PHOSPHOGYPSUM: SHOULD WE JUST LET IT GO TO WASTE? PARTS 1 AND 2

HEARINGS

BEFORE THE

SUBCOMMITTEE ON TECHNOLOGY, INFORMATION POLICY, INTERGOVERNMENTAL RELATIONS AND THE CENSUS

OF THE

COMMITTEE ON GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTH CONGRESS

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PHOSPHOGYPSUM: SHOULD WE JUST LET IT GO TO WASTE? PART 1

MONDAY, MARCH 15, 2004

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON TECHNOLOGY, INFORMATION POLICY,
INTERGOVERNMENTAL RELATIONS AND THE CENSUS,
COMMITTEE ON GOVERNMENT REFORM,
Bartow, FL.

The subcommittee met, pursuant to notice, at 9:33 a.m., in the West Wing, Southwest Florida Water Management District Headquarters, 170 Century Drive, Bartow, FL, Hon. Adam H. Putnam (chairman of the subcommittee) presiding.

Present: Representative Putnam.

Staff present: Bob Dix, staff director; John Hambel, senior counsel; Ursula Wojciechowski, professional staff member; Juliana French, clerk; and Matthew Joyner, district director.

Mr. PUTNAM. A quorum being present, this hearing of the Subcommittee on Technology, Information Policy, Intergovernmental Relations and the Census will come to order.

Good morning, and welcome everyone to the subcommittee's first hearing on phosphogypsum. Today's hearing is appropriately entitled, "Phosphogypsum: Should We Just Let It Go To Waste?"

I want to thank the community for their interest in this issue. As indicated by the wonderful turnout that we have today, this is an issue that is very important, not just to Polk County but to all of central Florida and even beyond that.

Currently there are about 1 billion tons of phosphogypsum stored in 24 stacks in Florida, 21 of those stacks here in central Florida. Thirty million new tons of phosphogypsum are produced every year, and we meet today in the shadows of one of those stacks, one of these gyp stacks, as the locals call them, here in the Southwest Florida Water Management District building.

Phosphogypsum is a byproduct of the chemical processing of phosphate rock mined here in Florida. In 1989, the U.S. Environmental Protection Agency promulgated a rule determining that the commercial product of phosphogypsum was a waste product and banned its use for any purpose whatsoever. From that point on, the phosphogypsum has been accumulating all over the State.

The possibility of a catastrophic spill in Manatee County last year raised local and Federal concerns. In 2001 the Mulberry Corp., the owner of the Piney Point Phosphates went bankrupt leaving a plant with unattended stacks of phosphogypsum. Since then, the State of Florida has kept the electricity going at the plant and monitored water levels in the phosphogypsum stacks. Last year,

the Florida Department of Environmental Protection was granted Federal permission to discharge more than 500 million gallons of treated wastewater from the Piney Point Plant into Bishop's Harbor in Tampa Bay. EPA and the Department of Environmental Protection insisted that it would not be harmful to marine life and others contended that the solution, while the lesser of two evils, would be less environmentally damaging and more economically sound than a spill. That discharge was estimated to span 19,500 square miles and cost $10 million. Although that cost will be covered by a trust fund that phosphate companies pay for environmental restoration, Florida State government has spent $40 million so far to maintain Mulberry's abandoned plants at Piney Point and in Polk County. The expected maintenance and closing costs will total $170 million which will fully deplete the trust fund.

Scientific research conducted and the results found by various entities support a position that phosphogypsum is not a waste but a potentially valuable commercial product. Conclusive evidence by independent researchers and research councils challenge the claims that use of the product is harmful and suggests that specific applications be reviewed. It can be environmentally safe and economically attractive to use phosphogypsum in a variety of ways serving industry and potentially benefiting the taxpayer. Considering that the environmental dangers of stacking phosphogypsum to the unlikely risks associated with the use of it outweigh the risks of storing it as a waste product. We will examine this question and the environmentally safe, potential uses for phosphogypsum this morning.

This morning's hearing will immediately be followed by our second hearing that will focus on understanding the purported risks of phosphogypsum as determined by the Environmental Protection Agency. Representatives from Florida's State and local government will share their thoughts on the risks and uses of phosphogypsum. And finally we will hear the concerns of a dedicated environmentalist involved with the Tampa Bay estuary program.

Ordinarily I would yield to the ranking member of the subcommittee, Mr. Clay from Missouri, for any opening remarks; however, given that this is a field hearing and not in Washington, we will immediately proceed to witnesses for their testimony.

As is the custom for the Government Reform Committee, we swear in our witnesses, so I would ask the first four panelists and anyone joining you who will provide supporting information to our questions to please rise and raise your right hands.

[Witnesses sworn.]

Mr. PUTNAM. I note for the record that all the witnesses respond in the affirmative.

We will proceed to our first witness, Mr. Michael Lloyd. Mr. Lloyd is the research director of chemical processing at the Florida Institute of Phosphate Research. He received his chemical engineering degree in 1950 from Clemson University. After graduation he worked in the Chemical Corp. for the U.S. Army and Southern Cotton Oil Co. Before joining the Florida Institute of Phosphate Research in 1982 Mr. Lloyd worked 30 years for Agrico Chemical Co. serving many roles from foreman to project coordinator and director. He participates in the American Institute of Chemical Engi-

neers and the American Chemical Society. Mr. Lloyd is quite possibly the only person to have direct contact with almost all of the events related to phosphogypsum and the EPA since the Florida Institute of Phosphate Research was formed in 1979. His extensive research on the subject of phosphogypsum is commendable and we look forward to his expert testimony. Welcome to the subcommittee, Mr. Lloyd, and you are recognized.

[The prepared statement of Hon. Adam H. Putnam follows:]

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SUBCOMMITTEE ON TECHNOLOGY, INFORMATION POLICY, INTERGOVERNMENTAL RELATIONS AND THE CENSUS
Congressman Adam Putnam, Chairman

OVERSIGHT HEARING
STATEMENT BY ADAM PUTNAM, CHAIRMAN

Hearing topic: "Phosphogypsum: Should We Just Let It Go To Waste?"
Parts 1 & 2

Monday, March 15, 2003
9:30 a.m.
Southwest Florida Water Management District Headquarters
170 Century Drive, Bartow, FL 33830

OPENING STATEMENT

Good morning and welcome to the Subcommittee's hearings on phosphogypsum. Today's hearings are appropriately titled, *Should We Just Let It Go To Waste?* Currently there are about one billion tons of phosphogypsum stored in 24 stacks in Florida- 21 in central Florida. Thirty million *new* tons of phosphogypsum are produced every year.

Phosphogypsum is a by-product of the chemical processing of phosphate rock, which is mined in Florida. In 1989, the US Environmental Protection Agency promulgated a rule determining that the commercial product of phosphogypsum was a "waste" product and banned its use for any purpose whatsoever. From that point on, the phosphogypsum has just been accumulating all over Florida.

Three years later, EPA modified the rule to allow the use of phosphogypsum from northern Florida for agricultural use.

Since then only one other rule regulating the use of phosphogypsum has been promulgated. In 1999, EPA raised the limit on the quantity of phosphogypsum that may be used for indoor research and development from 700 lbs to 7,000 pounds and clarified sampling procedures for phosphogypsum removed from stacks for other purposes. That was one step in the right direction.

The possibility of a "catastrophic spill" in Manatee County last year raised local and federal concern. Back in 2001, Mulberry Corp., the owner of Piney Point Phosphates, went bankrupt, leaving a plant with unattended stacks of phosphogypsum. Since then the state of Florida has kept the electricity on at the plant and monitored water levels in its phosphogypsum stacks.

Last year, The Florida DEP was granted federal permission to discharge more than 500 million gallons of treated wastewater from the Piney Point plant into Bishop's Harbor, part of Tampa Bay. EPA and DEP insisted that it would not be harmful to the marine life, and others contended that the solution, while only the lesser of two evils, would be less environmentally damaging and more economically sound than a spill.

That discharge was estimated to span 19, 500 square miles and cost about $10 million. Although that cost will be covered by a trust fund that phosphate companies pay for environmental restorations, Florida state government has spent about $40 million so far to maintain Mulberry's abandoned plants at Piney Point and in Polk County. The expected maintenance and closing costs will total $170 million, which will fully deplete the trust fund.

Scientific research conducted and the results found by various entities support a position that phosphogypsum is not a "waste" but rather a potentially valuable product. Conclusive evidence by independent researchers and research councils challenge the claims that use of the product is harmful and suggest that specific applications be reviewed. It can be environmentally safe and economically attractive to use phosphogypsum in a variety of ways serving industries and potentially benefiting public taxpayers.

The witnesses of our first hearing will propose that the use of phosphogypsum can be favorable to farmers, cattlemen, and taxpayers when used as a soil amendment, road base, and a land fill cover. Our second hearing will focus on understanding the purported risks of phosphogypsum as determined by the US EPA. Also, a representative from Florida's Department of Health will share his thoughts on the risks and uses of phosphogypsum. And finally we will hear the concerns of a dedicated environmentalist.

Considering the environmental dangers of stacking phosphogypsum, do the unlikely risks associated with the use of it outweigh the risks of storing it as a waste product? We will examine this question and the environmentally safe potential uses for phosphogypsum this morning.

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STATEMENTS OF G. MICHAEL LLOYD, JR., RESEARCH DIRECTOR, CHEMICAL PROCESSING, FLORIDA INSTITUTE OF PHOSPHATE RESEARCH; DR. MALCOLM E. SUMNER, AGRICULTURAL AND ENVIRONMENTAL CONSULTANT, REGENTS' PROFESSOR EMERITUS, UNIVERSITY OF GEORGIA; DR. DOUG CHAMBERS, EXECUTIVE VICE PRESIDENT, DIRECTOR OF RADIOACTIVITY AND RISK STUDIES, SENES CONSULTANTS LIMITED; AND DR. CHIH-SHIN SHIEH, ENVIRONMENTAL CONSULTANT, CS ENVIRONMENTAL SOLUTIONS

Mr. LLOYD. Thank you.

Finding environmentally sound ways to utilize phosphogypsum was an original priority with the Florida Institute of Phosphate Research. One of our first activities was to have an international symposium on phosphogypsum in November 1980. Our efforts looked at three different basic approaches. To use it as a chemical raw material, use it in construction and for agriculture. We did sponsor research to recover the sulfur values but economics made that somewhat impractical. For construction purposes the only thing we really looked at was to use it for road building. Our plan was to build a secondary road first, test it environmentally and for construction purposes and then go ahead and build a primary and later on an interstate type road.

We did build 2 secondary roads, one in Polk County and one up in north Florida in Columbia County. We have tested both of them environmentally and testing continues on the Polk County road even until today. Testing by the Florida Department of Transportation has revealed that the Polk County road has gotten stronger with time rather than getting weaker. It also has shown fewer repairs than what is necessary for other roads.

Phosphogypsum has been tested for all kinds of agriculture. We have used it for truck crops, for grass, and we have also tested for radionuclide uptake by both the cattle and by the grass. We have used it to find out about curing subsurface acidity and we have also used it to improve the water penetration in the soil. One of the other uses we have gotten into is for marine applications, for making glass and for daily cover in municipal solid waste landfills.

Until December 1989, phosphogypsum was sold as a product of commerce in all States of the country. At that time, EPA elected to declare it a waste and forbid its use, including forbidding research. In the time period between 1989 and 1992, EPA developed the risk assessments that are used as the basis for the use ban in the 1992 rule. The 1989 proposed rule did not have any data to support the ban. All of the bans that they have done are based on building a house on either the roadbed or building it on land that was fertilized with phosphogypsum for 100 years. A residency value of 70 years was used to calculate the risk, which is somewhat longer than the values used in many EPA risk calculations.

The ban on agriculture was based on averaging the use in California for soil treatment and using it for agriculture in this part of the country. The two uses that were used to get an average are totally unrelated. They are like saying apples and oranges are the same because both of them are fruits. The 1992 rule did allow the use of north Florida phosphogypsum in agriculture and prohibits all other uses. However, you can use EPA's methodology and prove

that building roads, using it in a landfill or anything else will not produce a risk that would exceed EPA's acceptable risk.

The question may be asked why are we so interested in using phosphogypsum. We do believe that leaving it in the stacks is a worse situation than using it. The road building economics are very attractive. The roads we built in Polk County, we saved $100,000 a mile by using phosphogypsum over traditional material. The actual soil use—using it for agriculture in Florida could have an even greater impact. All of the southeast is short on sulfur. Using our phosphogypsum, we would be able to increase the production and definitely affect what cattle raisers do in Florida.

One of the things we would like to continue at this point is using it in landfills. We have demonstrated in both pilot and in the bench scale tests that it would be possible to speed up the decomposition of the material in solid waste landfills. If we can do this we would be able to decrease the amount of landfills that would be needed by 50 percent.

We believe that all of these uses are practical, that the risks are acceptable and we would like to see something happen.

Mr. PUTNAM. Thank you very much, Mr. Lloyd.

[The prepared statement of Mr. Lloyd follows:]

Testimony by
G. Michael Lloyd, Jr.
Research Director Chemical Processing
Florida Institute of Phosphate research
1855 West Main Street
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At The
Government Reform Committee's Subcommittee on Technology, Information Policy, Intergovernmental Relationships and the Census
Oversight hearing on
"Phosphogypsum: Should We Just Let It Go To Waste?-Part 1"
Southwest Water Management District Headquarters
170 Century Drive
Bartow, FL 33830
Monday March 15, 2004

FIPR Phosphogypsum Research

Finding environmentally sound ways to utilize phosphogypsum has been a priority issue for FIPR since the Institute was organized. One of the first activities of the Institute was to sponsor an International Symposium on Phosphogypsum in November 1980. The meeting was attended by researchers and users from all over the world and papers were presented describing how phosphogypsum was being utilized throughout the world.

The FIPR research efforts looked at three basic approaches to phosphogypsum utilization, use as a chemical raw material, construction applications (primarily for road beds), and agricultural applications.

In the early 1980s there was a great interest in recovering and recycling the sulfur values in phosphogypsum. This interest was largely economic since sulfur was selling for $156.00 per long ton and sulfur could be recovered from phosphogypsum for less than $100.00 per ton of sulfur. FIPR sponsored research to recover sulfur values as both hydrogen sulfide and sulfur dioxide. By the time the research was completed, the price of sulfur had fallen to well under $50.00 per ton and there was no interest in building full scale operating plants.

In the field of construction activities FIPR elected not to investigate the use of phosphogypsum in wallboard and other related products. While we recognized that phosphogypsum is one of the better gypsums that have been used for this purpose and was being used for wallboard production in a number of countries, the economics for using phosphogypsum for this purpose in this country are such that phosphogypsum cannot compete with FGD gypsum from power plant stack scrubbing. Our primary research thrust was to use phosphogypsum for roadbed construction. Our plan was to

build a secondary road and test it for both environmental and operating characteristics. The same procedure was to be followed next for a primary road and then for an interstate type road.

Two secondary roads were constructed, one in Polk County in central Florida and a second in Columbia County in north Florida. Both were subjected to environmental testing with testing continuing for the Polk County road until today. Testing by the FLDOT revealed that the physical strength of the Polk County roadbed increased with time and use. The road has needed fewer repairs than similar roads in the area. These roads were completed shortly before the EPA ban on phosphogypsum use was issued and plans for the other roads were curtailed.

Agricultural research has been somewhat varied. Early research by Auburn University demonstrated that using phosphogypsum on winter wheat increased yields. Winter wheat in Alabama is planted in the fall and cattle are allowed to graze on the plants until spring. This forage was good for the cattle. Phosphogypsum was tested on truck crops and while yields were not increased for all crops, the quantity of each crop that was considered acceptable for sale was increased since there were fewer blemishes on such plants as broccoli and cauliflower. A very detailed study was carried out on forage grasses to address both the radiological aspects of phosphogypsum application and the increase in protein in the grass and the resulting increased rate of weight gain for the cattle consuming the treated versus the untreated pasture grasses. Radionuclide uptake by both the pasture grasses and the cattle were measured.

Other phosphogypsum agricultural research included using phosphogypsum to ameliorate subsoil acidity syndrome by substituting surface applications of phosphogypsum for deep plowing down to as deep as six feet to turn the soil over and mix it with lime and surface applications of phosphogypsum to increase the rate of water penetration into the soil, thereby significantly reducing soil erosion in heavy rain downpours.

Other phosphogypsum uses that have been researched are the use of phosphogypsum for marine applications as oyster culch and artificial reefs, as a raw material for the production of glass type ceramics that can be use for tiles, etc., and for daily cover in municipal solid waste landfills as a means of speeding the decomposition of the solid waste.

Research into the production of phosphogypsum based glass type ceramic materials has resulted in a very interesting spin off development. One variation for preparing the phosphogypsum for use in ceramic manufacture offers the opportunity to produce hydrogen as a by-product. While this study is in an informal preliminary stage, both NASA and the DOE have expressed interest in the processing scheme under study. The process has the potential to produce significant quantities of hydrogen resulting in reduced green house gas emissions.

EPA's Phosphogypsum Rule

Until December 1989 phosphogypsum was treated as any other item of commerce and was sold for agricultural and other uses in both central and north Florida as well as at all the locations where it was manufactured throughout the country. At that time EPA elected to classify phosphogypsum as a waste and prohibit all phosphogypsum research and uses. Prior to this time EPA had conducted public hearings on whether or not it was necessary to place layers of soil on top of the phosphogypsum stacks to reduce radon emanations from the stacks that might be harmful to people living in the vicinity of the stacks and had concluded that the risks associated with radon from the stacks did not justify such actions

For much of the time following this 1989 rule until the final rule was issued in June 1992, EPA announced they would not enforce the section of the rule related to the use of North Carolina and north Florida phosphogypsum in agriculture and allowed the farmers in Georgia, Florida, Alabama, and North Carolina to continue using phosphogypsum for fertilization. In the time period between November 1989 and June 1992 EPA developed the risk assessments that are used as the basis for the use ban in the 1992 rule. The 1989 proposed rule ban was not supported by such data.

The Fertilizer Institute, representing the industry, filed objections to the rule but EPA elected not to consider revising any part of the rule except that part relating to research. The research rule allowed the use of no more than 700 pounds (approximately one 55 gallon drum) for any single research project. The EPA risk methodology allowed you to use only one laboratory in a three-story laboratory with nine labs on each floor for phosphogypsum research. In addition EPA required that you sample the entire stack for radium before you could remove as little as a one-pound sample from the stack.

The ban on phosphogypsum use for agriculture and road building was based on building a house on the abandoned roadbed or on a field that had received agricultural phosphogypsum applications for 100 years. The residency values of 70 years used to calculate the risk is longer than the residency values used in some other EPA risk calculations.

The agricultural phosphogypsum ban was arrived at by averaging the amounts of phosphogypsum used for sodic soil treatment in California and fertilization practices for peanuts, primarily in Georgia. The two uses are completely unrelated. Considering a soil treatment and fertilization as the same is like saying that apples and oranges are the same because both are fruits or as a farming comparison equating planting seeds with harvesting because both involve using tractors. In this manner EPA arrived at a yearly

phosphogypsum application rate of 1350 pounds per acre per year that is virtually unknown in fertilization practices in our area and probably in much of the rest of the world.

In 1995 EPA proposed modifying the research rule to allow the researcher to have 7000 pounds on hand and to be able to replenish his supply as long as it did not exceed the 7000 pound limit. In addition you could do phosphogypsum research in all the labs in their three-story model laboratory building without incurring unacceptable risks. They also agreed that sampling the entire stack before you could remove a sample was unrealistic since the researcher would want to analyze his sample before using it and would know what he was using.

EPA's justification for changing the phosphogypsum research rule in February 1999 is quite interesting. These points, quoted from the February 1999 rule change, are discussed in the following paragraphs.

EPA: First, EPA revised the assumption made regarding the number of drums of phosphogypsum that would be opened at any one time and from which radon-222 could therefore escape to the ambient air in the laboratory. During the 1992 rulemaking, EPA's assessment assumed that five such drums would be open. EPA changed this assumption to reflect that at most only one single drum would be open under actual conditions in laboratories.

Comment: Since a single drum would contain approximately 700 pounds of phosphogypsum, having five drums in a laboratory or anywhere else at the facility would violate the 1992 rule limiting research to 700 pounds and was not likely to happen.

EPA: Second, EPA changed the assumption regarding how much of the radon-222 that is present in the phosphogypsum actually emanates into the ambient air of the laboratory. When setting the 1992 rule, EPA assumed that all the radon-222 generated by the radium-226 in phosphogypsum would be released.

Comment: The radon-222 emanations measured by EPA before making the 1989 rule and available to EPA when the 1992 rule was made did not support the emanation rates used.

EPA: Third, EPA revised the assumption on the number of hours a researcher spends in the laboratory from 4,000 hours down to 1,000 hours per year. The value of 4,000 hours that was used in the 1992 rulemaking exceeded by 100 percent the typical occupational year of 2,000 hours. The value of 1,000 hours was judged to be a more realistic estimate.

Comment: No comment needed.

Another problem with the 1992 rule is the procedure for requesting an exemption to the rule that would allow use of phosphogypsum for any purpose other than the one stated in the rule. While EPA said in 1992 that they would define the requirements for an exemption request, they have failed to provide this guidance. After asking for assistance a number of times, FIPR elected to file exemption requests that we felt satisfied the rule

requirements. In these instances we have been faced with a long wait before being advised that some additional information is needed only to be told after another long wait that some other additional information is needed. This makes it extremely difficult to make any progress.

The 1992 rule allows the use of north Florida and North Carolina phosphogypsum in agriculture and prohibits all other uses. Using EPA's own methodology it is easy to demonstrate that the risk associated with using north Florida phosphogypsum for road beds, municipal solid waste landfills, and any other use will not generate a risk that exceed the EPA's acceptable risk. In fact the calculated risk for use in roadbeds is less than the risk associated with agricultural uses

Another difficulty in dealing with EPA is the almost constant changes in personnel responsible for responding to requests for instruction relative to the phosphogypsum rule and how to prepare an acceptable exemption request. About the time the person in EPA learns what the rule is, he or she is off to some other position and we start all over with a need to repeat everything again to get back to where we were before the personnel change took place.

It should be noted that most of the time whenever we have been able to get EPA to meet with us to discuss our concerns, progress is made. However, it is not always simple to arrange such a meeting.

The question may be asked as to why we are so interested in using phosphogypsum for the purposes we have researched. To begin with we are convinced that the long term adverse environmental effects of leaving the phosphogypsum in stacks greatly exceeds any risks associated with its use for any of the purposes we have researched

When it comes to road building the economic advantages are impressive. When a two lane sixteen foot wide secondary county road was built in Polk County, FL, the saving when using phosphogypsum for the road base as compared to traditional road building materials and practices is almost $100,000 per mile. This translates to approximately $300,000 for a mile of interstate where there are two lanes that are twenty-four feet wide for each direction. The other interesting fact is that the phosphogypsum road base increases in strength with time as determined by FLDOT testing. The economic benefit of this effect has not been estimated. We recognize that phosphogypsum transportation costs will limit the areas in Florida where phosphogypsum could be used for road building but the economic advantages where it could be used are significant.

The potential economic importance of phosphogypsum to agriculture could easily exceed the advantages that could be realized in road building. Soils in Florida and all of the southeastern United States are generally deficient in sulfur. Phosphogypsum is the lowest cost way to correct this deficiency and it provides a sulfur source that is slowly available to the plants due to its limited solubility and is not easily leached out of the soil

by rainfall. There is hardly a crop in Florida that would not benefit from improved sulfur fertilization but perhaps the greatest advantage would be to use phosphogypsum on pastures. With adequate sulfur pasture grasses contain more protein that is more digestible by livestock and results in significant increased weight gain for the animals. It is generally accepted that weight gains increases of twenty per cent over a given time period are not uncommon where the sulfur content of grass is optimum. Since Florida raises more cattle than Texas the potential economic benefit to the Florida cattleman is quite interesting.

Another use that FIPR would like to continue researching is the use of phosphogypsum as a daily cover in municipal solid waste landfills. We have completed both bench and pilot scale testing but have been prevented from going on to a field demonstration test by the EPA's requiring an exemption request for the field testing. It has been more than two years ago that we requested the exemption and we are still waiting. The beauty of this approach is that the bacteria that decompose the waste will use the phosphogypsum as an energy source and continue to operate at top efficiency for the life of the landfill. In a normal landfill bacterial action slows to a crawl shortly after the waste is covered each day by soil. As a result of using phosphogypsum bacterial action is accelerated and it is possible to recover 45-50% of the landfill volume in approximately five years, thereby reducing the need for future landfills by 50%.

Mr. PUTNAM. Our next witness is Dr. Malcolm Sumner. Dr. Sumner is an agricultural and environmental consultant. Currently he is Regents' professor emeritus at the University of Georgia. He graduated first in his class with a BS in agriculture and cum laude with his masters of science in Agriculture from the University of Natal in South Africa. Additionally, he has a doctorate of philosophy from the University of Oxford. He has edited five books, including the Handbook of Soil Science; authored and co-authored two books; 249 referred papers; 41 book chapters and over 300 publications. Dr. Sumner's specialties include soil contamination and pollution, beneficial reuse of anthropogenic, solid and liquid wastes in agriculture and gypsum as an ameliorant for subsoil limitation, among many other topics. He has extensive experience in international soil science and agronomic research, consulting and teaching. He has received numerous awards recognizing his scientific contributions, including an honorary doctor of science degree from the University of Natal in 1997.

Aside from the fact that you are a Bulldog, you are a very well qualified individual for this panel. Welcome, Dr. Sumner, you are recognized.

Mr. SUMNER. Thank you, Mr. Chairman. Today I am going to talk about the agricultural uses of phosphogypsum. This should be judged against the EPA rule which came up with a value of 2,700 pounds per acre every 2 years for 100 years. This comes down to 1,350 pounds of gypsum per acre per year. So that is the yardstick against which we should judge.

Now gypsum is used in many facets of agriculture, for sodic soils which do not occur in the southeast here, so I will not dwell on those at all. But as a calcium and sulphur source for crops, very important, as an ameliorant for the subsoil acidity and as a physical ameliorant.

I am going to deal specifically, Mr. Chairman, with the rates recommended by our Cooperative Extension Service, which is the imprimatur of the State and Federal Government. For peanuts, in terms of calcium requirements, gypsum is used to strengthen the cell walls of the peanuts to prevent them from getting diseased. The recommended rates vary from 250 to 1,720 pounds per acre every 2 to 3 years. So you are going to divide those numbers by two or three depending on the rotation. That gives you a maximum recommended value of about 600 pounds per acre and a most likely rate of between 125 and 430 with a minimum rate of between zero and 83.

For tomatoes, the gypsum is used to extend shelf life. The recommended rates are between 430 and 860 pounds per acre every 2 years. You have to divide those numbers by two, giving you a maximum rate of somewhere in the region of 430 pounds, most likely rates somewhere between 200 and 300 pounds and a minimum rate of between zero and 143 pounds.

As far as sulphur requirements of the crops are concerned, these are much lower than the calcium requirements, and the recommended values are between 54 and 161 pounds per acre, giving you a maximum of 161 and a minimum of zero.

As far as subsoil acidity amelioration is concerned, the recommended rates vary between 2.2 and 4.4 tons per acre every 10,

that was in my report, but my work has continued and that can be now said to be every 15 years. So that gives the maximum rate at 800 pounds or for 15 years at 530 pounds per acre per year, and a minimum rate there would be zero.

To complete the picture, for sodic soils—which do not occur in this part of the world but occur in the western States—the recommended rates for gypsum would be between 7 and 35 tons per acre over the period of the reclamation which one can assume only once is 100 years, and that gives you a maximum rate of 700 pounds per acre per year and minimum rates of between zero and 200.

As far as soil crusting is concerned, the other physical ameliorant use, the recommended rate is between 0.5 and 1 ton per acre every 5 years giving you a maximum rate of 400 and a minimum rate of zero per year application.

For ameliorating subsoil hard pans there is no recommendation, but the rates that are being used are the regional 4.4 tons per acre every 10 years giving you a maximum again of 800 and a minimum of zero.

Now as far as the radiation hazard of the phosphogypsum is concerned, our experiments show that at the rate that we used, 4.45 tons per acre in one application, we found no significant increase in lead-214, bismuth-214 or radium-226 in the soil profile down to a depth of 3 feet over 5 years. There were no increases in radiation in the above-ground parts of the plants. In the sandy soil we found there was a light movement of radium-226 in a column study in the lab, but this level in the leachate was well below the drinking water standard.

So overall, from the rates I have shown you, the maximum rates that are actually likely to be applied in agriculture, this 1,350 pound per acre per year proposed by the EPA is too high. A more reasonable level in my view would be between 600 and 800 as the maximum, but the most likely rate, Mr. Chairman, would be between 100 and 400 pounds per acre per year.

The last point I would like to make, the basis of using concentration as the yardstick in banning the phosphate should be revised because I think cumulative load is much more important. Thank you, Mr. Chairman.

[The prepared statement of Mr. Sumner follows:]

GYPSUM AS A CALCIUM AND SULFUR SOURCE FOR CROPS AND SOILS IN THE SOUTHEASTERN UNITED STATES

Reconciliation of Literature Review with EPA=s Final Rule on Phosphogypsum

EXECUTIVE SUMMARY

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Preamble

In 1992, the Environmental Protection Agency (EPA) banned the use of phosphogypsum containing more than 10 pCi ^{226}Ra g^{B1} for application to soils. This ban was based on calculations of risk assessment on the assumption that phosphogypsum would be applied to a given soil at a rate of 2700 lb ac^{B1} biennially for 100 years. As will be shown in this report, this assumption is incorrect. The Fertilizer Institute unsuccessfully challenged the Final Rule made by the EPA who contended that this application rate truly reflected the likely usage of phosphogypsum in agriculture.

Introduction

Gypsum is used in agriculture for the following purposes:

- as an ameliorant for sodium-affected (sodic) soils which occur mainly in arid areas and is therefore of minor interest in this report,
- as a source of the nutrients calcium (Ca) and sulfur (S) required by all crops,
- as an ameliorant for the subsoil acidity syndrome which commonly afflicts soils in the Southeast, and
- as an ameliorant for crust and seal formation at the soil surface, a condition commonly encountered in the sandy textured soils of the Southeast.

This is a summary of a report prepared for the Florida Institute of Phosphate Research (FIPR) with the following objectives:

- to independently assess the published experimental evidence on gypsum use in agriculture in the Southeastern United States and in Florida in particular, and
- to compare the gypsum application rate assumed by the EPA in their calculations to actual field practice by computing both on a lb ac^{B1} yr^{B1} basis.

To achieve these objectives, a thorough literature review was undertaken in an attempt to survey all citations so that the final outcome cannot be contested on the basis of a limited data set.

Calcium (Ca) Requirements of Crops

The following are the essential roles Ca plays in the nutrition of all plants:

- serves vital functions in the development of cells,
- is essential for membrane integrity and functioning of hormones,
- aids in the signaling of environmental changes, and
- partially offsets the toxic effects of aluminum (Al).

The amounts of Ca required to be present in soil by various crops can differ widely and in circumstances where soil Ca levels are low, gypsum is often used to remedy this deficiency.

Peanuts

The major crop in the Southeast for which Ca is most critical, is the peanut which has received most of the attention in the literature. The responses obtained in the field have served as the basis for the development of State Recommendations by the Cooperative Extension Service for the application of gypsum to peanuts. As the literature review undertaken in this treatise indicates that these application rates are based on sound scientific data, they should be used as the basis for calculating an annual gypsum application rate. Research has clearly demonstrated substantial benefits to be derived from rotating peanuts with other crops which are not susceptible to peanut pests. This is by far the cheapest and most effective way of controlling peanut pests in the field. Consequently, the Cooperative Extension Service advises farmers to rotate peanuts with other crops on a routine basis. Rotation of peanuts in a 2- or 3-year rotation is practiced by over 75% of the farmers in the Southeast. This aspect of peanut production was not apparently considered by the EPA in arriving at the Final Rule on Phosphogypsum. Therefore, the gypsum application rates recommended by the various states in Table S1 must be divided by 2 or 3 depending in whether peanuts appear every other year or every third year in the rotation. Very few peanut farmers would ever be foolish enough to plant peanuts continuously on the same piece of land.

On a whole field basis (broadcast application), the highest gypsum rate recommended for peanuts in the Southeast is 1720 lb gypsum ac^{B1}. Taking the most conservative approach assuming that peanuts are grown in a two-year rotation, the maximum recommended rate on an annual long-term basis would be 860 lb ac^{B1} yr^{B1}. Because there is substantial financial gain to be achieved by growing peanuts in a three- over a two-year rotation, many farmers follow a three-year rotation system which would reduce this figure to 573 lb gypsum ac^{B1} yr^{B1}. Thus by comparison with the maximum rate at which gypsum would ever be applied in practice on a long-term basis to a given field (860-573 lb gypsum ac^{B1} yr^{B1}), the figure of 1350 lb gypsum ac^{B1} yr^{B1} used by the EPA in their risk assessment calculations is too high by a factor of between 1.56 and 2.35.

However in many cases, farmers usually band place gypsum because this is much more economical as only between 1/3 and 1/2 of the amount is required. As a result the most

likely rates at which gypsum would be applied to most production fields in any one year would be between 250 and 860 lb gypsum ac^{B1} yr^{B1} (Table S1). Consequently, the actual long-term rates would lie between 125 and 430 for a two- and 83 and 267 lb gypsum ac^{B1} yr^{B1} for a three-year rotation system. Thus in the most likely case, the EPA figure overestimates actual field practice by a factor between 3.1 and 16.3.

Table S1 Recommended gypsum rates for peanuts in the Southeast (Hodges et al., 1994)

State	Type	Soil Ca	Gypsum recommendation			
			lb ac^{B1}		kg ha^{B1}	
			Band[H]	Broadcast	Band	Broadcast
Alabama	Runner	Low	250[a]		280	
		Low	500		560	
		Med	250		280	
Florida	Virginia	All	800	1600	898	1795
	Runner, Spanish-seed	All	400	800	449	896
	Runner, Spanish	Low	400	800	449	896
Georgia[′]	Virginia	All	688-860	1376-1720	772-956	1544-1913
	Runner, Spanish-seed	All	344-430	688-860	386-483	772-965
North Carolina	Virginia	All	600-800	1200-1600	673-897	1346-1795
South Carolina	Virginia	All	600-800	1200-1600	673-897	1346-1795
	Runner, Spanish	All	400-500	800-1000	449-561	898-1122
Virginia	Virginia, Seed	All	600	900-1500	673	1010-1683

[H] Band widths vary by State: Alabama = 30 cm (12 in); Florida, Georgia, North Carolina, South Carolina = 45 cm (18 in); Virginia = 50 cm (20 in)
[′] Values for Georgia have been converted from Ca to equivalent pure $CaSO_4.2H_2O$
[a] When lime is applied

Assuming that half the farmers would broadcast phosphogypsum in a 2-year rotation and half would band place phosphogypsum in a 3-year rotation, the maximum average rate would be (860+267)/2 = 563 lb gypsum ac^{B1} yr^{B1}.

! ***Maximum Rate***: 600 lb phosphogypsum ac^{-1} yr^{-1}
! ***Most Likely Rate***: 125-430 lb phosphogypsum ac^{-1} yr^{-1}
! ***Minimum Rate***: 0-83 lb phosphogypsum ac^{-1} yr^{-1}

Tomatoes and Other Crops

Tomatoes and peppers also have a definite requirement for Ca which reduces the incidence of blossom-end rot that can take a heavy toll on the quality of the crop. However in most cases, leaf sprays of Ca salts in minute amounts are highly effective and seldom if ever would gypsum applications be made to the soil. Only two States (Georgia and Tennessee) have gypsum recommendations for soil application ranging from 430 to 860 lb ac^{-1}. Again these crops are highly susceptible to a wide range of diseases and for phytopathological control, rotations of these crops with others more resistant would always be practiced by farmers. Consequently, the most likely long-term annual rates would range between 215 and 430 for a two- and 143 and 287 lb ac^{-1} yr^{-1} for a three-year rotation. These values are between 3.1 and 9.4 times lower than the assumed EPA figure of 1350 lb ac^{-1} yr^{-1}.

! ***Maximum Rate***: 430 lb phosphogypsum ac^{-1} yr^{-1}
! ***Most Likely Rate***: 200-300 lb phosphogypsum ac^{-1} yr^{-1}
! ***Minimum Rate***: 0-143 lb phosphogypsum ac^{-1} yr^{-1}

Sulfur Requirements of Crops

Sulfur (S) which is an essential element for plant growth is a constituent of a number of amino acids and is therefore required for protein synthesis. Crops take up between 10 and 20 lb S ac^{-1} for normal growth. Extensive experimentation has been carried out in all States in the Southeast to determine the rate of S required to be applied to soil for optimal crop production and forms the basis of the State Recommendations complied by the Cooperative Extension Service. These recommendations which have been converted to an equivalent gypsum basis, are summarized in Table S2.

Table S2 Recommended rates of gypsum application to crops in the Southeast to supply the essential element sulfur (S)

State	Crop	Gypsum Rate (lb ac^{-1})
Alabama	All	54
Florida	Agronomic, grass	80-108
Georgia	All	54
North Carolina	Corn, small grains, cotton, tomato, bermudagrass	108-161

South Carolina	All	54

Thus the maximum recommended gypsum rate is 161 lb ac^{-1} yr^{-1} which is more than eightfold lower than the rate (1350 lb ac^{-1} yr^{-1}) assumed by the EPA in their risk assessment calculations.

! ***Maximum Rate***: 161 lb phosphogypsum ac^{-1} yr^{-1}
! ***Most Likely Rate***: 50-80 lb phosphogypsum ac^{-1} yr^{-1}
! ***Minimum Rate:*** 0 lb phosphogypsum ac^{-1} yr^{-1}

Gypsum for Subsoil Acidity Amelioration

Only a limited amount of research has been conducted in the Southeast to study the beneficial effects of gypsum on soils with acid subsoils where root penetration is limited. Most of the research has been confined to Georgia where a single 2.2-4.4 t gypsum ac^{-1} application has resulted in substantial yield responses which have been sustained over a long period of time. Because the longevity of this effect is in excess of 10 years, the recommended rate on an annual basis would be 400-800 lb gypsum ac^{-1} yr^{-1} which is at least 1.7-fold less than the assumed EPA value. At present very few farmers have attempted this amelioration strategy and because of the high initial cost in excess of $175 ac^{-1}, only very limited acreage devoted to highly remunerative crops is likely to be used in this cropping system.

! ***Maximum Rate***: 800 lb gypsum ac^{-1} yr^{-1}
! ***Most Likely Rate***: 400 lb gypsum ac^{-1} yr^{-1}
! ***Minimum Rate***: 0 lb gypsum ac^{-1} yr^{-1}

Gypsum as an Ameliorant for Soil Physical Properties

Reclamation of Sodic Soils

Although sodic soils do not occur to any appreciable extent in the Southeast, a brief overview of the gypsum requirements of these soils was made for the sake of completeness. Applications of between 7 and 35 t gypsum ac^{-1} are required to reclaim the top 20 in of a highly sodic soil (ESP =30). On an annual basis, this would correspond to applications between 140 and 700 lb gypsum ac^{-1} yr^{-1} over a 100 year period which is between 2- and 10-fold less than the EPA assumed value. However in certain cases, applications in excess of these amounts have been made to certain soils but these cases represent the exception rather than the rule.

! ***Maximum Rate***: 700 lb gypsum ac^{-1} yr^{-1}
! ***Most Likely Rate***: 200-500 lb gypsum ac^{-1} yr^{-1}
! ***Minimum Rate***: 0-200 lb gypsum ac^{-1} yr^{-1}

Crusting and Seedling Emergence

Most of the research on this aspect of gypsum use has been conducted in Georgia where, as a result of reduced crusting, substantial improvements in water entry into soils have been obtained thereby reducing runoff and erosion. Typically applications ranging between 0.5 and 2 t gypsum ac^{-1} have proven to be highly successful and currently the Cooperative Extension Service recommends 0.5-1 t gypsum ac^{-1} for this purpose. Such applications are only recommended as an interim measure in the establishment of a permanent vegetative cover of highly erosible soils. Thus, this should be considered as an application which would be made once only or at the most, once in five years in a no-till system. Thus the maximum amount of gypsum which would be applied over a 100 year period would not exceed 20 t ac^{-1}.

- ***Maximum Rate***: 400 lb gypsum ac^{-1} yr^{-1}
- ***Most Likely Rate:*** 100-200 lb gypsum ac^{-1} yr^{-1}
- ***Minimum Rate***: 10 lb gypsum ac^{-1} yr^{-1}

Mechanical Impedence

Gypsum applications to the soil surface have been shown to reduce the mechanical impedence (resistance to root penetration) of subsoil horizons as a result of improved flocculation of the clay. A single 4.4 t ac^{-1} application of gypsum was sufficient for this purpose and the effect has lasted in excess of 10 years giving a long-term application rate of about 800 lb gypsum ac^{-1} yr^{-1}. Because of the high cost involved in the initial gypsum application, very few farmers have attempted to use this strategy.

- ***Maximum Rate***: 800 lb gypsum ac^{-1} yr^{-1}
- ***Most Likely Rate***: 400 lb gypsum ac^{-1} yr^{-1}
- ***Minimum Rate***: ?

Environmental Impacts Associated with the Agricultural Use of Phosphogypsum

Application of a phosphogypsum with a high ^{226}Ra content (35 pCi g^{-1}) at the maximum rates for the different uses described above for a 100 year period would result in a maximum cumulative ^{226}Ra concentration of 1.57 nCi ^{226}Ra kg^{-1} of soil (58.0 Bq kg^{-1}) which is much lower than the 5 nCi ^{226}Ra kg^{-1} (185 Bq kg^{-1}) considered to be the upper limit of a safe range. Where phosphogypsum has been used as a source of Ca or S for crops, radiation added to the soil has, in all cases, not significantly increased native background levels. Even where a single rate of 4.45 t phosphogypsum (17.6 pCi ^{226}Ra g^{-1}) ac^{-1} was applied, no significant increases in ^{214}Pb, ^{214}Bi or ^{226}Ra could be detected anywhere in the profile of two different soils to a depth of 3 ft, 5 years after application. No significant differences in plant uptake of these radionuclides could be detected due to phosphogypsum treatment. However in a leaching experiment on a very sandy soil, elevated ^{226}Ra concentrations were found in the leachate but these concentrations were well below the maximum allowed in drinking water. Based on the scientific data, the conclusion can be drawn that there should be little concern associated with the use of phosphogypsum containing more than 10 pCi ^{226}Ra g^{-1} provided that Cooperative

Extension Service application rates are used.

Conclusions

All the soundly based experimental data strongly suggest that the phosphogypsum rate of 1350 lb ac^{-1} yr^{-1} for 100 years used by the EPA as the basis for formulating the Final Rule on phosphogypsum use, is too high. A more appropriate maximum figure would be in the range 600-800 lb gypsum ac^{-1} yr^{-1} with the most likely application rate lying in the range 100-400 lb gypsum ac^{-1} yr^{-1}.

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Mr. PUTNAM. Thank you very much, Dr. Sumner.

Our next witness is Dr. Doug Chambers. Dr. Chambers is the executive vice president and director of radioactivity and risk studies at SENES Consultants Limited which he co-founded in 1980. He has been working in the area of environmental radioactivity and risk assessment for more than 30 years and has studied both radioactive and non-radioactive substances. Dr. Chambers has worked on projects across Canada, throughout the United States and abroad. He has participated on the United Nations Scientific Committee on the effect of atomic radiation since 1998 as a member of the Canadian delegation. Dr. Chambers is currently a consultant to UNSCEAR with responsibility for preparing the next UNSCEAR assessment of radon. He has supervised and carried out numerous studies of naturally occurring radioactive material in a wide variety of industries, including studies for the Florida Institute of Phosphate Research to examine alternative potential radiological risks arising from alternate uses of phosphogypsum in agriculture, road construction and daily cover at municipal landfills.

Welcome to the subcommittee, Dr. Chambers. You are recognized.

Mr. CHAMBERS. Thank you very much.

As noted by Mr. Lloyd, the 1989 NESHAPS in effect converted phosphogypsum from a useful byproduct to a waste and the focus of the concern here was the radioactivity in the phosphogypsum, which is the same as the radioactivity in the phosphate rock and is naturally occurring.

In 1992 EPA did a reconsideration which allowed alternative uses with prior EPA approval. To my knowledge, I am not aware of any such uses having been approved to date. The EPA commented that the risk from indoor radon and direct gamma radiation were the issues of major concern at that time.

In their 1992 rule in deciding on the maximum acceptable level of radium-226 which they determined to be 10 picocuries per gram, the Environmental Protection Agency used a lifetime risk of 3 in 10,000. I will come back to that in a moment. It is interesting to note that in addition to the 1992 rule, the EPA has used the same lifetime risk of 3 in 10,000 to establish cleanup levels for unrestricted use in CERCLA Superfund sites which have been contaminated with radioactivity. This rule, I believe, specifically excludes the risk from radon in that factor.

Another important consideration in looking at the EPA's 1992 rule is the rate of which phosphogypsum is assumed to be applied. I cannot compete with Dr. Sumner in that regard. I think I will basically compress my comment to the following: If you use a reasonable maximum application of perhaps 900 pounds then following no other changes in EPA's 1992 risk assessment you could then have unrestricted use of phosphogypsum containing up to 40 picocuries per gram by that simple change in the application rate to something that is more appropriate as opposed to an application rate of 2,700 pounds.

In their 1992 analysis, the EPA assumed a lifetime of 70 years of exposure, and yes, that is indeed possible but it is highly unlikely. In their Exposure Factors Handbook, a document prepared by EPA based on national data and surveys, EPA for other risk as-

sessments recommends a duration of exposure of 30 years, which according to the EPA is the upper 95th percentile. In other words, only 5 people out of 100 might live longer in a single home than 30 years.

It is also interesting to note in their 1999 assessment of the risk from nonradioactive contaminants contained in agricultural fertilizers, the EPA used the average residency of a farmer of 17 to 18 years, also taken from their Exposure Factor Handbook. There is an inconsistency in this regard. I do not have time to go into the details but there is much more in my written presentation.

I would briefly like to comment on risk assessments we have done in support of FIPR's application for road construction, land use, agricultural application of phosphogypsum, daily soil cover for landfill. To comment that when you use distributions of parameters to take account of natural variability and uncertainty the numbers are very different. And we calculate using numbers that are generally traceable and would be consistent with many of EPA's risk assessments, upper risks that are below 1 in 10,000, well within the EPA's risk range from 1 to 3 in 10,000. I think this is very important. These numbers that we calculate would be for a person who lives in a home built on either a road that had been constructed with phosphogypsum or on land to which phosphogypsum had been applied for 100 years. We believe the maximum risk would be less than 1 in 10,000, much less even than the 3 in 10,000 risk limit that EPA has used. I believe it would be unfortunate to preclude beneficial and safe uses of phosphogypsum by unnecessarily conservative risk assessments.

Thank you very much.

[The prepared statement of Dr. Chambers follows:]

Submitted to The Government Reform Committee's Subcommittee on Technology, Information Policy, Intergovernmental Relations and the Census

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Summary

Prior to 1989, phosphogypsum was sold for agricultural use in central and north Florida and elsewhere in the United States. The December 1989 National Emission Standards for Hazardous Air Pollutants (NESHAPS) regulation specifically required that phosphogypsum be disposed of in stacks or mines and prohibited alternative uses of phosphogypsum in construction, agriculture or other uses, in effect, converting phosphogypsum from a beneficial by-product to a waste.

Subsequently, in a 1992 rulemaking, the Environmental Protection Agency (EPA) decided to allow the use of phosphogypsum in agriculture provided that the average radium-226 content was less than 10 pCi/g. The 1992 rule also allowed for the use of discrete amounts of phosphogypsum (up to 700 lbs) for specific research applications and for other uses on a case-by-case basis with the prior approval of the EPA. We are not aware that any such alternative uses have been approved to date. Subsequently, a 1999 reconsideration increased the amount of phosphogypsum that could be used for specific research applications to 7000 lbs.

The Florida Institute of Phosphate Research (FIPR) has carried out considerable research in support of a variety of beneficial alternative uses of phosphogypsum. Several of the FIPR evaluations have been supported by risk assessments conducted by SENES Consultants Limited. As is shown in the main body of this submission, none of the risk analyses carried out to date by EPA have specifically considered the factors and conditions that would apply to the beneficial use of phosphogypsum in Florida. Moreover, the risk assessments carried out to date by the EPA for the alternative uses of phosphogypsum use assumptions that are unnecessarily conservative. Several examples are provided in the submission.

When still conservative, but more reasonable, assumptions are used in the risk assessments for alternative uses of phosphogypsum, the risks estimated to a maximally exposed individual (who for example is assumed to build a home on a field where phosphogypsum has been applied for 100 years) are found, with a high degree of confidence, to be below the EPA's range of acceptable lifetime risk from 1 to 3 x 10^{-4}.

In addition, the doses (and risks) to the maximally exposed individual are predicted to be small with respect to the variation in natural background radiation which is unavoidable. In my opinion, potential radiological risks arising from alternative uses of phosphogypsum as for example, those proposed by FIPR, including in agriculture, in road construction and for daily cover at a municipal landfill are small and should not prevent such suitable beneficial uses of phosphogypsum.

1.0 Introduction

Phosphogypsum is a by-product of the production of phosphoric acid for the fertilizer industry. Phosphogypsum contains naturally occurring radioactivity, the same radioactivity that is present in the phosphate ore from which phosphogypsum is derived.

Prior to December 1989, phosphogypsum was considered an item of commerce and sold for agricultural use in central and north Florida and throughout the United States at locations where it was manufactured. The off-site use of phosphogypsum was prohibited by the final National Emissions Standards for Hazardous Air Pollutants (NESHAPS) for radionuclides promulgated in 40 CFR Part 61, Support R, National Emission Standards for Radon Emissions from Phosphogypsum Stacks (54 FR 51654 December 15, 1989). This rule required (as of March 15, 1990) that phosphogypsum be disposed of in stacks or mines and prohibited alternative uses of phosphogypsum in construction, agriculture or research and development. In effect, the December 1989 rule converted phosphogypsum from a useful by-product to a waste.

Subsequently, the Environmental Protection Agency (EPA) reconsidered the portion of Subpart R that required all phosphogypsum to be disposed in stacks or mines. On June 3, 1992, the EPA issued its decision on the reconsideration and adopted a final rule (FR Vol.57 No.107 pp.23305-23320) which:

1. Allowed distribution of phosphogypsum in agriculture, provided the phosphogypsum contains less than 10 pCi/g of radium-226;
2. Allowed, with prior EPA approval, the use of discrete amounts (up to 700 lbs) of phosphogypsum for specific R&D activity; and
3. Permitted other uses of phosphogypsum on a case-by-case basis with prior EPA approval.

In their June 1992 rulemaking, the EPA stated that the 10 pCi/g limit on the average radium-226 (Ra-226) concentration in phosphogypsum is intended to *"assure that the risk from indoor radon and direct gamma radiation exposure in residences constructed on land previously treated with phosphogypsum do not exceed an acceptable level"* (ibid at 23305). In discussing the basis for the limit of 10 pCi/g Ra-226 in phosphogypsum, the EPA indicate that phosphogypsum applied at the upper 95th percentile application rate in the United States, would result in a maximum individual lifetime risk from indoor radon and direct gamma exposure of 3×10^{-4} (ibid at 23312) suggesting that EPA considers a maximum individual lifetime risk of 3×10^{-4} to be "acceptable".

In essence, the 1992 rule allowed the use of phosphogypsum from north Florida and North Carolina for agriculture and research and development and prohibited all other uses. EPA determined that the use of phosphogypsum in road construction was not acceptable since the maximum individual risk was always greater than the *"outer bound of the presumptively safe level of approximately 1 x 10^{-4} "* (ibid 23312).

Subsequently, the EPA revised Subpart R in 1999 (64 FR 5574, February 3, 1999) to increase the limit from 700 to 7000 pounds of phosphogypsum used for indoor research and development, eliminated sampling requirements for phosphogypsum used in indoor research and development, and clarified the sampling procedures for removal of phosphogypsum from stacks for other purposes.

The Florida Institute of Phosphate Research (FIPR) has studied a number of potential beneficial uses of phosphogypsum, including among others, its use in agriculture, in road construction and as a daily cover for a sanitary landfill. In support of FIPR's work to develop safe and beneficial alternative uses of phosphogypsum, FIPR retained SENES to carry out independent evaluations of the potential radiological risks associated with various potential alternative uses of phosphogypsum.

In the remainder of this submission, I present overview comments on the evolution of the EPA's regulatory position on phosphogypsum, various aspects of EPA's risk assessments in support of their rulemaking, and selected observations from SENES risk assessments.

2.0 Regulatory Evolution

The National Emission Standards for Hazardous Air Pollutants (NESHAPS) were based on the framework outlined in the 1987 "vinyl chloride decision" (as referenced by 57 FR 23305, June 3, 1992). The "vinyl chloride decision" requires the administrator to use judgement under Section 112 of the Clean Air Act for radionuclide emissions in two steps:

1. Determine a "safe" or "acceptable" level of risk considering only health factors; and
2. Provide an "ample margin of safety, where the costs, feasibility, and other relevant factors in addition to health are considered.

The EPA implemented the "vinyl chloride decision" in the 1989 NESHAPS for Benzene (54 FR 38044, September 14, 1989). This NESHAPS established the "Benzene Policy" and set the specific criteria used by EPA for determining the safe level of risk under Section 112 of the Clean Air Act. The "Benzene Policy" includes the requirement that NESHAPS must protect the individual receiving the highest lifetime risk to a level of 1 in 10,000 (1 x 10^{-4}).

The EPA issued the first NESHAPS for radon emissions from phosphogypsum (PG) stacks on December 15, 1989 (54 FR 51654). This NESHAPS required that all PG be disposed of in stacks or in mines with all off-site use of PG prohibited, including PG use

in agriculture, road construction or research and development. Additionally, this NESHAPS set a radon flux standard of 20 $pCi/m^2/s$ for PG stacks.

After issuing the NESHAPS for radon emissions from PG stacks, EPA received petitions requesting reconsideration of the standards in order to permit alternate methods of PG disposal. Due to the potential impacts of farmers, researchers and other users of PG, EPA issued a Notice of Limited Reconsideration on April 10, 1990 (55 FR 13480) and a limited class waiver that would allow the use of PG for agricultural application during 1990, which was extended until June 1, 1991 (55 FR 40834) and further extended to October 1, 1991 (56 FR 23519). After October 1, 1991, all individuals possessing PG stacks became subject to the work practice requirements in subpart R of the NESHAPS for radon emissions from PG stacks; however, at the time of issuing the Notice of Limited Reconsideration, EPA issued a proposed rule concerning radon from PG stacks (55 FR 13482) with the following 4 options (EPA, May 1992):

1. *Retain Subpart R as promulgated on December 15, 1989;*
2. *Establish a threshold level of radium-226 which would further define the term "phosphogypsum",*
3. *Allow, upon EPA approval, use of discrete quantities of phosphogypsum for the research and development to processes to remove radium-226 from phosphogypsum, to the extent that such use is at least as protective of public health as is disposal of PG in stacks or mines; and/or*
4. *Allow, upon EPA approval, other alternative use(s) of phosphogypsum to the extent that such use(s) is at least as protective of public health as is disposal of phosphogypsum in stacks or mines.*

On June 3, 1992, EPA issued a final rule NESHAPS for 40 CFR Part 61 Subpart R (57 FR 23305) that allowed PG to be used in the following three categories:

1. Outdoor agricultural uses, provided that the certified average Ra-226 concentration in PG doesn't exceed 10 pCi/g (it should be noted that EPA determined the 10 pCi/g limit by assuming a maximum individual risk (MIR) of 3×10^{-4});
2. Indoor research and development (R & D) activities, provided facilities don't use more than 700 pounds of PG for a particular R & D activity and warning labels are in place; and
3. Other alternate uses that are approved by the EPA on a case-by-case basis.

Although this NESHAPS states that the *"risks represented by uses of phosphogypsum in which the MIR does not exceed the presumptively safe level of approximately 1×10^{-4} are acceptable"* (ibid p. 23311), it is further stated that ***"in the case of phosphogypsum, considering all of the information available on potential exposures and the associated risks, as well as the uncertainties inherent in deriving risk estimates, EPA has concluded that certain uses of phosphogypsum may be considered acceptable so long as those uses are restricted to limit the estimated lifetime risk to any individual to no more than 3 in 10 thousand."*** (ibid p23311-23312). [Emphasis Added]

After issuing the 1992 Final Rule (57 FR 23305), EPA received petitions regarding the revision to Subpart R and issued a further revision on February 3, 1999 (64 FR 5574) with the following three changes (effective April 5, 1999):

1. Increased the limit on PG quantity that can be used for indoor R&D from 700 to 7,000 pounds,
2. Eliminated current sampling requirements for PG used in indoor R&D; and
3. Clarified sampling procedures for removal of PG from stacks for other purposes.

The increased limit on PG quantity used in indoor R&D was revised since the EPA determined that there were calculation errors in the amount of Rn-222 (radon) that would be present in a laboratory with PG used for indoor R&D. Therefore, EPA revised three assumptions in the calculation of the revised limit (7000 pounds of phosphogypsum), which included, decreasing the number of phosphogypsum drums opened at one time from five drums to one drum, decreasing the amount of radon that actually emanates from phosphogypsum into ambient air of laboratory by incorporating ventilation, size of laboratory and effect of moisture, and decreasing the number of hours spent in the laboratory by the researcher from 4000 hours per year to 1000 hours per year (ibid p 5575). Additionally, the sampling requirements were removed since Subpart R doesn't contain a corresponding limit on Ra-226 in PG when it's used for indoor R&D activities. Furthermore, the sampling procedures were clarified to establish the level of statistical uncertainty that is allowed in measurements of Ra-226 in PG.

3.0 EPA's Risk Assessments for Alternative Uses of Phosphogypsum

3.1 1992 Reconsideration

In support of their 1992 reconsideration, the EPA used the PATHRAE dose assessment model to evaluate the *"incremental increases in the maximum individual risk associated with the use of phosphogypsum in agriculture, road construction, and research and development activities"* (FR Vol.57 No.107, p.22308).

The EPA modeled eight pathways of potential radiation exposure including: groundwater migration to a river, groundwater migration to a well, erosion and transport to a river, food grown on-site, direct gamma radiation, on-site dust inhalation, inhalation of radon in structures, and atmospheric transport of contaminants. Maximum individual lifetime risks from one year of exposure were obtained from the PATHRAE dose assessment results using the risk conversion factors in EPA's Environmental Impact Statement for radionuclide NESHAPS (EPA, May 1992).

In addition, the EPA used a different code, MicroShield, to augment the PATHRAE model in order to assess the potential exposure to gamma radiation from people carrying out experimental analysis.

In total, the EPA assessed twelve exposure scenarios[1]: seven agricultural scenarios, four road construction scenarios and one research scenario. In carrying out their assessment, the EPA calculated individual annual dose and subsequently lifetime risk based on the annual dose and an assumed 70-year exposure period.

Figure 1 of the 1992 rulemaking [FR Vol. 57 No.107, p. 23310] shows a curve that is generated from plotting the combinations of Ra-226 content and phosphogypsum application rate that yield an estimated maximum lifetime individual risk of 3×10^{-4}. The EPA noted that *"If the point representing a given Ra-226 content in phosphogypsum and a given application rate for phosphogypsum is located within or on this curve, the corresponding lifetime individual risk from exposure to gamma radiation and radon inhalation will not exceed the presumptively safe level."*. (ibid p. 23309)

In deciding on an acceptable level of risk from the use of PG in agriculture, the EPA estimated the upper 95th percentile of the phosphogypsum application rate. This estimate was based on the application rates reported **for various crops in California and for peanut crops in Georgia**. The curve in Figure 1 of the 1992 rulemaking discussed above was then used to identify the Ra-226 concentration in phosphogypsum that, when applied at the upper 95th percentile application rate (approximately 2,700 pounds per acre) would result in a maximum individual risk from indoor radon inhalation and direct gamma exposure of 3×10^{-4}. By this procedure, the EPA arrived at the limiting Ra-226 value of 10 pCi/g.

For the road construction scenarios analyzed by EPA, the use of phosphogypsum always resulted in a MIR greater than the outer bound of the presumptively safe level of approximately 1×10^{-4}.

In the risk estimates for the research and development scenario, the EPA determined that limiting the amount of phosphogypsum utilized in any research and development activity to 700 pounds (one 55 gallon drum) would correspond to a maximum individual risk to researchers over the time periods evaluated to 2.1×10^{-4}. This is within the range of risks that has been determined to be acceptable for other radionuclide NESHAPS categories.

3.2 1999 Reconsideration

As noted previously, the 1999 reconsideration increased the limit for use in indoor R&D activities from 700 to 7000 pounds.

[1] The EPA provides greater detail on their risk assessment methodology in the Background Information Document (BID) "Potential Use of Phosphogypsum and Associated Risks, Background Information Document" May 1992 (EPA 402-R92-002).

3.3 Selected Comments on EPA's Risk Assessment

EPA Lifetime Risk of 3×10^{-4}

As stated in the 1992 Final Rule NESHAPS for radon emissions from phosphogypsum stacks (Section 2.0, Regulatory Evolution), the EPA determined that for certain uses of PG the emissions corresponding to a 70 year lifetime risk with a 100 year biennial application period could be up to 3×10^{-4} (slightly higher than the presumptively safe level of 1×10^{-4}). Furthermore, EPA used the 3×10^{-4} risk to calculate the 10 pCi/g Ra-226 concentration limit allowed for the outdoor agricultural use of PG.

Additionally, EPA used the slightly increased lifetime risk for PG (3×10^{-4}) to establish the cleanup levels for the CERCLA sites with radioactive contamination in 1997. EPA concluded that an effective dose equivalent of 15 mrem/year (exclusive of radon) calculated from a site-specific dose assessment would be the maximum dose limit, and this dose corresponded to a lifetime risk of approximately 3×10^{-4}. [EPA, 1997a]

In May 1994, the EPA issued a working draft of radiation site clean-up regulations (EPA 1994). The proposed regulations (which to our knowledge have not been to date finalized or promulgated) set standards for the remediation of soil, groundwater, surface water, and structures at federal facilities contaminated with radioactive material that would allow these sites to be released for public use. The proposed regulations limit the doses received by members of the public to 15 mrem/year in excess of natural background levels for 1000 years after completion of the clean-up. In addition, the proposed 15 mrem/year limit excludes the dose from radon progeny.[2]

Application Rate

The potential risks resulting from the use of PG in agriculture are directly proportional to the assumed application rate.

Based on the risk assessment described in the 1992 Background Information Document (BID, EPA 1992) supporting their ruling on PG uses, the EPA ascertained that a biennial application rate of 900 lbs/acre for 100 years lead to a lifetime risk of approximately 1×10^{-4} (or 1 in 10,000). Trovato (1995) notes that the 900 lbs/acre rate is somewhat higher than many of the rates reported in a survey of PG use in agriculture in the southeast U.S.

The EPA derived a nationwide 95th percentile value for the application rate, or 2700 lbs/acre biennially i.e., the actual application rate used across the country in

[2] Doses due to radon were excluded from the draft U.S. EPA clean-up criterion. However, all existing and future buildings on the remediated sites would be required to meet the guidelines of the U.S. EPA radon program i.e., radon levels must be below 4 pCi/L.

95% of the cases would be less than this value. The corresponding lifetime risk of 3×10^{-4} was considered by the EPA to be the highest likely risk from the application of PG and was considered acceptable as a limiting risk.

Clearly, the use of more reasonable application rates specific to Florida would result in lower estimated risks. Based on the 1992 BID assessment (and Travato), an upper range biennial application rate of 900 lbs/acre at a Ra-226 concentration of 30 pCi/g, rather than 10 pCi/g, would be consistent with a lifetime risk limit of 3×10^{-4}.

Years of Fertilizer Application

EPA's risk assessment assumes 100 continual years of application. This seems highly unlikely for any particular site. Furthermore, the chance that the 95th percentile application rate would be used at a particular site for 100 years is vanishingly small.

Exposure Duration

In deriving the limiting concentration of 10 pCi/g radium in PG, the EPA risk assessment assumed a lifetime (70 y) of exposure to a site to which PG had been applied for 100 years at the likely maximum rate. However, very few people ever live at the same location for their entire lifetime.

Based on a review of several surveys and reports on the activities of the American public, the EPA Exposure Factors Handbook (1997b) recommends a value of 30 y, which is the 95th percentile for a family to reside in a single home; the central value is given as 9 y. The central residence time given for a farm residence in the same reference is about 17-18 y. Indeed, the EPA's own assessment of the risks from contaminants (non-radioactive) contained in agricultural fertilizers used this latter value (EPA 1999).

Using 17-18 y rather than 70 y as the duration of exposure would lower the estimated mean lifetime risk by about a factor of 4 (i.e. 70/17.5). Correspondingly, all other factors being equal, a radium concentration as high as 40 pCi/g would result in a lifetime risk of 3×10^{-4}, the same risk considered acceptable by the EPA in their PG rule making.

4.0 FIPR's Risk Assessments

FIPR has been carrying out research on a variety of potential alternative (to disposal in stacks and mines) uses of phosphogypsum, including among others, as an agricultural soil amendment, for use in road construction (as an alternative or complement to traditional borrow material) and as a landfill cover. In support of these research activities, SENES has carried out a number of radiological risk assessments, from which the following comments have been extracted.

4.1 Roads and Agriculture

In 1995 FIPR called for more realistic risk assessments (than those carried out by EPA) of the recognized hazards so that industry, the public and the regulators could make informed decisions based on facts.

The objective of a 1998 SENES risk assessment (SENES 1998) was to develop an updated methodology, and to use it to determine the radiological implications of PG use in agriculture and road construction in Florida and, using the updated methodology, to determine if the lifetime risk to a reasonably maximally exposed individual (MEI) is below the regulatory benchmark of 1×10^{-4} to 3×10^{-4}.

With the help of FIPR, available data, especially that relevant to Florida, was identified. Florida-specific data considered in the SENES study included, but was not limited to, information on: radon in homes, local soil types, moisture contents, depth to water table, near-by housing, water usage, agricultural practices and road construction methods.

(i) Deterministic Screening Analysis

Screening calculations incorporate conservatisms which result in predicted doses and risks exceeding the likely doses and risks to which people might be exposed. Screening calculations of incremental dose and risk attributable to radionuclides in PG from all potentially significant exposure pathways were carried out using simple models and deterministic methods (i.e. a single value for each of the parameters). The models and parameter values were selected to ensure that predicted doses and risk were unlikely to underestimate the doses and risks to which people might be exposed. Those pathways for which conservative screening risk estimates exceeded 10% of the risk criterion of 3×10^{-4} for the maximum exposed individual (MEI) were identified for more focussed and detailed evaluation.

The magnitude of the conservatism is illustrated in a qualitative manner by identification of the parameter values that tend to overestimate dose and risk. By comparison of the results of screening calculations to the results of the focussed calculations, the magnitude of the conservatism could be quantified.

For both roads constructed with PG and agricultural land amended with PG, the EPA estimated radiation doses and risks from one year of exposure to workers, and to members of the public on or living near the affected area. The results are reported in the BID (EPA, 1992) as risk from one year of exposure and are multiplied by the number of years of exposure (according to the EPA 70 years) to calculate risk values for a lifetime of exposure.[3]

[3] As a consistency check, SENES were asked to reproduce the EPA's result in the 1992 BID using the same parameter values.

Seven pathways by which on-site residents (residents in a house built on a field to which PG had previously been applied) may be exposed to radiation from and radioactivity in PG were considered in the screening analysis carried out by SENES:

- external gamma radiation - residents living in a house would be exposed to external gamma radiation from the radioactivity in the PG;
- inhalation of radon progeny - two radon pathways were evaluated, 1) some of the radon (Rn-222) gas produced by the Ra-226 in the PG will escape into the atmosphere above the field. The gas will be dispersed by the wind, radon progeny (Po-218 to Po-214) will grow in from the radioactive decay of radon, and residents will be exposed both inside and outside the residence; and 2) some of the radon gas produced by the Ra-226 in the PG under the house will be transported by diffusion and mass flow into the house to expose the residents;
- inhalation of resuspended dust - the wind will resuspend dust containing radionuclides from PG which may be inhaled by the resident;
- ingestion of dust - dust containing radionuclides from PG may become fixed to residents hands and other surfaces from which it may be ingested;
- ingestion of (irrigated) locally grown food - radionuclides in the PG may accumulate on produce and crops due to the deposition of dust from the field. Root uptake by plants may also result in radionuclides in plants. Radionuclides may also be transported by infiltrating rainwater from the field into the groundwater and to a well at the residence. Residents may irrigate a home garden and consume the fruit and vegetables. Residents may also use the well water to irrigate crops fed to livestock and to water the livestock. Soil ingested by animals during grazing is also considered in this pathway. Consumption of these animal products may transfer radionuclides from the PG to the residents;
- ingestion of contaminated well water - residents may consume water from the local well; and
- ingestion of fish - fish from an on-site pond may develop concentrations of radionuclides in their flesh.

The predicted effective doses to the on-site resident from one year of exposure to radionuclides in PG are listed in Table 1. The predicted dose from one year of exposure from all pathways was 53 mrem, and the single largest component was from inhalation of radon progeny (83% at 44 mrem/y). The predicted incremental lifetime risks of fatal cancer to the on-site resident from lifetime exposures are also summarized for each pathway in Table 1. The predicted lifetime risk (from 30 years of exposure) from all pathways was 8×10^{-4} (for 70 years of exposure, the risk would be $8 \times 10^{-4} \times \frac{70}{30} = 1.9 \times 10^{-3}$). The predicted risks from external gamma and the inhalation of radon progeny each exceeded the threshold of 3×10^{-4}. Therefore, both of these pathways were identified for detailed assessments as briefly described below.

Table 1
SCREENING RESULTS FOR DOSE AND RISK TO ON-SITE RESIDENT

Pathway	Annual Dose mrem/y	Risk from Lifetime Exposure*
External gamma radiation	3.7	6×10^{-5}
Inhalation of radon progeny	44	7×10^{-4}
Inhalation of resuspended dust	0.012	2×10^{-7}
Ingestion of dust	0.07	1×10^{-6}
Ingestion of well water	1.3	2×10^{-5}
Ingestion of fish	1.2	2×10^{-5}
Irrigated garden produce	1.8	3×10^{-5}
Irrigated animals products	0.52	8×10^{-6}
Total	53	8×10^{-4}

* 30 years of exposure

The potentially most exposed individuals were found to be the person who was assumed to live in a home constructed on a field after PG had been regularly added as a soil amendment or fertilizer for a period of time or on a reclaimed road which had been built using PG. The predominant pathways were found to be exposure to external gamma radiation and to indoor radon. The following example of dose (and risk) to a person who lives in a house built on a field treated with PG for 100 years is provided as an example.

(ii) Probabilistic Analysis

For more detailed evaluation, SENES (1998) adopted a probabilistic modelling methodology which takes account of natural variability and uncertainty to provide the most likely result and a probability distribution other possible results. With such a distribution of possible results, the level of confidence in the dose or risk is calculated. This information helps in the formulation of a reasonable decision regarding the acceptable levels of dose and risk. Such approaches, which attempt to account for uncertainty and variability, are widely used for risk assessments.

In the SENES (1998) analysis, the upper 95th percentile from the lifetime risk distribution was used to estimate the lifetime risk to the MEI and therefore, this MEI value was assumed to represent the reasonably maximum lifetime risk from within the exposure groups expected to have the highest lifetime risks.

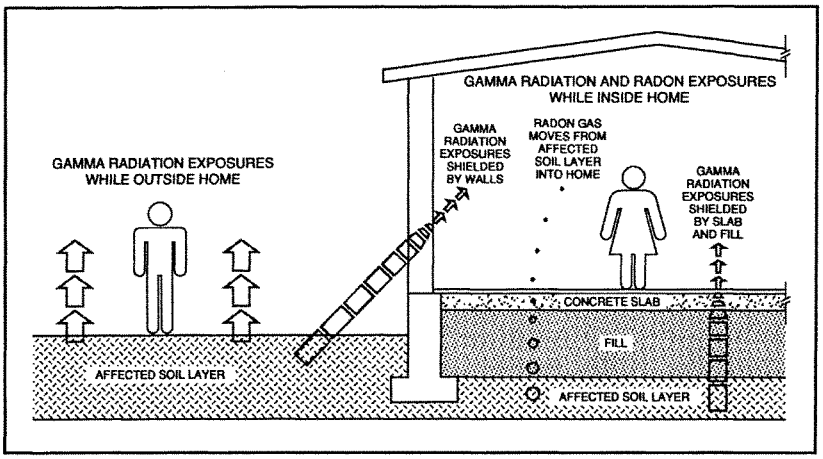
The exposure to residents of homes built on land that was previously used to grow crops and where PG had been applied for its agronomic benefits was assessed in detail. As suggested by Table 1, indoor radon and gamma radiation are the primary dose contributors and doses from other pathways can be considered negligible compared to indoor radon and gamma radiation pathways.

Incremental radium-226 levels in the affected soil layer were calculated using PG radium concentrations and representative application rates for growing peanuts. Application rates for other crops in Florida are generally lower than the application rate for peanuts.

Figure 1 shows a conceptual model of the gamma radiation and indoor radon pathways. Gamma radiation exposures were calculated for indoor and outdoor locations and incorporated the amount of time spent indoors and outdoors. Indoor gamma radiation exposures were modelled to include both geometry effects and shielding of the outdoor gamma radiation by the structure.

Figure 1

EXPOSURES TO RESIDENT OF HOME ON AFFECTED SOIL



For the on-site resident, partial excavation of the affected soil layer was modelled prior to construction and the houses were assumed to be slab-on-grade. Incremental indoor radon levels were predicted from the affected soil layer using a two step method. First, soil gas levels are estimated and then an empirically derived transfer factor was used to predict indoor radon levels as a function of soil gas levels.

Annual doses and risks were calculated based on exposure rates estimated for the residents. Lifetime risks are based on a distribution of occupancy that reflects the typical range of time people stay at a residence.

Table 2 and Figure 2 shows summary statistics from the probabilistic assessment. The table shows the mean value, the 95th percentile and other statistics. The 95th percentiles are considered to represent the reasonably maximum exposed individual (MEI) and reflect the upper end of the range of potential risk that may be compared to an acceptable risk level.

Table 2
SUMMARY OF PROBABILISTIC ANALYSES FOR AGRICULTURAL USE SCENARIO

	Units	5th Percentile	Median	Mean	95th Percentile
100 y of PG application					
Ra-226 Concentration in Soil	pCi g^{-1}	0.16	0.34	0.36	0.64
Years at Site	Y	1.0	8.9	11.4	30.0
Gamma Radiation Pathway					
Exp. (Indoor)	μR hr^{-1}	0.10	0.22	0.24	0.45
Exp. (Combined	μR hr^{-1}	0.12	0.27	0.29	0.53
Annual Dose	mrem y^{-1}	0.4	1.0	1.1	2.2
Lifetime Risk from One Year Exposure		$2.2x10^{-7}$	$5.2x10^{-7}$	$5.7x10^{-7}$	$1.1x10^{-6}$
Lifetime Risk		$4.4x10^{-7}$	$4.4x10^{-6}$	$6.5x10^{-7}$	$2.0x10^{-5}$
Years at Site x Risk from 1 year					
Radon Pathway					
Radon (Indoor)	pCi g^{-1}	0.007	0.033	0.050	0.149
RDP Dose (Indoor)	WLM y^{-1}	$9.5x10^{-4}$	$4.5x10^{-3}$	$7.0x10^{-3}$	$2.1x10^{-2}$
Annual Dose	mrem y^{-1}	0.4	1.8	2.8	8.4
Lifetime Risk from One Year Exposure		$1.9x10^{-7}$	$9.1x10^{-7}$	$1.4x10^{-6}$	$4.2x10^{-6}$
Lifetime Risk		$5.5x10^{-7}$	$7.5x10^{-6}$	$1.6x10^{-5}$	$5.8x10^{-5}$
Combined Pathway					
Annual Dose	mrem y^{-1}	1.00	3.00	3.90	9.90*
Lifetime Risk from One Year Exposure		$5.2x10^{-7}$	$1.5x10^{-6}$	$2.0x10^{-6}$	$4.9x10^{-6*}$
Lifetime Risk		$1.1x10^{-6}$	$1.3x10^{-5}$	$2.3x10^{-5}$	$7.4x10^{-5*}$

* Please note that the 95th percentiles in such an analysis are not additive and the 95th percentile values reported under "combined" are the appropriate values to consider.

Selected comments are presented below.

Radium-226 Concentration in Affected Soil Layer

The predicted (incremental) Ra-226 concentrations in the affected soil layer were 0.36 and 0.64 pCi g^{-1} for the mean and 95th percentile values, respectively, based on 100 year duration of PG application before the house was built. These incremental values are in the lower range of natural soil Ra-226 concentrations for Florida.

Gamma Radiation Pathway

The mean outdoor gamma radiation exposure above the affected soil was 0.73 μR h^{-1} and the 95th percentile value was 1.31 μR h^{-1} (SENES 1998). The primary component of indoor gamma radiation exposures was gamma radiation from affected soil outside the house. The house walls provided some shielding,

and most of the gamma radiation emitted by the affected soil located below the slab was attenuated by the fill and concrete slab. Indoor gamma exposure rates were 0.24 and 0.45 $\mu R\ h^{-1}$ for the mean and 95th percentile values, respectively. Since a higher proportion of time at a residence is spent indoors rather than outdoors, the average (indoor and outdoor durations) gamma exposure rate was closer to the indoor rate than to the outdoor rate and average values ranged from 0.29 for the mean to 0.53 for the 95th percentile.

Radon Pathway

Indoor radon levels were highly variable. The mean incremental radon level was 0.050 pCi L^{-1} and the 95th percentile value was about three times larger (i.e. 0.149 pCi L^{-1}). These incremental increases in indoor radon level are relatively small fractions of the mean indoor radon level, 1.0 pCi L^{-1}, measured in Florida slab-on-grade homes (GEOMET 1987).

Dose and Risk

The 95th percentile annual dose rate from the gamma radiation pathway was 2.2 mrem y^{-1} based on a application of PG for 100 years before the home was built. This value is about 25% of the estimated 95th percentile dose, 8.4 mrem y^{-1}, from the indoor radon pathway. The 95th percentile combined dose, from gamma radiation and indoor radon, was 9.9 mrem y^{-1}, which can be compared to the EPA's 15 mrem/y limit (exclusive of radon).

These dose rates lead to a 95th percentile risk value of 4.9×10^{-6} from living for one year in the house from the combined pathways. The 95th percentile value for lifetime risk from a lifetime of exposure (30 years) was 7.4×10^{-5}. This value is lower than the EPA's acceptable risk level of 3×10^{-4}.

Radon is the dominant contributor to dose and it must be acknowledged that some uncertainty is present with respect to the radon modelling component. The empirical factor used in the SENES analysis represents Florida slab-on-grade homes in 1986 and where actions were taken to reduce the air exchange rate (closed-room or closed home protocols) during the measurements. The empirical method implies that homes built in the future will have a similar relationship between indoor radon and soil gas radon.

There has been a tendency towards energy efficient homes and newer homes that will potentially have lower air exchange rates than found in the homes surveyed in the GEOMET study. However, there is increased consideration about indoor air quality and construction techniques that reduce transfer of soil gas, including radon into the buildings will potentially be more common in the future. These are counteracting effects. In our opinion, these anticipated developments, in combination with the reduced ventilation protocol implemented during the

GEOMET measurements, should result in the empirical model providing reasonable predictions of indoor radon levels in Florida homes built in the future.

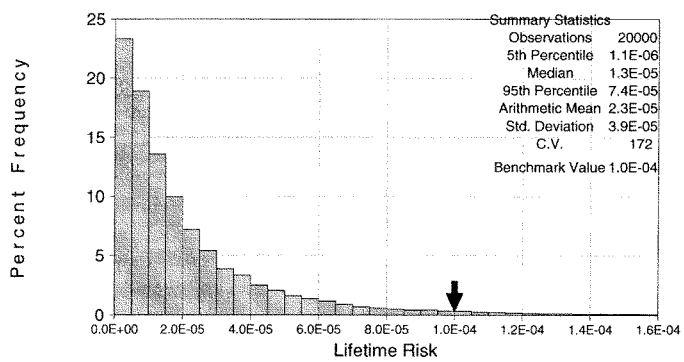
Context

Background terrestrial gamma radiation levels range from 3.2 to 62.4 $\mu R\ h^{-1}$ in a state-wide survey of Florida homes (GEOMET 1987). Most locations had gamma radiation levels below 10 $\mu R\ h^{-1}$, with 8.2 $\mu R\ h^{-1}$ being the 95th percentile and 6.1 $\mu R\ h^{-1}$ the mean value. Based on this value, the mean annual dose from continuous exposure to terrestrial gamma radiation (assuming equal indoor and outdoor rates) is about 32 mrem y^{-1}.

Indoor radon levels showed substantial variability across the State with values ranging from 0.2 to 32.4 pCi L^{-1} as measured in the GEOMET survey. The mean indoor radon level was 1.0 pCi L^{-1}; this concentration corresponds approximately to an annual indoor exposure of about 0.16 WLM which converts to an annual dose of about 64 mrem/y.

Thus average annual dose, from natural background terrestrial gamma radiation and indoor radon, is estimated at about 96 mrem y^{-1} or an lifetime risk level due to natural background terrestrial gamma radiation in Florida is approximately 3.4 x 10^{-3} (based on 96 mrem y^{-1} times a risk factor of 5×10^{-7} per mrem times a 70 year lifetime), more than 10 times larger than the 1.0 to 3.0 x 10^{-4} benchmark considered in this study.

Figure 2
TOTAL LIFETIME RISKS TO RESIDENTS FOR AGRICULTURAL SCENARIO



4.2 Landfill Daily Cover

In April 2002, an application for exemption was submitted to the EPA in order to obtain EPAs approval for a specific alternate use of phosphogypsum namely, to use PG as a landfill cover material in a test cell at the Brevard County Landfill, in Cocoa, Florida (SENES 2000). The test cell is proposed to be approximately 60' by 20' and to a depth of 10'. The PG would be used as a daily cover over municipal solid waste. Overall, a total of approximately 25 tons of PG was proposed to be used for the test cell.

Risks were estimated for four categories of receptors: landfill workers, PG researchers investigating the test cell during the experimental period, an on-site resident that could in the distant future live in a house that is located on the land that was previously the landfill site, and a resource recovery worker that digs into the former landfill to recover materials that remain.

Without going into details, the largest potential risks were estimated for the on-site resident who built a home on the test cell in the future. Other potential receptors under this scenario are not expected to result in as high exposures as those for the residential and occupational receptors. Other possible receptors that are reasonably expected to receive a lower dose and risk related to potential land use such as parkland, golf courses, agriculture, industrial/commercial development, etc.

Table 3 shows that all receptors and pathways are below EPA's presumptively safe risk level (which we take to be a lifetime risk of 3×10^{-4}). For all receptors except the on-site resident, the lifetime risks are several orders of magnitude below any reasonable levels of concern. These low risks result due to in part from the relatively low exposure durations for the receptors and, the design of the landfill, which eliminates several potential pathways through the inclusion of final covers and leachate collection systems. The design, operation and relatively limited access to the PG by the public makes a landfill a good opportunity for an alternate use of PG.

In our view, it is not reasonable to consider that a residence would be constructed on the landfill in the short or medium term time horizons. Other issues, such as methane production and chemical exposure are likely to be a greater immediate hazard. In the long term, while the theoretical potential exists for this scenario to arise, there is no foreseen attraction that would increase the likelihood that a person would choose the location of the test cell over any other location. It seems more probable that, if any historic records were maintained into the future, even with the loss of institutional control, the history of the site being a landfill would deter most people from building in that location.

Table 3
LIFETIME INDIVIDUAL RISK ESTIMATES
PG USE IN TEST CELL AT BREVARD COUNTY LANDFILL
(Test Cell Constructed Using Phosphogypsum Containing Radium-226 at 26 pCi/g)

Receptor - Pathways	Lifetime Risk from a Lifetime of Exposure
Landfill Spotter	
- gamma (no final cover, no shielding)	5.2×10^{-8}
- inhalation of radon/progeny	2.5×10^{-11}
- inhalation of dust	7.2×10^{-10}
- ingestion of dust	2.5×10^{-9}
PG Researcher	
- gamma (final cover)	7.8×10^{-10}
- inhalation of radon/progeny	5.8×10^{-10}
On-Site Resident	
- gamma	4.7×10^{-8}
- inhalation of radon/progeny	2.8×10^{-4}
Resource Recovery Worker	
- gamma	2.2×10^{-7}
- inhalation of radon/progeny	1.9×10^{-10}
- inhalation of dust	1.1×10^{-9}
- ingestion of dust	3.9×10^{-9}

Context

Exposure to radon is unavailable, the county of Brevard, the location of the landfill and proposed test cell, is reported to have an average indoor radon concentration of 0.5 pCi/L with a standard deviation of 0.4 pCi/L (GEOMET 1987). The maximum reading in the 85 homes measured in Bervard county was 3.2 pCi/L. When these values are compared to indoor radon concentration potentially due to the test cell of 0.26 pCi/L it is likely that the radon levels contributed from the PG in this scenario would be indistinguishable from the radon level from natural soils.

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Mr. PUTNAM. Thank you very much, Dr. Chambers.

Our next witness is Dr. Chih-Shin Shieh. Dr. Shieh is an environmental consultant at the CS Environmental Solutions that he founded in Melbourne, FL. Dr. Shieh was research faculty and the director of the Research Center for Waste Utilization when he conducted the phosphogypsum studies at the Florida Institute of Technology. Dr. Shieh's areas of expertise include waste characterization, minimization and utilization. His academic training, research experiences and professional services have allowed him to become one of the few scientists in the Nation who are able to deal with problems concerning pollution that occur in both terrestrial and marine systems. Dr. Shieh has published more than 40 scientific papers and technical reports in the area of waste stabilization and utilization. He has graduated more than 14 MS and four PhD students under his tutelage. Welcome to the subcommittee, Dr. Shieh.

Dr. SHIEH. About 10 years ago when I stood on the top of one of the 300-feet phosphogypsum stack piles, one idea that comes to my mind was what can we do about it. I mean, can we come up with a better approach to manage this material? And just like Mr. Chairman's opening statement, is phosphogypsum a waste or a resource? Now by definition, a waste is a substance that we do not want to use and has no usefulness at all. If the substance can be used for any beneficial purpose and in the meantime does not generate adverse effect to the environment then the material should not be considered as a waste.

So based on that concept we come up with an idea. We can apply phosphogypsum in municipal waste landfills. There is good evidence to suggest that the addition of phosphogypsum could enhance biodegradation of municipal waste in landfills, because during the early stage of waste decomposition in landfills the degradation process is essentially aerobic. That means it depends on the oxygen available so the microorganisms can carry out the process of biodegradation. However, very soon over time as oxygen is depleted the decomposition process becomes anaerobic. That means the bacteria used—you know, some oxygen compounds result dealing with free oxygen in the air. In an anaerobic process—again, that is in an oxygen depleted environment—bacteria depends on oxygen bound in the compound to carry out biodegradation. If there were limited oxygen bound compounds then the biodegradation process will be significantly minimized. So that is why it has been reported that buried bacteria—I am sorry, vegetables such as lettuce—a piece of lettuce was still in good shape after being buried at a site for more than 20 years, because the biodegradation was limited.

Since phosphogypsum is enriched with sulphate it is reasonable to assume that sulphate using bacteria colonies present in landfills will use phosphogypsum as an energy source after oxygen is depleted. The sulphur enriched phosphogypsum can be used in anaerobic conditions such as landfills.

About 10 years ago, in 1996, we carried out a three-phase study. Phase I took about 2 years, from 1996 to 1998—I am sorry, 1994 to 1996. The phase II started from 1997 to 1999 and three questions were addressed. First, does this concept work? Is this only a hypothesis or is this practical issues? Secondary, we want to know

under what conditions this concept could work. And third, we want to answer if this process would generate any adverse effect to the environment.

So in the phase I studies we concluded that yes, this concept is practical. Under experimental conditions phosphogypsum can actually be used by the bacteria and generation of a diverted level of hydrogen sulfate was not found. Also phase I study concluded that if we put one portion—one part of phosphogypsum with three parts of municipal waste together, the reaction would meet our purpose.

So following phase I, we carry out phase II right away. Similarly phase II is to kind of extend the reaction period and use a simulant of municipal solid waste, and we come up with similar conclusions that one portion of phosphogypsum can be used with municipal solid waste and can achieve more than 50 percent reduction in organic matters in 3 months.

So then immediately after the phase II study, we proposed to carry out a phase III field study. That was in 1999. That was about 5 years ago, and it is still pending EPA's approval. Through the field study we will come up with very conclusive findings to demonstrate that this approach is an environmentally sound approach and a lot of parameters will be monitored in the phase III study to further assure there is no adverse effect to the environment.

Thank you.

[The prepared statement of Dr. Shieh follows:]

Application of Phosphogypsum in Landfills

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In the state of Florida, phosphate rock is mined for the production of phosphoric acid. To produce a single ton of phosphoric acid, five tons of phosphogypsum are produced. Chemical analysis of air-dried phosphogypsum indicated that, in general, phosphogypsum is enriched with a sulfate compound ($CaSO_4$) at a level as high as 70%. The sulfate-enriched phosphogypsum can be used in the anaerobic (oxygen depleted) environment, such as landfills, to enhance microbiological processes to decompose municipal solid waste, and thus, extend the lifetime of landfills. The results of a laboratory study, to be described below, showed that application of phosphogypsum to typical municipal solid waste at ratio as high as one part phosphogypsum to three parts municipal solid waste under anaerobic conditions enhanced the decomposition of the waste by 50% in 3 months.

There is good evidence to suggest that the addition of phosphogypsum could enhance biodegradation of municipal solid waste (MSW) in the landfill. During the early stages of waste decomposition in a landfill, the degradation process is essentially aerobic i.e., with available oxygen), and carbon dioxide is the principal gas produced. The general model for this reaction is: complex organics + $O_2 \rightarrow CO_2 + H_2O + SO_4^{2-}$. As oxygen in the landfill is depleted the decomposition process becomes anaerobic, and other gases, principally methane, are generated in significant quantities. In an anaerobic environment, bacteria depend on bound oxygen to serve as electron acceptors in oxidation-reduction reactions. The general model for this reaction is: complex organics $\rightarrow CO_2 + CH_4 + H_2S + NH_4^+$.

Since the phosphogypsum is enriched with sulfate, it is reasonable to assume that a sulfate using bacterial colony present in landfills will use phosphogypsum as an energy source after oxygen is depleted. It is therefore anticipated that the use of phosphogypsum as landfill cover will enhance biological decomposition of MSW and at the same time reduce the accumulation of phosphogypsum and the volume of cover material remaining in a MSW landfill.

A three-phase, scientific study was developed to determine if the use of phosphogypsum as landfill cover is technologically and environmentally feasible. Phases I & II were conducted in the laboratory, while Phase III study is a proposed field study. Phase I study was a fundamental study that was accomplished in a period of two years (1994 – 1996). Phase II study was a simulation study that was accomplished in a period of three years (1996 – 1999). Phase III study was a field study that was proposed in 1999, immediately after the successful completion of the Phase II study. The proposed Phase III study is still pending EPA approval. Findings from Phases I & II were very promising and supported the consideration of using phosphogypsum as landfill cover. Phase III study would generate field data to further demonstrate that laboratory findings are applicable in field conditions, and that the use of phosphogypsum as landfill cover is a sound approach. The following more detailed report describes briefly the studies and findings in Phases I & II, and tasks/approaches to be conducted in the Phase III study.

LABORATORY STUDIES

A two-phase, laboratory study was carried out to examine the use of phosphogypsum in landfills in lieu of conventional landfill cover. Phase I study was conducted in 1994-96 to determine the feasibility of the hypothesis and to develop optimum conditions for the process. Immediately after the completion of Phase I study, the Phase II study was carried out in 1996-99 to demonstrate that findings from Phase I were applicable in simulated conditions in an ordinary MSW landfill.

PHASE I STUDY

About the Study

The duration of the study was two years. Studies in year 1 were conducted to determine the extent that phosphogypsum can be used to enhance biodegradation processes for MSW in landfills and to investigate the methodology for the application of phosphogypsum in landfills. Studies in year 2 were to develop optimum conditions and a standard procedure that can be practically used for a landfills operation.

To accomplish this research an anaerobic biodegradation system (ABS) was developed involving a lysimeter, which served as a decomposition chamber for simulated and shredded waste material. The lysimeter was designed to achieve and maintain an environment suitable for anaerobic biodegradation at a constant temperature of 50°C. To meet these requirements the lysimeter had to be sealed tightly enough to prevent contamination from atmospheric oxygen, while accommodating the frequent extraction of gas and leachate samples for analysis.

To obtain meaningful results on biodegradation of the waste within a short period of time, grass clippings and wood mulch were used as the waste matrix in the study. A series of studies, including formation of waste matrix, water content, exposure time, and waste/phosphogypsum ratio, were carried out to define reaction conditions for biodegradation using phosphogypsum. The approach to the study initially was to develop an anaerobic biodegradation system that allowed a study to simulate landfill conditions. The waste matrix was then prepared for exposure to designated conditions. By-products of biodegradation, both in gases and aqueous forms, were continuously monitored throughout the period of each test (exposure). At the end of each exposure the residual waste matrix was recovered and then was determined for the reduction in total volatile solid, which was then used to assess the degree of biodegradation.

Results of the Phase I Study

As a result of a series of operational testing, an effective equipment configuration for the biodegradation of simulated landfill materials involving application of phosphogypsum was developed. In general, the anaerobic biodegradation system consisted of the lysimeter (decomposition chamber), gas monitoring system, temperature control system, and leachate collection system.

The results of a series of exposures showed that the use of freshly clipped grass and wood mulch as the waste matrix provided needed information on anaerobic biodegradation within a certain period of time. The pH data obtained from the study followed the theorized path of initially falling and then rising over the period of test. The lysimeters containing phosphogypsum fell to a lower pH than did the control lysimeters, and in general, the more phosphogypsum the lysimeter contained the lower the pH value reached, and the slower its recovery.

The results of gas monitoring study suggested that, by introducing phosphogypsum to an anaerobic digester, the production of carbon dioxide (CO_2) would be prolonged and the formation of methane (CH_4) would be delayed. The net outcome would be an additional degradation of organic matter during the state of sulfate reduction. The expected pattern of gas composition was generally observed in each exposure conducted in the study.

Leachate samples collected in the study were analyzed for ammonia and sulfate. Since the waste matrix included only grass clippings and mulch, trace metals of environmental concerns were not monitored in the study. Ammonia in leachate was determined to investigate if the presence of ammonia would affect microbiological process occurred in lysimeter. Results showed that ammonia concentrations in leachate increased over time and then decreased. No clear indication on the difference in the degree of biodegradation could be drawn based on the ammonia data. Sulfate in leachate was also monitored over the period of each test. The results indicated that, based on the analytical data and calculated values, phosphogypsum was actually used by sulfate reducing bacteria under the landfill anaerobic conditions.

The results of biodegradation determination revealed that within a range of 1/10 to 1/3 phosphogypsum to waste matrix ratio the addition of phosphogypsum gypsum appeared to enhance biodegradation by approximately 15% in a three-month of exposure. The percent reduction in decomposable solids decreased when the phosphogypsum/waste-matrix ratio was greater than 1/3.

Summary of Primary Findings

- A lysimeter was developed to simulate biodegradation in landfills.
- Gas composition patterns in the waste/phosphogypsum system were very similar to the general patterns in ordinary landfills.
- The production of carbon dioxide (CO_2) was prolonged and the formation of methane (CH_4) was delayed, providing additional degradation of organic matter during the state of sulfate reduction in landfills.
- Formation of ammonia in leachate did not affect microbiological process in the waste/phosphogypsum system; no elevated level of hydrogen sulfide was found.
- Phosphogypsum was practically used by sulfate reducing bacteria under the landfill anaerobic conditions.
- A ratio of 3:1 for the mixture of waste/phosphogypsum was recommended.

PHASE II STUDY

About The Study

A three-year laboratory, large scale simulation study was conducted to demonstrate that findings from Phase I were reproducible when representative MSW typically found at landfills was used. Experiments were carried out to measure the reduction in volatile solids at a 3-month sampling interval for a period of two years to determine the degree of biodegradation of MSW as a function of time. To ensure the similarity of the material used in the 20 ABRs, a typical waste matrix was prepared and added to each of the ABRs according to the formula provided by ASTM D5525-94a. The mixture of waste material included food wastes (12.5%), garden wastes (10.5%), paper (44.2%), plastics (5.8%), textiles (1.5%), wood (1.9%), metals (8.0%), glass (7.7%), and dirt/rocks (7.9%). Variations in gas compositions, leachate characteristics, and percent reduction in decomposable solids were the primary parameters for determination during the period of the study.

The main focus in first year of the Phase II study was to develop a large-scale anaerobic biodegradation system (ABS) involving twenty 55-gallon stainless steel drums, which served as decomposition chambers for typical municipal solid waste. A water heater was used as the initial heat source and a heat transfer coil was designed and emplaced within each of the anaerobic biodegradation reactors (ABRs) to achieve and maintain an environment suitable for anaerobic biodegradation at a constant temperature of 52±3°C. Results of gas production and leachate characterization during first year of the study revealed that the ABS performed as anticipated.

Immediately after successful development of the ABS system, monitoring of the performance of the simulated landfill-biodegradation system was carried out and biodegradation by-products were determined. The overall experiment was set up for a period of 2 years, starting from the mid of the first year to the mid of the third year. Biodegradation that occurred within the ABRs was continuously monitored throughout the period of the study by recording daily temperature of each of the ABRs and by taking monthly leachate samples from each of the ABRs. At a 3-month interval two ABRs were terminated and taken apart to recover residual waste matrix to determine the loss of volatile solids. Biodegradation by-products, such as gas production/composition and leachate composition, were monitored throughout the period of the study. Loss of volatile solids was determined on both raw materials prior to the experiment and end products after each exposure interval to determine the degree of biodegradation.

Results of the Phase II Study

Monitoring of the performance of the entire system was carried out immediately after the ABRs were filled with waste material and sealed. Parameters such as flow rate of water through the system, temperature development within the complete system, and leakage observation were considered during the performance evaluation. The production of gases within the ABRs occurred rapidly in the initial 15 days and continued to increase at a slower rate. The observed continuous gas production indicated that the ABS was performing under the anticipated conditions. It was found that the anticipated interception of leveling of carbon dioxide (CO_2) concentrations and increasing of methane (CH_4) concentrations occurred around 40 days after reaction. It was noted

that a significant elevation of methane occurred after 100 days. This phenomenon supported the Phase I finding that, by introducing phosphogypsum to an anaerobic digester, the production of carbon dioxide (CO_2) would be prolonged and the formation of methane (CH_4) would be delayed. The end result was that more waste matrix was decomposed in the reactors with phosphogypsum added than in the control reactors without phosphogypsum added.

Leachate samples collected throughout the period of the study were analyzed for several selected elements, such as calcium (Ca), iron (Fe), lead (Pb) and zinc (Zn). Dissolved concentrations of sulfate in the leachate were also determined. Apparently the addition of phosphogypsum to the waste matrix did not result in additional lead (Pb) and zinc (Zn) to the leachate. Low leachate concentrations in iron (Fe), lead (Pb), and zinc (Zn) might be due to the removal of these metals by dissolved sulfur to form metal sulfide precipitate, which in the meantime prevent the formation of hydrogen sulfide. High concentration of calcium (Ca) in leachate supported the hypothesis that sulfate in phosphogypsum might have been dissociated. Dissolved sulfate ions would be available for biodegradation and in the meantime, dissolved sulfur ion would react with dissolved metal ions to form metal sulfide precipitate under the reducing conditions.

At the end of each exposure, residual waste was recovered to determine reduction in decomposable solids in the waste matrix. Analytical results indicated that approximately 90% of volatile solids in the experimental ABRs were degraded within 12 months of exposure, while less than 50% of volatile solids in the controlled ABRs, i.e., no phosphogypsum added, were degraded in one year. The results showed that application of phosphogypsum to typical municipal solid waste at ratio as high as one part phosphogypsum to three parts MSW under anaerobic conditions enhanced the decomposition of the waste by 50% in 3 months.

Summary of Primary Findings

- An anaerobic biodegradation system composed of twenty 55-gallon stainless steel drums was successfully developed to simulate landfill environment.
- The 3:1 ratio of waste/phosphogypsum determined from Phase I was demonstrated applicable to the simulated landfill conditions.
- Similar gas composition patterns to Phase I findings were found in the study.
- Prolonged carbon dioxide (CO_2) production and delayed methane (CH_4) formation was determined in the study, providing additional degradation of organic matter during the state of sulfate reduction.
- No elevated level of hydrogen sulfide (H_2S) was found.
- Leachate concentrations of lead (Pb), iron (Fe), and zinc (Zn) were in the range of typical landfill leachate; concentrations of calcium (Ca) and sulfate (SO_4^{2-}) were higher than the typical landfill leachate.
- About 90% of decomposable waste components were degraded in 1 year within the designated anaerobic biodegradation system.

PROPOSED FIELD STUDY

Work Plan for the Phase III Study

A full-scale field study was proposed as the third phase of the project to demonstrate that findings from Phases I and II are reproducible in landfills under natural environment. Due to the slow degradation rate of the waste, the duration of Phase III study will be four years and efforts will lead to the development of a procedure that can be practically used in landfill operations. During the four-year period, studies in year one will involve the construction of two landfill cells followed immediately by monitoring the biodegradation by-products of the waste. Two experimental landfill cells will be constructed on top of the closed cells at the existing landfill site at the Brevard County's Central Disposal Facility Landfill in Cocoa, Florida. Studies in years two and three will be devoted to conducting field monitoring and compilation of analytical results in a computer database. Studies in year four will involve the completion of field monitoring, data reduction and interpretation, methodology assessment, and reporting. The outcome of the study will be a procedure that can be practically used for a landfill operation providing a partial solution for managing both phosphogypsum and MSW landfills in Florida.

Outline of the Phase III Study

Test Cells:	Two cells (control and experimental) will be constructed on top of the closed cells at the existing landfill site that meets Florida DEP's requirement on landfill liner design.
Dimension of Cell:	60 ft (L) x 20 ft (W) x 10 ft (H)
Liner of the Cell:	Geomembrane liner will be used for both of the control and experimental cells.
MSW:	Typical municipal solid waste brought to the site will be used for both cells. Approximately 75 tons of MSW will be used for each cell.
Phosphogypsum:	Approximately 25 tons of phosphogypsum will be used for the experimental cell.
Layers of the Cell:	Three layers of each of the phosphogypsum and MSW will be placed within the cell. The thickness of phosphogypsum layer will be 2 in., while the thickness of MSW will be 2 ft. Cover material for the control cell will be typical soil/dirt, while for the experimental cell, phosphogypsum will be used as cover material.
Final Cover:	The final cover of the experimental cell will be a typical soil/dirt used for the control cell. However, a 2-in layer of phosphogypsum will be placed before the final cover is used. The completed cell will be capped entirely by a geomembrane liner.
Field Monitoring:	Leachate composition, gas formation, and cell settlement will be monitored. Leachate will be retained and re-circulated throughout the cell during the period of the study. Therefore, no storage of leachate will be expected.

Monitoring Plan for the Phase III Study

Monitoring of the experimental and control landfill cells will be carried out immediately after the completion of cell construction. Biodegradation by-products, such as gas production and composition, leachate composition, and cell settlement will be monitored throughout the period of the study. Gases to be monitored include carbon dioxide, methane, hydrogen sulfide, and radon. Leachate components to be monitored include pH, dissolved sulfate ion (SO_4^{2-}), radioactivity, and trace elements of environmental concerns, such as arsenic (As), silver (Ag), cadmium (Cd), chromium (Cr), lead (Pb), and selenium (Se).

Monitoring tasks will be carried out on day-to-day basis. Physical environment at the site will be visually inspected everyday to record any possible changes. Settlement reading on both cells will be recorded daily. Leachate and gaseous samples will be collected for analysis on weekly basis. However, sampling intervals for gas and leachate are subject to change according to daily site observation, data generation, and the progress of the project.

The current water quality-monitoring program for the Brevard County Central Disposal Facility consists of 48 monitoring wells located outside the slurry wall surrounding the landfill. Upgradient wells are about 1000 feet apart, while downgradient wells are about 500 feet apart. The wells are placed either in pairs or threes to monitor the upper surficial (12' - 28' deep), the lower surficial (20' - 36' deep), and the deep aquifer (40'-63'). There is one surface-water monitoring point and one leachate sample collection point. The ground water, leachate, and surface water are monitored semi annually at the site. Since the proposed site of the study will be located between existing monitoring wells, the routine monitoring data generated by the county, prior to and during the study, will be coordinated with the study's monitoring plan to form a database for later assessment.

ABOUT THE AUTHOR

Dr. Chih-Shin Shieh is an environmental consultant at the CS Environmental Solutions that he founded in Melbourne, Florida. Dr. Shieh was research faculty and the Director of the Research Center for Waste Utilization when he conducted the phosphogypsum studies at Florida Institute of Technology, Melbourne, Florida. Dr. Shieh's areas of expertise include waste characterization, minimization and utilization. His academic training, research experiences, and professional services have allowed him to become one of the few scientists in the nation who are able to deal with problems concerning pollution that occurs in both terrestrial and marine systems. Dr. Shieh has published more than 40 scientific papers and technical reports in the area of waste stabilization and utilization. He has graduated more than 15 M.S. and 4 PhD students.

Mr. PUTNAM. Thank you very much.

I want to thank all of our panel one witnesses. You know, for those who are trying to digest everything that these engineers and scientists have put before us, what I've heard is that you have through research identified essentially three key potential uses for phosphogypsum—road construction, soil amendment for agricultural purposes and the potential for cover fill on municipal solid waste landfills. And that there has been a great degree of inconsistency, almost a double standard or a rule unto itself promulgated by EPA that applies to phosphogypsum but does not apply to their risk models for other types of products that they are running risk assessment models on. So if we could, let us kind of start at 40,000 feet and work our way down.

What—to any or all of you—do you believe that the risks associated with dispersing phosphogypsum either through landfill, road construction or agricultural purposes, do you believe that the risks associated with its dispersal, outweigh the risks of stacking it in a concentrated form in the types of mountains that we see? Which risk is greater, concentrating it or dispersing it? We will begin with Mr. Lloyd.

Mr. LLOYD. No, I definitely do not think that the risk of using it is as great as leaving it in the stacks. I think you are going to have some long term effects that you will have to deal with. My concern with using it is basically not very large. One thing that I would tell you is, if we built a road with it, I would have no argument about my children or my grandchildren or myself living alongside the road, and I would not have any concern about living in a house 100 years from now, which I will not get a chance to do, that had been fertilized with phosphogypsum. I think the work that Dr. Chambers has done demonstrates this very, very strongly in a scientific basis.

Mr. PUTNAM. Dr. Sumner.

Mr. SUMNER. Mr. Chairman, I cannot speak for the risk of the stack because that is out in my backyard. I do not know much about that, but I can tell you pretty well categorically that if you use phosphogypsum at the recommended rates according to the Cooperative Extension Service, there is absolutely no risk because we were able to find no radiation residue as a result of applying phosphogypsum in all the agricultural applications that we have made. In fact, if one is concerned about the radon gas, in many parts—not so much in Florida, but in much of the Piedmont part of the Southeast, the radon emanating in basements is probably a bigger threat than anything you would ever get from phosphogypsum. So I think the risks are absolutely minimal when used correctly. Now, of course, if you use it incorrectly that is another matter, but that is off-label so to speak and one cannot address that in a hearing like this.

Mr. PUTNAM. Dr. Chambers.

Mr. CHAMBERS. Thank you. I would like to make two comments. First of all, I agree with Mr. Lloyd that the use of phosphogypsum for agriculture, for roads, for daily cover on a landfill, and there are some other uses we did not have a chance to talk about today as well, would indeed in my opinion actually be smaller risks than the risk associated with leaving the phosphogypsum in the stack.

The referenced scenario here is building a home. So if you were in the future to lose control of the land—and that is a whole other issue—and build a home on a phosphogypsum stack the radium-226 concentration, which is really the issue we are talking about, would in fact be simply the radium-226 concentration in the phosphogypsum per se. For any of the uses we are talking about with appropriate land application with dilution in the daily cover, the actual final concentration of radium-226 would in fact be smaller than it was in the undiluted phosphogypsum, and indeed so small that it would be difficult to find within the natural variability of radium-226 which occurs in my backyard and your backyard and everybody's backyard. And indeed the radon flux that would arise from the incremental radium-226 because of the phosphogypsum would in my opinion be so small that it would not be detectable within the natural variation of radon that occurs in homes in Florida and indeed throughout the United States at the present time. Setting aside the absolute risk, which I personally believe to be extremely small, the incremental risks compared to radium and radon from natural background would be vanishingly small and in my opinion not measurable. Thank you.

Mr. PUTNAM. Dr. Shieh.

Mr. SHIEH. If the use of phosphogypsum is under good monitoring, I do not think that kind of use will be worse than current practice.

One comment about the future of building on the site, the possibility in terms of risk assessment. For some reason that concept has been used everywhere in the whole country. When I was involved in Zinereta Ash project a similar question was always asked, how about 100 years later if my grandchildren build a house on the abandoned site with all kinds of waste material? We need to be honest and understood that today we already have very good systems, OK. One of the provision of service I am doing now is when the builder or the developer, they try to develop a site for new business, community or new residential community, they are required to do so-called phase I site assessment studies. And through that study any location—any property will be investigated for the history of the property. So practically and realistically that scenario will not happen even 100 years later unless the whole governmental system was destroyed for some reason, otherwise that is really not a scenario that would happen, that someone would build a house on the top of a waste pile. It is not going to happen. Again, we have very good system today already. So I truly believe if any good use of the material and under monitoring, then I support that idea.

Mr. PUTNAM. You know, the only way to deal with these issues is in a straight-forward science-based manner and you have certainly given us a foundation for a science-based approach to alternative uses of phosphogypsum. But, you know, radioactivity, that term certainly conjures up concerns, fear even among people. Help the subcommittee to understand the context of the radium-226 levels. How does it relate to other commonplace daily activities that people may be engaged in and whatever the background radiation of those may be, whether it is flying or smoking or the presence of radon in homes today? Help us put that number in context.

Mr. CHAMBERS. Perhaps I will try. First of all, I would like to try and provide a small context on the risk range of 1 times 10 to the minus 4. As I mentioned—that is 1 in 10,000—as I mentioned earlier, the EPA has also used risk numbers as high as 3 times 10 to the minus 4 in rulemakings and therefore at least for that purpose, EPA, one would presume, considers that level of risk as safe. Well what is a risk of 1 in 10,000? That is a lifetime risk. So if you use EPA's notion of a lifetime of 70 or 75 years, in essence that works out to an annual risk of about one in a million. I am not going to tell you my exact age, but I am somewhere between 50 and 60 and it is pretty typical unfortunately that at my age natural causes of death in the average person, I would have a risk of about one in a million from just 1 hour of doing what I do every day. So assuming this hearing this morning takes 2 hours, my risk would be approximately two in a million just from just simply sitting in this room and enjoying this conversation. That's the kind of context we are looking at. It is a risk I suffer every hour or am exposed to every hour of the day at my age. It is unavoidable.

Radioactivity is unavoidable. All soils everywhere have naturally occurring radioactivity and in particular radium-226, which is the focus really of this discussion because it is a source of the radon that crops up in the open air and comes through our floors into our homes.

In any event, if you look at—it does not matter whether you look at EPA's risk assessments or ours, the incremental contributions of radium, even after 100 years of application, that I think this panel would consider exceptionally high application rates, is still well within the range of natural radium-226 in soils. So you are not going to be changing that. And if you look at—GEOMET did a very detailed study of radium in soils and indoor radon in homes in this county and in many other counties in Florida. And if you look at the maximum incremental radon contribution it is less than a tenth of the average and less than a thirtieth of the upper number. It is a very small fraction, much less than the variation you would go from one home to the next because of the difference in life styles, slightly different age of construction. It is not a detectable phenomenon. I am a physicist, I like models, it is something I can predict. It is something EPA can predict, but I believe it is not something you could actually measure because it is there naturally in much higher and very variable quantities.

Finally I might add, the EPA has a 4 picocurie per liter standard at which they would like to have people initiate cleanup in the homes and what we are talking about, the maximum incremental contribution that I would predict would be more than 20 times smaller than that. The absolute maximum much less the average.

I hope that provides some context. Thank you.

Mr. PUTNAM. Does anyone else wish to add anything to that? Mr. Lloyd.

Mr. LLOYD. I always find it kind of comical that since you are in a granite office building in Washington, you probably have more radon than what most of the people in this room experience in a day.

Mr. PUTNAM. EPA has a nice big granite building, too, maybe that is what is going on there. [Laughter.]

The roads that were constructed in Polk County, there are homes along that road, Mr. Lloyd. Do you know how many homes are along that road?

Mr. LLOYD. May I ask a question?

Mr. PUTNAM. You may.

Mr. LLOYD. John, how many homes?

VOICE. About 40.

Mr. LLOYD. About 40.

Mr. PUTNAM. Forty homes along the road that had phosphogypsum used as the road base. Does testing continue along that road?

Mr. LLOYD. Testing is continuing on it even until today.

Mr. PUTNAM. And you mentioned that the DOT testing indicated that roadbed has grown stronger over time, which is certainly a favorable thing for its durability as a roadbed, but what are the health effects that have been detected as part of that testing?

Mr. LLOYD. The road is kind of difficult to come up with the health effect for one reason. Everything we have shown is fairly normal. The land the road is built on is reclaimed land. The radiation over the land next to the road is higher than the radiation on the road. So the people that are living there are experiencing radiation levels that are higher than they would ever have if they built the house on top of the road.

Mr. PUTNAM. OK. What other leachates have been found in the monitoring of the roads already built in Polk County?

Mr. LLOYD. The only thing that we may have seen—and I will ask Dr. Burkee to correct me if I am wrong—is the sulphate increase at one well.

Mr. PUTNAM. You mentioned that NASA and the Department of Energy have expressed an interest in using phosphogypsum based glass in a ceramic material. Could you elaborate on that?

Mr. LLOYD. Well we have a proposal to make glass out of phosphogypsum. We have done all the research. We are trying to—the people that did the research are trying to put together a system to start making glass. One of the techniques that has been studied would actually—in preparing the phosphogypsum for use, would enable you to produce hydrogen. In the course of our discussions—and this is still a preliminary study at this point, a paper study more than anything else. But in talking to both NASA and DOE, they are very interested in the fact that you might be able to produce hydrogen. NASA because they use it for launching space vessels and DOE because they would like to see us go this hydrogen-based economy that has been proposed that would reduce greenhouse gases. We are interested and we are working. That is all I know to say at the moment.

Mr. PUTNAM. All right, sir. Dr. Chambers.

Mr. CHAMBERS. I have one further comment. I did not have the chance in my comments this morning to say anything about the glass. I would like to point out that when you make the glass you do not do anything obviously to change the gamma radiation, but, in fact, you trap the radon. The radon cannot escape. So in essence because it is like wall tiles—it is like a ceramic like material—the radon which has a half life of 3.8 days will decay within the glass like material and actually not be available to enter the rooms of

living spaces or working spaces. So in actual fact, the radon risk in that case would be very much lower.

Mr. PUTNAM. Could you elaborate on the half life of 3.8 days? Was that what you said?

Mr. CHAMBERS. Yes, I will. Radon-222 is a noble gas so it is able to diffuse through air and through soils, but it does have a radioactive half life. If you take 120 atoms of radon now in 3.82 days you will have approximately, plus or minus, 60 and in 7.6 days if my arithmetic is correct, you will have half of that again. So you will have 30. In another 3.8 days you will have 15. That is about as far as my mental math can carry me.

But in essence the radon that is produced within the matrix of a soil, within a matrix of PG, within a matrix of a cemented road can only survive because of its physical half life for a finite time and the average time is 3.8 days. Therefore, if something interferes with how easy it is to diffuse through the pore space well then it will decay and never actually enter the open air or the air of a building in which you might use tiles for a roof or a floor. So in actual fact, as I say, it does not do anything to change the gamma levels which is another kind of radioactivity. But certainly making it into a glass-like material hugely reduces the fraction of radon that can survive long enough to actually be released into room air. Thank you.

Mr. PUTNAM. Thank you.

The EPA risk model for phosphogypsum was a 70-year residency for occupants of a hypothetical house. When calculating the risk for phosphogypsum that is 18 hours a day, 7 days a week for 70 years. Does that assume an airtight house, air conditioning, no air conditioning, ventilation, windows open? How does that factor into that risk assessment?

Mr. CHAMBERS. If I understand the EPA's risk analysis correctly, I do not think they actually considered any of that. I think they used—I stand to be corrected, but I believe they used a generic factor whereby they took the radium concentration in the soil that will be built up over time by application of this very high fertilizer rate, for example, and then use a factor—for every picocurie per gram of radium-226 in the soil you would find 1.25 picocuries per liter in the indoor air of the home. So it is a generic—it is a generic number.

Mr. PUTNAM. And what is a more reasonable risk analysis number to use other than the 70-year residency?

Mr. CHAMBERS. I have some sympathy for EPA nationally, but when you look at—for example, in Florida there is a huge amount of data that relates—from the GEOMET survey, for example, that relates specifically to soil concentrations of radium and the corresponding indoor radon levels. So one of the things that we did in our risk assessment for uses in Florida was to try and use as much Florida-specific data as possible. I think it is important where information exists to use data that is appropriate for the application and appropriate for the intended area of use.

Mr. PUTNAM. Mr. Lloyd, have you received approval from EPA to pursue NASA's request to utilize phosphogypsum in glass?

Mr. LLOYD. We have not really talked to EPA about the glass. That will be the next thing when we decide to go into a full scale

plan. We have done all the benchwork, we have done all the pilot work. We would like to go into a demonstration sized plant and that is in the works. We will need to go to EPA at that time. Based on our past experience with them, it will take 3 or 4 years to get an answer.

Mr. PUTNAM. Do you have any permit requests pending with them now?

Mr. LLOYD. We have one with them for the landfill that Dr. Shieh mentioned. Down in Brevard County they have agreed to let Dr. Shieh build a test cell that would be large enough to demonstrate to landfill operators the effectiveness of this technique. We asked 2 years ago, plus or minus, to get approval to do that. We have had—the problem we experience with most of these things is EPA said in 1992 that they would define the method to get an exemption to the rule. They have never done anything. We have tried to put things together, working particularly with Dr. Chambers for requests that would meet all of the requirements. Our biggest problem is we turn it in and in about 4 months, 6 months or 8 months later we get something that says you need to add this. So we add that, and in another 4, 6 or 8 months we get another request that says you need to add this. So getting anything through EPA in terms of an exemption to the rule is not the simplest thing that anybody ever did. The only thing that we have that would stand up today is, EPA has said that if we wanted to build a road, if we would get a deed restriction on the road so that you could never build a house on it, that they would have no objection to building the road. But even when we have worked with getting an exemption request for a given road, even with a deed restriction, we have to have an exemption request. It has been a long-term, frustrating affair.

Mr. PUTNAM. Dr. Sumner, you went into great technical detail on the calculations that EPA used particularly for the agricultural uses. Could you take some time to elaborate on the calculations they made versus the calculations that you believe that they should have made using realistic assumptions for the soil types and the crops that are being tested?

Mr. SUMNER. Well they came up with this value that was 2,700 pounds per acre every 2 years. That is the standard that they set the rule on. Now, I do not know the exact calculations that they went through establishing the rule. What I am saying is that the uses of gypsum that are recommended by the Cooperative Extension Service are all much below that level. So that should—the actual uses that are recommended in the agricultural industry are the rates that should be used in the calculation, not the value they used. That is my point.

Mr. PUTNAM. Are the calculations that they used available?

Mr. SUMNER. Yes, I think so. Well, I do not know if they are available. I started at the point of 2,700. That is what I know. I do not know about their calculations.

Mr. PUTNAM. Are the working papers that are used by the EPA, are they available to the public through our traditional open records laws?

Mr. LLOYD. The working papers for the 2,700 pounds are available in the BID documents for the 1989 rule. What they did was

take California's applications for sodic soil, which is, as Dr. Sumner has mentioned, are significantly higher than you would use for fertilization. They took those and averaged them with numbers that were used for fertilization from Georgia and Florida. They did a couple of things wrong when they did this. No. 1, they were not agronomists obviously. They did not look at what Dr. Sumner has mentioned about peanuts in which you apply phosphogypsum 1 year but you do not plant peanuts again for another 2 years. You use a 3-year crop rotation. If you do not do this, you get nematodes that destroy the quantity of peanuts and you get a fungus that will destroy the quality. So they took these two totally dissimilar techniques and used them to average to come up with a 1,350 pound per year average. We should really be dealing, as Dr. Sumner says, probably no more than 400 or 500 pounds per acre. We should not be comparing, as I say, the soil treatment with fertilization. This is like taking apples and oranges and saying they are both the same because they are fruit.

Mr. PUTNAM. You have made that point that the California numbers are irrelevant to the needs of the Southeast. Could you explain what a sodic soil is and why it is a different animal than the Southeast?

Mr. SUMNER. Mr. Chairman, I think I will do that.

Mr. LLOYD. He can do a better job than I can.

Mr. PUTNAM. Go right ahead.

Mr. SUMNER. Sodic soil, Mr. Chairman, is a soil that is impacted negatively by the presence of sodium irons. The sodium irons in the soil cause the physical properties of the soil—in other words, the ability of the soil to accept water at the surface and transmit water through the profile—to be very negatively impacted. So in sodic soil the transport of water from rainfall to some groundwater point is impacted very negatively. It is very slow and they are very difficult soils to work on. The phosphate—well phosphogypsum or any gypsum—generic gypsum is used in the reclamation of these soils and supplied at—relative to what we use in the Southeast here, relatively high rates, in order to exchange the sodium from the exchange complex of the soil and replace it with calcium which improves the physical condition of the soil. So that is a reclamation technique, and you would only do that once. So the rates that they use, sort of 35 tons maximum, would be for a one time application to reclaim the profile so you can bring it back into agriculture. So you should divide that by 100, in my view, by the standards that the EPA has used to assess the annual rate, because you only apply that once in the whole lifetime of the soil. Once you reclaim the soil, it will stay reclaimed provided it would not be inundated by the sea or some other negative introduction of sodium into the soil. So once you reclaim it it is reclaimed. So that is the crux. And, of course, it is not relevant here in the Southeast at all. We do not have any sodic soils that are in agriculture in the Southeast at all.

Mr. PUTNAM. Now in north Florida the phosphogypsum byproduct of the mining up there is allowed to be used as a soil amendment and it is used predominately by peanut growers. Do you believe that the differences in the north Florida phosphogypsum and the central Florida phosphogypsum are significant enough to allow the use of one and ban the use of the other?

Mr. SUMNER. Do I think that?

Mr. PUTNAM. I will begin with you.

Mr. SUMNER. Absolutely no. I mean, as far as I am concerned, at the rate you would use them as an ameliorant for peanuts, I do not think you would ever be able to find any difference in the peanuts or the soil. I mean, it is far lower than the rates—we actually tested the radiation, it was applied at rates that were of the order of three and four times the rate that would be cumulatively applied to peanuts.

Mr. PUTNAM. Mr. Lloyd.

Mr. LLOYD. I do not think you would have any problem. EPA based their ruling on the fact that north Florida has 10 picocuries per gram of radium and central Florida has an average of 26, and that is where their differences came from. But I am like Dr. Sumner, I cannot see where you would ever have enough phosphogypsum used in agriculture for fertilization that it would ever cause a problem. We did have some work that was done by Dr. Jack Grexicle with the University of Florida using it on forage. As I have mentioned, in Florida, if we could do what Jack thinks we could, we could improve the quality of the grass to the point that we could make a very definite positive economic effect for the Florida farmer, because a cow uses grass that has the proper level of sulphur more efficiently than it does some other grass. You have demonstrated in parts of the world 20 percent weight gains just because of having proper sulphur fertilization. Jack is here today. If you all would like to have him address you, he can give you all the details.

Mr. PUTNAM. Dr. Chambers.

Mr. CHAMBERS. Thank you, very much. It is difficult to add to what my colleagues have said, but I would like to make one additional comment. As Mr. Lloyd indicated there is considerable detail about the EPA's risk assessment in the 1992 BID, including the EPA's own analysis of the effects of a biennial, every 2 years, application rate at 900 pounds per acre for 100 years. Without any other changes, even leaving the 70 years, and without any other changes to the risk assessment the EPA themselves indicate the lifetime risk from the application of 900 pounds every 2 years is less than 1 in 10,000, well within their risk range. So even if you—even if you doubled that, that would still be well within the range of 3 in 10,000. So I think simply without any other changes, even by EPA's own risk assessment, with the appropriate application rates there should be no restriction in my opinion at least on the use of phosphogypsum as an agricultural installment.

Mr. PUTNAM. Dr. Shieh, do you wish to add anything?

Mr. SHIEH. No. I did not study on this subject, so I do not want to make comments.

Mr. PUTNAM. The phosphogypsum from north Florida is allowed by law to be used for agricultural purposes and the phosphogypsum down here is not, and it is not allowed to be used for a roadbed with the exception of the test roads that were built. Now this being Florida, do you not believe, Mr. Lloyd, that the likelihood of building homes on top of previous agricultural land is greater than the likelihood of building a home on a road bed?

Mr. LLOYD. Well, I have always had a problem in understanding why anybody would build a house on a roadbed. [Laughter.]

Particularly in Florida. I do not know how to explain the logic. That is all I am going to say. I would doubt—I just do not know where this ever happens, but I doubt that it is going to happen in Florida.

Mr. PUTNAM. Well, I do not want to ask our scientists who are very precise to speculate outside their field, but I think that the facts would show that more homes are built in Florida every year on former agricultural acreage than on former road beds.

Dr. Shieh, you suggest that the bacteria would use the sulphate enriched phosphogypsum after oxygen is depleted and delay anaerobic decomposition. Does that have any beneficial effects on methane reduction in landfill?

Mr. SHIEH. Yes. When I say that is typical in an ordinary landfill, carbon dioxide would be generated first when there was oxygen available, so that would be the byproduct of organic decomposition, is generation of carbon dioxide. And over time, when the oxygen has been depleted, the methane begins to degenerate and the carbon dioxide begins to convert to methane. So it is like a curve, from there, to rise and decrease over time and methane from left to right will increase over time. So there is intersection at a certain point. What we discovered is that the intersection between the two extends beyond the time. That is an indication that the production of carbon dioxide has extended, prolonged, as many more organics have been decomposed. And in the meantime, the generation of methane was delayed because as the more organics decomposed slows up the actions.

So that is what I meant in the summary, that by introducing additional available sulfate in phosphogypsum, that would extend and provide opportunity to have more organic matter decomposed and that further would reduce the volume of the waste accumulated at a landfill. And that is why we say we might be able to extend the lifetime of the landfill.

Mr. PUTNAM. So increasing the efficiency of the decomposition. Has your research given you any indication of how many more years of service a municipality or local government may get out of that landfill if they were able to use phosphogypsum as cover?

Mr. SHIEH. Just based on the laboratory results, for example, if we compare the experimental reactor and the control reactor, in 3 months, we actually see more than 50 percent of organic matter has been decomposed on the experiment with phosphogypsum. So we say 50 percent more of the organic matter will be decomposed from the landfill. So we can say that is two times that the time could be extended. So assuming the site, the ordinary landfill, they say is 25 years, so we might be proposing an assumption could extend to 50 years of time. That is one simple assumption. Of course, as I say, if we were able to carry out a phase III field study, then we would be able to come up with more conclusive comments.

Mr. PUTNAM. And you have a request pending before EPA to your phase III study?

Mr. SHIEH. Yes.

Mr. PUTNAM. And when did you submit that request?

Mr. SHIEH. Immediately after completion of phase II, we submit to FIPR and FIPR went through the typical reviewing process, tech committee and the board of directors. They reviewed it and they actually approved the funding but because of the issue on the radioactivity, we have to wait for EPA to make a final green light. That was in either 1999 or 2000, about 4 years ago.

Mr. PUTNAM. So you have been waiting 4 years for an answer to your request for your phase III.

Mr. SHIEH. Yes.

Mr. PUTNAM. And were there adverse results in phase I or phase II that might have led EPA to delay their decision?

Mr. SHIEH. I do not think so. Throughout the phase I and phase II studies, except the issue on radioactivity, which we did not address because that was not a task of the study. On the other hand, we looked at the possible production of hydrogen sulfite, because when we introduce additional sulfur, theoretically we will consider there is going to be more hydrogen sulfite produced at the site, and theoretically that is possible.

Another possible adverse effect would be the generation of ammonia. Ammonia at the site would prohibit microbiological process. And our study showed that the production of ammonia did not actually stop the microbiological process and the generation of H2S, hydrogen sulfite, was really not on a register label comparing the typical landfill site. And the reason we investigate and the reason could be because of formation of metal sulfite. During the formation of hydrogen sulfite, the sulfur compound could create ways to dissolve metal in the leachate and form the metal sulfite. Under that scenario, the hydrogen sulfite would not be generated.

So we believe throughout the phase I and phase II studies, there is no adverse effect that could make the EPA slow down the process, and personally, I have no idea why they cannot make a decision as quick as possible.

Mr. PUTNAM. Thank you, we'll have the opportunity to ask that this afternoon.

Dr. Chambers, you have gone into some detail about the 1 in 10,000 versus 3 in 10,000 standard. Are there other examples that you are aware of where they employ a 1 in 10,000 standard instead of their typical 3 in 10,000?

Mr. CHAMBERS. I believe I pointed out another example in my written testimony, which relates to the cleanup of a radioactive contaminated site from the fuel cycle. EPA I believe has a 15 millirem per year dose limit and the NRC, for the same situation, has a 25 millirem, and this has been much discussed. EPA equates a 15 millirem dose to a risk of 3 in 10,000, but it is also very clear that 15 millirems does not include the dose from radon. So in actual fact, if you added radon in, the equivalent risk level would be much higher.

I do believe that in that context, EPA would require a demonstration that you did not exceed their 4 picocurie per liter limit in addition to the 15 millirem.

Mr. PUTNAM. The 95th percentile application rate—and this is a followup to what we just discussed—is the 1 in 10,000 the 95th percentile, or is 3 in 10,000 the 95th percentile?

Mr. CHAMBERS. The 3 in 10,000 was the upper 95th percentile, which was the 2,700 pounds we referred to previously. As I mentioned though, the EPA's own analysis, using all their parameters in the 1992 BID concluded that an application rate of 900 pounds would produce a risk less than 1 in 10,000. So even if you doubled that to 1,800 pounds a year, that would certainly be less than 2 in 10,000, still within the EPA's risk range of 3 in 10,000.

So I think with the application rates that Dr. Sumner has indicated, that the EPA's own 1992 analysis would demonstrate, even with the conservative assumptions that they have made, that risk to someone building a home on land to which you applied 900 pounds or even twice that, for 100 years, would be well within their acceptable risk range.

Mr. PUTNAM. We have focused mostly on the road bed, the landfill and the agricultural uses with the additional potential for the glass use. Dr. Shieh, you have done some work on the marine side of things. Are there potentials in that arena as well?

Mr. SHIEH. In the marine environment, we actually had some idea in terms of using the material for artificial reef in the ocean. Our organization did not make this proposal. Louisiana State University with a similar group, they actually proposed to do that. Maybe Mr. Lloyd can make a further comment on that.

But yes, based on our previous studies and experience, we agree this material can be used for marine purpose, because the material is good for stabilization, can turn into a solid substance without any question at all. So if the radioactivity issue can be resolved, I do see it as a good application in the marine environment.

Mr. PUTNAM. Thank you. Mr. Lloyd, did you want to add anything to that potential use?

Mr. LLOYD. Louisiana State has done a great deal of research on using it in marine applications. They originally proposed using it for oyster conch, which is the solid material on which the young oyster attaches and grows from that point. It used to be you took all the oyster shells and returned them to the ocean and the young oysters could grow on the old oyster shells, but they have become too valuable to be put in the ocean. So now, they do import into Louisiana, granite out of Mexico. One of the problems in much of the Gulf is you put down this material and it is on top of the soil and over a period of time, it sinks down into the soil. So you no longer have a site for oysters.

In addition, they want to use material of this nature to stop the erosion of some of the shores along the Gulf. There is a great deal of erosion into the marshes in fact all along the Gulf in Louisiana.

And a third application that they are working on is for artificial reefs. They have developed formulas that would be economical and compete with material that would come out of Mexico. They have looked at the radionuclide situation to see what would likely happen if they had oysters growing or any other marine creatures growing on this material and they have determined that there is not a significant problem with any of the materials in phosphogypsum going into the food chain.

But they are quite enthused, and in fact, I have a proposal on my desk for some additional work right now from Louisiana State.

Mr. PUTNAM. That is an interesting segue into what other States are doing. Phosphate is not only mined in the United States either. What are other nations doing with phosphogypsum, what are the permitted uses in some of the other areas that also have phosphate mining? Dr. Sumner, perhaps you could speak to that?

Mr. SUMNER. Well, being a native South African, I know the situation in South Africa. The phosphogypsum that is made there is not radioactive, the source of phosphate is a different source and does not contain anywhere near the level of radioactivity that the Florida source does. And the gypsum is freely available and in fact, the excess until recently—they might not have stopped yet, but they are about to stop—was pumped out to sea. So there appears to be no environmental hazards associated with that at all, because it does not contain any radioactivity.

And may I add one——

Mr. PUTNAM. You may.

Mr. SUMNER [continuing]. New potential use, Mr. Chairman. Research has been carried out at the University of Georgia and is still underway, but in a very minor pilot study, we have found that application of gypsum, and it was not phosphogypsum, but generic gypsum, on the top of poultry litter in poultry houses, we can look forward to the possibility that when that litter is applied on land, that the application of gypsum will reduce the level of water soluble phosphorus which is a serious concern for the contamination of surface waters. We have only done this in the lab, pilot study, still going to be extended to the field, but that is another potential source that will be considerable in magnitude throughout the country because of the chicken industry being quite ubiquitous.

Mr. PUTNAM. Thank you. Dr. Chambers, would you like to speak to the international nature?

Mr. CHAMBERS. Yes, I would. First of all, I would like to say that the EPA is well-regarded, as it should be, nationally and internationally, and quite often—I was in Brazil last year and Brazilians basically look to EPA for what can be done with phosphogypsum in application there, again, for road construction. So the EPA's determinations are very important and they extend, not just in Florida and throughout the United States, but they have worldwide implications. And that was a road application I was involved in.

In Canada, at the present time, there are a variety of uses being looked at, one of which—and I am not an agronomist, so I apologize here, but I know that a company north of Edmonton is working with feedlots, cattle feedlot users, and the phosphogypsum is being mixed on an experimental basis to reduce odors. And it apparently is extremely successful. That could be a potentially important use.

There have been experimental studies done on using phosphogypsum to reclaim in northern Alberta something called the Tarsands, which is a large mining operation, there has been experimental work with regard to using phosphogypsum to help reclaim Tarsands, a very good, positive, positive thing, and it worked very well on the experimental test.

So there is work underway. I cannot speak to the work that is carrying on worldwide, but there do appear to be a number of po-

tentially beneficial uses, which have to be carefully thought out to make sure we are not putting anyone at risk, as I said before.

Mr. PUTNAM. Mr. Lloyd, prior to 1989, before EPA redefined a commercial product as a waste product that was therefore eligible for regulation, what were the primary uses of the phosphogypsum byproduct, and was it ever used in the construction of a building, for example?

Mr. LLOYD. Could I answer that construction thing first? Not in this country, but overseas at that same time, you were doing it in Japan with phosphogypsum for building products, wallboard and other structural members; in France, in Belgium; in Germany, at times they have used this for making structural members as well as wallboard. There was no real problem with that.

The biggest uses in U.S. history were agriculture. In California, you had a phosphoric acid plant, there is no gypsum stack. The phosphogypsum was used literally as it was manufactured. In the middle of the United States, you have some phosphogypsum stacks, most of those, there was some gypsum used for agriculture. At the time of the EPA ban, the only commercial application on roads was in Texas and at that time Mobil was actually building roads using phosphogypsum. We were still experimenting and going in a different direction than what they did. They had a different technique than what we were proposing to use.

There have been roads built all over Polk County where the mining companies were concerned, that they used phosphogypsum. There are untold number of parking lots at churches and at places like that, that were built with phosphogypsum because somebody at church worked for the phosphate industry, they could get the phosphogypsum free. You did have one company around here, one paving company, that worked with phosphogypsum all the time on this type of job.

That was about the uses of it.

Phosphogypsum had been used in other parts of the world, not in this country, to recover sulfur to recycle it to make additional sulfuric acid, particularly in South Africa.

But those are about the only uses I know of at that time.

Mr. PUTNAM. Is there a potential for use on unpaved roads, as far as strength and durability and the amount that is spent by local governments to maintain clay roads, unpaved roads in rural parts, is phosphogypsum suitable for that purpose, assuming it were permitted?

Mr. LLOYD. Structurally, yes. This is one of the things that we got into in north Florida with Columbia County. The road that was built up there is an asphalt paved road with a phosphogypsum base. One of the things they wanted to do was to go into all of their dirt, unpaved roads, and take and mix phosphogypsum into the soil and then compact it. The work we have done with Dr. Chang indicated this road would stand up an awful lot better than what the untreated road would. But that never went beyond that point.

When you do this, you will have to face the possibility of some leachate of calcium and sulfur because gypsum is very slightly soluble. We have not done any tests to be able to tell you what that would amount to.

Mr. PUTNAM. And do you know what the industry spends today managing the existing phosphogypsum stacks?

Mr. LLOYD. I would not even want to guess.

Mr. PUTNAM. Does anyone else have a comment on the environmental or economic impact of managing the stacks?

[No response.]

Mr. PUTNAM. Well, with that, I would like to ask each of our first panel of witnesses to make any closing comments that you wish to make, whatever issues we were unable to get to or whatever you wish could come out of this. This has been a process, very long in the making. I can remember trying to work through this issue in the legislature. Growing up in this area, watching these mountains come up, it certainly is an important issue I think for us to resolve for the environmental and economic health of central Florida. All of you have devoted your professional lives to it, so at this time, it is an open mic, beginning with Dr. Shieh and letting Mr. Lloyd have the last word for our first hearing. Dr. Shieh.

Mr. SHIEH. OK. Well, as I said earlier, the result of the study has supported to concept of use of phosphogypsum in landfill applications and if we were able to carry out the field study, by today we should have some conclusive findings available to interested parties. If there were any adverse effects that needed to be addressed, we would be able to identify. So my true belief is if we have something on the way and be able to provide solutions to an existing problem, then I think we should go ahead and do it.

I want to emphasize that this approach will not solve overall our phosphogypsum stack problem at all, but it will provide a solution to help minimize the existing problem. So we are still just waiting and waiting without any solution. I think we should go ahead and make a decision to do it. Thank you.

Mr. PUTNAM. Thank you, Dr. Shieh. Dr. Chambers.

Mr. CHAMBERS. Thank you very much. I will be brief, I think I have said most of what I want to say.

I would just like to reiterate from my examination of EPA's calculations and my own calculations that I believe the doses and the risks to even the most exposed person are small on an absolute basis and very small by comparison to the natural variation in dose from background radiation. And truly in that context, of very little concern.

I would fully support Dr. Shieh and I would like to see some of these tests at least licensed so we can actually get and confirm one model or the other. And I really do not understand the lengthy process in licensing, and in my opinion, it would be unfortunate if the theoretical concerns over radiological risks were to prevent uses of phosphogypsum that would be of benefit to the people of the State of Florida and indeed the country. Thank you.

Mr. PUTNAM. Thank you. Dr. Sumner.

Mr. SUMNER. Mr. Chairman, in summarizing, I would like to first of all draw the committee's attention to another use of phosphogypsum. Currently I hold a patent which was based on wallboard for making kitty litter out of gypsum. It is self-clumping, odorless kitty litter. It is doing very well in the market based on recycled wallboard. But if we were to use phosphogypsum, it would

be even better than recycled wallboard. So that is another potential use.

I would like to just finally say that the maximum rate in agriculture should be figured into the risk assessment calculations as between 600 and 800 pounds of phosphogypsum per acre per year. That would be the maximum rate that it could be used in agriculture.

Thank you, Mr. Chairman.

Mr. PUTNAM. Thank you. Mr. Lloyd.

Mr. LLOYD. I guess I always find it interesting when you re-invent the wheel. Dr. Sumner has said something about using phosphogypsum with chickens, with the waste from chickens. It has got to be at least 10 years ago that I told the DEP in Florida that was one of the ways to stop the odors from a chicken waste. If you will go all the way back into the 1900's, you will find the same sort of thing was practiced, both on dairy farms and other places, except they used what was then called normal super phosphate. But all of the gypsum, when you made normal super phosphate, ended up in the normal super phosphate. The gypsum was what knocked down the odors, what stopped the phosphorus leaching, what did all of the other things.

So we are re-inventing something that we should have known a long, long time ago.

I do think the landfill is one thing that ought to be put on a priority track. This is something that virtually every time you see somebody trying to build a landfill, everybody starts hollering and shouting do not build it near me. So one of the things that would be very beneficial, also very cost-effective, would be to build landfills and use phosphogypsum.

The Institute looks at things from so-called applied research point of view. One of the things in the area of phosphogypsum that we look at all the time is the economic impact. So when we start recommending one of these things, we are not only recommending it because we think it is environmentally sound, we know it is economically practical, and that it will contribute to the Florida economy. So this is one of the reasons we support all of the things we have done.

One thing I would mention, and I am sure that Dr. Chambers will second me on this, every time we have been able to sit down with EPA in a full scale scientific discussion, we have ended up making some progress. But that is again—next to getting an exemption application, that is one of the hardest things to do that you have ever tried to do. We have succeeded twice in the last 20 years. So if there would be some way that we could do this and let some of the things that Dr. Sumner has seen, let some of the things that Dr. Chambers has seen be presented to these people, we could probably make some progress.

I think for the opportunity.

Mr. PUTNAM. I want to thank all of you before we adjourn this first hearing. I want to tell you how much we appreciate the expert testimony that you have given this subcommittee panel. It strongly reinforces the premise that utilizing phosphogypsum can be safe and less costly to taxpayers and as well as being environmentally sustainable. I appreciate your willingness to be here, some of you

have traveled a great distance to share your knowledge and experience and thoughts and in some cases frustrations, and I would like to invite you to participate in the second hearing as well. So for those of you whose schedules allow, I would like for you to remain and participate in that hearing also.

In the event that there may be additional questions that we did not have time for today or did not get to, the record will remain open for 2 weeks for submitted questions and answers. And with that, we will stand adjourned for 15 minutes and reconvene hearing two at 11:15. Thank you.

[Whereupon, at 11:03 a.m., the subcommittee was adjourned.]

PHOSPHOGYPSUM: SHOULD WE JUST LET IT GO TO WASTE: PART 2

MONDAY, MARCH 15, 2004

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON TECHNOLOGY, INFORMATION POLICY,
INTERGOVERNMENTAL RELATIONS AND THE CENSUS,
COMMITTEE ON GOVERNMENT REFORM,
Bartow, FL.

The subcommittee met, pursuant to notice, at 11:30 a.m., in the West Wing, Southwest Florida Water Management District Headquarters, 170 Century Drive, Bartow, FL, Hon. Adam Putnam (chairman of the subcommittee) presiding.

Present: Representative Putnam.

Staff present: Bob Dix, staff director; John Hambel, senior counsel; Ursula Wojciechowski, professional staff member; Juliana French, clerk; and Matthew Joyner, district director.

Mr. PUTNAM. The Subcommittee on Technology, Information Policy, Intergovernmental Relations and the Census will come to order. This is officially the subcommittee's second hearing on phosphogypsum entitled, "Phosphogypsum: Should We Just Let It Go To Waste?"

In 1989, the U.S. Environmental Protection Agency promulgated a rule determining that the commercial product of phosphogypsum was waste product and banned its use for any purpose whatsoever.

Three years later, the EPA modified the rule to allow the use of phosphogypsum from north Florida for agricultural purposes.

Since then, only one other rule has been promulgated. In 1999, EPA raised the limit on the quantity of phosphogypsum that may be used for indoor research and development from 700 pounds to 7,000 pounds and clarified sampling procedures for phosphogypsum removed from stacks for other purposes. This was a step in the right direction.

Testimony provided for our first hearing, which we just concluded, suggests that the use of phosphogypsum can be favorable to farmers, cattlemen and taxpayers, particularly local governments, as a landfill cover, when used as a soil amendment, road base and again, landfill additive. Additionally, concern was expressed that the long-term adverse environmental effects of leaving phosphogypsum in stacks greatly exceeds any risks associated with its use for any purposes researched.

A number of other issues came forward that we hope to explore in this second hearing, including the delays in permitting for additional research and the inability to communicate effectively with the policymakers.

I would like to ask unanimous consent of the other subcommittee members to reseat the witnesses from our first hearing, so that we may benefit from a combined panel of expertise. Without objection, so ordered.

And without delay, I welcome our witnesses and look forward to your testimony.

As is the custom with the Government Reform Committee, all of our witnesses are sworn in. For those witnesses who were sworn in for the first panel, I would ask that you be sworn in again since this is technically a new hearing. And again, for any of our witnesses, if you have someone with you who will provide supporting testimony, slipping you notes, whispering in your ear, providing additional information for the benefit of the subcommittee, we would ask that they rise and be sworn as well.

So with that, please rise and raise your right hands.

[Witnesses sworn.]

Mr. PUTNAM. I note for the record that all of the witnesses responded in the affirmative.

Our first witness is Ms. Elizabeth A. Cotsworth, who is currently the Office Director of the Environmental Protection Agency's Office of Radiation and Indoor Air. She provides national direction for protecting people and the environment from harmful and avoidable exposure to radiation as well as protective measures and guidance for indoor air environments.

Prior to joining the ORIA, Ms. Cotsworth was the Office Director of the Office of Solid Waste from 1997 to 2002, after holding a series of positions managing national hazardous and solid waste programs.

She entered the EPA as a management intern in 1973, she holds a B.A. from Chatham College in History and an M.A. from the University of Virginia in Government and Foreign Affairs.

Welcome to the subcommittee. You are recognized.

STATEMENTS OF ELIZABETH COTSWORTH, DIRECTOR, OFFICE OF RADIATION AND INDOOR AIR, OFFICE OF AIR AND RADIATION, U.S. ENVIRONMENTAL PROTECTION AGENCY; HARLAN KEATON, ENVIRONMENTAL ADMINISTRATOR, BUREAU OF RADIATION CONTROL, FLORIDA DEPARTMENT OF HEALTH; AND DICK ECKENROD, EXECUTIVE DIRECTOR, TAMPA BAY ESTUARY

Ms. COTSWORTH. Thank you, Mr. Chairman, for the invitation to appear here today. I will comment on the approach that the Environmental Protection Agency has implemented over the last 15 years to address the issue of protection of human health and the environment with regard to phosphogypsum.

EPA has specifically regulated phosphogypsum since 1989 with a national emissions standard for hazardous air pollutants called NESHAPS, authorized under Section 112 of the Clean Air Act. Radionuclides are listed there as a hazardous air pollutant. Radionuclides are a known cause of cancer and genetic damage. It is the processing of raw phosphate ore that specifically concentrates radionuclides into the phosphogypsum. Phosphogypsum contains naturally occurring radiation, as well as its decay products such as

radium-226 and radon. Due to its health risk, its radon gas emissions in particular are the target of our NESHAPS regulation.

We strive to provide maximum feasible protection against risks to health from hazardous air pollutants, including radionuclides. We do so by trying to limit exposures such that an individual's lifetime excess cancer risk level is really no more than 1 in 10,000.

In our 1989 regulation, EPA specified stacks as the safest for phosphogypsum management. It is the use of stacks that provide appropriate risk protection with an ample margin of safety, as is required by the Clean Air Act.

Originally, there were no provisions for allowing alternatives of the material, but petitioners approached us afterwards for reconsideration. We determined, considering all of the information available on potential exposures and the associated risk, that certain uses may be considered acceptable as long as those uses are restricted to limit the estimated lifetime risk to approximately 1 in 10,000.

We now allow three types of activities using phosphogypsum.

First, outdoor agricultural uses. For example, as a conditioner of soils with high quantities of salt or low concentrations of calcium or other nutrients, as long as the average radium-226 concentration is less than 10 picocuries per gram. For example, peanut farmers in Georgia apply phosphogypsum to their fields to strengthen peanut shells. Also, when several counties in North Carolina recently found farmland soils to have high salinity, in part because of Hurricane Isabel.

Second, indoor research and development activities using up to 7,000 pounds of phosphogypsum; for example, to study the production of road base and building materials.

And third, other alternative uses that are approved by EPA on a case-by-case basis.

Some activities do not meet the criteria for ensuring safety and health protection on a national basis. For example, we found that a generic national exemption for road building material could not meet the risk criteria. This is because of radium-bearing dusts, which are dispersed as the road surface degrades and radon emissions from the road itself. In addition, when road material is eventually removed, disposed or abandoned, additional exposures can occur.

As we review and consider the safety of new potential phosphogypsum uses, we work in partnership with our colleagues in State government, such as the Florida Department of Environmental Protection. In addition to potential exposure, our review carefully considers impacts on State legal authority and interests such as groundwater protection from any alternative use.

We have received several petitions requesting EPA approval of alternative uses for phosphogypsum. We are currently reviewing a petition for its use as a landfill cover at a municipal solid waste landfill in Brevard County, FL. We hope to have a response on the completeness of this application in the next month to 6 weeks. We are also simultaneously in the process of developing much needed guidance to further and clearly explain the criteria discussed in our regulations, specifically providing our sense of what information is

required for a complete application that can then be evaluated for its support of a publicly and scientifically defensible decision.

We stress the importance of addressing radiation risk and giving confidence perhaps through monitoring, that other constituents in the waste, for example heavy metals, do not pose additional environmental concerns. Additionally, we seek to identify the benefits clearly associated with the alternative use and consistent with the principles of radiation protection, assure that potential exposures are justified and legitimate.

Managing phosphogypsum in stacks consistent with existing regulations is the best current management practice for most phosphogypsum. But we continue to be open to consideration of other beneficial and protected uses and remain supportive of research. Nevertheless, petitions submitted to the agency for such uses must clearly and fully demonstrate that the alternative use will be at least as protective as keeping the material in those stacks.

This concludes my prepared statement. I will be happy to answer any questions. Thank you.

[The prepared statement of Ms. Cotsworth follows:]

TESTIMONY OF
ELIZABETH COTSWORTH
DIRECTOR, OFFICE OF RADIATION AND INDOOR AIR
OFFICE OF AIR AND RADIATION
U.S. ENVIRONMENTAL PROTECTION AGENCY
BEFORE THE SUBCOMMITTEE ON TECHNOLOGY, INFORMATION POLICY, INTERGOVERNMENTAL RELATIONS, AND THE CENSUS
COMMITTEE ON GOVERNMENT REFORM
U.S. HOUSE OF REPRESENTATIVES
MARCH 15, 2004

Thank you, Mr. Chairman and members of the Subcommittee, for the invitation to appear here today to discuss the uses and associated risks of phosphogypsum. I will also comment on the approach the Environmental Protection Agency has implemented over the last fifteen years to address the issue of protection of human health and the environment with regard to phosphogypsum.

Mr. Chairman, EPA has specifically regulated phosphogypsum since 1989, with a National Emission Standard for Hazardous Air Pollutants, or NESHAPS, authorized under Section 112 of the Clean Air Act. Radionuclides are listed as a hazardous air pollutant under this section. EPA has determined that radionuclides are a known cause of cancer and genetic damage, and that radionuclides cause or contribute to air pollution that may reasonably be anticipated to result in an increase in mortality, or an increase in serious irreversible or incapacitating reversible illness. The processing of raw phosphate ore specifically concentrates radionuclides in the waste rock, phosphogypsum. Phosphogypsum contains naturally occurring radiation emitted by uranium-238 and its decay products, such as radium-226 and radon-222. Radium, as it decays, emits radon gas. Due to its health risk, radon emissions in particular are controlled by EPA's NESHAP regulation.

EPA strives to provide maximum feasible protection against risks to health from hazardous air pollutants like radionuclides by protecting the greatest number of persons possible. It does so by trying to limit exposures such that an individual's lifetime excess cancer risk level is no more than one in ten thousand and may be as little as one in a million. This risk is evaluated by assessing potential scenarios and associated exposures of workers and members of the general public to potential sources of emissions.

In our 1989 regulation, EPA specified that the safest thing to do with the waste phosphogypsum was for it to remain in place in the stacks that had been generated at most mining facilities. The use of stacks was determined to provide appropriate risk protection with an ample margin of safety as required by the Clean Air Act. Directing such waste to stacks also prevented the misuse or inappropriate disposal of this radioactive waste.

In that original version of the regulation, there were no provisions for permitting alternative uses of the material. Petitioners approached us after that rulemaking requesting that we reconsider setting standards to permit alternatives to disposal of phosphogypsum in stacks. EPA determined that the risks represented by the use of phosphogypsum in which the maximum individual risk does not exceed the presumptively safe level of approximately one in ten thousand are acceptable. We have determined that in the case of phosphogypsum, considering all of the information available on potential exposures and the associated risk, that certain uses of phosphogypsum may be considered acceptable as long as those uses are restricted to limit the estimated lifetime risk. That risk estimate is calculated using the radium-226 concentration of phosphogypsum removed from a stack at 10 picocuries/gram or less.

We considered a number of uses and modified our regulations to allow a small number that did not present unacceptable risk. This modified rule was published in 1993 and allows three types of activities using phosphogypsum:

- Outdoor agricultural uses, for example as a conditioner of soils containing high quantities of salt or low concentrations of calcium or other nutrients, where the average Radium-226 concentration is less than 10 picocuries/gram. For example, peanut farmers in Georgia apply phosphogypsum to their fields to strengthen peanut shells. This type of use has also occurred most recently in several counties in North Carolina, where farmland soils were found to have a high salinity, in part because of Hurricane Isabel's recent incursion along the coast.
- Indoor research and development activities, using up to 7,000 pounds of phosphogypsum, for example to study the production of road-base and building materials.
- Other alternative uses that are approved by EPA on a case-by-case basis.

Some activities do not meet the criteria for ensuring safety and health protection. For example, we found in our examination of potential uses that a generic exemption for road building material could not meet the risk criteria. This is because of radium bearing dusts which are dispersed as the road surface degrades and radon emissions from the road itself result in undesirable exposures. In addition, when road material is eventually removed, disposed, or abandoned, additional exposures can occur.

As we review and consider the safety of new potential phosphogypsum uses, we work in partnership with our colleagues in State government, in this instance the Florida Department of Environmental Protection. The DEP regulates phosphogypsum stack operating procedures, and has regulations in place for stack monitoring and maintenance. They also regulate the final

closure of the stacks, and have important responsibilities toward protecting their ground-water resources. In addition to potential exposure, our review carefully considers impacts on State authority and interests from an alternative use.

We have received several petitions requesting EPA approval of alternative uses for phosphogypsum. In particular, we are currently reviewing a petition for use of phosphogypsum as a landfill cover at a municipal solid waste landfill in Brevard County, Florida. We hope to have a response on the completeness of this application in the next month or so. We are also in the process of developing guidance to further explain the criteria discussed in the regulations – specifically on what information is required for a complete application that can be evaluated for the purposes of making a publically and scientifically defensible decision on whether an alternative use of phosphogypsum is safe. We stress the importance of addressing radiation risk, and giving confidence, perhaps through monitoring, that other constituents in the waste, for example heavy metals, do not pose additional environmental concerns. Additionally, we seek through our review to identify the benefits associated with the alternative use, and, consistent with principles of radiation protection, that potential exposures are justified and legitimate.

Managing phosphogypsum in stacks represents the best current management practice for phosphogypsum. We continue to be open to consideration of other beneficial and protective uses, and remain supportive of research that articulates possible beneficial uses of this material. Nevertheless, petitions submitted to the Agency for such uses must clearly and fully demonstrate that the alternative use will be at least as protective as keeping the material in a stack.

This concludes my prepared statement. I would be pleased to answer any questions you may have.

Mr. PUTNAM. Thank you very much, Ms. Cotsworth.

Our second witness for this hearing is Mr. Harlan Keaton. Mr. Keaton is an environmental administrator for the Bureau of Radiation Control, a branch of the Florida Department of Health.

Mr. Keaton has been an employee of the Department for 33 years. The last 20 years, he has served as the administrator of the statewide environmental radiation surveillance and radiological emergency response programs. He has received the Hammer Team Award from former Vice President Gore and the Board of Directors Award for Outstanding Achievement in the field of radiation protection from the Conference of Radiation Control Program Directors, of which he is an associate member.

Additionally, he is a member and former two time president of the Florida Chapter of the Health Physics Society. Mr. Keaton was a member of the Technical Advisory Committee at the Florida Institute of Phosphate Research and Chaired the E–35 Marson Committee of the Conference of Radiation Control Program Directors.

Welcome to the subcommittee. You are recognized.

Mr. KEATON. I would like to describe today what the Department of Health's limited role is regarding naturally occurring radioactive material in the environment, and specifically as it is associated with the phosphate mining industry.

The U.S. Environmental Protection Agency has primary responsibility for developing rules and national standards for handling phosphogypsum and waste issues. The Florida Department of Environmental Protection, under the authorization from EPA, also looks closely at the proper disposal and beneficial use of this material. As part of the Department of Health's mission to promote and protect the health and safety of all residents of Florida, we have a limited role in the monitoring of phosphogypsum. Through our Bureau of Radiation Control, we regulate the use of radiation and radioactive materials in medicine and industry. Please note, therefore, that our Bureau is only looking at the radioactive issues associated with phosphogypsum. We understand that there are also other environmental contaminants that can impact groundwater from the disposal and use of phosphogypsum, such as sulfates, sodium, iron, fluoride and trace heavy metals. These contaminants should also be evaluated when making beneficial use decisions about this waste.

The Bureau also has several environmental monitoring programs, including one that monitors the radiation levels on phosphate lands both before mining and after land reclamation. This program has been going on since 1986. The data we have gathered indicates a small—a very small—increase in radiation levels following reclamation of mine lands. However, please note that the premined and reclaimed lands are not identical in makeup to the phosphogypsum, although there are many similarities, including the presence of naturally occurring radioactive materials.

Although the Department of Health does not regulate the disposal or the use of phosphogypsum and has not been directly involved in research regarding the potential uses and possible health risks from the use of phosphogypsum, we do conduct some testing in the mining areas. Our staff have also served as advisors to FIPR to provide input on radiation related matters and advice on appro-

priate research areas. FIPR was established by the Florida Legislature to initiate, conduct or sponsor studies to minimize or rectify any negative impact of phosphate mining and processing on the environment and improve the industry's positive impact on the economy. FIPR is a public entity located within the Florida Department of Education.

One aspect of our direct involvement in assessment of health risks from naturally occurring radiation in the phosphate mining areas is the risks from indoor radon levels. In an effort to control indoor levels of radon, both the EPA and the State of Florida began developing mitigation techniques to be used in existing buildings.

In 1978, the State also embarked on a project to develop radon-resistant construction techniques for new homes built on reclaimed phosphate lands. Standards for new construction and the mitigation of radon in existing construction were developed between 1989 and 1995 by the Department of Community Affairs. These standards, called the "Florida Standards for Radon-Resistant Construction" are also included as appendices of the Florida Building Code. Again, although this effort is not directly related to the use of phosphogypsum, it shows that research can be performed and efforts can be taken to mitigate the risks associated with naturally occurring radioactive material and ensure that risk is at a safe level.

Studies of phosphate workers have not shown abnormal cancer rates and health reviews of populations living in previously mined areas do not indicate an increase or excess of lung cancers. More extensive research about the effects of exposure to phosphogypsum is needed.

In conclusion, it also makes sense to aggressively research appropriate and safe uses for this plentiful product. In Florida alone, we have approximately 1 billion tons in 24 stacks, with an annual product of 30 million new tons of phosphogypsum. We are interested in any scientifically valid research that shows possible health risks or lack of health risks associated with potential uses of phosphogypsum. We believe this is a significant issue that we could understand better through more research, research that can enable us to determine appropriate uses for this material and what steps are needed to protect the public's health and the environment.

We believe that the current practice of stacking the phosphogypsum has potential environmental and public health risks, as evidenced by unintended releases and spills and the recent need to dispose of millions of gallons of gypsum and acidic wastewater. Last year, the Federal Government granted the DEP permission to dispose of the treated wastewater in the Gulf of Mexico. We therefore support and encourage aggressive research to determine safe uses of phosphogypsum, while protecting the health and safety of the residents of Florida. Through this research, developments may allow for better roads, more efficient landfill covers, additional needed sulfur for the soil, and construction materials like safe glass, thereby providing a residual benefit to society.

I am happy to answer any questions that you may have.

[The prepared statement of Mr. Keaton follows:]

Phosphogypsum: Should We Just Let It Go To Waste?

Written Testimony of Harlan Keaton

Environmental Administrator

State of Florida

Florida Department of Health, Division of Environmental Health,
Bureau of Radiation Control

House Subcommittee on Technology, Information Policy,
Intergovernmental Relations and the Census

Committee on Government Reform

March 15, 2004, 9:30 am, 11:30am

Southwest Florida Water Management District Headquarters
In the West Wing
170 Century Drive, Bartow, FL 33830

Mr. Chairman and Members of the Subcommittee, I am Harlan Keaton, Environmental Administrator for the Bureau of Radiation Control, Division of Environmental Health, within the Florida Department of Health (DOH). I have been employed by DOH for 33 years and have served as the Administrator of DOH's Health Physics Laboratory, including several radiological environmental monitoring and emergency response programs, for the last 20 years. I also serve as an advisor to the Florida Institute of Phosphate Research (FIPR) regarding possible research projects. Thank you for the opportunity to discuss with you the potential environmental health risks of phosphogypsum, as well as the potential for its safe applications.

Role of Florida Department of Health

We would like to describe today what DOH's limited role is regarding naturally occurring radioactive material in the environment and specifically as it is associated with the phosphate mining industry.

The United States Environmental Protection Agency (EPA) has primary responsibility for developing rules and national standards for handling phosphogypsum and waste issues. The Florida Department of Environmental Protection (DEP), under authorization from EPA, also looks closely at the proper disposal and beneficial use of this material. As part of DOH's mission to promote and protect the health and safety of all residents of Florida, we have a limited role in the monitoring of phosphogypsum. Through our Bureau of Radiation Control (Bureau), we regulate the use of radiation and radioactive materials in medicine and industry. Please note, therefore, that our Bureau is only looking at the radioactive issues associated with phosphogypsum. We understand that there are also other environmental contaminants that can impact groundwater from the disposal and use of phosphogypsum such as sulfates, sodium, iron, fluoride and trace heavy metals. These contaminants should also be evaluated when making beneficial use decisions about this waste.

The Bureau also has several environmental monitoring programs, including one that monitors the radiation levels on phosphate lands both before mining and after land reclamation. This program has been ongoing since 1986. The data we have gathered indicates a small increase in radiation levels following reclamation of mined lands. However, please note that the pre-mined and reclaimed lands are not identical in makeup to the phosphogypsum, although there are many similarities, including the presence of naturally occurring radioactive materials.

Although DOH does not regulate the disposal of or use of phosphogypsum and has not been directly involved in research regarding potential uses and possible health risks from the use of phosphogypsum, we do conduct some testing in mining areas. Our staff have also served as advisors to FIPR to provide input on radiation related matters and advice on appropriate research areas. FIPR was established by the Florida Legislature to initiate, conduct or sponsor studies to minimize or rectify any negative impact of phosphate mining and processing on the environment and improve the industry's positive impact on

the economy. FIPR is a public entity located within the Florida Department of Education.

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In 1978, the State also embarked on a project to develop radon-resistant construction techniques for new homes built on reclaimed phosphate lands. Standards for new construction and the mitigation of radon in existing construction were developed between 1989 and 1995, by the Florida Department of Community Affairs. These standards, called the *Florida Standards for Radon Resistant Construction*, are included as appendices of the Florida Building Code. Again, although this effort is not directly related to the use of phosphogypsum, it shows that research can be performed and efforts can be taken to mitigate the risks associated with naturally occurring radioactive material and ensure that the risk is at a safe level.

Studies of phosphate workers have not shown abnormal cancer rates and health reviews of populations living in previously mined areas do not indicate an increase or excess of lung cancers. More extensive research about the effects of exposure to phosphogypsum is needed.

Conclusion

It also makes sense to aggressively research appropriate and safe uses for this plentiful by-product. In Florida alone, we have approximately one billion tons in 24 stacks with an annual production of 30 million new tons of phosphogypsum. We are interested in any scientifically valid research that shows possible health risks, or lack of health risks, associated with potential uses of phosphogypsum. We believe this is a significant issue that we could understand better through more research, research that can enable us to determine appropriate uses for this material and what steps are needed to protect the public's health and the environment.

We believe that the current practice of stacking the phosphogypsum has potential environmental and public health risks, as evidenced by unintended releases and spills and the recent need to dispose of millions of gallons of gypsum and acidic wastewater. Last year, the federal government granted DEP permission to dispose of the treated wastewater in the Gulf of Mexico. We therefore support and encourage aggressive research to determine safe uses of phosphogypsum, while protecting the health and safety of the residents of Florida. Through this research, developments may allow for better roads, more efficient landfill covers, additional needed sulfur for the soil, and construction material like safe glass, thereby providing a residual benefit to society.

I am happy to answer any questions that you may have.

Mr. PUTNAM. Thank you very much, Mr. Keaton.

Our third witness for this hearing is Mr. Dick Eckenrod. Mr. Eckenrod is the executive director of the Tampa Bay Estuary Program.

Since joining the Tampa Bay Estuary Program in December 1990, Mr. Eckenrod has directed the development of an innovative management approach for Tampa Bay that seeks to balance economic and environmental concerns.

Before coming to TBEP, he was part of an inter-disciplinary team of scientists and engineers employed by the Southwest Florida Water Management District.

From 1984 to 1987, he advised the Manatee County Commission on natural resources issues as director of the Department of Land and Natural Resources. His responsibilities included mining regulation and management of county-owned conservation areas. He served the county as phosphate mining coordinator from 1980 to 1984.

He has also worked in the private sector as a specialist in water quality management and environmental impact assessment and an environmental engineer with various consulting firms.

A member of the Water Environment Federation, Mr. Eckenrod serves on the Executive Steering Committee of the Agency on Bay Management and a number of other environmental advisory and coordinating committees in the Tampa Bay region.

Welcome to the subcommittee. And you are recognized.

Mr. ECKENROD. Thank you, Mr. Chairman, for this opportunity to address the subcommittee on the subject of beneficial uses of phosphogypsum and some of the environmental issues associated with those uses. I am Dick Eckenrod, executive director of the Tampa Bay Estuary Program.

Tampa Bay is 1 of 28 estuaries of national significance participating in the NEP established pursuant to Section 320 of the Clean Water Act. Tampa Bay was designated an NEP in 1990 by President George Bush and has subsequently developed a cleanup and restoration plan for Tampa Bay. That plan is now being implemented by the program's partners in the public and private sectors.

The Estuary Program is an independent special district of the State of Florida, organized through an Interlocal Agreement under the authority of Section 163.01 of the Florida statutes. The nine-member governing body of the Estuary Program, known as its Policy Board, consists of elected officials or senior administrators from the cities of Tampa, St. Pete, Clearwater, the counties of Hillsborough, Pinellas and Manatee along with U.S. EPA, the Florida Department of Environmental Protection and the Southwest Florida Water Management District.

The Estuary Program does not generally take positions on environmental permits or other regulatory matters, but does endeavor to serve as a source of reliable information and unbiased advice to all interested parties. It is in that spirit that I offer the following comments.

Among the priority issues addressed by the Estuary Program are controlling excessive nitrogen loading to Tampa Bay in order to maintain water clarity and foster expansion of submerged aquatic vegetation or seagrasses in the bay; reducing chemical contamina-

tion of bay sediments and protecting relatively clean areas of the bay from contamination; and developing a long-range dredged material management plan for the bay that will minimize adverse environmental impacts and maximize beneficial uses of dredged material.

Reusing or reclaiming liquids and solids that in the past were considered waste materials and threats to the bay is a key element of the Estuary Program's strategy to achieve its water quality and habitat restoration goals. The Program's local government partners, for example, have made major strides toward nitrogen load reduction by reclaiming domestic wastewater for irrigation of residential, commercial, agricultural and public properties. In addition to reducing nitrogen loadings to the bay, reclaiming wastewater is helping offset demands on ground and surface water supplies for public use.

Another Estuary Program partner, the Corps of Engineers, is selectively using dredged material from ship-channel construction and maintenance to create emergent wetland habitats, restore eroded beaches and improve the quality of submerged habitats in previously disturbed areas. Sediments once regarded as spoils or wastes are now being transformed from environmental liabilities into environmental benefits for Tampa Bay.

Managing the huge and ever-growing inventory of phosphogypsum in Florida similarly offers opportunities as well as challenges. Using all or a portion of the estimated 30 million tons of phosphogypsum generated each year for safe and appropriate uses could reduce the volume of contaminated process water that will ultimately need to be disposed of. And, as the recent experience at the Piney Point facility in Manatee County has shown, reducing the volume of stored process water also reduces the potential magnitude of accidental releases. Options for beneficial use of phosphogypsum should be actively pursued along with the research needed to reasonably assure protection of public health and the environment.

In addition to potential impacts on nutrient loads, evaluation of potential beneficial uses of phosphogypsum in the Tampa Bay watershed should take into account toxic contaminants that have been documented at various levels of concern in Tampa Bay. An ecological and human risk assessment conducted for the Estuary Program by Parsons Engineering Science in 1996 concluded that polychlorinated biphenyls, polycyclic aromatic hydrocarbons and specific metals—chromium, copper, mercury, nickel and silver—were priority contaminants of concern in one or more segments of Tampa Bay. Potential human health and environmental risks of contaminants of concern associated with phosphogypsum should also be thoroughly assessed before specific uses are approved.

In summary, beneficial uses of materials formerly regarded as wastes are now making important contributions to the recovery of the Tampa Bay ecosystem. Potential beneficial uses of phosphogypsum should be similarly explored, together with appropriate health and environmental risk assessments.

That concludes my prepared remarks.

[The prepared statement of Mr. Eckenrod follows:]

TESTIMONY OF RICHARD ECKENROD
EXECUTIVE DIRECTOR, TAMPA BAY ESTUARY PROGRAM

BEFORE THE SUBCOMMITTEE ON TECHNOLOGY, INFORMATION POLICY, INTERGOVERNMENTAL RELATIONS, AND THE CENSUS
COMMITTEE ON GOVERNMENT REFORM
U.S. HOUSE OF REPRESENTATIVES

PHOSPHOGYPSUM: SHOULD WE JUST LET IT GO TO WASTE?
MARCH 15, 2004

Thank you, Mr. Chairman, for the opportunity to address the Subcommittee on the subject of beneficial uses of phosphogypsum and some of the environmental issues associated with those uses. I am Dick Eckenrod, Executive Director of the Tampa Bay Estuary Program. Tampa Bay is one of 28 estuaries of national significance participating in the National Estuary Program, established pursuant to Section 320 of the Clean Water Act. Tampa Bay was designated an NEP in 1990 by President George Bush and has subsequently developed a clean-up and restoration plan for Tampa Bay. That plan is now being implemented by the Program's partners in the public and private sectors. The Estuary Program is an independent special district of the state of Florida, organized through an Interlocal Agreement under the authority of Section 163.01 of the Florida Statutes. The nine-member governing body of the Estuary Program, known as its Policy Board, consists of elected officials or senior administrators from the cities of Tampa, St. Petersburg, and Clearwater, the counties of Hillsborough, Pinellas, and Manatee, the USEPA, the Florida Department of Environmental Protection, and the Southwest Florida Water Management District.

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of stored process water also reduces the potential magnitude of accidental releases. Options for beneficial use of phosphogypsum should be actively pursued along with the research needed to reasonably assure protection of public health and the environment.

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In summary, beneficial uses of materials formerly regarded as wastes are now making important contributions to the recovery of the Tampa Bay ecosystem. Potential beneficial uses of phosphogypsum should be similarly explored together with appropriate health and environmental risk assessments.

That concludes my prepared remarks. Thank you again, Mr. Chairman, for the opportunity to address the Subcommittee.

Mr. PUTNAM. Thank you very much, Mr. Eckenrod.

And before we go to questions, I overlooked a small item when we were administering the oath. If the individuals who were sworn in outside of our seated witnesses would please rise and identify themselves and their title for the record. So everyone who was sworn in outside our witnesses, if you would please come to the front row and we will start on the left and identify by name and position or title.

Mr. ROSNICK. My name is Reid Rosnick, I am an environmental scientist with the Environmental Protection Agency. I am in the Office of Radiation and Indoor Air in Washington, DC.

Mr. PUTNAM. If you could step forward, please, so that we can get this for the record.

Mr. BUTTON. My name is Rick Button, I am a health physicist with the EPA, Region IV in Atlanta, GA with the Quantitative Technical Support Section.

Mr. PUTNAM. Thank you.

Mr. BURKEE. I am Brian Burkee, I am a research director with the Florida Institute of Phosphate Research.

Mr. DEGROVE. I am Bruce DeGrove, I am director of regulatory affairs for the Florida Phosphate Council in Tallahassee.

Mr. POSEY. I am Stan Posey, manager of environmental affairs for PTS Phosphate at White Springs.

Mr. PUTNAM. Thank you very much, and we will begin with our questions.

Ms. Cotsworth, your testimony—you said that the concern of the EPA was to make sure that any increased exposure was justified and legitimate. Did anything that was presented in hearing one lead you to believe that there is a scientific basis for changing the treatment of phosphogypsum from being a waste product to being a commercial product?

Ms. COTSWORTH. We would be happy to sit down with the members of that panel to discuss specifically the points that they made, to work with them to determine if there is sufficient early information that would support a petition to the agency under the regulatory authority that I cited, and to work with them, again, in terms of what we require for a complete evaluation and what we would require in order to be able to thoroughly assess and make again a publicly defensible and scientifically defensible conclusion or decision.

Mr. PUTNAM. So they have your commitment then that you and your people will meet with them and their people to do this?

Ms. COTSWORTH. We would be glad to. I know there have been frustrations, I think on both sides, but we certainly would be willing to sit down and be as clear and specific and informative as we can be.

Mr. PUTNAM. Until 1989, phosphogypsum was treated as any other item of commerce and sold for agriculture and was used locally, as was discussed in the first hearing, for any number of construction projects. What was the basis for the shift in policy from an item—where an item of commerce was suddenly treated as a waste product and subject to regulation?

Ms. COTSWORTH. We were implementing the requirements of the Clean Air Act to control the risks of hazardous air pollutants, and

our source controls were established as the legislation requires us to do consistent with all hazardous air pollutants. And in the 1989 rulemaking, we advised the public that we had found a basis to require management in stacks because of the potential for it to be incorporated into other products and be defused throughout the country such that we would be unable to ensure that the rate on emissions did not present an unreasonable risk. That was the basis.

Mr. PUTNAM. And an unreasonable risk in your opinion would be one that exceeds 1 in 10,000?

Ms. COTSWORTH. Generally yes, the risk range that we used consistently for Clean Air Act regulatory decisions is between 10 to the minus 6 which is one in a million risk to the 1 in 10,000 number generally. And that 1 in 10,000 is also a risk level that we use in many other of our regulatory programs.

Mr. PUTNAM. The risk analysis that you used employed an assumption of 70-year residency for occupants of the hypothetical home. That is a value that is not supported by any available data and shorter residency times are used by your agency in other risk calculations. So why was this item chosen for the 70-year residency risk calculation?

Ms. COTSWORTH. The 70-year residency is actually, again, consistent with the assumption that we use in risk analyses for all of our Clean Air Act rulemakings and for many of our other rulemakings and regulatory activities. There are some decisions where a 30-year residence time is included but for the regulatory purposes, we generally use a 70-year residence time. And we have data that suggests that it is not inappropriate to use for phosphogypsum and farmer residence time.

Mr. PUTNAM. You have studies that suggest that it is not inappropriate to use the 70—what studies were done to justify that action?

Ms. COTSWORTH. We have conducted studies, I believe that were associated with the 1992 and possibly the 1989 regulatory actions. I would be happy to go back and research and submit those particular studies and statements for the record.

Mr. PUTNAM. Well, I am just trying—the Federal Register in 1989 does not specify a reason for the ban, so I think it is important to know what action—what studies precipitated that action. And Dr. Chambers, in the first hearing, stated that your own handbook uses a 30-year risk model. Could you explain that difference?

Ms. COTSWORTH. I believe that the handbook that is being referred to is used in regard to cleanup decisions associated with our so-called Superfund program. I cannot absolutely say for sure, but I believe that is the reference. But in terms of most of our regulatory decisions, including those under the Clean Air Act, we do use a 70-year timeframe.

Mr. PUTNAM. For actions under the Clean Air Act, you use the 70-year timeframe. And is that directed by law or is that an internal rule?

Ms. COTSWORTH. I believe it is an internal approach, I cannot state with certainty. I will be glad to again check into that and get back to the staff.

Mr. PUTNAM. Why would there be such a dramatic risk calculation for a Superfund site which can be anywhere in a community

and, you know, through recent legislation on brown fields and everything else, subject to other uses—why would there be such a dramatically different risk calculation for that than there is for Clean Air Act compliance?

Ms. COTSWORTH. Well, the difference is largely a cleanup, a remedial situation dealing with contaminants that already exist in the environment as opposed to rulemaking, national generic level rulemaking, which are intended to be protective and preventative in nature.

Mr. PUTNAM. The calculations that you did use averaged the amounts of phosphogypsum used for soil treatment in California and in fertilization in Georgia and arrived at an annual application rate of 1,350 pounds per acre per year. Is there a practical basis for that application rate that you all used? Are you aware of any farmer who uses that much phosphogypsum?

Ms. COTSWORTH. The determination was based on data and information that was submitted to the agency and that is included in our background information document. And again, we were developing a national regulation, which is generic in scope and application rates across the country do vary, according to crop type, soil conditions, purpose of the application. And for us to be generally conservative and take into account the possibility of reasonable worst case exposure assumptions, we did use data and information provided from California in determining the application rates.

Mr. PUTNAM. Is there not an ability for you—you referred to the general application rate in a general generic rule to be applied nationwide. Is there not a basis for you to develop or promulgate a regional rule that would apply to sodic soils in the western United States and a different one that would apply to the treatments that are used in the southeastern United States, just as other aspects of EPA promulgate different labels for different crops in different regions?

Ms. COTSWORTH. It is possible; however, it becomes very difficult to implement, difficult to enforce and it transfers, in large part, the burden of implementation to the farmers and the small agribusinesses that would then have to spend the time and effort to be careful in regard to the use of a product as opposed to us regulating the content from the start.

Mr. PUTNAM. I appreciate your sympathy for the farmer and small business, but EPA has never hesitated to transfer that burden in the past.

The soil treatment and fertilization, two unrelated practices, why were those two unrelated practices used to justify the ban for fertilization? Again, would it not be reasonable to have a rule for fertilization and a rule for soil treatment?

Ms. COTSWORTH. Again, as I just indicated, the agency concluded that in order to provide protection for the possible most reasonable worst case scenario, that it was not appropriate to make that distinction.

Mr. PUTNAM. That is a fairly subjective thing. How do you know what a reasonable worst case scenario is? I mean, if you use this high concentration for sodic soils but you only do it once and then you are done for decades, if not forever, and then in the case of the peanut growers, they are using it every third year, is it the judg-

ment of EPA's scientist, is it peer reviewed? How do you come about determining a reasonable worst case scenario?

Ms. COTSWORTH. It is based on a risk assessment that is conducted according to the risk methodology that is in general use across EPA. There may have been some changes in methodology improvements over time since the 1989 and 1992 rulemakings; however, the risk assessments that were conducted at that time were consistent with all of the agency's practices and policies regarding risk assessment, including the scenarios, media transfers and how to use our data. Those risk assessments are normally, as with all of our background documents, are part of the public docket that is associated with public comment and notice rulemaking. They should have been available for public review at the time of the issuance of both the proposed and the final regulations.

Mr. PUTNAM. Well, let us come back to Florida for a second. What is the basis for banning north Florida phosphogypsum for roads but not for agricultural purposes when the road bed use has a lower risk than agricultural use? In other words, you have said it is OK to spread it on the fields that in a rapidly urbanizing State have a high risk of being homes in our lifetime, but banned it from a road bed usage, which is probably—which is highly unlikely in this State and most any other. What is the basis for that?

Ms. COTSWORTH. Well, we did evaluate, as I said, generically road building in the 1994 regulation and we did find that certain exposures would lead to excess cancer rates, in excess of the risk range that we specified, and that in fact road bed usage did have a higher risk than actually agricultural usage.

Mr. PUTNAM. What roads were you testing to make that determination, what tests, what studies indicated that the cancer rate—the risk rate would be greater?

Ms. COTSWORTH. The studies are detailed in our 1992 background information document. I apologize, I cannot personally speak to the specific studies that are accounted for here.

Mr. PUTNAM. Does your colleague know?

VOICE. No, I am sorry, I do not. I would have to look through the actual background information.

Mr. PUTNAM. Well, could you do that while we move on and we will come back to you.

Mr. Lloyd, do you know what studies the EPA used for their 1994 rule?

Mr. LLOYD. Some of the things that are mentioned we have never been able to find in the BID documents, so I do not know. We would be interested in finding the data that we requested in 1995 as to how they did the risk assessments for the 1992 rule. We have never been able to get the documents to show what the actual calculations were and it would be appreciated if we could get them.

Mr. PUTNAM. Is that type of document available to the public, Ms. Cotsworth?

Ms. COTSWORTH. The public record for that rulemaking should still be available. What I cannot personally attest to is whether the documents or calculations that were just referred to are in that rulemaking record. Again, we do have high standards for the documentation and technical support documents to be included in our public docket and in our—and referenced in our preambles to our

regulations. I apologize that, not having been with that office when the 1989 and 1992 regulations were promulgated, and at this point I have not seen those entire rulemaking dockets to be able to say specifically whether what was just alluded to is there, but I would certainly hope so.

Mr. PUTNAM. I would hope so too and I will make this my official request for those records and supporting documents and working papers as well, and we look forward to receiving those.

Why does EPA make atypical assumptions when calculating risk assessments for phosphogypsum in the 1992 ruling that are as unreasonable as those used in the 1989 rule that require correction only after a successful challenge?

Ms. COTSWORTH. Again, the regulatory process allows for public input, public participation, particularly in regard to the way our proposed and then final regulations are crafted, giving people the opportunity to comment on the technical information upon which our decisions are based. Certainly the additional input that was received by the agency post-1989 was found to be useful for making subsequent regulatory modifications and we always remain open to new information, new data for consideration as to whether we need to improve or change our regulations, or in this case, because we have a petition process, to be able to use the petition process to exercise regulatory flexibility.

Mr. PUTNAM. And how long does that regulatory flexibility usually take to work its way through the process?

Ms. COTSWORTH. It probably takes longer than the petitioners here would have liked. And we have not approved any petition to date. In part, that is probably due to change over in our staff and lack of clarity for the petitioners as to what we really need in a petition application. In some part, it is also due to the amount of time that it has taken for petitioners to respond to our data requests and our requests for more analyses.

Mr. PUTNAM. And do you know how long it took them to respond to your requests, the petitioners? How long did it take for them to respond to your requests for additional information?

Ms. COTSWORTH. I believe in some cases there has never been a response and in some cases, it has taken many months.

Mr. PUTNAM. And with regard to Dr. Shieh's request for a permit to move forward with phase III, that was a 4-year and still counting pending request—it seems to me this is unnecessarily adversarial. You have a group of credentialed, published, highly regarded scientists pursuing a line of research. In other words, they are seekers of information, of knowledge, of hopefully a solution to what we believe is a problem in the stacks. It would seem to me that at bare minimum for research purposes, the EPA would embrace that type of search for knowledge. Recognizing your own limitations as an agency and personnel constraints and funding constraints and everything else and the myriad of environmental issues you have to deal with, it would seem that when you have a group like this, and undoubtedly they are not the only ones, that that would be something that you would really embrace and join hands and move forward to solve an environmental problem.

I mean, I think everyone would admit that is not really how it is. I mean it has become this adversarial issue for years. I mean

it predates me but as recently as 5 years ago in the legislature when we tried to work through this. You can never find anybody to give you an answer, you can never find anybody that seems really interested in working to make it work. And that is the rub, that is the real frustrating part here.

We have all kinds of questions here about why things went the way they did and why they have not been answered and why we are waiting 4 years just to be able to dig a plot to research landfill material. I mean we are not talking about cancer drugs here, we are not talking about distributing something to every mouth in America, we are talking about allowing research to go forward. And for some reason, whether it was you or your predecessor or the agency's culture, there is this adversarial issue. Help me understand that or please convince me that is not the case.

Ms. COTSWORTH. I agree, it has been adversarial and what I believe and I believe the new administrator wants to make sure is that there is collaboration and honest dialog. You talked about the 4-years for review of Dr. Shieh's petition. Last June, members of my staff came here and had a meeting and basically indicated that what we had already in hand did not discuss the very issue of most concern to us, which was radioactivity. We have had a resubmission, additional information since December of last year, and we are actively reviewing that petition right now and at the same time trying to develop useful and clear guidance for all the petitioners in regard to what we expect relatively to again a complete application and one that will then support a final and clear decision.

I too believe that the process should be finite in terms of time, it should be transparent for everyone, the petitioners as well as others, including the general public who may have an interest, and that a decision is rendered. It may not necessarily be the decision that someone wants but I want to be able to give someone a final yes or no answer on the petition and to be able to tell them clearly why it was the answer that it was, so that they can understand and that we can again defend it in the public view and it will withstand scientific and technical challenge.

Mr. PUTNAM. There clearly are a lot of reasons why this has become a problem. But a change of administration is not one. When you look at the EPA and the number of employees that change from administration to administration, no matter who the President or the Administrator is, it is minimal. I mean this is a professional staff issue. The political appointees are not running road tests, road bed tests on radium-226. Regardless of who the Administrator is or who is in the White House, there ought to be some cultural openness to research and the search for answers.

Prior to EPA's 1989 rule banning the use of phosphogypsum, EPA conducted public hearings on whether or not to put layers of soil on top of the stacks to reduce the radon emanation that might be harmful to the people living in the vicinity of the stacks. Those public hearings concluded that the risks did not justify that action.

Now if the risk of having a multi-million ton concentration of phosphogypsum did not justify sprinkling top soil over it to reduce radon emanations, why would the risks exist in sprinkling phosphogypsum in central Florida agricultural fields or in building a road bed out of it?

Ms. COTSWORTH. I am not personally aware of the public meetings or hearings to which you refer. So I am unable to comment on that. But certainly as we consider additional uses, we have to look at a variety of scenarios and pathways through which people are exposed. And the presence of phosphogypsum in roads and agriculture can sometimes present different exposures than stack management and each one needs to be evaluated accordingly and appropriately.

Mr. PUTNAM. But you said radioactivity is the real issue. I mean that's really the issue.

Ms. COTSWORTH. Right.

Mr. PUTNAM. And so 40 million tons stacked, to me just common sense would say that radioactivity would be a greater issue in that concentrated form at that scale—that has to be a larger issue than when it is evenly spread in a road bed or on an agricultural field. And these are from the public hearings that your agency had prior to the 1989 rule.

Ms. COTSWORTH. Again, I am just not familiar with those public hearings and the situation that is being described, but again, it is looking at different exposure scenarios and certain management controls that are in place relative to the stacks that would not be present in other uses.

Mr. PUTNAM. You were provided these questions in advance of this hearing.

Ms. COTSWORTH. That is right, and between Friday afternoon and today, I could not find any reference to the hearings that were mentioned.

VOICE. Congressman, I could provide some light on that question.

Mr. PUTNAM. Please. Speak into the mic, come forward please and speak into the mic.

Mr. BUTTON. Richard Button. With regard to the soil on top of the stack, what we found is that on a stack, due to weight and volume, it creates its own cap, so putting soil on top of a stack does not reduce the radon emissions any more. And we find that the radon emissions tend to be greater on the side where the cap is broken up, which would explain why if you spread it out on farmland, the radon emissions would be higher than or equal to what they would on top of the stack.

Mr. PUTNAM. Thank you.

When did EPA last visit the phosphogypsum stacks to get a read?

Ms. COTSWORTH. I believe staff from my office, during their visit in June of last year, actually visited a stack.

Mr. PUTNAM. And did you test their level of radiation?

Ms. COTSWORTH. It was not a compliance visit or any kind of enforcement visit, it was for the purpose of information sharing relative to the petition process and getting a better understanding and appreciation of the problem and the issue.

Mr. PUTNAM. And as part of that information sharing, did you all test the stack?

Ms. COTSWORTH. No, not that I am aware of.

Mr. PUTNAM. Mr. Lloyd, do you know if they tested the stack while they were here?

Mr. LLOYD. The stacks were last tested prior to 1989, as Rick can attest to.

Mr. PUTNAM. And not since then?

Mr. LLOYD. Not at all that I know of.

Mr. PUTNAM. If radioactivity is the issue, and we have 24 stacks around the State, it is not a big enough issue to have an ongoing radiation testing program?

Ms. COTSWORTH. The NESHAPS that I referred to has been delegated to the State of Florida and I believe any monitoring would be conducted by the State. We have not—and I will look to Dick for some confirmation on this, I do not believe we, EPA, have done any oversight inspection or testing.

Mr. BUTTON. That is correct.

Mr. PUTNAM. OK. You are from the air quality/radiation piece of EPA, is that correct?

Ms. COTSWORTH. Yes, I am.

Mr. PUTNAM. Is there another piece of your agency that deals perhaps with water quality that is concerned about the concentration of these stacks and the Piney Point incident and the potential ecological hazard that stacking phosphogypsum presents?

Ms. COTSWORTH. I think it is safe to say yes, we are all concerned about what happened last year at Piney Point.

Mr. PUTNAM. Well, but it seems to me that your piece of the EPA has determined that—at least in 1989, you determined that it is safer to stack it up than it is to spread it out. But is there another office in another wing of Atlanta's regional headquarters or some place in Washington where the water quality people are saying we have a real problem here. We have hundreds of millions of gallons of acidic water building up in these stacks that we might need to do something about. Is there coordination within EPA between air quality and water quality as it relates to gyp stacks?

Ms. COTSWORTH. There is within the regional office, which was the group that dealt primarily with the Piney Point situation. I know Mr. Button here was involved as well as our Region IV emergency response personnel. I have not been approached by the EPA water office in regard to phosphogypsum during the time that I have been office director. But I would certainly not only coordinate with other State and appropriate agencies in regard to a phosphogypsum use application, but I would have to consult with my counterparts across EPA in terms of any concerns or issues that would arise that deal with their statutory responsibilities and the programs that they implement.

Mr. PUTNAM. Mr. Button, could you please come back to the microphone, since you were part of the emergency response to gyp stack management that occurred last summer?

Are you aware of a multi-disciplinary approach to managing these?

Mr. BUTTON. Yes, when Superfund emergency response in Region IV Atlanta, they were asked by the State of Florida to provide assistance and when they found that phosphate plant had some low level radiation, I met with them and talked with them and gave them some input on the radiation risk associated with it, and also talked to their water people and everybody else that could provide input for their response.

Mr. PUTNAM. Are you aware of any reports that the water people, as you put them, any conclusions that they arrived at that perhaps managing the stacks as we do today might not be the best approach from a water quality perspective?

Mr. BUTTON. No, I am not, but the Superfund emergency response people may be. I am not aware of that.

Mr. PUTNAM. Could you please, when you get back to the office, see if that information exists? I would like to make that official information request.

Mr. BUTTON. Yes, I can do that.

Mr. PUTNAM. So we can review their conclusions as it relates to their opinion of our management of phosphogypsum stacks.

Mr. BUTTON. Well, they officially made a decision to dump the water into the bay, so I'm sure there is some documentation to support that. So yes, I can followup on that.

Mr. PUTNAM. And assuming another rainy season, we might have to dump some more into the bay. So it becomes an ongoing water quality environmental hazard that does not appear as being necessarily shared with the air quality folks. Thank you.

Mr. Keaton, in your testimony, you mentioned that the State of Florida developed standards for radon resistant construction. Could you describe those in some detail and tell us how or if they might foil the 70-year residency assumptions that EPA used in their risk calculation?

Mr. KEATON. Let me caveat that by saying there was a lot of work going on at the time. The Florida Institute of Phosphate Research had a program where they were doing mitigation in homes, they actually built some homes. Florida and the Environmental Protection Agency at that time were developing mitigation techniques and eventually that turned into a project where new construction was to be used on reclaimed phosphate lands.

What basically these construction techniques do is prevent radon—or at least reduce it significantly from getting into the home and also lowering through the slab and elevated crawl space, lowering the gamma levels that could possibly be in a home. So these techniques would be very effective if you were to build a home on phosphogypsum or reclaimed phosphate lands.

Mr. PUTNAM. Does the Department of Health conduct their own risk calculations in the everyday work of your oversight of health and safety issues for the State?

Mr. KEATON. We do when there is an emergency situation, when we see major problems. There has been a lot of work that has already been done in this area, especially on the workers at the phosphate mines. We have looked at areas like the Cornet, I am sure you are familiar with that, we have also looked at Stouffer Chemical, these areas, and have not yet to date found elevated levels.

As far as an area-wide study on all the people in this area; no, that has not been done. But by that same token, we have not seen any levels that would indicate that would necessarily need to be done.

Mr. PUTNAM. But could you please refresh my memory on what you found in your health studies of the phosphate workers in populations living in the previously mined areas?

Mr. KEATON. They did not show any increase in lung cancers or any health effects. As a matter of fact, there were many studies done, there was—I have them here—I mean I do not have the studies, but I have the information, if you would like to have it.

Mr. PUTNAM. We would. Could you please, if you would, tell us if you believe the differences in the north and central Florida phosphogypsums are significant enough to allow the use of one and ban the use of the other?

Mr. KEATON. Well, there is a radiological difference, but we are looking at very low levels of radioactivity. The Environmental Protection Agency has done risk assessment on that and these are models. OK? You put information in, you get information out. If you look at these models and you change the parameters that you use, it would seem that from what we have seen from the SENES reports that, no, there may not be a problem.

What we would like to see is the EPA and the FIPR come together on this and make decisions on what uses and what risks are going to be acceptable and we can go from there.

Mr. PUTNAM. You know, let me perhaps go to one of our scientists. Again, help us understand the difference between the north Florida and central Florida in terms of the number of picocuries and what that really means in the context of atmospheric radiation or just inherent radiation that exists today. Give us some context for that, if you would.

Mr. CHAMBERS. I will try first. I am sure Mr. Lloyd or others will correct me.

I believe north Florida has a radium content in the order of 10 picocuries per gram and central Florida phosphate perhaps might be 26–27, something like that. So that is about two and a half times the radium-226 content. All other factors being equal, the rate of release of radon would be proportional to the concentration of radium-226. And that is why it is so important in looking at these risk assessments, whether it is EPA's or ours, to be reasonably conservative but not unrealistic or not unreasonable. And I think it was quite clear from Dr. Sumner's discussion this morning that there is a practical upper limit on the rate at which phosphogypsum might be applied, for example, to a farmer's field. And that is, for example, a ratio of 2,700 to 900, 2,700 being the upper 95 percentile as determined by EPA. That is larger than the difference in the radium-226 content.

So basically with any reasonable application rate and even following EPA's methodology, there should be no practical difference in the risk that would result from radium and radon.

Mr. PUTNAM. And Mr. Lloyd, do you or anyone with you have any additional information on that as it relates to how that compares to other activities that might lead to radiation exposure?

Mr. CHAMBERS. I will come back to that as well. I do not have my litany of comparisons in front of me. I think I said earlier that at my age, I have a risk of about one in a million dying from natural causes during this hearing. In any event, if you look at EPA's risk range of 1 in 10,000 lifetime, that is approximately equivalent to one in a million risk per year. So my 1 hour or 2 hours here from natural causes would be a risk of one to two in a million of passing away from natural cause during this hearing.

Similarly, if I was a smoker, and I am happy I am not, smoking somewhere between one and two cigarettes, that is all it takes, would be the kind of risk that you would get, that would result in a risk of one in a million. Similarly, if I was flying from Tampa to Colorado to go skiing and return, that kind of flight would incur an extra radiation risk in the order of one in a million. Here, the extra radiation is from outer space from cosmic rays, because as you go up in the air, higher in the altitude, the protection from the air from outer space cosmic rays is less. So basically a risk of one in a million is about the same as my chances of dying, it is about the same as a return flight from Tampa to Denver, it is about the same as smoking a cigarette or a cigarette and a half.

Mr. PUTNAM. A cigarette per year?

Mr. CHAMBERS. No, one cigarette.

Mr. PUTNAM. In your lifetime.

Mr. CHAMBERS. That is a risk of one in a million.

Mr. PUTNAM. Let me see if I can shuck the corn a little bit here. [Laughter.]

Are you saying that if you did stay in a house 18 hours a day, 7 days a week for 70 years and if you employ this model that EPA has constructed for phosphogypsum, even if you did do those things, it is the equivalent exposure to radiation as flying from here to Colorado to go snow skiing?

Mr. CHAMBERS. Plus or minus the uncertainties, I believe that is about correct.

Mr. PUTNAM. So even if you do employ their maximum risk model, you are still talking about negligible risk compared to every other normal activity.

Mr. CHAMBERS. Yes. As I indicated earlier, I feel that yes, there is a risk, it is a theoretical risk, but to me it is incredibly small and from my perspective, of no consequence because you are looking at an annual risk of about one in a million which converts to a lifetime risk of 1 in 10,000 and that is what we are regulating this industry to.

Mr. PUTNAM. Ms. Cotsworth, is that the typical benchmark that you all use in promulgating rules?

Ms. COTSWORTH. Basically our decision is consistent with the approach that the agency takes in regard to its regulation. Our philosophy is that regardless of the background and the risks that already exist, that we are required to take action to prevent additive additional risk over and above what people are already exposed to.

Mr. PUTNAM. Additive risk——

Ms. COTSWORTH. Any incremental risk that is within our purview, we try to control.

Mr. PUTNAM. Any additive risk above 1 in 10,000, greater than 1 in 10,000, or any additive risk?

Ms. COTSWORTH. Any additive risk. We look at an excess cancer rate of 1 in 10,000 as the basis for possibly regulating.

Mr. PUTNAM. Is that an internal decision or is that set by law?

Ms. COTSWORTH. In regard to, again, radionuclides as a hazardous air pollutant, there is a long history regarding the Clean Air Act implementation, the so-called benzene rule, court decisions that indicate that the agency is appropriate to be looking at excess risk in terms of 10 to the minus 6 and 10 to the minus 4 range and

applying a margin of safety. So that has been defended both in court and in other regulatory decisions.

Mr. PUTNAM. But you just said that you all attempt to control any additive risk, even I assume lesser than that 10 to the minus 6.

Ms. COTSWORTH. Right, we actually look at a range of one in a million and very often we back off from that to the 1 times 10 to the minus 4. In some cases, 3 times 10 to the minus 4. It's not an absolute hard line but it is generally 1 times 10 to the minus 4 in our regulatory decisions.

Mr. PUTNAM. I am sorry, go ahead.

Ms. COTSWORTH. No, that is fine.

Mr. PUTNAM. Do you believe that their research is correct, that their findings on the risk are what they say they are?

Ms. COTSWORTH. I would like to have the opportunity to look at it more thoroughly and look at the assumptions that were used, again, the scenarios to see how the studies and the research do compare against the risk assessment methodology that we used. It sounds intriguing.

Mr. PUTNAM. And if that is the case—well, I think they are dying to share it with you. But if it is correct, would that be the basis for changing the rule—would that be an adequate basis for changing the rule? Is their research adequate or do you have to go back to EPA and duplicate their research or do you accept them as accredited, certified, legitimate researchers?

Ms. COTSWORTH. We would—I would not be able to say yes, we would revisit the regulations based on what I have heard today. We do not at this point have what we consider to be sufficient and compelling reproducible data and information that suggests the need to completely overhaul the regulation. We are open to receiving data and information and assessing whether it is sufficient and adequate. We also encourage people to use the petition process that we have already set up. Since the regulation development process in the agency probably takes at least 5 years, the fact that we have an administrative option that is built into the current regulations, the agency has a preference, as I believe I stated before, for using the administrative procedures that are available to provide the flexibility and the relief on a more site-specific or region-specific, use-specific basis. And therefore not undergoing the very long laborious regulatory change process over which there is no control as to the outcome.

Mr. PUTNAM. Do you have a list of the information that they have not submitted or that you believe is insufficient, that they could check off. These are the things that EPA definitively says they must have? Do you have that?

Ms. COTSWORTH. We have correspondence with certain individuals in the record. We are working at the same time as we are processing the current petition, Mr. Rosnick, who is behind me, is the staff person assigned to that, and he is also, by virtue of reviewing that petition, trying to develop a quick, easy-to-use, simple guidance, probably no more than a fact sheet, that can more readily and clearly indicate what are the requirements that we have for, again, a complete application, which then can be thoroughly evaluated.

Mr. PUTNAM. Is the definition of a complete application a moving target? Is that what I am hearing you say, that you are trying to put together a fact sheet, but as of now, nobody really knows what meets your definition of complete?

Ms. COTSWORTH. The requirements that are in the regulations are very limited in their definition. We are trying to provide the definitiveness that the petitioners need, and again, based on our experience with working with the petitioners, they do need additional guidance from us as to what are the elements of the petition that are of most concern to us. As we indicated last June when we were here, we really want to know about the radioactive content and the issues related to that. We want to see if there is possibly any monitoring information that could be used to evaluate whether there are any other environmental hazards posed by the activity, the use or the research.

I agree it would be ideal if that guidance had been prepared some time ago. I cannot tell you why specifically it has not been, but it is important enough for me and my management team in the Office of Radiation and Indoor Air to say that this year, we want to provide our petitioners with good guidance so that they can develop a petition that is as quickly as possible able to be declared complete and then is ripe for that technical evaluation. And we commit to working and being in dialog with the petitioners, so again, they can clearly understand, as opposed to hearing it from, you know, a letter subsequently in terms of additional needs that still need to be met.

Mr. PUTNAM. So you certify that their application is complete and then you have to go evaluate it on its technical merits?

Ms. COTSWORTH. Yes.

Mr. PUTNAM. And where would you do that analysis? You don't have phosphogypsum in your office in Atlanta, you don't have it on Pennsylvania Avenue, so what laboratory does that occur in?

Ms. COTSWORTH. It may or may not occur in a laboratory. A lot of the review would be actually, again, evaluating and reviewing the documentation and the information that has been submitted on paper. We probably would want to come and visit with the petitioners and see some of the situations that they are talking about, we would ask what kind of monitoring data they have and can make readily available to us, what kind of monitoring information perhaps the State regulatory authorities might have. But we do not necessarily use a lab, but we will use, again, risk assessment methodologies——

Mr. PUTNAM. So if you certify it as complete and after visiting with the petitioners, it would be their research that you accepted after some review—if you certified it as complete and you made that determination, you would not recreate the wheel, you would work off of the research that has been done in Florida, is that what I am hearing you say?

Ms. COTSWORTH. That is right. And we might suggest some—as I believe was alluded to earlier, perhaps some controls, institutional controls, that might, in conjunction with the data and the science and the information, serve to again ensure that there is no unacceptable risk, that the risk is equivalent to the risk that the stacks pose right now, and go into our decisionmaking.

Mr. PUTNAM. The fundamental policy you are working off of, correct me if I am wrong, is that the stacks are inherently safer than any of the alternative uses proposed.

Ms. COTSWORTH. As of this time, yes.

Mr. PUTNAM. And so the standard that the petitioners——

Ms. COTSWORTH. When they are managed in accordance with current regulations.

Mr. PUTNAM. OK. The standards that the petitioner must then rise to is not that the alternative use is safe, but that its benefits outweigh the benefits of keeping it stacked up behind us here, is that correct?

Ms. COTSWORTH. We look at the benefits. It has to be equivalent in terms of the risk. We look at risk to human health and the environment and it has to be in a way that we can translate to safe and protective of human health and the environment, which is no greater than a 1 times 10 to the minus 4.

Mr. PUTNAM. But they have to prove though that it is a better use than the being stacked up, not just that it is effective and safe in the landfill, not just that it is safe and effective in a road bed, not just that it is effective and safe as an artificial reef or in a glass container on a rocket to Mars. They have to prove that it is better than being stacked up, because that is the fundamental policy that you are weighing against.

Ms. COTSWORTH. It has to be a use that is beneficial, a use for which there is a market, that there is a——

Mr. PUTNAM. Or that a market could be created from, whether there is an existing market.

Ms. COTSWORTH. Or that we have some reasonable assurance that a market could be created for. There are situations in regard to other wastes that I am aware of where not all uses would be considered beneficial and legitimate.

But our bottom line is the risk.

Mr. PUTNAM. Are you familiar with something called PATHRAE?

Ms. COTSWORTH. It is a model that my office relied on in regard to I believe the 1992 and subsequent rulemakings. That is as much as I know about PATHRAE.

Mr. PUTNAM. So it is the EPA's model for risk assessment, or it was at least in 1992.

Ms. COTSWORTH. It is a model I believe. I may be able to ask—I know it is cited in this document. I apologize, I cannot go technically any further in discussing PATHRAE.

Mr. PUTNAM. But it is the model that you used to promulgate the rule in 1992, it is the research model that you used, correct?

Ms. COTSWORTH. It was used. I cannot tell you whether it was the only model or not, but it was used.

Mr. PUTNAM. But you used it, so we assume that you would accept it, it is a pretty good model if you used it in 1992. Has any of this additional research been done using the PATHRAE model so that we could compare apples to apples, Dr. Chambers?

Mr. CHAMBERS. If I might comment. In 1998, it was, I believe, we did a very detailed risk assessment for FIPR on using phosphogypsum for roads and agriculture. And as a first step, we thought we would try and benchmark our models against the models used in the 1992 BID and there were in fact two models,

PATHRAE which is referred to as a multi-media pathways model, it takes air and soil ingestion; and I believe in some cases EPA complemented the PATHRAE model with a model called MicroShield, which is another widely used model for gamma radiation.

I do not have time here, but with some effort, we actually had some difficulty in tracking down the actual inputs that EPA used, but we were able to, in the end, reproduce their 1992 BID results plus or minus a few percent. So as a first step, we did reproduce them.

Then basically, because these models were quite awkward to use, we did a screening calculation using other regulatory models. We continued to use MicroShield plus also the models by NRC which were a bit more advanced at the time and easier to use, and for the same inputs, we could benchmark those also to the earlier PATHRAE. When we did a screening using the NRC models, we again came up with the same conclusions that the other pathways were negligible and it was really radon and gamma that were the issue.

So yes, we have been able to test them. We can, with the same assumptions, reproduce the EPA's numbers.

Mr. PUTNAM. Ms. Cotsworth's concern is that the models that are being used in this research may differ from EPA or may make certain assumptions that would not be the assumptions that they would make if they were running the same risk calculation. I am paraphrasing you, but what have you done in your research to ensure that it is something that the EPA would accept, that the models are credible, that they are using the right assumptions and that it is good science?

Mr. CHAMBERS. There is a whole history to this. As I mentioned before, we were able to benchmark our model. By benchmark, I mean get the same results for the same inputs to the EPA's models. And then to move forward, we did more than EPA with regard to pulling together information that is relevant to the situation in Florida for the soil application rates, road construction methods, house construction methods, indoor radon as it relates to soil radium-226 levels. And this is actually based on data that is documented in our report. I quite strongly believe that if we had the opportunity, we could convince EPA quite readily that our models were reasonable. It might be more difficult to convince them that our assumptions are appropriate; for example, the 70-year residency and this kind of thing.

However, I would like one final comment, to add that there is an inconsistency within even the radiation side of things between 70 years and 30 years, but also between Office of Radiation Programs and Office of Solid Waste. As I mentioned earlier, in 1999, when EPA did an examination of potential hazards from using fertilizer, they actually used a farm residency of 17 to 18 years, which is yet a different number.

So I think—I believe we can demonstrate good science behind our models and indeed EPA is moving toward the kind of modeling that we did, which uses Monte Carlo calculations to take account of uncertainties and I think EPA is moving in that direction. I think where the bigger challenge might be is arguing or discussing

what the appropriate assumptions are, and residency, for example, is one of them.

Mr. PUTNAM. So could you please clarify again what you do for the United Nations? That was in your biography, about the UNSCEARs?

Mr. CHAMBERS. The UNSCEAR is the United Nations Scientific Committee on the Effects of Atomic Radiation was created in about 1955 by the United Nations, and I believe there are 26 countries, could be 27 including the United States and Canada and Britain and Germany and Russia and Japan and China, etc. And the responsibility of this group is to periodically—typically every 4 to 5 years—review all of the new verified, published, refereed research on the occurrence of radioactivity in the environment, and most importantly the health effects. This includes dosimetry and epidemiology. These documents are produced every 4 to 5 years and are used and referred to frequently by the U.S. National Council on Radiological Protection, by the U.S. EPA for that matter, by the International Commission on Radiological Protection, to whom the EPA often refers.

And it is an honor, but it is an agony. Consultant is basically volunteer time and my task right now is to revise, actually write the next UNSCEAR report on radon health effects.

Mr. PUTNAM. So we are not talking about some fly by-night backyard outfit here, we are working for the United Nations. And coming from the Congress, that can be sort of a frustrating group to work with, so you are to be commended for doing it.

But the models that you have developed, the work that you have done is often referred to by EPA, is that what I heard you say?

Mr. CHAMBERS. The kinds of models that we have used, which include Monte Carlo calculations, which take account of uncertainty, have very much been used by EPA, and EPA I believe is moving more toward more routine use of these models because I am different than my colleague beside me, I may eat more, I am bigger, I may breathe more, and these models allow you to actually take account of difference in breathing rates and weight and this kind of thing. And it is the state-of-the-art that we have in modeling today.

Mr. PUTNAM. Thank you. The Tampa Bay Estuary Program coordinated a conference call for the EPA with more than 30 marine scientists to review the Piney Point situation that resulted in a unanimous consensus for the Gulf discharge plan. If we had heavy rains, if we had another Piney Point situation occur, would the Estuary Program support a similar decision and in reviewing that situation, what were the program's recommendations for ways to avoid a similar situation in the future?

Mr. ECKENROD. The request from EPA was whether or not the group of experts that we convened believed there was greater risk in disposing of a portion of that accumulated and partially treated wastewater offshore versus continuing to discharge into Tampa Bay. We consulted with marine experts from around the Gulf, experts in harmful algae blooms in particular, and the consensus of that group was that there was less risk in moving that water offshore than there was allowing that continued accumulation of that

water in the stacks at Piney Point, or alternatively, discharging it into Tampa Bay. Both of those were options.

There was no—I think the groups that I have been working with and the Estuary Program has been working with, and that includes the Agency on Bay Management in Tampa Bay, we all, you know, share the belief that we need to take every reasonable measure possible to avoid occurrences like Piney Point in the future. And that is part of the reason I was interested in participating in this hearing today, to share that concern and encourage this group to pursue, and EPA to actively pursue these beneficial uses of phosphogypsum to the extent that it can help reduce risk like Piney Point in the future.

Mr. PUTNAM. From your perspective, do you believe that the environmental risk associated with stacks is greater than the risk of dispersing the stacks throughout the State amongst the alternative uses that have been illustrated, is it a greater risk to leave them stacked up?

Mr. ECKENROD. Well, it is a difficult question for me to answer, not being an expert in radiation and obviously there are many people that have spoken today who do have that expertise. I can only say, Congressman, that based on the testimony I have heard, there is certainly expressed many potential uses of phosphogypsum that offer the hope that the risk would be—by making use of those opportunities, the risk could be reduced below what the current technology provides for; that is, stacking it.

Mr. PUTNAM. Dr. Sumner, do you wish to add anything to what we have heard in terms of the models that have been used and the work that you have done and others have done and this acceptability to the EPA?

Mr. SUMNER. Mr. Chairman, I have been in this game for 45 years and I have had all the research work I have ever done reviewed by my peers, and I find it is an insult to hear that any of the research that I am accredited in my report or that I might have done myself is suspect. Scientists work according to given rules and our science is the best available.

So in my report, there is no fiction. This is the fact of the matter as we know it today. There might be some holes in it, we do not know, but those are facts. I want to say that first.

Second, I want to interject a little bit of common sense into this discussion here today, Mr. Chairman. In the old days, we used to use single super phosphate, which was composed of calcium dihydrogen phosphate and calcium sulfate, gypsum, in a 50/50 mix roughly, roughly 50/50. So in the old days, if the engineers had not got to us and decided we needed high analysis fertilizers to cut down on transportation costs, we would still be spreading single super phosphate all over the country. And if we did that at the rate that is recommended, and this would be the low rate that is recommended, at about 30 pounds per acre per year, we would be spreading 120 pounds of gypsum and that would be Florida gypsum full of radiation probably on every acre of agricultural soil, definitely east of the Mississippi and probably some distance west of the Mississippi. And we would have been doing that now for more than 100 years and we would have far exceeded the 2,700 pounds that the EPA has used and I venture to say right now that

the EPA would not have had the temerity to ban single super phosphate.

Thank you, Mr. Chairman.

Mr. PUTNAM. Mr. Lloyd, your comments at this stage in the game?

Mr. LLOYD. I would like to correct one thing that was said. Ms. Cotsworth made the comment that the concentration was increased in phosphogypsum. The concentration of radioactivity is actually reduced in phosphogypsum.

I would like to receive the documentation that she had mentioned that says they had checked out building roads with 10 picocurie phosphogypsum. If that is in any of the BID documents, I cannot find it. Doug, were you ever able to find it, using 10 picocuries for road building?

Dr. CHAMBERS. I did not see their analysis—I cannot recall seeing their analysis of 10 picocuries per gram.

Mr. LLOYD. So I would like to see that.

The one thing that might be interesting to you as a Congressman, in the 1989 rule, the public participation never discussed banning phosphogypsum. That part was not part of the discussion or the rule. And I would appreciate this easy-to-use guidance. We asked for it back in 1995. I would think 19 years is a long time to get it done.

Mr. PUTNAM. Ms. Cotsworth, could you provide to the subcommittee the background information, the studies on road building using to 10 picocurie per gram material for north Florida?

Ms. COTSWORTH. Just a minor correction. I indicated that we did studies that suggested that a national generic permission for use as road building material was not supported in terms of risk. I do not believe I used the term 10 picocuries per gram in regard to that specific reference.

In the BID documents, as requested, the specific reference is to an investigator by the name of Roffler, Gamma radiation and radon flux from roads constructed with bases having phosphogypsum-bearing aggregate, from the University of Florida, 1987. And the information is contained, I believe, on pages 426 and 427. That is the information that the staff at that point used.

Mr. PUTNAM. Thank you.

The real crux of all this is that it is the opinion of—and I believe the adopted policy of at least this county that finding a viable economic use for these stacks is our goal. And the State of Florida has invested, through the Department of Education and with substantial support from the private sector, in the Florida Institute of Phosphate Research, as well as the other academic studies that have gone on, to find a use for this product.

I am hopeful that this hearing will have communicated to the EPA our interest in allowing research to go forward that would provide us some guidance for alternative use of this product. It has bubbled under the surface for years and has been something that people talk about when they drive down Highway 60 and they see them. But it has reached an important sense of urgency as a result of the events of last summer and the discharge that had to occur, that highlights the potential risk that storing these stacks poses. I think it is tragic that legitimate, accredited, highly thought of re-

searchers have a difficult time interacting with their government and finding a way to share research that has the potential for public benefit. And that has transcended Republican administrations, Democrat administrations. It is a culture issue at EPA that has absolutely nothing to do with who is in charge, because the same people are in those offices in Atlanta and at the mid level and everything else that make these decisions.

So I would hope that as a result of this hearing, which may just be the second of several if need be, that we would facilitate a better information transfer, that we could have some objective, some goal line of knowing what the definition of a complete application is so that process can move forward and the people of Polk County, people of Florida and the potential new industries that could come from alternative uses and the potential savings that could accrue in terms of road building or land fill management would be able to have some guidance. And that guidance, that progress, has been lacking. And it has been, I think very frustrating for an awful lot of people.

So, you know, I would hope that we would get the information that we have requested, that we can facilitate the meetings that you have committed to and, frankly, I think expand it certainly to include my office and your water office, we will make that communication as well, because I think something that has come forward today is that there clearly has to be a conflict of environmental goals between your water office and your air quality office when your water office is sent to respond to an emergency created by the concentration of phosphogypsum in stacks and the water that is held as a result of rainfall and everything else. So I think that is an important component to this as well. And I invite you to respond.

Ms. COTSWORTH. I want to make this petition process work for both the agency and the petitioners. And I have made it a priority since I have become the office director to both clearly respond to and process the current petition that we have in-house, and to issue the guidance that petitioners have been crying for. I also believe that I personally have a reputation for being someone who deals honestly and openly and is accessible to members of the regulated community as well as the rest of the public. And I am interested in making sure that—the bottom line is that the decisions that we make are clear and transparent, but also publicly and technically and scientifically defensible.

So I will certainly be willing to work with your office and the other people at this table. I know science has progressed, there have been changes in the agency since 1989 and the 1992 regulations. There has also been culture changes within the agency. But I will be glad to work with the petitioners, your office, our fellow regulatory agencies and others in regard to this issue.

Mr. PUTNAM. Thank you very much.

How many other issues are in your portfolio that involve this type of history with a State-sponsored research laboratory who has been specifically charged with investigating the use of a product that you regulate and has that kind of 19-year tradition of trying to move this along. Is that a fairly common thing?

Ms. COTSWORTH. No, it is fairly unique.

Mr. PUTNAM. In most agencies or departments, you would assume in life that when you have sort of a small universe of players and one of them has been around since day one and are legitimate, you know, they are not—you know, being in the constituent service business, we all understand that sometimes folks come to the table bearing more research and more facts and have the credentials to back those up. It would seem that a better relationship would have just naturally developed over time, knowing that there is a whole building out here full of laboratories working to do nothing but find a better use for phosphogypsum, and it just seems odd that it has degenerated into sort of an adversarial thing instead of really a committed partnership to find a better use.

I take you at your word and hope that today marks a turning point and a move toward progress toward working to resolve these issues.

I also just wanted to ask if there were, as part of the Clean Air Act reauthorization, if there were a legislative change that affected the regulation of phosphogypsum that would allow for the use in these instances—road beds and landfills as well as a couple of the other things that we talked about, the glass and the marine life—would you lay awake at night worried about public health and the impact that might have on the population?

Ms. COTSWORTH. It is inappropriate for me to comment on the possibility of legislative changes. Again, we will be glad to work with you or whomever on the Hill in regard to technical evaluation, give you our best technical and scientific input for you to use in making your tough decisions relative to legislation and then we will implement them appropriately.

Mr. PUTNAM. Thank you.

Mr. Keaton, would you like to add anything?

Mr. KEATON. Well, I guess in listening to everything that has been said, I think one thing that maybe we ought to point out here is that the doses and the risks that we have been talking about are calculated. These are numbers and models that we use to work with. There is real risk involved with hazards with this material getting into the environment as far as a dam breaking or things along these lines. So there are risks there that have to be balanced and I guess the EPA and the people have to deal with that.

What we do, what we would welcome is that the unfettered research and development of these products and these techniques in using this material, we welcome them and would work to help do that.

Mr. PUTNAM. Thank you. Mr. Eckenrod.

Mr. ECKENROD. You may have heard me shudder a little bit at the discussion earlier about some of the potential marine uses of phosphogypsum. I think we do need to think very carefully, as we would about any potential uses on the environmental effects of those. But it looks to me like—and I go back to what Mike Lloyd said earlier—that in the past when FIPR has talked to EPA, it has been constructive, they have made progress. So to the extent that this hearing can help get that constructive dialog back on track, I think it will be very successful.

Mr. PUTNAM. Thank you very much. Mr. Lloyd. Dr. Sumner. Dr. Chambers.

Mr. CHAMBERS. Just a very brief comment. I would like to correct something as well.

There was in fact a detailed radiological assessment submitted along with the petition and so someplace in EPA files, there is information on radioactivity and potential radiological risks associated with it.

Other than that, when we submitted these, we tried to write them in a form, we sat down and asked ourselves a question if we were EPA, what kind of information would we like. So it may not be quite right, but we did make an attempt to make it easy. So we are hoping that EPA considers the work that we did in submitting the application when they come up with their guidelines.

Thank you very much.

Mr. PUTNAM. Thank you. Dr. Shieh.

Mr. SHIEH. I would like to make a final comment. It seems to me the whole process looks at the project as a full scale operation, but it is not. It is still just one study and the finding of that study will provide solutions for big scale application. So a lot of effort has been put to me, it seems not in the right direction—a lot of effort we are doing today may not be necessary. So I want to ask again, please do not treat this project as a full scale application request, this is just one study to demonstrate if this idea is feasible or not feasible.

Mr. PUTNAM. Especially the phase III request, right?

Mr. SHIEH. Yes, yes, yes.

Mr. PUTNAM. Well, I want to thank all of our distinguished panelists for their contribution to our understanding of this issue and the potentially beneficial uses as well as the risks that have to be balanced in using phosphogypsum for purposes other than stacking. It is necessary to reconsider the calculations that determine the commercial product or waste, in my view. We have a number of studies that suggest that it would be advantageous to everyone as well as environmentally sustainable to revise the EPA ban of phosphogypsum in research and in industry.

Certainly as was the case in the event there are additional questions we did not have time for today, the record will remain open for 2 weeks for submitted questions and answers. I believe that the subcommittee has put forward a number of information requests that we expect to be answered promptly, and we certainly appreciate the efforts that everyone has put into this.

I would note also for the record that the Florida Institute of Phosphate Research is within walking distance of this facility and I suspect if we want to use this as an opportunity to put our panelists together, I believe Mr. Lloyd might answer this correctly—available for all of our panelists to huddle up and talk about exactly what some of the issues are and how we can resolve this and make the application complete and move forward in a thoughtful, science-based manner.

So with that, I want to thank the audience for attending as well, I think your interest certainly demonstrates community involvement and a community interest in seeing this move forward in a productive and fruitful way. And the subcommittee stands adjourned.

[Whereupon, at 1:19 p.m., the subcommittee was adjourned.]

[Additional information submitted for the hearing record follows:]

Statement of the Florida Phosphate Council
March 25, 2004

Response to Inquiry/ Statement of Position

The Florida Phosphate council is a trade association representing five member companies engaged in the mining and beneficiation of phosphate rock and in the production of phosphate fertilizers and other phosphate-based products in Florida. Our member companies represent essentially all the phosphate fertilizer manufacturing capacity in Florida and account for 75% of the production capacity in the United States. Phosphogypsum is produced and managed at each of these facilities.

During the oversight hearing of March 15, 2004, in Bartow, Florida, on the use of phosphogypsum, Congressman Putnam asked for information on the cost of phosphogypsum management in phosphogypsum stack systems, as required by federal and state law. For calendar year 2002, the last year for which complete figures are available, our member companies estimated capital and expense costs of approximately $29 million for phosphogypsum stack system management. Since 1997, when we began collecting this information, the annual costs have averaged nearly $35 million. This does not include the costs for closure of stacks at the end of their useful life.

Based on the weight of scientific evidence, we believe that phosphogypsum is a safe byproduct of fertilizer production that poses no significant risk to the thousands of workers employed in the phosphate industry. Likewise, the responsible use of phosphogypsum in commerce would pose no significant risk to the public. Inherent in that statement is our very strong position that phosphogypsum and any associated process water, when handled responsibility and in accordance with federal and state law, pose no significant risk to the public from the operation, management, and closure of phosphogypsum stack systems. The management of phosphogypsum is closely regulated by state law and rule. The physical and mechanical characteristics of phosphogypsum that make it attractive for road-base material also make current practices used for on-site management of phosphogypsum safe and stable. Alternate uses of phosphogypsum should be viewed as opportunities to bring a resource into commerce, to take advantage of a low-cost material and its beneficial uses, and optimally, to reduce the volume of phosphogypsum required to be managed. A reduction in the volume of phosphogypsum in storage would result in a concomitant reduction in the storage footprint. Less phosphogypsum in storage and a decreased storage footprint will result in less process water storage and manage.

The unfortunate and unacceptable situation at the Piney Point Phosphate Complex is unique in the 100-year history of the industry and does not, in and of itself, provide any special imperative for the approval of alternate uses of phosphogypsum. Such approval is warranted based on the independent grounds addressed elsewhere in this submittal. Piney Point should not be considered the model or norm for any aspect of phosphogypsum stack system management.

Alternate uses of phosphogypsum should be considered and evaluated on their own merits. We are confident that sound science, practically applied, will lead to a variety of beneficial uses. We commend Congressman Putnam for bringing additional attention to this important issue, and hope that his work will lead to greater opportunities for phosphogypsum use in commerce.

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