 1 to 2 pounds of B per acre can be applied yearly to sandy soil. On finer-textured soils, 3 to 4 pounds of B per acre can be applied in the first hay year to correct the deficiency for a few years. Oats are sensitive to B. If oats accompany alfalfa during the establishing year, it is better to apply B after the first year. Foliar applications of 0.1 to 0.3 pounds of B per acre are recommended for severely deficient fields. Do not apply B to alfalfa the year before corn. Both corn and soybean have

Table 8.9. Suggested soil-test levels for micronutrients.

Micronutrient and procedure	Soil-test level (lb/A)		
	Very low	Low	Adequate
Boron—hot-water soluble	0.5	1	2
Iron—DTPA	—	<4	>4
Manganese—DTPA	—	<2	>2
Manganese—H_3PO_4	—	<10	>10
Zinc—.1N HCl	—	<7	>7
Zinc—DTPA	—	<1	>1

Table 8.10. Soil situations and crops susceptible to micronutrient deficiency.

Micronutrient	Sensitive crop	Susceptible soil situations	Conditions favoring deficiency
Zinc (Zn)	Young corn	Low in organic matter, inherently or from erosion or land shaping Restricted root zone High pH (>7.3) Coarse-textured (sandy) soils Very high phosphorus Organic soils	Cool, wet
Iron (Fe)	Soybeans, grain sorghum	High pH	Cool, wet
Manganese (Mn)	Soybeans, oats	High pH Organic soils Restricted root zone	Cool, wet
Boron (B)	Alfalfa	Low organic matter Strongly weathered soils (south-central Illinois) High pH Coarse-textured (sandy) soils	Drought
Copper (Cu)	Corn, wheat	Infertile sand Organic soils	Unknown
Molybdenum (Mo)	Soybeans	Acidic, strongly weathered soils (south-central Illinois)	Unknown
Chlorine (Cl)	Unknown	Coarse-textured soils	Excessive leaching by low-Cl water

low requirements for B and can suffer toxicity if the previous alfalfa crop received heavy or repeated B applications.

Zinc deficiency in corn is characterized by interveinal light green to whitish bands from the base to the tip of new leaves. Normally the edge of the leaf, including the tip, and the midrib area stay green, but in cases of severe deficiency the new leaves can be completely white. Also, corn plants will look stunted and have shorter internodes. Applications of 5 and 10 pounds of Zn per acre are recommended for band and broadcast applications, respectively. If a chelated product is used, follow the manufacturer's directions.

Iron deficiency in soybean appears in new leaves, typically at early stages of development. The entire leaf blade turns yellow except for the veins, which remain green. The growth is often stunted. Foliar applications are more effective in restoring green color. Typically 1 to 2 pounds of Fe per acre are recommended. When using chelated products, follow the manufacturer's directions. Research in Minnesota has shown that for soybean, time of Fe application is critical to attaining a response. Apply 0.15 pounds of Fe as Fe chelate per acre to leaves within 3 to 7 days after chlorosis symptoms develop (usually in the second-trifoliate stage of growth). Waiting for soybeans to grow to the fourth- or fifth-trifoliate stage before applying Fe would result in no yield increase.

Manganese deficiency in soybean causes stunted plants with green veins in yellow or whitish newer leaves and typically occurs in late May and June if the weather turns cool and wet. To correct Mn deficiency in soybean, spray either manganese sulfate or an organic Mn formulation onto the leaves after the symptoms appear. Broadcast applications on the soil are not recommended; band applications of 5 to 8 pounds of Mn per acre can be effective. Foliar applications of 0.5 pounds of Mn per acre are recommended. For chelated products, follow the manufacturer's directions. Foliar applications of MnEDTA at rates as low as 0.15 pounds of Mn per acre in mid-June to soybean planted in early May have shown significant yield increases. Similarly, multiple applications or delaying applications to early July have been beneficial.

Nontraditional Products

Many products circulate the fertilizer market claiming to replace fertilizers and to cost less, to make nutrients in the soil more available, to supply micronutrients, or to be a natural product. Those promoting the products typically use testimonials by farmers and present data from suspect sources. The best approach that producers can take is to challenge these peddlers to produce unbiased research results in support of their claims.

Extension specialists at the University of Illinois are ready to give unbiased advice when asked about new products. An additional resource entitled *Compendium of Research Reports on Use of Non-traditional Materials for Crop Production* contains searchable data on a number of nontraditional products that have been tested by university researchers in the U.S. The publication can be accessed at extension.agron.iastate.edu/compendium.

Attachment 36:

Phosphorus Runoff from Incorporated and Surface-Applied Liquid
Swine Manure and Phosphorus Fertilizer
Daverede et al. 2004

Phosphorus Runoff from Incorporated and Surface-Applied Liquid Swine Manure and Phosphorus Fertilizer

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ABSTRACT

Excessive fertilization with organic and/or inorganic P amendments to cropland increases the potential risk of P loss to surface waters. The objective of this study was to evaluate the effects of soil test P level, source, and application method of P amendments on P in runoff following soybean [*Glycine max* (L.) Merr.]. The treatments consisted of two rates of swine (*Sus scrofa domestica*) liquid manure surface-applied and injected, 54 kg P ha^{-1} triple superphosphate (TSP) surface-applied and incorporated, and a control with and without chisel-plowing. Rainfall simulations were conducted one month (1MO) and six months (6MO) after P amendment application for 2 yr. Soil injection of swine manure compared with surface application resulted in runoff P concentration decreases of 93, 82, and 94%, and P load decreases of 99, 94, and 99% for dissolved reactive phosphorus (DRP), total phosphorus (TP), and algal-available phosphorus (AAP), respectively. Incorporation of TSP also reduced P concentration in runoff significantly. Runoff P concentration and load from incorporated amendments did not differ from the control. Factors most strongly related to P in runoff from the incorporated treatments included Bray P1 soil extraction value for DRP concentration, and Bray P1 and sediment content in runoff for AAP and TP concentration and load. Injecting manure and chisel-plowing inorganic fertilizer reduced runoff P losses, decreased runoff volumes, and increased the time to runoff, thus minimizing the potential risk of surface water contamination. After incorporating the P amendments, controlling erosion is the main target to minimize TP losses from agricultural soils.

Intensive livestock farming enterprises that concentrate large numbers of animals indoors, particularly non-ruminants, have emerged as a result of improvements in animal housing and the success of crop production on cash-crop farms (Beegle et al., 2000). The cost of transporting low-density manure more than short distances from livestock farms to cash-crop farms exceeds its nutrient value. Therefore, most animal waste is land-applied near the animal production facility. The dominant geology, soils, and topography of the local area are often not considered before manure application (Sharpley et al., 1994). Continued inputs of fertilizer and manure in excess of crop P requirements have led to a buildup of soil P levels, which are of environmental rather than agronomic concern (Sharpley et al., 1994).

Phosphorus transported by surface runoff to streams and lakes often accelerates eutrophication, thus affecting the usage of water resources for many purposes such as drinking, fishing, and recreation (Foy and Withers, 1995). The transport of P occurs in dissolved and particulate forms. Particulate phosphorus (PP) encompasses all solid-phase forms and includes P sorbed by soil particles and organic matter eroded during runoff. While dissolved P is, for the most part, immediately available for biological uptake, PP can provide a long-term source of P for aquatic plant growth. Algal-available P represents the dissolved phase and the amount of PP that is potentially available for algal uptake (Sharpley et al., 1991).

The main factors controlling P movement in surface runoff are transport (runoff and erosion) and source factors (surface soil P content and method, rate, and timing of fertilizer and animal manure applications) (Sharpley et al., 1993). High rates of P applied either as a fertilizer or manure, particularly if it is left on the soil surface, will exacerbate the potential for movement of DRP from fields (Baker and Laflen, 1982; Mueller et al., 1984). Incorporation of P materials either through tillage or through injection will generally reduce the potential for DRP runoff (Eghball and Gilley, 1999; Withers et al., 2001; Tabbara, 2003). On the other hand, tillage operations may increase the potential for TP loss, especially on highly erosive sites. Eghball and Gilley (1999) found that runoff DRP and AAP concentrations were greater for no-till than disked treatments during two consecutive simulated rainfall events on wheat (*Triticum aestivum* L.) residue plots with a 6% slope. In contrast, concentrations of TP and PP were greater for the disked treatments compared with the no-till plots. Cox and Hendricks (2000) reported a more than threefold increase in TP concentration in runoff from conventionally tilled compared with no-till soils for a wide range of soil P levels on 2 to 6% slopes.

Runoff transport of P from surface-applied manure increases with the application rate. Edwards and Daniel (1993) observed that DRP and TP concentration in runoff from fescue (*Festuca arundinacea* Schreb.) plots was directly related to swine slurry application rate. Tabbara (2003) also found a proportional increase in TP, PP, AAP, and DRP concentration and load in runoff from fallow soils when surface-applied liquid swine manure rates were doubled.

Phosphorus losses from treatments that compare inorganic versus organic amendments tend to vary among different experiments. Eghball and Gilley (1999) observed that the concentrations of DRP and AAP in

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Abbreviations: AAP, algal-available phosphorus; DRP, dissolved reactive phosphorus; HM, high manure rate; LM, low manure rate; 1MO, first rainfall simulation (one month after treatment application); 6MO, second rainfall simulation (six months after treatment application); PP, particulate phosphorus; TP, total phosphorus; TSP, triple superphosphate.

runoff were significantly greater for a fertilizer treatment than two rates of beef cattle feedlot manure when all were surface-applied before an initial rainfall event. However, in a second rainfall event, increased DRP and AAP in runoff resulted from the highest manure rate. Withers et al. (2001) observed that P runoff from TSP was similar to liquid cattle manure when it was either surface-applied or incorporated with a rotovator. Tabbara (2003) found higher concentrations and load of all P forms from plots receiving broadcast P fertilizer compared with plots receiving surface-applied liquid swine manure.

Rainfall frequency and time of rainfall occurrence after the application of manures or fertilizers have also been shown to affect P runoff. Sharpley (1997) studied the effects of rainfall frequency and timing on P runoff after poultry litter had been applied to different soils. He observed decreasing concentration of P after successive rainfall events. Dissolved reactive P and AAP decreased when the rainfall event occurred 35 d compared with 1 d after the poultry litter had been applied. Similar trends were reported by Westerman and Overcash (1980) for TP runoff from swine and poultry wastes applied over fescue grass.

The objectives of this study were to (i) determine the effect of placement of P-containing materials on the concentration and load of three P forms (DRP, AAP, and TP); (ii) determine the effect of P source and rate on P in runoff; (iii) determine the relationship between soil test P levels and P in runoff; and (iv) evaluate P in runoff 1 and 6 mo after the treatment application.

MATERIALS AND METHODS

Study Site and Experimental Design

The study was conducted from 1999 to 2001 at the Northwestern Illinois Agricultural Research and Demonstration Center, Monmouth, IL, on a Tama silt loam soil (fine-silty, mixed, mesic Typic Argiudoll). The texture of the A horizon has an average of 24% clay, 70% silt, and 6% sand. Average pH and organic matter content are 6.1 and 37 g kg^{-1}, respectively. Mean annual precipitation in the area is 940 mm. Figure 1 details monthly averages of natural rainfall and air temperatures measured at the study site.

The experiment was done as a randomized complete block design with two repetitions and two observations per plot (1 and 6 mo after P amendment applications). The treatment structure was a $4 \times 2 \times 4 \times 2 \times 2 \times 2$ factorial arrangement generated from four P source amendments (HM, LM, TSP, and a control), two application methods (chisel plow or injection and surface application), four Bray P1 extraction levels, two years, two blocks per year, and two times (1 and 6 mo after P amendment application). Each block contained thirty-two 9- by 6-m unit plots, with a 5.5% mean slope.

Plot Establishment and Treatment Application

To obtain four categories of soil P levels ranging from 30 to 300 mg kg^{-1}, each 9- by 6-m main plot was soil sampled from 0 to 2.5 cm on 3 May 1999 and sent to a commercial lab (for rapidity), to be analyzed by the Bray and Kurtz P1 soil extraction method. Triple superphosphate was broadcast to every main plot based on the soil test and every treatment combination was then randomly assigned to each soil P level category. A field cultivator was used to mix and prepare the soil that was going to be used for Year 1, and soybean was planted on 19 May 1999 at 38-cm row spacing. Meanwhile, the adjacent field that was going to have soybean planted in 2000 to repeat the experiment was being planted with corn (*Zea mays* L.), having being tilled with a field cultivator to incorporate the phosphorus fertilizer.

In early October 1999, after the soybean crop was harvested, soil samples were collected from the outside perimeter of the microplots of Year 1 to be analyzed for Bray P1 soil extraction levels and by a water-extractable P method. Simulated rainfall collection microplots 2 by 1.5 m were delimited by flags at the center and lower part of the 9- by 6-m main plots. Simulated rainfall took place only on the 2- by 1.5-m microplots. The shorter sides of microplots and main plots were perpendicular to the slope. The same experimental design was set up again in late September 2000 on an adjacent site to repeat the experiment. This field had residue from soybean that had been planted on no-till at 38-cm row spacing. Before the first rainfall simulation, soil samples were collected from the outside perim-

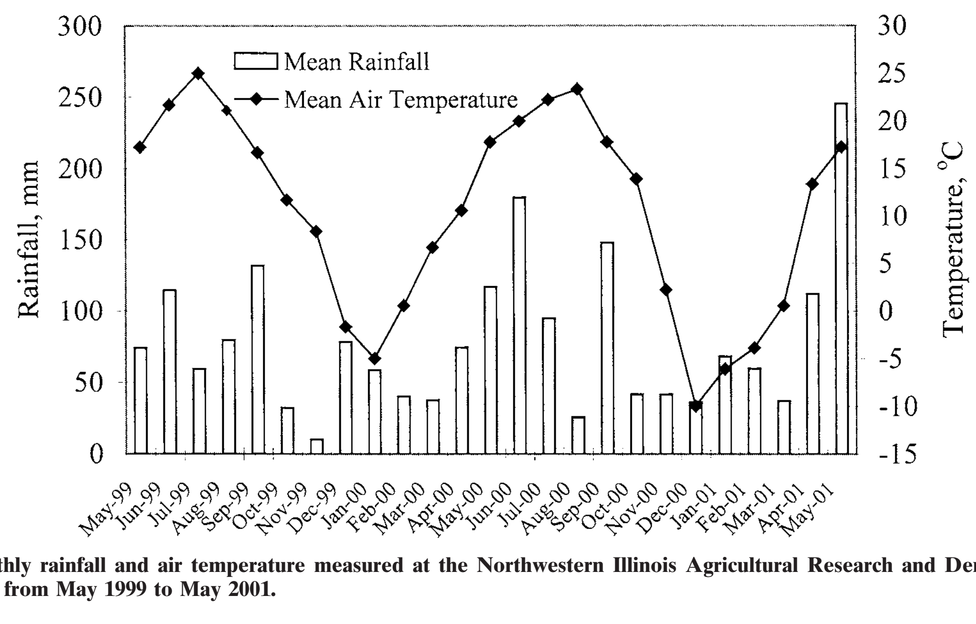

Fig. 1. Mean monthly rainfall and air temperature measured at the Northwestern Illinois Agricultural Research and Demonstration Center, Monmouth, IL, from May 1999 to May 2001.

eter of the Year 2 microplots and were later analyzed for Bray P1 soil extraction levels and by a water-extractable P method. The range of Bray P1 soil extraction values for both years was 27 to 1248 mg kg^{-1}, which was many times greater than the range sought originally. We found out that the commercial lab had not been diluting the samples with high P levels so many of the Bray P1 extraction values from May 1999 were extremely underestimated. The corrected Bray P1 extraction values for each category are found in Table 1.

In mid-October 1999 and early October 2000, after the plots had been delimited but before framing the microplots, liquid swine manure with 98% moisture (SD = 0.28) was surface-applied and row-injected at rates of 46 680 and 93 370 L ha^{-1} and 54 kg ha^{-1} of P as TSP was surface-broadcast. In 1999, the manure volumes represented 39.4 and 78.6 kg P ha^{-1} for LM and HM, respectively, and in 2000, they represented 33.1 and 66.2 kg P ha^{-1} for LM and HM, respectively. The TSP and control treatments included both no-till and chisel plow to a depth of 25 cm, perpendicular to the slope. Manure was injected in a horizontal band at a 10-cm depth and 76-cm spacing using an injector with disk sweeps. Plots with injected manure were not chisel-plowed. Manure was surface-applied by spreading it back and forth within the plot limits and across the slope with a hand-held hose connected to a supply tank for a certain amount of time, depending on the rate assigned to the plot.

After the P amendments were applied, each microplot was isolated with three plastic frames: the 2-m-long and 20-cm-wide frames were set along the slope and the 155-cm-long and 15-cm-wide frame was set across the slope and at the top side of the microplot. A 155-cm-wide by 76.2-cm-long collection triangle was attached at the downhill side above a 50.2-cm-diameter by 76.2-cm-high cylindrical plastic container that had been inserted into a hole augered into the soil. The barrel was uncovered during rainfall simulation, but the collection triangle was always covered to prevent rainfall simulation water from drifting onto it and flowing into the barrel. The plastic frames (1.3-cm-thick) were inserted 5 cm into the soil. An extra 7 cm at the top of the collection triangle (adjacent to the lower part of the microplot) was bent 90 degrees, and this part was inserted into the soil to prevent water from flowing under the triangle. Residue-cover percentage was determined subsequently by the line-transect method (Shelton et al., 1992). The collection equipment was left in place until the following rainfall simulation (6MO). In November 1999, the microplots were brought to field capacity 24 h before rainfall simulation using a hose connected to a water tank. This was done because soils were very dry due to lack of natural rainfall and we sought to minimize the effect of soil moisture on runoff.

Rainfall-Runoff Simulation and Sample Collection

Rainfall simulations were conducted at each of the microplots in mid-November 1999 and in mid-May 2000. The trial was repeated in late October 2000 and early May 2001. Four rainfall simulators (Humphry et al., 2002), each equipped with one nozzle (TeeJet 1/2HH-SS50WSQ; Spraying Systems, Wheaton, IL) placed 3 m above the soil surface, were used to simulate a 95 ± 12 mm h^{-1} intensity rainfall. Rainfall intensity was measured by placing rain gauges on the microplots during the rainfall simulations. The aluminum frame supporting the nozzle was fitted with tarpaulin sheets to provide a windscreen. The duration of simulated rainfall varied from microplot to microplot, but was sufficient to provide water for a 30-min runoff event. The water used for rainfall simulation came from a 76-m-deep aquifer near Monmouth, IL. This water was stored in a tank, and the DRP value of this water ranged from 0.02 to 0.12 mg L^{-1}, depending on the day of supply. In 6MO 2001, while sampling the last block, the hose used to transfer water from the main storage tank to the container used for the experiment was contaminated with high levels of P. All P runoff data obtained from the 19 subsequent rain simulations were discarded.

Runoff samples were collected from each microplot at 2.5, 7.5, 17.5, and 27.5 min after the onset of runoff. These numbers represented the midpoints of the first, second, fourth, and sixth 5-min periods of collection. The concentrations were weighted according to each runoff volume to collect one composite sample per experimental unit per time. Runoff volumes were recorded by measuring the depth of water in the bucket at each sampling time (including time 0) and after 30 min.

Table 1. Bray P1 soil extraction categories (32 observations per category) used in the factorial arrangement.

Soil P level categories	Average	Maximum	Minimum	Standard deviation
		mg kg^{-1}		
1	63	160	12	35
2	97	264	32	58
3	307	588	49	175
4	796	1600	288	255

Water and Soil Analysis

Within 12 h after sample collection, portions of the runoff samples for DRP analysis were filtered through Whatman (Maidstone, UK) no. 1 filter paper and then vacuum-filtered through a 0.45-μm Millipore (Billerica, MA) filter paper. After filtering, samples were stored at 4°C and were analyzed within 24 h for DRP using the ascorbic acid method (American Public Health Association, 1995).

Unfiltered portions of samples were stored at 4°C until analysis for AAP. Algal-available P was measured on unfiltered runoff samples using the iron-oxide strip method (Sharpley, 1993). Unfiltered samples were also analyzed for TP by a Kjeldahl digestion method (Patton and Truitt, 1992). Samples analyzed for both AAP and TP were neutralized before using the ascorbic acid method (American Public Health Association, 1995). This was done by adding two drops of phenolphthalein indicator solution to the filtered acid sample and subsequently adding drops of 10 *M* NaOH while swirling the bottle until the solution turned light pink. Phosphorus load (kg ha^{-1}) was calculated by multiplying the total volume of runoff in 30 min by the composite sample concentration. "Rainwater" DRP concentration was subtracted from the runoff P concentration. Runoff water sediments were measured by drying 10 mL of unfiltered water sample at 110°C until constant weight.

The Bray and Kurtz P-1 test for extracting soil P was used (Frank et al., 1998). Water-extractable P was determined by slightly modifying the method of Pote et al. (1996) by mixing 1 g of soil with 25 mL of distilled water, shaking for 1 h, and syringe-filtering through a 0.45-μm Millipore filter paper. The ascorbic acid method procedure was used for the color development of Bray P1 and water-extractable P. When the transmittance exceeded the standard curve, the extractant was diluted as needed. Soil organic matter was estimated as the weight loss on ignition (Combs and Nathan, 1998). Total P in manure was analyzed by the inductively coupled plasma atomic emission spectroscopy method SW846-6010B (USEPA, 1992). Soil pH was measured in a 1:1 soil to water slurry (Watson and Brown, 1998). Eight subsamples from around the microplot were collected for each soil sample, which was subsequently air-dried, crushed, and sieved to pass a 2-mm sieve. Clay content was determined by the hydrometer method (Klute, 1986) on 10 samples.

Data Analysis

The mixed model analysis for repeated measures was performed using the MIXED procedure of SAS (Littell et al., 2000; SAS Institute, 2001). Bray P1 extraction level was used as a covariate. The variance–covariance matrix was modeled with the unstructured option in SAS. Year and block within year were considered random variables. Time (1MO and 6MO), P source (HM, LM, TSP, and control), and two application methods (chisel plow or injection, and surface application or no-till) were considered fixed variables. The model included all possible interactions between time, P source and application method, and Bray P1 as a covariate. The repeating subject was the microplot nested in year × P source × application method. Means comparisons were performed using the Scheffé method (Scheffé, 1953) because it provides a conservative experimentwise error protection for any number of contrasts. P values <0.1 were considered significant when comparing means.

The incorporated data were analyzed by regression procedures using PROC REG (SAS Institute, 2001) with the stepwise selection method to select the independent variables that significantly affected the dependent variables ($P = 0.05$). Bray P1 soil extraction value, residue cover, and sediment concentration and load were used in the regression model as independent variables for DRP, AAP, and TP concentration and load. The Type II sums of squares were taken into account when assessing the relative contribution of each term in explaining the dependent variable.

RESULTS AND DISCUSSION

Time to Runoff, Runoff Volume, Sediment Concentration, and Residue Cover

The F and P values for the fixed effects in time to runoff, runoff volume, and sediment concentration are found in Table 2. The three-way interaction time × P source × application method was significant for time to runoff ($P < 0.1$). The longest time to runoff occurred in the incorporated amendments and the chisel-plowed control, averaging 1 h compared with an average of 9 min for the surface-applied treatments (Table 3). The interaction time × application method was significant for runoff volume, and the highest runoff volume resulted for the surface-applied treatments in 1MO, averaging 16.5 mm. Plots with incorporated treatments in 1MO and all the plots in 6MO resulted in significantly lower runoff volumes, averaging 5.9 mm.

The interaction P source × application method was significant for sediment concentration, and the highest values were observed for the chisel-plowed plots (control and TSP), averaging 4.1 g L^{-1}, followed by injected LM, HM, and the surface-applied treatments (that were not significantly different at $P = 0.1$) that altogether averaged 1.8 g L^{-1} (Table 3).

Residue cover was only measured before 1MO, and the interaction P source × application method was significant ($P < 0.0001$). The highest residue cover was observed in the no-till plots (surface-applied amendments and control) with an average of 92%, followed by the injected manure plots with an average of 61%, and the least residue cover was observed in the chisel-plowed plots, averaging 37% (Table 3). Residue cover was negatively correlated to sediment concentration ($r = -0.41$, $P < 0.0001$), and positively correlated to runoff volume ($r = 0.54$, $P < 0.0001$). The positive correlation of residue cover with runoff volume is most probably due to the relationship between residue cover percentage and application method since the highest residue cover percentage was measured in the no-till, surface-applied plots, which had the highest runoff volumes.

Soil Phosphorus

The relationship between Bray P1 soil extraction (mg kg^{-1}) and water-extractable soil P (mg kg^{-1}) in 2.5-cm-deep soil samples was linear, and the following equation was found:

$$B1 = 6.2 + 5.3WEP \quad [1]$$

where B1 (mg kg^{-1}) is Bray P soil extraction value and WEP (mg kg^{-1}) is water-extractable P ($R^2 = 0.96$, $P < 0.0001$).

Dissolved Reactive Phosphorus

Time × P source × application method interaction was significant for DRP concentration and load in runoff (Table 4). High DRP concentrations and loads were observed in runoff from plots that had been amended with surface-applied TSP and manure one month earlier (1MO) (Fig. 2 and 3). When these amendments were

Table 2. Type 3 tests of fixed effects for time to runoff, runoff volume, and sediment concentration as affected by time of rainfall simulation (1 and 6 mo after P amendment application); four phosphorus sources (PS) (control, triple superphosphate, and two manure rates); two application methods (AM) of P amendments (incorporation and surface application); and Bray P1 as a covariate.

	df		F value		
	Numerator	Denominator	Time to runoff	Runoff volume	Sediment
Time	1	1	NS	NS	NS
PS	3	230	NS	NS	4.1**
Time × PS	3	230	7.9***	NS	NS
AM	1	1	194.2†	NS	NS
Time × AM	1	230	258.0***	75.6***	2.4 ($P < 0.12$)
PS × AM	3	230	NS	NS	2.5†
Time × PS × AM	3	230	3.0†	NS	NS
Bray P1	1	230	NS	NS	NS

** Significant at the 0.01 probability level.
*** Significant at the 0.001 probability level.
† Significant at the 0.1 probability level.

Table 3. Mean values for time to runoff, residue cover, runoff volume, and sediment concentration.†

	Surface-applied				Incorporated: chisel plow (control, TSP); injected (LM, HM)‡			
	Control	TSP	LM	HM	Control	TSP	LM	HM
					1MO§			
Time to runoff, min	8a	14a	7a	8a	129b	126b	114b	82b
Residue cover, %¶	93a	93a	92a	91a	38b	35b	57c	65ac
Runoff volume, mm	16.5a				3.5b			
					6MO§			
Time to runoff, min	18ab	17ab	20ab	26ab	19ab	27ab	39ab	47b
Runoff volume, mm	8.7b				5.4b			
					1MO and 6MO			
Sediment, g L^{-1}	1.7ac	1.6ac	1.5a	1.4a	3.9bc	4.2b	2.7ab	1.8a

† Values across each variable that are followed by the same letter are not significantly different at $P = 0.1$, determined by the Scheffé test.
‡ TSP, triple superphosphate; LM, low manure rate; HM, high manure rate.
§ Rainfall simulation one month (1MO) and six months (6MO) after P amendment application.
¶ Residue cover was only measured before 1MO rainfall simulation.

incorporated, DRP concentration and load were greatly reduced in 1MO, showing no difference with the control plots. The differences in DRP concentration and load between surface-applied and incorporated treatments were only significant for HM at 6MO (Fig. 2 and 3). Eghball and Gilley (1999), working on wheat and sorghum [*Sorghum bicolor* (L.) Moench.] residues, also found that DRP concentrations in runoff from surface-applied cattle manure and inorganic fertilizer were significantly greater than those from incorporated treatments. This application method effect was observed again in a second rainfall simulation 24 h after the first one, but as occurred in the 6MO event in our study, the differences among the tillage treatments in the second rainfall simulation were smaller. Concentration and load of DRP in runoff from surface-applied HM were not significantly higher than those from surface-applied LM (Fig. 2 and 3). Dissolved reactive P concentration from surface-applied TSP was smaller than for surface-applied HM ($P < 0.01$). Withers et al. (2001) surface-applied TSP and liquid cattle manure at rates of 60 kg ha^{-1} P on a growing crop of winter wheat. The first 25 mm of natural rainfall occurred 3 wk after the treatment application and the DRP concentrations in runoff were 6.5 and 3.8 mg L^{-1} for TSP and liquid cattle manure, respectively. In our study, the average DRP concentrations for the surface-applied HM, LM, and TSP were 10.3, 7.6, and 5.6 mg L^{-1}, respectively. The TSP concentration was very similar to Withers et al. (2001), and the differences between the manure treatments are probably due to the higher content of water soluble P in the swine manure compared with cattle manure. In our 6MO simulation event, we observed DRP concentration in runoff to be around 1.3 mg L^{-1} from TSP and manure treatments. These results were very similar to the ones observed by Withers et al. (2001) after two subsequent runoff events.

The incorporated treatments showed no differences in DRP concentration or load between time or P sources. However, there was a linear effect of Bray P1 soil extraction value on the concentration of DRP in runoff from incorporated treatments (Fig. 4). The data were fit separately by chisel-plowed plots and injected manure plots since the injected manure plots had a higher slope compared with the chisel-plowed plots. Andraski and Bundy (2003) also observed a strong relationship between Bray P1 soil extraction value and DRP concentration in runoff from a Typic Argiudoll soil that had recently incorporated dairy manure (with a chisel plow). Sharpley and Smith (1995) found that labile and chemisorbed inorganic P increased when soils were amended with feedlot wastes. In addition, Reddy et al. (1980) reported that a soil receiving high rates of manure sorbed less P and desorbed more P. In our study, the amendments probably increased P desorption in the soils, and this

Table 4. Type 3 tests of fixed effects for concentration (mg L^{-1}) and load (kg ha^{-1}) of dissolved reactive phosphorus (DRP), total phosphorus (TP), and algal-available phosphorus (AAP) in runoff as affected by time of rainfall simulation (1 and 6 mo after P amendment application); four phosphorus sources (PS) (control, triple superphosphate, and two manure rates); two application methods (AM) of P amendments (incorporation and surface application); and Bray P1 as a covariate.

	df		*F* value					
	Numerator	Denominator	DRP (mg L^{-1})	DRP (kg ha^{-1})	TP (mg L^{-1})	TP (kg ha^{-1})	AAP (mg L^{-1})	AAP (kg ha^{-1})
Time	1	1	NS	NS	NS	47.8†	NS	51.6†
PS	3	211	19.8***	28.1***	13.4***	8.4***	18.5***	20.7***
Time × PS	3	211	17.1***	30.6***	14.5***	12.2***	17.0***	29.4***
AM	1	1	99.9†	378.2†	46.3†	88.2†	91.2†	282.3†
Time × AM	1	211	110.5***	295.2***	93.6***	101.3***	104.1***	270.5***
PS × AM	3	211	17.5***	29.0***	22.4***	12.0***	19.3***	28.1***
Time × PS × AM	3	211	16.1***	22.2***	15.0***	7.1***	16.2***	16.3***
Bray P1	1	211	101.9***	26.7***	39.6***	4.8†	163.4***	31.1***

** Significant at the 0.01 probability level.
*** Significant at the 0.001 probability level.
† Significant at the 0.1 probability level.

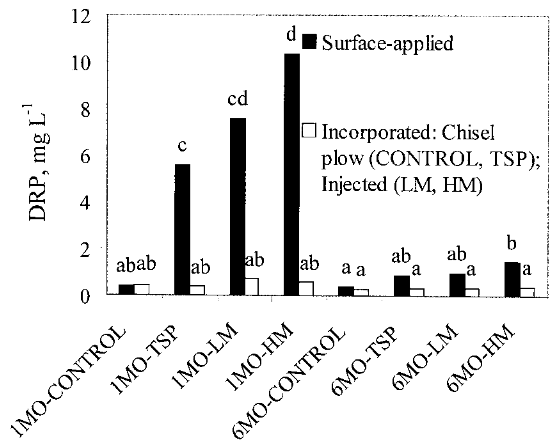

Fig. 2. Mean dissolved reactive phosphorus (DRP) concentration in runoff as affected by time of rainfall simulation (one [1MO] and six months [6MO] after P amendment application); P source (control, TSP = 54 kg P ha^{-1} as triple superphosphate, LM = low swine manure rate, and HM = high swine manure rate); and application method (surface-applied and incorporated, where the control and TSP were chisel-plowed, and LM and HM were injected). Mean values (n = 16) that have the same letters are not significantly different (P < 0.1) as determined by the Scheffé test.

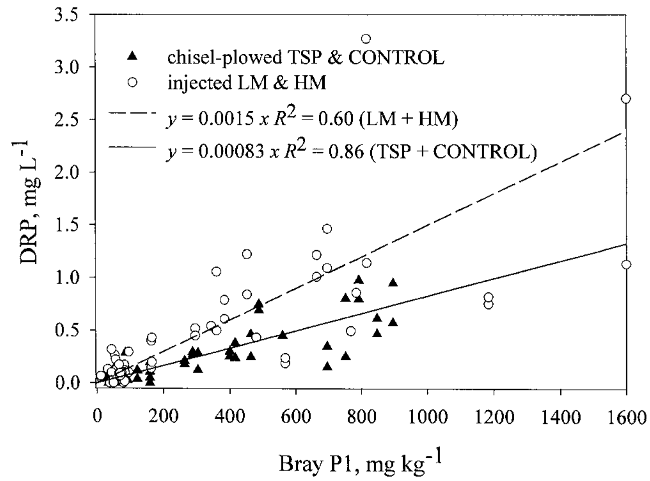

Fig. 4. Relationship between runoff dissolved reactive phosphorus (DRP) concentration and Bray P1 soil extraction values for incorporated treatments (chisel-plowed control, TSP = chisel-plowed 54 kg P ha^{-1} as triple superphosphate, LM = injected low swine manure rate, HM = injected high swine manure rate).

effect was evidently enhanced at increasing Bray P1 soil extraction levels.

Dissolved reactive P load in runoff from the incorporated treatments was linearly related to Bray P1 soil extraction levels, but the model did not explain a large amount of the variability ($P < 0.001$, $R^2 = 0.25$). Dissolved reactive P load in our study was more variable than concentration since DRP load is related to runoff volumes, which depend on residue cover, slope, and surface roughness, all of which differed among plots.

Total Phosphorus

Time × P source × application method interaction was significant for TP concentration and load in runoff ($P < 0.001$; Table 4). In 1MO, surface-applied manure produced greater TP concentration and load in runoff compared with injected manure (Fig. 5 and 6). In 6MO, no differences were found for TP concentration or load in runoff between surface and incorporated treatments.

In a study where beef cattle manure and fertilizer P had been surface-applied and disked up and down the slope, Eghball and Gilley (1999) found that TP concentration and load were not influenced by the application method when running off sorghum residue. Moreover, when working on wheat residue, they reported that concentration and load of TP were less for no-till than for disked treatments, because greater erosion from the disked soils resulted in more PP and TP being carried by runoff. In our study, the incorporated manure was injected on the contour, and the residue cover doubled

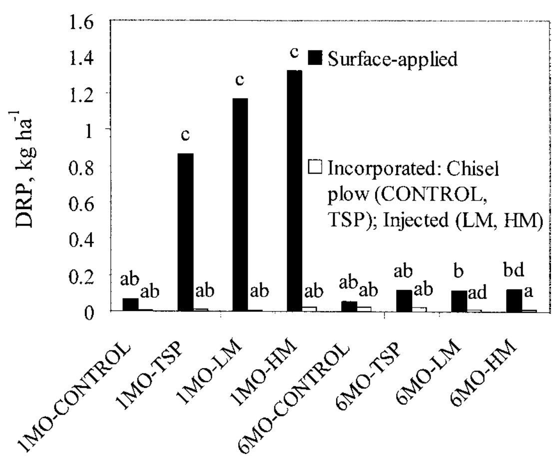

Fig. 3. Mean dissolved reactive phosphorus (DRP) load in runoff as affected by time of rainfall simulation (one [1MO] and six months [6MO] after P amendment application); P source (control, TSP = 54 kg P ha^{-1} as triple superphosphate, LM = low swine manure rate, and HM = high swine manure rate); and application method (surface-applied and incorporated, where the control and TSP were chisel-plowed, and LM and HM were injected). Mean values (n = 16) that have the same letters are not significantly different (P < 0.1) as determined by the Scheffé test.

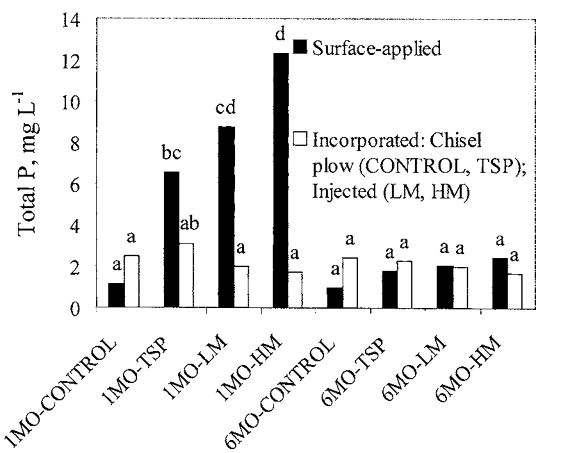

Fig. 5. Mean total phosphorus (TP) concentration in runoff as affected by time of rainfall simulation (one [1MO] and six months [6MO] after P amendment application); P source (control, TSP = 54 kg P ha^{-1} as triple superphosphate, LM = low swine manure rate, and HM = high swine manure rate); and application method (surface-applied and incorporated, where the control and TSP were chisel-plowed, and LM and HM were injected). Mean values (n = 16) that have the same letters are not significantly different (P < 0.1) as determined by the Scheffé test.

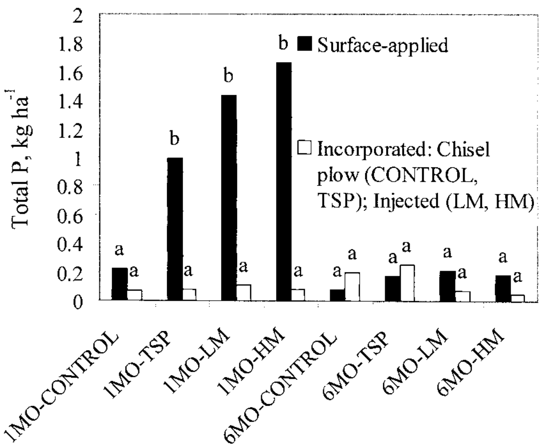

Fig. 6. Mean total phosphorus (TP) load in runoff as affected by time of rainfall simulation (one [1MO] and six months [6MO] after P amendment application); P source (control, TSP = 54 kg P ha^{-1} as triple superphosphate, LM = low swine manure rate, and HM = high swine manure rate); and application method (surface-applied and incorporated, where the control and TSP were chisel-plowed, and LM and HM were injected). Mean values (n = 16) that have the same letters are not significantly different ($P < 0.1$) as determined by the Scheffé test.

the one used in the study by Eghball and Gilley (1999). In addition, the injection and chisel-plowing in our study produced high surface roughness whereas the disked soils in Eghball and Gilley (1999) probably produced a smooth surface. These facts may explain why the TP concentration and load running off our chisel-plowed and injected plots were less than half of the TP concentration for the tilled plots reported for their plots.

No differences were found for TP concentration between surface-applied and chisel-plowed TSP in 1MO (Fig. 5). This was mainly caused by the high TP concentration from the chisel-plow treatments that equaled the TP from the surface-applied TSP. Ninety percent of the TP from chisel-plow plots was PP, and only 33% of the TP from surface-applied TSP was PP. So evidently what caused the high TP concentration in runoff was the erosion coming off the chisel-plow treatments. However, if we take into account that the time to runoff for the chisel-plowed TSP treatment was in average 126 min compared with 14 min for the surface-applied TSP (Table 3), it is clear that incorporating TSP is the preferred practice to reduce P runoff. The TP load was much lower in the chisel-plowed TSP compared with the surface-applied TSP (Fig. 6). This was caused by the very low runoff volumes coming off chisel-plow plots, which were about one-fifth the runoff volumes from no-till plots.

Total P concentration and load in runoff did not differ between the two surface-applied manure rates (Fig. 5 and 6). Higher TP concentration was observed in HM compared with the TSP treatment in 1MO, whereas no differences were observed among the surface-applied amendments for TP load ($P < 0.1$).

Total P concentration and load in runoff from incorporated treatments showed no differences between times or P sources. However, sediment concentration and Bray P1 soil extraction level were related to TP concentration from all the incorporated treatments including the control (Fig. 7). The following equation was found:

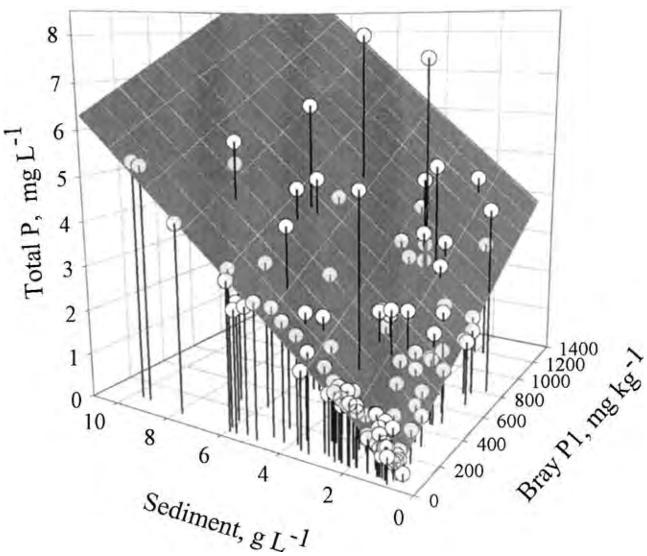

Fig. 7. Relationship between total phosphorus (TP) concentrations in runoff from incorporated treatments (including control), sediment (SED) concentration in runoff, and Bray P1 (B1) soil extraction value. TP concentration = 0.0025B1 + 0.571SED; R^2 = 0.91, P = 0.001.

$$TPC_{inc} = 0.0025B1 + 0.571SED \quad [2]$$

where TPC_{inc} (mg L^{-1}) is TP concentration from incorporated treatments in runoff, B1 (mg kg^{-1}) is Bray P1 soil extraction value, and SED (g L^{-1}) is sediment concentration in runoff. The adjusted R^2 was 0.91 ($P <$ 0.001). Sediment concentration explained three times more variability (Type II sums of squares) than did Bray P1 soil extraction value. The close association between sediment and TP concentration has also been observed in other studies (Aase et al., 2001; Andraski and Bundy 2003; Andraski et al., 1985; Cox and Hendricks 2000).

Total P load was related to sediment load and Bray P1 soil extraction value (Fig. 8). The following equation explained the relationship between the variables:

$$TPL_{inc} = 0.114B1 + 0.456SED \quad [3]$$

where TPL_{inc} (g ha^{-1}) is total P load from incorporated treatments in runoff, B1 (mg kg^{-1}) is Bray P1 soil extraction value, and SED (kg ha^{-1}) is sediment load in runoff. The adjusted R^2 was 0.72 ($P < 0.001$). Sediment load explained nine times more variability (Type II sums of squares) than Bray P1 soil extraction value. It is clear that erosion control is the main target when the objective is to minimize TP loss from agricultural soils where nutrients have been incorporated.

Algal-Available Phosphorus

Algal-available phosphorus (AAP) concentration and load in runoff were similar to DRP concentration and load. For surface-applied amendments, DRP constituted an average of 81% of AAP, while for incorporated treatments, DRP was 55% of AAP. Sediment concentration in runoff and Bray P1 soil extraction value were the

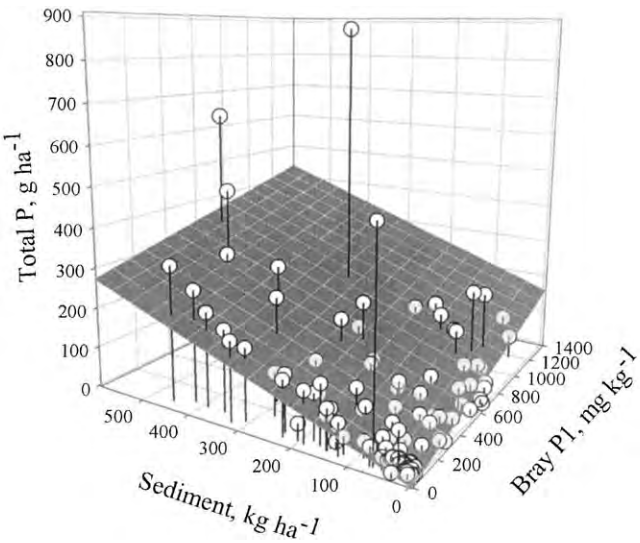

Fig. 8. Relationship between total phosphorus (TP) load in runoff from incorporated treatments (including control), sediment (SED) load in runoff, and Bray P1 (B1) soil extraction value. TP load = 0.114B1 + 0.456SED; R^2 = 0.72, P = 0.001.

only variables that affected the AAP concentration in runoff from incorporated treatments (Fig. 9). The following equation was found:

$$\mathrm{AAPC_{inc}} = 0.0018\mathrm{B1} + 0.016\mathrm{SED} + 0.00017\mathrm{B1} \times \mathrm{SED} \quad [4]$$

where $\mathrm{AAPC_{inc}}$ (mg L^{-1}) is algal-available P concentration from incorporated treatments in runoff, B1 (mg kg^{-1}) is Bray P1 soil extraction value, SED (g L^{-1}) is sediment concentration in runoff, and B1 × SED is the interaction between sediment concentration and Bray P1 soil test value. The adjusted R^2 was 0.85 ($P < 0.001$). Bray P1 explained 20 times more variability (Type II sums of squares) than sediment concentration, and Eq. [4] was therefore simplified to Eq. [5], where sediment concentration was removed from the model:

$$\mathrm{AAPC_{inc}} = 0.00224\mathrm{B1} \quad [5]$$

where $\mathrm{AAPC_{inc}}$ (mg L^{-1}) is algal-available P concentration from incorporated treatments in runoff, and B1 (mg kg^{-1}) is Bray P1 soil extraction value. The adjusted R^2 decreased to 0.82 ($P < 0.001$). The slope for DRP concentration as a function of Bray P1 soil extraction levels (0.012) was approximately half the slope for AAP concentration (Eq. [5]), which may reflect the adsorbed orthophosphates in the sediment matrix that diffused into solution during the AAP extraction process.

Algal-available P load in runoff was related to sediment load, Bray P1 soil extraction levels, and the interaction between Bray P1 and sediment load (Fig. 10):

$$\mathrm{AAPL_{inc}} = 0.041\mathrm{B1} + 0.056\mathrm{SED} + 0.00043\mathrm{B1} \times \mathrm{SED} \quad [6]$$

where $\mathrm{AAPL_{inc}}$ (g ha^{-1}) is AAP load from incorporated treatments in runoff, B1 (mg kg^{-1}) is Bray P1 soil extraction value, SED (kg ha^{-1}) is sediment load in runoff, and B1 × SED is the interaction between sediment load in runoff and Bray P1 soil test values. The adjusted R^2 was 0.80 ($P < 0.001$). The interaction between Bray P1 and sediment load explained four times more variability than each factor separately. Sediment load is the product of sediment concentration and runoff volume, so Bray P1 soil extraction value interacts with sediment load because at low runoff volumes (and therefore low sediment load), there will be low AAP load regardless of the Bray P1 soil extraction value. Only at increasing sediment load does Bray P1 soil extraction value influence AAP load. Increasing water infiltration to reduce runoff is therefore an important management practice to reduce AAP load in runoff.

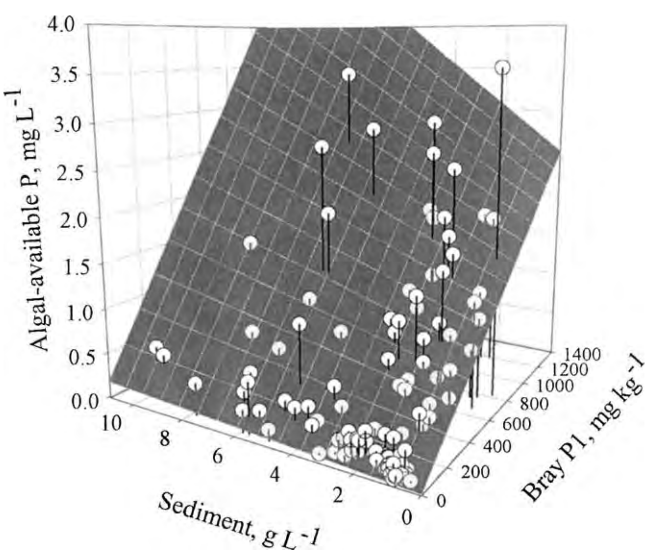

Fig. 9. Relationship between algal-available phosphorus (AAP) concentrations in runoff from incorporated treatments (including control), sediment (SED) concentration in runoff, and Bray P1 (B1) soil extraction value. AAP concentration = 0.0018B1 + 0.016SED + 0.00017B1 × SED; R^2 = 0.85, P = 0.001.

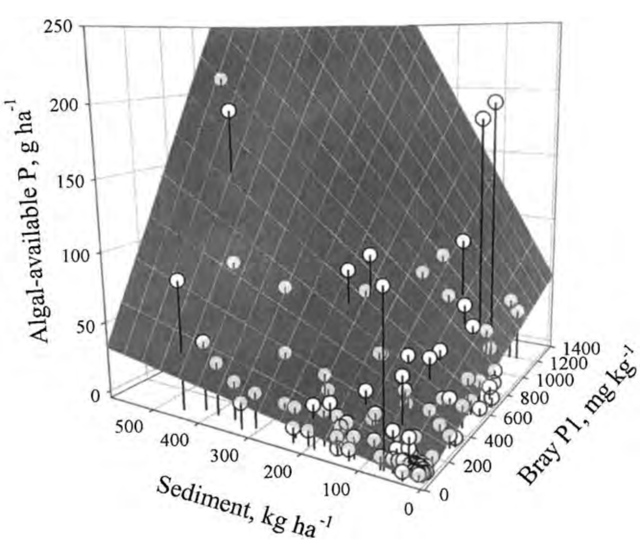

Fig. 10. Relationship between algal-available phosphorus (AAP) load in runoff from incorporated treatments (including control), sediment (SED) load in runoff, and Bray P1 soil extraction (B1) value. AAP load = 0.041B1 + 0.056SED + 0.00043B1 × SED; R^2 = 0.80, P = 0.001.

CONCLUSIONS

Injection of manure was very effective in reducing DRP, TP, and AAP concentration and load in runoff. The same trends were observed when inorganic fertilizer was incorporated with a chisel plow.

Concentration and load of DRP, TP, and AAP for the high surface-applied manure rate were not significantly different compared with the low surface-applied manure rate. The high rate of surface-applied manure produced generally more DRP, TP, and AAP concentration in runoff than the inorganic fertilizer P, whereas the P concentration in runoff from the latter was similar to the low rate of surface-applied manure. Runoff volumes introduced variability when calculating P load in runoff, and no significant differences were observed between surface-applied P amendments.

Phosphorus losses one month after surface amendment applications were greater than the P losses after six months, when only small or no differences were observed between surface-applied and incorporated treatments for DRP, TP, and AAP concentration and load. Therefore, the residual effect of the surface-applied amendments for this scenario was very small.

Soil test P levels and sediment content in runoff influenced P loss from incorporated treatments. Only Bray P1 soil extraction value influenced DRP concentration and load in runoff from injected manure and chisel-plowed TSP and control, and the relationship was linear. Bray P1 soil extraction value and sediment concentration and load in runoff from the incorporated treatments were significantly related to TP and AAP concentration and load. Sediment concentration and load were the most important variables in explaining TP concentration and load in runoff. In contrast, AAP concentration was highly associated with Bray P1 soil extraction value, and to a much lesser extent with sediment concentration. The interaction between sediment load and Bray P1 soil extraction value was most important in explaining AAP load in runoff.

Incorporating organic and inorganic amendments was shown to be an acceptable technique to reduce P losses from agricultural fields. Injecting manure and chisel-plowing inorganic P fertilizer on the contour was not only effective in reducing P losses, but it also increased the time to runoff and decreased the runoff volumes. However, this practice should be accompanied by Bray P1 soil extraction levels below 100 mg kg^{-1} (0–2.5 cm) and by keeping residue cover on the field to prevent sediment losses.

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REFERENCES

Aase, J.K., D.L. Bjorneberg, and D.T. Westermann. 2001. Phosphorus runoff from two water sources on a calcareous soil. J. Environ. Qual. 30:1315–1323.

American Public Health Association. 1995. Standard methods for the examination of water and wastewater. 19th ed. APHA, Washington, DC.

Andraski, B.J., D.H. Mueller, and T.C. Daniel. 1985. Phosphorus losses in runoff as affected by tillage. Soil Sci. Soc. Am. J. 49:1523–1527.

Andraski, T.W., and L.G. Bundy. 2003. Relationships between phosphorus levels in soil and in runoff from corn production systems. J. Environ. Qual. 32:310–316.

Baker, J.L., and J.M. Laflen. 1982. Effects of corn residue and fertilizer management on soluble nutrient runoff losses. Trans. ASAE 25: 344–348.

Beegle, D.B., O.T. Carton, and J.S. Bailey. 2000. Nutrient management planning: Justification, theory, practice. J. Environ. Qual. 29: 72–79.

Combs, S.M., and M.V. Nathan. 1998. Soil organic matter. p. 53–58. *In* J.R. Brown (ed.) Recommended chemical soil test procedures for the North Central Region. North Central Region Publ. 221 (revised). Missouri Agric. Exp. Stn., Columbia.

Cox, F.R., and S.E. Hendricks. 2000. Soil test phosphorus and clay content effects on runoff water quality. J. Environ. Qual. 29:1582–1586.

Edwards, D.R., and T.C. Daniel. 1993. Runoff quality impacts of swine manure applied to fescue plots. Trans. ASAE 36:81–86.

Eghball, B., and J.E. Gilley. 1999. Phosphorus and nitrogen in runoff following beef cattle manure or compost application. J. Environ. Qual. 28:1201–1210.

Foy, R.H., and P.J.A. Withers. 1995. The contribution of agricultural phosphorus to eutrophication. Proc. Fert. Soc. 365:1–32.

Frank, K., D. Beegle, and J. Denning. 1998. Phosphorus. p. 21–23. *In* J.R. Brown (ed.) Recommended chemical soil test procedures for the North Central Region. North Central Region Publ. 221 (revised). Missouri Agric. Exp. Stn., Columbia, MO.

Humphry, B.J., T.C. Daniel, D.R. Edwards, and A.N. Sharpley. 2002. A portable rainfall simulator for plot-scale runoff studies. Appl. Eng. Agric. 18:199–204.

Klute, A. (ed.) 1986. Methods of soil analysis. Part 1. 2nd ed. Agron. Monogr. 9. ASA and SSSA, Madison, WI.

Littell, R.C., J. Pendergast, and R. Natarajan. 2000. Modelling covariance structure in the analysis of repeated measures data. Stat. Med. 19:1793–1819.

Mueller, D.H., R.C. Wendt, and T.C. Daniel. 1984. Phosphorus losses as affected by tillage and manure application. Soil Sci. Soc. Am. J. 48:901–905.

Patton, C.J., and E.P. Truitt. 1992. Methods of analysis by the US Geological Survey national water quality laboratory-determination of total phosphorus by a Kjeldahl digestion method and an automated colorimetric finish that includes dialysis. Open-File Rep. 92-146. USGS, Reston, VA.

Pote, D.H., T.C. Daniel, A.N. Sharpley, P.A. Moore, Jr., D.R. Edwards, and D.J. Nichols. 1996. Relating extractable soil phosphorus to phosphorus losses in runoff. Soil Sci. Soc. Am. J. 60:855–859.

Reddy, K.R., M.R. Overcash, R. Khaleel, and P.W. Westermann. 1980. Phosphorus adsorption-desorption characteristics of two soils utilized for disposal of animal wastes. J. Environ. Qual. 9:86–92.

SAS Institute. 2001. The SAS system for Windows V8. Release 8.2. SAS Inst., Cary, NC.

Scheffé, H. 1953. A method for judging all contrasts in the analysis of variance. Biometrika 40:87–104.

Sharpley, A.N. 1993. An innovative approach to estimate bioavailable phosphorus in agricultural runoff using iron oxide-impregnated paper. J. Environ. Qual. 22:597–601.

Sharpley, A.N. 1997. Rainfall frequency and nitrogen and phosphorus runoff from soil amended with poultry litter. J. Environ. Qual. 26: 1127–1132.

Sharpley, A.N., S.C. Chapra, R. Wedepohl, J.T. Sims, T.C. Daniel, and K.R. Reddy. 1994. Managing agricultural phosphorus for protection of surface waters: Issues and options. J. Environ. Qual. 23: 437–451.

Sharpley, A.N., T.C. Daniel, and D.R. Edwards. 1993. Phosphorus movement in the landscape. J. Prod. Agric. 6:492–500.
Sharpley, A.N., and S.J. Smith. 1995. Nitrogen and phosphorus forms in soils receiving manure. Soil Sci. 159:253–258.
Sharpley, A.N., W.W. Troeger, and S.J. Smith. 1991. The measurement of bioavailable phosphorus in agricultural runoff. J. Environ. Qual. 20:235–238.
Shelton, D.P., E.C. Dickey, and P.J. Jasa. 1992. Estimating residue cover. p. 15–20. Conservation tillage systems and management: Crop residue management with no-till, ridge-till, mulch-till. 1st ed. MWPS-45. MidWest Plan Service, Ames, IA.
Tabbara, H. 2003. Phosphorus loss to runoff water twenty-four hours after application of liquid swine manure or fertilizer. J. Environ. Qual. 32:1044–1052.
USEPA. 1992. Inductively coupled plasma-atomic emission spectroscopy. Method 6010B. *In* Test methods for evaluating solid waste [Online]. Physical/chemical methods. SW-846. 3rd ed. Available at www.epa.gov/epaoswer/hazwaste/test/6_series.htm (verified 26 Mar. 2004). USEPA, Washington, DC.
Watson, M.E., and J.R. Brown. 1998. pH and lime requirement. p. 13–20. *In* J.R. Brown (ed.) Recommended chemical soil test procedures for the North Central Region. North Central Region Publ. 221 (revised). Missouri Agric. Exp. Stn., Columbia, MO.
Westerman, P.W., and M.R. Overcash. 1980. Short-term attenuation of runoff pollution potential for land-applied swine and poultry manure. *In* Livestock waste: A renewable resource. Proc. 4th Int. Symp. on Livestock Wastes. ASAE, St. Joseph, MI.
Withers, P.J.A., S.D. Clay, and V.G. Breeze. 2001. Phosphorus transfer in runoff following application of fertilizer, manure, and sewage sludge. J. Environ. Qual. 30:180–188.