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LANDFILL AND LANDSPREADING HAZARDS

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LANDFILL AND LANDSPREADING HAZARDS

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A variety of human activities affect the quality of our surface and ground waters, but none are so poorly understood as the effects of where we dump municipal, industrial, and agricultural wastes. It is an "out of sight, out of mind" issue for most urban dwellers, since we tend to view the issue as simply household garbage, picked up weekly to go to a landfill "somewhere else." Urban citizens aren't even aware of the generation and disposal of industrial waste, much less the fact that their local sewage plant produces an "end product" of sludge that must be disposed of somehow. This issue opens a window on the mysteries of where all of this waste is going, the hazardous and unregulated compounds in it, and its effects on our soil, water, and food.

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Front Cover ... Bulldozer working at a landfill site. Cattle grazing in a canal. (www.istockphoto.com)

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WATER RESOURCES IMPACT

LANDFILLS, GROUND WATER QUALITY, AND THE FUTURE OF WASTE MANAGEMENT IN AMERICA

Eric J. Fitch

A BRIEF HISTORY OF SOLID WASTE MANAGEMENT

The creation of waste is part of the human condition. Knowledge of ancient humans and their lifestyles often comes from excavation of middens and tells. The transition to fixed sedentary settlements and away from nomadic lifestyles amplified the need to have ways of disposing of wastes. As early as 3000 BCE in the City of Mohenjo-Daro in the Indus Valley, multistory buildings had waste slides to get the trash to ground level. Outside the ancient city of Jerusalem, in the Hinnom Valley there was a place called Gehenna. Some believe this place name has become associated with the concept of Hell over the centuries because this is the place that became the city dump as Jerusalem grew. The odor of decay, the fires, the vermin, and other aspects of this site made it the perfect image for preachers and teachers to employ as a place of eternal suffering. Civil authorities have long attempted to limit certain waste disposal practices and promote others to limit negative health and aesthetic impacts. Roman Emperor Augustine established an office of waste management to limit pollution of the Tiber. Approximately 1,500 years later, the United States (U.S.) enacted its earliest federal pollution control law, the Rivers and Harbors Act of 1899, to deal with the same problem. People were using rivers as dumps as well as sewers and endangering health and navigability

There are only a few ways in which humans have dealt with their solid wastes over time. Humans have mainly dumped them in the water (rivers and streams, lakes, oceans), burnt/incinerated them, or dumped them on or into the land. Certain wastes have required more intensive treatment (e.g., pyrolysis, vitrification, etc.) Historically, the rules of thumb that were in operation were "out of sight, out of mind" and "the solution to pollution is dilution." As the number of humans and per capita resource consumption levels rose, and as society began to understand the negative consequences of waste generation, methods of disposal were banned or modified to reduce environmental and health impacts. Greater emphasis has been given to reducing the overall waste stream through the 3 Rs (waste Reduction, materials Reuse, and Recycling) as well as through implementation of Life Cycle Analysis and other techniques. More and more the defining goal is to have integrated sustainable systems that deal with materials on a cradle to cradle basis rather than cradle to grave (McDonough and Braungart, 2002).

SOLID WASTE MANAGEMENT OPTIONS IN THE U.S.

The fact remains, however, that in the U.S. as well as throughout most of the developed world, historically high levels of waste production exist and must be dealt with. Ocean dumping of solid, hazardous and radioactive wastes is functionally prohibited under U.S. and international law. Similar restrictions apply to surface freshwater bodies. Incineration and pyrolysis have emission restrictions under the law that functionally eliminates the techniques in certain locales. What remains? The number one alternative for waste management is placement on (landspreading) and in (landfilling) the land. Landspreading applies to certain specific types of wastes (e.g., sewage sludge, industrial wastes, animal wastes, etc.) and needs specific land forms and uses. For a broader spectrum of wastes, landfilling is the preferred option (Tammemagi, 1999).

Prior to the 1970s in the U.S., the disposal of solid and hazardous waste was mostly a matter of state or local control. There was no national system of waste classification nor standards for disposal. This changed with the enactment in 1976 of two laws: RCRA (the Resource Conservation and Recovery Act) and TSCA (the Toxic Substances Control Act). RCRA was viewed as the logical continuation of federal legislation on the environment following passage of the Clean Water Act and Clean Air Act earlier in the decade. RCRA was aimed at controlling what was seen as the primary sources of contamination to soil/ground water portion of the environment: solid waste dumps, hazardous waste dumps, and leaking underground storage tanks. TSCA was established to provide the U.S. Environmental Protection Agency (USEPA) with information on the properties, health, and environmental impacts and environmental fate of chemicals. In 1980, soil and ground water protection was augmented by enacting the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), which is more commonly referred to by its funding mechanism, Superfund. This Act was to deal with a major problem uncovered thorough RCRA implementation, the discovery of large numbers of closed and abandoned waste sites that were contributing contamination to the environment.

... even though the siting of new landfills will continue to be difficult and that these systems are far from perfect, solid waste management is not the highest environmental management issue for federal and state authorities at this time

How are these laws working to protect soil and ground water after 20 plus years? The results are somewhat mixed. Under RCRA, the primary avenue for disposal of solid wastes is landfills. Landfills are considered a modern necessity in the U.S. today. They are a vast improvement in terms of public health and environmental

quality impact over previous techniques, especially open dumps, open mounds, and open burning. Fugitive wastes were major sources of contamination to surface waters, ground water, and to the air. Open wastes were key sources of disease, as vermin and other vectors had open access to infectious organisms.

CURRENT STATE OF WASTE GENERATION AND DISPOSAL

In 1960, the per capita generation of solid waste in the U.S. (pounds/person/day) was 2.68 with only a small fraction of it being recycled. At 1960 population levels, this resulted in an annual waste generation of 88.1 million tons/year of municipal solid waste, or MSW. (MSW is a catch-all term for various categories of nonhazardous solid garbage, trash, and refuse). In 2007, per capita waste generation had risen to 4.62 lbs/person/day, resulting in an annual MSW generation of 254.1 million tons. On the bright side, recycling rates (including composting) have risen to a little over 33%. On the dark side, this meant that 3.1 pounds per day are going into some type of waste disposal. Even though per capita generation has leveled off and recycling has increased, this still leaves the U.S. with over 150 million tons per year and growing of MSW to do something with (USEPA, 2008). Why is increasing waste generation a given? A key thought equation used by environmental scientists is I=PxAxT [Impact (environmental) = (level of human) Population x (level of) Affluence x (level of) Technology. Combine the level of economic and technological development with the growing population of the U.S. and despite its unsustainability, most projects have waste generation growing for the foreseeable future. Greater application of the 3Rs and techniques such as Life Cycle Analysis will help, but current techniques of waste management are going to be utilized into the future.

Setting aside considerations of hazardous wastes and underground storage tanks and focusing on solid (municipal) wastes, RCRA drove disposal methods away from open waste dumps/mounds and into the use of sanitary landfills. The key goals were to control fugitive wastes from MSW during its collection, transit, and disposal phases, and ultimate "dry" entombment of the wastes. The "sanitary landfill" has emerged as the dominant technology. These landfills are engineered sites on the natural landscape which ideally are located where there is easy access to key modes of transportation with sufficient proximity to the service area to be cost effective. The site should be geologically stable and have geologic and soil features that will aid in the containment of the wastes and any negative by-products (i.e., air and water pollution, windblown trash, etc.). Modern landfills are almost always made through excavation and filling of a site, but historically they have been established utilizing existing pits (especially from mining), canyons/valleys, and through the creation of mounds. Sites are selected to have sufficient capacity for disposal of wastes over a considerable (usually, at least several decades) period of time.

One more driving factor with regard to waste management is not just regulatory control, but social and economic controls. Landfills, incinerators, and other waste disposal and 3R activities are generally considered locally unwanted land uses (LULUs) and/or NIMBYs (Not In My Backyard). Although most accept the proposition that wastes must be disposed of somewhere, considerations for aesthetics, livability/quality of life, property values and other related concepts cause people not to want these sites/facilities in their neighborhoods or even their regions. It would be inconceivable under today's social institutions to site a facility such as the Fresh Kills landfill. Until its closure, Fresh Kills was the largest landfill in the world. The site name comes from Dutch from the days when New York was New Amsterdam. Fresh Kills literally means Fresh Stream. It was in this place on Staten Island that in 1947/1948 a refuse dump was established for the MSW generated by much of New York City. When it was fully operational, the site accepted 13,000 tons of waste a day. By the time of its official closure in March 2001 (though it was used as a debris sorting site for materials from the World Trade Center), the site was 2,200 acres (3.4 sq. miles) and the waste was concentrated and covered in four large sealed and earth covered mounds ranging from 90 to 225 feet in height. Its total volume exceeds that of the Great Wall of China, and the largest mound is broader than the Great Pyramid of Khufu (Cheops). The tallest mound by some measures is the highest physical point on the eastern seaboard of the U.S. (if it is considered a part of the landscape). The site has been turned over to the New York City Department of Parks and Recreation and is being converted into a series of parks that in aggregate will be three times larger than Central Park. The Fresh Kills site demonstrates both the transition from the open dump and mound technologies into the use of modern landfills on a scale and urban proximity unlikely to be repeated.

GROUND WATER IMPACTS

Even assuming sanitary landfills: (1) are a necessity of modern life in the U.S., (2) there will be an ongoing need even as society adopts more environmentally sustainable practices, (3) are a vast improvement over earlier disposal methods, and (4) properly siting them will be an increasing difficult thing to do, this does not mean they are an environmentally perfect solution. The end goal is "dry entombment." In this state, a capped/sealed landfill will allow little to no water to enter and maintain a functional stasis. William Rathje and other archeologists ("garbologists") have clearly demonstrated that this can be accomplished in a variety of settings (Rathje and Murphy, 2001). During the operational lifetime of even the best designed sanitary landfill, exposure to water and air will foster the creation of air pollution (primarily methane and other gases associated with organic decay, though any wastes that can volatilize will contribute to off-gassing), surface water pollution through runoff, and most importantly ground water pollution. Water from precipitation and from the wastes themselves percolates

through the landfill's contents mobilizing a wide variety of water soluble materials and particulates.

This "garbage soup," or leachate, can become a rather nasty brew through dilution and absorption of normal organic decay products. Although MSW does not contain designated Subtitle C hazardous wastes, this does not mean that there are no hazardous wastes in landfills. Landfills can accept solid and semi-solid wastes, and small volume liquid wastes. Hazardous wastes comprise the highest number of generators of hazardous wastes, because their individual volume from households is below regulatory cutoffs and thus are allowed in the trash. This is out of functional necessity and the best alternative found so far is voluntary household hazardous waste separation and drop-off. Other waste generators, such as businesses, can also place certain volumes of hazardous materials into the waste stream, and others can get exemptions through statute, regulation, or as parts of emergency declarations. There are even some radioactive wastes which federal and state agencies have attempted to declare as "below regulatory concern." Therefore, the range of materials and their levels of toxicity can be quite varied depending on what gets deposited in the landfill's service area (Eldridge, 2003).

In 1991, the USEPA established standards for the construction and operation of landfills. Along with requiring state of the art controls for dealing with air emissions and runoff, liners and leachate control systems were mandated. Leachate is to be collected and treated as waste water. Ground water in underlying and adjacent systems is to be monitored and fugitive leachate is to be cleaned up. Debate continues in the regulatory and professional waste management realms as to how to manage the operation of landfills and suppressing or enhancing organic decay. Some advocate sealing wastes away in dry entombment as quickly as possible to suppress decay and leachate production. This system helps preserve wastes in their original condition. This is often the position of those who see the landfills of today as the resource "mines" of the future. Others advocate the promotion of decay to process out the more "mobile" components of the waste stream and thus produce a more stable aggregate when the time comes to seal the landfill. Either philosophy must confront the reality that no leachate system can work in perpetuity, no cap will last forever, and most importantly, no liner system will remain intact forever. Optimistically, today's waste management community envisions a future where the stabilized waste will simply become part of the ground beneath and no longer present a source of water pollution. Alternatively, the landfills will only need to hold the wastes for their "rebirth" into the stream of future material culture. Truth of the matter is that even though regulatory standards continue to be debated and

disposal methods and engineering continue to be improved, there are more daunting questions with regard to waste management (e.g., solid, hazardous, radioactive, specialty) and groundwater protection that do not yet have nearly the level of closure as solid waste management (Davis and Cornwell, 2006).

UNRESOLVED ISSUES

Here is a "Bottom 10" list of problems that waste managers and regulatory authorities need to deal with in this arena:

1. Thousands of federal (National Priorities List) and state listed hazardous waste disposal sites hazardous to human health and the environment that remain dangerous and unremediated due to lack of funding.

2. Impoundments of single types of wastes such as coal slurry that present hazards to surface and ground water.

3. Impacts on ground and surface waters from certain current mining practices, especially mountaintop removal.

4. Impacts from abandoned mines.

5. Lack of an operational high level radioactive waste disposal facility.

6. Lack of integrated markets and systems for implementation of an integrated waste recycling, reuse, and reduction strategy.

7. Lack of process and/or funding and/or ability in many locations to remediate existing groundwater degradation from contamination by leachate and other liquid wastes.

8. Conflicts within and between communities in "hosting" waste disposal sites (NIMBY and LULU at play).

9. Impacts from direct contamination to the soil and ground water environment through LUST (Leaking Underground Storage Tanks).

10. Ongoing problems with implementation of cradle to grave systems for hazardous wastes.

CONCLUSION

It is entirely likely that solid waste management processes, procedures, laws, and regulations will continue to be discussed and revisited into the future. The reality is that even though the siting of new landfills will continue to be difficult and that these systems are far from perfect, solid waste management is not the highest environmental management issue for federal and state authorities at this time. Though imperfect, the current system provides much greater protection for ground water resources than past practices. Legacy problems from these older practices as well as other waste management problems will likely keep the current system intact for years or decades to come.

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LANDSPREADING HAZARDOUS WASTES IN THE UNITED STATES

Laurel E. Phoenix

We can evade reality, but we cannot evade the consequences of evading reality ... Ayn Rand

In a highly urbanized and specialized society, few citizens think about industrial waste or sewage sludge, much less know where they end up. They assume the government has taken care of the problem. After all, we have hazardous waste laws and an Environmental Protection Agency, do we not? Few people know where their food was grown, or what types of fertilizers were used, but again, we assume there must be laws and agencies protecting our soil, water, food, and health. As consumers, we might be surprised to discover a connection between industrial waste, sewage sludge, and fertilizers. Only in a James Bond movie might we expect a connection between innocuous, beneficial fertilizer, and hazardous material threatening health and life. But, it seems that 007 has stepped off the screen, and that truth is often stranger than fiction.

ORIGINS OF FERTILIZER

The two major sources of wastes turned into fertilizer are industries and sewage treatment plants. Some industrial waste materials include used acids, waste lime, baghouse dust, mine tailings, coal fly ash, metal ore slag waste, paper and pulp mill sludge, and cement kiln ash. The list is not limited to these, as there are many more. Look at the Environmental Working Group (EWG) report (EWG, 1998) listed at the end of this article for lists of industries and materials. Sewage treatment plants take municipal and industrial sewage and put it through some treatment processes to kill pathogens and separate liquids from solids. The liquids are then released into a waterbody and the remaining solids (sludge) must be disposed of on land or incinerated. In general, the more cleaning the liquid effluent receives before it is released, the more material, some of it toxic or hazardous, is concentrated in the sludge.

Some waste materials from industries and sewage treatment plants are landspread over fields rather than landfilled because landspreadng is much cheaper. It is cheaper because our county has a history of allowing industries to transfer the externalities of their production onto the public in general, and onto areas of less economic and political power, such as poor, minority, or rural regions in particular. Landspreading is not only cheaper, but has the extra benefit of allowing these industries and sewage plants to greenwash their operations by claiming they are recycling. The public has always understood recycling to have only a positive connotation, and may not be aware of the other constituents in the waste being recycled (transferred) onto land.

DIVERTING WASTES TO FERTILIZERS

Although the drive to look for lowest cost disposal of wastes is common to both waste generators, the catalyst for diverting wastes to fertilizers is not. For industries, the promulgation of toxic and hazardous waste laws in the 1970s presented them with new and far more expensive requirements for where they could dump their wastes. Because placing materials in hazardous waste landfills cost significantly more than municipal landfills, industries pushed for loopholes in the laws. For sewage treatment plants, the Ocean Dumping Reform Act of 1988 made ocean dumping of sewage sludge illegal, thus closing the last avenue of water dumping of sludge. Even if sludge was assumed to have no harmful constituents, the options of landfilling or incinerating were still expensive relative to historical dumping methods.

... the issue of the effects of industrial and and sewage sludge landspreading is an ominous conjunction of loopholes of water laws, hazardous waste laws, and agricultural laws

WHAT'S IN A NAME? WHAT'S IN A LAW?

A combination of lobbying to forestall more stringent requirements, weakening laws by redefining what words meant, or adding lists of materials to be excluded from the laws resulted in an end-run around hazardous waste laws and opened the countryside (and your backyard gardens) to virtually unregulated fertilizers with unlisted chemical or metal contaminants. The first thing industries did was stop calling their wastes "waste." Under federal law, any waste products from industries would be checked for hazardous content, and if found, then the waste would have to be sent to a more expensive hazardous waste facility rather than a regular municipal landfill. But, if industries cleverly took what they previously called "waste" (because they threw it away, having no more use for it) and now called it "fertilizer" (and therefore not waste, since now it was a product), then they could legally avoid the costs of hazardous waste dumping. And because hardly any requirements existed for what could go into products called fertilizer or soil amendments (e.g., lime, topsoil, mulch), industries could rid themselves of unwanted materials with little or no cost to themselves. Something sold as fertilizer merely needs to contain something with fertilizing qualities, such as nitrogen, phosphorus, potassium, or a soil amendment could have an acid or alkaline quality to alter soil pH. Some wastes with higher levels of dangerous ingredients could still be landspread, but just not on

fields growing food for humans. This practice is deceptively called landfarming.

Exemptions to hazardous waste laws often contradict the objective of the law itself. For example, the 1980 Bevill Amendment in P.L. 96-482 exempted fossil fuel plant combustion wastes from U.S. Environmental Protection Agency (USEPA) regulation despite the heavy metals, dioxins, and other hazardous materials commonly found in them. Thus, these can be spread on land to reduce soil acidity while simultaneously adding dangerous constituents. Other wastes from mineral mining or processing as well as cement kiln dust are specifically exempted by the USEPA from hazardous waste laws. According to Duff Wilson, author of "Fateful Harvest," (Wilson, 2001) the USEPA exempts industrial ash and acids from hazardous waste reporting, and steel companies may send their industrial ash to fertilizer factories without any testing of the ash components.

Sewage treatment plants needed a more appealing name for sewage sludge. Their trade group held a naming contest resulting in the innocuous term "biosolids" (Stauber and Rampton, 1995). Consequently, in addition to selling their sludge in bulk to fertilizer factories or public entities (e.g., sell in bulk to school districts or cities to use on their grass fields), they could package and sell sewage sludge by the bag to homeowners looking for just a bag or two of fertilizer. Most people don't read ingredient lists anyway, and if they did, they would only see the word "biosolids." There are no requirements to list the PCBs, dioxins, heavy metals, or other Persistant Organic Pollutants that might also be in the fertilizer, so the customer goes home happy. Cities with large sewage plants were happy too, selling their sludge to innocent customers unaware of its secret ingredients. Los Angeles sells Nitrohumus, Milwaukee sells Milorganite, New York has Granulite, and Chicago sells Nu-Earth.

DUMPING URBAN WASTES ON RURAL LANDS

Urban areas dumping their sewage sludge on distant rural areas can ignore the more spectacular consequences they have initiated. Elizabeth Royte, in "Garbage Land" (Royte, 2005), found that back in the 90s, New York City shipped 150 flatcars a week for close to ten years all the way to Sierra Blanca, a tiny, poor town in rural Texas. The practice was stopped, not because of numerous violations, or because the smell was horrendous and made people ill, but only when rising fuel costs made shipping over long distances unaffordable. For several years now, the greater Los Angeles area has exported the sewage sludge from over 10 million people and 6,000 industries over the mountains to two sludge farms near Bakersfield in Kern County (Ruby, 2006). Just one of the Los Angeles area treatment plants alone (the new Hyperion plant) sends 650 tons of sludge per day to Kern County. Concerned with contaminating the closed basin's ground water and its agricultural soils with metals, fire retardants called poly-brominated di-phenol ethers (PBDEs), Persistant Organic Pollutants (POPs), and pharmaceuticals and personal care products (PPCPs), Kern County residents passed Measure E in June of 2006 to ban sludge farms on croplands in unincorporated Kern County. Los Angeles area lawyers immediately sued Kern County and won, but Kern County appealed. This lawsuit is currently being reviewed by the 9th Court of Appeals. In the meantime, 300,000 wet tons per year of sludge keeps on rolling along over the mountains, to be landspread on a mere 7,000 acres.

Augusta, Georgia's, sewage treatment plant sent sludge to dairy farmers in the 90s for fertilizing feed crops (U.S. Water News Online, 2008). The U.S. Department of Agriculture was ordered by a federal judge to compensate two farmers for the loss of their entire dairy herd and the poisoning of thousands of acres of land from the thallium (often used in rat poison), arsenic, other heavy metals and PCBs in the sludge. The sewage treatment plant had altered test records and sent the sludge to farmers without notification. Milk tested from the cows and from milk already on store shelves had 120 times the level of thallium allowed in drinking water. Oddly, when officials were notified that the milk was contaminated, there was still no move to pull the milk off the shelves.

A few researchers have started to ask more questions and develop research methods to determine what is in these pseudo-fertilizers, and their quantifiable effects on soil organisms, plants, animals, and humans. The Cornell Waste Management Institute is one such group, and has recently published a report surveying studies of health and environmental impacts from landspreading the hazardous wastes in sewage sludge (Harrison and McBride, 2009).

RESEARCHING EMERGING PROBLEMS

According to the Waste Management Institute report, while over 500 synthetic organic chemicals have been found in sewage sludge, the USEPA does not address them, but currently regulates only the metals listed in Table 1 under the Clean Water Act.

Table 1. Metals Currently Regulated Under the Authority of the Clean Water Act (40CFRPart503).

Arsenic
Cadmium
Copper
Lead
Mercury
Molybdenum (not regulated for soil loading limits)
Nickel
Selenium
Zinc

Current USEPA rules are based on outdated risk assessments from a 1988 National Sewage Sludge Survey. USEPA conducted a new survey in 2006-2007 but has not yet determined which of the 145 tested contaminants, if any, it will regulate. Sludge composition can be highly variable over the year at each treatment plant, as well as between treatment plants. Sludge was tested

for polycyclic aromatic hydrocarbons (PAHs), fire retardants (PBDEs), pathogens, pharmaceuticals, hormones, steroids, metals, antimicrobials, and more. Concern has been building among scientists over the effects of these contaminants.

The Waste Management Institute begins its report by stating, "Protecting agricultural soils requires anticipating and avoiding potential harms since once contaminated with persistent pollutants, the damage will remain for the foreseeable future." To this end, the Institute published this report on several contaminants of concern, many of which are not regulated by the USEPA. Most of the Institute's detailed study is summarized in Table 2.

WHERE DO WE GO FROM HERE?

There are already many gaps in ground water protection in state and federal laws dealing directly with water. However, the issue of the effects of industrial and sewage sludge landspreading is an ominous conjunction of loopholes of water laws, hazardous waste laws, and agricultural laws. Numerous industries and interest groups have helped to obscure the practice of landspreading industrial wastes and sewage sludges, helping us to "evade reality." However, as Ayn Rand said, we can't run from the consequences. As the USEPA is currently working on researching additional sludge contaminants to regulate, we need to communicate our support for strong and effective standards to protect our soils, water, and food.

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Table 2. Cornell Waste Management Institute Review of Contaminants of Concern in Sewage Sludge.

Endocrine Disruption – Lead reduces fertility in animals, and lead reduces several sperm function biomarkers in humans. Cadmium acts as an estrogen mimic, causing denser mammary gland tissue, denser uterine tissue (related to cancer) and earlier onset of puberty. Sheep grazing on sewage sludge forage have fetuses with smaller male testis.

Livestock – Livestock can take in sewage sludge contaminants either through plant uptake (the forages they eat have incorporated the contaminants from the soil into the plant itself), from soil clinging to the plants, or from inhaling the soil. Sheep have bone tissue abnormalities, and fetuses have lower body weight. Grazing cattle acquire copper deficiencies from grazing on sludge with molybdenum and sulphur. Legumes, soybeans, and grasses, among other crops, take up molybdenum and harm livestock health. Buildup of metals in organ meats can pose hazards for human consumption.

Aerosols – There are numerous complaints around the country from residents stating that proximity to sludge spreading or discing has caused them to breathe in contaminants, damaging their health. A few studies have found statistically higher health-related symptoms (e.g., eye irritation, gastrointestinal or respiratory problems). Some studies have found airborne bacteria (e.g. coliforms), and others correlate higher winds with greater spreading of sludge-related aerosols. One study found chemicals and pathogens may combine to cause health-related symptoms.

Organic Chemicals – Depending on the combination of constituents in raw sewage entering the plant and the treat--ment process employed, some chemicals pass through treatment unchanged (e.g. organotins), and some are altered to daughter products more dangerous than the initial chemical (APE surfactants, which are restricted in Europe). For example, fire retardants and perfluorinated chemicals build up in the fat of cows, posing a bioaccumulation threat for beef-eating consumers. Anti-bacterials are bioaccumulating in earthworms, and potentially can kill the good bacteria in the soil. POPs like PCBs have been found to persist unchanged in the soil for 260 days.

Bacteria – Sludge categorized as Class A or Class B sludges have been thought to have no or little pathogens, and so are allowed to be spread either on crops for human consumption or for animal consumption. Studies have shown that bacteria in these sludges could regrow and reactivate.

Antibiotic Resistance – Drug-resistant bacteria are increasing with exposure to antimicrobials in sludge and in sewage effluent.

Ecological Impacts – Communities of soil microbes and plants are being altered by sewage sludge in both diversity and composition. Bioaccumulation of numerous sludge contaminants has been found in earthworms.

Movement to Ground Water Through Facilitated Transport – Facilitated transport refers to how the presence of additional substances may mobilize something (such as a metal) that otherwise would have remained immobile in the soil. Also, the movement of water through soil can not only help transport contaminants, but speed contaminant transport through root channels and worm holes in the soil or bedrock fractures. This is critical because the current 503 rules were not based on field studies of groundwater transport but of simulations in test tubes. Studies have found much higher leaching of metals and viruses because of the presence of sludge colloids. Moreover, sludge colloids increase the leaching of pesticides down through the soil.

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HIGHLIGHTS OF JAWRA TECHNICAL PAPERS • JUNE 2009 • VOL. 45 • NO. 3

FEATURED SERIES: SATELLITES AND TRANSBOUNDARY WATER: EMERGING IDEAS

We are pleased to introduce a featured series of papers, organized by Associate Editor Faisal Hossain, showing how commercial and scientific satellite data, generally available to all, impacts the way we have traditionally done business with water crossing international boundaries. The initial papers appear in this issue; others will be published as they become available.

Other Papers

John S. Jacob and Ricardo Lopez, in asking, "Is denser greener?" show how a simple doubling of standard suburban densities in most cases could do more to reduce contaminant loadings than many traditional stormwater best management practices, and that higher densities such as those associated with transit-oriented development could outperform almost all traditional practices in terms of reduced loadings per person.

Lauren E. Hay *et al.,* present a method for streamflow forecasting where hydrologic model parameters are selected based on the climate state.

Edward R. Schenk and Cliff R. Hupp examine the legacy effects of colonial millponds on floodplain sedimentation, bank erosion, and channel morphology in a high sediment yielding region of the Chesapeake Bay watershed.

Stephanie L. Johnson *et al.,* describe an automated load duration curve creation tool called LDCurve. Though currently applicable only to Texas, the tool is noteworthy for its use of automated data retrievals and computations to greatly reduce the amount of time required to create curves and calculate load reductions.

Thomas C. Pagano *et al.,* explain a new Natural Resources Conservation Service product that allows the automated production and delivery of water supply outlooks for the western United States with a daily update frequency.

Christine L. Goldstein *et al.,* examine the relationship between autumn-olive, an invasive nitrogen fixer, and stream water quality. Their results suggest this exotic species can be an additional source of nitrate in local and regional water bodies, and demonstrate an additional negative ecosystem consequence of invasion beyond losses in biodiversity.

Huidae Cho and Francisco Olivera examine the spatial variability of data in using the SWAT model. When the watershed is small, they conclude more realistic representations of the spatial data do not necessarily improve the model performance.

A full Table of Contents may be viewed at http://www.blackwell-synergy.com/toc/jawr/45/3.

JAWRA ~ Journal of the American Water Resources Association

WATER RESOURCES IMPACT

PHARMACEUTICALS AND PERSONAL CARE PRODUCTS IN BIOSOLIDS

Sara C. Monteiro and Alistar B.A. Boxall

INTRODUCTION

While we now know a lot about the occurrence and effects of pharmaceuticals and personal care products (PPCPs) in aquatic systems, our understanding of the inputs, fate, and effects of PPCPs entering the terrestrial environment, following sludge (biosolid) application, is less well developed. This article surveys some information on PPCPs in sludge and sludge-amended soils; explores their fate and transport following sludge application, and discusses the potential implications of biosolid-associated PPCPs in terms of human and environmental health. Finally we make recommendations on priorities for future research.

OCCURRENCE OF PPCPs IN BIOSOLIDS AND BIOSOLID-AMENDED SOILS

Because sewage sludge may pick up pharmaceuticals either by absorption or adsorption during sewage treatment, we should not be surprised to learn that a plethora of pharmaceuticals and personal care products have been detected in biosolids and sludge. Hormones and steroids, stimulants, antiepileptics, antidepressants, antibiotics, and musks are among the range of compound classes found in sludge. These compounds are released to the soil environment when biosolids or manure are used as fertilizer, or when soils are irrigated with contaminated wastewater.

FATE OF PPCPs FOLLOWING BIOSOLID APPLICATION

Following landspreading of biosolids, PPCPs may either be sorbed (absorbed or adsorbed) or degraded. Sorption of pharmaceutical compounds in soils is an important process because this affects potential mobility and availability for degradation. PPCPs display a wide range of sorption in soils. For example, some classes of antibiotics are strongly sorbed to soils through cation bridging to clay minerals, and therefore have limited mobility through soils. In contrast, analgesics are less sorptive to soils. Soil pH affects sorption of PPCPs, since most of these compounds are ionizable. The sorption of acidic compounds is therefore dependent on the pH of the soil they move through.

The persistence of PPCPs in manure-amended and sludge-amended soils is significant, since great variability in persistence has been found between classes of antibiotics. But degradation of pharmaceuticals in soils is also important. For example, caffeine rapidly degrades to carbon dioxide at different rates in various loamy soils (Topp *et al.,* 2006), and Monteiro and Boxall (2009) found that naproxen degrades rapidly but fluoxetine and carbamazepine are highly persistent.

Like sorption, the presence of the biosolid or sludge matrix also seems to affect degradation rates compared to soil only. For example, caffeine degradation rates in soils increased when aerobically-digested sewage sludge was added, but not with anaerobically-treated sewage sludge (Topp *et al.,* 2006).

Many pharmaceuticals bind strongly to soil particles, so in many cases observed degradation may not be true degradation but dissipation caused by the formation of bound residues. We do not yet know what the implications are of these bound residues for environmental health.

MOVEMENT OF PPCPs FROM SOILS TO SURFACE WATERS AND GROUND WATERS

Contaminants applied to soil can be transported to aquatic systems via surface runoff, subsurface flow, and through pipes. The extent of transport is determined by the solubility, sorption behavior, and contaminant persistence; the physical structure, pH, organic carbon content, and cation exchange capacity of the soil matrix, and climatic conditions such as temperature and rainfall volume and intensity. Although most work on contaminant transport from agricultural fields has focused on pesticides, nutrients, and bacteria, more recently studies have explored fate and transport of some PPCPs. Studies find the leaching behavior of pharmaceutical compounds vary in different soils.

Pharmaceuticals can run off from soils amended with sewage sludge. A field study of sewage sludge applied using two common practices, broadcast and injection application, concluded that carbamazepine, ibuprofen, acetaminophen, and naproxen do run off with wet weather from a broadcast application (Topp *et al.,* 2008). Studies into the leaching behavior of antibiotics have shown that selected compounds have the potential to leach to ground waters (e.g. Blackwell *et al.,* 2007).

While there are a number of potential questions over the risks of pharmaceuticals in sewage sludge on terrestrial and aquatic systems, some mitigation options might be used to minimize the PPCP risks of sludge applications to agricultural fields

UPTAKE AND EFFECTS ON ORGANISMS

Uptake of PPCPs by soil organisms has also been reported following application of sewage sludge to soils (Kinney *et al.,* 2008). Some antibiotics have been shown to be taken up by plants from soils and sludge or manure-amended soils. Figure 1 demonstrates the variability of pharmaceuticals taken up by lettuce and carrots. Various PPCPs have also been found in earthworm tissue.

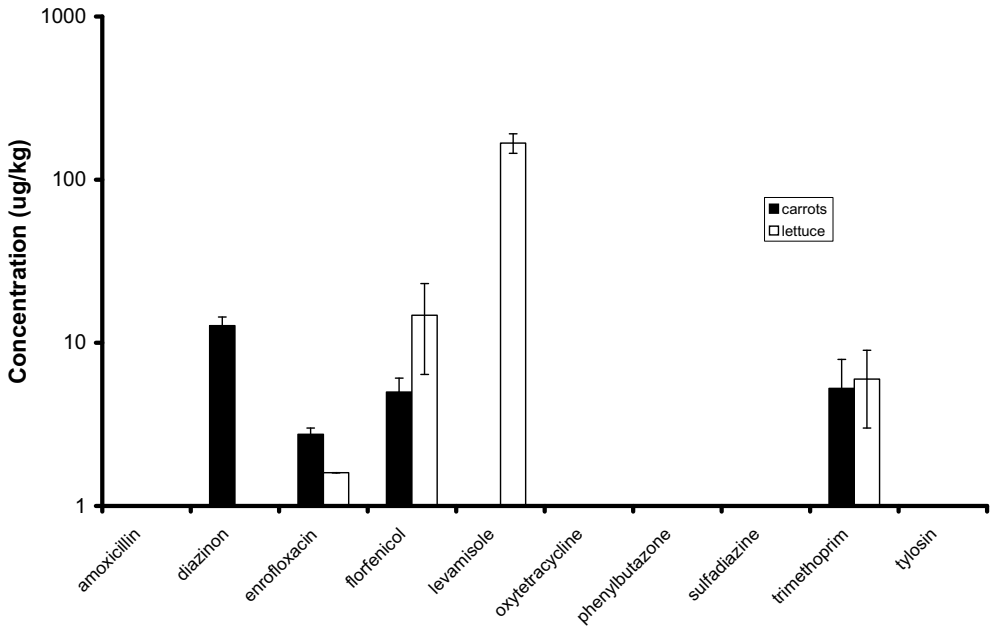

Figure 1. Observed Uptake of Antibiotics and Other Pharmaceuticals From Soils Into Plants (Boxall *et al.*, 2006).

Many plants have receptors or biochemical pathways associated with pharmaceutical modes of action and it would be expected that uptake of pharmaceuticals into plants could result in effects on transcription (RNA synthesis) and translation of chemical messages. Data from whole plant toxicity studies has supported this with a range of pharmaceuticals being demonstrated to affect growth, root length, hypocotyls, and cotyledons in a range of species (Boxall *et al.*, 2006). Uptake into plants may also pose a risk to human health, particularly for people who are allergic to antibiotics. The influence of PPCPs on soil organisms is dependent on their bioavailability, which depends on soil and chemical properties. Therefore, compounds strongly sorbed to soils are likely to be less bioavailable for uptake into plants and soil organisms. However, we currently know little about the effects of many pharmaceuticals in soil systems so more studies are needed on the ecotoxicological effects.

While there are a number of potential questions over the risks of pharmaceuticals in sewage sludge on terrestrial and aquatic systems, some mitigation options might be used to minimize the PPCP risks of sludge application to agricultural fields. For example, injection application reduces overland runoff when compared to a broadcast application. Timing the landspreading of sewage sludge only during dry periods might reduce the risk of contamination to surface water. Rather than flush unused drugs down the drain, the public could turn pharmaceuticals in for safe disposal, thus reducing the pharmaceutical load entering in the environment. In addition, risk classification schemes could be used that identify for doctors and the general public which pharmaceuticals pose the greatest environmental risk. Where possible, doctors could prescribe drugs with low environmental risk.

CONCLUSIONS

A number of recent studies have explored the inputs, fate and effects of PPCPs in soils receiving biosolid applications. These studies demonstrate that PPCPs are present in biosolids and sludge and enter the soil environment where they may be taken up and affect organisms or be transported to water bodies. PPCPs may also be of concern to the soil environment, however, we believe this area has not received enough attention. More extensive studies to explore PPCP risks to terrestrial systems should focus on the following:

1. There are over 3,000 PPCPs in use yet the environmental risks of only a small fraction of these has been established. Reliable usage and consumption data needs to be obtained for pharmaceuticals across the world to prioritize substances posing the greatest risk to both the aquatic and terrestrial environments. This should include both prescription medicines and over the counter drugs.

2. For substances identified to have a potential risk, analytical methods need to be developed to detect them in terrestrial systems at environmentally realistic concentrations. These methods could then be applied

to explore the occurrence and fate of yet to be studied pharmaceuticals.

3. Besides research on parent compounds, more work on the occurrence, fate and effects of transformation products and metabolites is needed.

4. Data from more research on the chemical and environmental properties affecting sorption, persistence, transport, and accumulation in the terrestrial environment could support model building for predicting the fate and behavior of pharmaceuticals for a range of environmental conditions. This work should consider the effect of sewage sludge on the behavior of pharmaceuticals.

5. The available occurrence data should be used to evaluate existing regulatory exposure models and where appropriate guide the further development of these models. This will assist in determining risks of new pharmaceuticals in the future.

6. Combining data on the ecotoxicity of PPCPs to terrestrial organisms with the occurrence and fate of pharmaceuticals would identify substances posing the greatest ecosystem risk. As pharmaceuticals will never be in the environment on their own, the impacts of mixtures of different pharmaceuticals as well as pharmaceuticals with other compounds needs to be assessed.

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Sara C. Monteiro holds degrees in chemistry; a BS (University of Oporto, Portugal) and a Ph.D. (University of York-UK). Sara is investigating the fate of human pharmaceuticals in the soil environment following the application of sewage sludge as a fertilizer. The initial component of the project involves the development of analytical methods (HPLC and SPE) or the determination of human pharmaceuticals in environmental matrices. She is also studying the sorption behavior of human pharmaceuticals, as well as their leaching behavior and degradation at field level. The final aim of this project will be to model the fate and behavior of these compounds in the environment.

Alistair B.A. Boxall was appointed lecturer in Environmental Science in September 2004. He is an environmental chemist with research interests in the fate, behavior, and effects of pesticides, biocides, veterinary medicines, industrial chemicals, and nanomaterials in the environment. He has worked in a number of areas including: environmental risk assessment; bioavailability of contaminants; environmental monitoring studies; toxicant identification evaluations; environmental fate modelling; and the use of molecular modeling techniques to predict toxicity.

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WATER RESOURCES IMPACT

LIVESTOCK MANURE MANAGEMENT IN THE AMERICAN PACIFIC ISLANDS

Carl I. Evensen

INTRODUCTION

A common metaphor describing life and resource use in the Pacific Islands is that of a voyaging canoe – a small area of habitation in a vast sea, in which resources are limited, highly interdependent, and often irreplaceable. The island cultures of the Pacific have thrived for centuries through careful management of limited resources, such as pure fresh water. Among the serious threats to water quality faced as populations burgeon in the Pacific Islands are livestock manure that wash into surface waters or leach into ground water. The tragedy is that these materials are too often treated as wastes for disposal, rather than as nutrient-rich organic amendments, to be used productively, in the spirit of wise management of our island ancestors.

The American-affiliated Pacific Islands lie in a great swath across the central Pacific Ocean, from Hawaii in the east to Palau in the west (Figure 1). Climate, soils, and land uses present tremendous diversity despite the small size of the islands. Annual rainfall ranges from 250 mm to over 6,000 mm and differences of 2,000 mm with in a distance of 10 km are common. Surface and ground water concerns are serious in the islands, with problems caused by pollution as sediments, nutrients, toxins, and pathogens flow from diverse sources. Among the important contributors to these water quality problems are manure from livestock feeding operations, which are associated mainly with nutrient and pathogen contaminants. These livestock operations (including cattle, dairy, swine, and poultry) face difficulties developing economically viable and environmentally sound manure management plans. Although island livestock operations are small (e.g., 80% of the 225 swine farms in Hawaii have fewer than 50 sows) most have very limited land area for disposal of animal waste and few have manure management plans. Most livestock waste management practices in the continental United States (U.S.) are not appropriate for the small scale and limited resources of Pacific Island farms, so appropriate technologies must develop locally.

Improved land application of livestock manure in the Pacific Islands requires good management skills and scientific knowledge of the manure-soil-plant systems. While much information is available on the land application of manure in temperate climates, similar information for tropical soils and cropping systems is very sparse. Among the important differences of Pacific Island soils from temperate ones are the widespread distribution of highly weathered and infertile soils, the exceptionally high phosphorus-binding capacity of some soils, and strong aggregation properties that cause many tropical clay soils to behave like sands in terms of water infiltration. Year round cropping and the different crops grown in tropical environments, also limits direct transfer of technologies from temperate areas. In developing appropriate technologies for the Pacific Islands, the goal is to protect stream, coastal, and ground water resources through promotion of manure management practices that are culturally acceptable and economically feasible.

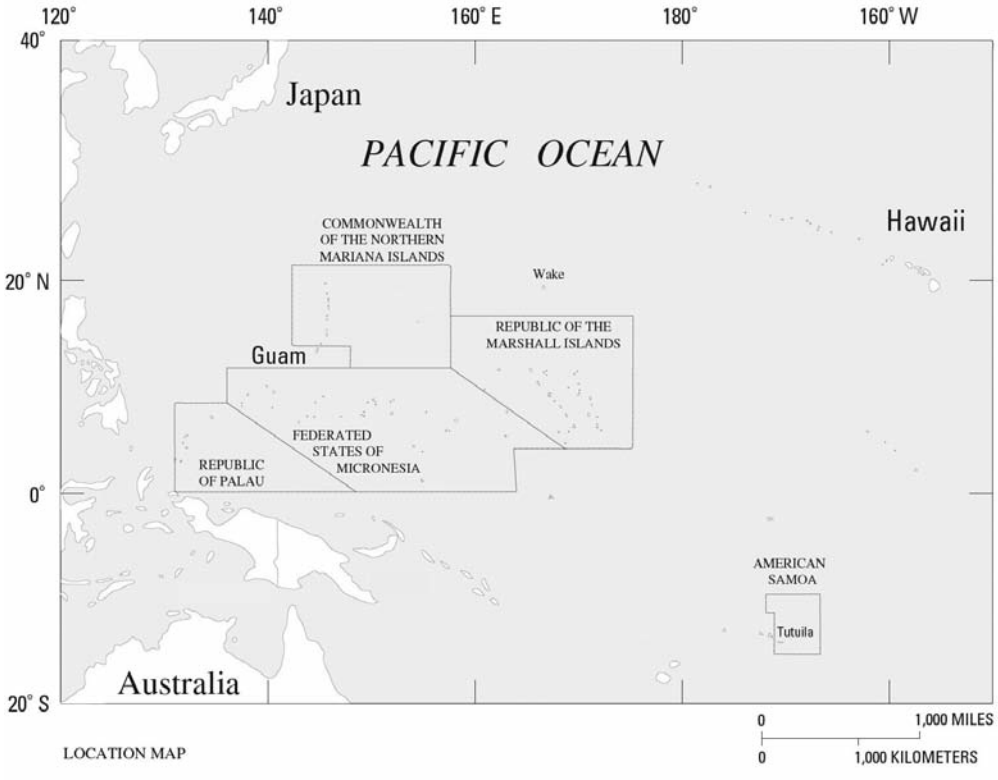

Figure 1. Map Showing the Location of the American-Affiliated Pacific Islands (adapted from Carruth, 2003).

ISLAND WATER RESOURCES

The water resources of the American-affiliated Pacific Islands are extremely diverse and strongly influenced by island geology. The islands can be characterized as either high volcanic (e.g., Hawai'i, American Samoa, and Pohnpei), high limestone (e.g., Guam and the Northern Marianas Islands) or low-lying atolls (e.g., the Marshall Islands and much of the Federated States of Micronesia). Geology determines flow patterns of water due to the differing permeability of volcanic or limestone parent materials that make up the islands. In many areas, ground water provides most of the municipal and domestic water supply while streams are important sources for agricultural water as well as supporting freshwater ecosystems. Rainfall is the source of all fresh water and varies from over 11,000 mm per year (in Waialeale, Hawai'i) to less than 300 mm in the rain shadows of high mountains. Much of the rainfall occurs when the trade winds release their moisture as they reach the steep mountain slopes, so that the greatest rainfall is on the windward sides of the islands. Intense rain events associated with passing typhoons are also common in Micronesia. Most watersheds are small and streams are short in length with peak flows that are brief and intense. Many streams are intermittent, flowing only when rainfall is high enough to generate significant runoff. Permanent streams have highly variable flow, with low flows primarily from ground water discharge and high flows in response to short-term rainfall events (USGS, 2003).

Using the nutrients from animal manure is good business and good for the environment ... proper manure management can go a long way in improving water and soil quality

Pacific Island water resources include surface, coastal waters, and ground water. Surface waters in the islands range from pristine streams and coastal waters to heavily polluted canals, streams, lakes, and bays. In a 2002 report to Congress, the Environmental Protection Agency rated 64 percent of Hawai'i's 3,900 miles of streams as being "impaired" by pollutants, including nutrients, pathogens, sediments, nonnative species, and organic matter that lowered oxygen levels (USEPA, 2002). Over 95 percent of coastal shorelines were assessed as having good water quality, but about half of the 55 square miles of bays and estuaries were impaired, mainly by sediments and nutrients. Ground water quality in Hawai'i, based on tests of well water, show the presence in many wells of solvents, pesticides, and other organic chemicals, generally below minimum reporting levels. While this detailed analysis of water quality is generally unavailable for other Pacific Islands, similar effects of urban and agricultural runoff on surface waters are likely. The extreme permeability of high limestone islands and atolls make them highly susceptible to ground water contamination associated with population growth and land-use change (USGS, 2003). Many islands also have inadequate human and animal waste treatment systems in rural areas (Kingston, 2004) and contamination of surface and ground water with infectious disease organisms can occur. Recent outbreaks of Leptospirosis in American Samoa and diarrheal diseases in the Marshall Islands underscore the dangers.

LIVESTOCK PRESENCE AND PROBLEMS IN THE ISLANDS

Agriculture is a major contributor to island economies and preserves green space and rural lifestyles. However, it is also a source of various pollutants such as sediments, nutrients, pesticides, and pathogens. Animal production provides concentrated sources of nutrients, pathogen, and organic matter contamination to the environment. Concerns exist about the leaching, runoff, and discharge of nutrients and pathogens from these wastes into ground water and surface waters. Throughout the region, adoption of waste management practices can reduce the introduction of pollutants from farms into the water supplies, helping to improve water quality. Serious contamination of surface and ground water with pig waste occurs throughout the American Pacific Islands, where manure is often discharged directly without treatment.

While Pacific Island livestock numbers are lower than those in the mainland U.S. (Table 1), they share similar concerns with overloading land with nutrients near the areas where the livestock operations concentrate. The capacity of croplands to assimilate nutrients, especially phosphorus, from the manure, is greatly overtaxed in many areas.

Throughout the Pacific, pork is traditional fare for all observed occasions and large gatherings; consequently, the demand for whole pigs is very high. In contrast to the continental U.S. where a handful of large animal operations would supply regional demand, Pacific-Island demand is met by hundreds of "backyard" enterprises, called "piggeries." Island piggeries are small, numerous, and mostly unregulated. Often manure is discharged directly without treatment. These wastes can leach into ground water on porous soils (such as in the Northern Marianas Islands) or contaminate streams through direct discharge. In contrast, most livestock operations in Hawaii do treat and store manure. Management is characterized by high water use, accumulation of effluent in earthen lagoons, and limited land application of manure or effluents among livestock producers. Few farms have manure management plans.

MICROBIAL CONTAMINATION CONCERNS

Microbial contamination affects human health through the transmission of infectious diseases in untreated drinking water and through environmental and recreational contact in streams and coastal waters. Sources of microbial contamination can be from direct discharge of inadequately treated human or animal wastes, leakage from sewage pipes or septic systems, or polluted runoff from natural or developed areas. Pathogens associated with animal manure include

Table 1. Number of Pigs and Size of Farms Throughout the American-Affiliated Pacific Islands and the State of Iowa. Data Sources: Hawaii, CNMI, Guam, and Iowa (USDA, 2009), American Samoa (USDA, 2005).

		2002 (1998 for American Samoa)	2007 (2003 for American Samoa)
Hawaii	pigs	23,364	14,933
	farms	204	225
	pigs / farm	115	66
CNMI	pigs	2,242	1,483
	farms	61	62
	pigs / farm	37	24
Guam	pigs	675	635
	farms	34	22
	pigs / farm	20	29
American Samoa	pigs	35,301	64,208
	farms	2,739	3,050
	pigs / farm	13	21
Iowa	pigs	15,486,531	19,295,092
	farms	10,205	8,330
	pigs / farm	1,518	2,316

bacteria (such as *Salmonella, Shigella*, and *Leptospira*), protozoans (such as *Giardia* and *Cryptosporidia*) and Helminths (such as *Ascaris* roundworms), among many others. Disease transmission to humans from waters contaminated by livestock wastes is a concern throughout the Pacific Islands.

For example, Leptospirosis is a serious bacterial disease transmitted by water contaminated with the urine of infected animals, domestic or wild. The disease is difficult to diagnose in humans, though blood serum analysis can determine if people have been previously exposed. The difficulties of detecting *Leptospira* in water samples have impeded progress in identifying sources of the parasite. However, research conducted at the University of Hawaii and the University of Nevada has demonstrated techniques for isolating spirochetes from water samples using simple filters and processing the filters using genetic testing to determine if *Leptospira* is present. If a reliable method is developed to detect pathogenic *Leptospira* in natural waters, stream and runoff testing will be conducted throughout the islands to document their occurrence and to confirm the effectiveness of management practices.

In American Samoa, the U.S. Centers for Disease Control conducted an island-wide study of leptospirosis prevalence in 2004 that found a 17 percent exposure rate in the population. The study also determined that pigs are the major reservoir of the disease, which is passed to humans through water contaminated with pig urine. This problem led to the formation of an Interagency Piggery Management Council to improve pig waste management. The American Samoan EPA implemented regulatory actions such as facility inspections, elimination of direct discharge of untreated wastes, and set backs from streams and houses. The Natural Resources Conservation Service Pacific Basin office is assessing the use of composting to kill pathogenic *Leptospira*. Preliminary studies at the University of Nevada have determined that ranges of temperature and pH conditions lethal to common variants of *Leptospira* can be achieved through composting of manure. Field research is planned throughout the Pacific Islands to confirm the compost temperature and pH conditions existing in the field and to advise producers on optimal management.

SOLUTIONS

Composting and dry litter systems are being introduced throughout the islands. Composting involves combining manure and carbon materials in bins or piles. The piles can be turned, but are usually left static for up to six months. Dry litter composting systems are being adapted in the Pacific Islands to include sloping floors (to allow slow compost movement out of the pens) and locally available carbon sources, such as coconut husks. Farmers like the simplicity of these systems, as well as the lower water use and the nutrient-rich fertilizer produced. Advantages include eliminating pen wash down or discharge of effluent, small land areas required, low capital and operating costs, and an organic fertilizer produced as a by-product. However, a consistent supply of carbon materials is required and this system is applicable only for small to medium scale operations (Fukumoto *et al.*, 2008).

A similar practice being promoted in the islands is a portable dry litter system that eliminates discharges into waterways and integrates composting. A pen is constructed of eight-foot lengths of fence panels, filled with about six inches of carbon-based bedding material, such as coconut husks or wood chips, and holds up to four weaned pigs for four to six months. New bedding is added weekly. This is a very inexpensive system well suited to small scale, backyard farming.

Dry litter systems are being demonstrated in Micronesia, Palau, and American Samoa and instructional literature and a promotional DVD have been developed and distributed around the Pacific Basin primarily through the efforts of the Northern Marianas College. Workshops were conducted in 2004-2008 in the Northern Marianas, Guam, Micronesia, and Palau with over 150 farmer and agency participants, and demonstrations have been established in all these areas. Future workshops will advocate the economic advantage of using the nutrient-rich "wastes" in on-farm composting and fertilization.

The livestock industries in the Pacific Islands are relatively small but provide valuable benefits by producing and supplying nutritious and lucrative food products. The opportunity for the livestock industries to use the nutrients in manures to increase the production of island crops is obvious. In essence, all of the nutrients generated by livestock can be absorbed by island crop production, replacing expensive imported fertilizers. The prospect for producing a value-added product in the form of composted manure or other composted products is very good. At the same time, proper management, handling, and processing of these manures can reduce the pollution risks in livestock farming.

Using the nutrients from animal manure is good business and good for the environment. Proper manure management can go a long way in improving water and soil quality. Manure that is not retained or used has the potential to reach a water body. A well designed nutrient management system provides more opportunities to properly apply and use the manure, reduces odor and pests, reduces pollution risks, keeps the farm in compliance with government regulations, and limits the operation's liability (Kellogg *et al.,* 2000).

ACKNOWLEDGEMENT

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WATER RESOURCES
IMPACT

EFFECTS OF ANIMAL WASTE SPREADING ON GROUND WATER AND CHALLENGES FOR WATER RESOURCES EDUCATION

Kevin Masarik

The intimate connection between the land and ground water quality is dramatically evident to homeowners who rely on rural residential wells for their drinking water. More often than not, activities on their own land or their neighbors' land are partially responsible for the quality of their household water. This article seeks to articulate the major issues in well water education in agricultural regions where there may be concerns about the effects of landspreading animal wastes and other biosolids on ground water. This is an increasingly contentious issue in states like Wisconsin, which have a strong tradition of dairy farming and increasing numbers of rural residents who rely on ground water supplied by wells for their drinking water. Educating the general public about the responsibilities and realities associated with well water in agricultural regions is challenging. If the goal is to reduce the incidence of illness among rural well owners, local and state government officials, residents, and farmers all need to have a more open discussion about the effects of farming on ground water quality and the future development of rural lands.

WELL WATER IN WISCONSIN

Wisconsin is fortunate to have abundant and accessible ground water, and the state relies heavily upon this important resource. Ground water is the principal source of water for nearly 70% of the state's residents, including all rural residents who rely on household wells to provide their family's water needs. Increasingly, much of our agricultural lands are yielding to new homes and other development; many of those new homes are tapping ground water that has been affected by decades of agricultural activity.

Nonpoint source pollution associated with agriculture is arguably the greatest of all water resource management challenges. Monitoring the effects of nonpoint pollution on ground water is difficult and the impacts have primarily been inferred from relatively limited research studies. Valuable information has been collected from homeowners who are willing to have their well water tested through community testing programs, or who share their results with local agencies; residential wells are often windows into local ground water quality. One individual well water test result means little and may not be representative of ground water in a specific region; however, combining results can be a powerful tool to identify ground water quality issues within a community.

AGRICULURAL POLLUTION

Nitrate and pesticides are known, widespread agricultural pollutants in ground water. Because nitrate moves readily through soils and ground water, it is often used as an indicator that ground water has been affected by local land use and may indicate other potential contaminants. A Wisconsin study estimated that 9% of the wells in Wisconsin exceeded 10 mg/L of nitrate-nitrogen, a sign that land use is degrading ground water quality. The percentage of wells impacted by nitrate is often much higher in agricultural areas; one Wisconsin town was found to have nearly 80% of wells tested exceeding the human health standard for nitrate. Across Wisconsin, an estimated 33.5% of rural wells contain detectable levels of pesticides or pesticide metabolites.

Wisconsin has a long and proud history of dairy farming. One of the greatest environmental concerns related to that industry is finding ways to safely spread and utilize animal waste. As more land is converted to development, the amount of area available to landspread animal wastes and other biosolids is decreasing. Households relying on wells for their drinking water are concerned with the effects of spreading animal waste and other biosolids on ground water quality in general, and specifically on their own well water.

While water resource professionals continue working to reduce the impacts of agriculture on the ground water, we must be honest about the task at hand and realize that given current land use practices we cannot completely clean up our ground water resources

Nitrate leaching is a widespread consequence of animal waste spreading on ground water. While animal wastes and other biosolids are not the sole source of nitrate to ground water, their application, particularly on fields already fertilized at an appropriate optimal rate, can certainly exacerbate the problem. A seven-year leaching study conducted below a continuous corn rotation on a well drained silt loam soil that received economically optimal commercial fertilizer showed that flow-weighted mean nitrate concentrations resulted in concentrations close to the 10 mg/L human health standard, but significantly above background concentrations of nitrate in ground water. When animal waste was added on top of optimally fertilized fields, the flow-weighted mean concentration increased substantially with the additional nitrogen inputs.

PREVENTING WELL WATER POLLUTION

Nutrient management is intended to minimize the environmental degradation caused by overfertilization of fields by encouraging crediting of the nutrients in animal wastes and other biosolids as a part of the fertilizer nutrient concentration, together with commercial fertilizer to ensure that farmers apply economically optimal rates of nutrients. While following a nutrient management plan may result in less nitrogen loss, it will not completely

eliminate the loss of nitrate to ground water. Even at nitrogen application rates near or below the economic optimum, significant nitrate leaching below the root zone has been shown to occur. Throughout the state, commercial fertilizers are responsible for a larger percentage of the nitrate found in ground water than are manure and other biosolids.

Bacterial contamination of ground water is another concern that is associated with land application of animal waste. Unlike nitrate, however, it should not be assumed that landspreading waste will always result in bacterial contamination of ground water. The opportunity for this type of contamination is greatest following large rain events or snowmelt, and occurs most often in specific geologic settings. Bacterial contamination can be minimized by avoiding environmentally sensitive lands, and by avoiding landspreading during times when rapid infiltration of surface water into ground water can occur. Ground water contamination with bacteria from animal waste often generates significant attention when it occurs in a community, because health effects are acute, and severe gastrointestinal illnesses can occur, often resulting in hospitalization and even death.

In comparison to the issue of nitrate and pesticides in ground water, less information is available to show the extent to which bacteria and pathogens from agricultural sources are finding their way into ground water. Sources of bacterial contamination are often difficult to confirm given the wide range of analysis that would need to be performed to understand whether the pathogens are associated with animal waste or human waste from septic systems. Data are also scarce because many instances of well contamination likely go undetected, unconfirmed, or unreported. Microbial source tracking and other tools can help determine the source of contamination but are still relatively new and expensive, making them out of reach for the average homeowner.

Over the last couple of years, a few widely publicized incidences of manure entering aquifers have drawn considerable attention to the issue in northeastern Wisconsin. In response, a Task Force was convened to consider existing data and make recommendations on addressing the problem. The Task Force was able to identify specific areas posing the greatest risk of contamination from landspreading animal waste because of geologic formations. The areas of most concern are centered on small portions of northeastern Wisconsin where Silurian bedrock, a fractured dolomitic limestone, occurs at or relatively near the land surface. A variety of sound recommendations were proposed aimed at reducing the occurrence of animal wastes contaminating water supplies. While those recommendations have yet to be implemented, there is still hope that they will. Even if the recommendations are implemented, there are still likely to be occasional incidences of animal wastes contaminating ground water.

HOMEOWNER CONCERNS

Where does that leave homeowners if recommendations are not implemented, or if they live outside of the most environmentally sensitive areas where recommendations may not apply? Even though the risks may be less severe, should they not be worried? With stories of well contamination still fresh in people's minds, rural well owners remain understandably concerned about landspreading animal wastes on nearby lands. Those concerns are heightened when expansions of dairy herds into the thousands of animal units are proposed in their community. While states and communities push for better management practices concerning animal wastes, homeowners in rural areas should be aware of the inherent risks associated with well water.

Well water testing in agricultural regions has revealed persistent water quality problems as a result of farm practices: elevated levels of nitrate, pesticide residues, and in some cases bacterial contamination of wells are unfortunate realities many in agricultural regions. While water resource professionals continue working to reduce the impacts of agriculture on the ground water, we must be honest about the task at hand and realize that given current land use practices we cannot completely clean up our ground water resource. If we are willing to acknowledge the current level of ground water quality degradation and realize that it is not likely to improve anytime soon, then we must begin to ask people moving out to rural areas whether they are willing to accept the additional risk and responsibility associated with owning a rural well.

It is important that those living and moving out to rural areas are made aware of their options when it comes to obtaining a safe water supply. While drilling a new well or connecting to a municipal water supply would be the ideal solutions, oftentimes they are not possible or practical. The alternatives then are relying on water treatment technology or purchasing bottled water. Which decision to choose is solely up the individual homeowner. The best way to aid homeowners in their decision making process is to develop more effective methods of communication with well water users and potential home buyers.

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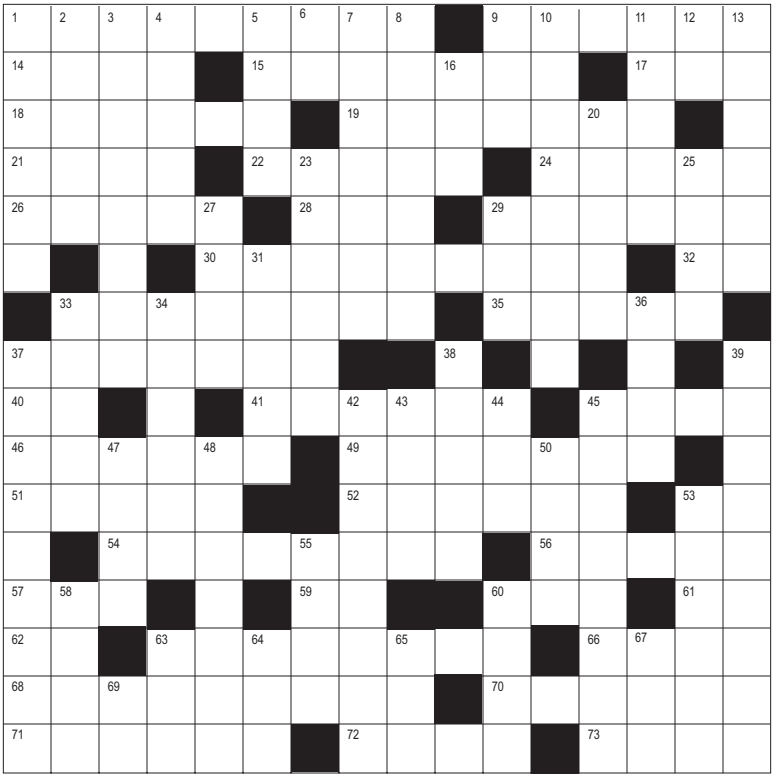
WATER RESOURCES PUZZLER (answers on pg. 27)



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39 most thin
42 peg-board game
43 return to health
44 forerunner of JAWRA
45 immoral
47 06/06/44
48 followed by Hemisphere or shore
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55 the A.M. hours (poet.)
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LAS VEGAS READY'S WATER PIPELINE PLAN

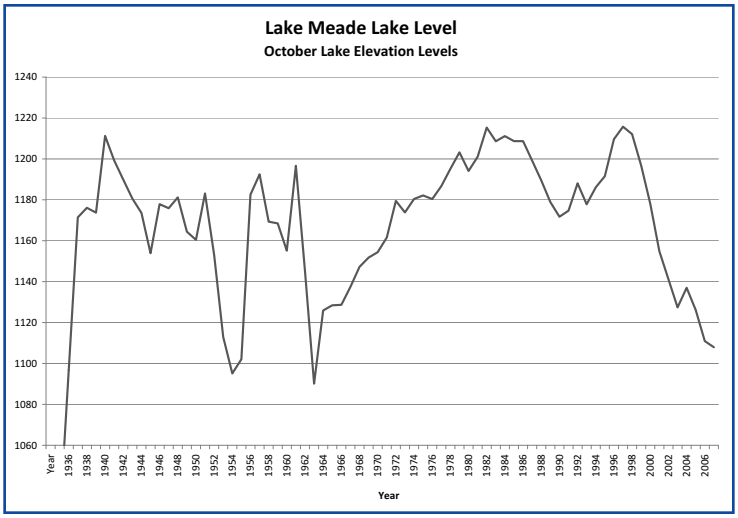
Clay J. Landry

The Southern Nevada Water Authority announced in June that it will seek funding approval for a controversial multibillion dollar ground water pipeline project if water levels at Lake Mead fall another 23 feet. The water authority board has already approved the pipeline concept and signed off on ongoing efforts to secure water rights and environmental permits, but it has never voted to build the project.

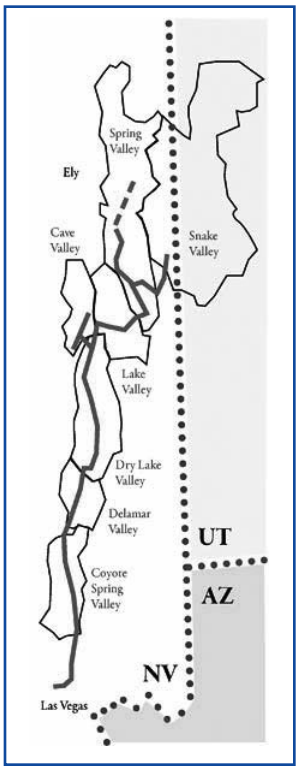
Water Authority General Manager Pat Mulroy said that board members will have to make that decision when the surface of Lake Mead sinks to an elevation of 1,075 feet above sea level, a low-water mark last seen in 1937 when the reservoir was filled for the first time. The Bureau has predicted that Lake Mead's water level will remain above 1,075 for at least the next two years. However, these projects are based on average river flows, and the Colorado has been anything but average over the past 10 years.

From 1999 to 2008, the river had about 66 percent of its normal inflow, most of which comes from melting snow in the Rocky Mountains. Over that same period, lakes Mead and Powell, the two largest man-made reservoirs in the United States, lost about half their total volume.

Lake Meade serves as the primary water supply for Las Vegas and has reached historic lows. A recent study by Scripps Institution of Oceanography predicts that there is a 50 percent chance that Lake Meade will be dry by 2021 if climate change patterns and current water demand trends continue. According to data maintained by the U.S. Bureau of Reclamation, lake levels have steadily dropped since 1997 (see chart below). The U.S. Bureau of Reclamation, which operates Hoover Dam and the reservoir, says the high-water mark of the lake is 1,229 feet, which is more than 7-1/2 feet above the top of the dam's raised spillway gates. Current lake levels are near 1,096 feet.



The precipitous drop in lake levels has prompted the Southern Nevada Water Authority to begin developing backup water supply plans. The most ambitious being the 250-mile pipeline project that would tap ground water across eastern Nevada and deliver it to metropolitan Las Vegas (see map). The project is estimated to cost $3.5 billion and would be the largest public works project in the state's history. The project would convey approximately 170,000 acre-feet per year of ground water from five hydrographic basins in eastern Nevada.



The trigger point was set at 1,075 feet and is designed to give the agency time to construct and begin pumping its closest ground water holdings in rural Nevada before water from Lake Meade may be unavailable entirely. If the lake level falls to 1,050 feet above sea level, the authority will be forced to shut down one of two intakes it uses to draw drinking water from the reservoir.

The collapse in new home construction and one of the nation's highest foreclosure rates has tempered water demand at least temporarily. In 2008 housing starts in the Las Vegas metro area fell 40 percent and 67,223 properties went through foreclosure, a 121 percent increase from 2007.

The decline in the housing market has had a direct impact on the Southern Nevada Water Authority's water revenues, which in turn could impact the agency's ability to finance capital projects. In 2006 the agency took in $188.45 million in connection fees. Revenues fell to $121.36 million in 2007 and $61 million in 2008 with another decline forecast for this year. The agency is holding on tightly to its reserves of $480 million, amassed during the boom years. The reserve is needed to maintain the agency's good bond rating, which helps it obtain money needed for major capital projects such as the pipeline project.

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FOOLS FOR THE CITIES:* THE GLOBAL URBAN TRANSITION

Eric J. Fitch

That night after seeing the new Star Trek movie as I drifted off to sleep my mind wandered to the story of Romulus and Remus. They were as the legend tells the twin sons of Mars the god of War and the involuntary vestal virgin Rhea Silvia. Due to a convoluted mix of prophecy, politics, and broken vows, she gave birth to twin baby boys. Mother and sons were cast into the Tiber River to drown, but the deity of the river protected them. They all survived, but were separated. The boys were found and (improbably) suckled by a she-wolf (perhaps the origin of a question often asked of teenagers: "Were you raised by wolves?"). In turn they were found by a shepherd and raised as his sons. As adults, they founded a city and in a horrible example of sibling rivalry quarreled over "naming rights." This ended with Romulus killing Remus; hence there is no city of Reme but of Rome. Yuri I. Dolgoruki, Pedro de Valdivia, Christiaan Hendriksen, and Moses Cleaveland are but a few of the people like Romulus we remember mostly because they are credited with the founding of cities (though to the best of my knowledge none of the rest got an an alien homeworld and empire named after them in the Star Trek Universe: respectively they founded Moscow, Santiago (Chile), New Amsterdam aka New York, and Cleveland, Ohio ... though we dropped the first A).

There are many existing and lost cities for whom we know little or nothing of the original founders. For those which have failed, the reasons are usually pretty clear: the four horsemen of the Apocalypse - famine, plague, war and pestilence, and their cousins natural disasters and the depletion or destruction of key natural resources. For others it is not so clear. Debate continues for example about the Polynesian settlement called Rapa Nui (Easter Island). When was it settled, how long was it inhabited, and why did the inhabitants leave are subjects of continued debate.

This brings us to a key event that occurred some time during 2007 or 2008 that went mostly unnoticed by almost all but the global community of demographers and environmental scientists. A major change overtook the global human community; we became a urban majority species (i.e., more people live in cities than in rural areas). This key social and cultural transition has huge implications for the water resource community. As many can remember from their study of history, cities from Rome to New York to Los Angeles to Beijing have grown to the major status not because of their proximity to fresh water resources, but of their ability to move water from where it is to where it is needed by means of engineering and architecture. Cities have become the prime habitats for the human species in no small part because of the ability to transport water around the landscape from where it is plentiful to where, combined with other resources, humans find prime habitat. This does not however mean that the supply of fresh water no longer is a limiting factor and one of the prime considerations in the carrying capacity of any habitat. Increasing freshwater scarcity and impacts on sea level and the intensity of coastal storms can radically alter habitability of certain urbanized areas.

Overconcentration of human population in any one region or type of habitat has proven disastrous for human and other species in the past. We all have heard the folk proverb about not "putting all your eggs in one basket". Current theory of human social evolution indicates that our species had dispersed itself widely throughout the African continent and beyond over 100,000 years ago. A single natural disaster, the eruption of the Toba supervolcano approximately 75,000 years ago almost wiped out all our ancestors. This "weak Garden of Eden model" indicates that global human population was reduced to 10,000 individuals or fewer in widely separated clusters of survivors. If the history of extinction in our planet's prehistory teaches us anything, it is that even humans can not risk having us too concentrated. Stephen Hawking has suggested that even having us all on Earth gives us too small a safety margin.

This brings us to the "Global Assessment Report on Disaster Risk Reduction" just released by UNISDR (United Nations International Strategy for Disaster Reduction Secretariat) in May this year. The contents are as gloomy as the title suggests. As the global human community has urbanized, we have put ourselves invariably in harms way; humankind's eggs are more and more concentrated in urban baskets. Water related disasters from drought to flooding to coastal storms /storm surge, to sea level rise are becoming key pillars in the temple of species risk.

One potential saving grace for much of the United States, Canada, and other affluent nations of the world from the report is that engineering, architecture and infrastructure have allowed creators of cities to reduce the risk from these hazards. This does not mean that we have avoided these risks completely. Some of the key cautionary lessons from this report for developed nations is that technological prowess can only partially offset in time and impact the forces of natural and human made disaster. As the Red Queen in "Alice Through the Looking Glass" put it, "in this place it takes all the running you can do, to keep in the same place." Water resources in southern California, peninsular Florida, and the desert southwest including cities such as Phoenix, Tempe, and Las Vegas are already being stretched to the limits of resource availability and technological prowess. More and more populations are not only urbanized, but clustered on coasts and shores, in river valley and in deserts – repeatedly tempting fate with their location in harms way.

(continued on pg. 24)

LEATHERBACKS, LOGGERHEADS, AND STIMULUS

Michelle Henrie and J. Brian Smith

At the end of May, the Center for Biological Diversity and other environmental groups filed a lawsuit under the Endangered Species Act (ESA) seeking to protect two types of sea turtle: the leatherbacks and the loggerheads. According to the Complaint, both species face numerous threats: incidental capture, injury, and death in fishing gear, loss of nesting beaches from development and sea level rise, and other adverse impacts from climate change and ocean acidification. The suit is filed against the two federal agencies that administer the ESA: the U.S. National Marine Fisheries Service (known as NOAA Fisheries Service), which is a division of the Department of Commerce, and the U.S. Fish and Wildlife Service, a division of the Department of the Interior. The applicable Cabinet Secretaries, Gary Locke and Ken Salazar, are also named as defendants.

Under the ESA, there are several steps that must be taken to protect at-risk species. First, the species must get on the list. There are two lists: "threatened" species, which are comparatively less at-risk, and "endangered" which are more at-risk. The applicable Cabinet Secretary (Commerce or Interior) places species on the lists, either on his own initiative or as a result of someone else's petition. The lawsuit involves the petition process.

According to the Complaint, Plaintiffs in the lawsuit petitioned the predecessors' Secretaries in 2007. In sum, they sought to move distinct geographic populations of loggerheads from the "threatened" list to the "endangered" list and they sought to expand the leatherback's designated critical habitat area to include specific geographic locations.

After receiving a petition, the ESA requires the agencies to determine whether the petitioned-for action "may be warranted" within 90 days. If so, the agency has 12 months to carry out a more detailed review and determine whether such action is "in fact warranted." The lawsuit claims that during each agency's requisite initial "90-day period," they found that the petitioned-for action "may be warranted," but failed to take the next step. Plaintiffs state that the required 12-month findings are now between six and ten months overdue. (One of the Plaintiffs was quoted as saying "this is a classic example of the Fisheries Service dragging its feet ... sea turtles can't continue to wait for these essential protections. More sea turtles will be caught and killed with each passing day, pushing them closer to extinction." So far, there has been no statement from Plaintiffs as to why they waited six and ten months before filing suit.) The Plaintiffs now want the Court to compel the agencies to evaluate their petitions.

If the agencies are forced to evaluate Plaintiffs' petitions, what might this mean? Three things. First, more areas could be designated as critical habitat. "Critical habitat" means areas where the listed species currently is found or areas that may provide additional habitat for the species' recovery. The Fish and Wildlife Service has been a frequent target of lawsuits alleging failure to designate critical habitat (as of October 2007, Fish and Wildlife Service had designated critical habitat for only about 36% of the listed domestic species). Designation of critical habitat raises concerns because actions within the critical habitat area could affect the at-risk species.

Second, more turtles would be protected from "take." "Take" is a defined term that includes killing or harming members of a listed species. For example, actions that are likely to result in a "take" of an endangered fish include: constructing or maintaining barriers to passage, discharging pollutants, removing or destroying plants or animals needed for food or shelter, physically altering habitat, withdrawing water or otherwise impairing spawning, migration, or feeding by changing streamflow, release of nonindigenous species, providing inadequate or non-existent fish screens or passage facilities, working on stream banks or unstable slopes above habitat, and increasing sediment loading to habitat. There are civil and criminal penalties for violations (e.g., fines), and suits may be brought against alleged violators by individual citizens.

Third, more permits and consultations may be required. Proposed actions that may have adverse impacts on listed species require one of two approaches depending on who the actor is. If there is no federal nexus whatsoever (e.g., no federal funding, no federal permit or license), then the Secretary may issue a permit allowing an "incidental take" of members of the listed species during otherwise lawful actions upon submittal of a Habitat Conservation Plan. By contrast, if there is a federal nexus, and if the Secretary finds after a "§7 Consultation" that the proposed action is likely to jeopardize the listed species or destroy or adversely modify critical habitat, he issues a biological opinion specifying terms and conditions under which "take" of the listed species will be allowed without triggering penalties.

For example, in early June, NOAA released a biological opinion relating to water pumping operations in California's Central Valley by the federal Bureau of Reclamation (BOR). NOAA found that the pumping jeopardizes the continued existence of several threatened and endangered species. The terms and conditions imposed on BOR will require it to change its water management practices to increase cold water storage and flow rates. On the ground, this means that about 330,000 acre feet per year of water moved by the federal and state pumps will be impacted. NOAA's press release assures us that the effect will be "tiered", and that the opinion includes exception procedures for drought and health and safety issues. It also notes that stimulus funds "will mitigate some costs resulting from the opinion's recommended actions."

(continued on pg. 25)

BUILDING STRONG COLLABORATIVE RELATIONSHIPS FOR A SUSTAINABLE WATER RESOURCES FUTURE

Ada Benavides

In this era of economic difficulty, discretionary funding for water resources solutions is hard to come by, and the more minds that can focus on water resources challenges, the better. Strong collaborative relationships bring enormous brainpower to bear and help avoid duplication of effort or working at cross purposes.

Water resources management is a shared responsibility among the States, numerous Federal agencies, Native American Tribes, and regional, local, and non-government entities to address concerns about having enough water to serve often competing demands. Plans and processes need to be in place to promote smart use of water to serve multiple purposes, prioritize the use of water, and safeguard its quality and quantity to meet diverse needs.

Since the "Listening Sessions" of 2000 and numerous forums since then, the American Water Resources Association (AWRA) has endeavored to foster a collaborative approach to water resources. In that spirit, AWRA is proud to be a partner of a U.S. Army Corps of Engineers (Corps) project to assess America's water resources needs and to promote open discussion across government levels and with stakeholders about how to meet today's and tomorrow's water needs and priorities. The undertaking includes a series of workshops to listen to water resources officials in every state about what they deem to be their biggest challenges and most important needs. Beginning with a review of state water plans and related documents, followed by collaborative discussions and interviews with key officials, the Corps is summarizing what each state is saying about its needs and priorities and getting a sense of its water resources planning process.

The Corps believes the time is ripe to gain an objective assessment of states' water needs from their perspective. By looking beyond their own borders, states can integrate needs and objectives to make more efficient and effective use of resources for more lasting and sustainable effects. The Corps is facilitating the opportunity to bring partners together to move the Nation toward a more Integrated Water Resources Management.

Regional entities and other federal agencies are joining the dialogue at three regional conferences being held in the western, central, and eastern regions of the U.S. under the co-sponsorship of federal agencies and non-governmental organizations such as the, Interstate Council for Water Policy, the Western State Water Council, the Upper River Basin Mississippi Commission, and AWRA. The first regional conference took place in Orlando, Florida, on February 17, 2009, with representatives from 13 Eastern states, 4 interstate river basin commissions, 7 federal agencies, and 6 nongovernmental organizations engaging in a dialogue around critical water resources needs and strategies – especially partnerships – to address them. This was followed by the Western regional conference held in Kansas City, Kansas, on April 19-21, 2009, in conjunction with the Western States Water Council. Representatives were invited from the 17 "Reclamation States" plus Alaska and Hawaii. The Central regional conference, held June 23-25 in St. Louis, Missouri, featured key water resources players within that region. The results of the three regional workshops will be unveiled at a National Conference in August 2009 in Washington, D.C.

As Deputy Chief of the South Pacific Regional Integration Team at the Corps Headquarters, I'm leading the project team as a special assistant to the Director of Civil Works for the Corps, with the assistance of the CDM Corporation. We expect that the needs and challenges are so important that they will elevate the national will to put water needs on the radar screen of the decision makers across the country including State governors, Congress and the Administration. This time, however, the report will not be what the Federal Government thinks is needed but what the states actually say they want and need. There is a great opportunity to unify the Federal family to produce a Federal "Toolbox of Support" containing a hub of information about authorities, programs, policies, methods, models, and data and to build strong relationships and partnerships for smart water resources investments. My hunch is that the secret to water management success will be an inclusive and focused team effort to build and implement a national vision for better water resources management in the Nation.

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What's Up With Water ... cont'd. from pg. 22

So, what to do? According to the Book of Ecclesiastes, There is nothing new under the Sun. Humans have seen the destruction of our cities in the past in a variety of forms: some immediate, some over long period. Perhaps through the combined use of hindsight and foresight, the same fates may be spared humanity and our cities in the future. Or to put it another way, perhaps we can avoid the consequences by heeding George Santayana's Aphorism on Repetitive Consequences: "Those who cannot remember the past are condemned to repeat it."

*With apologies to Dave Peverett and the members of Foghat

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▲ PRESIDENT'S MESSAGE ... GERALD SEHLKE. PRESIDENT, AWRA

Over the weekend I heard and read much about the "stimulus package" and it made me wonder if it was really helping to address our pressing water resources needs in the United States (U.S.). We know that maintaining adequate quantities of clean water is essential to the health and economic prosperity our nation, and to protect our environment. However, after several decades of improvement, its seems we have been losing the battle to protect our water and associated land resources, to maintain the essential water resources infrastructure that provides us with clean, healthy water supplies, and to protect us from extreme events. I wondered whether the facts are matching the hype in the press; are we really putting adequate Recovery Act funding to work protecting our water resources and fixing and/or upgrading our water resources infrastructure?

The American Society of Civil Engineers (ASCE) recently issued a new "infrastructure report card" (http://www.asce.org/reportcard/2009/grades.cfm), including major water resources-related infrastructure. According to ASCE the U.S. has more than 85,000 dams that are on average about 51 years old, with approximately 4,000 being high potential hazard dams. Their overall condition was rated as poor (D); no estimate was given for upgrading or replacing them but it is surely in the 10s to 100s of billions of dollars. There are approximately 100,000 miles of levees in the U.S.; they too are aging and are estimated to require about $100 billion to repair and rehabilitate. Their overall condition was rated D-. It is estimated that it will cost at least $11 billion per year to replace aging drinking water infrastructure (D-) just to keep up with maintenance and upgrades, let alone expand our capacity to meet future needs, and approximately $20 billion/year to maintain existing and to meet future wastewater treatment needs (D-). In addition, it is estimated that it will cost more than $125 billion to upgrade or replace our existing inland waterways shipping locks (D-).

When proposing the Recovery Act, the Administration promised to educate the public, and to be transparent and accountable in the use of Recovery Act funds. In an effort to do this, the Administration developed a website to inform the public on its use of these funds (www.recover.gov). I anticipated that the website would allow the public to learn how much of the recovery funds will be spent on upgrading our aging infrastructure. It provides a very high level summary of allocations (e.g., total investments for infrastructure and science are about $126 billion); however, I found the site severely lacking in details. It offers some hope of finding more details by linking to USASpending.gov (http://www.usaspending.gov). However, after an hour or so of trying to navigate that website, with its mountains of bureaucratese, broken links, and "error" messages, it was apparent that it wasn't going to enlighten me any further any time soon. Unfortunately, that forced me to look at unofficial estimates like Wikipedia for insights.

Wikipedia (http://en.wikipedia.org/wiki/Recovery_Act) estimates that the total Recovery Act infrastructure investments to be $80.9 billion for all infrastructure (largely highways). It estimates approximately $20 billion for water-related projects; $6 billion for wastewater and drinking water infrastructure, $4 billion infusions into the Clean Water and $2 billion into the Drinking Water State Revolving Funds; and $4.6 billion in funding for Army Corps of Engineers environmental restoration, flood protection, hydropower, and navigation infrastructure projects. Another $3 or so billion of supplemental dollars are estimated to address rural drinking water and waste disposal projects, watershed projects and flooding along the Rio Grande.

The take home from my weekend "homework exercise" is two-part. First, the Administration has a long ways to go to meet its goals of educating, being transparent and being accountable to the public relative to the Recovery Act. Summary information should be readily available on its official website in tabulated, clear and easy to understand language. Second, while $20 billion is a significant amount of money, when compared to the estimated funds needed, it is clear that the U.S. is continuing to fall further and further behind in its effort to ensure the health and economic prosperity our nation, and to protect our environment.

Legal Issues ... cont'd. from pg. 23

Speaking of stimulus funds ... recipients beware. You have just accepted a federal nexus and are now subject to the terms of a biological opinion if your project happens to be (or become) located in a listed species' habitat.

(Note: The leatherback and loggerhead case is styled: *Center for Biological Diversity, et al., v. Locke, et al.,* filed in U.S. District Court, Northern District of California, Docket No. 3:09-CV-02346-MMC. Please contact Michelle Henrie if you would like a copy of the Complaint.)

E-MAIL CONNECTION

michelle@mhenrie.com / brian@jones-smithlaw.com

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AWRA'S 2009 SPRING SPECIALTY CONFERENCE
STUDENT PRESENTER COMPETITION WINNERS ANNOUNCED

Congratulations to the two Student Presenter Competition winners of AWRA's 2009 Spring Specialty Conference on "Managing Water Resources Development in a Changing Climate" that was held during the conference in Anchorage, Alaska, May 4-6. Twenty-eight students participated and were scheduled throughout the 50 sessions and the poster session. Conference attendees were given the opportunity to judge the students during their scheduled session. The following criteria was used for both oral and poster competitors:

- Efficient use of allotted presentation time or poster space.
- Quality of responses to audience questions in oral or at poster sessions.
- Effective integration of audio-visual materials.
- Perceived preparedness.
- Logic and understandability of material (problem, methods, results, conclusions).
- Adequate description of context for material – conveyed purpose of paper, identified relevant literatures, etc.
- Overall style and presence; effective communicator – enthusiasm or persuasiveness
- Suitability for AWRA/professional audience.
- Significance and originality of the material presented.

Everyone did a terrific job and made the decision difficult. However **Maria E. Milanes-Murcia** (Session 3, Oral Presentation, *Water Resources in Sudan*) and **Erin McDonald** (Poster Presentation, *The Effects of Surface Water Quality and Microfiltration Membrane Charge Characteristics on Membrane Fouling;* co-author: Silke Schiewer) were selected as the outstanding winners:

Again, our congratulations on a job well done to all those students who were in the competition and we wish them all the best in their future endeavors. We look forward to hearing more from everyone at future AWRA conferences!

MARIA E. MILANES-MURCIA
McGeorge School of Law ~ Sacramento, California

Maria E. Milanes-Murcia is originally from Spain where she is a member of the Murcia/Spain Bar Association. She is fluent in Spanish, English, and Italian. She was awarded her Law Degree at Murcia University in 2003. While a law student, Milanes-Murcia moved to Italy, where she studied law at Università degli studi Roma Tre and Universitá degli studi di Pisa on an Erasmus Grant. She has practiced Environmental Law, Water Law, Criminal Law, Business Law and Family Law in Spain.

In 2007, she earned her MS Degree in Economics with emphasis in water markets and water value at New Mexico State University, during which time she also worked as a teacher and researcher at New Mexico State University, as well as for the New Mexico Environmental Department Surface Water Quality Bureau.

In 2008, Milanes-Murcia was awarded a LL.M. in International Water Resources Law at the University of the Pacific, McGeorge School of Law in Sacramento California. She wrote her LL.M thesis, "Interstate Water Agreements in Federal Countries: A Comparative Analysis," at the Legal Services Department of the Food and Agriculture Organization of the United Nations in Rome, Italy.

Currently, Milanes-Murcia continues her education at Pacific McGeorge in the J.S.D. program under Professor Stephen McCaffrey. She also works for the California Resources Agency, the California Department of Forestry and Fire Protection, and teaches Environmental Law at Sacramento State University.

Erin McDonald
University of Alaska-Fairbanks ~ Fairbanks, Alaska

Erin McDonald, E.I.T. is currently pursuing an M.S. in Environmental Engineering at the University of Alaska-Fairbanks. She works as a graduate research assistant at the Water & Environmental Research Center. Her research is focused on the effects of surface water quality and membrane material properties on microfiltration membrane fouling for drinking water applications. She received her B.S. in Environmental Resources Engineering at Humboldt State Univ. in Arcata, California. While at Humboldt State she worked as an undergraduate research assistant in indoor air quality and held a renewable energy internship at Schatz Energy Research Center. She also worked as a civil and environmental engineer at SHN Consulting Engineers and Geologists, Inc. on projects related to municipal water treatment, stormwater, remediation and environmental permitting.

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HAVE SOME COMMENTS ABOUT THIS ISSUE OF IMPACT?

SEND US YOUR FEEDBACK

Water Resources IMPACT is in its 11th year of publication and we have explored a lot of ideas. We hope we have raised some questions for you to contemplate. "Feedback" is your opportunity to reflect and respond.

We want to give you an opportunity to let your colleagues know your opinions ... we want to moderate a debate ... we want to know how we are doing. For this issue send your letters by e-mail to Laurel Phoenix (phoenixl@uwgb.edu), Eric Fitch (fitche@marietta.edu), or Earl Spangenberg (espangen@ uwsp.edu).

Please share your opinions and ideas. Please limit your comments to approximately 350 to 400 words. If published, your comments may be edited for length or space requirements. Also visit AWRA's Water Blog at http://awramedia.org/mainblog/ to view past essays from our Future-ing Project.

▲ SCHEDULED TOPICS FOR FUTURE ISSUES OF *IMPACT*

SEPTEMBER 2009
WATER RESOURCES AND BOUNDARY ISSUES
JOE BERG (GUEST EDITOR) ~ jberg@biohabitats.com

NOVEMBER 2009
SPIRITUALITY AND WATER MANAGEMENT
ERIC J. FITCH (ASSOCIATE EDITOR) ~ fitche@marietta.edu

JANUARY 2010
RETURN ON INVESTMENT IN GIS
(SPRING SPECIALTY CONFERENCE)
SANDRA FOX (GUEST EDITOR)

MARCH 2010
ZERO IMPACT DEVELOPMENT
JONATHAN E. JONES (ASSOCIATE EDITOR)
jonjones@wrightwater.com

The topics listed above are subject to change. For information concerning submitting an article to be included in the above issues, contact the designated Associate Editor or the Editor-in-Chief N. Earl Spangenberg at espangen@uwsp.edu.

WHAT'S YOUR OPINION?

Over the last 10 years, *Water Resouces IMPACT*'s Associate Editors have been doing their best to provide you with a variety of topics that we hope you have found interesting and informative. We are sure that you all have a lot of other topics that you want to know more about.

Let us know what topics you would like to see us address in future issues of *IMPACT*. Just drop a line to espangen@uwsp.edu or to Terry Meyer (terry@awra.org) to give us an idea of where your interests lie.

Thanks ... Earl Spangenberg, Editor-in Chief
Water Resources IMPACT

Solution to Puzzle on pg. 20

AMERICAN WATER RESOURCES ASSOCIATION MEMBERSHIP APPLICATION – 2009

MAIL THIS FORM TO . . . AWRA • C/O Middleburg Bank • P.O. Box 2217 • Leesburg, VA 20177-2217
FOR FASTEST SERVICE . . . FAX this form (credit card or P.O. orders only) to (540) 687-8395
QUESTIONS? . . . CALL AWRA HQ at (540) 687-8390 or E-MAIL at info@awra.org

➤ Complete All Sections (please print)

LAST NAME FIRST MIDDLE INITIAL

TITLE

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MAILING ADDRESS

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IS THIS YOUR ❑ HOME OR ❑ BUSINESS ADDRESS?

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RECOMMENDED BY (NAME) AWRA MEMBERSHIP #

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➤ Your Primary Reason For Joining? (check one)

- ❑ To Receive Information Through JAWRA and Impact
- ❑ Networking Opportunities
- ❑ Technical Committee Interactions
- ❑ Conference Discount
- ❑ Employment Opportunities
- ❑ Other: _____

➤ How Did You Learn Of AWRA? (check one)

- ❑ Promotional Mailing
- ❑ Internet Search
- ❑ Journal (JAWRA)
- ❑ IMPACT
- ❑ Boss/Friend/Colleague
- ❑ Email Received
- ❑ Other: _____

AWRA
Community, Conversation, Connections

DEMOGRAPHIC CODES

(please limit your choice to one in each category)

JOB TITLE CODES

- JT1 Management (Pres., VP, Div. Head, Section Head, Manager, Chief Engineer)
- JT2 Engineering (non-mgmt.; i.e., civil, mechanical, planning, systems designer)
- JT3 Scientific (non-mgmt.; i.e., chemist, biologist, hydrologist, analyst, geologist, hydrogeologist)
- JT4 Marketing/Sales (non-mgmt.)
- JT5 Faculty
- JT6 Student
- JT7 Attorney
- JT8 Retired
- JT9 Computer Scientist (GIS, modeling, data mgmt., etc.)
- JT10 Elected/Appointed Official
- JT11 Volunteer/Interested Citizen
- JT12 Non-Profit
- JT13 Other

EMPLOYER CODES

- CF Consulting Firm
- EI Educational Institution (faculty/staff)
- ES Educational Institution (student)
- LR Local/Regional Gov't. Agency
- SI State/Interstate Gov't. Agency
- IN Industry
- LF Law Firm
- FG Federal Government
- RE Retired
- NP Non-Profit Organization
- TG Tribal Government
- OT Other _____

EDUCATION CODES

- HS High School
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- BA Bachelor of Arts
- BS Bachelor of Science
- MA Master of Arts
- MS Master of Science
- JD Juris Doctor
- PhD Doctorate
- OT Other _____

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- AG Agronomy
- BI Biology
- CH Chemistry
- EY Ecology
- EC Economics
- ED Education
- EG Engineering
- FO Forestry
- GR Geography
- GE Geology
- GI Geographic Information Systems
- HY Hydrology
- LA Law
- LM Limnology
- OE Oceanography
- PS Political Science
- OT Other _____

PLEASE NOTE YOUR SELECTED CODE NUMBERS FROM ABOVE

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2009

NOVEMBER 9-12, 2009
AWRA'S ANNUAL WATER RESOURCES CONFERENCE
RED LION ON FIFTH AVENUE ~ SEATTLE, WASHINGTON
EARLY-BIRD REGISTRATION DEADLINE ~ OCTOBER 19, 2009

2010

MARCH 29-31, 2010
AWRA's SPRING SPECIALTY CONFERENCE ON GIS
ROSEN SHINGLE CREEK HOTEL ~ ORLANDO, FLORIDA

NOVEMBER 1-4, 2010
AWRA'S ANNUAL WATER RESOURCES CONFERENCE
LOEWS PHILADELPHIA HOTEL ~ PHILADELPHIA, PENNSYLVANIA

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