ENERGYWORKS ®
ENERGY & INFRASTRUCTURE SERVICES

EnergyWorks BioPower,LLC
71 Old Mill Bottom Road North
Annapolis, MD 21409
Tel 410-349-2001
Fax 410-349-2063
www.energyworks.com

August 22, 2014

Mr. Miles McEvoy
Deputy Administer National Organic Program
Room 4008-So., Ag Stop 0268
1400 Independence Ave., SW
Washington, DC 20250

Re: Petition to Modify Manure Ash prohibition on the National List

Dear Mr. McEvoy:

Please accept this Petition to modify the list of prohibited non-synthetic substances to clarify the definition of "ash from manure burning" 205.602(a). We petition to allow organic producers to participate in the significant public and global ecosystem benefits that accrue when controlled combustion reactions are used to separate the nutrients in animal manures. Our understanding is that the NOP prohibition was established because burning of manure was seen as being "wasteful" of nutrients. Our petition suggests that extraction of minerals by controlled combustion preserves their non-synthetic nature while allowing organic growers to derive increased value from manure as a nutrient resource.

We Petition to amend 205.602(a) to read as follows:

- Ash from manure burning ***except where the combustion reaction does not involve the use of synthetic additives and is controlled to separate and preserve nutrients***.

EnergyWorks BioPower, LLC owns and operates a facility near Gettysburg, Pennsylvania that uses a staged thermochemical reactor to extract over 30 tons of minerals from 240 tons of egg-layer poultry manure each day. The energy from this reaction is converted into enough renewable electricity to power 2,500 homes. In addition, this is the largest facility in the Chesapeake Bay region focused on processing of manure to reduce excess nutrient loading to the watershed. This type of facility can help solve the kinds of problems seen recently in Lake Erie due to excess nutrients in the environment. The proposed modification of 205.602(a), will diversify and expand the market for recovered minerals, increasing the potential for development of similar commercial processing facilities in many regions of the United States.

We believe that this modification is entirely consistent with the goals in your recent presentation on the National Organic Program:

- Relies on renewable resources – Phosphorus, a scarce resource with no synthetic substitutes, can be effectively recycled and reclaimed in a managed fashion.
- Supports local economies – Manure processing supports well-paying local jobs in technology and transportation and allows larger farms to more successfully integrate into their communities.

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- Builds soil and water quality – Effective manure management is a key to achieving water quality and soil nutrient balance in the Chesapeake and many other watersheds.
- Promotes environmental stewardship – Projects such as EnergyWorks' Gettysburg Energy and Nutrient Recovery Facility are widely supported by the environmental community and viewed as a cornerstone upon which a sustainable balance between reliable, low-cost food supplies and water quality can be built. Moreover, recycling phosphorus and calcium offers a clear alternative for organic growers, allowing them to disassociate from the environmental hazards accompanying the synthesis of strip-mined calcium phosphates which are currently allowed as a synthetic on the NOP list.
- Increases reliance on non-synthetic resources – Allows minerals in manure to be stored, transported and applied more effectively, replacing synthetic commercial fertilizers on a larger scale.
- Innovates, benefitting all agriculture – Innovations in manure and nutrient management are a key to sustainable animal agriculture systems.

We are hopeful that this petition will be considered and favorably voted upon at the NOSB meeting in October 2014. If you need any additional information, please contact me at 410-349-2001 or Jeff Noland, Director of Product Marketing & Development, at 443-875-2556.

Sincerely,

Patrick Thompson
President

Attachments:

Petition Process – Recommended Inclusions
Appendix A – Layer Manure Ash Mineral Composition
Appendix B – Layer Manure Ash Preliminary Material Safety Data Sheet
Appendix C – EPA Notes on Phosphogypsum
Appendix D – World Resources Institute – Sources and Drivers of Nutrient Pollution
Appendix E – Chesapeake Bay Foundation – Open Letter regarding Manure Pollution
Appendix F – Hen Manure Ash as a Feed Supplement for Laying Hens

Cc: Andria Schulze, Organic Materials Research Institute

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PETITION PROCESS – RECOMMENDED INCLUSIONS

Item A

Please indicate which section or sections the petitioned substance will be included on and/or removed from the National List.

We Petition to modify 205.602(a) to allow the use of inorganic minerals extracted from animal manure through controlled thermal reactions to be allowed for use in organic crop production. We recommend that the provision be modified approximately as follows:

- Ash from manure burning ***except where the combustion reaction does not involve the use of synthetic additives and is controlled to separate and preserve nutrients***.

Item B

Please provide concise and comprehensive responses in providing all of the following information items on the substance being petitioned:

1. The substance's chemical or material common name.

   The material's common name is Poultry Litter Ash or Egg-Layer Manure Ash. Egg-Layer Manure Ash has a mineral composition shown in Exhibit A which is similar to that of Poultry Litter Ash. The material is an effective substitute for Phosphate and other minerals in fertilizer regimens.

2. The manufacturer's or producer's name, address and telephone number and other contact information of the manufacturer/producer of the substance listed in the petition.

   Our firm's business offices are at the following address:

   EnergyWorks BioPower, LLC
   Suite 101
   71 Old Mill Bottom Road
   Annapolis, Maryland 20409
   Phone: (410)-349-2001

3. The intended or current use of the substance such as use as a pesticide, animal feed additive, processing aid, nonagricultural ingredient, sanitizer or disinfectant. If the substance is an agricultural ingredient, the petition must provide a list of the types of product(s) (*e.g.*, cereals, salad dressings) for which the substance will be used and a description of the substance's function in the product(s) (*e.g.,* ingredient, flavoring agent, emulsifier, processing aid).

   Compliant manure ash is applicable as a crop nutrient and replacement for synthesized calcium phosphates. In addition, the Egg Layer Manure Ash product is currently in the final stages of FDA review as an animal feed ingredient, replacing dicalcium phosphate and limestone.

4. A list of the crop, livestock or handling activities for which the substance will be used. If used for crops or livestock, the substance's rate and method of application must be described. If used for handling (including processing), the substance's mode of action must be described.

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The material is a generalized crop and horticultural plant nutrient and would be applied as a dry component of a targeted, balanced soil amendment program.

5. The source of the substance and a detailed description of its manufacturing or processing procedures from the basic component(s) to the final product. Petitioners with concerns for confidential business information may follow the guidelines in the Instructions for Submitting CBI listed in #13.

   a. The source of the substance is pure manure from egg-laying hens, maintained in conventional and cage-free housing systems.

   b. The source of the substance is poultry litter or manure from conventional large scale broiler poultry housing operations.

   c. The following is a description of the thermochemical manufacturing process. Other processes may vary, but will likely involve similar steps:

      1. Raw manure is transported by trucks to the processing facility. Manure is received only from contracted supply chain partners.
      2. Delivered manure unloaded into a fully enclosed receiving area.
      3. Manure is conveyed to an automated drying system to normalize moisture content. Depending on the manure type (broiler litter or layer manure) the material is sized before or after the drying operation. Dryer exhaust is filtered and vented to atmosphere. The dryer residence time and temperature exceed standards for organic dried manure.
      4. Normalized manure is conveyed to the inlet of a thermochemical reactor. Manure is continuously fed and conveyed within the reactor by the oscillatory motion of vibrating grates. Within the reactor, manure is exposed to a carefully controlled combination of heat and oxygen in a succession of reaction zones. The heat and oxygen combination is adjusted in each zone to achieve the desired conversion of organic material into combustible biogas. Denitrification is a primary goal of the process – to eliminate polluting forms of nitrogen that would otherwise enter the Chesapeake Bay watershed during long-term storage and land application of manure.
      5. Mineral residual/bottom ash is continuously removed from the reactor and cooled in fully-enclosed stainless steel screw conveyors.
      6. Ash is pneumatically conveyed to a quarantine silo, where it is sampled and where processing/reactor historical data are analyzed. Ash meeting standards for reaction temperature control and nutrient/mineral composition tolerances is released for sale.
      7. Biogas is ducted to a separate vessel and combusted to produce high temperature flue gas. Heat from the flue gas produces superheated steam that provides thermal energy for manure feedstock drying and drives a conventional Rankine steam cycle to produce electricity.
      8. Once heat is extracted from the flue gas, it is filtered and exhausted to atmosphere under the conditions of a Pennsylvania air permit.

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6. A summary of any available previous reviews by State or private certification programs or other organizations of the petitioned substance. If this information is not available, the petitioner should state so in the petition.

   In the first quarter of 2014, EnergyWorks submitted its separated mineral product, *New Bay Peake*, to the Organic Materials Review Institute (OMRI) for approval on the grounds that its process did not constitute burning in the (uncontrolled) sense intended by the original prohibition. EnergyWorks' arguments were rejected because OMRI's technical committee felt that the process was either burning (in which case it fails 205.602(a) or pyrolysis (in which case it would be a synthetic). OMRI did not consider the middle ground of staged combustion, which is where EnergyWorks' process lies. In addition, even though this process helps solve the eutrophication challenges of the Chesapeake Bay and its tributaries by converting the nitrogen in raw manure into N_2 gas and even though EnergyWorks supplied evidence of broad support of leading local environmental and political organization, OMRI's review panel considered the EnergyWorks process to be "wasting" nitrogen.

   Even though we feel that this review could have been successfully appealed (i.e. the failure to consider that there is a process continuum between uncontrolled burning and pyrolysis and the failure to consider the hazards of over-application of excess nitrogen), we decided that the best course of action is to seek the amendment of 205.602(a) to distinguish between uncontrolled and controlled burning and between indiscriminate nutrient reduction and nutrient separation/preservation. Additionally, given the mandate of NOP to consider environmental and sustainability benefits, EnergyWorks believes that the concern for wasting nitrogen is greatly outweighed by the environmental and societal benefits resulting from improving watershed water quality, conserving a valuable resource (phosphorus) and reducing the spread of pathogens.

7. Information regarding EPA, FDA, and State regulatory authority registrations, including registration numbers. If this information does not exist, the petitioner should state so in the petition.

   EnergyWorks is licensed to manufacture and sell fertilizer in Pennsylvania. EnergyWorks' ash material can be sold as a liming agent or a fertilizer mineral substitute for calcium phosphates in accordance with a co-product determination by the state.

   In addition, the product is currently in the final stages of review by FDA Division of Animal Feed, case 14036, for use as a mineral animal feed ingredient and substitute for dicalcium phosphate and limestone at a 1.42% inclusion rate. EnergyWorks has responded to initial FDA comments and anticipates referral to AAFCO in September 2014.

8. The Chemical Abstract Service (CAS) number or other product numbers of the substance and labels of products that contains the petitioned substance. If the substance does not have an assigned product number, the petitioner should state so in the petition.

   Manure ash is not listed in the Chemical Abstract Service. The CAS number for calcium phosphate is 7758-87-4.

9. The substance's physical properties and chemical mode of action including:

   (a) Chemical interactions with other substances, especially substances used in organic production: Similar to synthetic dicalcium phosphate.

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(b) Toxicity and environmental persistence: Similar to synthetic dicalcium phosphate.

(c) Environmental impacts from its use and/or manufacture: Manufacturing process denitrifies raw manure and separates remaining minerals. Otherwise similar to synthetic dicalcium phosphate.

(d) Effects on human health: Removing excess raw manure from watersheds has significant positive health benefits in terms of improved water quality and the elimination of harmful pathogens applied to farm fields.

(e) Effects on soil organisms, crops, or livestock: Similar to synthetic dicalcium phosphate.

10. Safety information about the substance including a Material Safety Data Sheet (MSDS) and a substance report from the National Institute of Environmental Health Studies. If this information does not exist, the petitioner should state so in the petition.

    A preliminary MSDS for *New Bay Peake* (Layer Manure Ash) is attached in Appendix B. A finalized MSDS is in the process of being prepared.

11. Research information about the substance which includes comprehensive substance research reviews and research bibliographies, including reviews and bibliographies which present contrasting positions to those presented by the petitioner in supporting the substance's inclusion on or removal from the National List. For petitions to include non-organic agricultural substances onto the National List, this information item should include research concerning why the substance should be permitted in the production or handling of an organic product, including the availability of organic alternatives. Commercial availability does not depend upon geographic location or local market conditions. If research information does not exist for the petitioned substance, the petitioner should state so in the petition.

    See attached Pennsylvania State University research paper (Appendix F) on the suitability of *New Bay Peake* as a safe and effective replacement for dicalcium phosphate in an egg-layer diet. While it is likely that the uncontrolled burning of manure could be wasteful of nutrients and that the resulting product could be irregular, variable, and unsuitable as a standard ingredient, conversely, sample analyses shown in Appendix A demonstrate that manure nutrients processed through an effectively controlled combustion process results in manure ash with consistent quality and utility.

12. A ''Petition Justification Statement'' which provides justification for any of the following actions requested in the petition:

    a. Explain why the non-synthetic substance should be permitted in the production of an organic product.

        1. The prohibition on ash from manure burning is interpreted too broadly and needs clarification to avoid penalizing controlled thermal processes that produce uniform products that preserve many valuable nutrients while benefitting local ecosystems and public safety by reducing the excess nutrients that and public health risks that result from storage and land application of unprocessed manure.

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2. Prohibiting compliant ash as a non-synthetic alternative to calcium phosphates also drives organic suppliers towards approved synthetic materials (i.e. 205.605(b) – Calcium Phosphates) – that have a long history as polluters (see Appendix C) and that are essentially contributing to the rapid depletion of the planet's supplies of economically available phosphorus.

3. Dried manure is allowed as an organic fertilizer. The EnergyWorks process produces dried manure as an intermediate product in a relatively low-temperature process (i.e. 350 F). Because the boiling point of ammonia is low, a significant percentage of nitrogen is lost to atmosphere during the drying – in our process this is approximately 15% of total N. Commercial dryers are known to be producing organic dried manure at much higher temperatures (i.e. 1,000 F inlet temperature) and would drive off a higher percentage of N prior to its beneficial use. Thus, the NOP list already permits a process that is, by a strict definition, wasteful of nitrogen and possibly other minerals with low boiling points.

b. Describe the beneficial effects to the environment, human health, or farm ecosystem from use of the non-synthetic substance that supports its use instead of the use of other non-synthetic or synthetic substances on the National List or alternative cultural methods.

1. The problem of excess raw manure contributing to poor water quality in national watersheds is very well documented and understood by the USEPA, USDA, USDOI and major environmental organizations (See Appendix D for references). While arguments are often made in favor of de-centralized food production, most consumers benefit from the economies of scale associated with concentration of food animal operations. Although this also results in the concentration of manure, replacing traditional manure management methods (storage and land application) with manure processing as exemplified by EnergyWorks' Gettysburg Energy & Nutrient Recovery Facility can eliminate water quality and other environmental impacts of manure concentration. NOP inclusion of non-synthetic minerals from these processes for use in organic plant growth will increase the commercial viability of commercial manure processing facilities, leading to improved environmental quality, improved public safety and greater availability of essential materials to support increased organic farming.

2. Drying and pelletizing are partial answers to overcome the logistics of storage and land application of animal manure. As previously noted, some nutrients are lost during commercial drying processes. However, there are at least two challenges with relying on drying as the only way to make manure nutrients widely available to organic producers. First, the application of minimally-processed manure provides nitrogen, phosphorus and other nutrients in the proportions dictated by the animal feeding program. If pelletized manure is applied for its nitrogen content, phosphorus is also applied, whether it is desired or not. Over time, excess nutrients in the environment from over-application can lead to the problems seen in the Chesapeake Bay's recurring dead zones and the recent Lake Erie/Toledo toxic algae challenges. Separating nitrogen and other mineral nutrients helps to solve this problem through precision application. Second, significant amounts of fuel and electrical energy are expended in drying and pelletizing manure. Unlike the EnergyWorks process, this energy is non-renewable.

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3. A “zero waste” approach such as the EnergyWorks process contributes greatly to sustainable agriculture and is supported in the environmental community (see Appendix E, for example). The process is capable of self-supplying its process needs for heat and electricity while also exporting renewable energy to a nearby industrial host and the local electric grid. Non-synthetic minerals and nutrients are recovered in a sterile, uniform format that facilitates storage, transportation and end-use. Converting large quantities of raw animal manure from a potential source of pollution to multiple beneficial uses contributes to sustainable agriculture, ecosystem management and and human health. Approval of this Petition to modify 205.602(a) will help unleash the potential for zero waste solutions for animal operations.

Appendix A - Layer Manure Ash Mineral Composition

Table 1.

Average Mineral Composition (4 full-scale batches) of Layer Manure Ash.

	Analysis	Method	Units	Average Value	CV
1	Aluminum (total)	ICAP	ppm	3,232	3.48%
2	Antimony (total)	ICAP	ppm	n.d	
3	Arsenic (total)	ICAP	ppm	n.d.	
4	Barium (total)	ICAP	ppm	88	10.44%
5	Boron (total)	ICAP	ppm	145	19.54%
6	Bromide	EPA 300.0 (MOD)	mg/kg	7	0.00%
7	Cadmium (total)	ICAP	ppm	n.d.	
8	Calcium (total)	ICAP	ppm	359,015	6.97%
9	Chloride	WDXRF	%	2.8	5.65%
10	Chromium (total)	ICAP	ppm	9.0	18.46%
11	Cobalt (total)	ICAP	ppm	2.3	14.64%
12	Copper (total)	ICAP	ppm	286	30.64%
13	Fluoride	EPA 340.2	mg/kg	n.d.	
14	Iodine (total)	ICP-MS	ppm	18.1	16.36%
15	Iron (total)	ICAP	ppm	2,781	10.41%
16	Lead	ICAP	ppm	n.d.	
17	Magnesium (total)	ICAP	ppm	21,555	12.81%
18	Manganese	ICAP	ppm	1,196	18.17%
19	Mercury	EPA 7471	ppm	n.d.	
20	Molybdenum (total)	ICAP	ppm	16.50	12.62%
21	Nickel (total)	ICAP	ppm	17.75	18.61%
22	Nitrogen Total (N)	AOAC 993.13	%	0.17	44.78%
23	Phosphorus (total)	ICAP	ppm	66,462	15.45%
24	Potassium (total)	ICAP	ppm	81,543	13.92%
25	Selenium (total)	ICAP	ppm	n.d.	
26	Silicon (total)	WDXRF	%	1.23	11.50%
27	Sodium (total)	ICAP	ppm	13,205	15.00%
28	Sulfur (total)	ICAP	ppm	8,355	14.54%
29	Tin (total)	ICAP	ppm	n.d.	
30	Total Carbon	C-Analyzer	%	4.44	23.69%
31	Tungsten (total)	ICAP	ppm	n.d.	
32	Vanadium (total)	ICAP	ppm	3.41	10.42%
33	Zinc (total)	ICAP	ppm	1,406	10.99%
34	pH	pH Meter	S.U.	12.00	0.00%

Layer Hen Ash
Safety Data Sheet

Revision date: 02/18/2013

SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

Product name. : Layer Hen Ash

1.2. Relevant identified uses of the substance or mixture and uses advised against

Use of the substance/mixture : Animal feed ingredient. Agricultural fertilizer and liming agent.

1.3. Details of the supplier of the safety data sheet

EnergyWorks BioPower, Inc.
71 Old Mill Bottom Road N
Annapolis, MD 21409

1.4. Emergency telephone number

Emergency number : Chemtrec 1 800 424 9300

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

GHS-US classification

Acute Tox. 4 (Oral)	H302
Skin Corr. 1A	H314
Carc. 1A	H350
STOT SE 3	H335
Aquatic Acute 1	H400

2.2. Label elements

GHS-US labelling

Hazard pictograms (GHS-US) :

Signal word (GHS-US) : Danger

Hazard statements (GHS-US) :
H302 - Harmful if swallowed
H314 - Causes severe skin burns and eye damage
H335 - May cause respiratory irritation
H350 - May cause cancer
H400 - Very toxic to aquatic life

Precautionary statements (GHS-US) :
P201 - Obtain special instructions before use
P202 - Do not handle until all safety precautions have been read and understood
P260 - Do not breathe dust/fume/gas/mist/vapours/spray
P261 - Avoid breathing dust/fume/gas/mist/vapours/spray
P264 - Wash ... thoroughly after handling
P270 - Do no eat, drink or smoke when using this product
P271 - Use only outdoors or in a well-ventilated area
P273 - Avoid release to the environment
P280 - Wear protective gloves/protective clothing/eye protection/face protection
P301+P312 - If swallowed, call a doctor if you feel unwell
P301+P330+P331 - IF SWALLOWED: Rinse mouth. Do NOT induce vomiting
P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower
P304+P340 - IF INHALED: Remove person to fresh air and keep comfortable for breathing
P305+P351+P338 - If in eyes: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing
P308+P313 - IF exposed or concerned: Get medical advice/attention
P310 - Immediately call a POISON CENTER/doctor/…
P312 - Call a POISON CENTER/doctor/…/if you feel unwell
P321 - Specific treatment (see ... on this label)
P330 - If swallowed, rinse mouth
P363 - Wash contaminated clothing before reuse
P391 - Collect spillage
P403+P233 - Store in a well-ventilated place. Keep container tightly closed
P405 - Store locked up
P501 - Dispose of contents/container to ...

2.3. Other hazards

No additional information available

2.4. Unknown acute toxicity (GHS US)

No data available

SECTION 3: Composition/information on ingredients

3.1. Substances

Not applicable

3.2. Mixture

Name	Product identifier	%	GHS-US classification
Calcium oxide	(CAS No.) 1305-78-8	54.6	Skin Irrit. 2, H315 Eye Dam. 1, H318 STOT SE 3, H335
Phosphorus pentoxide	(CAS No.) 1314-56-3	15.02	Skin Corr. 1A, H314
Potassium oxide	(CAS No.) 12136-45-7	10	Not classified
Magnesium oxide fume	(CAS No.) 1309-48-4	4.24	Not classified
Quartz	(CAS No.) 14808-60-7	3.99	Acute Tox. 4 (Oral), H302 Carc. 1A, H350
Sulfur trioxide	(CAS No.) 7446-11-9	2.44	Carc. 1A, H350
Carbon dioxide	(CAS No.) 124-38-9	1.94	Not classified
Sodium oxide (Na2O)	(CAS No.) 1313-59-3	1.83	Not classified
Chlorine	(CAS No.) 7782-50-5	1.24	Ox. Gas 1, H270 Acute Tox. 3 (Inhalation), H331 Skin Irrit. 2, H315 Eye Irrit. 2A, H319 STOT SE 3, H335 Aquatic Acute 1, H400
Aluminum oxide	(CAS No.) 1344-28-1	1.03	Not classified

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures after inhalation : Remove victim to fresh air. If not breathing, give artificial respiration. Call a physician is irritation or burning develops.

First-aid measures after skin contact : Remove contaminated clothes and flush skin burns with water for at least 15 minutes. If irritation persists, extend the water rinse period from twenty to thirty minutes. Call a physician immediately after adequate rinsing if irritation of burning develops.

First-aid measures after eye contact : Immediately flush with large quantities of running water for 10 to 30 minutes. Hold eyes open while flushing. Call a physician immediately if irritation or burning develops. Continue water flush up to one hour during transport to a medical facility.

First-aid measures after ingestion : Do NOT induce vomiting. If conscious, have victim rinse mouth, then drink large amounts of milk or water. Never give anything by mouth to an unconscious person. Call a physician immediately.

4.2. Most important symptoms and effects, both acute and delayed

Symptoms/injuries after inhalation : May cause severe respiratory irritation.

Symptoms/injuries after skin contact : Causes severe burns.

Symptoms/injuries after eye contact : Causes serious eye damage.

Symptoms/injuries after ingestion : May be harmful if swallowed.

4.3. Indication of any immediate medical attention and special treatment needed

No additional information available

SECTION 5: Firefighting measures

5.1. Extinguishing media

Suitable extinguishing media : Use extinguishing media appropriate for surrounding fire.

Unsuitable extinguishing media : None.

5.2. Special hazards arising from the substance or mixture

Fire hazard : None known.

Explosion hazard : None known.

5.3. Advice for firefighters

Protection during firefighting : Firefighters should wear full protective gear.

SECTION 6: Accidental release measures

6.1. Personal precautions, protective equipment and emergency procedures

General measures : Avoid contact with the skin and the eyes.

6.1.1. For non-emergency personnel

No additional information available

6.1.2. For emergency responders

No additional information available

6.2. Environmental precautions

Avoid release to the environment.

6.3. Methods and material for containment and cleaning up

For containment : Stop the flow of material, if this is without risk.

Methods for cleaning up : Place dry material in an approved container and dispose in accordance with local, state and federal regulations.

6.4. Reference to other sections

No additional information available

SECTION 7: Handling and storage

7.1. Precautions for safe handling

Precautions for safe handling : Avoid contact with eyes, skin and clothing.

7.2. Conditions for safe storage, including any incompatibilities

Storage conditions : Keep container closed when not in use.

7.3. Specific end use(s)

No additional information available

SECTION 8: Exposure controls/personal protection

8.1. Control parameters

Chlorine (7782-50-5)		
USA ACGIH	ACGIH TWA (ppm)	0.5 ppm
USA ACGIH	ACGIH STEL (ppm)	1 ppm
USA OSHA	OSHA PEL (Ceiling) (mg/m3)	3 mg/m³
USA OSHA	OSHA PEL (Ceiling) (ppm)	1 ppm

Calcium oxide (1305-78-8)		
USA ACGIH	ACGIH TWA (mg/m³)	2 mg/m³
USA OSHA	OSHA PEL (TWA) (mg/m3)	5 mg/m³

Magnesium oxide fume (1309-48-4)		
USA ACGIH	ACGIH TWA (mg/m³)	10 mg/m³
USA OSHA	OSHA PEL (TWA) (mg/m3)	15 mg/m³

Aluminum oxide (1344-28-1)		
USA OSHA	OSHA PEL (TWA) (mg/m3)	5 mg/m³

Carbon dioxide (124-38-9)		
USA ACGIH	ACGIH TWA (ppm)	5000 ppm
USA ACGIH	ACGIH STEL (ppm)	30000 ppm
USA OSHA	OSHA PEL (TWA) (mg/m3)	9000 mg/m³
USA OSHA	OSHA PEL (TWA) (ppm)	5000 ppm

Quartz (14808-60-7)		
USA ACGIH	ACGIH TWA (mg/m³)	0.025 mg/m³

8.2. Exposure controls

Appropriate engineering controls : Local exhaust and general ventilation must be adequate to meet exposure standards.

Personal protective equipment : Gloves. Safety glasses. Face shield. Protective clothing.

Hand protection : Chemical resistant gloves should be worn when handling this product.

Eye protection : Chemical safety goggles or face shield should be worn when handling this product.

Skin and body protection	:	Rubber apron, rubber boots should be worn when handling this product.
Respiratory protection	:	If exposure limits are exceeded or irritation is experienced, NIOSH approved respiratory protection should be worn. Handle in accordance with practices used for handling lime and other alkaline agricultural products. NIOSH approved particulate respirators (NIOSH type N100 filters) should be worn when handling this product.`

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

Physical state	:	Solid
Appearance	:	Powder
Colour	:	Light Gray
Odour	:	odorless.
Odour threshold	:	No data available
pH	:	12.25 (10 g/L in water)
Relative evaporation rate (butylacetate=1)	:	No data available
Melting point	:	No data available
Freezing point	:	No data available
Boiling point	:	No data available
Flash point	:	No data available
Self ignition temperature	:	No data available
Decomposition temperature	:	No data available
Flammability (solid, gas)	:	No data available
Vapour pressure	:	No data available
Relative vapour density at 20 °C	:	No data available
Relative density	:	No data available
Solubility	:	Water: 30 %
Log Pow	:	No data available
Log Kow	:	No data available
Viscosity, kinematic	:	No data available
Viscosity, dynamic	:	No data available
Explosive properties	:	No data available
Oxidising properties	:	No data available
Explosive limits	:	No data available

9.2. Other information

No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity

No additional information available

10.2. Chemical stability

The product is stable at normal handling- and storage conditions.

10.3. Possibility of hazardous reactions

Will not occur.

10.4. Conditions to avoid

This product is a strong desiccant and will absorb moisture from the air. Keep product dry in original containers until used.

10.5. Incompatible materials

Not determined.

10.6. Hazardous decomposition products

Not determined.

SECTION 11: Toxicological information

11.1. Information on toxicological effects

Acute toxicity : Harmful if swallowed.

Layer Hen Ash	
ATE (oral)	500 mg/kg

Chlorine (7782-50-5)	
LC50 inhalation rat (mg/l)	0.86 mg/l (Exposure time: 1 h)
LC50 inhalation rat (ppm)	293 ppm (Exposure time: 1 h)

Calcium oxide (1305-78-8)	
LD50 oral rat	500 mg/kg
ATE (oral)	500 mg/kg

Sulfur trioxide (7446-11-9)	
LC50 inhalation rat (mg/l)	1.2 mg/l (Exposure time: 1 h)

Phosphorus pentoxide (1314-56-3)	
LC50 inhalation rat (mg/l)	1.22 mg/l (Exposure time: 1 h)

Aluminum oxide (1344-28-1)	
LD50 oral rat	> 5000 mg/kg

Quartz (14808-60-7)	
LD50 oral rat	500 mg/kg
ATE (oral)	500 mg/kg

Skin corrosion/irritation : Causes severe skin burns and eye damage.
pH: 12.25 (10 g/L in water)

Serious eye damage/irritation : Not classified
pH: 12.25 (10 g/L in water)

Respiratory or skin sensitisation : Not classified

Germ cell mutagenicity : Not classified

Carcinogenicity : May cause cancer.

Sulfur trioxide (7446-11-9)	
IARC group	1

Quartz (14808-60-7)	
IARC group	1
National Toxicity Program (NTP) Status	2

Reproductive toxicity : Not classified

Specific target organ toxicity (single exposure) : May cause respiratory irritation.

Specific target organ toxicity (repeated exposure) : Not classified

Aspiration hazard : Not classified

SECTION 12: Ecological information

12.1. Toxicity

Ecology - general : Very toxic to aquatic life.

Chlorine (7782-50-5)	
LC50 fishes 1	0.44 mg/l (Exposure time: 96 h - Species: Lepomis macrochirus [flow-through])
EC50 Daphnia 1	0.017 mg/l (Exposure time: 48 h - Species: Daphnia magna)
LC50 fish 2	0.014 mg/l (Exposure time: 96 h - Species: Oncorhynchus mykiss [flow-through])

Calcium oxide (1305-78-8)	
LC50 fishes 1	1070 mg/l (Exposure time: 96 h - Species: Cyprinus carpio [static])

12.2. Persistence and degradability

No additional information available

12.3. Bioaccumulative potential

Chlorine (7782-50-5)	
BCF fish 1	(no bioaccumulation expected)

Calcium oxide (1305-78-8)	
BCF fish 1	(no bioaccumulation)

Carbon dioxide (124-38-9)	
BCF fish 1	(no bioaccumulation)

12.4. Mobility in soil

No additional information available

12.5. Other adverse effects

No additional information available

SECTION 13: Disposal considerations

13.1. Waste treatment methods

Waste disposal recommendations : Dispose of contents/container in accordance with local/regional/national/international regulations.

SECTION 14: Transport information

In accordance with DOT / ADR / RID / ADNR / IMDG / ICAO / IATA

14.1. UN number

Not applicable

14.2. UN proper shipping name

Not applicable

14.3. Additional information

Other information : No supplementary information available.

Overland transport

No additional information available

Transport by sea

No additional information available

Air transport

No additional information available

SECTION 15: Regulatory information

15.1. US Federal regulations

Potassium oxide (12136-45-7)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Chlorine (7782-50-5)

Listed on the United States TSCA (Toxic Substances Control Act) inventory
Listed on SARA Section 302 (Specific toxic chemical listings)
Listed on SARA Section 313 (Specific toxic chemical listings)

SARA Section 302 Threshold Planning Quantity (TPQ)	100
SARA Section 313 - Emission Reporting	1.0 %

Calcium oxide (1305-78-8)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Magnesium oxide fume (1309-48-4)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Sodium oxide (Na2O) (1313-59-3)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Sulfur trioxide (7446-11-9)

Listed on the United States TSCA (Toxic Substances Control Act) inventory
Listed on SARA Section 302 (Specific toxic chemical listings)

SARA Section 302 Threshold Planning Quantity (TPQ)	100 (This material is a reactive solid. The TPQ does not default to 10000 pounds for non-powder, non-molten, non-solution form)

Phosphorus pentoxide (1314-56-3)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Aluminum oxide (1344-28-1)

Listed on the United States TSCA (Toxic Substances Control Act) inventory
Listed on SARA Section 313 (Specific toxic chemical listings)

SARA Section 313 - Emission Reporting	1.0 % (fibrous forms)

Carbon dioxide (124-38-9)

Listed on the United States TSCA (Toxic Substances Control Act) inventory

Quartz (14808-60-7)
Listed on the United States TSCA (Toxic Substances Control Act) inventory

15.2. US State regulations

Quartz (14808-60-7)				
U.S. - California - Proposition 65 - Carcinogens List	U.S. - California - Proposition 65 - Developmental Toxicity	U.S. - California - Proposition 65 - Reproductive Toxicity - Female	U.S. - California - Proposition 65 - Reproductive Toxicity - Male	No significance risk level (NSRL)
Yes				

Potassium oxide (12136-45-7)
U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - New Jersey - Special Health Hazards Substances List

Chlorine (7782-50-5)
U.S. - Massachusetts - Right To Know List U.S. - Minnesota - Hazardous Substance List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Calcium oxide (1305-78-8)
U.S. - Massachusetts - Right To Know List U.S. - Minnesota - Hazardous Substance List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Magnesium oxide fume (1309-48-4)
U.S. - Massachusetts - Right To Know List U.S. - Minnesota - Hazardous Substance List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Sulfur trioxide (7446-11-9)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Phosphorus pentoxide (1314-56-3)
U.S. - Massachusetts - Right To Know List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Aluminum oxide (1344-28-1)
U.S. - Massachusetts - Right To Know List U.S. - Minnesota - Hazardous Substance List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Carbon dioxide (124-38-9)
U.S. - Massachusetts - Right To Know List U.S. - Minnesota - Hazardous Substance List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

Quartz (14808-60-7)
U.S. - Massachusetts - Right To Know List U.S. - Minnesota - Hazardous Substance List U.S. - New Jersey - Right to Know Hazardous Substance List U.S. - Pennsylvania - RTK (Right to Know) List

SECTION 16: Other information

Full text of H-phrases:

Acute Tox. 3 (Inhalation)	Acute toxicity (inhalation) Category 3
Acute Tox. 4 (Oral)	Acute toxicity (oral) Category 4
Aquatic Acute 1	Hazardous to the aquatic environment - Acute Hazard Category 1
Carc. 1A	Carcinogenicity Category 1A
Eye Dam. 1	Serious eye damage/eye irritation Category 1
Eye Irrit. 2A	Serious eye damage/eye irritation Category 2A
Ox. Gas 1	Oxidising gases Category 1
Skin Corr. 1A	skin corrosion/irritation Category 1A
Skin Irrit. 2	skin corrosion/irritation Category 2
STOT SE 3	Specific target organ toxicity (single exposure) Category 3
H270	May cause or intensify fire; oxidizer
H302	Harmful if swallowed
H314	Causes severe skin burns and eye damage
H315	Causes skin irritation
H318	Causes serious eye damage
H319	Causes serious eye irritation
H331	Toxic if inhaled
H335	May cause respiratory irritation
H350	May cause cancer
H400	Very toxic to aquatic life

This information is based on our current knowledge and is intended to describe the product for the purposes of health, safety and environmental requirements only. It should not therefore be construed as guaranteeing any specific property of the product.

http://www.epa.gov/radiation/neshaps/subpartr/about.html
Last updated on 7/31/2012

Radiation Protection

About Phosphogypsum

Phosphogypsum is a the primary byproduct of the wet-acid process for producing phosphoric acid from phosphate rock. It is largely calcium sulfate and has been given the name phosphogypsum. (Gypsum is the common name for hydrated calcium sulfate, a common building material.)

Phosphate production generates very large volumes of phosphogypsum, which is stored in huge piles called "stacks" that cover hundreds of acres in Florida and other phosphate-processing states.

On this page:

General Information

How much phosphogypsum is being produced?

Since the mid-eighties, the annual production rate of phosphogypsum has been in the range of 40 to 47 million metric tons per year. The total amount generated in the United States from 1910 to 1981 was about 7.7 billion metric tons.

In Central Florida, one of the major phosphoric acid producing areas, the industry generates about 32 million tons of phosphogypsum each year. They have a current stockpile in stacks of nearly 1 billion metric tons.

Why is so much phosphogypsum produced?

The agriculture industry uses large amounts of chemical fertilizers to replenish and supplement the nutrients that growing plants take up from the soil. The demand for fertilizers and animal feed additives accounts for about 95% of the 8-10 million metric tons of phosphoric acid that is made each year. The production of each ton of phosphoric acid is accompanied by the production of 4½ tons of the by-product calcium sulfate, also known as phosphogypsum.

Phosphate rock, which is processed to make phosphoric acid, contains concentrations of naturally occurring radioactive elements (radionuclides). Even high grade ores, which contain about 70% calcium phosphate, also contain a large number of impurities, such as calcium fluoride, chlorides, chromium, rare earths, and radionuclides. At the end of the production process, the radionuclides end up in the phosphogypsum.

Processing Phosphate Rock

Where does the phosphate rock come from?

In the United States, main deposits of phosphate rock are in Florida, Tennessee, and North Carolina. There are also deposits that can be mined in Idaho. The phosphate rock, which eventually yields the phosphogypsum by-product, is recovered by open pit mining. The rock is transported to a washing facility, where it is separated from accompanying soil, stones, etc. and processed. The desired phosphorus content of the phosphate rock is in a form (calcium phosphate) that will not dissolve in water and so cannot be taken up by crops. As a result, phosphate processors must solve the problem of getting it into a water-soluble form.

The most common solution to the problem is converting the calcium phosphate to phosphoric acid. There are wet and dry processes for doing the conversion. U.S. production facilities utilize a wet process in which the prepared rock is treated with sulfuric acid to produce the phosphoric acid. Phosphoric acid is water soluble so it can be taken up by crops. It can also be concentrated, as desired, by evaporating water from the mixture.

The by-product remaining after the acid conversion is largely calcium sulfate and has been given the name phosphogypsum. (Gypsum is the common trade name for hydrated calcium sulfate, a common building material.)

How many facilities are producing phosphoric acid and phosphogypsum?

As of September 1989, the phosphoric acid production industry consisted of 21 active facilities that use the wet-acid production process. The majority of the 21 facilities are located in the southeast, with 12 in Florida, three in Louisiana, and one in North Carolina.

Stacks

The phosphogypsum, separated from the phosphoric acid, is in the form of a solid/water mixture (slurry) which is stored in open-air storage areas known as stacks. The stacks form as the slurry containing the by-product phosphogypsum is pumped onto a disposal site. Over time the solids in the slurry build up and a stack forms. The stacks are generally built on unused or mined out land on the processing site.

As the stack grows, the phosphogypsum slurry begins to form a small pond (gypsum pond) on top of the stack. Workers dredge gypsum from the pond to build up the dike around it and the pond gradually becomes a reservoir for storing and supplying process water. A total of 63 phosphogypsum stacks were identified nationwide in 1989. They were in 12 different states, but the majority, two-thirds, were in Florida, Texas, Illinois, and Louisiana.

The surface area covered by stacks ranges from about 5 to 740 acres. The height ranges from about 10 to 200 feet. In 1989, the total surface area covered by stacks was about 8,500 acres. More than half that acreage is in Florida.

The tops of operating phosphogypsum stacks (ones that are still receiving phosphogypsum) are covered by ponds and ditches containing process water. "Beaches," saturated land masses, protrude into the ponds. These surface features may cover up to 75 percent of the top of the stack. Other surface features include areas of loose, dry materials; access roads; and thinly crusted stack sides. (The crust thickens and hardens when the stacks become inactive and no longer receive process slurry.)

Radioactivity in Phosphogypsum

How much radioactivity is in the phosphogypsum?

The concentrations of uranium and radium-226 in phosphogypsum samples taken in central Florida were about 10 times the background levels in soil for uranium and 60 times the background levels in soil for radium-226.

The radium-226 concentration in phosphogypsum varies significantly at different sampling locations on a single stack and also in phosphogypsum from different stacks within the same geographical area.

How are people exposed to the radiation from phosphogypsum stacks if they don't go near them?

Radionuclides that are small particles (i.e., radionuclide dust) can become airborne as wind-blown dust or as dust thrown up into the air by cars and trucks. The radionuclides, uranium and radium-226, are present in the phosphogypsum and can become airborne. Once these radionuclides are in the air, people and animals can breathe them and they can settle out onto ponds and agricultural areas. Radon-222, a decay product of radium-226, is a gas and so may become airborne by diffusing into the air. EPA has determined, however, that the risks associated with stacking phosphogypsum are in line with acceptable risk practices.

Other Phosphogypsum Constituents of Concern

In addition to the radiation health hazards covered by Subpart R, phosphogypsum contains some trace metals in concentrations that EPA believes may pose a chemical hazard to human health and the environment. Analysis of samples from various facilities contained arsenic, lead, cadmium, chromium, fluoride, zinc, antimony, and copper at concentrations that may pose significant health risks. The concentrations of these contaminants vary by more than three orders of magnitude among samples taken from various locations. These trace metals may also be leached from phosphogypsum and migrate to nearby surface and groundwater resources.

The presence of these trace metals in phosphogypsum is mentioned here in order to provide a more complete description of phosphogypsum, but they are not to be addressed in the risk assessment.

Understanding Radiation in Your Life, Your World

Programs · Topics · References

WRI POLICY NOTE

WATER QUALITY: EUTROPHICATION AND HYPOXIA No. 2

WORLD RESOURCES INSTITUTE

EUTROPHICATION: SOURCES AND DRIVERS OF NUTRIENT POLLUTION

MINDY SELMAN AND SUZIE GREENHALGH

Key Findings

Nutrient over-enrichment of freshwater and coastal ecosystems, or eutrophication, is a rapidly growing environmental crisis. Worldwide, the number of coastal areas impacted by eutrophication stands at over 500. In coastal areas, occurrences of dead zones, which are caused by eutrophic conditions, have increased from 10 documented cases in 1960 to 405 documented cases in 2008. In addition, many of the world's freshwater lakes, streams, and reservoirs suffer from eutrophication; in the United States, eutrophication is thought to be the primary cause of freshwater impairment. Many of our largest freshwater lakes are entrophic, including Lake Erie (United States), Lake Victoria (Tanzania/Uganda/Kenya), and Tai Lake (China).

The increase in eutrophication is the result of human activities. Major sources of nutrients to freshwater and coastal ecosystems include wastewater, agriculture, and atmospheric deposition of nitrogen from burning fossil fuels.

The drivers of eutrophication are expected to increase for the foreseeable future. Specifically:

- World population will continue to grow, reaching an estimated 9.2 billion by 2050, which will increase pressures on the productive capacity of agriculture and industry.
- Intensive agriculture and land use conversion—for crops, livestock, and aquaculture—will increase, especially in the developing world. In addition to population growth, intensification is driven by changing dietary patterns. For example, over the period from 2002 to 2030, global meat consumption is expected to increase by 54 percent.
- Energy consumption is expected to grow 50 percent from 2005 to 2030. Fossil fuels, which release nitrogen oxides (NO_x) into the environment when burned, will continue to be the dominant fuel source in this century.

As a result of these increasing global trends in population growth, energy use, and agricultural production, we expect that coastal and freshwater systems impacted by eutrophication and hypoxia will continue to increase, especially in the developing world.

Human-induced eutrophication, or nutrient over-enrichment, is a rapidly growing environmental crisis in freshwater and marine systems worldwide. Nutrients that cause eutrophication include nitrogen and phosphorus. While nitrogen and phosphorus are critical to biological processes in aquatic ecosystems, increased runoff of these nutrients to aquatic ecosystems from land-based sources results in increased biomass production, upsetting the natural balance of these ecosystems. Eutrophication can ultimately result in harmful algal blooms, the formation of hypoxic[1] or "dead" zones, and ecosystem collapse. Today, over 500 coastal areas have been identified as suffering from the effects of eutrophication; of these, 405 have also been documented as hypoxic (compiled from Selman et al. 2008 and Diaz and Rosenberg 2008). In freshwater systems, phosphorus is often the main cause of impairment, while nitrogen is generally linked with the impairment of coastal systems. In addition to contributing to eutrophication, nitrogen pollution also contributes to other environmental problems such as acid rain, climate change, and local air pollution. Nitrous oxide (N_2O)—a nitrogen-based greenhouse gas that contributes to climate change—is linked primarily to agriculture and is 310 times more powerful than carbon dioxide. Nitrogen oxides (NO_x) are another family of nitrogen-based gases that are released into the atmosphere from fossil fuel combustion. NO_x is highly reactive and contributes to the formation of smog—which can have significant impacts on human health—and acid rain.

This policy note provides a snapshot of the sources of nutrient pollution and the corresponding socioeconomic drivers that are increasing nutrient levels in our waterways. It complements *Eutrophication and Hypoxia in Coastal Areas: A Global Assessment of the State of Knowledge* (Selman et al. 2008), a previously released publication on the extent of eutrophication worldwide.

Where Do Nutrients Come From?

Sources of nutrient pollution released to freshwater and coastal areas are diverse, and include agriculture, aquaculture, septic tanks, urban wastewater, urban stormwater runoff, industry, and fossil fuel combustion. Nutrients enter aquatic ecosystems via the air, surface water, or groundwater (Table 1). Among regions, there are significant variations in the relative importance of nutrient sources that contribute to eutrophication of local and coastal waterbodies. For example, in the United States and the European Union, agricultural sources—commercial fertilizers and animal manure—are typically the primary sources of nutrient impairment in waterways, while urban wastewater is the primary source in Asia and Africa.

TABLE 1. Primary Sources and Pathways of Nutrients

	Pathways		
Sources	**Air**	**Surface Water**	**Groundwater**
Sewage treatment plants		✔	
Industry	✔	✔	
Septic systems		✔	✔
Urban stormwater runoff		✔	
Agricultural fertilizers	✔	✔	✔
Livestock operations	✔	✔	✔
Aquaculture		✔	
Fossil fuel combustion	✔		

Urban and Industrial Sources

Municipal wastewater treatment plants and industrial wastewater discharges, nitrogen leaching from below-ground septic tanks, and stormwater runoff are some of the urban and industrial sources of nutrient losses. Municipal and industrial sources are considered "point sources" of nutrient pollution because they discharge nutrients directly to surface waters or groundwater via a pipe or other discrete conveyance. They are typically the most controllable sources of nutrients and are often regulated in developed countries.

TABLE 2. Percent of Sewage Treated by Region

Region	**Percent of Sewage Treated**
North America	90
Europe	66
Asia	35
Latin America & Caribbean	14
Africa	<1

Source: Martinelli 2003 as cited in MA 2005

The most prevalent urban source of nutrient pollution is human sewage, though its importance varies by region and country. Sewage is estimated to contribute 12 percent of riverine nitrogen input in the United States, 25 percent in Western Europe, 33 percent in China, and 68 percent in the Republic of Korea (MA 2005). This variation is due, in large part, to differences in sewage treatment levels among countries (Table 2). In developing countries, fewer than 35 percent of cities have any form of sewage treatment (UNEP and WHRC 2007), and when sewage is treated, it is typically primary treatment aimed at removing solids, not nutrients. Where households are not connected to municipal wastewater treatment plants, septic systems are often used in developed countries. Septic systems are designed to purify waste by leaching it through soils. They leach, on average, 14 kilograms of nitrogen per system per year—much of which then conveys into groundwater or nearby surface waters (Anne Arundel County Maryland DPW 2008).

Stormwater runoff is another significant source of nutrients from urban areas. Rainfall events flush nutrients from residential lawns and impervious surfaces into nearby rivers and streams. In some cities, combined sewer overflow (CSO) systems worsen stormwater runoff problems. CSOs are designed to collect rainwater, domestic wastewater, and industrial wastewater in the same pipe. During heavy rain or snowmelt, wastewater volume can exceed the capacity of the CSO system, as well as that of the wastewater treatment plant receiving the flow. As a result, the excess wastewater, including raw sewage, is discharged directly into nearby streams and rivers. In the United States, over 772 cities had CSOs in 2007 (EPA 2007).

For industrial sources of nutrient pollution, certain industries are larger sources than others. Pulp and paper mills, food and meat processing, agro-industries, and direct discharge of sewage from maritime vessels are some of the larger sources of industrial nutrient pollution.

Agricultural Sources

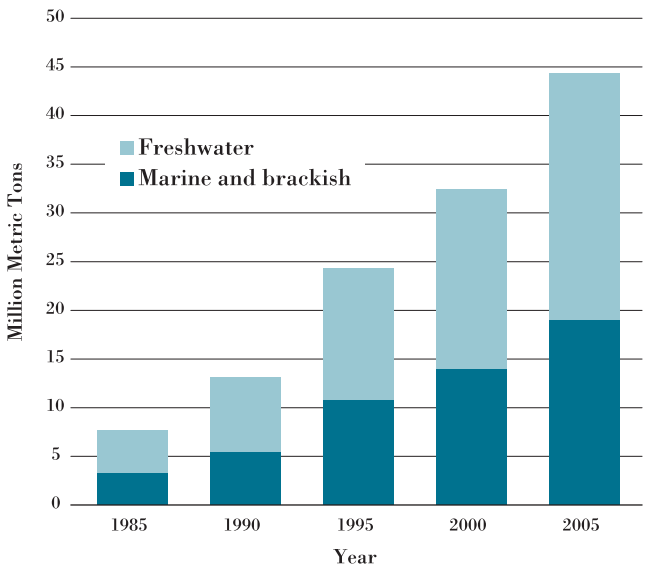
Fertilizer leaching, runoff from agricultural fields, manure from concentrated livestock operations, and aquaculture are the largest agricultural nutrient sources. Between 1960 and 1990, global use of synthetic nitrogen fertilizer increased more than sevenfold, while phosphorus use more than tripled, with chemical fertilizers often being applied in excess of crop needs (MA 2005). The excess nutrients are lost through volatilization, surface runoff, and leaching to groundwater. On average, about 20 percent of nitrogen fertilizer is lost through surface runoff or leaching into groundwater (MA 2005). Synthetic nitrogen fertilizer and nitrogen in manure that is spread on fields is also subject to volatilization. Volatilization is where nitrogen in the form of ammonia is lost to the atmosphere. Under some conditions, up to 60 percent of the nitrogen applied to crops can be lost to the atmosphere by volatilization (University of Delaware Cooperative Extension 2009); more commonly, volatilization losses are 40 percent or less (MA 2005). A portion of the volatilized ammonia is redeposited in waterways through atmospheric deposition. Phosphorus, which binds to the soil, is generally lost through sheet and rill erosion from agricultural lands.

The rapidly changing nature of raising livestock has also contributed to a sharp increase in nutrient fluxes over the last century. Animal production is intensifying, with increasingly more production occurring further away from feedstock supplies. The large quantity of manure produced by these operations is applied to land as fertilizer, stacked in the feedlot, or stored in lagoons. Frequently, the rate and timing of land application of manure is dictated by the volume and availability of manure and not by crop needs. This leads to ill-timed or overapplication of manure, further exacerbating nutrient runoff and leaching.

In China, meat production rose by 127 percent between 1990 and 2002 (FAO 2009a), but fewer than 10 percent of an estimated 14,000 intensive livestock operations have installed pollution controls (Ellis 2007). In the Black Sea region, one swine operation—which subsequently closed—had over 1 million pigs and generated sewage equivalent to a town of 5 million people (Mee 2006).

Aquaculture is another growing source of nutrient pollution. Annual aquaculture production worldwide increased by 600 percent, from 8 million tons in 1985 to 48.2 million tons in 2005 (Figure 1). Today nearly 43 percent of all aquaculture production is within marine or brackish environments, with the remainder in freshwater lakes, streams, and man-made ponds (FAO 2007). Marine fish and shrimp farming often occur in net pens or cages situated in enclosed bays. These farms generate concentrated amounts of nitrogen and phosphorus from excrement, uneaten food, and other organic waste. If improperly managed, aquaculture operations can have severe impacts on aquatic ecosystems as nutrient wastes are discharged directly into the surrounding waters. For every ton of fish, aquaculture operations produce between 42 and 66 kilograms of nitrogen waste and between 7.2 and 10.5 kilograms of phosphorus waste (Strain and Hargrave 2005).

FIGURE 1 The Global Increase in Aquaculture Production



Source: FAO 2007

Fossil Fuel Sources

When fossil fuels are burned, they release nitrogen oxides (NO_x) into the atmosphere. NO_x contributes to the formation of smog and acid rain. NO_x is redeposited to land and water through rain and snow (wet deposition), or can settle out of the air in a process called dry deposition. Coal-fired power plants and exhaust from cars, buses, and trucks are the primary sources of NO_x. Fossil fuel combustion contributes approximately 22 teragrams[2] of nitrogen pollution globally every year (Table 3), approximately one-fifth of the contribution of synthetic nitrogen fertilizers (MA 2005). In the Baltic Sea, atmospheric deposition, primarily from burning fossil fuels, accounts for 25 percent of nitrogen inputs (HELCOM 2005). Similarly, in the Chesapeake Bay, atmospheric deposition accounts for 30 percent of all nitrogen inputs.[3] In some areas, such as in the U.S. North Atlantic, atmospheric deposition of nitrogen can exceed riverine nitrogen inputs to coastal areas (Spokes and Jickells 2005).

TABLE 3. Global Nitrogen Oxide Emissions, 2000

Region	NO_x Emissions (1,000 metric tons)
Asia (excluding Middle East)	37,722
Central America & Caribbean	3,881
Europe	25,536
Middle East & North Africa	7,572
North America	21,839
Oceania	3,381
South America	11,748
Sub-Saharan Africa	14,926
TOTAL	126,605

Source: WRI 2009

What Drives the Increasing Eutrophication Trends?

Complex and interrelated socioeconomic factors drive the increase in nutrient pollution, which is causing increased occurrences of eutrophication. Indirect drivers include population growth; economic growth in the developing world, which will impact consumer consumption; and the growth of intensive agriculture. Direct drivers of eutrophication include higher energy consumption, increased fertilizer consumption, and land-use change.

Indirect Drivers of Eutrophication

Population Growth

The global population is predicted to grow from 6.5 billion in 2005 to nearly 9.2 billion in 2050, with the majority of population growth occurring in less developed countries (UNPD 2008). Population growth will increase the demand for food, land, energy, and other natural resources, ultimately leading to greater agricultural production and increased burning of fossil fuels to heat homes, power cars, and fuel industry.

Economic Growth

Global per capita income is projected to double between 2002 and 2030, with the greatest income growth occurring in developing countries (Dargay et al. 2007). Per capita income of developing countries is expected to grow by 2.2 percent annually between 2002 and 2030. In developed countries, per capita income is forecast to grow approximately 1.5 percent annually (Dargay et al. 2007).

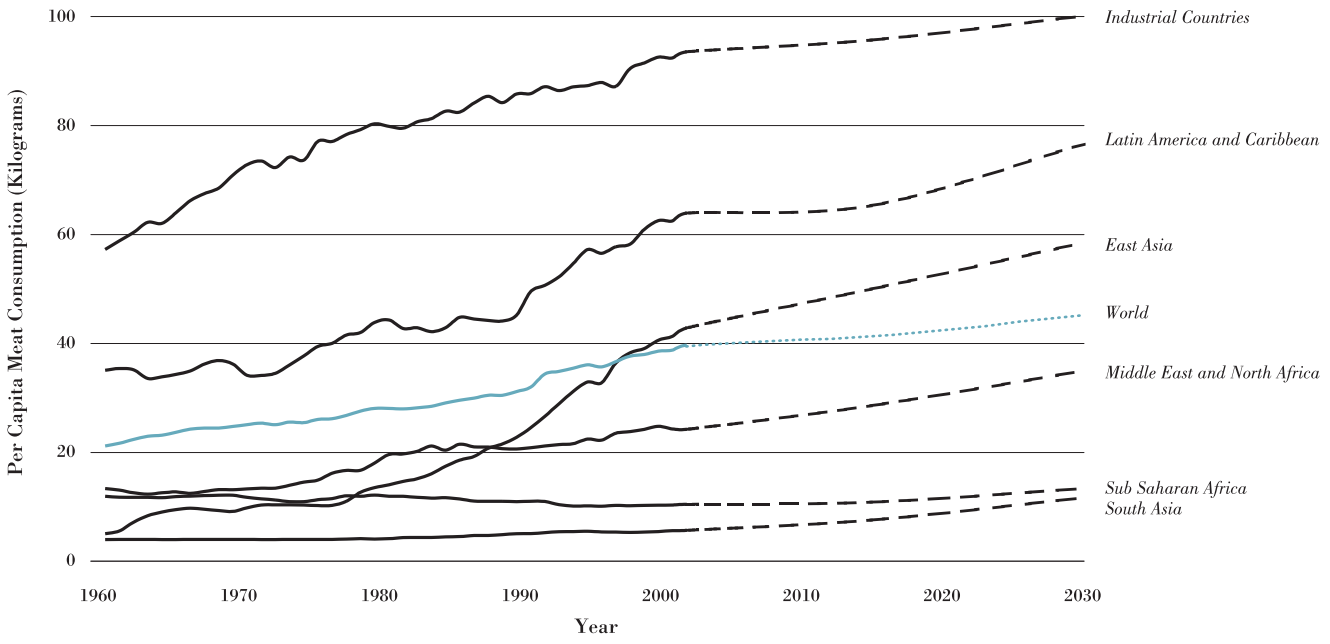
Increasing incomes will lead to changes in consumption patterns, such as different dietary choices, increasing energy use, and increasing consumption of consumer goods. For example, worldwide, dietary trends are moving toward greater meat consumption as a result of increased purchasing power, especially in the case of lower to middle income populations (FAO 2002). Between 1961 and 2002, the average worldwide per capita meat consumption rose by 87 percent, from an average per capita consumption of 21.2 kilograms per person to 39.7 kilograms per person (FAO 2009a). Between 2002 and 2030, meat consumption is expected to increase by 44 percent in the Middle East and North Africa region, 36 percent in East Asia, and 28 percent in Latin America and the Caribbean. South Asia, which currently has the lowest per capita meat consumption, is expected to double its meat consumption by 2030. Worldwide, per capita meat consumption is expected to increase by 14 percent by 2030, to an estimated average consumption of 45.3 kilograms of meat per person (Figure 2). When population growth is included, this rise equates to an estimated increase of 53 percent in total meat consumed worldwide.

The increased livestock production that will be necessary to meet growing global demand for meat is expected to have significant implications for for the severity of nutrient pollution worldwide. For example it is estimated that only 20 percent of the nitrogen used in swine production is actually consumed by humans; the remainder is excreted as manure or lost to the environment during the production of animal feed (UNEP and WHRC 2007). In contrast, one study of the Mississippi River Basin estimated that if feed cultivation for meat production were switched to crops that would support a lacto-ovo-vegetarian diet, nitrate exports to the Gulf of Mexico would decrease by 50 percent (Donner 2006).

Agricultural Intensification

In the past 70 years, the way in which we grow food has changed dramatically. The "Green Revolution," which began in the 1940s, made significant advances in agricultural production, introducing the widespread use of agrochemicals such as synthetic fertilizers and pesticides to improve crop yields. These chemicals and modern machinery allowed the intensification of agriculture. While the intensification of agriculture has led to economies of scale and improved food security, it has also led to significant unintended environmental impacts such as nutrient pollution. While agriculture in developed countries is already highly intensive, we expect to see greater agricultural intensification in developing countries in the coming decades.

FIGURE 2 | **Per Capita Meat Consumption**



Source: Historical data from FAO 2009a, projected data from FAO 2002

Direct Drivers of Eutrophication

Energy Consumption

Growing populations and expanding economies demand more energy. Total worldwide energy consumption rose by 33 percent between 1990 and 2005 (EIA 2008). Currently, more than 86 percent of the world's energy needs are being met by fossil fuel sources (coal, oil, and natural gas) (EIA 2008). Once combusted, fossil fuels discharge NO_x into the atmosphere. While alternative energy sources such as solar, wind, and geothermal are available, the heavy reliance on fossil fuels is expected to continue in the short to medium term. Between 2005 and 2030, experts estimate that per capita energy consumption will increase by approximately 18 percent, while total global energy consumption will rise by 50 percent; the developing world is projected to account for the majority of increased energy consumption (EIA 2008). Fossil fuels are expected to continue meeting approximately 86 percent of global energy needs (EIA 2008).

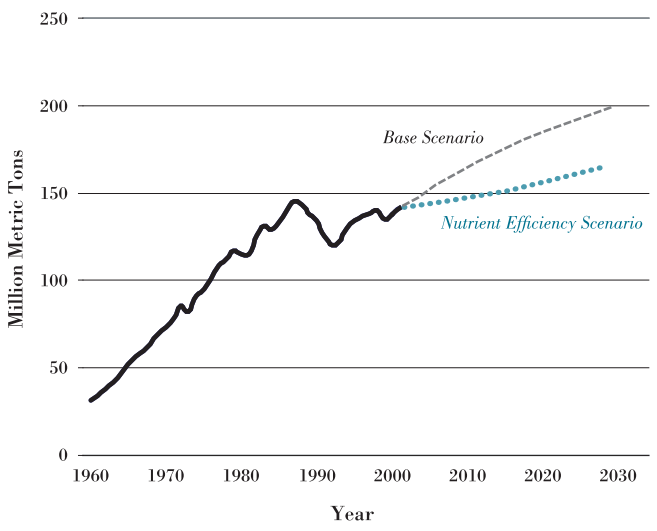
Fertilizer Consumption

Growing populations, changing dietary trends that are increasing the demand for meat, and the expanding use of biofuels will necessitate increased agricultural production. As a result, fertilizer consumption is expected to increase 40 percent between 2002 and 2030 (Figure 3, base scenario) (FAO 2000). With genetic engineering to improve crop nutrient-use efficiency, this increase in fertilizer use is estimated to be only 17 percent over the same time period (Figure 3, nutrient efficiency scenario) (FAO 2000). The majority of the projected increase in global fertilizer consumption is attributed to the developing world where food production and adoption of intensive agricultural practices are expected to increase (FAO 2000).

Land-use Conversion

Tied to increased food production is the conversion of land from perennial vegetation to annual cropping. From 1995 to 2002, cropland has experienced a net increase globally of about 3 million hectares per year, with over 90 percent of the total cropland gains coming from forests (Holmgren 2006). Agriculture is also the single largest cause of wetland loss. Approximately 50 percent of the world's wetlands have been lost since the 1950s. The majority of wetland loss occurred as a result of drainage for agricultural production (OECD/IUCN 1996). The FAO predicts that land-use conversion for agriculture will continue, but at a slower pace than in the past (FAO 2002). Natural landscapes such as forests and wetlands are important for capturing and cycling nutrients. Increasing land-use conversion reduces the ability of these landscapes to intercept nutrients and leads to greater nutrient losses to local waterways.

FIGURE 3 **Projected Increase in Global Fertilizer Consumption***



Source: Historical data from FAO 2009b, projected data from FAO 200.

* Fertilizer consumption includes nitrogen (N), phosphates (P_2O_5) and potash (K_2O).

Conclusions and Next Steps

Population growth is driving increased demand for energy and food. This increase will further exacerbate nutrient losses from urban, industrial, and agricultural sources as well as those from combustion of fossil fuels. As a result, we expect to see increasing numbers of coastal and freshwater ecosystems impacted by eutrophication and hypoxia in the future. It is likely that eutrophication will increase most rapidly in the developing world, where population, meat consumption, and energy consumption are expected to increase more rapidly than in developed countries.

At its core, eutrophication is a byproduct of unsustainable agricultural production and energy use. Because the pathways, sources, and drivers of nutrient pollution are varied and diverse, the policies that address eutrophication cannot be limited to traditional environmental regulations. Instead, policymakers must look more broadly at agricultural, energy, land use, and public health policies and find ways that these policies can be designed to mitigate nutrient pollution. Finally, there are strong linkages between the sources and drivers of eutrophication and those of climate change and other critical environmental issues like air pollution and acid rain. Developing a more robust understanding of the sources and drivers of eutrophication will allow policymakers to identify the linkages between eutrophication and other local, regional, and global environmental issues and identify those policies that minimize tradeoffs and maximize environmental benefits. A forthcoming publication in this series will focus on the types of institutions, actions, and policies that are critical for addressing eutrophication.

Notes

1. Hypoxia generally occurs when the dissolved oxygen concentration of water is 2.0 milligrams per liter or less.
2. 1 teragram (Tg) is equal to 1 million metric tons
3. Source: Personal communication with Lewis Linker at the Chesapeake Bay Program Office. May, 2009. Estimate is based on a study whose results will be presented in a forthcoming publication.

About the Authors

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Suzie Greenhalgh is the research leader for Sustainable Ecosystems and a senior economist at Landcare Research New Zealand Ltd.

Acknowledgments

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- Eutrophication and Hypoxia in Coastal Areas: A Global Assessment of the State of Knowledge (March 2008)
- Eutrophication: Policies, Actions, and Strategies to Address Nutrient Pollution (forthcoming July 2009)

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Appendix E - CBF Letter regarding Manure Pollution

CHESAPEAKE BAY FOUNDATION
Saving a National Treasure

December 18, 2013

To whom it may concern:

As outlined below, the Chesapeake Bay Foundation (CBF) is supportive of alternate uses of animal manure, such as the energy and nutrient recovery process developed by EnergyWorks. As an alternative to storage and land application, the process converts manure into renewable energy and recycled mineral products. Technology solutions such as this are an integral part of addressing the water pollution problems associated with excess manure-nutrients in the Chesapeake Bay watershed. The Chesapeake Bay Foundation will continue its long-standing efforts to educate the general public on the importance of water quality and how decisions by individual consumers can make a difference.

Background: The Chesapeake Bay and its rivers and streams are highly degraded due to excessive amounts of nitrogen and phosphorus pollution that fuel harmful algae blooms which damage fish habitat, block sunlight from vital underwater grasses and create Dead Zones of little or no oxygen for aquatic organisms. Because of these problems, in December 2010, the Environmental Protection Agency established enforceable pollution limits for nitrogen, phosphorus, and sediment pollution in the Chesapeake Bay. Subsequently, the six Bay states and the District of Columbia released their plans to meet those limits by 2025. Together the pollution targets and the states' plans comprise a Clean Water Blueprint for the Chesapeake and its rivers and streams. Pollution reductions are needed from all sources, including sewage treatment plants, agriculture, urban and suburban polluted runoff, and air pollution. Agriculture is the largest source of pollution in the Chesapeake Bay watershed, a major portion of which comes from animal waste produced by modern intensive livestock operations.

Manure to Energy- Part of the Solution: Livestock production in the Chesapeake watershed is concentrated in three primary regions, which produce far more animal waste than local farmers can use as fertilizer. Lancaster County, Pennsylvania, at the center of the lower Susquehanna Valley, is one of these regions and has the second-highest agricultural production of any county east of the Mississippi and is the fifth biggest county nationally in overall animal production. Traditionally, livestock and poultry manure has been a valuable resource for farmers, because it provides a cost-effective source of fertilizer for their fields. Applied appropriately, manure adds nutrients as well as organic matter, improving both soil fertility and quality. There is a threshold, however, to the amount of nutrients that can be applied and used productively on fields.

Manure's ratio of phosphorus to nitrogen is higher than the ratio that crops need. Thus a farmer who applies enough manure to meet the crops' need for nitrogen is over-applying phosphorus. The unused phosphorus builds up in the soil, and these elevated levels can greatly increase phosphorus pollution.

PHILIP MERRILL ENVIRONMENTAL CENTER | 6 HERNDON AVENUE | ANNAPOLIS, MD 21403
410/268-8816 | FAX: 410/268-6687 | CBF.ORG

In addition, since manure is bulky and difficult to transport long distances, it is usually spread close to the farm where it was produced—which also leads to excess nutrients in the soil, making them more susceptible to runoff. They enter groundwater and stormwater runoff; they find their way to the Bay and the rivers that feed it.

The need to rebalance the use of nutrients and protect water quality in the Bay region, combined with the nation's growing demand for renewable energy, presents a new and potentially huge opportunity: manure-based energy. Because of this, CBF has been engaged in promoting alternate uses of excess manure throughout the watershed and support projects like EnergyWorks' Gettysburg Energy & Nutrient Recovery Facility as a viable and promising alternative.

Sincerely,

Kim Coble
Vice President
Environmental Protection and Restoration

HEN MANURE ASH AS A FEED SUPPLEMENT FOR LAYING HENS

P.H. Patterson[1], T.L. Cravener[1], H.K. Burley[1] and G.H. Perdew[2]
[1]Department of Animal Science, and [2]Department of Veterinary and Biomedical Sciences, Penn State University, University Park, PA 16802

Introduction

Gasification of laying hen manure utilizes the carbon as a renewable energy source and recycles the elemental nutrients (Ca, P, K and trace minerals) as a feed supplement. This strategy of nutrient management eliminates manure applications to farm land and reduces the nutrient load on ground and surface waters to the Chesapeake Bay and beyond. There are only a few studies demonstrating the potential energy to be derived and nutrients to recycle when hen manure undergoes methane digestion, gasification or incineration (McElvaney, 1990; Patterson and Loy, 1992; Rao et al., 1992; Burley et al., 2011). Therefore the objectives of this study were to document the utility and impact of feeding hen manure ash (HMA) to laying hens as a dietary calcium and phosphorus source, and to assure the health of the hens and safety of the eggs.

Materials and Methods

The hen manure ash (HMA) utilized in this study was generated from commercial belted hen manure by gasification using a pilot scale gasification system. The HMA and dietary dicalcium phosphate were extracted and analyzed using EPA approved methods for dioxin/halogenated polycyclic hydrocarbons (HPAHs) by Analytical Perspectives (Wilmington, NC). The actual levels of individual HPAHs were determined by GC-MS and reported as WHO-TEQ (World Health Organization toxic equivalents) for dioxins and related PCDD/PCDF (polychlorinated dibenzo-p-dioxin and polychlorinated dibenzofuran, respectively).

Day old Hy-Line W-36 pullet chicks were housed in the fall of 2011, brooded and reared in cages under environmentally control conditions, and fed standard commercial diets until 18 wks of age when they were moved to an environmentally controlled, mechanically ventilated hen house. Hens (360) were randomly assigned to one of four dietary treatments with 10 replicate experimental units of 9 birds in 3 adjacent cages with 3 birds per cage (80in^2/bd) with a common feed trough and egg tray. Feed and water (nipple drinkers) were provided *ad libitum.* All lighting and management practices aside from dietary alterations specified by dietary treatments were in accordance with current recommendations for the breed (Hy-Line, 2009). Photoperiod was progressively increased to 16 hr light:8 hr dark at 27 weeks of age and maintained on this schedule for the remainder of the trial.

Dietary treatments include a control diet with no HMA, and low, medium, and high levels of HMA inclusion. The low inclusion rate corresponded with 33% of dicalcium

phosphate replaced by HMA. The medium included 66% of dicalcium phosphate replaced by HMA, and the high included 100% of dicalcium phosphate replaced by HMA. The levels of Ca, P and HMA inclusion changed with the three dietary phases of egg production and nutrient requirements. Phase I (20-36wks) diets were formulated to contain 1288 kcal/lb ME, 17.2% CP 4.00% Ca and 0.42% Av P, Phase II (36-52wks) diets contained 1282 kcal/lb ME, 16.7% CP 4.10% Ca and 0.40% Av P, and Phase III (52-68wks) diets 1284 kcal/lb ME, 16.25% CP 4.15% Ca and 0.38% Av P. Eggs were gathered and recorded daily, feed intake and egg weights were measured every 4 wk period, and body weight and egg quality were measured every phase. The Pennsylvania State University Institutional Animal Care and Use Committee approved all techniques and procedures involved in this study (IACUC #38928). Significant differences between dietary treatments were detected using a one-way ANOVA and Duncan's test for comparisons of the means (Duncan, 1955). Data analysis was done using the PROC GLM procedure of SAS version 9.2 (SAS, 2008) and statistical significance was set at $P \leq 0.05$.

Results and Discussion

In the first 5 periods of egg production until 40 wks of age no significant differences were measured between the treatments (Table 1). The same was observed for eggs per hen housed (data not shown). Feed intake was significantly different between treatments in periods 1, 4 and 5 (Table 2) with the trend for the Control and low HMA fed hens to eat more than those fed med or high HMA. Feed conversion (Table 3) was significantly better among the hens fed the med and high HMA in periods 3 and 4 following the lower level of feed consumption. Egg weight was lower in period 1 from hens fed the med and high levels of HMA, but this did not repeat itself in periods 2, 3, 4 or 5 (Table 4). Body weight of hens was lower for the med and high HMA treatments in periods 3, 4 and 6 corresponding with lower feed intake (Table 5). Egg quality parameters appeared to be influenced by the dietary treatments. Egg shell strength measured significantly higher for hens fed the med and high HMA treatment diets in period 2 compared to the control and low level (Table 6). A similar trend ($P=0.09$) in egg specific gravity was observed in period 2, indicating greater shell density among those fed the higher levels of HMA (data not shown). Egg albumen height and Haugh units measured in period 4 were significantly greater for the med and high HMA vs. the controls (data not shown). Lastly, mortality was low for the first 5 periods and not significantly different between the treatments.

These findings would indicate that up to 40 weeks of age the HMA diets are capable of maintaining egg production, egg weight and livability equal to control diets using dicalcium phosphate and limestone. Feed intake appears to be marginally lower, resulting in better feed conversion and lower body weight. And finally egg quality measures indicate both shell quality and albumen height may be enhanced by the HMA additions.

Table 1. Hen Day Egg Production %.

Treatment	Period 1 (20-24wk)	Period 2 (24-28wk)	Period 3 (28-32wk)	Period 4 (32-36wk)	Period 5 (36-40wk)
Control	73.93	93.18	94.25	93.22	91.31
33 % HMA	69.01	93.10	93.93	93.45	92.99
66 % HMA	73.17	94.56	95.44	95.06	90.93
100 % HMA	69.13	93.29	95.12	93.21	90.75
P- value	0.4206	0.6862	0.7745	0.7908	0.4600

Table 2. Feed Intake Per Hen Per Day (g).

Treatment	Period 1 (20-24wk)	Period 2 (24-28wk)	Period 3 (28-32wk)	Period 4 (32-36wk)	Period 5 (36-40wk)
Control	85.9[a]	94.6	97.0	91.3[a]	88.0 [a]
33 % HMA	83.7[ab]	95.2	97.3	92.8[a]	87.3 [a]
66 % HMA	80.87[bc]	93.2	95.4	87.8[b]	83.9 [b]
100 % HMA	77.3[c]	92.0	94.6	88.4[b]	85.0 [ab]
P- value	0.0005	0.1667	0.2387	0.0005	0.0419

Table 3. Feed Conversion (kg Feed Per Dozen Eggs).

Treatment	Period 1 (20-24wk)	Period 2 (24-28wk)	Period 3 (28-32wk)	Period 4 (32-36wk)	Period 5 (36-40wk)
Control	1.408	1.221	1.237[ab]	1.177[a]	1.157
33 % HMA	1.483	1.228	1.245[a]	1.194[a]	1.127
66 % HMA	1.331	1.183	1.200[bc]	1.109[b]	1.108
100 % HMA	1.351	1.184	1.193[c]	1.138[b]	1.123
P- value	0.1088	0.0835	0.0199	0.0002	0.0616

Table 4. Egg Weight (g).

Treatment	Period 1 (20-24wk)	Period 2 (24-28wk)	Period 3 (28-32wk)	Period 4 (32-36wk)	Period 5 (36-40wk)
Control	53.4[a]	55.2	57.3	59.0	59.2
33 % HMA	52.5[b]	56.1	57.0	58.7	59.4
66 % HMA	51.9[b]	55.3	56.5	58.2	58.1
100 % HMA	51.9[b]	55.2	56.7	58.6	58.8
P- value	0.0004	0.1931	0.4242	0.4802	0.0893

Table 5. Body Weight (g).

Treatment	Period 1 (20wk)	Period 3 (30wk)	Period 4 (36wk)	Period 6 (42wk)
Control	1341	1550[a]	1585[a]	1598[a]
33 % HMA	1335	1552[a]	1601[a]	1601[a]
66 % HMA	1331	1500[b]	1518[b]	1511[b]
100 % HMA	1333	1495[b]	1499[b]	1500[b]
P- value	0.6635	0.0003	0.0001	0.0001

Table 6. Egg Shell Strength (N).

Treatment	Period 2 (26wk)	Period 5 (40wk)
Control	38.9[b]	35.9
33 % HMA	40.8[ab]	35.1
66 % HMA	42.0[ab]	36.9
100 % HMA	43.4[a]	35.4
P- value	0.0267	0.6946

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October 9, 2014

Agricultural Marketing Service
National Organic Program
ATTN: Dr. Lisa M. Brines
1400 Independence Avenue S.W.
Room 2648-S, STOP 0268
Washington, DC 20250-0268

Dear Dr. Brines:

Thank you for your letter of September 15, 2014 regarding our petition to amend and clarify the manure ash burning prohibition in section 205.602 of the National Organic Program's (NOP) List of Allowed and Prohibited Substances.

We are answering the three points raised in your letter. However, we would like to note that the request we are making is not on behalf of a specific product that is being made today. While we are making products today and plan to make additional products in the future, the amendment is requested on behalf of a broader category of processes possibly used by other firms.

This said, we offer the following to you regarding Layer Manure Ash (LMA) and Poultry Litter Ash (PLA):

- Regarding information on substance physical characteristics and mode of action, we offer the following table and attached product labels:

	New Bay Peake - EL (Layer Manure Ash)	New Bay Peake - PL (Poultry Litter Ash)
Available Phosphate (P_2O_5)	15.3%	24.4%
Soluble Potash(K_2O)	10.24%	16.3%
Calcium (CaO)	50.26%	17.3%

- The recommended application rates for the products are as follows:
  - New Bay Peake – EL apply as agricultural fertilizer at rate of 653 pounds per acre
  - New Bay Peake – PL apply as agricultural fertilizer at rate of 409 pounds per acre
- We confirm via this letter that our petition does not contain any confidential information.

We look forward to a successful introduction of the petition to the NOSB and to a fair outcome reflective of the fact that nutrient separation technologies acting on animal manures solve significant environmental challenges while allowing organic farmers to more effectively balance nutrients in their fertilization programs.

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Thank you for your responsiveness and for taking time to answer our questions. Please call me via cell phone at 443-875-2556 if more information is needed. We look forward to a timely consideration of the petition.

Sincerely,

Jeff Noland
Director, Product Development and Sales
EnergyWorks Biopower, LLC

Cc: Patrick Thompson, EnergyWorks

ATTACHMENTS: Product labels

NEW BAY PEAKE-EL

0-6-8

GUARANTEED ANALYSIS

Available Phosphate (P_2O_5) 15.3%
Soluble Potash (K_2O) 10.24%
Calcium (Ca) 50.26%

NET WT. 50 LBS.

MANUFACTURED BY:

ENERGYWORKS BIOPOWER, LLC

NEW BAY PEAKE-PL

0-10-13

GUARANTEED ANALYSIS

Available Phosphate (P_2O_5) 24.4%
Soluble Potash (K_2O) 16.3%
Calcium (CaO) 17.3%

NET WT. 50 LBS.

MANUFACTURED BY:

ENERGYWORKS BIOPOWER, LLC