commentletters - Comment letters---proposed recycled water policy

Public Comment
Recycled Water Policy
Deadline: 12/22/08 by 12 noon

From: Edo McGowan <edo_mcgowan@hotmail.com>
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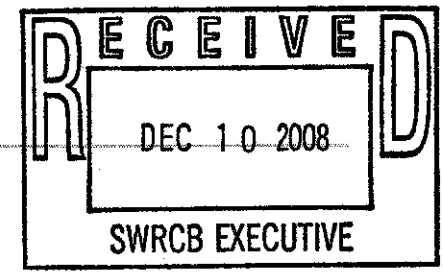
Date: Wednesday, December 10, 2008 11:23 AM
Subject: Comment letters---proposed recycled water policy



To: Members of the State Water Resources Control Board

Fm: Dr Edo McGowan
Re: Comments on the November 19, 2008 DRAFT DRAFT STAFF REPORT AND CERTIFIED REGULATORY PROGRAM ENVIRONMENTAL ANALYSIS FOR THE STATE WATER RESOURCES CONTROL BOARD RECYCLED WATER POLICY

Via-------GordonInnis (ginnes@waterboards.ca.gov
Via-------jramsey-lewis@waterboards.ca.gov

Members of the Board, I will comment on the Draft Staff Report (SR) from the perspective of one with expertise in pathogen transmission and impacts to public health. Your Board already has my credentials on file. In addition, I was recently invited as a scientist to a conference at Research Triangle Park on pharmaceuticals in water. The Research Triangle area of North Carolina is unique with respect to the number of world-class organizations focused on environmental health research and policy and has become the epicenter of contemporary thinking about environmental health. The Research Triangle Environmental Health Collaborative held its inaugural Environmental Health Summit on November 10-11 assembling 150 experts to discuss "Pharmaceuticals in Water: What We Know, Don't Know and Should Do."

Attendees were selected from the Research Triangle area of North Carolina and beyond and represented academia, industry, local, state and federal government and public interest groups. Representatives from the EPA, FDA and USGS provided background information on the major environmental and potential human health issues and the current regulatory considerations.

From p 6 of Staff Report (SR)

When adopting requirements for projects eligible for streamlined permitting, the proposed Policy does not allow the State or Regional Water Board to establish project-specific receiving water and groundwater monitoring requirements, unless such project-specific monitoring is required by a salt/nutrient management plan that has been adopted by the Regional Water Board.

For all landscape irrigation projects, the proposed Policy requires, in addition to any appropriate recycled water monitoring requirements, effluent monitoring for CECs once a year and priority pollutant twice a year.

Comment----------You, as Board members and officers of this State in your job of protecting the health and welfare of its citizens, are ask to consider if these limits noted above are adequate to protect public health? As you will see while reading the following, the issues are highly complex, although staff seems to have missed this by a wide margin. What is gained, except perhaps by industry, in *not allow [ing] the State or Regional Water Board to establish project-specific receiving water and groundwater monitoring requirements, unless such project-specific monitoring is required by a salt/nutrient management plan ?* As you will see the issues impacting public health far exceed the narrow scope of salt/nutrient and thus by ignoring these aspects a serious disservice is dealt to the people of this state. The limitation of monitoring CECs to once a year is also short sided. You should ask yourselves not only what the list of CECs contains but more importantly who came up with the list and from that what does it **not** contain□?

Do you anticipate that pathogens will be monitored, and with them genetic fragments that confer both antimircrobial resistance and enhanced virulence? If not, why not? Pathogens may follow seasonal cycles. Pharmaceuticals may shadow these cycles to a certain extent. How then does this impact such monitoring? What if there is a blow-out in an area of a particularly virulent pathogen? Is the recycled water likely to convey that pathogen to areas frequented by the public? Will this water be used for irrigation of crops consumed raw? What of sprinkler irrigation and aerosol drift? It is conceivable that aerosol delivery may spread a serious pathogen over wide areas----does once yearly monitoring control for such an event, and if not where is the backup? What are the monitoring protocols for recycled water in the event of a pandemic or local epidemic? These are some of the questions you should ask yourselves as you read through these comments.

From SR p. 7

The first is that the project must comply with regulations adopted by CDPH or, in the interim until such regulations are approved, CDPH's recommendations for the project. The second is the implementation of a monitoring program for CECs that is consistent with the recommendation of the "blue ribbon panel" discussed below.

Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."

Comment----------Some things to consider relating to the best practicable treatment or control. As it is now, current standards and technology can not and do not adequately control pathogens, their genetic fragments, or pharmaceuticals. There is no argument about this and thus, there is failure thus to protect the public health. The WERF report by Joan B rose, in evaluating sewer plants and the recycled water produced by these plants (see Harwood below) offered several suggestions for effecting change and thus better quality water. I discussed these findings with one plant that was part of the WERF study which was ongoing for an entire year. This was the El Estero plant of Santa Barbara, my home town. The WERF report by Rose came out in circa 2004. Rose also has family in Santa Barbara and she served with me on an EPA panel looking at pathogens in sewage and sewage byproducts. I asked Joan if Santa Barbara had ever discussed the findings with her or discussed the suggestions within the WERF report for correcting some of the deficiencies. She indicated that they had not. I also discussed the Rose findings in 2007 with the managers of El Estero and asked what they had changed in the production of recycled water since the WERF report. They indicated that there were no changes. I asked this after I had found multi-drug resistant bacteria in the El Estero recycled water---water presumably meeting state standards and noting multi-drug resistant bacteria for the second year running. This second year's test results on this water were consistent with the prior year and thus our findings were not merely the result of some unusual momentary flaw in the system.

From SR p. 8

CECs include a wide range of chemicals that are being detected in our water supply at very low levels. Some are from personal care products and prescription and non-prescription drugs, which people use directly, at much larger concentrations. Some CECs have been found to have effects on fish at low concentrations.

The impacts of persistent but low-level exposure to CECs in the environment and the potential human-health implications are unknown. However, some Regional Water Boards have utilized the narrative water quality objectives for toxicity in their Basin Plans to establish enforceable limits for recycled water quality. Similar enforceable limits do not yet exist for potable water quality, because of the lack of scientifically based risk assessments. This practice of interpreting narrative objectives to establish enforceable limits results in a disincentive for recycled water use because the recycled water is regulated to a quality standard that exceeds the regulatory standard applied to potable water. At the same time, a firm scientific understanding of the effects of CECs and the appropriate standards for

setting regulatory limits is necessary.

Comment---------The proposed Policy states that knowledge regarding CECs is incomplete and establishes a "blue ribbon" advisory panel of scientific experts to provide guidance to the State Water Board on future actions.

In the first paragraph above, staff indicate that aquatic organisms are affected. This would seem to be a significant adverse effect. The staff report goes on to indicate that setting narrative objectives tends to create a disincentive for recycled and in addition the quality standard for recycled water exceeds those applied to potable water. Something is wrong with this picture. If the quality of recycled water exceeds potable standards, how does this work for finding of pathogens and drug resistant pathogens, as well as pharmaceuticals in recycled water? I think this statement really reflects the fact that the standards are badly flawed. Additionally if the CDPH is the arm of government determining what is acceptable from a public health standpoint, how will a "blue ribbon" advisory panel (which is advisory only) interact and what criteria and mile stones are established for the "blue ribbon" panel in its interaction with both the water boards, state board and CDPH?

Now leaving the SR for a moment.

California Water Code 13350, et seq notes that after concurrence with the State Department c is determined not to be injurious to plantlife, fish, and wildlife. Thus the question must be raised

MEMORANDUM OF AGREEMENT BETWEEN
THE DEPARTMENT OF HEALTH SERVICES
AND THE STATE WATER RESOURCES CONTROL BOARD
ON USE OF RECLAIMED WATER

I. PURPOSE AND SCOPE OF MOA
Water reclamation involves several activities that have potential impacts on public health. The primary activities are the introduction of pollutants into the wastewater collection system, wastewater treatment, storage and distribution of reclaimed water, and the use of the reclaimed
water. The planning, design, construction, and operation of the various facilities associated with
these activities all require oversight by regulatory agencies to ensure protection of public health.

One of the primary conditions on the use of reclaimed water is protection of public health (Water Code
Sections 13521, 13522, 13550(a)(3)).

To assure protection of public health where reclaimed water use is involved, the Department has been statutorily directed to establish uniform statewide reclamation criteria for the various uses of reclaimed water (Water Code Section 13521). The Department has promulgated regulatory criteria which are currently set forth in Title 22, Division 4, Section 60301 et seq., California Code of Regulations. The Department's regulatory criteria include specified approved uses of reclaimed water, numerical limitations and requirements, treatment method requirements and performance standards. The Department's regulations allow use of alternative methods of treatment, in some cases, so long as the alternative methods used are determined by the Department to assure equivalent treatment and reliability.

Comment----------Again via the memorandum, it is clear that the public health is to be protected. Thus the question to the Board would be how one accomplishes such protection with the admitted lack of information on constituents found within recycled water and the

admission that risk analyses have not been undertaken? The issue of pathogens again seems to be under-discussed if discussed at all. Where the recycled water contains pathogens and their genetic fragments and such are, through the use of recycled water, exposed to the public directly or indirectly, those uses of recycled water should be prohibited.

SR p 7

Any activity which produces or may produce a waste or increased volume or concentration of waste and which discharges or proposes to discharge to existing high quality waters will be required to meet waste discharge requirements which will result in the best practicable treatment or control of the discharge necessary to assure that (a) a pollution or nuisance will not occur and (b) the highest water quality consistent with maximum benefit to the people of the State will be maintained."

Comment----------The question, which is tied to the above comment-----what happens if in the processing of recycled water, it is not possible to *assure that (a) a pollution or nuisance will not occur?* We thus need to go to H&SC sections 5410 and 5411 to appreciate this as discussed below.

On SR p 8, the authors invoke provisions of law to justify the following: *This section of the proposed Policy on State Agency Roles is a summary of roles established by existing statutory authority. It does not create new directives. Hence, its effect on the environment is less than significant.*

Comment----------The proposed Policy states that that State Water Board shall use the authority provided in Water Code sections 13550 *et seq*. *This is essentially a statement that the State Water Board* ***shall*** *implement existing law.* State law here is a double edged sword which the staff seems to conveniently ignore. One of the primary conditions on the use of reclaimed water is protection of public health (Water Code Sections 13521, 13522, 13550(a)(3)). Section 13522 requires abatement of contamination. H&SC 5410 defines contamination as impairment of the quality of the waters of the state to a degree which creates a hazard to public health through poisoning or **spread of disease.** H&SC 5410 (d) further defines contamination and H&SC 5411 states that no person shall discharge sewage or other waste effluent of treated sewage or other waste in any matter which will result in contamination, pollution or nuisance. Nuisance is defined by H&SC 5410(f) as anything which is injurious to health and occurs during or as a result of the treatment of wastes.

Thus the staff report appears to ignore, several the provisions of H&SC relating to the spread of disease through recycled water. As presented previously by McGowan (see STATEWIDE POLICY FOR WATER RECYCLING COMMENTS by Edo McGowan,9-17-07, 9-20-07, 10-18-07,10-21-07,10-25-07, 10-25-07, 10-25-07, all hereby incorporated herein by reference), there is an abundance of papers within the peer reviewed scientific and medical literature to support the fact that pathogens and pharmaceuticals are found within recycled water meeting current state standards. This fact tends to give lie to staff conclusions that and statement in Staff Report (p 9) that----------***2- B: State Agency Roles***
This section of the proposed Policy on State Agency Roles is a summary of roles established by existing statutory authority. It does not create new directives. Hence, its effect on the environment is less than significant.

Comment----------While this may not create new directives, it is obvious from the above that it ignores critical directives and mechanisms within state law that call for the protection of public health---specifically the above noted provisions of the Water code and Health & Safety Code. Thus although trumpeting WC 13550, et seq as its driving force, the staff report ignores the above provisions and this smacks of a clientèle captured regulator. In consequence, the claim of less than significant is challenged and thus via provisions of CEQA on disagreements between experts; thus, the subject must be reviewed as to potentially significant based on substantial evidence and in light of the whole record supports a fair argument that the proposed project may have a significant effect on the environment. This is contra to what the staff report would have one to believe.

The SR, p. 9 states that------*The proposed Policy defines incidental runoff as unintended, small*

amounts of runoff from recycled water use areas, such as unintended, minimal over-spray from sprinklers that escape the recycled water use area.

Comment----------This completely ignores the potential for aerial drift of entrained pathogens to move off site. Again, there are abundant data to describe the aerial drift of pathogens from sprinkler irrigation. That recycled water meeting state standards contains pathogens is beyond denial---see works by McGowan, Joan B Rose, and Valerie Harwood. These pathogen-containing aerosols can and do impinge upon surfaces with which people have contact and there is again ample literature discussing transfer of pathogens from finger to mouth. Drift distances can be impressive. Once ingested, the genetic information can be multiplied by the gut flora. Again, this has been discussed by McGowan in previously submitted data. Accordingly, the dismissal of incidental off-site movement merely represents a high level of ignorance within the Board staff and thus through such, the Board is misled into making potentially serious errors that can and will detrimentally impact public health. The staff finding that----------*With these requirements, the impacts of incidental runoff will be reduced to a less than significant level* is thus potentially false and thus warrants consideration within the EIR as a potentially seriously adverse impact for an evaluation of off-site movements of pathogens, their genetic material and potential impacts on public health.The EIR needs to spell out how the projects various aspects will mitigate off-site incidental movement.

Page 11 of the SR notes----------***2--G: CECs***
The proposed Policy establishes a "blue ribbon" scientific advisory panel to guide future State Water Board actions regarding CECs. These include endocrine disruptors, personal care products, pharmaceuticals, and other constituents such as antibiotic resistant bacteria or genes that may potentially be harmful to human health or the environment. Since the panel only has advisory power, its establishment will not have a significant environmental effect.

From the proposed policy we have a description of the "Blue Ribbon" panel----------

*The panel shall be actively managed by the State **Water** Board and shall be composed of at least the following: one human health toxicologist, one environmental toxicologist, one epidemiologist, one biochemist, one civil engineer familiar with the design and construction of **recycled water** treatment facilities, and one chemist familiar with the design and operation of advanced laboratory methods for the detection of emerging constituents. Each of these panelists shall have extensive experience as a principal investigator in their respective areas of expertise*

Comment----------The issue of pathogens, transfer of genetic material and human health issues related to pathogens as well as pharmaceuticals carried by recycled water are understated here. This is a curious situation because McGowan demonstrated to the Board that multi-drug resistant bacteria had been grown out of recycled water meeting state standards. It is thus difficult to buy into the logic of the staff here and its argument that the Blue Ribbon Panel is of insignificance-----why have it in the first place is it is insignificant? My fear is that it as a panel will be composed of industry-friendly representatives and thus any unbiased analysis will be foregone. Nonetheless, the impact of a truly unbiased panel should not be relegated to advisory only. What assurances are there if a truly unbiased panel, but strictly advisory panel, came up with issues that needed prompt response for protecting public health and thus implementation of that advice were to retard the implementation of this policy, would the advice of the panel be taken seriously---especially given potential adverse impacts to the profits seen from recycled water? What if those determinations by a truly unbiased panel meant that current state standards were not protecting the public health and to protect public health would see increased cost to industry? Where does politics and profit balance with impacts to public health?

As to the panel as described above. I have been stressing the lack of input or discussion within the proposed policy or its staff report on pathogens, antibiotic resistance and gene transfer. Where, within the proposed panel members, is such background represented? This is a critical question for you to

consider. As it appears now, this area seems very thin in the proposed make up of the panel. My reading of this seems to remind me that the staff of the Board are also thin in these areas and thus may fail to appreciate that members of the panel need to be well versed in microbiology and public health impacts of pathogenic organisms. Additionally, where are the clinicians that must treat persons made ill via organisms picked up through contact with recycled water. As it stands now the panel is tilted toward toxicants but thin on pathogens and infectious disease.

From SR p. 15, we have the following----------*AGRICULTURAL RESOURCES. In determining whether impacts to agricultural resources are significant environmental impacts, lead agencies may refer to the California Agricultural Land Evaluation and Site Assessment Model (1997) prepared by the California Department of Conservation as an optional model to use in assessing impacts on agriculture and farmland.* .

Comment----------The analysis completely misses the fact that as currently produced, recycled water contains both pathogens and their genetic material conferring both antibiotic resistance as well as virulence, that when applied to crops consumed raw may see these pathogens, genetic information as well as pharmaceuticals taken up by the crops and internalized within the crop's tissues. There are good peer reviewed papers in the literature discussing this. Once internalized in the crops, these pathogens are exempt from any effect of external washing of such produce. Further, it is well known that certified organic crops that are consumed raw are irrigated with this water and that pharmaceuticals and other CECs are delivered with the recycled water. As an economic impact, what will the consumers of certified organic crops think when it is found out that the produce for which they pay a premium to be free of pesticides and other CECs, in fact, is potentially contaminated with pathogens and pharmaceuticals that came from the urine or feces of others? This may have significant adverse economic impacts on agriculture.

Certain plants can concentrate pollutants and in fact this is why bioremediation works. Thus, there may be significant impacts to agriculture through embargo on California crops irrigated with the current quality of recycled water. These issues need to be explored in much greater detail within the EIR. Thus to say that there is no or less than significant impact to agriculture is patently false.

If housing tracts are going to be supplied with recycled water, what provisions are made for back yard gardens and thus will one see pathogens and CECs accumulate in crops raised in home gardens? What of community gardens?

The next item relates to air quality---------

3. *AIR QUALITY/ CLIMATE CHANGE. Where available, the significance criteria established by the applicable air quality management or air pollution control district may be relied upon to make the following determinations.* The analyses go on to say--------c*) Expose sensitive receptors to substantial pollutant concentrations? —and* answers this question as stating the impact is less than significant.

Comment----------This is fallacious reasoning. There have been no risk analyses for pathogens contained within recycled water, there have been no analyses of aerosol drift and thus to state that exposure may be less than significant is no more that wishful thinking and certainly bad guidance for the Board. Consider the down wind drift from the irrigation of several thousand acres of leafy greens such as found in the Salinas Valley. Where are the test data on what is coming out of the sprinkler heads? Considering the work by Valerie Harwood and the WERF report on reclaimed water by Joan B Rose, it would be impossible to make the claim that there is a less than significant impact. Thus the EIR needs to delve deeply into this issue as it is potentially significant and adverse.

The SR on p.16 states----------*Recycled water projects implemented in accordance with the proposed Policy are generally not expected to expose sensitive receptors to substantial pollutant concentrations. However, in some limited situations sensitive receptors could be exposed to recycled*

water, in the form of spray, mist, or runoff of recycled water. The Water Recycling Criteria in the California Code of Regulations, Title 22 sections 60301-60355, includes requirements to protect outdoor eating areas, food handling facilities, drinking fountains, and employees. The potential for exposure of sensitive receptors to substantial pollutant concentrations is less than significant.

Comment----------The above does note that exposure is possible. Unfortunately those making this statement while although aware of the potential for pollutants to drift, also seem to unable to consider that it is not just sensitive receptors that are of concern. Further, it is unclear from the text if these authors also consider pathogens and their genetic fragments as being within the context of the term "pollutant"? Because there have been no risk assessments, the final sentence above can not be made on a scientifically valid basis and thus the whole area is ripe for further analysis within the EIR.

The document neglects to consider the ability of the various skin and gut flora to take up that genetic information relating to either resistance or virulence and then multiply it out as well as seeing shifts within and into higher level pathogens. That multiplication then greatly confounds the ability to rely on classic dose response curves, essentially rendering them useless. To the extent that a program's risk analysis relies on these dose response factors, the curve-ball thrown to the program by not considering mobile genetic elements must be considered.

These bacteria when released by recycled water are thus able to colonize environmental niches, and animals, including humans, through ingestion. Once ingested, the mobile genetic elements may be transferred to normal flora, and subsequently to pathogenic bacteria found in humans or animals, making later treatment with particular antibiotics ineffective. Thus, here we have two mechanisms that can see transfer to humans. The first is straight human contamination, the second is secondary, from contaminated surfaces or agriculture produce to humans. Stuart Levey in his book, the *Antibiotic Paradox*, discussed this train of transfer. It is also seen via soil organisms such as nematodes which feed on bacteria and then infest crops. If those crops are consumed raw, then the genetic information is transferred to the human gut flora. Also one must consider transfer of genetic information from these microorganisms to more robust organisms as highlighted by Sjolund et al. (2005) indicating that resistance in the normal flora, which may last up to four-years, might contribute to increased resistance in higher-grade pathogens through interspecies transfer.

Sjolund et al go on to note that since populations of the normal biota are large, this affords the chance for multiple and different resistant variants to develop. This thus enhances the risk for spread to populations of pathogens. Furthermore, there is crossed resistance. For example, vancomycin resistance may be maintained by using macrolides. One of the macrolides commonly found in recycled water is erythromycin which has been shown to bioaccumulate in the soils (see works by Chad Kinney). None of this seems to be considered within the draft SR document.

The finger to mouth route is also necessary to discuss in any drift study as surfaces distant from the source can become contaminated.

AEROSOLS

How far are the nearest critical targets from the proposed recycled water application area? How does later dust arising from disking affect the movement of pathogens, their genetic fragments or accumulated pharmaceuticals. In the Caribbean, dust arising from as far away as Africa causes respiratory disease. That is a trans-Atlantic movement of somewhere over 3,000 miles and during the 2 to 3 weeks the dust is in transit, it is subjected to intense UV at the very high altitudes it attains while crossing the Atlantic. This dust is still capable of causing

respiratory disease.

In looking at local agriculture, what is the average wind speed and wind run in the area, then what are the upper ranges? At least in California, the air quality boards do not have control over particulates that are pathogens. Thus does the issue of protecting public health fall back to to the Water Boards? If not the Water Boards, then upon whom does this responsibility fall and with what impact on public health and what are the controls?

From Tellier's tables on pathogen aerosol drift, I generated a small series of curves, the base data for which are noted below (see: R Tellier - Emerg Infect Dis, 2006 Nov;12(11):1657-62. ncbi.nlm.nih.gov)

These are for the drift of particulates in the following range: 10uM and 5uM. Something smaller than 3uM will essentially not settle out and this is also the range into which pathogens and genetic fragments fall and also those that reach the deepest recesses of the respiratory system.

The table below demonstrates the extent of pathogen drift. By definition, an aerosol is able to remain in suspension for prolonged periods because of its low settling velocity. The energy and disturbance supplied by tillage may see the dust rise several meters. Thus is not only the immediate application of recycled water but the soil accumulation of pathogens and CECs. Irritation of inflammed tissues caused by CECs sees the protective barriers disrupted and thus the entry of pathogens is enhanced (for the interested reader, David L. Lewis of the EPA has, along with Gattie, published on this).

For spherical particles of unit density the settling time for a 3-M fall is noted in the table below. As we all know, sprinkler mist as well as the dust behind a tractor may rise several meters above this. Nonetheless, using the 3-meter fall and considering the size of both bacteria and viruses it will be noted that aerosol movement is considerable. Remember that the average bacteria is 1 uM and a virus about 1/00 of that.

TABLE*

Assumptions: 5 mph** average wind speed, laminar flow. In an open flat areas such as farmland laminar flow would need to be considered.

Particle Diameter	Settling Time	Distance at wind speed 5 mph
100 uM	10 sec	44 ft
20 uM	4 minutes	1780 feet
10 uM	17 minutes	7480 feet (1.4 miles)
5 uM	62 minutes	approx 5 miles
< 3uM	These essentially will not settle.	

* Adapted from Tellier's work.
** 5 mph is about as fast as a rapid walk.

Note: The median diameters at which particles exhibit aerosol behavior also corresponds to the size range that will reach the deepest recesses of the respiratory tract.

Assume that a 10uM particle settles in 17 minutes from a drop height of 3 M; in a 5 mph wind with laminar flow it moves 7480 ft from the release point (about 1.4 miles).

At 10 mph it will now move .....2.8 miles
At 15 mph.....4.25 miles
At 20 mph.....5.7
At 25 mph.....7.1
At 30 mph.....8.5
At 35 mph.....9.9
At 40 mph.....11.3
At 45 mph.....12.7

Assume a 5uM particle that settles in 62 minutes from a fall of 3 meters.

At 10 mph.....10.3 miles
At 15 mph.....15.5
At 20 mph.....20.6
At 25 mph.....25.7
At 30 mph.....30.9
At 35 mph.....41.2
At 45 mph.....46.4

When we get much smaller, the distances go up almost exponentially.

I would also like to have you note that after several seasons of application, there will likely be a shift in soil biota and thus the potential adaptation of pathogens and incorporation of genetic information into that soil. There are several papers on the persistence of viable genetic material within dry soils, long past the detection of their progenitors. When these soils are worked later in the season, the more robust microbes and genetic fragments may be surviving, especially the spore-formers. This is not discussed. Please remember that during WW II, the Brits played about with Anthrax, a sporeformer, on a small island off Britain and subsequently were required to quarantine it for 50 years. I think more needs to be said here about the spore-formers and later tilling operations that may generate large clouds of dust. These are not insignificant issues in contrast to what the staff might have one believe.

Additionally friable soil can move with wind and thus, disking is really not needed. As the global climate shifts to a dryer system, the various climate agencies are predicting the return to dust bowel days and this needs to be considered, especially where there are years of accumulated pathogens and pharmaceuticals.

Thus for the question-------Would sensitive receptors be exposed to substantial pollutant concentrations, the answer should be that a potentially significant impact but may be reduced to less than significant through the removal of pathogens, their genetic fragments conferring antimicrobial resistance and virulence as well as factors that would tend to cause soil microbes to become pathogenic or contain resistance conferring genetic information that would be transmissible to humans. This thus includes removal of pharmaceuticals.

The next item of interest is found on SR p. 16 in the following statement----------*The operation of facilities for producing and conveying recycled water may generate small amounts of criteria air pollutants, primarily hydrogen sulfides and oxides of nitrogen emitted from water treatment processes. The emissions, however, will not result in a cumulative considerable net increase of any criteria pollutant.*

Comment----------It is quite clear from the accumulated literature that biofilms will arise in water conveyance systems. Since the recycled water as produced today contains both pathogens and their

genetic fragments as well as nutrients and pharmaceuticals, the opportunity for production of biofilms containing serious human pathogens exists. Further, the statement above--------*The emissions, however, will not result in a cumulative considerable net increase of any criteria pollutant.* Is inaccurate and as shown by the work of Chad Kinney, certain pharmaceuticals will accumulate in the soils, among these is erythomycin which is able to cross react with vancomycin. Thus one may see the development of vancomycin resistant bacteria through this mechanism.

We are faced with a problem: how to address the fact that pharmaceuticals are now found widely in the environment and even in the municipal drinking water supply of many communities. How should we understand this finding? How do we explain it to the public? What steps need to be taken to understand the impact of pharmaceuticals? What steps need to be taken to protect the environment and water supplies that are now confronted with small doses of very powerful drugs? As the population ages, and as more people take long term courses of medications, we can only anticipate that with current technology, the levels of pharmaceuticals in the environment and drinking water supply will continue to increase. These drugs are not removed from recycled water.

There is thus a need to look at the impact of pharmaceuticals found in recycled water and the subsequent synergistic impact upon antibiotic resistance within biofilms (see abstracts below) that form within the water delivery systems. The work of Amy Pruden (see below) demonstrates that antibiotic resistant genes (ARGs) are not affected by the levels of chlorine presently utilized by wastewater treatment systems and this also applies to recycled water. Further, this same work demonstrated that the typical filtering systems employed by treatment works did not select-out these genetic fragments. Thus both pathogens and their genetic fragments as well as pharmaceuticals may be able to impact biofilms found within water pipes. Since these biofilms do shed, this is an increased risk to consumers of crops irrigated with such water or landscape where there is human contact.

Because sewer plants are unable to effectively deal with pathogens, their genetic fragments or through-put of pharmaceuticals, the Board needs to be aware of these short comings. It is generally established that about 95% of the pharmaceuticals entering the sewer plant can not be controlled. The pharmaceuticals enter the wastewater treatment plant and exit intact or as metabolites, in recycled effluent.

To give you some appreciation for the combined result of the above dynamics, consider the following which relates to potable water. The college spends two weeks each semester of the introductory medical microbiology class dealing with the microbiology of water. One of the students in our medical micro class, who worked part time at a local outlet of a national pharmacy brought in some presumed sterile water that was used to mix prescription drugs. This water was run for bacterial content and showed multi-antibiotic resistance to 11 of the 12 antibiotics in our Kirby Bauer suite (this, by the way is the same number of antibiotics to which bacteria I found in recycled water were resistant). We thought that this must be contamination so the test was repeated several times with the same result. It was not contamination. Similar water was then brought in from a competing drug store and this also showed multi drug resistance. We surmised that a biofilm had developed within the equipment. The source was the local potable supply, and thus it was not suspected. Remember, this was water used to mix prescriptions. If this in potable supplies, what of recycled water?

If the city had increased the residual chlorine, this might have prevented the issue to some extent but one must remember that ARGs are not impacted by current levels of chlorine and with shedding biofilms, the risk may remain. Also, one must appreciate the import of the work by Matt Wook Chang (see below) on the effect of chlorine on enhancing virulence factors. Thus it is conceivable that added chlorine may also increase virulence.

It would be helpful for the Board as a whole to acknowledge that most municipal wastewater treatment plants as currently designed and operated are not capable of removing a significant level of pharmaceuticals and also that many treatment works can not effectively deal with ARGs. With many of these sewer plants potentially expanding to produce recycled water, the public is at potentially increased risk. The result of this combined unknown has potentially important impacts on public health that warrant increased attention in the EIR to allow for a better perspective. The impact is potentially significantly adverse in deference to what the staff may contend.

It would be reckless for the Board to ignore these facts and the fact that the treatment technology for our toilet and industrial wastes cannot manage these compounds.
++++++++++++++++++++

Detection of Escherichia coli in biofilms from pipe samples and coupons in drinking water distribution networks.

Juhna T, Birzniece D, Larsson S, Zulenkovs D, Sharipo A, Azevedo NF, Ménard-Szczebara F, Castagnet S, Féliers C, Keevil CW.

Riga Technical University, Department of Water Engineering and Technology, 16/20 Azenes Street, Riga LV 1048, Latvia. talisi@bf.rtu.lv Appl Environ Microbiol. 2007 Nov;73(22):7456-64. Epub 2007 Aug 24.

Fluorescence in situ hybridization (FISH) was used for direct detection of Escherichia coli on pipe surfaces and coupons in drinking water distribution networks. Old cast iron main pipes were removed from water distribution networks in France, England, Portugal, and Latvia, and E. coli was analyzed in the biofilm. In addition, 44 flat coupons made of cast iron, polyvinyl chloride, or stainless steel were placed into and continuously exposed to water on 15 locations of 6 distribution networks in France and Latvia and examined after 1 to 6 months exposure to the drinking water. In order to increase the signal intensity, a peptide nucleic acid (PNA) 15-mer probe was used in the FISH screening for the presence or absence of E. coli on the surface of pipes and coupons, thus reducing occasional problems of autofluorescence and low fluorescence of the labeled bacteria. For comparison, cells were removed from the surfaces and examined with culture-based or enzymatic (detection of beta-d-glucuronidase) methods. An additional verification was made by using PCR. Culture method indicated presence of E. coli in one of five pipes, whereas all pipes were positive with the FISH methods. E. coli was detected in 56% of the coupons using PNA FISH, but no E. coli was detected using culture or enzymatic methods. PCR analyses confirmed the presence of E. coli in samples that were negative according to culture-based and enzymatic methods. The viability of E. coli cells in the samples was demonstrated by the cell elongation after resuscitation in low-nutrient medium supplemented with pipemidic acid, suggesting that the cells were present in an active but nonculturable state, unable to grow on agar media. E. coli contributed to ca. 0.001 to 0.1% of the total bacterial number in the samples. The presence and number of E. coli did not correlate with any of physical and/or chemical characteristic of the drinking water (e.g., temperature, chlorine, or biodegradable organic matter concentration). We show here that E. coli is present in the biofilms of drinking water networks in Europe. Some of the cells are metabolically active but are often not detected due to limitations of traditionally used culture-based methods, indicating that biofilm should be considered as a reservoir that must be investigated further in order to evaluate the risk for human health.
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Comment in:

Environ Sci Technol. 2007 Apr 1;41(7):2651-2.

Antibiotic resistance genes as emerging contaminants: studies in northern Colorado.

Pruden A, Pei R, Storteboom H, Carlson KH. Environ Sci Technol. 2006 Dec 1;40(23):7445-50.

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This study explores antibiotic resistance genes (ARGs) as emerging environmental contaminants. The purpose of this study was to investigate the occurrence of ARGs in various environmental compartments in northern Colorado, including Cache La Poudre (Poudre) River sediments, irrigation ditches, dairy lagoons, and the effluents of wastewater recycling and drinking water treatment plants. Additionally, ARG concentrations in the Poudre River sediments were analyzed at three time points at five sites with varying levels of urban/agricultural impact and compared with two previously published time points. It was expected that ARG concentrations would be significantly higher in environments directly impacted by urban/agricultural activity than in pristine and lesser-impacted environments. Polymerase chain reaction (PCR) detection assays were applied to detect the presence/absence of several tetracycline and sulfonamide ARGs. Quantitative real-time PCR was used to further quantify two tetracycline ARGs (tet (W) and tet(O)) and two sulfonamide ARGs (sul(I) and sul(II)). The following trend was observed with respect to ARG concentrations (normalized to eubacterial 16S rRNA genes): dairy lagoon water > irrigation ditch water > urban/agriculturally impacted river sediments ($p < 0.0001$), except for sul(II), which was absent in ditch water. It was noted that tet(W) and tet(O) were also present in treated drinking water and recycled wastewater, suggesting that these are potential pathways for the spread of ARGs to and from humans. On the basis of this study, there is a need for environmental scientists and engineers to help address the issue of the spread of ARGs in the environment.

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Toxicogenomic response to chlorination includes induction of major virulence genes in Staphylococcus aureus.

Chang MW, **Toghrol F**; **Bentley WE**. Environ Sci Technol. 2007 Nov 1;41(21):7570-5

School of Chemical and Biomedical Engineering, Nanyang Technological University, Singapore.

Despite the widespread use of chlorination for microbial control in aqueous environments, cellular response mechanisms of human pathogens, such as Staphylococcus aureus, against chlorination remain unknown. In this work, genome-wide transcriptional analysis was performed to elucidate cellular response of S. aureusto hypochlorous acid, an active antimicrobial product of chlorination in aqueous solution. Our results suggest that hypochlorous acid repressed transcription of genes involved in cell wall synthesis, membrane transport, protein synthesis, and primary metabolism, while amino acid synthesis genes were induced. Furthermore, hypochlorous acid induced transcription of genes encoding major virulence factors of S. aureus, such as exotoxins, hemolysins, leukocidins, coagulases, and surface adhesion proteins, which all play essential roles in staphylococcal virulence. This work implies that chlorination may stimulate production of virulence factors, which provides new insight into host-pathogen interactions and effects of chlorine application for microbial control

Griffin DW. African desert dust in the Caribbean atmosphere: Microbiology and public health. Aerobiologia. 2001 Sept : Volume 17, Number 3, pp. 203 - 213

Sjolund et al. (2005) Emerging Infectious Diseases (Vol. 11, # 9, Sept 2005 @ p. 1389 et seq),

Giacometti A, Cirioni O, Kamysz W, Silvestri C, Licci A, D'Amato G, Nadolski P, Riva A, Lukasiak J, Scalise G. In vitro activity and killing effect of uperin 3.6 against gram- positive cocci isolated from immunocompromised patients. Antimicrob Agents Chemother. 2005 Sep;49(9):3933-6. Robertson GT, Zhao J, Desai BV, Coleman WH, Nicas TI, Gilmour R, Grinius L, Morrison DA, Winkler ME. Vancomycin tolerance induced by erythromycin but not by loss of vncRS, vex3, or pep27 function in Streptococcus pneumoniae. J Bacteriol. 2002 Dec;184(24):6987-7000.].

SR p. 16----------We are faced with a problem: how to address the fact that pharmaceuticals are now found widely in the environment and even in the municipal drinking water supply of many communities. How should we understand this finding? How do we explain it to the public? What steps need to be

taken to understand the impact of pharmaceuticals? What steps need to be taken to protect the environment and the drinking water supply that are now confronted with small doses of very powerful drugs? As the population ages, and as more people take long term courses of medications, we can only anticipate that with current technology, the levels of pharmaceuticals in the environment and drinking water supply will continue to increase.

The next point is found on SR p. 16----------*Chlorine is frequently used as a disinfectant in the wastewater industry; residual chlorine odors could be considered objectionable by some people in the immediate vicinity of the point of use. The number of people potentially affected by chlorine-derived odors is expected to be insubstantial; therefore, the quality impact is expected to be less than significant.*

Comment----------As seen from the work of Matt Wook Chang above, added chlorine may enhance virulence factors of pathogens. Thus the statement above by staff is hardly accurate---it may be significantly adverse. This needs to be further evaluated within the context of the EIR.

The next series of points is found on SR p. 17---------*4. BIOLOGICAL RESOURCES*.

Comment----------It should be of interest here that many of the pharmaceuticals and emerging contaminants of concern have the potential to impact aquatic species through action as endocrine disrupters Thus with a drive to increase the production of recycled water and liberalization of allowances for incidental runoff or over-spray, it is conceivable that these materials as carried within recycled water, upon reaching riparian and aquatic habitats, could produce significantly adverse impacts. Thus the staff appraisal that impacts are less than significant needs to be reevaluated and the best way to do so is via a public document such as an EIR. These impacts are certainly potentially adverse at a significant level.

The next item is found on SR p. 18----------relating to migratory corridors.

Comment----------This appraisal by staff unfortunately completely ignores the fact that pathogens could be picked up by migratory fowl and thus disease spread to distant areas. It also shows the naiveté of those within the Board's staff for the literature in this area is rather abundant and again raises questions about to quality of direction that staff is able to provide to the Board. As it is now, there is much concern over reassortment of pathogens by running them through various species. This is already well discussed in the literature. Canadian geese are now known to be carrying pathogens (see below) this needs to be considered within the context of the works by Harwood and the WERF paper by Rose. Note the pathogens carried by the geese and other water fowl and the pathogens found in reclaimed (recycled) water by Harwood and also by Rose. One of the plants tested by both of these authors was El Estero, Santa Barbara, the same plant I tested and noted resistant bacteria that were resistant to 11 of the 12 antibiotics in our Kirby Bauer suite.

Giardia sp. Cysts and Infectious _Cryptosporidium parvum_ Oocysts in the Feces of Migratory Canada Geese (_Branta canadensis_)

Thaddeus K. Graczyk,[1,*] Ronald Fayer,[2] James M. Trout,[2] Earl J. Lewis,[3] C. Austin Farley,[3] Irshad

Sulaiman,[4] and Altaf A. Lal[4]
Department of Molecular Microbiology and Immunology, School of Hygiene and Public Health, Johns Hopkins University, Baltimore, Maryland 21205[1]; Immunity and Disease Resistance Laboratory, Livestock and Poultry Science Institute, Agricultural Research Services, U.S. Department of Agriculture, Beltsville, Maryland 20705[2]; Cooperative Oxford Laboratory, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Oxford, Maryland 21654[3]; and Department of Parasitic Diseases, National Center for Infectious Diseases, Centers for Disease Control and Prevention, Chamblee, Georgia 30341[4]
Received 18 March 1998/Accepted 21 April 1998
Fecal droppings of migratory Canada geese, *Branta canadensis*, collected from nine sites near the Chesapeake Bay (Maryland), were examined for the presence of *Cryptosporidium parvum* and *Giardia* spp. *Cryptosporidium* sp. oocysts were found in feces at seven of nine sites, and *Giardia* cysts were found at all nine sites. The oocysts from three sites were infectious for mice and molecularly identified as the zoonotic genotype of *Cryptosporidium parvum*. Waterfowl can disseminate infectious *C. parvum* oocysts in the environment.
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Validity of the Indicator Organism Paradigm for Pathogen Reduction in Reclaimed Water and Public Health Protection†

Valerie J. Harwood,[1*] Audrey D. Levine,[2] Troy M. Scott,[3] Vasanta Chivukula,[1] Jerzy Lukasik,[3] Samuel R. Farrah,[4] and Joan B. Rose[5]
Received 27 September 2004/ Accepted 20 December 2004
The validity of using indicator organisms (total and fecal coliforms, enterococci, *Clostridium perfringens*, and F-specific coliphages) to predict the presence or absence of pathogens (infectious enteric viruses, *Cryptosporidium*, and *Giardia*) was tested at six wastewater reclamation facilities. Multiple samplings conducted at each facility over a 1-year period. Larger sample volumes for indicators (0.2 to 0.4 liters) and pathogens (30 to 100 liters) resulted in more sensitive detection limits than are typical of routine monitoring. Microorganisms were detected in disinfected effluent samples at the following frequencies: total coliforms, 63%; fecal coliforms, 27%; enterococci, 27%; *C. perfringens*, 61%; F-specific coliphages, ~40%; and enteric viruses, 31%. *Cryptosporidium* oocysts and *Giardia* cysts were detected in 70% and 80%, respectively, of reclaimed water samples. Viable *Cryptosporidium*, based on cell culture infectivity assays, was detected in 20% of the reclaimed water samples. No strong correlation was found for any indicator-pathogen combination. When data for all indicators were tested using discriminant analysis, the presence/absence patterns for *Giardia* cysts, *Cryptosporidium* oocysts, infectious *Cryptosporidium*, and infectious enteric viruses were predicted for over 71% of disinfected effluents. The failure of measurements of single indicator organism to correlate with pathogens suggests that public health is not adequately protected by simple monitoring schemes based on detection of a single indicator, particularly at the detection limits routinely employed. Monitoring a suite of indicator organisms in reclaimed effluent is more likely to be predictive of the presence of certain pathogens, and a need for additional pathogen monitoring in reclaimed water in order to protect public health is suggested by this study.

Science 21 April 2006:
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Review

Global Patterns of Influenza A Virus in Wild Birds

Björn Olsen,[1,2] Vincent J. Munster,[3] Anders Wallensten,[4,5] Jonas Waldenström,[6] Albert D. M. E. Osterhaus,[3] Ron A. M. Fouchier[3*]
The outbreak of highly pathogenic avian influenza of the H5N1 subtype in Asia, which has subsequently spread to Russia, the Middle East, Europe, and Africa, has put increased focus on the role of wild birds in the persistence of

influenza viruses. The ecology, epidemiology, genetics, and evolution of pathogens cannot be fully understood without taking into account the ecology of their hosts. Here, we review our current knowledge on global patterns of influenza virus infections in wild birds, discuss these patterns in the context of host ecology and in particular birds' behavior, and identify some important gaps in our current knowledge.

The next item is found on p. 18 of the SR----------*GEOLOGY and SOILS* .

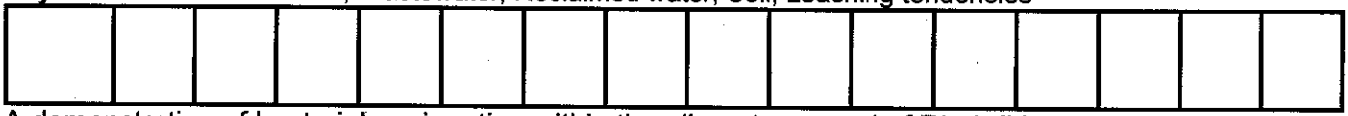
Comment----------With respect to soils, as noted by Chad Kinney (see below), pathogens, resistant pathogens, and pharmaceuticals may build up in soils. Thus soils can become contaminated sources. This is potentially a serious adverse impact and needs to be analyzed within the EIR. The conclusion of staff that there is no impact is patently wrong. Further, because plants can up-take these materials as well as pathogens, the contamination of the soil base has far reaching potentially adverse effects. Additionally because nematodes feed on bacteria, the antimicrobial resistance can be passed to the gut bacteria of nematodes, thence to humans via crops consumed raw.

PRESENCE AND DISTRIBUTION OF WASTEWATER-DERIVED PHARMACEUTICALS IN SOIL IRRIGATED WITH RECLAIMED WATER

Chad A. Kinney[1, 2], Edward T. Furlong[1], Stephen L. Werner[1], and Jeffery D. Cahill[1]

Three sites in the Front Range of Colorado, USA, were monitored from May through September 2003 to assess the presence and distribution of pharmaceuticals in soil irrigated with reclaimed water derived from urban wastewater. Soil cores were collected monthly, and 19 pharmaceuticals, all of which were detected during the present study, were measured in 5-cm increments of the 30-cm cores. Samples of reclaimed water were analyzed three times during the study to assess the input of pharmaceuticals. Samples collected before the onset of irrigation in 2003 contained numerous pharmaceuticals, likely resulting from the previous year's irrigation. Several of the selected pharmaceuticals increased in total soil concentration at one or more of the sites. The four most commonly detected pharmaceuticals were erythromycin, carbamazepine, fluoxetine, and diphenhydramine. Typical concentrations of the individual pharmaceuticals observed were low (0.02–15 µg/kg dry soil). The existence of subsurface maximum concentrations and detectable concentrations at the lowest sampled soil depth might indicate interactions of soil components with pharmaceuticals during leaching through the vadose zone. Nevertheless, the present study demonstrates that reclaimed-water irrigation results in soil pharmaceutical concentrations that vary through the irrigation season and that some compounds persist for months after irrigation.

Keywords: Pharmaceuticals, Wastewater, Reclaimed water, Soil, Leaching tendencies



A demonstration of bacterial conjugation within the alimentary canal of Rhabditis nematodes

Joseph A. Adamo [a], Michael A. Gealt* [b]

ABSTRACT

Abstract: Rhabditis nematodes fed a diet of Escherichia coli defecate viable undigested bacteria. These bacteria retain phenotypic characteristics, including those encoded on plasmids. Nematodes can survive a 2-min surface sterilization with 2% chlorine bleach; internalized bacteria also survive this treatment and are released in the nematode wastes. Bacteria alone or on the surface of dead nematodes are unable to survive incubation with this solution. There were 3.2×10^5 viable bacteria per nematode, indicating that sufficient bacteria were present for gene transfer. Transconjugants ($lac^-nal^Rstr^Rcm^R$) were recovered in the nematode fecal material following a protocol where nematodes were initially fed a plasmidless $lac^-nal^Rstr^Scm^S$E. coli and then, after surface sterilization, a lac^+nal^SE. coli plasmid donor containing the conjugative R100JA (str^Rcm^R) plasmid. The presence

of plasmids in the transconjugants was confirmed by gel electrophoresis. The occurrence of conjugation in the gut was confirmed by dissection of individual surface-sterilized nematodes and isolation of transconjugants.

The next point is found on p. 22 of the SR----------*The intent of the proposed Policy is to ensure attainment of water quality objectives. The proposed Policy may increase the use of recycled water and, hence, the salt / nutrient loadings on groundwater basins. The proposed Policy, however, mitigates this effect by requiring the development of regional salt/nutrient management plans that would consider all sources of salts and nutrients and that would prescribe requirements for meeting groundwater quality objectives for all dischargers within a basin.*

Comment----------For some reason, the whole of the policy seems to either completely ignore pathogens, their genetic fragments as well as pharmaceuticals or assumes that the only issue is salt or nutrient loading. This very narrow perspective relating to salt/nutrients really corrupts the intent of protecting the public health. Certainly the provisions of Section 13522 which requires abatement of contamination seems ignored. H&SC 5410 defines contamination as impairment of the quality of the waters of the state to a degree which creates a hazard to public health through poisoning **or spread of disease**. Movement of pathogens and their genetic material conferring antimicrobial resistance and virulence certainly fits this definition. H&SC 5410 (d) further defines contamination and **H&SC 5411 states that no person shall discharge sewage or other waste effluent of treated sewage or other waste in any matter which will result in contamination**, pollution or nuisance. Nuisance is defined by H&SC 5410(f) as anything which is injurious to health and occurs during or as a result of the treatment of wastes.

Accordingly, I really fail to see how this staff report adequately prepares the Board to make an informed decision and carry out its statutory duty to protect the public health.

The next item of note is the following, as found on SR p. 28----------*The implementation of the proposed Policy is not expected to result in exceedances of wastewater treatment requirements of the applicable Regional Water Quality Control Board.* .

Comment----------The answer here is YES, contrary to the findings of the staff. To truly correct the above discussed issues will mean a severe redesign of recycled wastewater production, its standards, regulatory controls, testing and use. As it is now, water meeting the current recycled water criteria does not protect public health and there is ample evidence to demonstrate this----it is a fact that is indisputable. To pretend otherwise is a reckless adventure.

On p. 29 of the SR, we have----------*17. MANDATORY FINDINGS OF SIGNIFICANCE*

Comment----------From the above discussion it seem fairly clear that the staff report substantially understates the case and in doing so grossly misguides the Board. There are many areas, as discussed above where there are potentially significant impacts. Thus ignoring these issues and failing to adequately examine them via an EIR does a major disservice to the people of this state.