Please add these pictures and comments to the official record on compost regulations

thanks

Norman

D. Norman Diaz
25789 Community Blvd
Barstow, CA 92311

760 963-3585


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MT 311


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STOP


BARSTOW


CLEARANCE 13FT11 IN

Flooding washes out Route 66

September 10, 2012 5:58 PM

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Brooke Edwards Staggs, City Editor

ORO GRANDE • For the second time in less than two weeks, a portion of National Trails Highway in Oro Grande washed out Monday afternoon due to flooding and left residents without a way to navigate across the historic roadway.

“There is a river coming down off the mountain,” said Darline Gyurcsik, who owns a ranch in the rural community. “It was hailing, it was raining sideways. When you can’t see your back porch...”

The California Highway Patrol responded to the area just after 3 p.m. with reports a driver was stuck in the muddy roadway that was once Route 66, near Barbosa Road. Though officials with the San Bernardino County Fire Department initially thought they would need to perform a swift water rescue, the driver was able to get out of the black Ford Explorer on her own.

The road was expected to be closed for up to two hours, or until roughly 6:30 p.m., as fire department personnel, CHP officers and sheriff’s officials helped to divert traffic and try to clear the roadway.

Just before 4 p.m., Gyurcsik said her neighbor Howard West pulled someone out of a white truck who had become stuck on National Trails Highway.

“He’s lucky,” Gyurcsik said of the driver. “Don’t go through standing water.”

She said the road in front of the railroad tracks was washed out, her neighbor’s empty lakes had filled up and there were reports of damage at a nearby ostrich farm.

National Trails Highway was also flooded at Hodge Road in Barstow, according to CHP reports, and residents requested flooding signs on Navajo Road and Waalew Road in Apple Valley.

There were reports of minor flooding in other parts of the Victor Valley, though officials with the county fire department said no other rescues were needed. There were also a couple scattered power outages affecting a small number of residents in Pinon Hills and El Mirage on Monday afternoon, Southern California Edison reports, though it wasn’t known if the outages were triggered by the weather.

Heavy thunderstorms were predicted across the High Desert on Monday night, according to AccuWeather, with a flash flood watch in effect until midnight.

The temperature is expected to cool off a bit today to a high of 88

enlarge
JAMES QUIGG, DAILY PRESS
5 of 5

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degrees, with a 60 percent chance of thunderstorms again this afternoon.

Brooke Edwards Staggs may be reached at (760) 955-5358 or at bedwards@VVDailyPress.com.

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6 comments Add a comment

Linda Marie · Proprietor at Linda Marie's Enchanted Treasures · 103 subscribers
Still stranded . . Yipps
Reply · 2 · Like · Monday at 8:08pm

Linda Fudge Nickel
Oh no!
Reply · 2 · Like · Monday at 8:11pm

Linda Tinics Micu · Owner at Kalla-lilly-creations.blogspot.com
oh no
hope you didnt take losses again xxxxoooo!!!!
Reply · 2 · Like · Monday at 8:16pm

Linda Marie · Proprietor at Linda Marie's Enchanted Treasures · 103 subscribers
All is Good ... Just still a Little Damp and The Yard Tore Up ...
Reply · Like · Monday at 9:34pm

Laura Andersen Goldberg · Consultant at INDEPENDANT MARY KAY BEAUTY CONSULTANT
I live on Navajo....glad to see the town was so concerned to put signs up....our street has had issues with flooding MULTIPLE times, we have brought it to the towns attention each time...they do nothing...our entire front yard and garage were flooded out with mud everywhere....I heard something about the apple valley airport opening up flood gates? anyone know anything about that? maybe there is a number I can call to contact them....its pretty difficult to scrap up silt and mud and water when I'm 33 weeks pregnant....maybe they should come clean it up! (its not like we haven't taken measure to try and prevent the flooding we even built a brick wall to try and fix the problem ourselves).
Reply · Like · Monday at 10:30pm

Cheri Clark Brem · Top Commenter
Navajo gets mini lakes.
Reply · Like · 33 minutes ago

Sanford W. Cramer III · Top Commenter · Victor Valley College
Glad no one was injured. We the people need to have our politicians put in drainlage equipment for this area.
Sanford W. Cramer III for City of Victorville city councip.
Reply · Like · Monday at 6:58pm

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cleaning up a homeless mess (11 Photos)


BUILDING FURNITURE, JOBS AT SCLA (10 Photos)


COMPETITIVE EDGE (15 Photos)


Salon Spotlight (13 Photos)


Storms trigger flash flooding in Victor Valley (14 Photos)


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» Lifestyle
» Sports
» Health

Alex Contreras · Top Commenter · SJVC
Yea because that's what our politicians do....
Reply · 4 · Like · Monday at 8:05pm

James C. Foy · Top Commenter · Co-founder at Pfaes Consulting
As soon as we aren't paying Bacon-Davis Act wages to do so. Flooding is always a problem in deserts.
Reply · Like · Yesterday at 5:09am

David John Mueller · Top Commenter · Apple Valley, California
Brooke, the good news is the sewage spill the VVWRA got fined for in your other story was just diluted, and from the sounds of it, we just got another micro burst of almost free water!
Reply · Like · Monday at 9:29pm

Cheri Clark Brem · Top Commenter
My hubby got stuck in that traffic for several hours. Couldn't go around to Shadow Mt. Rd or into Barstool.
Reply · Like · Yesterday at 6:36am

Billie Wilken · Chaffey College, Rancho Cucamonga, CA
it wiped out our road to our house and down on the hwy. We helped dig out a van that got stuck up to it's axcel when we tried to go to town. Didn't get far since the road was a mess! Sand bagged our house to save the foundation and not flood again! Way more fun then we needed
Reply · Like · Yesterday at 8:11am

Cheri Clark Brem · Top Commenter
Billie Wilken our road is in severe need of grading also BUt even tho it is a "County Rd", and on Mapsas a street, they will not grade it....we have to do it ourselves
Reply · Like · 33 minutes ago

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State of California—Health and Human Services Agency
Department of Health Services

California Department of Health Services

SANDRA SHEWRY
Director

ARNOLD SCHWARZENEGGER
Governor

May 5, 2005

Dear Petitioner:

The Environmental Health Investigations Branch (EHIB) of the Department of Health Services (DHS) is writing in response to your request for assistance in addressing health concerns related to operations at the Nursery Products, LLC (hereafter "Nursery Products") biosolids (sewage sludge) composting facility in Adelanto, California. In April 2004, you contacted the federal Agency for Toxic Substances and Disease Registry (ATSDR) for assistance in addressing potential exposure and health concerns from the facility. DHS works under a cooperative agreement with ATSDR and is following up on your request.

Since April 2004, DHS staff has spoken with you on several occasions about health concerns you believe to be related to airborne exposures from Nursery Products. In July 2004, Tivo Rojas, a Health Educator with DHS, met with you along with other members of the Nursery Products Citizens Oversight Committee and participated in a tour of the Nursery Products facility. DHS staff noted that a great deal of dust was being generated during the windrow (piles of compost) turning process. Some odors were smelled in areas where the windrow turning was being conducted, but overall odors were characterized as being minimal.

To evaluate potential exposures, DHS staff obtained and reviewed the following data/information:

- U.S. Environmental Protection Agency (USEPA) Plain English Guide to the EPA Part 503 Biosolids Rule, September 1994;
- Nursery Products Annual Report (2004) and February 2005 monitoring results;
- San Bernardino County Environmental Health monthly inspection reports (February 2002 – January 2005);
- Final Report: Air Monitoring at the Adelanto Converter Station, Los Angeles Department of Water and Power, January 12, 2005;
- Laboratory report of runoff water from Adelanto Nursery: Los Angeles Department of Water and Power, March 31, 2005; and
- Limited review of the scientific literature as related to biosolids composting and land application.

General concerns about biosolid composting and land application:

In 1993, the USEPA established regulations (Code of Federal Regulations Title 40, Part 503— commonly referred to as Rule 503) governing composting and land application of biosolids. Public health concerns related to these activities are increasing as facilities and land application sites become more prevalent. In 2002, the National Research Council (NRC) of the National Academy of Sciences released a report concluding that the potential adverse human health impact from exposure to biosolids is uncertain and there is a need for the USEPA to update the scientific basis of Rule 503. The NRC recommended the USEPA conduct additional studies looking at potential chemicals of concern in sewage sludge that are not currently regulated. The NRC also recommended that a number of activities be conducted related to

pathogen/disease causing microorganisms (bacteria, viruses, and parasites) standards, as there is question to whether "current management controls are adequate to maintain minimal exposure concentrations over an extended period of time." Rule 503 was implemented without an evaluation of the health risks from exposure to pathogens. The NRC stressed the need for USEPA to develop effective ways to monitor specific pathogens and evaluate the potential for regrowth of pathogens and bacterial toxins (endotoxin and exotoxins) that may occur after the waste treatment process (NRC, Gattie 2004). Concerns have also been raised about exposure to volatile chemical emissions, which are not regulated under Rule 503.

In studies discussing potential exposure to pathogen-contaminated dust and runoff water from land-applied biosolids and composting (biosolids and green/yard waste), the health concerns reported by the adjacent communities show similar patterns (NRC 2002, Herr 2002). Symptoms commonly reported include respiratory infections, skin rashes, burning eyes, burning lungs, difficulty breathing, and gastrointestinal effects. These effects can be more severe in immunocompromised individuals, individuals with chronic disease, and other sensitive populations. Similar health effects have been observed in workers at composting and sewage treatment facilities. In some studies, workers have been shown to have higher rates of airway mucous membrane complaints, respiratory inflammation, skin rashes, and diseases involving immunological hypersensitivity reactions (Gattie 2004, Herr 2002). In a cross-sectional study, researchers investigated effects of bioaerosol (organic dusts - mixtures of air and microorganisms) polluted outdoor on airways of residents living next to a composting facility in Germany. Researchers compared self-reported health complaints to measurable bioaerosol pollution in residential outdoor air. The microorganisms measured in the study included, total bacteria, molds, thermophilic and thermotolerant actinomycetes. The study found detectable levels of bioaerosol pollution at a distance of 550 meters (maximum distance sampled in study), with the highest levels measured closest to the site. All exposure groups, including residents living the furthest away from the site (> 400-500 meters / ~$^1/_3$ mile) reported higher rates of health complaints compared to the unexposed controls. Researchers concluded, "this bioaerosol exposure in turn could be associated, as far as concentrations of bioaerosols and duration of exposure were concerned, with symptoms suggestive of airway inflammation also reported in respective workplaces" (Herr 2002).

Specific concerns about Nursery Products

In February 2002, Nursery Products was permitted and operations began in November of that same year. Based on the Nursery Products' permit, the facility generates/prepares up to 1,440 cubic yards per day of compost. The facility uses green waste and mostly [1] Class B (designation with respect to pathogens) biosolids in their process. Pathogen levels in Class B biosolids are partially reduced (~90%) at the sewage treatment plant of origin. Through the composting process, pathogen levels are further reduced so that the finished product meets Class A designation. Under Rule 503, if pathogens are below detectable levels, then the biosolids meet the Class A designation.

DHS is aware that there have been numerous (in the hundreds) community complaints about odors, flies, and dust due to operations at Nursery Products. There have also been anecdotal reports of nausea, increases in bloody noses and respiratory effects in school children at Bradach Elementary School, believed to be due to releases from Nursery Products. According to county staff, Nursery Products addressed the fly and odor issue by changing their composting process (J. Adams, San Bernardino County Environmental Health, personal communication, February 24, 2005). We were also informed that Nursery

[1] Some of the biosolids accepted by Nursery Products would not meet the Class B designation due to operational processes at the POTW (Publicly Owned Treatment Works) of origin (L. Fondahl, USEPA, personal communication, May 4, 2005)

Products is relocating its operation at some point this coming summer or fall. It is unclear whether the current location in Adelanto will be used for storage of composted material.

CDHS reviewed available data (listed above), in an effort to understand whether operations at the Nursery Products facility could be impacting public health. The first step is to determine whether there is a pathway for people to be exposed to contaminants from the site. DHS identified two potential pathways of exposure: 1) airborne releases of contaminants and 2) dust surface water runoff.

The only surface water sampling obtained by DHS was collected by the Los Angeles Department of Water and Power, at the Adelanto Converter Station (ACS) on February 12, 2005 and February 24, 2005. The ACS is located on the adjacent property directly north of Nursery Products. Six samples of runoff water from four locations on the ACS property were collected and measured for total coliforms, fecal coliforms, and Escherichia coli (E-coli). The laboratory analysis revealed high levels of these pathogens in all of the samples—total coliforms ranged from 300,000 to 1,100,000 MPN/100 ml (most probable number per 100 milliliters of water); fecal coliforms ranged from 50,000 to 800,000 MPN/100 ml, and E-coli ranged from 50,000 to 280,000 MPN/100 ml.

There are no health-based standards that directly apply to this situation. As a means of comparison, we reviewed draft water quality standards for pathogens that apply to recreational waters (places where people swim or are likely to come into contact with water). The DHS Draft Guidance for Fresh Water Beaches[2] describes bacteria levels that may require posted warning signs in order to protect public health. The closest scenario provided in the guidelines applies to storm drain waters adjacent to a "public beach," which includes rivers, streams, and creeks. The following table lists the guidelines for "fresh water beaches" and adjacent storm drains and the range of pathogens detected in runoff water samples collected on the ACS property:

Pathogen	Range of Pathogens Detected in Runoff Water (MPN/100 ml)	Fresh Water Beach Standards (MPN/100 ml)	Strom Drain Standards (MPN/100 ml)
Total Coliform	300,000 – 1,100,000	1,000	10,000 1,000 (if ratio of fecal/total exceed 0.1)
Fecal Coliform	50,000 – 800,000	200	400
E. coli:	50,000 – 280,000	126	

As shown, the levels of pathogens detected in runoff water collected at the ACS exceed guidelines for fresh water beaches and adjacent storm drains. It is possible that if someone (most likely ACS employees) were to have come into contact and ingest the runoff water (during the days and at the locations the samples were collected) they could have experienced flu like symptoms such as gastrointestinal distress, nausea, and vomiting. Since the facility is located in an area that is fairly remote with respect to residential populations, it is not likely that these types of exposures occurred to residents, but possibly to ACS employees.

[2] These guidelines have not been adopted as a standard at this time, which means both that they may change and that they are not enforceable.

From May 11, 2004, to October 21, 2004, Applied Measurement Science a consultant hired by the Los Angeles Department of Water and Power conducted air monitoring at the ACS property. The main purpose of the air monitoring was to understand the magnitude of dust impacts from Nursery Products on the ACS property. The air monitoring activities included collection of meteorological (MET) data (wind patterns), continuous hourly PM 10 (particulate matter less than 10 microns in aerodynamic diameter) measurements, directional integrated PM 10 (24 hour or longer periods) when ASC was determined to be downwind of Nursery Products, conductivity and ionic composition of dust. There were no samples measured for volatile chemicals. The authors of the report did note that on many days they smelled odors "immediately upon entering the ACS property on the north side of the site, several hundred yards from the Nursery Products facility."

The ACS property is considered downwind of Nursery Products, as the prevailing wind direction is from the south / south-south west. At the ACS property, the 24-hour average California Ambient Air Quality Standard of 50 $\mu g/m^3$ (micrograms per cubic meter air) was exceeded 74% of the time. At times, hourly concentrations were measured in excess of 1000 $\mu g/m^3$, with an average hourly PM 10 concentration of 123 $\mu g/m^3$. The report shows that 68% of the hourly PM 10 measurements were for sectors originating at Nursery Products. The average PM 10 concentration at all the other locations (non-downwind) was 48.8 $\mu g/m^3$.

From a public health perspective, PM 10 is considered among the most harmful of all air pollutants, that "when inhaled, these particles evade the respiratory system's natural defenses and lodge deep in the lungs." (CARB). Potential health effects include exacerbation of asthma, reduced immune function, bronchitis, and other lung diseases. Sensitive populations (children, people with chronic disease, the elderly, and exercising adults) are more susceptible to these effects. According to the California Air Resources Board, recent studies suggest a link between PM 10 exposure and premature death in people suffering from heart and lung disease, especially the elderly.

It is not possible to determine whether PM 10 concentrations were elevated in other areas of Adelanto. The data does show that during the time period measured, operations at Nursery Products were responsible for generating a great deal of dust. Studies on the global transport of dust have shown that dust, especially small particles, have the ability to travel great distances.

As mentioned earlier, there is a concern about potential exposure to pathogen-contaminated dust. There is no site-specific air monitoring data measuring pathogens in dust. The monitoring data (finished compost and temperature data collected during the composting process) that is available indicates the facility is in concurrence with requirements under Rule 503 at the time of those sampling/monitoring events. However, while these data may indicate that the finished compost meets pathogen requirements, it does not rule out the possibility for pathogens present in pre-composted materials to become airborne on dust and other particulates.

Another potential exposure concern relates to inhalation of volatile chemicals. A number of volatile chemicals, ammonia, hydrogen sulfide, and other sulfur and nitrogen based compounds are released from composting facilities. Currently, there are no monitoring requirements for these chemicals under Rule 503. In the Los Angeles area, the South Coast Air Quality Management District recognized the composting industry as a significant source of air pollution for criteria air pollutants and adopted measures (regulations) to reduce composting emissions. The City of Adelanto falls with in the jurisdiction of the Mojave Desert Air Quality Management District (MDAQMD). The MDAQMD has not adopted any volatile chemical emission standards associated with composting. Given the numerous odor

complaints documented, it is clear that airborne releases of certain compounds occurred. However, DHS could not evaluate these exposures and potential health implications due to a lack of data.

In summary, we could not quantify exposures to site-related compounds due to a lack of data. However, there is sufficient information both site-related and in the scientific literature to suggest the possibility for some Adelanto residents (depending on time and location) to have been exposed to airborne contaminants (volatile chemicals), and dust originating from Nursery Products. While it is not possible to determine whether the health effects you have experienced were/are caused by exposures from Nursery Products, some of the symptoms you have expressed to DHS are consistent with biosolid-related exposures documented in the scientific literature.

Next Steps

DHS plans to make further inquiry with the various agencies (city, county, state, and federal), along with experts in the field, to explore ways in addressing public health concerns around this issue. As acknowledged by the NRC, the USEPA, and other experts in the field, many uncertainties need to be addressed in understanding the full range of public health issues associated with land application and composting of biosolids. We recognize that it may take years to answer these important questions. Thus, we believe it is prudent to explore the possibility for implementing precautionary measures at the local level.

We will keep you informed of our progress. If you have any questions, please do not hesitate to call Tracy Barreau (510) 622-4489.

Sincerely,

Tracy Barreau, REHS
Senior Environmental Scientist
Environmental Health Investigations Branch

Marilyn C. Underwood, Ph.D.
Acting Chief, Site Assessment Section
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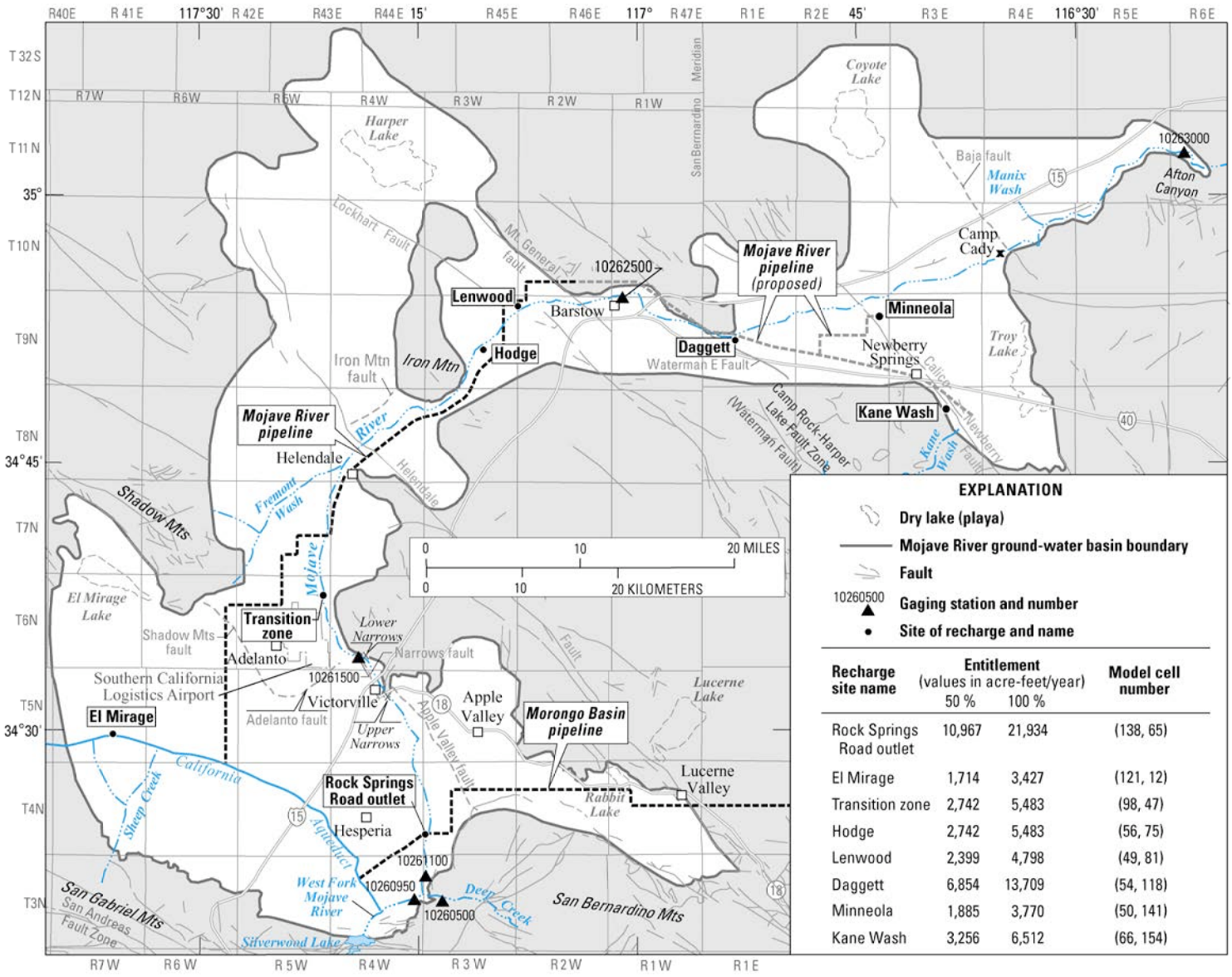

Recharge site name	Entitlement (values in acre-feet/year) 50 %	100 %	Model cell number
Rock Springs Road outlet	10,967	21,934	(138, 65)
El Mirage	1,714	3,427	(121, 12)
Transition zone	2,742	5,483	(98, 47)
Hodge	2,742	5,483	(56, 75)
Lenwood	2,399	4,798	(49, 81)
Daggett	6,854	13,709	(54, 118)
Minneola	1,885	3,770	(50, 141)
Kane Wash	3,256	6,512	(66, 154)

Figure 41. Location of Mojave Water Agency artificial-recharge sites in the Mojave River ground-water basin, southern California.

CENTER FOR FOOD SAFETY

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VIA EMAIL

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PUBLIC COMMENTS ON THE DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT FOR NURSERY PRODUCTS HAWES COMPOSTING FACILITY

Pursuant to the County of San Bernardino's ("County") Notice of Availability for the Draft Supplemental Environmental Impact Report for Nursery Products Hawes Composting Facility, the Center for Food Safety ("CFS") submits the following comments. CFS is a nonprofit membership organization that works to protect human health and the environment by curbing the proliferation of harmful food production technologies and by promoting organic and other forms of sustainable agriculture. CFS represents members in California and throughout the country that are opposed to the use of sewage sludge[1] in compost for agriculture.

I. THE COUNTY'S ISSUANCE OF THE SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT IS IMPROPER.

The California Environmental Quality Act ("CEQA") is a procedural statute mandated for "projects," which are "[activities] directly undertaken by any public agency" that "may cause either a direct physical change in the environment, or a reasonably

[1] Also known as and used interchangeably in this document as "Biosolids."

foreseeable indirect physical change in the environment."[2] A project is either "undertaken by a public agency, undertaken by a person with assistance from a public agency," or an "activity that involves the issuance of a lease, permit, etc., for use by one or more public agencies.[3]

> CEQA is implemented through initial studies, negative declarations and EIR's. CEQA requires a governmental agency to prepare an EIR whenever it considers approval of a proposed project that may have a significant effect on the environment. . . [T]he Supreme Court has recognized that CEQA requires the preparation of an EIR whenever it can be fairly argued on the basis of substantial evidence that the project may have significant environmental impact.[4]

"A significant effect on the environment is defined as a substantial, or potentially substantial, adverse change in the environment."[5] CEQA defines "environment" as the "physical conditions which exist within the area which will be affected by a proposed project, including land, air, water, minerals, flora, fauna, noise, objects of historic or aesthetic significance."[6] An Environmental Impact Report (EIR) "provide[s] public agencies and the public in general with detailed information about the effect which a proposed project is likely to have on the environment; to list ways in which the significant effects of such a project might be minimized; and to indicate alternatives to such a project."[7]

Here, the project is the proposed Nursery Products Hawes Facility, which will compost sewage sludge and green material on 80 acres of a 160 acre parcel located within an unincorporated area in the County of San Bernardino.[8] The project proposes to combine this sludge and green waste to create Class A compost.[9] In December, 2005, Nursery Products, LLC ("Nursery Products") submitted an application with the County seeking approval of the Hawes sludge composting facility. Pursuant to CEQA, the final EIR was issued in November, 2006 and certified by the planning commission in early 2007.

The Center for Biological Diversity and HelpHinkley.org jointly filed a lawsuit in Superior Court outlining the inadequacies of this EIR and asking the court to invalidate the EIR.[10] In *Center for Biological Diversity v. County of San Bernardino*, Judge Feer ruled that the initial EIR was flawed, vacated all permits given in association with the

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[2] CAL PUB. RES. CODE § 21065; *Sherwin Williams, Co. v. South Courst Air Quality Management Dist.*, 86 Cal.App.4th 1258 (Cal.App. 2d Dist., 2001).
[3] CAL PUB. RES. CODE § 21065.
[4] *California Sportfishing Protection Alliance v. State Water Resources Control Board,* 160 Cal.App.4th 1625 1642 (CalApp. 1 Dist 2008) (internal citations omitted).
[5] *Id.*
[6] CAL PUB. RES. CODE § 21060.5.
[7] *Id.* at § 21061.
[8] Draft Supplemental Impact Report Nursery Products LLC Hawes Composing Facility, State Clearinghouse No. 2006051021, at ES-1 (July 2009).
[9] Draft Supplemental Impact Report Nursery Products LLC Hawes Composing Facility, State Clearinghouse No. 2006051021, at ES-1 (July 2009).
[10] *Center for Biological Diversity v. County of San Bernardino*, Case No. BCV 09950 (Super. Ct. 2008).

document, and held that "[n]o part of the project is severable."[11] CFS firmly believes that the issuance of this Supplemental Environmental Impact Report ("SEIR") directly contradicts the Judge's Order. An SEIR is appropriate only for the following reasons: where there have been substantial changes to the project that require major revisions of the EIR; there are substantial new circumstances surrounding the project; or new information of substantial importance became available.[12] However, the decision clearly requires the County to vacate the previous EIR, therefore issuing the SEIR violates the decision of the court.

This decision was stayed when the county appealed. However, only two possible outcomes can result from the appeal: the county loses and must prepare an entirely new EIR, or the county prevails, and the original EIR is reinstated. Under either scenario, the SEIR is unnecessary. CFS believes that the SEIR will ultimately be vacated by the District Court if the County proceeds with its appeal. In the event that this is not the case, CFS comments on the inadequacies of the SEIR.

II. THE SUPPLEMENTAL ENVIRONMENTAL IMPACT REPORT FAILED TO ASSESS THE ENVIRONMENTAL IMPACTS OF SEWAGE SLUDGE COMPOST.

The County failed to assess the environmental impacts of composing sewage sludge. Sewage sludge contains a number of contaminants not addressed by the governing federal regulatory scheme. These contaminants can and will be released into the environment. Therefore, the County must assess the effects.

A. Federal Sewage Sludge Regulations are Inadequate to Address the Overwhelming Number of Contaminants in Sewage Sludge and Sludge Compost.

Sewage sludge is a combination of industrial waste and household sewage, both of which are routed for treatment through municipal sewage treatment plants.[13] This sewage "contains not only human fecal wastes from homes and businesses but also products and contaminants from homes, industries, businesses, stormwater, and landfill leachate (in some locals) and contaminants leached from pipes."[14] At treatment plants, wastewater is treated to remove chemicals, pathogens, and toxic metals from the effluent and these materials are concentrated in the byproduct, sewage sludge.[15] The resulting sewage sludge is replete with toxic chemicals. For example, it has been estimated that 90% of the dioxins in the incoming water routed thought the treatment plant will end up in sewage sludge.[16]

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[11] *Id.* at 4.
[12] California Environmental Quality Act, CAL PUB. RES. CODE § 21166 (2009).
[13] *R.A. McElmurray v. U.S. Dep't Agric*, 535 F.Supp.2d 1318, 1321 (S.D.Ga. 2008).
[14] Ellen Z. Harrison et al., *Land Application of Sewage Sludges: An Appraisal of the US Regulations*, 11 INT'L. J. ENV. & POLLUTION 1, 2 (1999).
[15] *McElmurray*, 535 F.Supp.2d at 1321.
[16] Harrison et al., *supra*, n.14.

Sewage sludge contains a variety of organic wastewater contaminants ("OWCs"), which are compounds produced to offer improvements in industrial, medical and household products and applications.[17] "Compounds that can be classified as OWCs include pharmaceuticals, hormones, detergent metabolites, fragrances, plasticizers, and pesticides."[18] Sewage sludge can also contain a variety of other contaminants, such as flame retardants and metals. In a recent EPA survey of sewage sludge, samples from across the US found that sewage sludge can contain heavy metals, pathogens, steroids, hormones, flame retardants, pharmaceuticals and endocrine disruptors.[19] Particularly alarming is that almost all the samples contained 27 metals, 10 different flame retardants, 12 pharmaceuticals, and high levels of known endocrine disruptors.[20] There are as many as 100,000 chemicals used in American industry, with about a thousand new chemical compounds put to commercial use each year.[21] Any of these can enter the wastewater stream and if they do, they will ultimately be found in sludge.

Sewage sludge is regulated by the Environmental Protection Agency ("EPA") by what is commonly known as the "Part 503 Rule."[22] Part 503 requires the treatment of sewage sludge so that it can be land applied and used in agriculture. The rule includes concentration limits for nine metals and pathogens, as well as for vector attraction and reduction.[23] Sewage sludge can be Class A, in which pathogens are essentially eliminated, or Class B, in which pathogens have been reduced but not eliminated.[24] However, sewage sludge contains a diverse collection of wastewater contaminants of emerging and known toxicological concern not addressed whatsoever by the Part 503 Rule.[25] Despite EPA's own study indicating high levels of a variety of toxins other than the nine metals and pathogens that sewage sludge is treated for, no additional federal requirements exist to eliminate these toxins.

A recent federal court decision indicates not only that EPA's regulations are inadequate, but that EPA actively hidden and subverted critical information concerning the dangers of sewage sludge. In *McElmurray v. US*, a Georgia judge stated that EPA's sludge program has ignored scientific dissent indicating that sewage sludge is harmful to humans and the environment. In this case, a Georgia dairy farmer entered into an agreement with the City of Augusta in 1979 to allow the city to apply local sewage sludge.[26] Over the next

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[17] Chad A. Kinney et al., *Survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application*, 40 ENVTL SCI. TECH. 7202, 7207 (2006).
[18] *Id.*
[19] EPA, Targeted National Sewage Sludge Survey, EPA-822-R-08-014, 7 (January 2009) available at http://www.epa.gov/waterscience/biosolids/tnsss-overview.pdf.
[20] *Id.*; Josh Harkinson, *Sludge Happens*, MOTHER JONES, April 21, 2009, at 1, available at http://www.motherjones.com/environment/2009/05/sludge-happens.
[21] Robert C. Hale and Mark J. Laguardia, *Have Risks Associated with the Presence of Synthetic Organic Contaminants in Land-Applied Sewage Sludges Been Adequately Addressed?*, 12 NEW SOLUTIONS J. ENV. & OCCUPATIONAL HEALTH POLICY 371, 372 (2002).
[22] 40 C.F.R. § 503.
[23] Harrison et al., *supra*, n.14 at 3.
[24] *Id.*
[25] Mark J. La Guardia et al., *Organic Contaminants of Emerging Concern in Land-Applied Sewage Sludge (Biosolids)*, 1 J. OF RESIDUALS SCI. & TECH. 111, 119 (2004).
[26] *McElmurray*, 535 F.Supp.2d at 1321.

decade, McElmurray began having trouble with his crops and about half of his 700 cows died from severe diarrhea.[27] McElmurray hired an expert to test his soil, who opined that McElmurray's fields were contaminated by heavy metals, and that there was a correlation between the cattle eating silage produced from the field and the cattle mortality. [28] McElmurray submitted an application to the USDA for disaster relief, and when denied, sued in federal court.[29] The district court found the USDA's denial to be arbitrary and capricious and ruled in favor of McElmurray.[30] Additionally, the court indicated that "[o]ther evidence of record calls into question the fairness and objectivity of the EPA's opinions with respect to the sludge land application program. The administrative record contains evidence that senior EPA officials took extraordinary steps to quash scientific dissent, and any questioning of the EPA's biosolids program."[31]

Thus, sewage sludge contains many harmful chemicals, which are inadequately regulated. EPA's Part 503 Rule is an inadequate tool for protecting the public from the various harmful toxins in sewage sludge.

B. Composting Sewage Sludge Does Not Effectively Eliminate Toxins and Poses Direct Harm to the Public.

Sewage sludge poses severe threats to human health, and while composting sludge may eliminate pathogens, it wholly fails to eliminate toxic chemicals. "Treated" sewage sludge, renamed "biosolids" by the EPA, finds its way into agriculture, either by direct land application, as an ingredient in industrial and processed fertilizer, or as "compost." According to the EPA, composting is one of several methods for treating sewage sludge to "create a marketable end product that is easy to handle, store and use."[32] The end product is considered "Class A" compost that can be and is applied as "a soil conditioner and fertilizer to gardens, crops and rangelands."[33] This "compost" is often given away to area residents, community gardeners, even schools for application on school gardens.[34] EPA claims that Class A sludge compost is without a detectible level of pathogens. While composting may reduce pathogens, it does not reduce or eliminate the variety of other toxins commonly found in sewage sludge.

Kinney et al. studied the effects of adding plant material (green material) to sewage sludge as proposed at the Nursery Products facility. The results indicated that composting does not reduce OWC concentrations.

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[27] *Id.*; Josh Harkinson, *Sludge Happens*, MOTHER JONES, April 21, 2009, at 1, available at http://www.motherjones.com/environment/2009/05/sludge-happens.
[28] *McElmurray* at 1327.
[29] *Id.* at 1322-24.
[30] *Id.* at 1321.
[31] *Id.* at 1333.
[32] EPA, Biosolids Technology Fact Sheet: Use of Composting for Biosolids Management, available at http://www.epa.gov/owm/mtb/combioman.pdf.
[33] *Id.*
[34] *See* SFPUC's Big Blue Bucket Eco Fair, available at http://sfpucbigbluebucket.eventbrite.com/.

> The addition of plant material effectively dilutes biosolids samples, while possibly increasing the organic matter content of the biosolid production. Composting has been recognized as an effective means to limit or eliminate some organic contaminants, but when the biosolids that are composted are compared to the unamended sludges and granulated biosolid products, the comparable concentrations observed in this study suggest that composting is relatively ineffective at reducing OWC concentrations.[35]

Toxins found in sewage sludge can leach into the soil on site, or become food safety hazards when the compost is used on gardens, farms, or rangelands. For instance, EPA recognizes that 27 metals are present in almost all sludge samples taken for their most recent risk assessment.[36] "Toxic metals do not breakdown in the treatment process or in the environment. As a consequence they can build up in the soil upon repeated application."[37] Since the US standards for metals in sewage sludge are among the most lenient in the world, and since the US only regulates 9 of the 27 metals found in sewage sludge, it is inevitable that metals will be released from sludge and expose humans to their harmful effects.

Plants fertilized with sludge or sludge compost often contain increased levels of metals. A 2007 study found that, for potatoes and peppers grown in soil spread with sewage sludge, the cadmium concentration was almost at the "Codex-established maximum limit"[38] and the lead concentration in potatoes exceeded the maximum level.[39] Further, research indicates that increased dissolved organic carbon (DOC) in sewage sludge decreases the adsorption of metals to soil surfaces through formation through formation of organometalic complexes, thereby increasing the bioavailability of metals to plants.[40] Adverse health effects from heavy metals have been recognized for a long time. For instance, arsenic is a well known toxin and carcinogen.[41] Adults chronically exposed to lead can experience seizures, anorexia, abdominal disorders and personality changes.[42] Children exposed to lead suffer a far worse fate, brain damage.[43] Mercury can also cause brain damage, even in adults.[44] Cadmium and lead are of the greatest concern, because plants actively take them up and introduce them into the human food chain.[45] Even though the health effects of these metals are well-known, the County failed to assess the

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[35] Kinney et al., *supra*, n.17 at 7212.
[36] EPA, Sewage Sludge Survey, *supra*, n. 19.
[37] Hale and Laguardia, *supra*, n.21 at 373.
[38] George F. Antonious & John C. Snyder, *Accumulation of Heavy Metals in Plants and Potential Phytoremediation of Lead by Potato, Solanum tuberosum* L., A 42 J. ENVT'L. SCI & HEALTH 811, 814 (2007).
[39] *Id.*
[40] *Id.*
[41] Heavy Metals in the Environment and Their Effects, July 21, 2009, http://soil-environment.blogspot.com/2009/07/heavy-metals-and-their-health-effects.html
[42] The Hazards of Heavy Metals, http://www.physics.ohio-state.edu/~wilkins/energy/Companion/E14.2.pdf.xpdf.
[43] *Id.*
[44] *Id.*
[45] Antonious and Snyder, *supra*, n.38 at 814.

impact of the release of heavy metals on the environment and potential exposure to the population.

Furthermore, there are a variety of other toxic agents found in sewage sludge with known and unknown consequences to human health and the environment. Poly-brominated diphenal ethers (PBDEs), for example, are commonly found in sewage sludge and are recognized for their impact on human health and the environment.[46] They are chemically related to PCBs and PBBs and replaced them in chemical applications.[47] Chronic exposure to PBDEs or exposure during development can compromise the endocrine and nervous systems.[48] Numerous additional organic pollutants have been found to be present in US sludge, such as polycyclic aromatic hydrocarbons, PCBs, DDT degradation products, chlordadanes, synthetic musk products, triclosan, and tributytin.[49] The presence of these compounds at the Hawes Composting Facility site presents severe human health and environmental risks that must be addressed. Further, the use of sludge compost in local home gardening and in agriculture presents unstudied and unacceptable food safety risks.

The County did not assess the impacts of the release of the above toxins in the environment via the Hawes Composting facility. As a matter of public policy, the County's failure to analyze the human health and environmental risk associated with sewage sludge is inexcusable. As a matter of law, this failure violates the most basic requirements of CEQA to review the environmental impacts of this project.[50]

III. CONCLUSION

The County's issuance of the SEIR was improper. Regardless, this document is inadequate because the County did not assess the environmental impacts of sewage sludge compost. Specifically, the SEIR did not take into account the release of heavy metals, OWCs and other contaminants on the environment. For the above reasons, the County must vacate the current SEIR and prepare an EIR that addresses these and other environmental impacts.

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[46] *See* Hale and Laguardia, *supra* ,n.21.
[47] *Id.* at 376.
[48] *Id.*
[49] *Id.* at 382.
[50] CAL PUB. RES. CODE § 21061.

Sewage Sludge Contents / Tip of Iceberg

Heavy Metals, Pathogens, Synthetic Chemicals, Hydrocarbons, Petrochemicals & Organochlorines, Pharmaceuticals, Steroids & Hormones.

This list of contents represents only the "tip of the iceberg" of toxics concentrated in sewage sludge. Federal and most state and local land application regulations limit concentrations of only nine heavy metals and one "indicator" pathogen in land applied sewage sludge (in BOLD).

Heavy Metals

Aluminum,	Dysprosium,	MERCURY,	Tantalum,
Antimony,	Erbium,	MOLYBDENUM,	Tellurium,
ARSENIC,	Europium,	NICKEL,	Terbium,
Barium,	Gadolinium,	Niobium,	Thallium
Beryllium,	Germanium,	Palladium,	Thorium,
Bismuth,	Gold,	Praseodymium,	Thulium,
Boron,	Hafnium,	Rhodium,	Tin,
Bromine,	Holmium,	Rubidium,	Titanium,
CADMIUM,	Iron,	Ruthenium,	Tungsten,
Cerium,	Lanthanum,	Samarium,	Uranium,
Cesium,	Lutetium,	Scandium,	Vanadium,
Chromium,	LEAD,	SELENIUM,	Yttrium,
COPPER,	Magnesium,	Silver,	Ytterbium,
Cobalt,	Manganese,	Strontium,	ZINC

Pathogens

Bacteria

FECAL COLIFORM,	Enteropathogenic E. coli,	Mycobacteria, Aeromonas,
Salmonella (2,000 types),	Yersinia enterocolitica,	Legionella, Burkholderia,
Shigella (4 spp.),	Campylobacter jejuni,	Endotoxins,
E. coli 0157:H7,	Vibrio cholera, Leptospira,	antibiotic resistant bacteria,
Staphylococcus aureus,	Listeria, Helicobacter,	

Viruses

Adenovirus, Astrovirus,	Coxsackie A, Coxackie B,	Hepatitis E virus,
Calcivirus, Coronavirus,	Echovirus, Enterovirus 68-	Norwalk virus,
Enterovirus (Poliovirus,	72), Hepatitis A virus,	Reovirus, Rotavirus

Protozoa

Cryptosporidium,	Giardia lamblia,	Toxoplasma gondii
Entamoeba histolytica,	Balantidium coli,	

Helminths (Parasites)

Ascaris lumbicoides	Tainia saginata (tapeworm),	Toxocara canis,
(roundworm),	Trichuris (whipworm),	Taenia solium,
Ancylostoma duodenale	Toxocara (roundworm),	Hymenolepis nana
(hookworm), Necator	Strongyloides (threadworm),	
americanus (hookworm),	Ascaris suum,	

Fungi

Aspergillus fumigatus,	Epidermophyton spp.,	Phialophora spp.,
Candida albicans,	Trichophyton spp.,	
Cryptococcus neoformans,	Trichosporon spp.,	

Prions (spongiform encephalopathy)

While Federal law and regulations limit none of contents below, they allow localities to set more restrictive limits on sewage sludge and soil contamination. Some states do so &/or permit precautionary local control, and others do neither.

Once spread on land, the contaminants above and below persist for centuries - to decades - to months affecting soil, water, plants, air, animals and people.

Unlike pesticides (distinct chemicals subject to specific analysis), sewage sludge is a very complex, variable and concentrated mixture of the vast multitude of unstudied and unregulated hazardous wastes dumped into sewer systems.

Synthetic Chemicals

Dioxins & Furans

Dioxins, Octachlorodibenzo-P-Dioxin, 1,2,3,4,6,7,8-Heptachlorodibenzo-P-Dioxin, Octachlorodibenzo Furan, 1,2,3,4,6,7,8-Heptachlorodibenzo-Furan (71), 2,3,7,8-Tetrachlorodibenzo-Furan, 1,2,3,6,7,8-Hexachlorodibenzo-P-Dioxin, 1,2,3,4,7,8-Hexachlorodibenzo-Furan , 1,2,3,7,8,9- Hexachlorodibenzo-P-Dioxin, 1,2,3,6,7,8-Hexachlorodibenzo-Furan, 2,3,4,6,7,8- Hexachlorodibenzo-Furan, 1,2,3,4,7,8,9-Heptachlorodibenzo-Furan, 2,3,4,7,8-Pentachlorodibenzo-Furan, 1,2,3,4,7,8- Hexachlorodibenzo-P-Dioxin, 1,2,3,7,8- Pentachlorodibenzo-Furan, 1,2,3,7,8- Pentachlorodibenzo-P-Dioxin, 1,2,3,7,8,9- Hexachlorodibenzo-Furan, 2,3,7,8- Tetrachlorodibenzo-P-Dioxin, Polychlorinated Dibenzodioxin/Polychlorinated Dibenzofuran (PCDD/PCDF), Tetrahydrofuran, 2,4-D, 2,4,5-T, dioxin (TCDD),

“Organics” (carbon-based)

Acetone, Chloroform, Cyclohexanone, Bis(2-ethylhexyl) Phthalate, Bis(2-ethylhexyl) tetrabromophthalate, Di-n-undecyl phthalate, Alkyl benzyl Phthalate, Di-(2-Ethylhexyl) Phthalate (DEHP), Butyl Benzyl Phthalate, Toluene, 2-Propanone, Methylene Chloride, Hexanoic Acid, 2-Butanone, Methyl Ethyl Ketone, Alcohol Ethoxylate, Alkylphenolethoxylates, Phenol, Nonylphenol, 2,2'-methylenebis[4-methyl-6- nonyl-Phenol, p-Nonylphenol, 4,4'-butylidenebis[2-(1,1-dimethylethyl)-5-methyl-, 4-Methylphenol, Phenol, 4,4'-(1-methylethylidene)bis[2-(1,1-dimeth, Phenol, 4,4'-(1-methylethylidene)bis[2-(1,1-dimeth, 2,4-dicumylphenol, p-Dodecylphenol, 2,4,5-Trichlorophenol, N-Hexacosane, N-Tetracosane, N-Dodecane, N-Tetradecane, N-Triacontane, N-Eicosane, N-Hexadecane, N-Octacosane, Carbon Disulfide, N-Decane, N-Docosane, N-Octadecane, P-Cymene, Benzo(B)fluranthene, Fluoranthene, P-Chloroaniline, Pyrene, Tetrachloromethane, Trichlorofluoromethane, 2-Hexanone, 2-Methylnaphthalene, 4-Chloroaniline, Benzo(a)pyrene

Pesticides & Insecticides

Aldrin, Chlordane, Cyclohexane, Heptachlor, Endosulfan, Endosulfan-II, Lindane, Dieldrin, Endrin, DDT, DDD, DDE, 2,4,5-Trichlorophenoxyacetic Acid, Acetic Acid (2,4-Dichlorophenoxy), 2,4,5-Trichlorophenoxypropionic Acid, Pentachloronitrobenzene, Chlorobenzilate, Beta-BHC, Kepone, Mirex, Methoxychlor,

PCBs (PolyChlorinated Biphenyls)

PCB-1016, PCB-1221, PCB-1232, PCB-1242, PCB-1248, PCB-1254, PCB-1260

PBDEs (PolyBrominated Diphenyl Ethers)

BDE-28, BDE-47, BDE-66, BDE-85, BDE-99, BDE-100, BDE-138, BDE-153, BDE-154, BDE-183, BDE-209,

Hydrocarbons, Petrochemicals, Organochlorines

PCBs, PCT, PBB, PBT, Anthracene, Pentachlorophenol, Benzo(g,h,i)perylene, Benzene, Benzene, C14-C24-branched, Polyethylbenzene residue, Octane, Hexachlorobenzene, Ethylbenzene, Chlorinated Benzenes, Naphtha (petroleum), turpentine-oil, Hydrotreated kerosene, Hydrocarbon oils, Hydrocarbons, C10 and C12, Distillates (petroleum), Fuel oil, Creosols, P-Cresol, O-Cresol, 2-(2H-Benzotriazol-2-yl)-p-cresol, Hexachlorobutadiene, N-Nitrosodimethylamine, Toxaphene, Trichloroethane, Tetrachloroethane, Hexachloroethane, Carbon Tetrachloride, Dichloroethylene, Trichioroethylene, Tetrachloroethylene, Xylene,

Pharmaceuticals

1,7-Dimethylxanthine, 4-Epianhydrochlortetracycline, 4-Epianhydrotetracycline, 4-Epichlortetracycline, 4-Epioxytetracycline, 4-Epitetracycline, Acetaminophen, Albuterol, Anhydrochlortetracycline, Anhydrotetracycline, Azithromycin, Caffeine, Carbadox, Carbamazepine, Cefotaxime, Chlortetracycline, Cimetidine, Ciprofloxacin, Clarithromycin, Clinafloxacin, Cloxacillin, Codeine, Cotinine, Dehydronifedipine, Demeclocycline, Digoxigenin, Digoxin, Diltiazem, Diphenhydramine, Doxycycline, Enrofloxacin, Erythromycin-Total, Flumequine, Fluoxetine, Gemfibrozil, Ibuprofen, Isochlortetracycline, Lincomycin, Lomefloxacin, Metformin, Miconazole, Minocycline, Naproxen, Norfloxacin, Norgestimate, Ofloxacin, Ormetoprim, Oxacillin, Oxolinic Acid, Oxytetracycline, Penicillin G, Penicillin V, Ranitidine, Roxithromycin, Sarafloxacin, Sulfachloropyridazine, Sulfadiazine, Sulfadimethoxine, Sulfamerazine, Sulfamethazine, Sulfamethizole, Sulfamethoxazole, Sulfanilamide, Sulfathiazole, Tetracycline, Thiabendazole, Triclocarban, Triclosan, Trimethoprim, Tylosin, Virginiamycin, Warfarin,

Steroids & Hormones

17 Alpha-Dihydroequilin, 17 Alpha-Estradiol, 17 Alpha-Ethinyl-Estradiol, 17 Beta-Estradiol, Androstenedione, Androsterone, Beta Stigmastanol, Campesterol, Cholestanol, Cholesterol, Coprostanol, Desmosterol, Epicoprostanol, Equilenin, Ergosterol, Estriol, Estrone, Ethinylestradiol, Norethindrone, Norgestrel, Progesterone, Stigmasterol, Sitostanol, Beta-Estradiol 3-Benzoate, Beta-Sitosterol, Equilin, Testosterone,

"Acceptable" levels of exposure to sewage sludge contaminants are based on obsolete and faulty scientific data and processes. In 2002 and 2010, the National Academy of Sciences and National Institutes of Health established those facts [3, 1].

The risk assessments upon which these levels are based neglected dietary impacts on children; multi-pathway exposure; synergistic impacts; infectious organism exposure; ecological, wildlife, food chain, soil microorganism & forest soil impacts; long-term heavy metal accumulation; and used a cancer risk safety factor 100 times less protective than used for air and water pollution.

References:

1. "Reducing Environmental Cancer Risk - What We Can Do Now", President's Cancer Panel, 2008–2009 Annual Report, National Institutes of Health/National Cancer Institute, April 2010.
2. Targeted National Sewage Sludge Survey, Statistical Analysis Report, January 2009, U.S. Environmental Protection Agency, Office of Water (4301T), EPA-822-R-08-018.
3. "Biosolids Applied to Land: Advancing Standards and Practices", National Research Council, July 2002, Committee on Toxicants and Pathogens in Biosolids Applied to Land, Board on Environmental Studies and Toxicology, National Academy Press.
4. "In silico screening for unmonitored, potentially problematic high production volume (HPV) chemicals prone to sequestration in biosolids", Deo & Halden, Journal of Environmental Monitoring, July 2010, 12, Center for Environmental Biotechnology, Arizona State University.
5. "Fate of organohalogens in US wastewater treatment plants and estimated chemical releases to soils nationwide from biosolids recycling", Heidlera, et al, J. Environ. Monit., 2009, 11, 2.
6. "National Water Program Research Compendium 2009-2014", EPA 822-R-08-015, 10-30-08, US EPA, Office of Water.
7. "Organic chemicals in sewage sludges", Harrison, et al., Science of the Total Environment, 2006, 367, 481–497, Cornell Waste Management Institute, Cornell University, 6-5-06.
8. "Survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application", Kinney, et al., Environmental Science & Technology, 2006, 40, 9-13-06 (American Chemical Society).
9. "Flame Retardants: Persistent Pollutants in Land-Applied Sludges", Hale, et al., Nature, 412, 12, July 2001, Department of Environmental Science, Virginia Institute of Marine Science.
10. "Land Application of Sewage Sludges", 1998 CU Recommends From: 1998 Cornell Recommends for Integrated Field Crop management; A Cornell Cooperative Extension Publication, C.U.N.Y.
11. "Fate of Pathogens During the Sewage Sludge Treatment Process & After Land Application", J. Smith Jr: Senior Environmental Engineer - EPA Center for Environmental Research Information, Cinn, Ohio, & J.B. Farrel, Consultant, Cinn, Ohio (1998).
12. "Dioxins and furans in sewage sludges: A review… significance… agricultural…", Jones et al., Critical Reviews Environ. Sci. & Tech., 27, 1, January 1997, Lancaster University, U.K.
13. "Biosolids & Sludge Management", Krogman, et. al., Rutgers U. Coop. Ext., Solid Waste Management, Dep't. of Environmental Sciences, N.J., Water Environment Research, 69, 4, 6-97.
14. EPA "Technical Support Document for the Round Two Sewage Sludge Pollutants", EPA-822-R-96-003, August 1996.
15. "Pathogen risk assessment methodology for municipal sewage sludge landfilling and surface disposal", U.S. EPA, 1995, EPA 600/R-95/016.
16. NSSS USEPA 1988 "National Sewage Sludge Survey Availability of Information & Data, and Anticipated Impacts on Proposed Regulations; Proposed Rule"; Fed Reg, vol. 55, # 218, 11-9-90, pgs 47210-47283, Table I-12.
17. "Land Application of Wastewater Sludge", Younos, American Society of Civil Engineers, 1987, Chapters 1 (Intro) & 7 ("The Health Effects of Land Application of Sludge").
18. "National Survey of Elements & Other Constituents in Municipal Sewage Sludges", R. Mumma, et. al. Arch. of Environ. Contam. Toxicol. vol 13, 1, 1984.

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Case for Caution Revisited: Health and Environmental Impacts of Application of Sewage Sludges to Agricultural Land

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Posted at: cwmi.css.cornell.edu/case.pdf

September 2008

Note: Text in this Arial font is written by the authors. Text in this Times New Roman font is quotations and citations.

TABLE OF CONTENTS

Over the past 15 years since the 40CFRPart503 rules were promulgated, there have been many new scientific findings regarding the environmental and health implications of the application of sewage biosolids to agricultural soils. Many of these findings show increased risks, risks that were not assessed as part of the risk assessment that USEPA used as the basis for the standards promulgated in 1993. These new findings support the rational basis for U.S. EPA to revise the federal regulations and for states and municipalities to regulate the application of sewage biosolids in order to protect their citizens and the land-base.

Agricultural soils are a unique and valuable resource. Protecting agricultural soils requires anticipating and avoiding potential harms since once contaminated with persistent pollutants, the damage will remain for the foreseeable future. Once contaminated, stopping the application of pollutants such as metals and many organic chemicals that are in sewage biosolids will not correct the problem. The contamination will remain for decades or centuries. It is thus critical to prevent this essentially permanent degradation.

Current Rules are Based on Outdated and Inadequate Science

As pointed out the by the National Research Council, the risk assessment on which current rules are based was conducted nearly 20 years ago and is outdated. A tremendous amount of new knowledge about the presence and behavior of chemicals and pathogens has been developed in the last decades.

NRC Targets Pathogens in Sludge for Research. Rebecca Renner, 2002.Environmental Science and Technology: Science News - July 24. <http://pubs.acs.org/doi/pdf/10.1021/es022404s>

The U.S. EPA rules for using treated sewage sludge as fertilizer are based on outdated science, according to a report released in July from the National Academies, National Research Council (NRC). The report, which was produced after two years of study, recommends new research to update the rules. In particular, EPA needs to investigate the growing number of complaints about illnesses and even deaths from exposure to Class B sludge.

Under a 1993 Clean Water Act rule, treated sewage sludge, or biosolids, can be applied to land with certain limitations. Pathogen-containing Class B sludge, which makes up the bulk of sludge applied to land, may be used as fertilizer in situations in which public exposure is limited. Class A sludge can be applied on public sites. Of the 5.6 million tons of sewage sludge generated in the United States each year, 60% ends up being applied as fertilizer.

The agency needs to investigate the potential health effects from sludge exposure and find out more about the pathogens in sludge, according to committee chair Thomas Burke, a public health professor at Johns Hopkins University in Baltimore, Md. There is a serious lack of health-related information about populations exposed to treated sludge, adds Burke.

The NRC report also recommends a new national sludge survey to measure sludge contaminants, which would update the previous 1988 survey. This earlier study was unreliable and needs to include newly recognized chemicals of potential concern, including polybrominated biphenyl ether flame retardants, pharmaceuticals, and personal care products such as shampoos and soaps, says the NRC committee. EPA also needs to redo its assessment of the human health risks posed by metals in sludge. The revised risk assessments should reflect the potential for variations in climate, water flow, and sludge characteristics. The report also notes that more rigorous enforcement of the current standards is needed."

New information on the impacts of the regulated contaminants

Endocrine Disruption

New information indicates that some of the handful of metals that are regulated under Part 503

pose risks that were not evaluated in the risk assessment upon which the Part 503 USEPA rules are based. The whole subject of endocrine disruption due to exposure to chemicals in the environment (i.e. our knowledge regarding the disruption to human and animal hormones and reproductive systems posed by a number of chemicals) has developed since those rules were promulgated.

Examples of several of the regulated metals for which new risks have been identified are lead and cadmium. Recent work shows that lead has a number of effects on sperm and may play a role in the rising infertility that is being observed. Cadmium has been shown to mimic estrogen and may be related to increased breast cancer. These metals are contained in all sewage biosolids. The contaminant limits in Part 503 do not include any recognition of these endocrine-disrupting impacts.

Increased seminal plasma lead levels adversely affect the fertility potential of sperm in IVF. Susan Benoff, Grace M. Centola, Colleen Millan, Barbara Napolitano, Joel L. Marmar and Ian R. Hurley, 2003. Human Reproduction, V. 18, No. 2, 374-383

BACKGROUND: Lead remains in high levels in the environment and is known to reduce fertility in animal models, but a direct link between lead exposures and human infertility has not yet been established. METHODS: In a prospective, double-blind study of the metal ion levels and sperm function, semen was obtained from partners of 140 consecutive women undergoing their first IVF cycle. Lead in seminal plasma was determined by atomic absorption spectroscopy. Motile sperm populations were assessed for surface receptors for mannose binding, and the ability to undergo premature ('spontaneous'), and free mannose-induced acrosome reactions. Fertile donor (n = 9) sperm were exposed to exogenous lead during capacitating incubations and then assessed for mannose receptor expression and acrosome loss. RESULTS: Lead levels were negatively correlated with IVF rates. Lead levels were negatively correlated to two of the three sperm function biomarkers (mannose receptors, mannose-induced acrosome reactions). Lead levels positively correlated with the spontaneous acrosome reaction. These findings were mimicked by in-vitro exposure of fertile donor sperm to lead. CONCLUSIONS: Multiple sperm parameters are affected as lead levels rise. Increased lead levels may contribute to the production of unexplained male infertility.

Cadmium mimics the in vivo effects of estrogen in the uterus and mammary gland. Michael D Johnson, Nicholas Kenney, Adriana Stoica, Leena Hilakivi-Clarke, Baljit Singh, Gloria Chepko, Robert Clarke, Peter F Sholler, Apolonio A Lirio, Colby Foss, Ronald Reiter, Bruce Trock, Soonmyoung Paik, and Mary Beth Martin, 2003. Nature Medicine, 9:1081-1084. Letter Published online: 13 July 2003.

Abstract: "It has been suggested that environmental contaminants that mimic the effects of estrogen contribute to disruption of the reproductive systems of animals in the wild, and to the high incidence of hormone-related cancers and diseases in Western populations. Previous studies have shown that functionally, cadmium acts like steroidal estrogens in breast cancer cells as a result of its ability to form a high-affinity complex with the hormone binding domain of the estrogen

receptor1, 2. The results of the present study show that cadmium also has potent estrogen-like activity *in vivo*. Exposure to cadmium increased uterine wet weight, promoted growth and development of the mammary glands and induced hormone-regulated genes in ovariectomized animals. In the uterus, the increase in wet weight was accompanied by proliferation of the endometrium and induction of progesterone receptor (PgR) and complement component C3. In the mammary gland, cadmium promoted an increase in the formation of side branches and alveolar buds and the induction of casein, whey acidic protein, PgR and C3. *In utero* exposure to the metal also mimicked the effects of estrogens. Female offspring experienced an earlier onset of puberty and an increase in the epithelial area and the number of terminal end buds in the mammary gland."

Cadmium mimics effects of estrogen. NewScientist.com News Service, 13:44, July 14, 2003.

Cadmium is astonishingly good at mimicking the effects of the female sex hormone estrogen, new research on rats has revealed. The discovery raises concerns that the metal, and others like it, could increase the risk of illnesses like breast cancer in people.

Cadmium is widely used in batteries, and is present in cigarette smoke and sewage sludge spread on agricultural land. It is best known for obvious toxic effects on the liver and kidneys.

But new research by Mary Beth Martin's team at Georgetown University in Washington DC shows that, at much lower doses, cadmium can cause very similar effects as estrogen.

Martin gave cadmium to female rats whose ovaries had been removed, so they could not make estrogen themselves. The animals received doses comparable to the level set by the World Health Organization as a tolerable weekly intake for people. The results were unexpectedly striking, with the effects of the cadmium appearing almost identical to those of estrogen.

Denser tissue

Rats given cadmium rapidly developed heavier wombs, denser mammary glands and thicker womb linings - just as they did when given estrogen itself. They also began to make milk, and two genes usually activated by estrogen were switched on.

And when Martin's team gave cadmium to pregnant rats, their female offspring went through puberty sooner and developed denser mammary gland tissue, again matching the effects of estrogen.

Impacts on livestock

Livestock that graze on sludge-amended pastures ingest biosolids that adhere to the forage plants and also ingest soil directly. Particularly in arid conditions, soil can be up to 18% dry weight of a grazing animal's diet. Even where lesser amounts are ingested, recent research has shown impacts to grazing animals from biosolids additions to soils. These impacts include an accumulation of toxic metals in edible body organs, with implications for the human food chain. Additionally, endocrine disruption (reduced testis size) has been documented, with implications for livestock reproduction.

Accumulation of potentially toxic elements by sheep given diets containing soil and sewage sludge. 1. Effect of type of soil and level of sewage sludge in the diet. Hill, J. B. Stark, J. Wilkinson, M. Curran, I. Lean, J. Hall, C. Livesey, 1998. Animal Science, 67:73-86.

Live weight gain was depressed by the addition of sludge to the diet. Levels of cadmium and lead in liver and kidneys increased, with the lead levels approaching the UK statutory limit for human food.

Cellular and hormonal disruption of fetal testis development in sheep reared on pasture treated with sewage sludge. Catriona Paul, Stewart M. Rhind, Carol E. Kyle, Hayley Scott, Chris McKinnell, and Richard M. Sharpe, 2005. Environmental Health Perspectives, 113(11):1580-1587

Fetuses of pregnant sheep reared on sludge-treated pasture had reduced body weight. Male fetus testis were significantly reduced. "These findings indicate that exposure of the developing male sheep fetus to real-world mixtures of environmental chemicals can result in major attenuation of testicular development and hormonal function, which may have consequences in adulthood." This has the potential for impact on fertility.

Movement to groundwater through facilitated transport

New understanding about the movement of contaminants (both chemicals and pathogenic organisms) through soils into groundwater has been developed in recent years. This includes information showing that contaminants may "piggy-back" on other chemicals that move in water (this is termed "facilitated transport"). Thus a chemical which by itself is relatively immobile in soils (such as many metals), can move rapidly through soils when other chemicals are present (such as organic matter in biosolids). In addition another mechanism that provides for rapid movement of chemicals through soils is that water and the contaminants carried in it can move through soils along preferential flow paths (such as worm holes, root channels or wetting fingers).

Recent short feature articles on these topics prepared by Cornell include *Colloidal transport: the facilitated movement of contaminants into groundwater* (B.K. Richards, J.F. McCarthy, T.S. Steenhuis, A.G. Hay, Y. Zevi, A. Dathe. 2007. Journal of Soil & Water Conservation 62(3)55A-56A) and *The unintentional secret*. (B.K. Richards, N. Peranginangin, T.S. Steenhuis and L.D. Geohring. 2003. Journal of Soil & Water Conservation, September-October 2003 59(5):104A-105A). By these mechanisms, contaminants can move through the soil and into groundwater much more quickly than predicted in the very limited risk assessment of groundwater transport potential performed to support the Part 503 rules. The rate of contaminant movement predicted by that risk assessment relied on data from a *single* paper based on *test tube* mobility tests from a *single soil type*. No actual field data were used. Furthermore, the transport models employed by that assessment assumed uniform homogenous soils. The risk assessment thus did not account for these common rapid flow phenomena.

Biosolid colloid-mediated transport of copper, zinc, and lead in waste-amended soils. A.D. Karathanasis, D.M.C. Johnson, and C.J. Matocha, 2005. Journal of Environmental Quality, 34(4):1153-1164

A significant increase in the leaching of metals (up to 10,000 times) was measured in a laboratory experiment as a result of the binding of metals to the organic colloids in sewage sludge. “The findings demonstrate the important role of biosolids colloids as contaminant carriers and the significant risk they pose.”

Effect of Mineral Colloids in Virus Transport through Saturated Sand Columns. Yan Jin, Ellen Pratt, and Marylynn V. Yates, 2000. Journal of Environmental Quality, 29(2):532-539

The movement of viruses through soils was facilitated by adsorption on to colloidal particles.

Facilitated Transport of Napropamide by Dissolved Organic Matter in Sewage Sludge-Amended Soil. L. Nelson, W. Farmer, C.J. Williams, and M. Ben-Hur, 1998. Journal of Environmental Quality, 27:1194-1200.

Abstract: The application of sewage sludge to agricultural soils is practiced to minimize landfill disposal. Organic matter amendments to soil are generally thought to improve soil quality, but pesticide application to these soils may lead to groundwater contamination problems. The complexation of pesticides with a water-soluble carrier such as dissolved organic matter (DOM) may facilitate chemical movement through soil. Sewage sludge amendments may lead to greater downward movement of organic chemicals if associated with DOM. Napropamide [2-α-napthoxy)-*N,N*-diethylpropionamide] was applied to a silt loam soil with (SS) and without (NoSS) sewage sludge application. Laboratory batch equilibrium and soil column studies were performed to determine the potential for herbicide complexation with DOM. Over 98% of the herbicide in soil columns followed typical adsorption and transport behavior as the center of mass of the lower organic matter soil (NoSS) moved twice the depth as that of SS. However, napropamide was detected in the initial leachate eluted from repacked soil columns with steps taken to prevent preferential flow. Napropamide concentrations in the initial leachate of SS were twice that from NoSS with <1.5% of the total applied chemical mass eluting from the bottom of each column. A strong positive relationship was found between napropamide concentration and DOM content in soil leachates. Equilibrium dialysis methods were used to determine that napropamide moving through the soil columns was complexed with DOM. The results show that DOM can facilitate herbicide movement through soil and that sewage sludge-derived DOM may lead to enhanced chemical transport in sludge-amended soils.

Enhanced Transport of Pesticides in a Field Trial with Treated Sewage Sludge. E. Grager, I. Dror, F. Bercovich, and M. Rosner, 2001. Chemosphere, 44: 805-811

Pesticide leaching in arid field soils was increased by the application of sewage sludge.

Aerosols and human health effects

Health effects from exposure to sewage sludge during land spreading have been reported frequently, but these reports have been considered anecdotal and not confirmatory evidence that illness can result from aerosols released during application. Few studies have actually addressed symptoms related to land application. A study of people living near application sites compared

with a control population showed statistically elevated health-related symptoms in the exposed population. Another study of 48 people located near 10 land application sites indicated that chemical irritants and pathogens in sludge may interact to cause symptoms.

Several recent publications have tracked aerosol emissions from fields during sewage sludge (biosolids) application and tillage. DNA-based microbial tracking has proven that wind is a critical factor in the formation and off-site migration of aerosols. Biosolids aerosols of inhalable size (< 10 µm), containing bacteria such as coliforms and Health survey of residents living near farm fields permitted to receive biosolids.

Health Survey of Residents Living near Farm Fields Permitted to Receive Biosolids. Sadik Khuder, Sheryl A. Milz, Michael Bisesi, Robert Vincent, Wendy McNulty, and Kevin Czajkowski, 2007. Archives of Environmental and Occupational Health, 62(1):5-11.

Abstract: The authors studied the health status of residents living in Wood County, OH, near farm fields that were permitted to receive biosolids. They mailed a health survey to 607 households and received completed surveys from 437 people exposed to biosolids (living on or within 1 mile of the fields where application was permitted) and from 176 people not exposed to biosolids (living more than 1 mile from the fields where application was permitted). The authors allowed for up to 6 surveys per household. Results revealed that some reported health-related symptoms were statistically significantly elevated among the exposed residents, including excessive secretion of tears, abdominal bloating, jaundice, skin ulcer, dehydration, weight loss, and general weakness. The frequency of reported occurrence of bronchitis, upper respiratory infection, and giardiasis were also statistically significantly elevated. The findings suggest an increased risk for certain respiratory, gastrointestinal, and other diseases among residents living near farm fields on which the use of biosolids was permitted. However, further studies are needed to address the limitations cited in this study.

Interactions of pathogens and irritant chemicals in land-applied sewage sludges (biosolids). David L Lewis, David K Gattie, Marc E Novak, Susan Sanchez, and Charles Pumphrey , 2002. BMC Public Health, 2:11

Background: Fertilisation of land with processed sewage sludges, which often contain low levels of pathogens, endotoxins, and trace amounts of industrial and household chemicals, has become common practice in Western Europe, the US, and Canada. Local governments, however, are increasingly restricting or banning the practice in response to residents reporting adverse health effects. These self-reported illnesses have not been studied and methods for assessing exposures of residential communities to contaminants from processed sewage sludges need to be developed.

Methods: To describe and document adverse effects reported by residents, 48 individuals at ten sites in the US and Canada were questioned about their environmental exposures and symptoms. Information was obtained on five additional cases where an outbreak of staphylococcal infections occurred near a land application site in Robesonia, PA. Medical records were reviewed in cases involving hospitalisation or other medical treatment. Since most complaints were associated with

airborne contaminants, an air dispersion model was used as a means for potentially ruling out exposure to sludge as the cause of adverse effects.

Results: Affected residents lived within approximately 1 km of land application sites and generally complained of irritation (e.g., skin rashes and burning of the eyes, throat, and lungs) after exposure to winds blowing from treated fields. A prevalence of *Staphylococcus aureus* infections of the skin and respiratory tract was found. Approximately 1 in 4 of 54 individuals were infected, including 2 mortalities (septicaemia, pneumonia). This result was consistent with the prevalence of *S. aureus* infections accompanying diaper rashes in which the organism, which is commonly found in the lower human colon, tends to invade irritated or inflamed tissue.

Conclusions:When assessing public health risks from applying sewage sludges in residential areas, potential interactions of chemical contaminants with low levels of pathogens should be considered. An increased risk of infection may occur when allergic and non-allergic reactions to endotoxins and other chemical components irritate skin and mucus membranes and thereby compromise normal barriers to infection.

Particulate matter composition and emission rates from the disk incorporation of class B biosolids into soil. Tania Paez-Rubio, Xin Huab, James Anderson, Jordan Peccia, 2006. Atmospheric Environment, 40:7034-7045

Abstract: Biosolids contain metal, synthetic organic compound, endotoxin, and pathogen concentrations that are greater than concentrations in the agricultural soils to which they are applied. Once applied, biosolids are incorporated into soils by disking and the aerosols produced during this process may pose an airborne toxicological and infectious health hazard to biosolids workers and nearby residents. Field studies at a Central Arizona biosolids land application site were conducted to characterize the physical, chemical, and biological content of the aerosols produced during biosolids disking and the content of bulk biosolids and soils from which the aerosols emanate. Arrayed samplers were used to estimate the vertical source aerosol concentration profile to enable plume height and associated source emission rate calculations. Source aerosol concentrations and calculated emission rates reveal that disking is a substantial source of biosolids-derived aerosols. The biosolids emission rate during disking ranged from 9.91 to 27.25 mg s^{-1} and was greater than previously measured emission rates produced during the spreading of dewatered biosolids or the spraying of liquid biosolids. Adding biosolids to dry soils increased the moisture content and reduced the total PM10 emissions produced during disking by at least three times. The combination of bulk biosolids and aerosol measurements along with PM10 concentrations provides a framework for estimating aerosol concentrations and emission rates by reconstruction. This framework serves to eliminate the difficulty and inherent limitations associated with monitoring low aerosol concentrations of toxic compounds and pathogens, and can promote an increased understanding of the associated biosolids aerosol health risks to workers and nearby residents.

Source Tracking Aerosols Released from Land-Applied Class B Biosolids during High-Wind Events. Carolina Baertsch, Tania Paez-Rubio, Emily Viau, and Jordan Peccia, 2007. Applied and Environmental Microbiology, 73:4522-4531

Abstract: DNA-based microbial source tracking (MST) methods were developed and used to specifically and sensitively track the unintended aerosolization of land-applied, anaerobically digested sewage sludge (biosolids) during high-wind events. Culture and phylogenetic analyses of bulk biosolids provided a basis for the development of three different MST methods. They included (i) culture- and 16S rRNA gene-based identification of Clostridium bifermentans, (ii) direct PCR amplification and sequencing of the 16S rRNA gene for an uncultured bacterium of the class Chloroflexi that is commonly present in anaerobically digested biosolids, and (iii) direct PCR amplification of a 16S rRNA gene of the phylum Euryarchaeota coupled with terminal restriction fragment length polymorphism to distinguish terminal fragments that are unique to biosolid-specific microorganisms. Each method was first validated with a broad group of bulk biosolids and soil samples to confirm the target's exclusive presence in biosolids and absence in soils. Positive responses were observed in 100% of bulk biosolid samples and in less than 11% of the bulk soils tested. Next, a sampling campaign was conducted in which all three methods were applied to aerosol samples taken upwind and downwind of fields that had recently been land applied with biosolids. When average wind speeds were greater than 5 m/s, source tracking results confirmed the presence of biosolids in 56% of the downwind samples versus 3% of the upwind samples. During these high-wind events, the biosolid concentration in downwind aerosols was between 0.1 and 2 µg/m 3. The application of DNA-based source tracking to aerosol samples has confirmed that wind is a possible mechanism for the aerosolization and off-site transport of land-applied biosolids.

Off-Site Exposure to Respirable Aerosols Produced during the Disk-Incorporation of Class B Biosolids. Swee Yang Low, Tania Paez-Rubio, Carolina Baertsch, Matthew Kucharski, and Jordan Peccia, 2007. Journal of Environmental Engineering, 133:987-994

Abstract: Field experiments were conducted at a Class B biosolids land application site in central Arizona to measure, model, and source-track the off-site transport of aerosols emitted when biosolids were disk-incorporated into soils. Real-time PM10 monitoring provided time-resolved aerosol information sufficient for verifying both off-site concentration and off-site exposure time model results. Under the conditions considered and at a distance of 165 m from the aerosol source, biosolids disk-incorporation resulted in an intermittent exposure to biosolids-derived aerosol concentration between 15 and 40 µg/m3 and an inhalable biosolids dose between 2 and 8 µg. Transport modeling predicted that these doses will decrease with increasing wind speed. In addition, three DNA sequence-based biosolids source tracking methods were applied to aerosol samples and confirmed the presence of biosolids in aerosols at 5, 65, and 165 m from the aerosol source. Field measurements and modeling indicate that the nature of biosolids-derived aerosol exposure is a series of intermittent high concentration puffs, rather than a continuous low concentration.

Emission Rates and Characterization of Aerosols Produced During the Spreading of Dewatered Class B Biosolids. Tania Paez-Rubio, Abel Ramarui, Jeffrey Sommer, Hua Xin, Hua, James Anderson, and Jordan Peccia, 2008. Environmental Science and Technology, 41(10):3537-3544.

Abstract: This study measured aerosol emission rates produced during the spreading of dewatered class B biosolids onto agricultural land. Rates were determined in multiple independent experimental runs by characterizing both the source aerosol plume geometry and aerosol concentrations of PM10, total bacteria, heterotrophic plate count bacteria (HPC), two types of biosolids indicator bacteria, endotoxin, and airborne biosolids regulated metals. These components were also measured in the bulk biosolids to allow for correlating bulk biosolids concentrations with aerosol emission rates and to produce reconstructed aerosol concentrations. The average emission rates and associated standard deviation for biosolids PM10, total bacteria, HPC, total coliforms, sulfite-reducing Clostridia, endotoxin, and total biosolids regulated metals were 10.1 ± 8.0 (mg/s), 1.98 ± 1.41 × 10^9 (no./s), 9.0 ± 11.2 × 10^7 (CFU/s), 4.9 ± 2.2 × 10^3 (CFU/ s), 6.8 ± 3.8 × 10^3 (CFU/s), 2.1 ± 1.8 × 10^4 (EU/s), and 36.9 ± 31.8 (μg/s) respectively. Based on the land application rates of spreaders used in this study, an estimated 7.6 ± 6.3 mg of biosolids were aerosolized for every 1 kg (dry weight) applied to land. Scanning electron microscopy particle size distribution analysis of the aerosols revealed that greater than 99% of the emitted particles were less than 10 μm and particle size distributions had geometric mean diameters and standard deviations near 1.1 ± 0.97 μm. The demonstrated correlations of bulk biosolids concentrations with aerosol emission rates, and the reconstruction of aerosol concentration based on PM10 and bulk biosolids concentration provide a more fundamental, bulk biosolids based approach for extending biosolids aerosol exposure assessment to different land application scenarios and a broader range of toxins and pathogens.

Non-regulated contaminants and POPs

Only 9 contaminants are regulated under the Part 503 rules. There are many unregulated contaminants present in sewage biosolids. Some were considered when the rules were being developed and EPA decided not to regulate them. Chemicals considered for regulation, but not included in the 503 rules, include both chemicals for which there were insufficient data to evaluate the risks as well as chemicals for which EPA determined the risk was not substantial. There are, however, many other chemicals now in widespread usage that were not even considered when the 503 rules were promulgated. Among those are the brominated flame retardants, antibacterials, wastewater treatment flocculant polymers, organotins, surfactants, fragrance chemicals and pharmaceuticals.

Over 500 different synthetic organic chemicals have been reported in sewage sludges. Concentrations of many exceed Soil Screening levels set by EPA. None are regulated in sewage biosolids in the US. EPA eliminated organic chemicals from regulatory consideration based on insensitive analyses that had high detection limits for most organic chemicals, too high to measure levels that would be of environmental significance.

All sewage biosolids contain an array of synthetic organic chemicals. An array of pharmaceuticals was found in all of the biosolids tested, regardless of the type of treatment. All biosolids are "highly enriched" in organic wastewater contaminants. Some are present in high concentrations in sewage biosolids (up to 1% by dry weight). Some have demonstrated toxicity.

Pharmaceuticals are designed to be biologically active at very low concentrations and thus even at trace levels they may impact plants and animals. There is new information showing that antibiotics and other pharmaceuticals have an impact on plants grown in soils containing these chemicals.

The fate of chemicals entering a wastewater treatment plant depends on the chemical and the treatment processes. They may pass through the treatment plant virtually undegraded and travel with the water effluent, they may be sorbed onto the sludge solids, they may volatilize or they may be transformed or degraded in the treatment process. Most organic chemicals tend to sorb onto and thus concentrate in sewage biosolids rather than volatilizing or traveling through the wastewater treatment plant for discharge with the water effluent.

While many organic chemicals are not degraded or transformed by treatment processes (including composting), some compounds are transformed through chemical and biological process, creating daughter products that may be more or less toxic than the original compound. For example, surfactants are a group of chemicals present in large quantities in biosolids. The degradation products of alkyl phenol ethoxylate (APE) surfactants are significantly more toxic than the original compounds and anaerobic digestion processing at wastewater treatment plants promote this transformation, resulting in high concentrations of the recalcitrant and toxic daughter product. This has led to the restriction in use of APEs in Europe. Even compounds that may degrade to less toxic products may be present in such high concentrations in sludges that despite degradation that may take place when the sludge is applied to land, the concentration of the original compound remains at levels of concern. The surfactant LAS is such a compound.

Determination of Anionic and Nonionic Surfactants, Their Degradation Products, and Endocrine-Disrupting Compounds in Sewage Sludge by Liquid Chromatography/Mass Spectrometry. M. Petrovic and D. Barcelo, 2000. Analytical Chemistry, 72: 4560-4567

Surfactants are present in sludges in high concentrations. Degradation may result in more toxic compounds. Aerobic conditions are necessary for more complete degradation of some surfactants to more benign products.

Organic Chemicals in Sewage Sludges. Ellen Z. Harrison, Summer Rayne Oakes, Matthew Hysell, and Anthony Hay, 2006. Science of the Total Environment 367(2-3): 481-497

Abstract: Sewage sludges are residues resulting from the treatment of wastewater released from various sources including homes, industries, medical facilities, street runoff and businesses. Sewage sludges contain nutrients and organic matter that can provide soil benefits and are widely used as soil amendments. They also, however, contain contaminants including metals, pathogens, and organic pollutants. Although current regulations require pathogen reduction and periodic monitoring for some metals prior to land application, there is no requirement to test sewage sludges for the presence of organic chemicals in the U. S. To help fill the gaps in knowledge regarding the presence and concentration of organic chemicals in sewage sludges, the peer-reviewed literature and official governmental reports were examined. Data were found for 516

organic compounds which were grouped into 15 classes. Concentrations were compared to EPA risk-based soil screening limits (SSLs) where available. For 6 of the 15 classes of chemicals identified, there were no SSLs. For the 79 reported chemicals which had SSLs, the maximum reported concentration of 86% exceeded at least one SSL. Eighty-three percent of the 516 chemicals were not on the EPA established list of priority pollutants and 80% were not on the EPA's list of target compounds. Thus analyses targeting these lists will detect only a small fraction of the organic chemicals in sludges. Analysis of the reported data shows that more data has been collected for certain chemical classes such as pesticides, PAHs and PCBs than for others that may pose greater risk such as itrosamines. The concentration in soil resulting from land application of sludge will be a function of initial concentration in the sludge and soil, the rate of application, management practices and losses. Even for chemicals that degrade readily, if present in high concentrations and applied repeatedly, the soil concentrations may be significantly elevated. The results of this work reinforce the need for a survey of organic chemical contaminants in sewage sludges and for further assessment of the risks they pose.

Survey of Organic Wastewater Contaminants in Biosolids Destined for Land Application. C.A. Kinney, E.T. Furlong, S.D. Zaugg, M.R. Burkhardt, S.L. Werner, J.D. Cahill, and G.R. Jorgensen, 2006. Environmental Science and Toxicology, 40(23):7207-7215

Abstract: In this study, the presence, composition, and concentrations of organic wastewater contaminants (OWCs) were determined in solid materials produced during wastewater treatment. This study was undertaken to evaluate the potential of these solids, collectively referred to as biosolids, as a source of OWCs to soil and water in contact with soil. Nine different biosolid products, produced by municipal wastewater treatment plants in seven different states, were analyzed for 87 different OWCs. Fifty-five of the OWCs were detected in at least one biosolid product. The 87 different OWCs represent a diverse cross section of emerging organic contaminants that enter wastewater treatment plants and may be discharged without being completely metabolized or degraded. A minimum of 30 and a maximum of 45 OWCs were detected in any one biosolid. The biosolids used in this study are produced by several production methods, and the plants they originate from have differing population demographics, yet the percent composition of total OWC content, and of the most common OWCs, typically did not vary greatly between the biosolids tested. The summed OWC content ranged from 64 to 1811 mg/kg dry weight. Six biosolids were collected twice, 3-18 months apart, and the total OWC content of each biosolid varied by less than a factor of 2. These results indicate that the biosolids investigated in this study have OWC compositions and concentrations that are more similar than different and that biosolids are highly enriched in OWCs (as mass-normalized concentrations) when compared to effluents or effluent-impacted water. These results demonstrate the need to better describe the composition and fate of OWCs in biosolids since about 50% of biosolids are land applied and thus become a potentially ubiquitous nonpoint source of OWCs into the environment.

Organic Contaminants in Canadian Municipal Sewage Sludge. Part II. Persistent Chlorinated Compounds and Polycyclic Aromatic Hydrocarbons. J. |Kohli, H.B. Lee and T.E. Peart, 2006. Water Quality Research Journal of Canada, 41: 47-55

PAHs, PCBs, and other persistent organic pollutants are found in essentially all sludges, but at widely varying concentrations depending on the source of sludge.

Persistence of organic contaminants in sewage sludge-amended soil: A field experiment. S.C. Wilson, R. E. Alcock , A.P. Sewart , K.C. Jones, 1997. J. Environ. Qual., 26: 1467-1477.

POPs introduced into soils by sewage sludge incorporation, specifically dioxins and PCBs, persisted in the soil with concentrations unchanged up to 260 days.

Fate of higher brominated PBDEs in lactating cows. A. Kierkegaard, L. Asplund , C.A. deWit , M.S. McLachlan , G.O. Thomas, A.J. Sweetman, K.C. Jones, 2007 Environ. Sci. Technol., 41:417-423

Brominated fire retardant chemicals in contaminated feed accumulated in the fat of cows, indicating that meat consumption may be an important human exposure route to higher brominated BDEs. This observation has important implications for pasture and forage land contamination by these chemicals in sewage sludge.

Removal of Organotins During Sewage Treatment: A Case Study. N. Voulvoulis, M.D. Scrimshaw, and J.N. Lester, 2004. Environmental Technology, 25(6):733-740

Organotins are highly toxic compounds found in sludges. They do not degrade in the wastewater treatment process.

The potential impact of veterinary and human therapeutic agents in manure and biosolids on plants grown on arable land: a review. Patrick K. Jjemba, 2002. Agriculture, Ecosystems and Environment, 93(1-3):267-278

Substantial quantities of pharmaceuticals are applied to land in sludges and manures. Detrimental impacts of pharmaceuticals on crops is observed with some species of plants.

Bacterial regrowth/viable non-culturable (VNC)

Recent research has demonstrated that sewage biosolids believed to meet Class A or Class B standards were subject to regrowth and reactivation of bacteria. Thus materials have been land applied that contained bacterial levels far above those of Class A or Class B as defined by USEPA under Part 503. Coliform concentrations were found to increase by 100-1000-fold in biosolids and in soil/biosolid mixtures after centrifugation of anaerobically digested biosolids. Coliform concentrations up to 100,000 times those measured by conventional culture methods may be found in thermophilically digested sludges after centrifugation. This results from the presence of viable but non-culturable bacteria.

Increases in Fecal Coliform Bacteria Resulting From Centrifugal Dewatering of Digested Biosolids. Yinan Qi, Steven. K. Dentel, and Diane S. Herson, 2007. Water Research, 41(3):571-580.

Abstract: In many countries, the classification of biosolids for disposal purposes can be based, in part, on fecal coliform levels, with alternative criteria also available based on the stabilization process used, such as anaerobic digestion. The assumption that these alternative criteria provide equivalent protection may be flawed. This paper demonstrates that fecal coliform levels determined after digestion do not always indicate the bacterial levels after the same biosolids have been dewatered by centrifugation. In samples from mesophilic digestion, half had significant increases in coliform numbers ($P<0.05$) with up to one order of magnitude increase during centrifugation, suggesting coliform regrowth. Thermophilically digested samples had significant increases of several orders of magnitude during dewatering, more likely from reactivation of viable but non-culturable coliforms than from regrowth. In other cases, centrifugation induced coliform regrowth or reactivation upon incubation and storage of dewatered samples, but not digested samples. These 2–3 order of magnitude increases occurred with both 25 and 37 °C incubations. Coliform increases continued for up to 5 days, then gradually declined. However, by day 20 coliform numbers were still 2 orders of magnitude greater than when originally sampled. The magnitude of the increases could be due either to regrowth or reactivation, but the nature of the longer-term increases—also seen in biosolids/soil mixtures—suggests regrowth. Differences in numbers between digested and dewatered samples could not be duplicated with high shear processing in lab-scale devices, with nitrogen purging to remove volatile or gaseous constituents, or with redilution using centrate. They could not be attributed to enumeration methods, to interference of Bacillus spp. on apparent coliform counts, or to temperature changes. The increases have practical implications in the use of fecal coliform or alternative criteria to define pathogen content in biosolids.

Reactivation and Growth of Non-Culturable Indicator Bacteria in Anaerobically Digested Biosolids After Centrifuge Dewatering. Matthew J. Higgins, Yen-Chih Chen, Sudhir N. Murthy, Donald Hendrickson, Joseph Farrel, Perry Schafer, 2007. Water Research, 41(3):665-673

Abstract: Recent literature has reported that high concentrations of indicator bacteria such as fecal coliforms (FCs) were measured in anaerobically digested sludges immediately after dewatering even though low concentrations were measured prior to dewatering. This research hypothesized that the indicator bacteria can enter a non-culturable state during digestion, and are reactivated during centrifuge dewatering. Reactivation is defined as restoration of culturability. To examine this hypothesis, a quantitative polymerase chain reaction (qPCR) method was developed to enumerate Escherichia coli, a member of the FC group, during different phases of digestion and dewatering. For thermophilic digestion, the density of E. coli measured by qPCR could be five orders of magnitude greater than the density measured by standard culturing methods (SCMs), which is indicative of non-culturable bacteria. For mesophilic digestion, qPCR enumerated up to about one order of magnitude more E. coli than the SCMs. After centrifuge dewatering, the non-culturable organisms could be reactivated such that they are enumerated by SCMs, and the conditions in the cake allowed rapid growth of FCs and E. coli during cake storage.

Antibiotic resistance in sludge bacteria

Recent studies have confirmed that the use of antimicrobials had created a large pool of antibiotic-resistance genes in bacteria that are detected in sewage sludge and effluent from sewage treatment plants. Antibiotic resistant bacteria were found in higher numbers downstream of sludge-treated farmland as compared to upstream.

Increased Frequency of Drug-resistant Bacteria and Fecal Coliforms in an Indiana Creek Adjacent to Farmland Amended with Treated Sludge. Shivi Selvaratnam and David J. Kunberger, 2004. Canadian Journal of Microbiology, 50(8):653-656

Abstract: Many studies indicate the presence of human pathogens and drug-resistant bacteria in treated sewage sludge. Since one of the main methods of treated sewage disposal is by application to agricultural land, the presence of these organisms is of concern to human health. The goal of this study was to determine whether the frequency of drug resistant and indicator bacteria in Sugar Creek, which is used for recreational purposes, was influenced by proximity to a farmland routinely amended with treated sludge (site E). Surface water from 3 sites along Sugar Creek (site E, 1 upstream site (site C) and 1 downstream site (site K)) were tested for the presence of ampicillin-resistant (AmpR) bacteria, fecal and total coliforms over a period of 40 d. Site E consistently had higher frequencies of AmpR bacteria and fecal coliforms compared with the other 2 sites. All of the tested AmpR isolates were resistant to at least 1 other antibiotic. However, no isolate was resistant to more than 4 classes of antimicrobials. These results suggest that surface runoff from the farmland is strongly correlated with higher incidence of AmpR and fecal coliforms at site E.

Potential ecological and human health impacts of antibiotics and antibiotic-resistant bacteria from wastewater treatment plants. S. Kim and D.S. Aga, 2007. Journal of Toxicology and Environmental Health-Part B-Critical Reviews, 10:559-573

Abstract**:** The occurrence of antibiotics and other pharmaceuticals in the environment has become an increasing public concern as recent environmental monitoring activities reveal the presence of a broad range of persistent pharmaceuticals in soil and water. Studies show that municipal wastewater treatment plants (WWTPs) are important point sources of antibiotics and antibiotic-resistant bacteria in the environment. The fate of antibiotics and other pharmaceuticals in WWTPs is greatly influenced by the design and operation of treatment systems. Because knowledge on the fate of antibiotics and resistant bacteria in WWTPs is important in estimating their potential impacts on ecology and human health, investigations on occurrence, treatment, and observed effects are reviewed in this article. In addition, human health risk assessment protocols for antibiotic and resistant bacteria are described. Although data on other pharmaceutical compounds are also presented, discussion is focused on antibiotics in the environment because of the potential link to increased emergence of resistance among pathogenic bacteria. The applications of modern analytical methods that facilitate the identification of novel transformation products of pharmaceuticals in environmental matrices are also included to illustrate that the disappearance of the parent pharmaceuticals in WWTPs does not necessarily equate to their complete removal.

Effect of wastewater treatment on antibiotic resistance in Escherichia coli and Enterococcus sp. S. Garcia, B. Wade, C. Bauer, C. Craig, K. Nakaoka, and W. Lorowitz, 2007.Water Environment Research, 79:2387-2395

Abstract**:** The effects of wastewater treatment on the proportion of Escherichia coli and Enterococcus sp. resistant to specific antibiotics were investigated at two facilities in Davis County, Utah, one of which received hospital waste. Samples were taken from the influent, effluent before disinfection, and secondary anaerobic sludge digester effluent. There was very little difference in antibiotic resistance among E. coli in the inflow waters of the plants but the plant receiving hospital waste had a significantly higher proportion of antibiotic resistant Enterococcus. The effect of wastewater treatment on antibiotic resistance was more pronounced on enterococci than E. coli. Although some increases in antibiotic resistance were observed, the general trend seemed to be a decrease in resistance, especially in the proportion of multidrug resistant Enterococcus sp.

Antimicrobial resistance in Enterococcus spp. isolated in inflow, effluent and sludge from municipal sewage water treatment plants. P.M. Da Costa, P. Vaz-Pires, and F. Bernardo, 2006. Water Research, 40:1735-1740

Abstract**:** Antimicrobial resistance of enterococci was investigated in 42 samples of crude inflow, treated effluent and sludge collected in 14 municipal sewage treatment plants of Portugal. A total of 983 enterococci were recovered and tested, using the diffusion agar method, regarding their sensitivity to 10 different antimicrobial drugs. Multidrug resistance was present in 49.4% of the isolates. Only 3.3% and 0.6% of the investigated strains were resistant to ampicillin and vancomycin, respectively. Resistances found against rifampicin (51.5%), tetracycline (34.6%), erythromycin (24.8%) and nitrofurantoin (22.5%), are causes for substantial concern. Almost 14% of isolates were resistant to ciprofloxacin. Wastewater treatment resulted in enterococci decrease between 0.5 and 4log; nevertheless, more than 4.4 x 10(5) CFU/100ml were present in the outflow of the plants. Our data indicate that the use of antimicrobials had created a large pool of resistance genes and that sewage treatment processes are unable to avoid the dissemination of resistant enterococci into the environment.

Prions

The potential for prions that might be present in wastewater to accumulate in sludges and to persist through treatment is a concern.

***Persistence of Pathogenic Prion Protein during Simulated Wastewater Treatment Processes*.** G.T. Hinckllley, C.J. Johnson, K.H. Jacobson, C. Bartholomay, K.D. McMahon, D. McKenzie, J.M. Aiken, and J.A. Pederson, 2008. Environmental Science and Technology, 42(14):5254-5259.

Abstract: Transmissible spongiform encephalopathies (TSEs, prion diseases) are a class of fatal neurodegenerative diseases affecting a variety of mammalian species including humans. A misfolded form of the prion protein (PrPTSE) is the major, if not sole, component of the infectious

agent. Prions are highly resistant to degradation and to many disinfection procedures suggesting that, if prions enter wastewater treatment systems through sewers and/or septic systems (e.g., from slaughterhouses, necropsy laboratories, rural meat processors, private game dressing) or through leachate from landfills that have received TSE-contaminated material, prions could survive conventional wastewater treatment. Here, we report the results of experiments examining the partitioning and persistence of PrPTSE during simulated wastewater treatment processes including activated and mesophilic anaerobic sludge digestion. Incubation with activated sludge did not result in significant PrPTSE degradation. PrPTSE and prion infectivity partitioned strongly to activated sludge solids and are expected to enter biosolids treatment processes. A large fraction of PrPTSE survived simulated mesophilic anaerobic sludge digestion. The small reduction in recoverable PrPTSE after 20-d anaerobic sludge digestion appeared attributable to a combination of declining extractability with time and microbial degradation. Our results suggest that if prions were to enter municipal wastewater treatment systems, most would partition to activated sludge solids, survive mesophilic anaerobic digestion, and be present in treated biosolids.

Ecological impacts

Soil microorganisms play a critical role in the functions of soil as a source of plant nutrition and in the cycling of nutrients. Recent research shows that sludge application changes the soil microbial community and decreases its diversity. A number of human-use compounds (such as triclosan found in many personal care products such as antibacterial soaps) bioconcentrate in earthworms where soil has been amended with sewage sludges.

Computational Improvements Reveal Great Bacterial Diversity and High Metal Toxicity in Soil. Jason Gans, Murray Wolinsky, and John Dunbar, 2005. Science, 309:1387-1390

Sewage sludge greatly reduced the diversity of bacterial species in soils.

Parallel Shifts in Plant and Soil Microbial Communities in Response to Biosolids in a Semi-Arid Grassland. Tarah S. Sullivan, Mary E. Stromberger, and Mark W. Paschke, 2006. Soil Biology and Biochemistry, 38 449-459

Abstract: Approximately 70,150 dry Mg of biosolids from over 450 wastewater treatment facilities are applied to the semi-arid rangelands of Colorado every year. Research on semi-arid grassland responses to biosolids has become vital to better understand ecosystem dynamics and develop effective biosolids management strategies. The objectives of this study were to determine the long-term (~12 years) effects of a single biosolids application, and the short-term (~2 years) effects of a repeated application, on plant and microbial community structure in a semi-arid grassland soil. Specific attention was paid to arbuscular mycorrhizal fungi (AMF) and linkages between shifts in plant and soil microbial community structures. Biosolids were surface applied to experimental plots once in 1991 (long-term plots) and again to short-term plots in 2002 at rates of 0, 2.5, 5, 10, 21, or 30 Mg ha^{-1}. Vegetation (species richness and above-ground biomass), soil chemistry (pH, EC, total C, total N, and extractable P, NO_3-N, and NH_4-N), and soil microbial community structure [ester-linked fatty acid methyl esters (EL-FAMEs)], were characterized to assess impacts

of biosolids on the ecosystem. Soil chemistry was significantly affected and shifts in both soil microbial and plant community structure were observed with treatment. In both years, the EL-FAME biomarker for AMF decreased with increasing application rate of biosolids; principal components analysis of EL-FAME data yielded shifts in the structure of the microbial communities with treatment primarily related to the relative abundance of the AMF specific biomarker. Significant (p%0.05) correlations existed among biomarkers for Gram-negative and Gram-positive bacteria, AMF and specific soil chemical parameters and individual plant species' biomass. The AMF biomarker was positively correlated with biomass of the dominant native grass species blue grama (Bouteloua gracilis [Willd. ex Kunth] Lagasca ex Griffiths) and was negatively correlated with western wheatgrass (Agropyron smithii Rydb.) biomass. This study demonstrated that applications of biosolids at relatively low rates can have significant long-term effects on soil chemistry, soil microbial community structure, and plant community species richness and structure in the semi-arid grasslands of northern Colorado. Reduced AMF and parallel shifts in the soil microbial community structure and the plant community structure require further investigation to determine precisely the sequence of influence and resulting ecosystem dynamics.

Bioaccumulation of Pharmaceuticals and Other Anthropogenic Waste Indicators in Earthworms from Agricultural Soil Amended With Biosolid or Swine Manure . C.A. Kinney, E.T. Furlong, D.W. Kolpin, M.R. Burkhardt, S.D. Zaugg, S.L. Werner, J.P. Bossio and M.J. Benotti, 2008. Environmental Science and Technology, 42:1863-1870

Abstract: Analysis of earthworms offers potential for assessing the transfer of organic anthropogenic waste indicators (AWIs) derived from land-applied biosolid or manure to biota. Earthworms and soil samples were collected from three Midwest agricultural fields to measure the presence and potential for transfer of 77 AWIs from land-applied biosolids and livestock manure to earthworms. The sites consisted of a soybean field with no amendments of human or livestock waste (Site 1), a soybean field amended with biosolids from a municipal wastewater treatment plant (Site 2), and a cornfield amended with swine manure (Site 3). The biosolid applied to Site 2 contained a diverse composition of 28 AWIs, reflecting the presence of human-use compounds. The swine manure contained 12 AWIs, and was dominated by biogenic sterols. Soil and earthworm samples were collected in the spring (about 30 days after soil amendment) and fall (140-155 days after soil amendment) at all field sites. Soils from Site 1 contained 21 AWIs and soil from Sites 2 and 3 contained 19 AWIs. The AWI profiles at Sites 2 and 3 generally reflected the relative composition of AWIs present in waste material applied. There were 20 AWIs detected in earthworms from Site 1 (three compounds exceeding concentrations of 1000 μg/kg), 25 AWIs in earthworms from Site 2 (seven compounds exceeding concentrations of 1000 μg/ kg), and 21 AWIs in earthworms from Site 3 (five compounds exceeding concentrations of 1000/μg/kg). A number of compounds that were present in the earthworm tissue were at concentrations less than reporting levels in the corresponding soil samples. The AWIs detected in earthworm tissue from the three field sites included pharmaceuticals, synthetic fragrances, detergent metabolites, polycyclic aromatic hydrocarbons (PAHs), biogenic sterols, disinfectants, and pesticides, reflecting a wide range of physicochemical properties. For those contaminants detected in earthworm tissue and soil, bioaccumulation factors (BAF) ranged from 0.05(galaxolide)to 27

(triclosan).Thisstudydocuments that when AWIs are present in source materials that are land applied, such as biosolids and swine manure, AWIs can be transferred to earthworms.

International Standards for Heavy Metals

The USEPA standards for sewage biosolid contaminant concentrations (standards are set for 9 metals) are higher than those in other developed countries and higher than recommendations of scientists in the northeastern U.S. Switzerland has banned sludge application.

Since the 503 rule was promulgated by USEPA, there has been no reassessment of the heavy metal loading limits on agricultural soils set at that time. In fact, there has been no significant research effort in the US to test the assertion by EPA that the very high metal loading limits (by international standards) of the 503 rule have a high safety margin in protecting soil productivity and crop quality.

Two recent large multi-site field investigations measuring the long-term impacts of sludge metals on soil health and crop quality were undertaken independently in Australia and the UK. In the absence of a comparable study of this scale or longevity in the US, the results of the Australian and UK studies are highly useful in developing guidelines for heavy metals in the US.

The Australian study addressed the impact of Cd loading on food crop quality (levels of Cd in edible crops), and Cu and Zn impacts on crop production (phytotoxicity) and soil health (microbial processes). The recommended limits are much lower for most soils than the allowed soil concentrations of Cd, Zn and Cu based on metal loadings permitted by the USEPA 503 rule. However, the study revealed the high sensitivity of harmful metal effects in soils on soil properties such as pH, clay content and organic matter content. Therefore, the recommended limits for the heavy metals vary greatly by soil type, with acid sandy soils being the most sensitive soils to metal additions.

"Ban on the Use of Sludge as a Fertiliser". Switzerland: Federal Office for the Environment, 2003. http://www.umwelt-schweiz.ch

Bern, 26.03.2003 – The use of sludge as a fertiliser is to be banned throughout Switzerland; in the future sludge will have to be incinerated using an environmentally friendly method. The Swiss Federal Council will modify the Ordinance on Materials accordingly on 1 May 2003. The ban will be introduced in stages: from May this year, sludge may no longer be used in the production of fodder crops and vegetables. A period of transition lasting until 2006 at the latest has been accorded for other types of cultivation which until now have been fertilised using sludge; in individual cases the cantonal authorities may extend this period until 2008. This decision is part of the Federal Council's implementation of precautionary provisions for the protection of soils and public health.

Although sludge contains plant nutrients such as phosphorus and nitrogen it also comprises a whole range of harmful substances and pathogenic organisms produced by industry and private households. For this reason, most farmers already avoid using sludge as a fertiliser since they are

aware of the risk of irreversible damage to the soil, the danger to public health and possible negative effects on the quality of the food they produce."

Australian recommendations on soil limits for cadmium, zinc and copper

Recommendations of the Australian National Biosolids Research Program on Biosolids Guidelines. Michael Warne, Mike McLaughlin, Diane Heemsbergen, Mike Bell, Kris Broos, Mark Whatmuff, Glenn Barry, David Nash, Deb Pritchard, Daryl Stevens, Grant Pu, and Craig Butler, 2007. Draft Position Paper.

Executive Summary: A set of soil specific maximum limits for copper and zinc in soils that have received biosolids were derived. These recommended limits state the amount of copper or zinc that can be added to a soil. In acidic, low carbon soils (pH 5, OC 1%) the recommended limit is 25 mg/kg added copper, which increases to 245 mg/kg added copper in alkaline soils (pH 8) irrespective of the organic carbon content. The recommended limits are, depending on the soil properties at a site, considerably smaller to considerably larger than the current limits of 100 – 200 mg/kg total copper. In acidic, low cation exchange capacity (CEC) soils (pH 5, CEC 3 cmolc/kg) the recommended limit for zinc in soils that have received biosolids is 20 mg/kg added zinc, which increases to 300 mg/kg added zinc when the soil pH is greater than or equal to 7.5 irrespective of the cation exchange capacity. Thus, the recommended limits can be considerably lower to marginally higher than the current limits of 200 – 250 mg/kg total zinc, depending on the properties of the soils at sites. Critical soil concentrations of cadmium that would lead to exceedance of the Food Standards Australian New Zealand (FSANZ) standard (0.1 mg/kg) for human consumption were determined across all NBRP sites. The critical values were affected by soil properties, principally soil pH and clay content. A set of recommended soil specific maximum cadmium concentrations in soils that have received biosolids were developed. The recommended limit for total cadmium at a soil pH of 5.5 is 0.6 mg/kg in sandy soils (5% clay or less). In alkaline (pH 7.5 or greater) and clayey soils (25% or greater) the recommended limit for total cadmium in soil is approximately 1 mg/kg or greater. Thus depending on the soil properties at a site the recommended cadmium soil concentration is considerably smaller to considerably greater than the value of 1 mg/kg previously recommended by the National Cadmium Management Committee. From the above recommended limits for cadmium, copper and zinc it is apparent that soils that are acidic combined with either low organic carbon, low clay content or low cation exchange capacity have low critical soil metal concentrations. The critical soil concentrations increased as the pH, organic carbon content, clay content or cation exchange capacity of soils increased. Based on the recommended soil limits, typical metal concentrations in biosolids and current land application practices example masses of biosolids that could be applied cumulatively to land were calculated. For high risk sites as little as 40 to 90 tonnes in total may be added, while at low risk sites between 280 and 970 tonnes in total may be applied. At typical current agronomic application rates of 10 t/ha this translates to 4 to 98 applications.

UK findings on the effect of sewage sludge metals on soil health

The UK study also addressed the impact of Cd loading on food crop quality (levels of Cd in edible crops), and Cu and Zn impacts on soil health (microbial biomass, rhizobium numbers, and microbial respiration). The results suggest that Zn is the metal responsible for the decrease in rhizobial population. It is important to stress that this study was designed to test the adequacy of existing UK limits for Cd, Zn and Cu in agricultural soils (e.g., 200-300 mg/kg for Zn). As some important detrimentral effects are being seen, at least in the early years of this long-term study, it is possible that UK limits for these metals will be adjusted lower. The present UK limits are well below those permitted in the US under the 503 rule.

Effects of Sewage Sludge Applications to Agricultural Soils on Soil Microbial Activity and the Implications for Agricultural Productivity and Long-Term Soil Fertility: Phase III, ADAS, Rothamsted Research, Water Research Centre (WRc), 2007.

Project synthesis: During the four years (2002-2006) of this project, significant ($P < 0.05$) responses in soil microbial properties (i.e. rhizobia numbers and microbial biomass size) and agricultural crop quality (i.e. grain Cd concentrations) were measured following the application of metal-rich sludge cakes and metal-amended liquid sludges during Phase I (1994-1997). The soil samples taken in spring 2003 and 2005 at all nine sites in Britain (and additionally in 1999 and 2001 during Phase II of the project) showed significant ($P < 0.05$) responses in rhizobia numbers on the Zn sludge cake treatments, and in soil microbial biomass size on the Zn and Cu sludge cake treatments. Further soil sampling and measurements during future years of this long term study will help to establish whether the effects measured so far are permanent and consistent over time.

Northeastern U.S. application guidelines

A review of published research by 9 scientists from 5 Northeastern states produced recommended limits for heavy metals that are substantially lower than those permitted under the USEPA 503 rule.

Guidelines for Application of Sewage Biosolids to Agricultural Lands in the Northeastern U.S., Ellen Z. Harrison and Uta Krogmann (Eds.), 2007. New Jersey Agricultural Experiment Station, Rutgers Cooperative Extension Bulletin, 36 pp.

Maximum recommended cumulative soil trace element concentration limits for sites to which sewage biosolids are applied are intended to address and protect the agricultural productivity under Northeast soil conditions and for Northeast farming practices and demographics some of which are unique to this region (Table 3).

Table 3. Recommended Maximum Soil Trace Element Concentrations for the Northeast US

Metal	Recommended Maximum Soil Concentration (mg/kg)		
	Sand to loamy sand	Sandy loam to silt loam	Silt to clay
cadmium	1.2	2	3
copper	50	75	120
nickel	30	40	60
lead	120	120	120
zinc	90	150	230

New Technologies as Alternative Beneficial Uses

Application of sewage biosolids is not the only option for recycling this material. New energy recovery technologies make use of the energy embedded in the sludge. Other technologies are in place to make construction material out of sludges.

***Emerging Technologies for Biosolids Management*, US EPA, 2006.**
http://www.epa.gov/OW-OWM.html/mtb/epa-biosolids.pdf

Preface: The U.S. Environmental Protection Agency (U.S. EPA) is charged by Congress with protecting the nation's land, air, and water resources. Under a mandate of environmental laws, the Agency strives to formulate and implement actions leading to a balance between human activities and the ability of natural systems to support and sustain life. To meet this mandate, the Office of Wastewater Management (OWM) provides information and technical support to solve environmental problems today and to build a knowledge base necessary to protect public health and the environment well into the future.

This publication has been produced under contract to the U.S. EPA by Parsons Corporation and provides information on the current state of development as of the publication date. It is expected that this document will be revised periodically to reflect advances in this rapidly evolving area. Except as noted, information, interviews and data development were conducted by the contractor. It should be noted that neither Parsons nor U.S. EPA has conducted engineering or operations evaluations of the technologies included. Some of the information, especially related to embryonic technologies, was provided by the manufacturer or vendor of the equipment or technology and could not be verified or supported by full-scale case study. In some cases, cost data were based on estimated savings without actual field data. When evaluating technologies, estimated costs, and stated performance, efforts should be made to obtain current information.

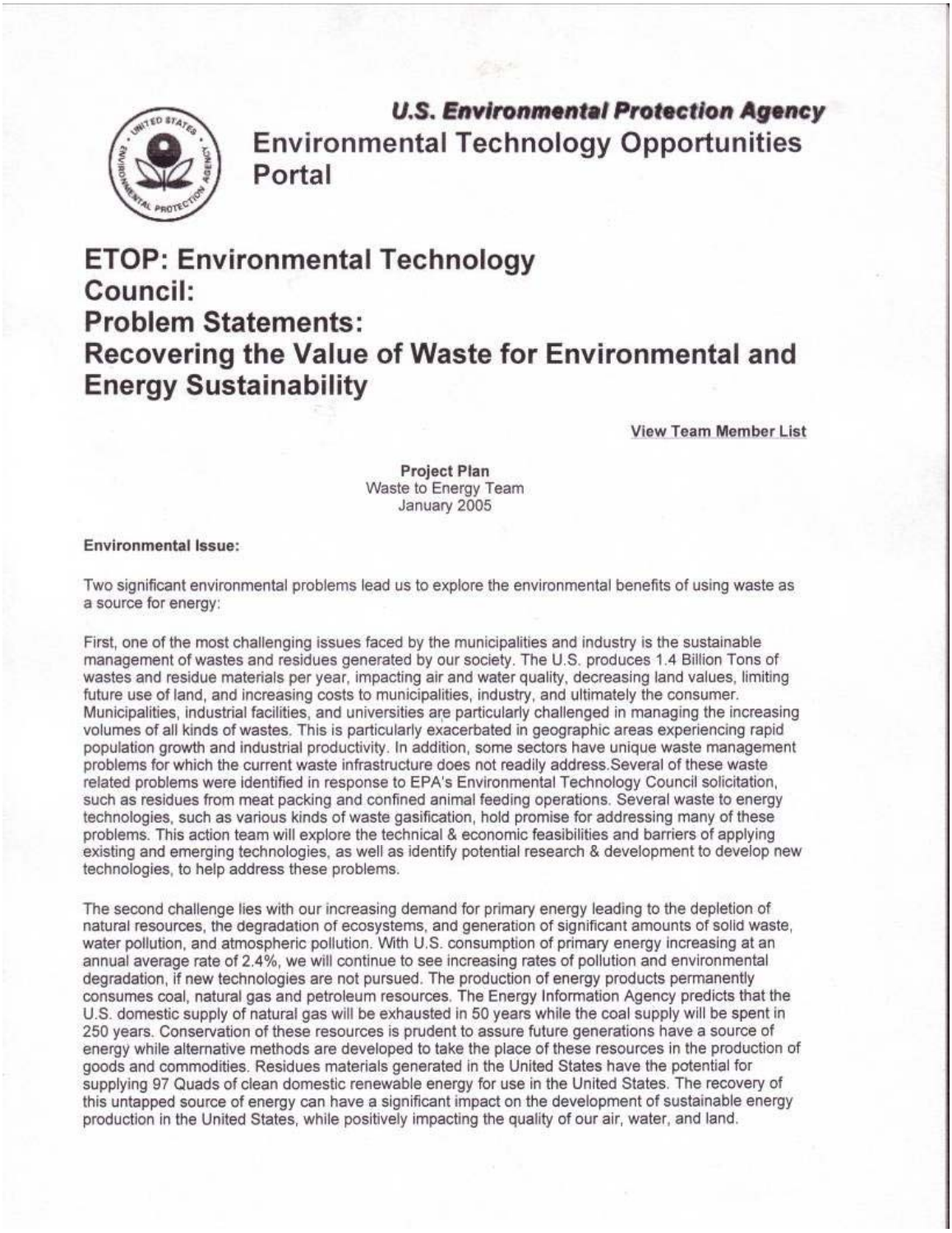
The mention of trade names, specific vendors, or products does not represent an actual or presumed endorsement, preference, or acceptance by the U.S. EPA or the Federal government. Stated results, conclusions, usage, or practices do not necessarily represent the views or policies of the U.S. EPA.

Energy alternatives

Combustion and Land Application Can Both be Beneficial? Roger Tim Haug, Deputy City Engineer City of Los Angeles, F. Michael Lewis, PE, Peter Brady, BE MIEI

Abstract: Both combustion and land application have played important roles in biosolids management practices for many decades. Land application in almost all of its forms has been proclaimed as beneficial use. By contrast, many have viewed combustion as a "disposal only" option, even if energy is recovered in the process and the resulting ash reused. These views and opinions are often proclaimed with no basis or criteria to support the conclusion. Five criteria are presented in this paper for judging whether a management practice is beneficial or not. When judged by these criteria, one can conclude that many combustion installations are beneficial. One can also conclude that land application is beneficial in most, but perhaps not all, installations."

Gasification presents an opportunity that EPA is promoting.



U.S. Environmental Protection Agency

Environmental Technology Opportunities Portal

ETOP: Environmental Technology Council: Problem Statements: Recovering the Value of Waste for Environmental and Energy Sustainability

View Team Member List

Project Plan
Waste to Energy Team
January 2005

Environmental Issue:

Two significant environmental problems lead us to explore the environmental benefits of using waste as a source for energy:

First, one of the most challenging issues faced by the municipalities and industry is the sustainable management of wastes and residues generated by our society. The U.S. produces 1.4 Billion Tons of wastes and residue materials per year, impacting air and water quality, decreasing land values, limiting future use of land, and increasing costs to municipalities, industry, and ultimately the consumer. Municipalities, industrial facilities, and universities are particularly challenged in managing the increasing volumes of all kinds of wastes. This is particularly exacerbated in geographic areas experiencing rapid population growth and industrial productivity. In addition, some sectors have unique waste management problems for which the current waste infrastructure does not readily address.Several of these waste related problems were identified in response to EPA's Environmental Technology Council solicitation, such as residues from meat packing and confined animal feeding operations. Several waste to energy technologies, such as various kinds of waste gasification, hold promise for addressing many of these problems. This action team will explore the technical & economic feasibilities and barriers of applying existing and emerging technologies, as well as identify potential research & development to develop new technologies, to help address these problems.

The second challenge lies with our increasing demand for primary energy leading to the depletion of natural resources, the degradation of ecosystems, and generation of significant amounts of solid waste, water pollution, and atmospheric pollution. With U.S. consumption of primary energy increasing at an annual average rate of 2.4%, we will continue to see increasing rates of pollution and environmental degradation, if new technologies are not pursued. The production of energy products permanently consumes coal, natural gas and petroleum resources. The Energy Information Agency predicts that the U.S. domestic supply of natural gas will be exhausted in 50 years while the coal supply will be spent in 250 years. Conservation of these resources is prudent to assure future generations have a source of energy while alternative methods are developed to take the place of these resources in the production of goods and commodities. Residues materials generated in the United States have the potential for supplying 97 Quads of clean domestic renewable energy for use in the United States. The recovery of this untapped source of energy can have a significant impact on the development of sustainable energy production in the United States, while positively impacting the quality of our air, water, and land.

Converting Biosolids to a Renewable Fuel. Michael Moore, Layne Baroldi, Deirdre Bingman, Ray Kearney, 2006. BioCycle, 47(10):32-35

Orange County CA is working with EnerTech Environmental Inc on a facility to convert 1/3 of their biosolids to energy. The E-fuel is certified as a renewable fuel by CA Energy Commission.

Turning trash into energy in St. Lucie County. TCPalm newspaper editorial, December 1, 2006.

St Lucie County, FL is proceeding with plans to have Geoplasma INC build a plasma arc facility to deal with trash and sludge.

Green Production of Hydrogen from Excess Biosolids Originating from Municipal Waste Water Treatment. B. Bagchi, J. Rawlston, R.M. Counce, J.M. Holmes, and P.R. Bienkowski, 2006. Separation Science and Technology, 41:2613-2628

Rialto, CA OKs Energy Plant at Landfill Site. National Biosolids Partnership. 3/1/06 Weekly Biosolids Update. http://www.biosolids.org/news_weekly.asp?id=1911

Sewage turned into hydrogen fuel. NewScientist.com News Service, April 29, 2002.

RENEWABLE ENERGY: They hope to turn an array of biomass material into fuels by early 2008. John Welsh. The Press-Enterprise, Sept 14, 2006.

Bricks and glass

Sludge can be used to make construction materials including brick and aggregate.

Lightweight aggregate made from sewage sludge and incinerated ash. Ing-Jia Chiou, Kuen-Sheng Wang, Ching-Ho Chen, and Ta-Ting Lin, 2006. Waste Management, 26:1453-1461

Sewage sludge bulks up house bricks. Andy Cohlan, August 31, 2002. New Scientist

Advances in Envir Research. Chih-Huang Wend, I-Shou U in Kachsiung Co Taiwan.

Sewage vitrification. The Illinois North Shore Sanitary District has a new sludge recycling facility that is the first in the world to convert municipal biosolids into a reusable glass aggregate. Each day, up to 200 tons of municipal biosolids are transformed into 7.5 tons of glass.

Biosolids Reuse as Clear as Glass, 2006. Water Environment Federation, 18(11). http://www.wef.org/ScienceTechnologyResources/Publications/WET/06/06Nov/06NovemberProblemSolvers.htm

Please accept these comments on compost regulations onto the official record. I am concerned that I have been working on compost regulations for over 6 years and just received this notice this morning and comments are due by noon.

Any compost containing sewage, sludge, biosolids, biowaste must be enclosed to protect water quality. I have tried to get regulations in place to require enclosure and capture of all dust, gases and other byproducts for the sludge compost process.

We here in Hinkley have been struggling to strengthen regulations on an open air sludge compost site (Nursery Products). This specific company has a history of discharge violations in their last facility in Adelanto and now has been permitted to operate a much larger operation in our area. This operation has conditions to adhere to but little oversight to enforce those regulations. MDAQMD, CalRecycle, County Code Enforcement, Fish and Game, Fish and Wildlife, SWAT, DEH, and Lahonton all have regulations and rules required to be followed, but all lack the desire or ability to enforce those requirements and conditions.

Here in the High Desert we are in the monsoon season right now. Every couple of days we have flash flood conditions and flooding is expected yet unpredictable. Yestarday Highway 66 was closed trapping a school bus of children including mine.

http://www.vvdailypress.com/news/route-36550-washes-flooding.html

This was not far from the open air sludge dump in Hinkley. This is a yearly event. This is not a 1000 year event as Lahonton says. When speaking with Lahoton officials, they said that they were not concerned that the Hinkley sludge dump was operating illegally because we were in the summer and not the winter raining season. These are the experts you have protecting our water rights? These officials live here and must look outside to see the weather. I have submitted these concerns and photos of local flash floods, but the Water Board does not seem concerned, even those Staff members who live locally. When, not if one of these weather events hits the sludge site, the retention ponds will not be able to contain the run-off. It is not possible to design ponds large enough capable of containing the run-off for an industrial size site. With enclosure, this problem is solved. No exposed sludge, no dust, no run-off and no emissions if designed properly.

Enclosure, containment, and capture of all byproducts must be required.

All dust must be captured that comes off composting sites as it can regrow into dangerous substances. Please see State DHS Letter attached as proof of such occurrences being documented in Adelanto at an open-air sludge compost facility. Only enclosure can protect the waterways and water quality from this threat. When dust from these facilities during composting or even in stockpiled “finished product” can be dangerous to water quality. Note the water recharge sites in our area that can and will be contaminated by the dust from the sludge site in Hinkley.

Sewage Sludge, biosolids if a substance of unknown contaminants. Please reference the list of known contaminants contained in this email and attached.