2021 New Zealand Land Treatment Collective (NZLTC)

Conference Proceedings

Technical Session 41

PART 1

New Zealand Land Treatment Collective

CONFERENCE

4 - 6 May 2021, Palmerston North

Coachman Hotel

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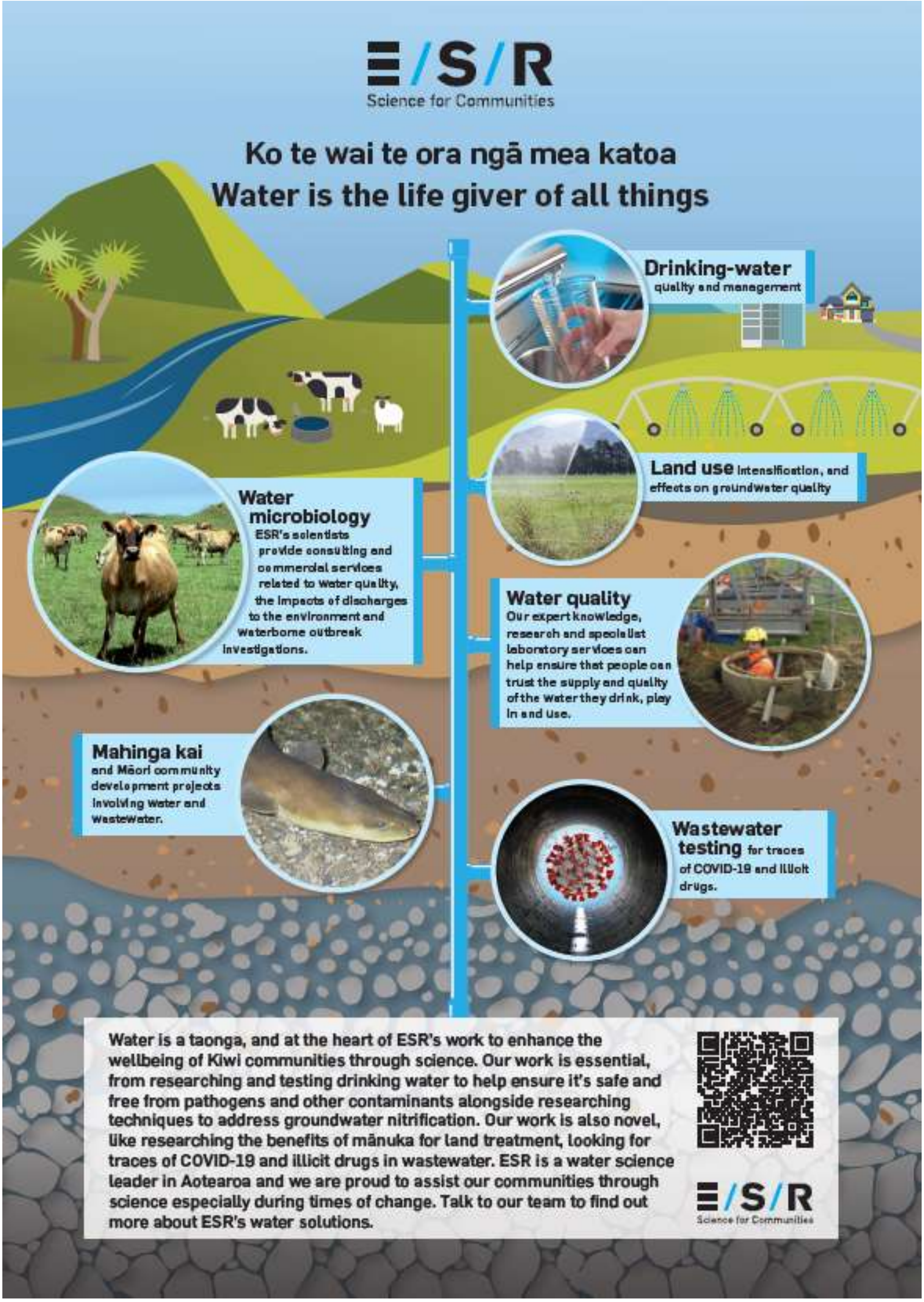
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CONTENTS

COWS, PEOPLE AND GROUNDWATER QUALITY

Dr Mark Borchardt[AB]

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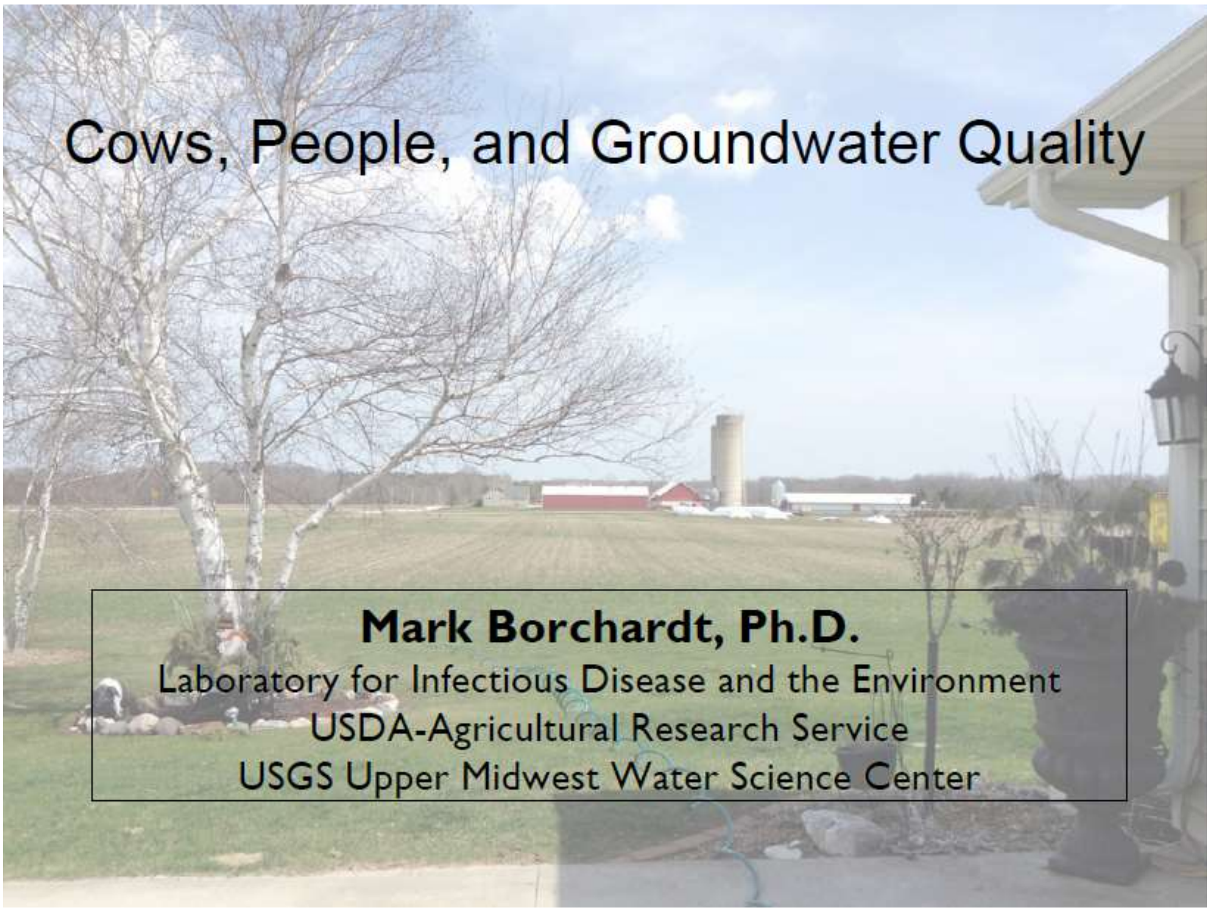

Transcript from Dr Mark Borchart (4th May 2021, NZ Land Treatment Collective Conference, Palmerston North)

I'm going to talk about cows, people, and groundwater quality here in the upper Midwest in my home state of Wisconsin, and a couple of studies that we've done.

The Research Team

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Davina Bonness Kewaunee County Land and Water Conservation

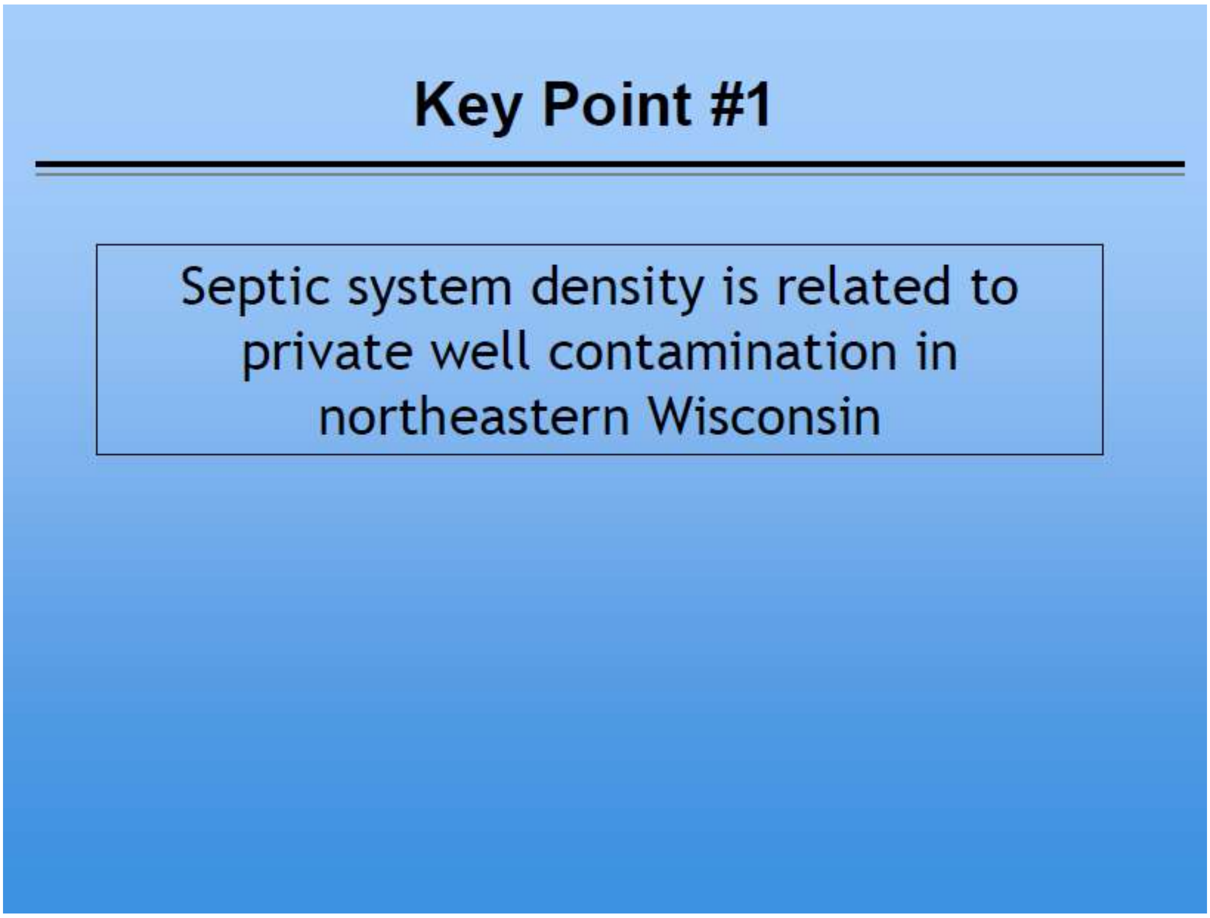
Burney Kieke Marshfield Clinic Research Foundation

USDA United States Department of Agriculture

L·I·D·E LABORATORY FOR INFECTIOUS DISEASE AND THE ENVIRONMENT

USGS science for a changing world

Of course it's not just me doing this work, it's a large research team, that have participated in this. People that I've had a real joy to work with Mareen, Sue, Randy, Joel, Aaron, Dave, Divina, and the biostatistician on the team that has been with me for about 20 years; Bernie Kiki. This is a large team effort between the USDA and USGS and our joint laboratory is called the laboratory for infectious disease, the environment or LIDE.



I'm going to give three points today, three key points stemming from two studies. That's how the talk is organized. The first point is that septic system density is related to private well, contamination in north-eastern Wisconsin, where we did the study. By septic system density, I mean the number of septic systems in an area surrounding a household private well.

Septic system types in this presentation

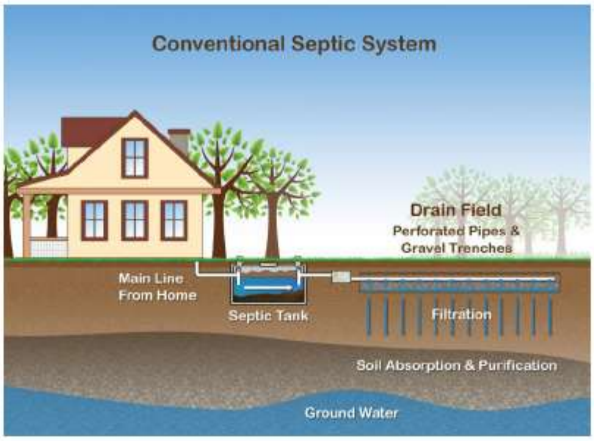


Image from Minnesota Pollution Control Agency

Class 5 System (Holding Tank)

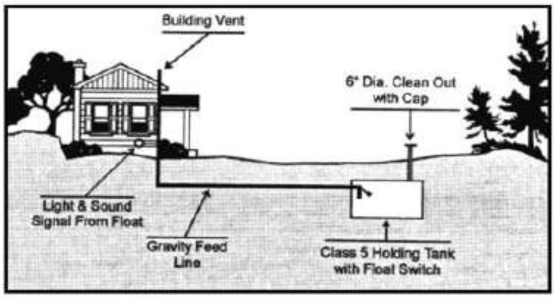
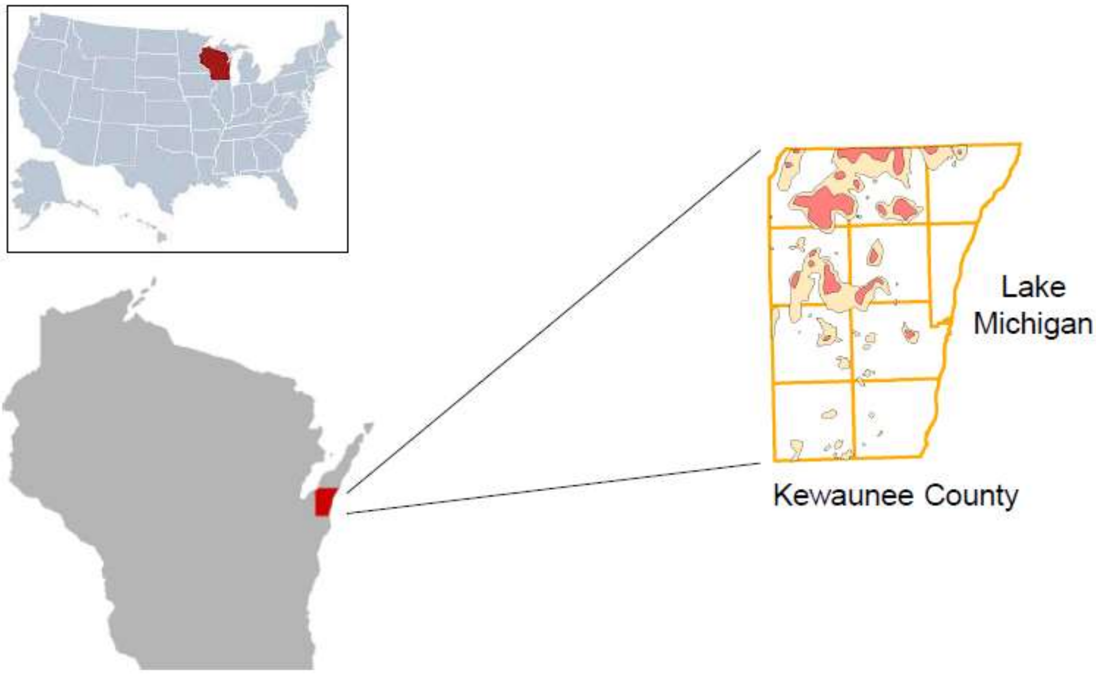


Image from Huron-Kinloss Community Septic Inspections

First of all what we need to do is clarify what I mean by septic systems. Primarily for the studies I'm talking about there have been two, what we would call a conventional septic system, which is a tank with a drain field. The other portion I'm going talk about is a holding tank, where there is no release of effluent to the land, or to the subsurface. Instead, the household effluent grey water and black water is retained in the tank and then it's periodically pumped, usually once a month or so. What I don't know for New Zealand, I know you call them on site wastewater management systems. I'm not sure how many drain fields you have, I'm not sure how many of holding tanks you have. I can't tell you that for the studies I've been involved in with septic systems, it's rare for us to have a secondary treatment system, or an aerated system. There will be a few in this study, but it's rare.

Study Location – Kewaunee County, Wisconsin



So this first study I'm going to talk about occurred in one county, In my home state of Wisconsin. The name of the county is Kewaunee County. Here's a picture of the states. Here's Wisconsin, my home state. The study occurred in this county right along Lake Michigan. This is work that occurred in this one county.

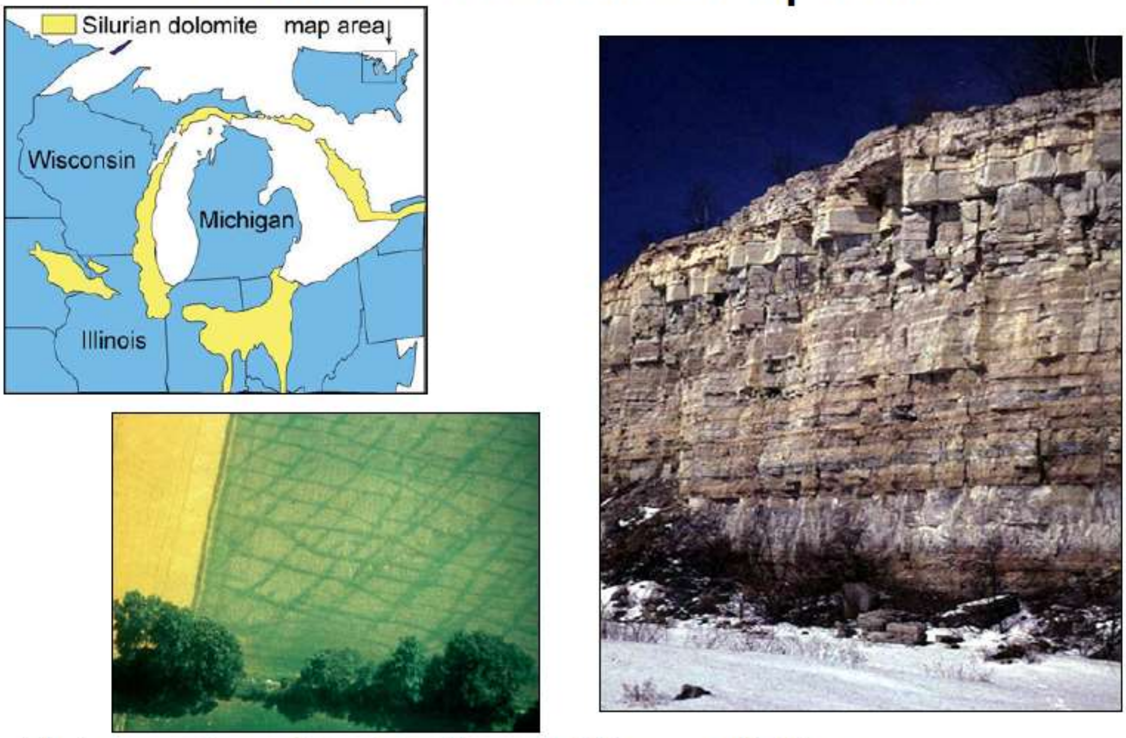
Brown Water Events in Northeast Wisconsin

- Groundwater recharge, especially spring snow melt, can generate brown water events
- Several outbreaks associated with these events e.g., EHEC, *Campylobacter jejuni*
- This well is code compliant, 123 ft deep, cased to 63 ft

Photos courtesy of Chuck Wagner

This county has had some groundwater quality issues. These brown water events that these two little granddaughters of my friend Chuck Wagner, after they filled their tub, they saw one of these happen. Brown water events are a euphemism for cattle manure coming out of the tap. I'm going to talk about some fairly sophisticated genetic methods today for this particular event. When this happens, you really don't need any fancy genetics, you can just use your rural nose and smell the manure coming out of the tap. This has been happening periodically in this county. It tends to happen when there's groundwater recharge, when the groundwater is rising, especially during snow melt in our spring. There have been disease outbreaks associated with these events, enterohemorrhagic E. coli and Campylobacter jejuni. These things are not happening in dug wells or noncompliant wells, they're happening in new wells. This has created a fair amount of controversy in this county.

Silurian Dolomite Aquifer



Photos courtesy of Ken Bradbury and Maureen Muldoon

The reason these happen is because of this highly productive, yet vulnerable aquifer. The Silurian and dolomite aquifer that encircles the Great Lakes in the United States. It's the water supply for millions of people in both Canada and in the United States. The reason it's productive is it's dolomite is fractured and has the ability to retain water, but its benefits are also its Achilles heel in that it is vulnerable to contamination from the surface. This road cut here shows some of the horizontal fractures, where waterflow can be as fast as 100 feet per day. Then this cut Alfalfa field shows the vertical fractures that are in place where the Afalfa that is more deeply rooted after cutting appears more green, so you can see these vertical fractures and horizontal fractures. This has resulted in as I said, a productive aquifer but vulnerable aquifer. I tried to look up in New Zealand, how much of your aquifers are dolomite or limestone and I have to say I was unsuccessful. I didn't figure that out. But my guess is that for the flow rates that we have here in this sort of fractured limestone, of hundreds of feet per day, you probably see similar flow rates for your alluvial sand and gravel aquifers. So that's aquifer supplying this county that we're studying.

Kewaunee County Cattle

- All cattle & calves in 2016 = 97,000
- Milk cows in 2013 = 45,500
- Milk cow herds in 2016 = 167
- Concentrated Animal Feeding Operations (CAFOs) 15 dairy, one beef
- Approximately 700 million gallons cattle manure per year

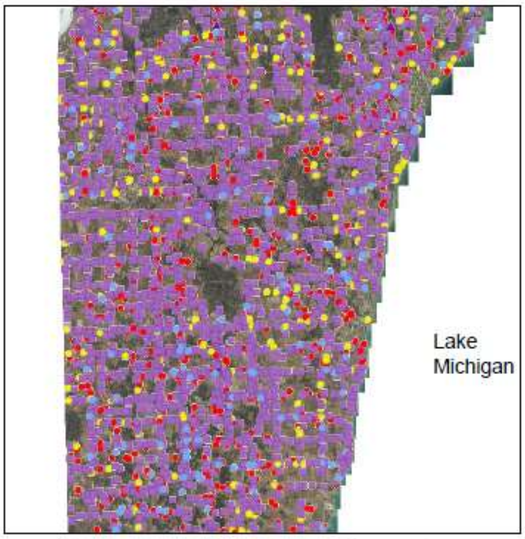
On top of the landscape the dairy industry has really taken off. It's a wonderful climate for dairying because of the Lake Michigan onshore and offshore breezes that help keep the cows comfortable. The population of cattle calves is about 100,000, milking around 46,000, and 167 herds. We have these concentrated animal feeding operations of which one is pictured here to the right of 15 dairy one beef. And if you do the math, for the amount of manure and urine produced by these cattle, it's about 700 million gallons of cattle manure per year. All of this is land applied. It's all it's all applied to the landscape and various crop fields. So that's one faecal source.

Kewaunee County Septic Systems

- 4822 septic systems in the county
- 540 holding tanks, 155 abandoned

Personal comm. Lee Luft, Kewaunee County Supervisor, March 7, 2017

Legend
Purple = replaced or inspected
Red = not inspected
Yellow = holding tank
Blue = abandoned system



Kewaunee County septic systems

Approximately 200 million gallons septic effluent per year released to the subsurface

The other faecal source are the septic systems in this county. This is a highly rural county, it's an agricultural County. There's very few villages. Most people live in a home with a private well and a septic system. There's about 5000 septic systems in the county. If you subtract off the holding tanks and those that are abandoned. If you do the math for the number of people in each household, you end up with about 200 million gallons of septic effluent that's released each year to the subsurface. 700 million gallons of cattle manure per year and 200 million gallons of septic effluent per year released in the subsurface and the controversy in this county that's made the national news here in the states is who's responsible for this contamination of the groundwater? Is it the dairy industry or is it these exuberant homes? Both the dairy industry and these exurban homes have been increasing.

More Cows + More People = More Fecal Wastes

There's one mathematical equation in this talk and that is if you've got more cows, and you've got more people, and both have faecal waste that's released to the landscape, you're just going to have more faecal waste. That's been a real problem in that part of our state.

Research Objectives

1. Determine source of fecal contamination using viruses and fecal markers
2. Identify risk factors for private well contamination using statistical models

We approached this with several study objectives of which I'm going to touch upon two today in the study that we did in that in that county, and that is to answer this question, determine the source of the faecal contamination. For that we're going to be using host specific viruses and faecal markers. Then I'm also going to present to you some of the risk factors, some of which are related to septic systems, that result in contamination of these private wells and those risk factors we modelled using statistical models.

Sampling and analyses for determining fecal source by microbial source tracking

- Collected 138 samples from 131 household wells
- Pump ~800 L through hemodialysis filters
- qPCR for microbial genetic targets
  - Human-specific microbes
  - Bovine-specific microbes
  - Non-specific microbes (pathogens of both people and cattle)

Here's how we sample for the sources of Pico contamination. We use a haemodialysis filter and an ultra filter, which has sufficiently small pore size that we can collect any microorganism including viruses. This is a method that was developed by the United States, the Centers for Disease Control. For what I'm going to show you, it's going to be 138 samples from 131 household wells. Then after processing these samples through a long process, ultimately, what we do is quantitative polymerase chain reaction that is a genetic method, looking for the specific genes for three groups of microorganisms. Those that are human specific and are only found in human wastewater, those that are bovine specific that are only found in cattle manure, and then this third group are those microbes that we can't say what the hosts. It's either people or cattle, could even be birds. I'm not going to talk about those. Today I'm going to talk about the first two and some other microorganisms. This method is called microbial source tracking. I think if I remember from your program, I think Megan Devane (ESR) might be talking about this tomorrow in your conference. So we're trying to determine the source of the faecal contamination.

Microbes: Identifying the Fecal Source

(n = 138 samples from 131 wells) (red font indicates pathogenic)

Host	Microorganism	Wells
Human-specific	Adenovirus A	1
	Bacteroidales-like Hum M2	7
	Human *Bacteroides*	27
	Cryptosporidium hominis	1
	Rotavirus A (G1 P[8])	7
	Any human microbe	**33**

Not detected: [human-specific] adenovirus B & C, D, F, enterovirus, human polyomavirus, norovirus GI & GII [bovine-specific] coronavirus, bovine diarrheal virus 1 & 2

Here's what we found. This is on the human side. This is from human wastewater, those microorganisms that are just specific to human beings and this is again 138 samples from 131 wells, and an organism listed in red is pathogenic. We had one well positive for Adenovirus A. We had a well positive for the human specific Cryptosporidium. We had seven wells with Rotavirus Group A. Rotavirus is a very common infection of children. Of course, there is a vaccine now, and we did have the techniques to subtype it and determine that these were human. But the number one contaminant, if you will, was this human Bacteroidales in 27 wells. This particular bug is in all of our gut tracks and is one of those friendly bacteria that help us digest our food, but it's specific to human beings. So overall we had 33 wells out of the 131, 33 wells that had evidence of human wastewater in them. With that data, the dairy industry said it’s these exuberant homes that are responsible for the groundwater contamination.

Microbes: Identifying the Fecal Source

(n = 138 samples from 131 wells) (red font indicates pathogenic)

Host	Microorganism	Wells
Bovine-specific	*Bacteroidales*-like Cow M2	2
	Bacteroidales-like Cow M3	4
	Ruminant *Bacteroides*	36
	Bovine polyomavirus	8
	Bovine enterovirus	1
	Rotavirus A (G10 P[11])	12
	Any bovine microbe	**44**

Not detected: [human-specific] adenovirus B & C, D, F, enterovirus, human polyomavirus, norovirus GI & GII [bovine-specific] coronavirus, bovine diarrheal virus 1 & 2

The other side of the coin are those microbes that are specific to ruminants or to cattle and for that, we had 44 wells. We had some wells with some bovine pathogens, Bovine polyomavirus, Bovine enterovirus. This Rotavirus A, we weren't able to use genetic methods to subtype it and figure out that this was a Rotavirus that was specific to cattle. But like for the human beings, the number one bug was the sister Bacteroidales to cattle or ruminants that helps them in the rumen digest their food, which was found 36 wells. But overall, we had 44 wells positive for cattle manure. So 33 wells for humans, 44 wells for cattle, that's really not a difference given the sensitivities and analytical sensitivities of these methods. The bottom line is that both groups, we've been sort of pitted against each other. Both groups were responsible for the contamination of the groundwater. So that answered that question and then we wanted to take a look at what are the sort of risk factors that lead to the contamination with these microbes, either human wastewater, or cattle manure.

Risk Factors Investigated

Land Use – *Distance; count or acres within 750, 1500, 3000 feet of well*

Agricultural	*Septic Systems*
Agricultural fields	All septic types
Fields with crops	Drain fields
Manure storages	Not inspected systems
	Septage-applied fields

Bedrock Features – *Count within 750, 1500 and 3000 feet of well*

Sinkholes

Bedrock ledges at the surface

Precipitation – *2, 7, 14, 21 days prior to sampling*

Rainfall (cumulative, no snowfall)

Groundwater Recharge – *2, 7, 14, 21 days prior to sampling*

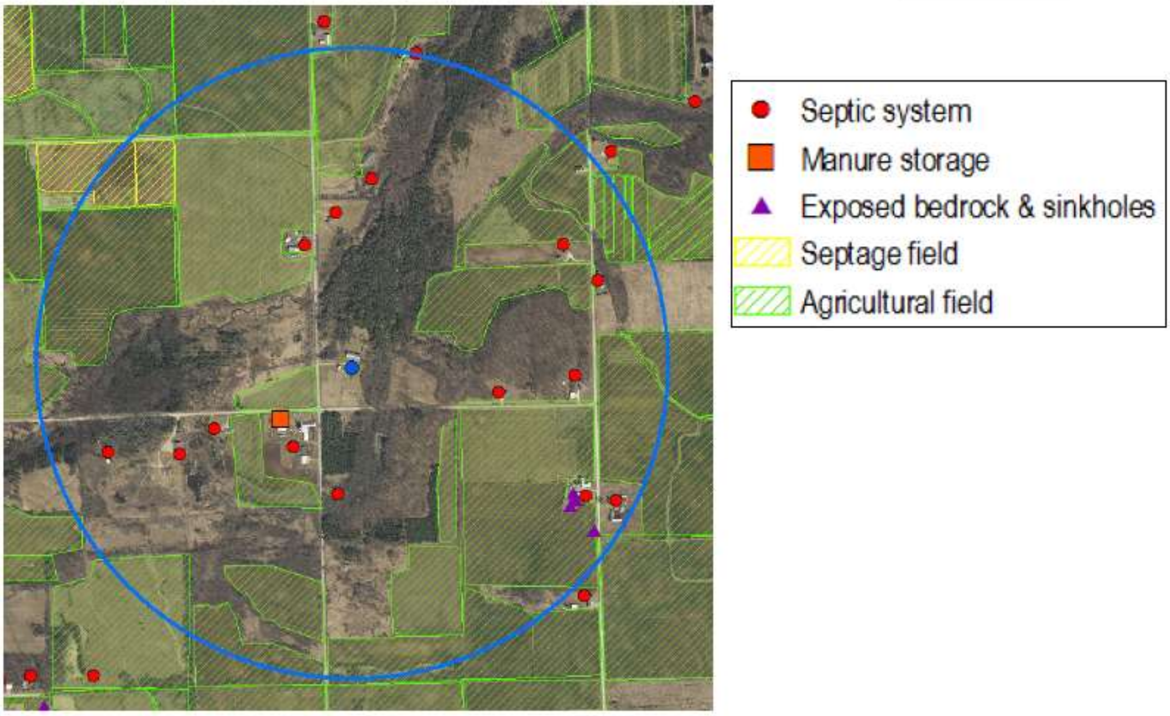
Groundwater recharge (cumulative)

Depth to groundwater (median & minimum)

Depth to Bedrock

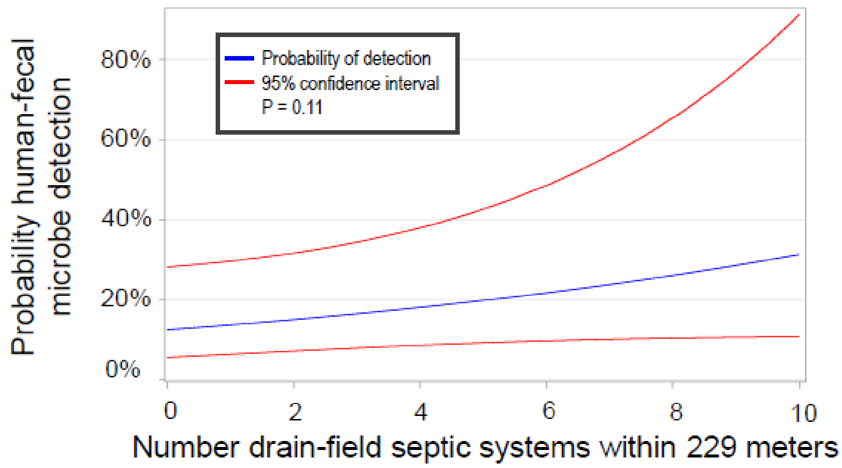
For that, we had a whole list of risk factors that we took a look at. The categories here are land use, bedrock features, precipitation, groundwater recharge, and depth to bedrock. For land use we looked at agricultural things like agricultural fields, we could determine those. We also were had a method using nutrient management plans, that we could tell that a field actually had a crop on it. Then we also had data manure storage. For the septic systems, we could look at all types. We had records on that. Those septic systems were drained fields and septic systems had never been inspected. Then also we looked at those agricultural fields where human subject was being applied. We looked at three radii from each private well. I'm sorry these are feet. I didn't convert them to meters, although later in some of the slides, I did convert to meters and hectares. These three radii were 750 feet, 1500 feet and 3000 feet from a well. We looked at bedrock features like sink holes, we looked at rainfall to 714 and 21 days prior to sample. Then we also looked at groundwater recharge, that is how much the water was rising up after rainfall or during spring snowmelt. We also looked at depth to bedrock, that is how much soil or glacial overburden is overlying the site at which the wall was located.

We spatially related land use risk factors to private well locations using Geographic Information Systems



The way we did this was using geographic information systems and this slide just gives a gives one example of one well of how we collected these data. The blue here is the private well and then this particular radius is 3000 feet. So we would identify the private wall location using GIS, draw the radius either 750 feet which is 229 meters, 1500 feet, or 3000 feet, and then count up the risk factors. So in this particular case each of these orange dots is a septic system neighbouring this private well and this home so we would calculate the number of septic systems within this radius, and then also the nearest distance. So the distance from this private well to the septic system. The orange square indicates the location of a manure storage most likely a manure lagoon and so we would calculated the distance from the private well to manure lagoons. These purple triangles are sinkholes. We counted the number of sinkholes, and the distance from the well to the sinkholes. The green hashed lines are agricultural fields. So we would calculate the area of agricultural fields within that radius. Then also the distance the nearest agricultural field. We also had data on where human septage was applied to agricultural fields. So we gathered these data for all the wells in the study. These were our independent risk factors, those things that now we're going to relate statistically to the probability of contamination.

More septic systems around a well means greater risk for contamination by human fecal microbes



Model accounts for the effects of:
Rainfall total previous 2 days
Depth to groundwater previous 14 days
Depth to bedrock

So here's some of the data. The plots that are like this are going to be the same throughout the talk. So once you understand how this works it can be applied to the subsequent slides. What we saw here was that the more septic systems that were around a private well, in this part of the state, the greater the probability of contamination with human wastewater. On the x axis here is the number of drain fields septic systems within 229 meters, equivalent to our 750 feet. We had a maximum of 10 septic systems within 229 meters of our study wells. On the y axis is the probability of having that well contaminated with human wastewater. For those of you that don't know stats, these are logged binomial models. The percentage represents the probability. So you know that if you were to flip a coin and look for one side of that coin, you would have a 50% chance that'd be aligned right here. These probabilities are no different than that, it's just that they can range from zero probability to 100% probability. The blue line is the model estimate and the red lines are the 95% confidence intervals. So what we see is we have a probability value statistical model 0.11 for this relationship between the number of drain field septic systems within 229 meters, and the probability of wastewater. Having no having no septic systems, to having 10 septic systems is a 2.5 fold increase in the risk of having human wastewater contamination. The models I'm going to show you, including this one are multivariable models. It accounts for the other variables that we found to be important. So this particular model also accounts for rainfall, the previous two days, the depth of groundwater the previous 14 days, and the depth of bedrock, that is how much soil was there between the landscape surface and bedrock which was fractured and potentially vulnerable. What I'm showing you here is the number of septic drain fields; it turns out the most important variable was the depth the groundwater that had the most statistical significance. So that makes sense, because the shallower the groundwater depth, the less travel distance from the microbes from the bottom of the drain field to the top of the groundwater table. The reason I'm showing you this slide is that at least in our state, there is no regulatory framework for groundwater depth. But there is a regulatory framework for the number of septic systems. From a policy standpoint, it makes sense to take a look at septic systems as opposed to groundwater depth, and that's why I'm showing you this plot. So anyhow, the density of septic systems are related to private well contamination.

10 septic system drainfields within 229 meters of a well is equivalent to 0.6 systems/hectare

Recommended maximum septic system densities to avoid groundwater contamination

Systems/hectare	Reference
0.15	US EPA 1977
1 – 2.5	Gardner et al. 1997
5	Reneau 1979
6	Morrissey et al. 2015

Gardner T, Geary P, Gordan I. 1997. Ecological sustainability and on-site effluent treatment systems. Australas J Environ Manag 4(2):144-156.

Morrissey PJ, Johnston PM, Gill LW. 2015. The impact of on-site wastewater from high density cluster developments on groundwater quality. J Contam Hydrol 182:36-50.

Reneau, Jr. RB. 1979. Changes in concentrations of selected chemical pollutants in wet, tile-drained soil systems as influenced by disposal of septic tank effluents. J Environ Qual 8(2):189-196.

US EPA. (United States Environmental Protection Agency) 1977. The report to Congress – waste disposal practices and their effects on ground water. U.S. Environmental Protection Agency, Washington, D.C.

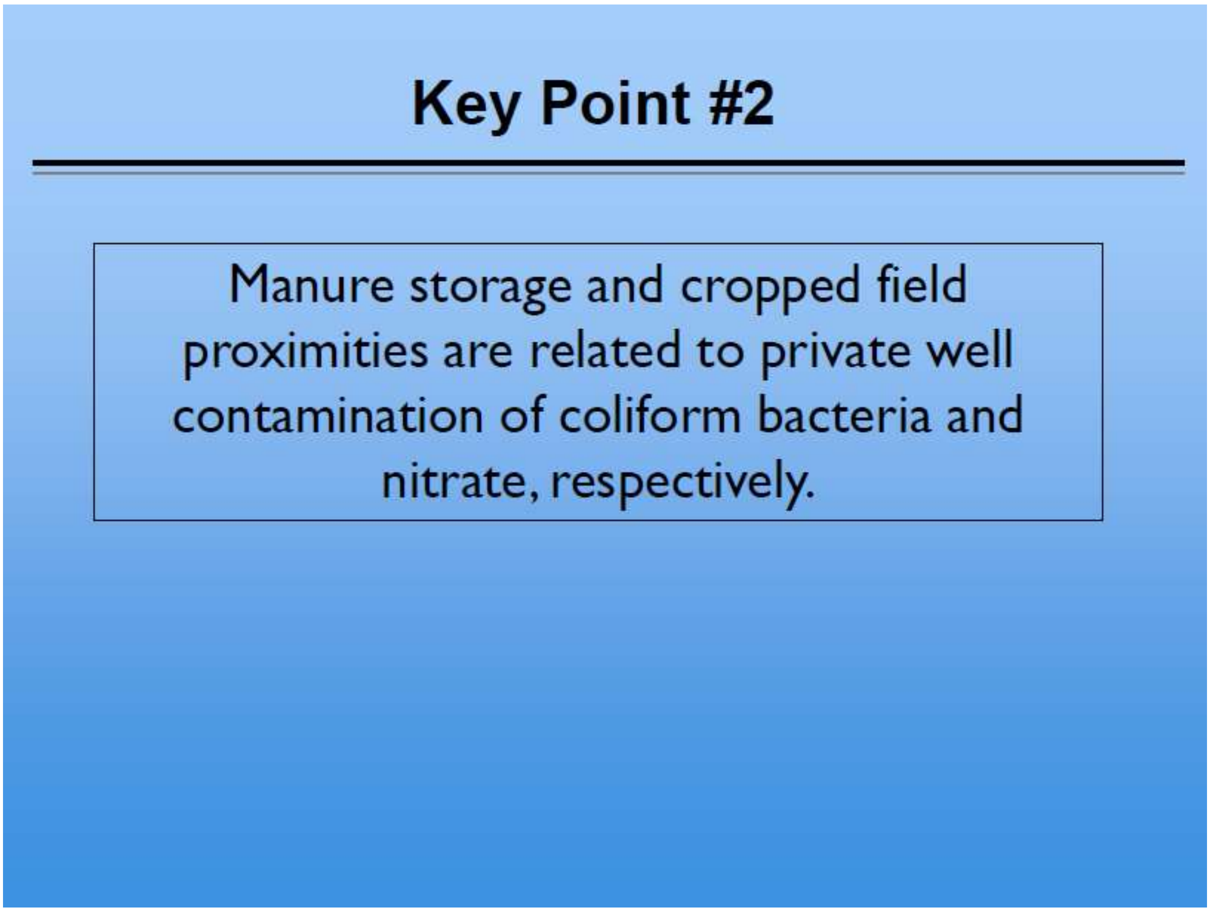
I want to put this in some context as to how this relates to what other people have found for allowable densities or maximum densities and septic systems to avoid groundwater contamination. Our 10 septic systems within 229 meters is the equivalent 0.6 systems per hectare. The US EPA in 1977 came out with the first recommendation the United States for the septic system density. The maximum upon which if you exceeded, it would result in groundwater contamination. Their rule of thumb was 40 per square mile, which translates to 0.15 systems per hectare. We were seeing an effect at lower densities, maximum 0.6 systems per hectare. Our 0.6 is somewhere between 0.15, and this study by Gardner, which was done in Australia, recommending 1 to 2.5 systems per hectare. A couple of other studies have said you can go even higher,5 systems per hectare, 6 systems per hectare. You might be interested in looking at these. I put the put the references here. These are the only studies that I could find in which I cite in the manuscript to put our what we learned in context. The densities we had were higher than the US EPA recommendation, but lower than what other scientific studies have shown.

Land-applied septage was NOT associated with private well contamination

Caveats for the absence of an association:

- Only 10 fields in the county received human septage
- Septage applied volume during study period was only 2.57×10^6 liters
- Whereas, septic system drainfield effluent was calculated to be 6.79×10^8 liters/year (260 times more than septage volume)

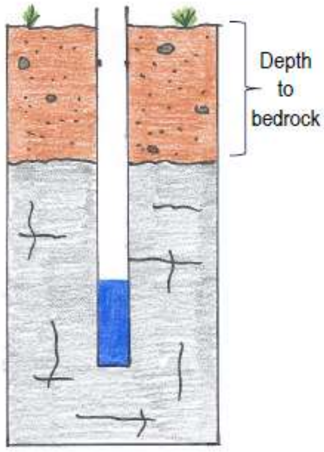
You also might be interested to know that for our study, we did not see any association of land applied septage and private well contamination. The two weren't associated in this particular study. But there are some caveats to that. In this county, there were only 10 fields in the entire county that were receiving human septage. The volume of septage is just really tiny compared to the subject system drain field effluent. There's only a couple million litres applied during the study period to these 10 fields. Whereas, in contrast the septic system drain field effluent, we calculated it was about 7×10^8 or 700 million litres per year, which is 260 times more than the septage drawing that was applied during the study. So it might be that the reason we didn't see an association is not that septage is not a risk factor, It's just that very little was applied during the study.



Key point number two, derived from the same study is that manure storage and crop field proximities are related to private well contamination of coliform bacteria and nitrate, respectively. Now this association I'm talking about between crop field proximity and nitrate isn't really big news. Other studies have shown similar statistical associations. What's different in our study, is that we used, as our cut off point, the US health standard of 10 parts per million. This other association I'm going to show you is manure storage and coliform bacteria. That is new and was a significant point of controversy in my home state of Wisconsin.

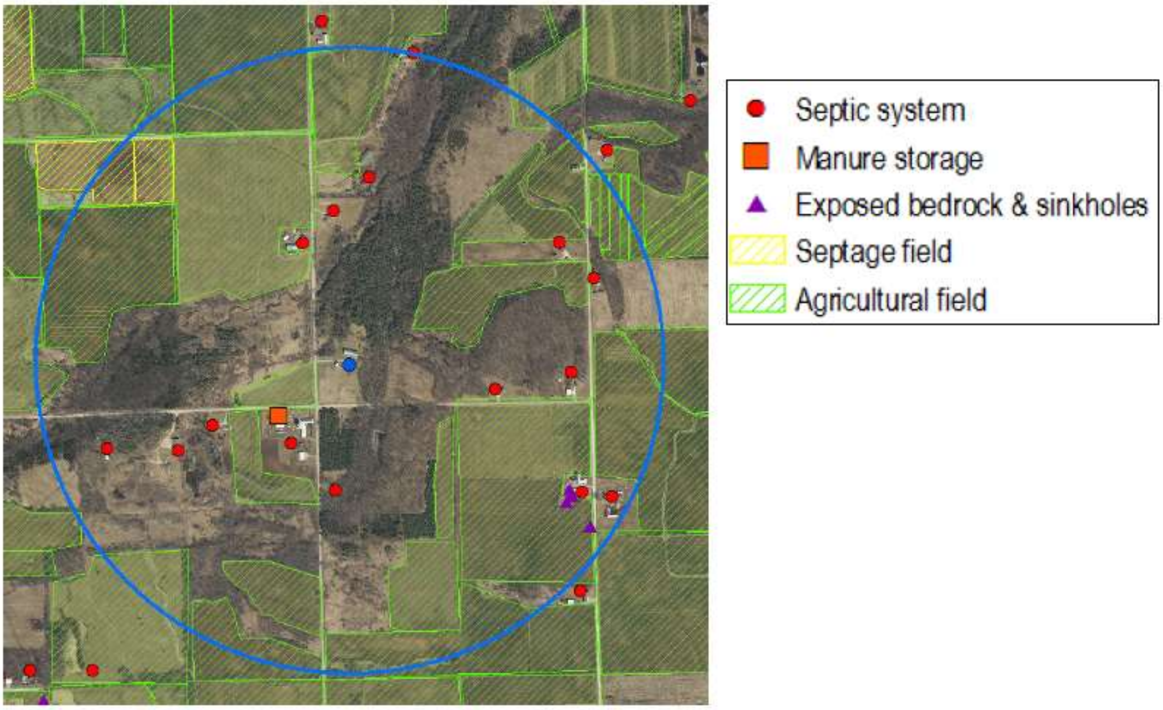
Sampling for total coliforms and nitrate

- County-wide randomized sampling of private wells – 4,896 in county
- Stratified by depth-to-bedrock:
  - Less than 1.5 meters
  - 1.5 – 6.1meters
  - Greater than 6.1 meters
- Well owner participation rate ~ 50%
- Sampled twice:
- November 2015
  - 317 wells in analysis
- July 2016
  - 400 wells in analysis



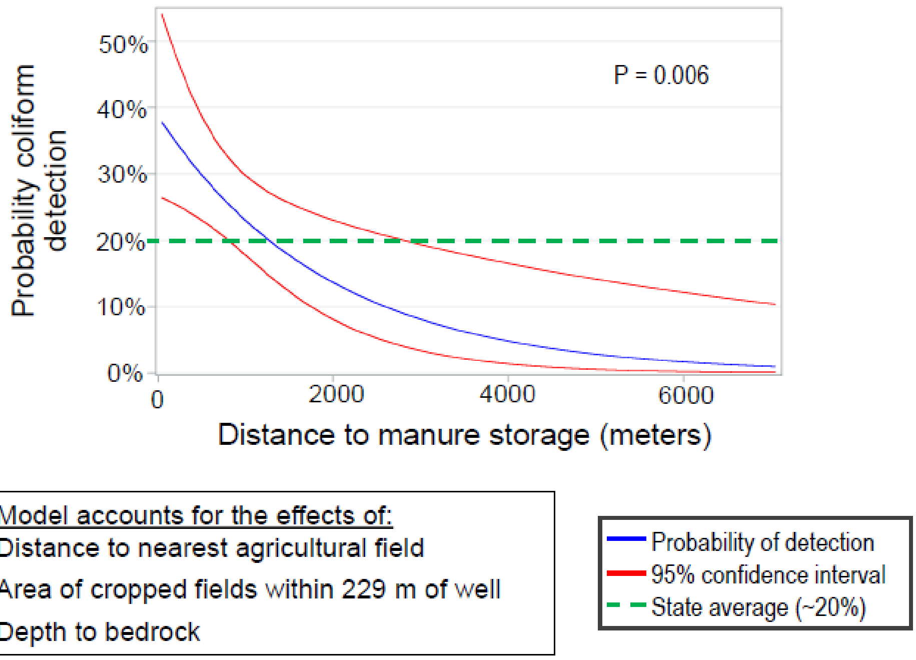
The way we did this in this study is that we sampled wells in the county for coliform bacteria, which of course is not a pathogen, it's an indicator, and nitrate. We randomized this, there's about 5000 wells in the county, similar to the 5000 septic systems in the county. We figure that depth of bedrock was probably an important parameter for contamination. So we did stratified random sampling. We stratified by these three depths depth of bedrock. Less than 1.5 meters 1.5 to 6.1, or greater than 6.1 meters. We had a very high homeowner, well owner participation rate. 50% of the people we contacted by letter wanted to participate. 50% of those that would have been randomly selected. Then we sampled twice. Once in the fall of 2015 and once in July 2016. The data I'm going to show you these were analyzed separately, but I'm just going to give you the gestalt with these next plots. Now we have two different outcomes, coliform bacteria and nitrate levels.

We spatially related land use risk factors to private well locations using Geographic Information Systems



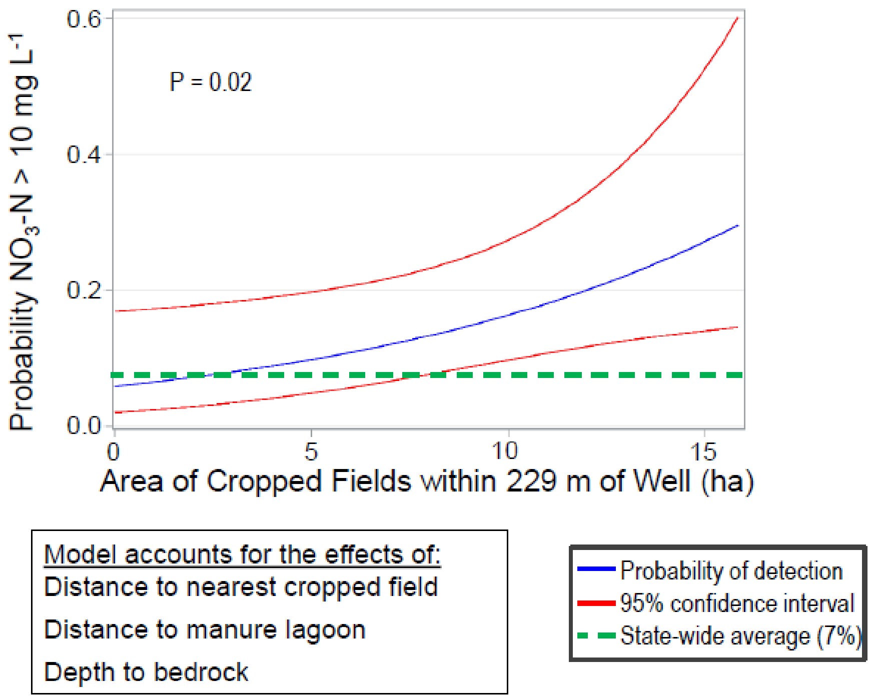
Again, just to remind you, the way we got the independent predictor variables was through the geographic information system. So the same approach I talked about just a few minutes ago, the same predictive variables now went into the modelling for coliform detection in nitrate levels greater than the US health standard of 10 parts per million nitrate nitrogen.

Wells located farther from manure lagoons are less likely to be contaminated with coliform bacteria

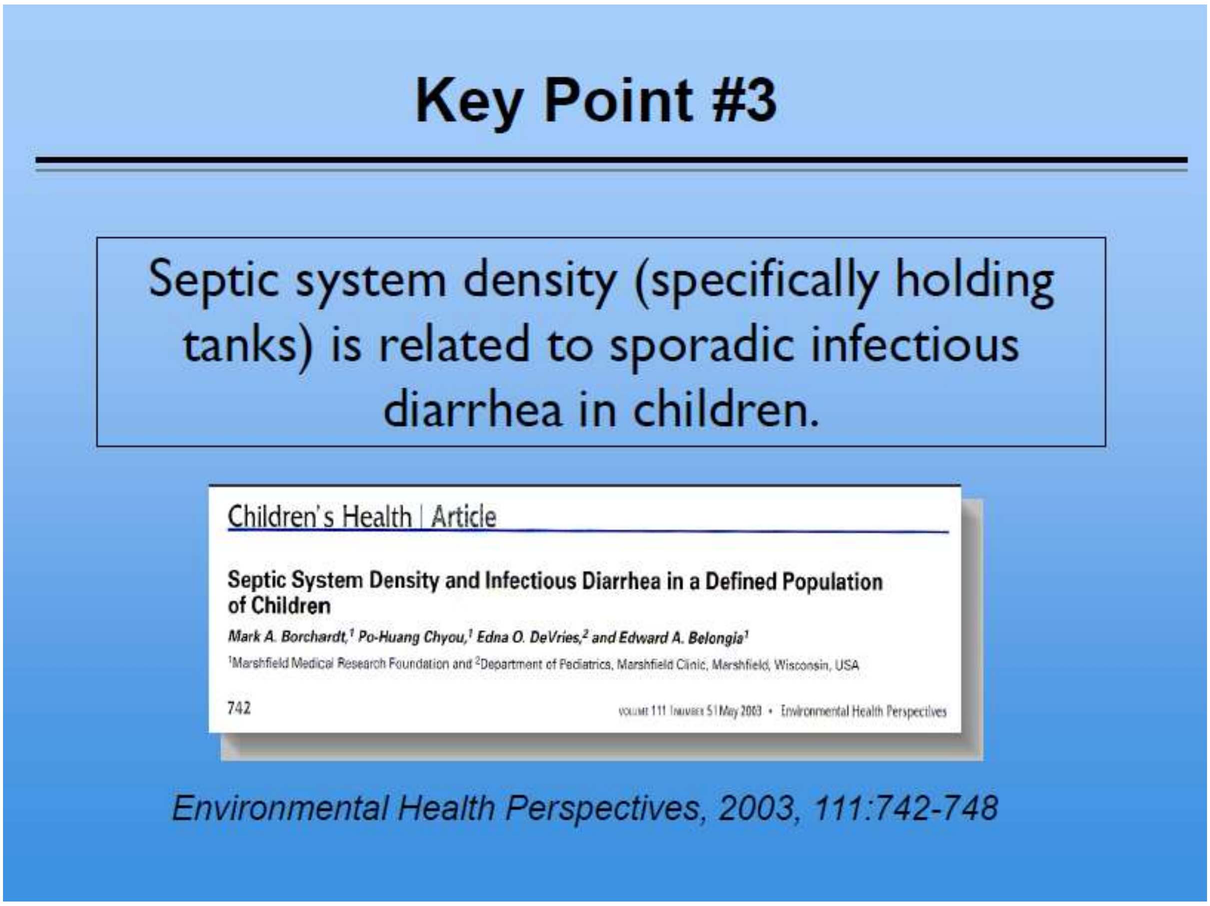


Here's what we found. So interestingly, shocking to us is that wells located farther from manure storage lagoons, are less likely to be contaminated with coliform bacteria. Here's that probability of detection, same kind of log binomial statistical model. This is the distance to manure storage lagoon in meters. 90% of the manure storage lagoon in this county are manure lagoons and they're primarily earthen constructed in the landscape. What you can see is for those walls closest to manure lagoon, I think our closest wall was 48 meters, there was ~38% chance of those wells being contaminated with coliform bacteria. By the time you got more than a kilometer away, maybe two kilometers, four kilometers, six kilometers to have a really low probability of coliform contamination, this was a highly significant decrease. This green dashed line is our state average for positive wells and coliform detection. So in this county, that type of hydrogeologic setting, the distance needed to have a probability lower than the state wide average for coliform contamination, the distance needed from a manure storage lagoon was about one and a half kilometres. Again, this is a multivariable model. There were other important risk factors that went into the statistical model. This relationship that you're seeing with this blue line, this decrease is accounting for these other variables, such as the distance the nearest agricultural field, the area of crop fields within 229 meters of the well, and depth to bedrock. This was a rather shocking result for us, the importance of manure storage lagoons on the landscape for coliform detections in these private wells.

More crop land near private wells means more risk for contamination by high nitrate (crop land receiving manure and inorganic fertilizer)



The other relationship I thought you might be interested in seeing is how cropland is related to nitrate contamination. On the y axis, this is the probability of having a well with a nitrate nitrogen level greater than the health standard of 10 milligrams per litre. This is the area of cropped fields that we determined by nutrient management plans, the area of crop fields within 229 meters of a well. The area here is in hectares, five, ten, and 15 hectares. 15 to 16 hectares for this distance would mean that the home is pretty much surrounded by cropland. The green dashed line is our state wide average for nitrate, deemed too high nitrate levels, which is 7% in their state. What you can see is that as the area of crop land around these private wells increases, the probability of having a well where you really shouldn't be drinking the water because it exceeds the health standards, increases quite a bit. It's around two and a half hectares of land cropped around a well, were then for those folks in this part of the state have a probability greater than the state wide average for nitrate contamination. This is corrected for, adjusted for distance to the nearest crop field, distance to the manure storage lagoon, which has also important for nitrate, and then depth to bedrock



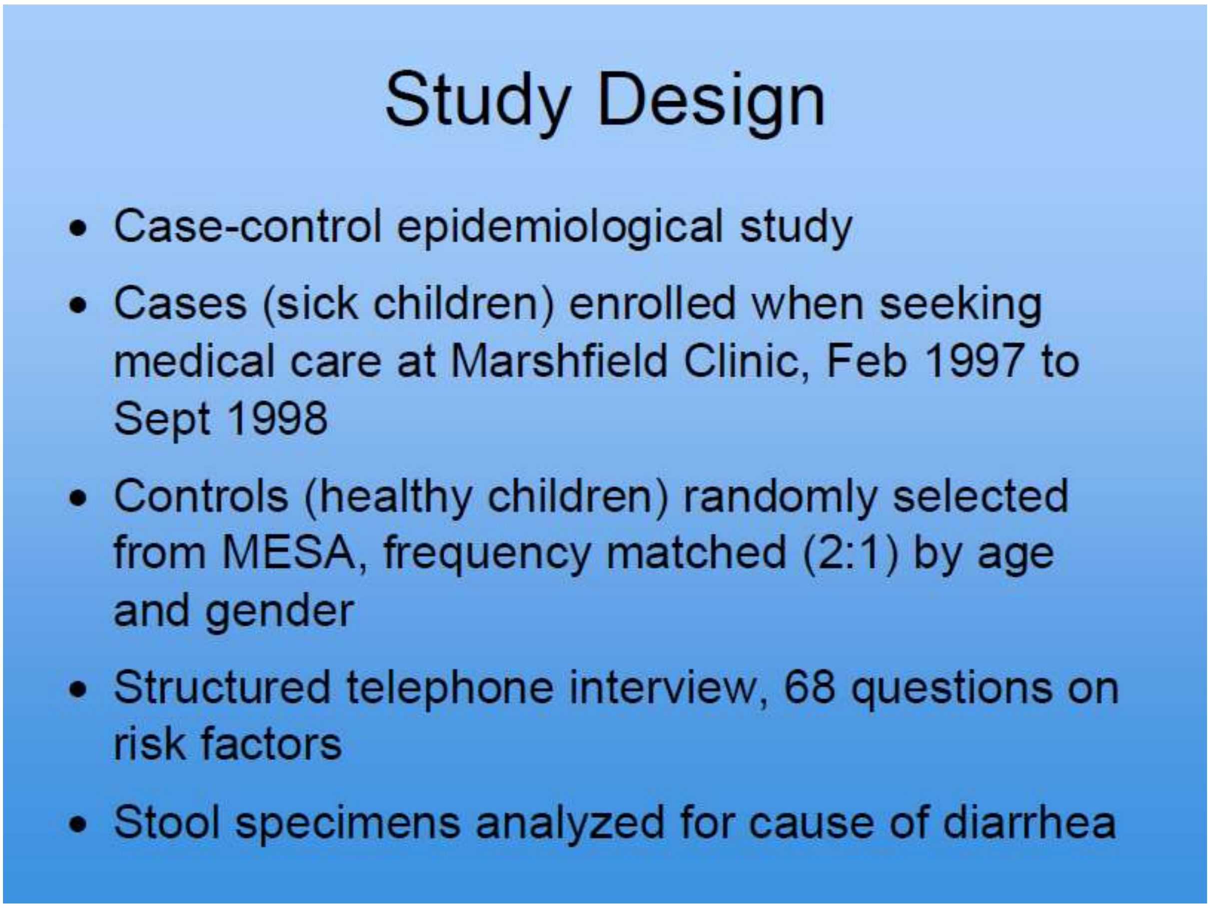
Now I want to make the last of the key points here. Key Point number three, and that is septic system density, that is the number of septic systems around the household, and specifically when we're talking about these holding tanks where the effluent is put into the tank, and then pumped out periodically. That is related to sporadic infectious diarrhea in children. I actually published this in 2003. It's a study that we did in the late 1990s, published in 2003. What's interesting to me is that every year I get a request to talk about this study, even though it was published so many years ago. Your invitation and your interest in septic system has kept my streak alive now for 18 years of talking about this particular study, and as far as I know, it's still the only epidemiologic study that's been done showing this link between septic system density and infectious diarrhea. If you if you're interested, it was published in environmental health perspective, which is open access, or I'm happy to send it to Bronwyn if you'd like to see it but you can find it online.

We did this study in the central part of the state where holding tanks are common, because the soil is not amenable to putting in a drain field. Quite a few people don't want to make those payments to have that holding tank pumped, instead they just let it come out the top. You see many scenes like this where effluent is coming out of the riser and then flowing downhill.

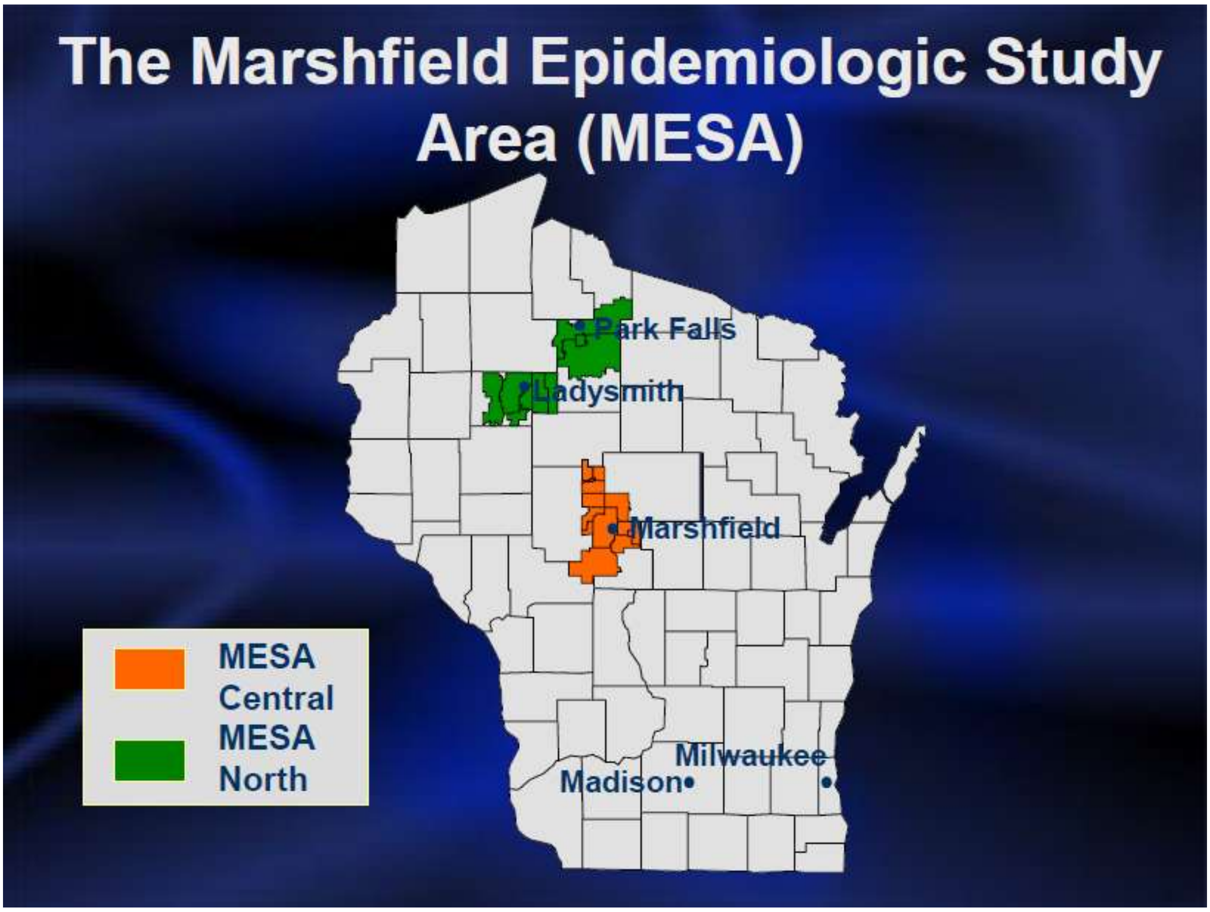
We also looked at conventional drain field septic systems in this study, and this too is not an uncommon scene, where the drain field fails and effluent bubbles up and erupts at the top.

It's not uncommon at all to drive along the roadways and see the effluent coming out of the tank, then flowing downhill to the ditch. This particular family have had this stream, it looks like for quite a while, it's a little bit eroded. They must have gotten tired of jumping over because if you look here in the background, they built a little wooden bridge to walk across their effluent stream.

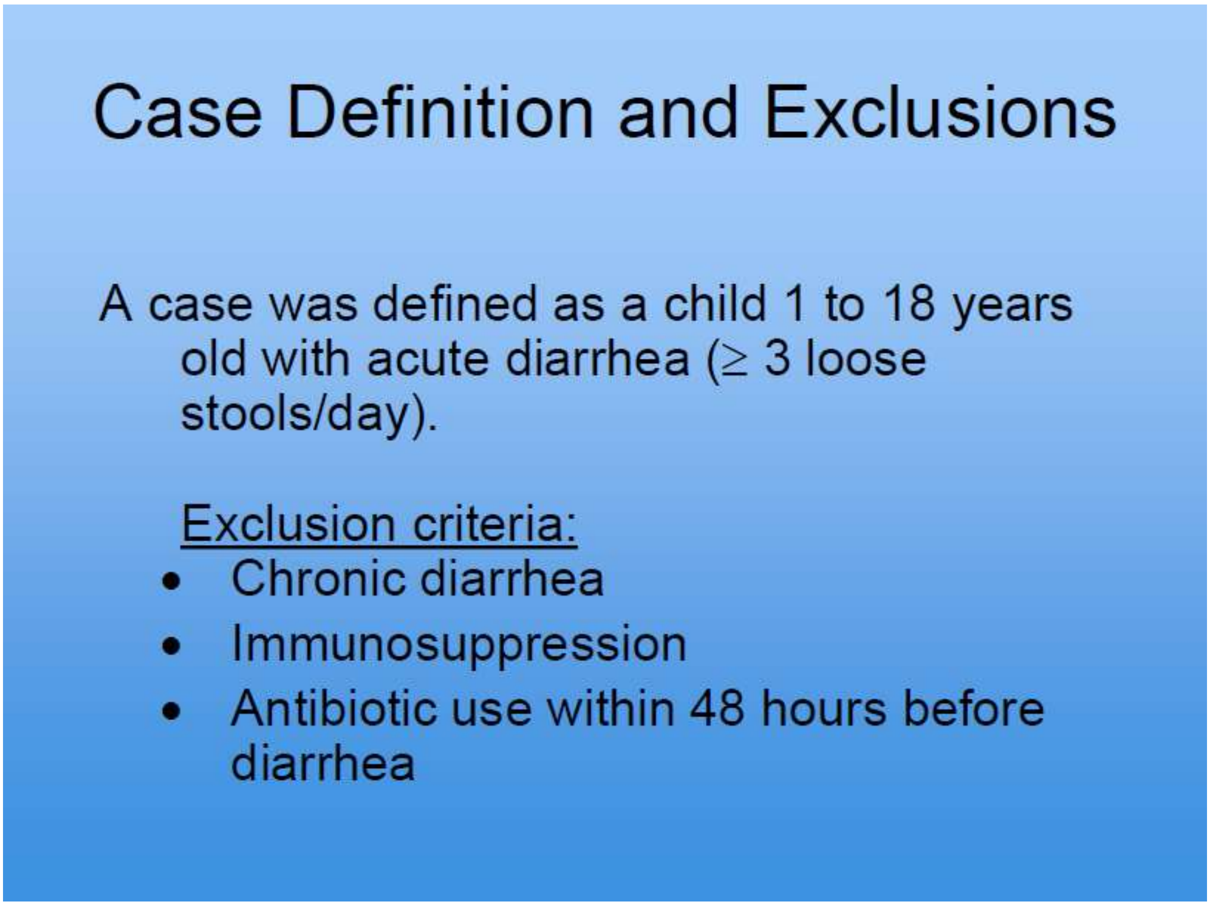
These folks for this particular one, what some people do. Instead of having it erupt from the surface is they run a pipe from the holding tank to the ditch, and you know, sort of mow over it. This particular family took the trouble, over their effluent outlet from the holding tank, to make a little border with rocks, plant a few daffodils and looks like they're even growing a few herbs. These scenes are actually less common now as a result of this study, but I still see them on my biking around my home in the rural countryside.



The question was, is anyone getting sick from all this effluent out there? We posed an epidemiologic studies design that we got funded. This was a case control epi study. Our cases were those children that came from seeking medical care, they were sick enough with acute gastroenteritis that they sought care at Marshfield Clinic where I worked at that time. Our controls were healthy kids. We randomly selected them from this epidemiologic study here that I'm going to show you here in the next slide. For every case, for every sick kid, we enrolled two controls, and we match them by age and gender. Then for every family we have a structured telephone interview with 68 questions on these risk factors. Then the stool specimens, we analyze for the cause of diarrhea, whether the diarrhea was viral, bacterial, whether it was protozoan, like cryptosporidium, and in some cases, we couldn't tell what it was.

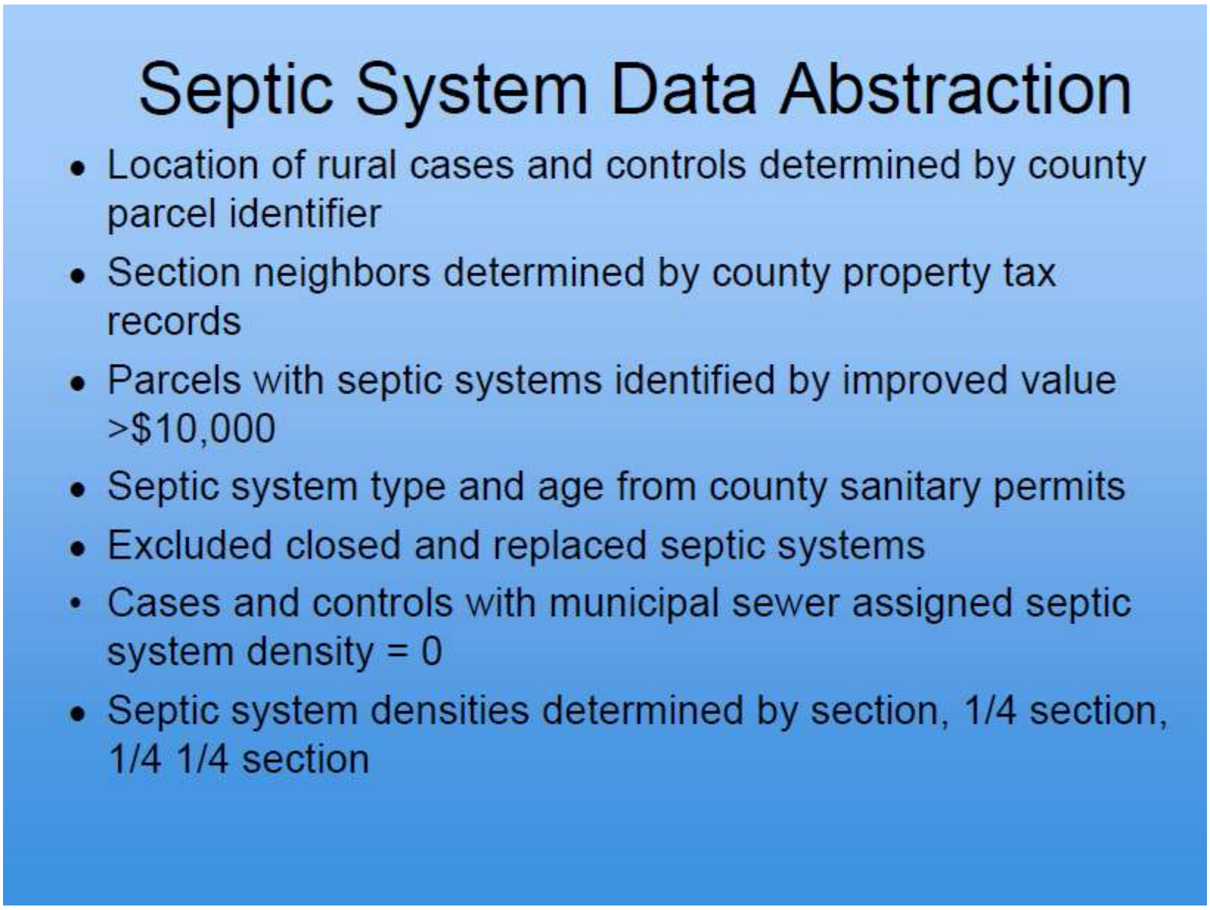


Here's what the study was conducted. Here's Wisconsin here. This right here, that's where the previous study had just talked about this is that Kewaunee County, I live here. Here is the border of this epidemiologic study area. It covered three counties for which we did the study. The beauty of this, what we call MESA, this epidemiologic study area, is that due to the nature of the healthcare system, all the in migrations of people and out migrations of people can be tracked. You always know the population denominator in that area. What you can do is then calculate something called attributable risk, that is the fraction of an illness, in this case, infectious diarrhea, the fraction of an illness attributable to a specific cause. I'm going to show you those data in a few slides, but this is where the study was conducted.

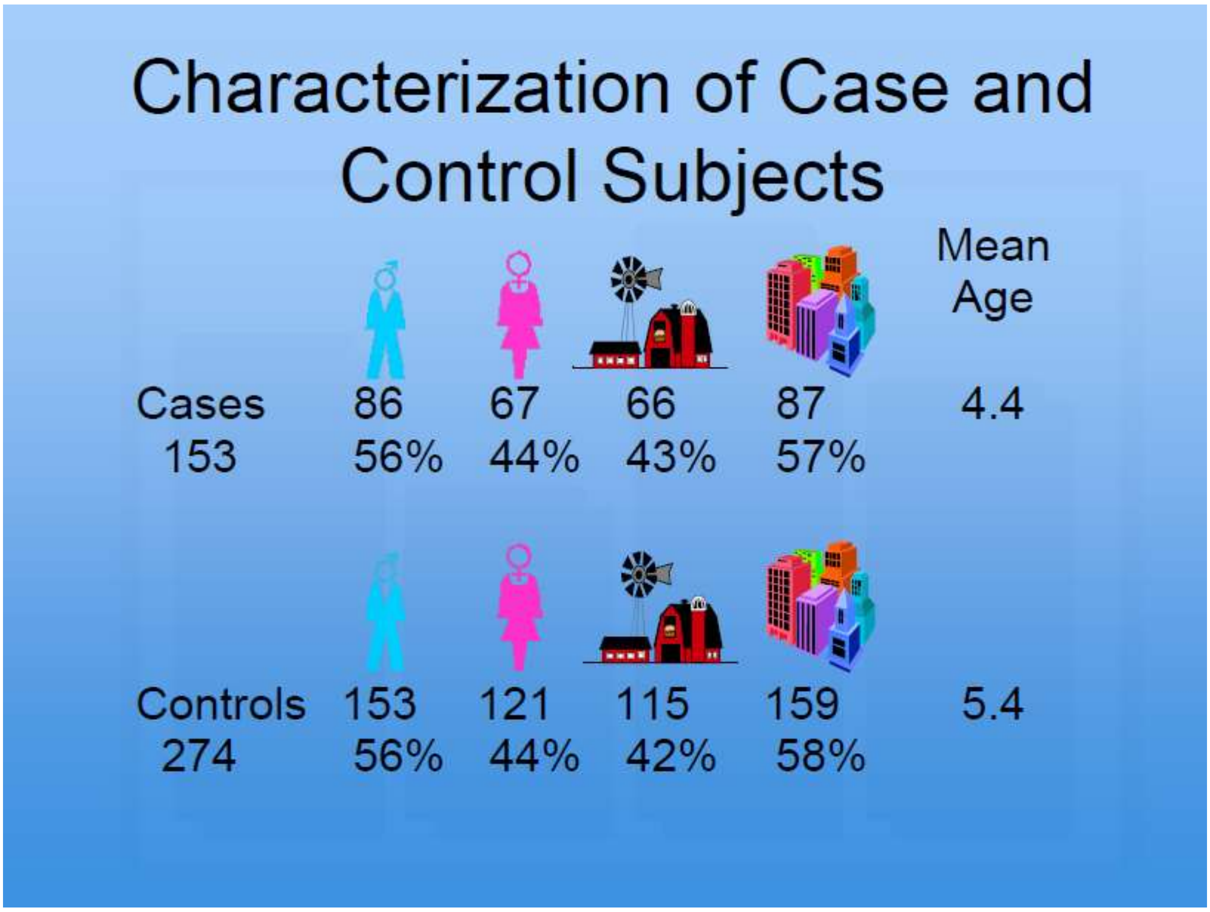


Our case definition was a trial between one and 18 years old that had acute diarrhea; having at least three or more loose stools in a day. We excluded those kids that had chronic diarrhea for other reasons like irritable bowel syndrome. We excluded children that were immunosuppressed. We excluded children that said they had taken antibiotics within 48 hours before the diarrhea began.

These are the sorts of things that we adjusted for, looked into because they are also associated with diarrhea, person to person transmission, travel, dietary history, pets, farm activities, recreational water activities, and drinking water sources. These were all part of that 68 structured questionnaire, so that we could account for these other activities and sources of illness besides septic systems.



Here's how we got the septic system data. Keep in mind this study was done in 1997 and 1998. Really, before geographic information systems were widely adopted by the counties that keep track of the records of septic systems. The way we identified where folks were is by a tax purse identifier, and then we put them in what we call a section. Not sure this language translates to New Zealand. A section for us is a square mile, 640 acres, which I believe if coming up here I think it's 259 hectares, but we identified them from the same property tax records. Anything that had a valuation more than 10,000 US dollars, we said was improved and likely had a septic system. We got the type of septic systems and the age from the sanitary permits. We excluded from our analysis, all the septic systems that have been replaced, reclosed, or abandoned. Anyone any child and their family that had a municipal sewer we assigned a septic system density of zero and then we determined the septic system densities, by these three areas of 640 acres, of 160 acres, and 40 acres. Again, 640 acres is 259 hectares. We just pick these then interestingly, I use these same areas, that's what you just saw in that other Kewaunee County study, because of the data I had here. This is how we obtained the locations and numbers of septic systems.



Turned out that the matching for the cases and controls worked well. We had 153 cases, 274 controls, equal number of boys, equal number of girls, almost an equal number of people that lived out in the country, and almost equal number of people that had municipal sewer, age of 4.4 years for those kids that were sick, and 5.4 for the healthy controls.

Number of Septic Systems per 640 acres (259 hectares) Where Cases and Controls Resided

Type	Mean	Range
All septic systems	14	1 - 56
Holding tanks	6	0 - 50
Drainfields	8	1 - 25
Drainfields less than 20 years old	1	0 - 5
Drainfields more than 20 years old	7	0 - 25

Here are the type of septic systems that we were working with in this study. This is the number per 640 acres, 259 hectares, and this is where the cases and controls resided. For all septic systems, our average was 14 within 249 hectares with a range of one to 56. You can see that we exceeded that EPA recommendation of no more than 40 in a square mile, because the 640 acres 259 hectares is a square mile. Within all septic systems categories, we have these subcategories: holding tanks, septic drain fields, then we divided the drain fields into those less than 20 years old thought to be operational. And then those drain fields more than 20 years old, that we figured we're getting close to failing. Here are the average densities and the range.

Septic System Type and Density Related to Diarrhea Etiology (☆Significant)

Septic Type	Area (acres)	Cause of Diarrhea			
		Viral	Bacterial	Protozoan	Unknown
All septic systems	640	☆	-	-	-
	160	☆	☆	-	-
	40	☆	☆	-	☆
Holding tanks	640	☆	-	-	-
	160	☆	-	-	-
	40	☆	☆	-	-
Drainfields	640	-	-	-	-
	160	☆	☆	-	-
	40	☆	-	-	☆

This slide shows you this relationship between children and their cause of diarrhea, and the density of septic systems in these three areas that I just discussed 640, 160, and 40 acres. This particular analysis is what's called a univariable analysis. All we're doing is looking at the illness and comparing that to the septic systems and not only for those other things that were the question. What you can see here, surprising to us, is that for diarrhea, we could identify in the stool specimen, a virus causing the diarrhea. All the categories and septic systems and all the areas that we studied them were significantly associated with viral diarrhea. For that diarrhea caused by bacterial infections, four significant associations: two with all septic systems, one was holding tank and one was drain field. Protozoa, we didn't have any associations. We also had some unknown etiology, where we can identify the cause of diarrhea. At least in this one variable, this dependent variable, the independent variable relationship, we found these statistical associations which then justify doing the additional multivariable modelling to account for those other factors that could also be related to diarrhea.

Independent Risk Factors For Viral Diarrhea (n=18)

Risk Factor	Adjusted Odds Ratio	95% CI	P-value
Holding tanks/sec	1.08	1.02 - 1.15	0.008
Age	0.66	0.47 - 0.92	0.015
Household member with diarrhea previous 4 weeks	5.04	1.70 - 14.95	0.004

Here's what we found. So this is the multivariable model for those children who had viral diarrhea, and lo and behold again, so surprising to us, given the small number of children we had with this diarrhea etiology is that the number of holding tanks within 259 hectares was significantly associated with viral diarrhea. This relationship adjusted for age. This number here indicates that the older child was, the more protected they were against becoming infected. Not surprisingly, this also adjusted for having a household member with diarrhea the previous four weeks, indicating person to person transmission. Even though this is a large effect here, not surprisingly, living in the same household person a person, we were still able to see the effect of holding tanks, so that for every increase of one holding tank, in 259, hectares there was an 8% increase in the risk of a child having viral diarrhea. That was statistically significant.

Independent Risk Factors For Bacterial Diarrhea (n=20)

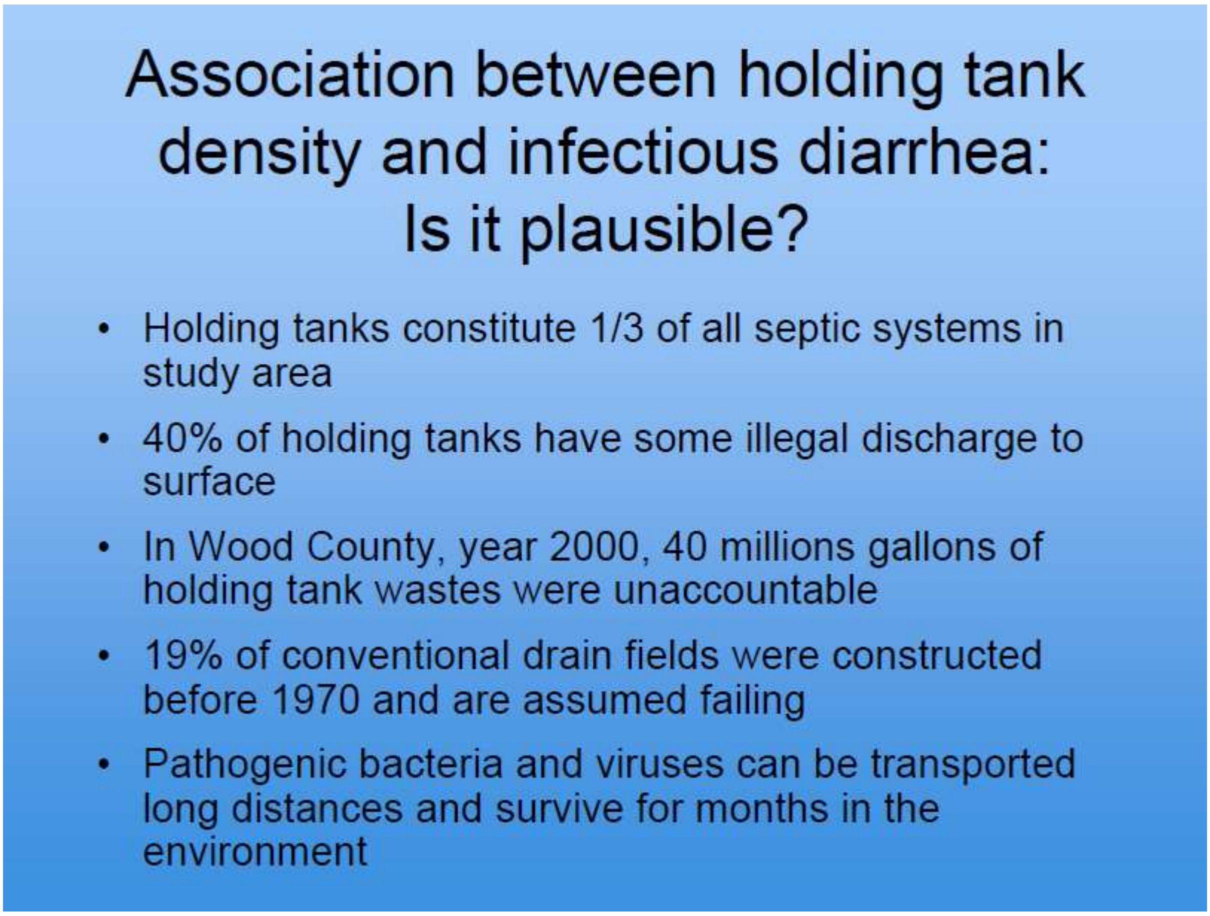
Risk Factor	Adjusted Odds Ratio	95% CI	P-value
Holding tanks / 1/4 1/4 section	1.22	1.02 – 1.46	0.026
Child inside calf hutch or pen	12.74	4.67 – 34.72	<0.001

About bacterial diarrhea that etiology for those children that had diarrhea that were a result of a bacterial infection. Lo and behold, holding tanks turned up again as a significant variable. In this case, it was the number of holding tanks in 40 acres, what we call a quarter quarter section. It would be better to do the math quickly my head. A fraction of the 259 hectares, 640 acres, is 40 acres. The way you interpret this is that for every increase of one holding tank in that 40 acres, there was a 22% increase in the risk of bacterial diarrhea for a child with that. That too was statistically significant. For this area, which were heavy dairy, were one of the largest dairy production areas United States. Children do have a lot of contact with calves, and in this particular case the other variable that was highly important, more important than holding tanks in terms of the odds ratio, was a child having said in the questionnaire that they entered a calf pen. But despite this strong relationship right here holding tanks, still popped out, if you will, in the statistical modelling as being important for bacterial diarrhea.

Fraction of Diarrhea Attributable to Holding Tanks

Etiology	Risk Factor	Percent Cases Exposed	Attributable Fraction	95% Confidence Interval
Viral	Number of holding tanks in same 640 acre section	28%	20%	2% - 42%
Bacterial	Number of holding tanks in same 40 acre / 1/4 1/4 section	35%	19%	0% - 39%

Going back to that epidemiologic study area we can calculate what I said was the attributable fraction, that is that fraction of these illnesses that are attributable to our risk factor in this case holding tanks. What we see that for diarrhea of viral origin, about 20% of the illness in the study area was due to this this holding tank exposure. The number of holding tanks in 259 hectares
Here's the 95% confidence interval 2% to 42%, we estimated 20% of the illnesses were due to holding tanks. For bacterial, we again calculated the typical fraction, similar to this, 19% could have been as low as 0%, the 95% confidence interval. Again, the number of holding tanks in this 40 acre area.



Having said all that, for those of you that are familiar with epidemiologic studies, you know that these are correlations or associations is another term. When one finds these statistical relationships you always have ask question, is it plausible. Is it plausible what you're finding here. For example if we had found a relationship between childhood diarrhea and the number of electric line poles around the household. Is there a biological mechanism for electric line poles, and diarrhea? No, you'd there's no biological possibility. But here it does look like it's biologically plausible. In the study area, the holding tanks are 1/3 of all septic systems, because of the nature of our soil, and inability to have these drain fields. We know from county records that 40% of the holding tanks have some illegal discharge to the surface. People aren't paying the money to pump them. For one year for which we have data in one county in the study; Wood County. They couldn't account for 40 million gallons of holding tank waste. There was that much of a discrepancy between what they figured people's average water usage and average household size and number of family members and household, and what was actually being reported voluntarily for a holding tank effluent pump. Holding tanks are one possible source. What we can't do is we can't necessarily separate because the densities are correlated, the holding tank, what came out as a risk factor but it also could be linked, there could be a contribution from conventional drain fields. Since we couldn't separate those two variables out. We know that about 20%, 1/5 of the drain fields in the study area were constructed before 1970 and are assumed to be failing. So the effluent is there, the effluent is on the landscape for exposure. It's plausible in that respect, and it's also plausible, because pathogenic bacteria and viruses, we know that can be transported long distances. You certainly have good scientists in New Zealand that have shown the same thing for groundwater transport, and you know that they can survive for months in the environment. We think that the associations that we found are true, because of this biological plausibility.

Key Points Reprise

1. Septic system density is related to private well contamination in northeastern Wisconsin.
2. Manure storage and cropped field proximities are related to private well contamination of coliform bacteria and nitrate, respectively.
3. Septic system density (specifically holding tanks) is related to sporadic infectious diarrhea in children.

THE DARFIELD WASTEWATER MANAGEMENT STORY

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ABSTRACT

Darfield is a rural township (pop. 2,230) in the Selwyn District, located towards the top of the Canterbury Plains. Underlying the town is an extensive unconfined alluvial gravel aquifer that is the regions principal freshwater drinking water resource. Darfield holds the ignominious title of being the septic-tank capital of New Zealand; all households operate an on-site wastewater management system (OWMS).

Community and Public Health (CPH), and Selwyn District Council (SDC) have long harboured concerns regarding the sustainability of wastewater management practiced in the town and the hazard it presents to groundwater quality and human health.

This presentation will provide an overview of the receiving environment and the wastewater management issues the town faces. Future research opportunities will be discussed, such as hydrogeophysical investigation to potentially map the wastewater plume beneath the town that could guide defensive and/or investigative groundwater quality monitoring.

Keywords: on-site wastewater management systems, nitrate, pathogens, groundwater, risks

THE DARFIELD WASTEWATER MANAGEMENT STORY

Rob Potts [AC] and Lee Burbery [BC]

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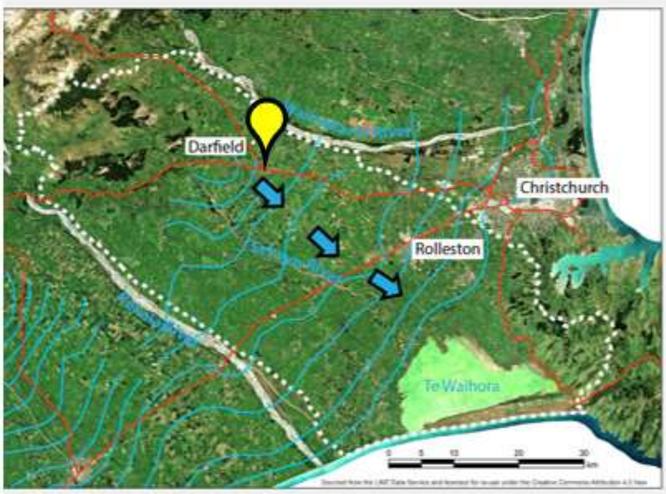
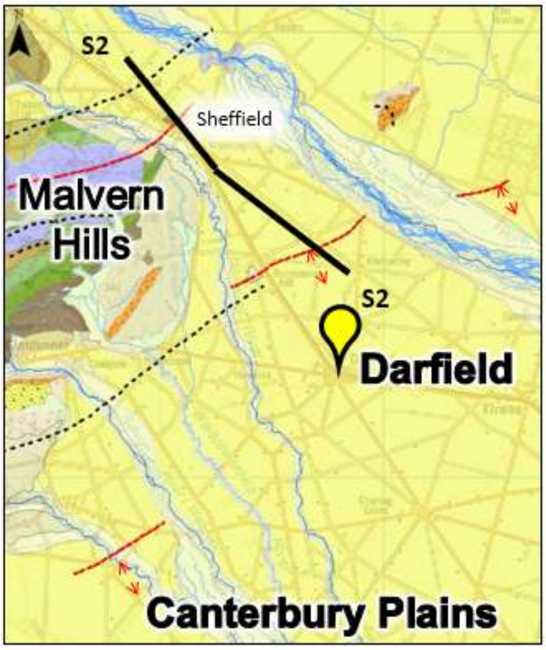
Introduction

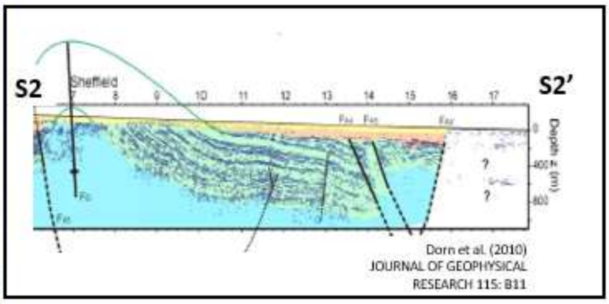
- Darfield - rural town in Selwyn District, located top of Canterbury Plains.
- 45 km west of Christchurch.
- Known as septic-tank capital of New Zealand
- In Te Waihora Catchment.
- MoH 2014 assessment found no evidence of N contamination above Regional values.



Hydrogeological setting

L W E Environmental Impact





- Effective upper hydraulic boundary of regional aquifer
- Steep vertical hydraulic gradients
- Rainfall the only effective diluent of groundwater pollutants

Qmap (source: GNS, 2008)

ESR

Darfield demographics (2018)

L W E Environmental Impact

https://www.stats.govt.nz/

- Population 2,700 people
- +38% since 2011 earthquake;
- Median age 44 yrs, with >20% population >65;
- 1,060 occupied private dwellings + commercial = 2.54 people/dwelling;
- Overall Density 5.7 people/ha;
- Predict 3,500 people by 2025;
- Survey of 100 homes: <10% serviced, 1/3 not emptied in 5 yrs, 1/3 some failure.

ESR

N loading/leaching Assumptions

People /Dwelling	**2.5**
Flow/Person/day	**250 L**
Flow/Dwelling/day	**625 L**
Annual Flow/Dwelling	**230 m^3**
Septic Tank Effluent TN	**60 mg/L - 13.7 Kg/dwelling/yr**
Secondary Treatment TN	**30 mg/L - 6.8 Kg/dwelling/yr**

Existing On-site WMS's

Treatment System	Number of System	Discharge System			N Reduction in soil system (modified from Beggs, et.al)
		Soak Hole	**LPED**	**SDI**	
Septic Tank	750 old	✓			0
	150 new		✓		7.5%
Secondary Treatment	120 new		✓		15%
	40 new			✓	30%

- **Soil Type** Lismore Stony Silt Loam – shallow (20 – 45 cm), free draining, moderate leaching vulnerability. Denitrification rate of 30% for loam soil for SDI following secondary treatment.
- LPED and soak holes assumed to be below active topsoil layer.

LOWE Environmental Impact

N Leaching from OWMS

Treatment System	Number of Dwellings using the Treatment System	Reduction in Loam via Denitrification, soil microbes, etc. (%)	kg N/Dw/yr	Total N Leached kg/yr
Septic Tank Soak hole	750	**0**	**13.7**	**10,275**
Septic Tank LPED	150	**7.5**	**12.7**	**1,900**
Secondary Treatment LPED	120	**15**	**5.8**	**694**
Secondary Treatment SDI	40	**30**	**4.8**	**190**

- Total N Leached in order of **13 t N/yr** from existing 1,060 dwellings.

ESR

LOWE Environmental Impact

N Leaching Limits - CLWRP

- Selwyn Waihora Zone – Table 11i
  - Te Waihora/Lake Ellesmere – sensitive to nutrients
  - 4,830 t N/yr for existing farming, plus 980 t/yr for CPW
  - 152 t/yr from milk processing/industrial
  - 62 t N/yr from community sewerage schemes, including biosolids and on-site system's septage
  - Silent on OWMS N leaching
- Note that there are 15,250 on-site systems in Selwyn (some outside zone) – equates to approx 150 – 200 t N/yr leaching load

ESR

Options for Wastewater in Darfield

- Has been assessed and investigated for 20 Years.
- Full reticulation or partial reticulation: all sites, central township only, township plus older areas.
- Community WWTP scheme at Darfield – 140 ha purchased in 2001, set aside for WWTP; OR
- Pipe to The Pines WWTP at Rolleston.
- Covid-19 Govt $10.6 M boost for shovel ready projects needs $ used by March 2022 – this resulted in Pump to Rolleston option recommended due to no additional consents.

Proposed Solution

- Business case including public consultation. Reticulated scheme only for central Darfield township and older/smaller sites and for new developments - full township area was not warranted.
- Connections to wastewater network rolled out over number of years in stages. Combination of pressure sewer and gravity:

➢ **Stage 1** properties in central Darfield and new growth areas during 2021/22 and 2022/23.

➢ **Stage 2** and **Stage 3** extending network to other existing properties from 2024/25 and 2025/26

Proposed Solution

Growth shown Yr 2070 - 2,760 additional dwellings plus business zone, i.e. nearly 4 x current. Excludes current 0.5 ha and larger lots.

Proposed location of Pumping Station

Pipeline and The Pines WWTP/LTA

- Low lift pump and screen at Darfield site.
- 25 km pipeline with 130 m fall. Partial gravity partial pump.
- Picks up Kirwee on the way.
- 62 L/s design PWWF plus 15 L/s from Kirwee.
- 300 mm uPVC plus buffer tanks.
- Odour treatment at WWTP.
- BNR Activated Sludge. Consented median of: BOD; 15; TSS, 20; TN, 7; FC, 500.
- Cut and Carry following centre pivot irrigation.

The Pines WWTP and LTA

- BNR Plant with sludge solar drying chambers.
- LTA 485 ha consented, 190 currently used – in same N catchment.

Costs and Funding

- Total cost for the scheme is $38 million.
- Government stimulus grant of $10.6 million.
- The stimulus grant results in cost per house reduced by about $5,000.
- Borrowings of $28 million; repaid through rates on existing properties and development contributions for future new properties.

Costs in LTP

Capital works local infrastructure network, plus connection to the treatment plant in Rolleston	$17,360/dwelling
Property owner's cost to connect – boundary kit, septic tank decommissioning, etc.	$5,000 But up to $20,000/dwelling depending on the type of connection and distance
Approximate total cost/dwelling	**Generally $22,360** **But up to $37,360**

- Targeted rate based on interest rate 3%, for 40 years;
- Plus annual district-wide rate for wastewater.

Costs for Existing Properties

	2025/26 $/yr
Targeted rate for capital works	$751/dwelling/yr for 40 years
Annual operations rate	$659/dwelling/yr
Total annual rate	**$1,410/dwelling/yr**
Less sewerage investigations rate	($89/dw/yr)
Net increase in rates	**$1,321/dwelling/yr**

Cost Incurred by New Properties

- Land developers connect by paying DC's.
- Local reticulation within the subdivision will be provided by the land developer.
- The amount payable will be $6,085 per HUE.
- There is some uncertainty around the funding of future capital works for wastewater due to Government proposed 3W reforms- future costs??

Cost Associated with Continued OWMS

- Cost of a new OWMS ranges between $10,000 and $30,000 plus cost of consenting.
- Cost of operating and maintaining an OWMS ranges between $200 and $800 per year, depending on type of system, what regular checks are required and whether a pump-out is needed. This does not include R&M.
- So new properties will be better off and out-of mind. Some may have an on-site PS depending on location.

Public Thoughts

- Without observed environmental effects, its hard to convince public.
- Feedback on the LTP is currently:
  - 80% opposed – mainly due to already sunk capital
  - 20% in favour
  - Central township has butchers, bakers (no candlestick makers), also a hospice and aged care facility – all in favour
  - A lot of misinformation on Facebook over costs and who has to connect
  - Without a community scheme, Darfield will remain a small rural town – this is what many prefer.
- CRC PA rules are on-site systems must connect if available.
- Resource consents require to connect within 6 months if reticulation < 30 m boundary and Council accept.
- Issues over sunk capital - standard issue for schemes starting in existing communities – any silver bullets welcome.

LOWE
Environmental
Impact

Advice AEE Agricultural Analysis Application Approachable Assessments Assimilation Assistance Biosolids Capability Client Communications Communities Compliance Compost Consents Consultation Contamination Coordinate Council Cultural Current Data Degradation Design Detention Developments Discharges Documentation Drafting E. coli Ecosystems Effects Engagement Environment Equipment Evidence Excellence Experienced Expert Facilitating Farming Feasibility Fieldwork First-flush Fit-for-purpose Flooding Fun Geology Graphs Greywater Groundwater Guidelines Handbag Hazardous Hydraulics Innovation Interpretation Investigation Irrigation Land Landfills Landscape Land-treatment Leaching Lodge Management Metals Microbiology Modelling Monitoring NES Nitrogen Nutrients Onsite Optimisation Organics Overseer Papers Pathogens Phosphorus Plain-english Plans Preparation Presentations Project Quality Relevant Remediation Reports Research Review Sampling Scientific Septage Sludge Soil Solutions Spreadsheets Standpipes Stormwater Strategy Support Surface Water Sustainability Systems Team Testing Timely Treatment Validation Wastewater Water Water-balance Waterways

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DEPARTMENT OF CONSERVATION WASTEWATER MANAGEMENT

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ABSTRACT

DOC is the largest provider of public toilets in New Zealand, with over 2000 wastewater systems. Two of the systems are reticulated town supplies, Aoraki/Mt Cook and Whakapapa. The rest are a mix of systems of varying sizes servicing campsites, huts, public toilets, track or road end facilities, staff residences, lodges and visitor centres. Treatment and disposal of wastewater is primarily 'on-site'.

Types of systems include pit toilets, dry vaults, wet vaults, septic tanks, composting toilets, vermiculture composting toilets, mechanical plants of varying types, oxidation ponds, trickling filters, wetlands and hybrid systems. Land treatment/disposal includes trench's, beds, LPED, evapotranspiration, mounds, drip irrigation, surface irrigation and increasingly hybrid subsurface treatment/disposal systems.

DOC is facing a number of critical issues with its wastewater infrastructure including increasing visitor numbers, rising environmental standards, servicing remote facilities, sustainability, aging infrastructure, poor consent compliance, poor asset knowledge and asset management, varying standard of design and lack of in-house expertise and training. DOC is implementing a number of actions to address these issues including, amongst other actions, formation of an asset management unit, asset site pickup and compilation of other relevant asset information, employing engineers and other relevant specialists within DOC and setting up a consultant panel.

Keywords: Wastewater, Land Treatment, DOC

Department of Conservation Wastewater Management

Systems and Operations

13 April 2021

Department of Conservation
Te Papa Atawhai

New Zealand Government

DOC Wastewater Systems

Overview

- Over 2000 wastewater systems nationally
- Primarily onsite systems
- Wide variety of type and size of wastewater systems
- Largest single provider of public toilets in New Zealand
- 5.5 Million visitors annually

DOC Wastewater Systems

Overview

- 329 campsites
- 994 backcountry huts
- 261 houses/lodges/units – Majority with onsite system or small networked system of some type
- Miscellaneous sites, public toilets, track end facilities, road end facilities, historical locations

DOC Wastewater Systems

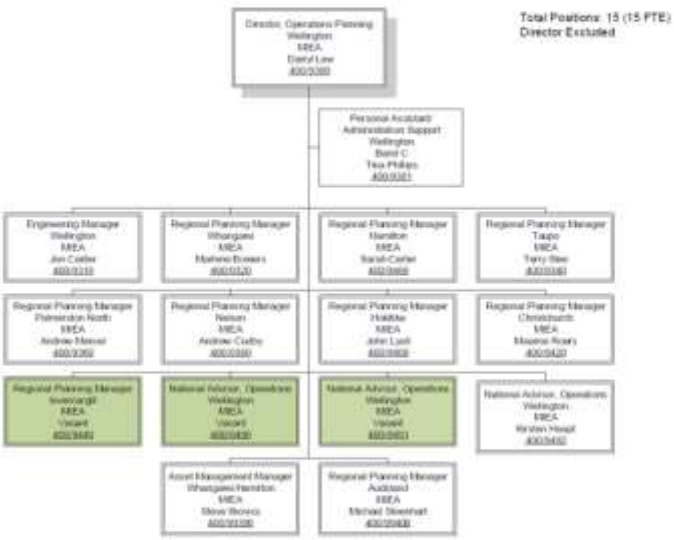
Overview

- Numbers
  - 993 Pit toilets
  - 541 Dry vaults
  - 228 Wet vaults
  - 237 Septic tank systems
  - 94 Composting toilets
  - 26 Reticulated wastewater systems of some description
- Number and type of system varies depending on the search parameters in asset management system

DOC Wastewater Systems

Overview

- DOC is a regional organisation



DOC Wastewater Systems

Overview

- Planning, design and construction managed by regional planning managers and works officers
- Engineering unit established 2000 aftermath of Cave Creek disaster
    - Seven structural engineers – structure design and structure inspections – extensive experience in cable structures
    - One water supply and wastewater engineer – employed 2018
- Asset management unit set up in 2019
    - One three waters asset specialist employed 2019
- Some operational staff have interest and considerable knowledge/experience in backcountry wastewater management
- DOC generally reliant on consultants or contractors (package systems) for design/assessment of wastewater systems

DOC Wastewater Systems

Design documents/guides

DOC Wastewater Systems

Overview

- Numerous designs – no real standardisation – some common design types
- Very mixed standard of design – some great – some poor
- Varying age and condition of assets – as new to very poor condition
- Poor organisational knowledge of condition of assets
- Varying compliance with design standards and planning documents
- Aging infrastructure – very large future replacement costs
- Three waters regulatory changes has enormous implications for DOC that have not really understood yet

DOC Wastewater Systems

Overview

- Currently ad-hoc wastewater management that relies on local institutional knowledge/expertise/experience
- Often lacking or poor O&M manual and as-built drawings
- AMIS centralised asset management system but information on three water assets in AMIS poor or non-existent
- No systematic inspection regime, management plan or infrastructure renewal programme in place for three waters infrastructure
- Generally no information on compliance with conditions of consents, managed locally with no management oversight
- Recent enforcement actions by regional councils. Regional councils generally tolerant of DOC but patience starting to wear out

DOC Wastewater Systems

Overview

- Two town supplies
  - Aoraki/Mt Cook
  - Whakapapa
- Equivalent to small town wastewater systems

Aoraki / Mt Cook

Reticulated supply

Gravity with one pump station

Operated by DOC infrastructure rangers, generally well run but dependent on individuals rangers with no backup

Aoraki / Mt Cook Treatment Plant

Aerated oxidation pond

Rock bunds

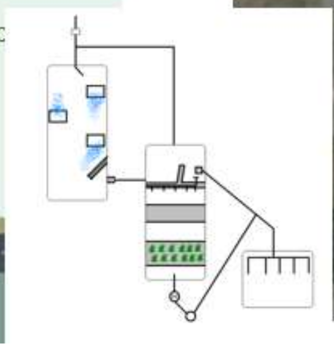
Subsurface flow planted bund

Soakage trenchs

Treatment plant op
well

Takes waste from

vaults in park



Whakapapa

Reticulated supply

Gravity with six pump stations

Gravity pipe from Iwikau (top of Bruce)

Treatment plant with onsite land disposal

Very seasonal flows as includes skifield

Whakapapa Treatment Plant

Treatment and Disposal Process

- Inlet bar screen
- Pasveer ditch with cage aerators
- Settling tanks/clarifiers
- Media filtration
- UV disinfection
- Drip/trench disposal
- History of poor operation, design mistakes and issues with consent compliance

Whakapapa WWTP

- July 2015 RDC took over operation of scheme
- Formal agreement for operation DOC/RDC signed end 2017
- RDC operations contractor Veolia became operator
- Veolia carried out number of upgrades to improve performance but still issues with consent compliance and operation
- Recent enforcement action and DOC have committed to carrying out programme of upgrades to improve operation and compliance
- Planning and consenting process underway for new disposal area out of the national park. Process to identify, assess and secure site is underway, consultation with iwi underway
- New operations contract being issued for tender

Great Walk Huts

- 33 Great Walk Huts
- 4 Great Walk huts capacity over 50
  - New Mintaro Hut (Milford Track)
  - Lake McKenzie Hut (Routeburn Track)
  - Iris Burn Hut (Kepler Track)
  - Luxmore Hut (Kepler Track)
- Generally have hut warden (Fiordland in season) or roving track warden (Heaphy Track)
- Southern Great Walk huts dual wastewater system, in season septic system, out of season (winter) vault/containment system

Great Walk Huts

Lake Mckenzie Hut

Routeburn Track




Great Walk Huts

Mackay Hut

Heaphy Track




Great Walk Huts

Howdon Hut

Routeburn Track

Badly damaged in 202 slips and hut now demolished

Wastewater upgrade was in progress

Great Walk Huts

Great walk season servicing is a large logistical exercise

Great Walk Huts

Wastewater servicing (pumpout) usually done as backload in conjunction with hut servicing

Serviced Huts

96 Huts

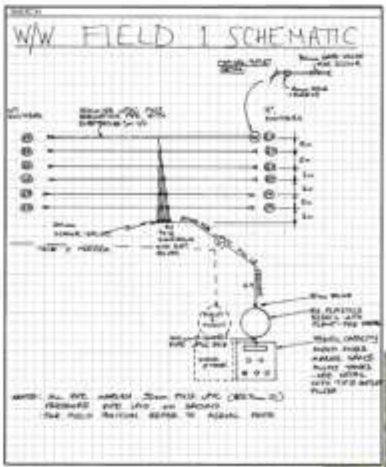
Generally have cooking/gas/firewood supplied

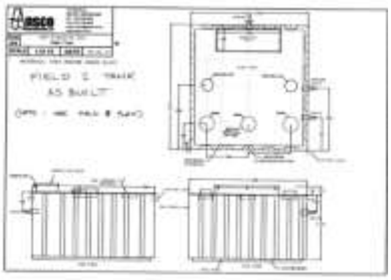
Largest Hut Pinnacles Hut in Coromandel

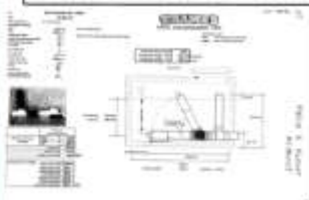
Capacity 80

Type of system varies

Serviced via Helicopter







Alpine Serviced Huts

15 Huts

Largest Hut Plateau Hut Aoraki/Mt Cook

Capacity 33

Usually pump out or flyout vault toilets

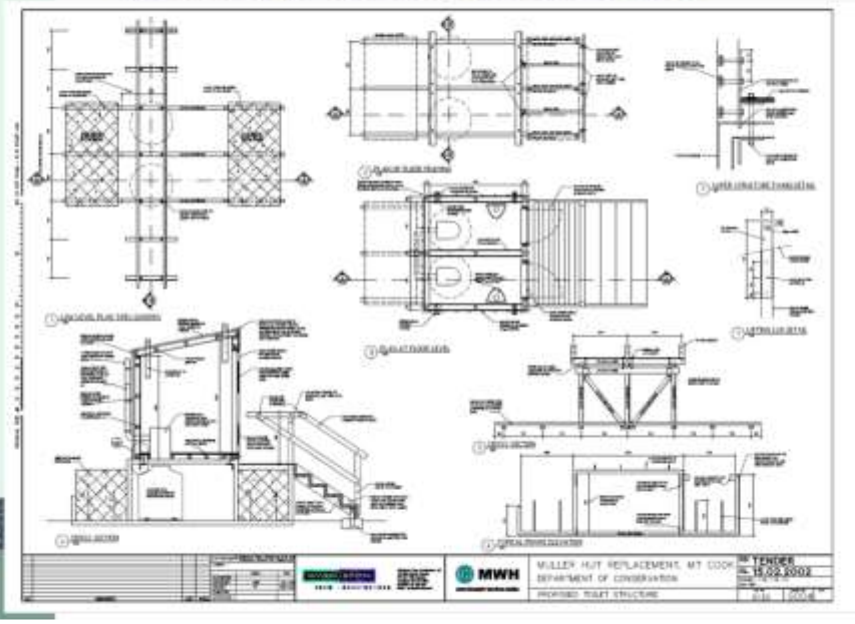
Baron Saddle

Alpine Serviced Huts

Tasman Saddle

Alpine Serviced Huts

Mueller Hut – Relocated to Plateau Hut



Alpine Serviced Huts

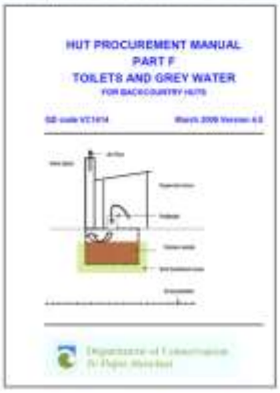
Plateau Hut – Relocated to Mueller Hut

Backcountry Huts

Building Code Acceptable Solution

BCH/AS1

- Building Code Acceptable Solution BCH/AS1 covers backcountry Huts
- Department of Conservation (DOC) backcountry huts have simplified Building Code requirements
- Calls up the DOC Hut Procurement Manual – DOC SOP



Backcountry Huts

Building Code Acceptable Solution

BCH/AS1

- The simplified requirements mean DOC's backcountry huts do not need:
  - smoke alarms
  - emergency lighting
  - access and sanitary facilities for wheelchair users
  - a potable water supply
  - artificial lighting
- Some huts too big to fit the definition of a backcountry hut and must comply with the full requirements of the Building Code (new Mintaro Hut)

Backcountry Huts

Hut Procurement Manual

- A ventilation improved pit (VIP) toilet comprises:
  - A excavation in the ground over which a small building is sited
  - A small building that is specifically design for enhanced passive ventilation

Table 1.1: Number of Toilets

Sleeping capacity [1]	No of VIP Toilets
Up to 20	1
21 to 36	2
37 to 48	3
Above 48	4

Notes

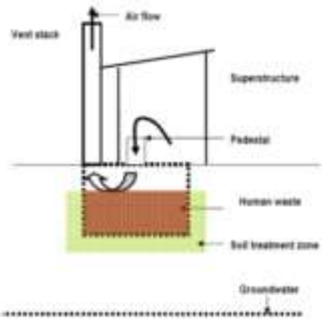
1. Calculated sleeping capacity includes staff hut sleeping capacity as the backcountry hut toilet is used by staff.

Table 1.2: Pit Sizing

Sleeping capacity	Pit size		
	Length	Width	depth [1&2]
2 – 8	1.35m	0.7m	0.8m
		0.9m	0.6m
10 – 12	1.35m	0.7m	1.1m
		0.9m	0.85m
20	1.8m	1.0m	1.3m

Notes

1. These depths include the allowance of 500mm cover soil
2. A minimum depth of 900mm is required to avoid 'piling' below and blockage of the toilet dropper.



Backcountry Huts

Pit toilets

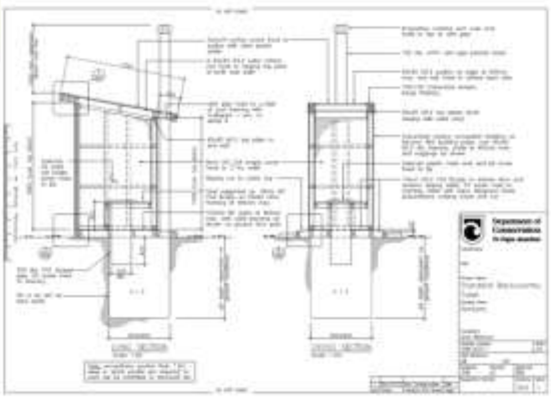
Vault toilets

Septic systems

Composting toilets

Vermiculture composting toilets

Standard Backcountry Pit Toilet



Backcountry Huts

Pit toilets

Vault toilets

Septic systems

Composting toilets

Vermiculture composting toilets

Norski Vault Toilets

Backcountry Huts

Pit toilets

Vault toilets

Septic systems

Composting toilets

Vermiculture composting toilets

Old Ghost Road Compost Toilet Bioloo


Backcountry Huts
Pit toilets
Vault toilets
Septic systems
Composting
Vermicultur
composting
Matiu Somes Island
Rotaloo


Backcountry Huts
Pit toilets
Vault toilets
Septic systems
Composting toilets
Vermiculture
composting toilets
Vermiculture
Composting Toilet
Lake Daniels
Toilet Operation:

Backcountry Huts

Pit toilets

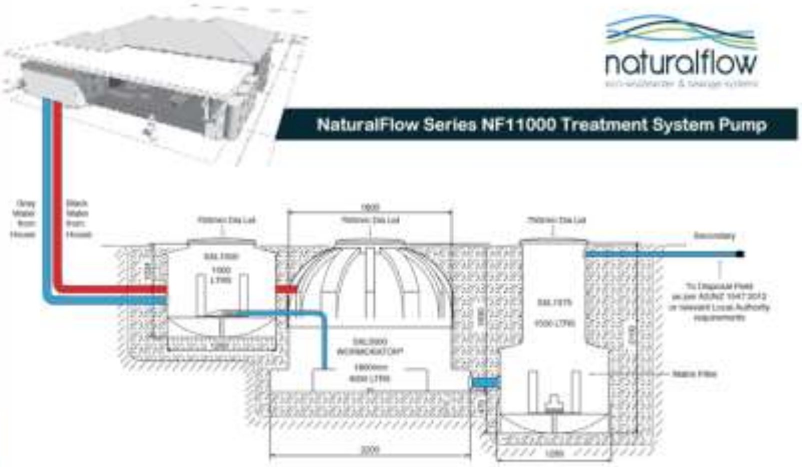
Vault toilets

Septic systems

Composting toilets

Vermiculture composting toilets

Vermiculture Composting/Septic System Little Barrier Island



Backcountry Huts

Pit toilets

Vault toilets

Septic systems

Composting toilets

Vermiculture composting toilets

Vermiculture Composting Toilets Recent Legal Advice

At present it is the Department of Conservations view that it is unlikely to be legal to import exotic composting worms (tiger worms) onto the following categories of PCL:

1. Scenic reserves, nature reserves, scientific reserves and historic reserves
2. Any parts of a national park except amenities areas
3. Sanctuary areas, wilderness areas and wildlife management areas held under the Conservation Act

Campsites

329 campsites

- 329 campsites
- 222 campsites road accessible
- Some large campsites
  - Totaranui – 550 Sites – Limited to approx. 850
  - Uretiti – 500 Sites
  - Waikawau Bay – 400 Sites – Limited to approx. 850
- 54 backcountry campsites associated with great walks
- Campsite populations vary widely with season – full over summer holidays and empty over winter
- Wastewater design difficult – high strength and highly variable flows

Campsites

329 campsites

- DOC SOP Campsite service standards details number of toilets, site areas, services (potable water) etc


CAMPSITE SERVICE STANDARDS

QD code: VC/1149

August 2006

Campsites

329 campsites

- Totaranui
  - Septic tanks and pump stations
  - Innoflow/Orenco textile filter
  - PCDI in area planted with flax, quite a few of the line blocked and haven't been able to be recovered
  - New consent obtained and upgrade programmed including new LPED field

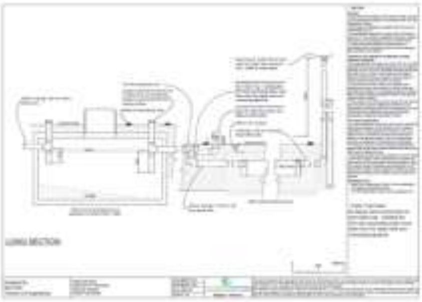
Campsites

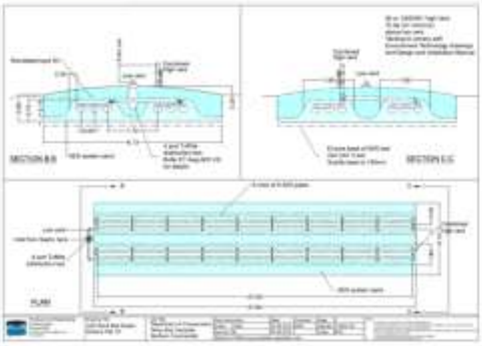
329 campsites

- Stony Bay
  - Septic tank and AES bed

S1 bed with light covering of sand – more required from S2 excess.

Eastern end set out





Campsites

329 campsites

- Te Paki
  - Bioloo Composting

Miscellaneous

Track end

Track side

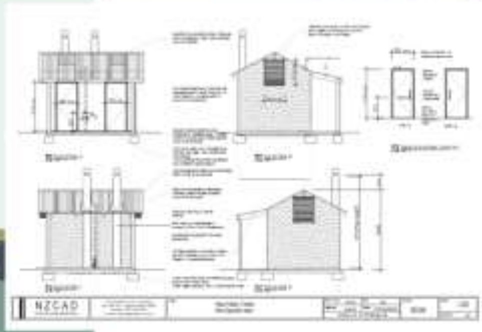
Visitor location

Recreation area

Residential

Ranger Station

Historic



Otago/Southland Vault Toilet

Marahau (Able Tasman Track End)

Miscellaneous

Track end

Track side

Visitor location

Recreation area

Residential

Ranger Station

Historic

Routeburn Track
Forge Flat / Sappers Pass

Miscellaneous

Track end

Track side

Visitor location

Recreation area

Residential

Ranger Station

Historic

Tongariro Crossing

Miscellaneous

Track end

Track side

Visitor location

Recreation area

Residential

Ranger Station

Historic

Milford Track Mckinnon Pass

Miscellaneous

Track end

Track side

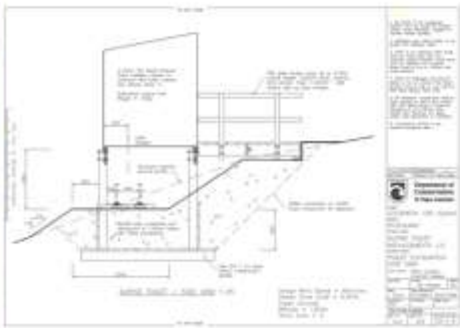
Visitor location

Recreation area

Residential

Ranger Station

Historic

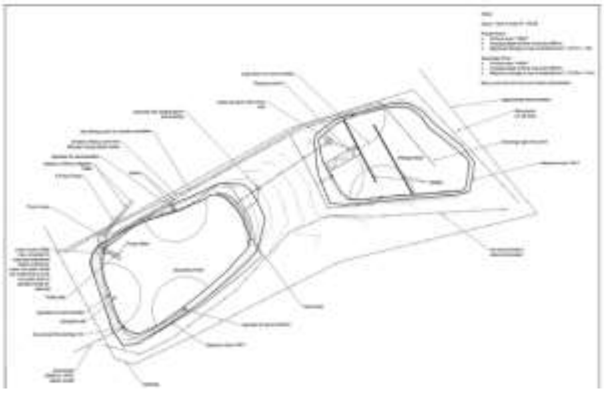


Miscellaneous

Track end
Track side
Visitor location
Recreation area
Residential
Ranger Station
Historic

Kawau Island

- Upper primary pond with baffles and floating wetland
- Dosing chamber discharges to lower pond through squirt pipes
- Lower pond acts as buffer pond
- Four sprinkler disposal areas plus sprinkler recirculation



Miscellaneous

Track end
Track side
Visitor location
Recreation area
Residential
Ranger Station
Historic

Kawau Island

Miscellaneous Sites

Track end

Track side

Visitor location

Recreation area

Residential

Ranger Station

Historic

Matiu / Somes Island

- Gravity drainage to pump stations and oxidation pond
- Treated effluent disposal into mystery trenchs
- Batch composting visitor toilet (rotaloo)

Miscellaneous Sites

Track end

Track side

Visitor location

Recreation area

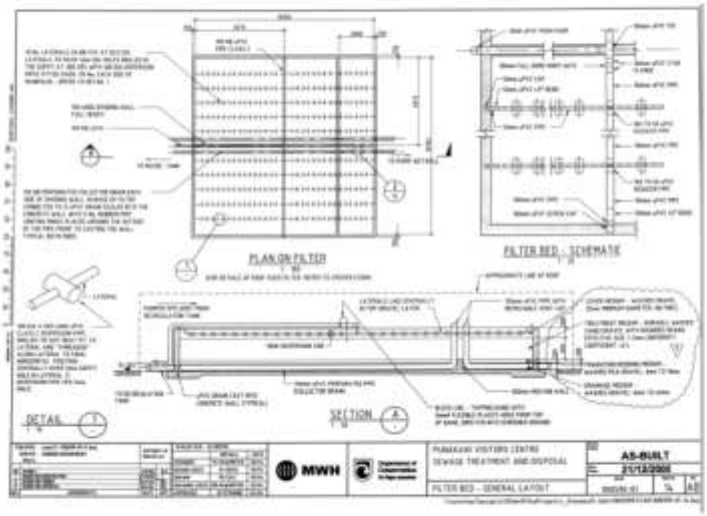
Residential

Ranger Station

Historic

Punakaiki Visitor Centre

- Recirculating sand filter
- Lightly loaded and produces high quality effluent



Lake Paringa

Miscellaneous Sites

Track end

Track side

Visitor location

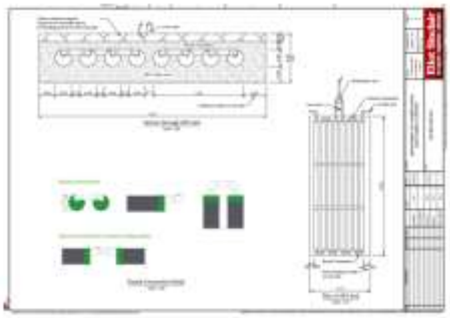
Recreation area

Residential

Ranger Station

Historic

- Septic tanks
- AES gravity pipe discharge system



ECOCULTURAL TECHNOLOGIES FOR RURAL AND MĀORI COMMUNITY ON-SITE TREATMENT

Rupert Craggs [AB], James Sukias [A], Jason Park [A], Andrew Dakers [A], Rebecca Stott [A], and Chris Tanner [A]

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ABSTRACT

NIWA's MBIE funded research programme will co-develop (with Māori, industry and local government) eco-cultural wastewater treatment technologies (ECWT) that will incorporate Mātauranga Māori and address current barriers to ecotechnology implementation. ECWT will provide effective and culturally acceptable "natural" options to upgrade failing rural wastewater infrastructure. For on-site treatment we will co-develop:

- Intensified multi-layered wetland filters (IMWF) for marae and papakāinga WWT, using novel active filter layers and intermittent dosing to enhance treatment performance in terms of nutrient and faecal indicator bacteria removal.
- Sludge treatment wetlands (STW) that will convert wastewater sludge into a soil amendment, reducing Māori concerns and costs of sludge transport and disposal.
- Septic Tank Digesters to recover energy from onsite treatment and reduced GHG and carbon emissions

Affordability and sustainability of ECWT will be enhanced by co-development of culturally appropriate and resource recovery (biogas energy, bioproducts, and treated water).

A central part of the first year of the project is to work with our Maori partners and the onsite wastewater treatment industry to understand current barriers to ecotechnology implementation.

Keywords: Maori co-development; wetland filters, biogas recovery, onsite sludge treatment

Ecocultural technologies for rural and Māori community on-site wastewater treatment

Rupert Craggs, James Sukias, Jason Park, Andrew Dakers and Chris Tanner

THE UNIVERSITY OF WAIKATO | NIWA | Te Waiora Joint Institute for Freshwater Management

Programme Aims

To co-develop (with Māori, industry and regional government) novel, affordable, highly effective eco-technologies incorporating mātauranga Māori (eco-cultural technologies) to:

- Provide culturally acceptable "natural" options to upgrade failing rural wastewater infrastructure
- Enhance treatment to reduce nutrient and microbial pollution (advanced secondary)
- Provide effective treatment of widely varying loading.
  - Improved resilience to periodic large events
- Reduced cost of treatment
  - Half the "whole of life cost" of current technology options
- Recover resources (energy, nutrients, water) in culturally acceptable ways
- Understand and address barriers to implementation
- Understand and facilitate consensus on consenting issues
- Provide design guidelines and training

WAIKATO | NIWA | Te Waiora Joint Institute for Freshwater Management

Iwi co-development and implementation partners

- Akerama Trust Marae (Whangarei)
- Te kopua Trust (Raglan)
- Pōhara Marae Trust (Maugatautari)
- Kearoa Marae Trust (Rotorua)
- Parihaka Papakāinga Trust (Taranaki)
- Mahaanui Kurataiao (Banks Peninsula)

Co-development Team

- Māori Advisory Panel (Poto Davies, Craig Pauling)
  - Ensuring alignment of outputs with Māori partner needs
  - Oversee eco-cultural technology co-development incorporating Mātauranga Māori
  - Assist with understanding and documentation of Mātauranga Māori
  - Provide peer review and dissemination and socialization of results.
- University of Waikato (Graeme Glasgow, Mark Lay)
- EcoEng (Andrew Dakers)
- Implementation Panel

Endusers / Implementors / Partners

- Wastewater industry endusers / implementation
  - Regional Councils (Waikato, Bay of Plenty, Northland, Canterbury)
  - MfE
  - DIA, TPK, Housing NZ
  - WaterNZ (Noel Roberts)
- Setting research direction and risk mitigation
- Ensuring alignment of outputs with end-user needs
- Peer review
- Dissemination and socializing of results

Te Waiora Joint Institute for Freshwater Management

NIWA Project Team

Erica Williams
Pou Whakarae - Te Hiringa Taiao

Niketi Toataua
Pou Ārahi

Stephen FitzHerbert
Social Scientist

Chris Tanner
Treatment Systems / Māori Co-development

Rupert Craggs
Treatment System Co-development

Darcel Rickard
Manager Te Kūwaha

Tuana Kuka
Māori Wastewater Engineer

Juliet Milne
Resource Management

Rebecca Stott
Faecal Indicator Bacteria Monitoring / Human Health

James Sukias
Treatment System Co-development

Programme Critical Steps

- Hui with each Māori partner
  - Understanding the specific needs and concerns with current on-site wastewater treatment system
    - Identify current wastewater issue that needs to be resolved in next 2-3 years
    - Understand long term marae development use plans,
    - Align with kaitiakitanga practises,
  - Discuss and document Mātauranga Māori that may be relevant to eco-cultural WWT co-development and implementation
    - Interviews with kaumātua
    - Traditional waste management practises
    - Acceptable media/wetland/aquatic plants/design etc
    - To guide more holistic management of wastewater treatment and disposal
    - IP agreements to safeguard how mātauranga is documented and used

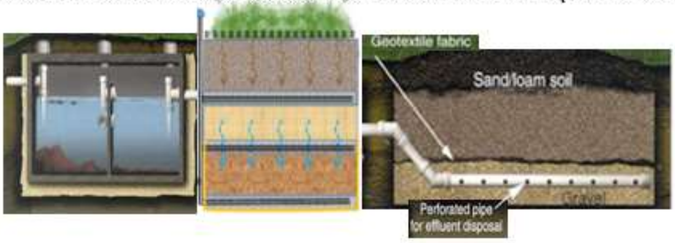
Programme Critical Steps

- Meetings with Industry and Regulators
  - Identify and understand current barriers to ecotechnology implementation
    - Decreased financial reward for engineering consultancies;
    - Lack of knowledge and experience of ecotechnologies, leading to
    - A perception that they have greater risk and inflated costs;
    - An unfavourable regulatory environment;
    - A lack of holistic systems thinking and whole-of-life assessment

- Understanding planning, policy, resource consent and compliance issues for onsite treatment
  - Meeting future Regional Council consent conditions
  - Consistency between Regional Councils
  - MfE, MoH, DIA, TPK, DHBs

Programme Critical Steps

- Co-develop a range of Eco-cultural Technologies for onsite wastewater treatment and culturally appropriate resource recovery by linking mātauranga with scientific advances :
  - **Digester Tanks** to more effectively treat wastewater solids and capture biogas GHG emissions for energy use
  - **Intensified Multi-Layered Wetland Filters** (IMWF) to provide effective removal of nutrients and faecal microbes and beneficial use of wetland plants and treated effluent



  - **Sludge Treatment Wetlands** (STW) to convert wastewater sludge to soil negating Māori concerns and costs of sludge transport and disposal.

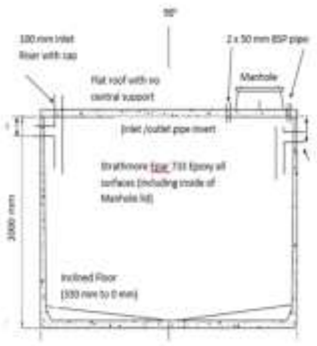
Programme Critical Steps

- Co-develop preliminary design concepts
- Laboratory testing
- Pilot-scale testing
- Demonstrate at full-scale with Māori, industry and governance partners
  - Design and costing
  - Funding application
  - Resource consenting and Installation
  - Monitor for 1 year to demonstrate performance
- Performance reporting
- Accreditation
  - OSET Testing

Programme Critical Steps

- Implementation
  - Develop performance and economic models
  - Publish selection tool for end-users (performance and cultural acceptability)
  - Publish design and construction guidelines for industry
  - Publish operation and maintenance manuals
- Capacity Building
  - Engineering course units on Eco-cultural Technologies
  - Professional development course units on Eco-cultural Technologies
  - Teach design and operation to each iwi partner
  - Local school projects
  - Master's and PhD projects (for Māori students)

Digester tanks



- To enhance sludge digestion and substantially reduce volume
- To capture GHG emissions from primary treatment
- To flare or beneficially use biogas energy
- To periodically (perhaps monthly, after the first year of operation) remove small amounts of digested sludge

Te Kopua Whanau Campground

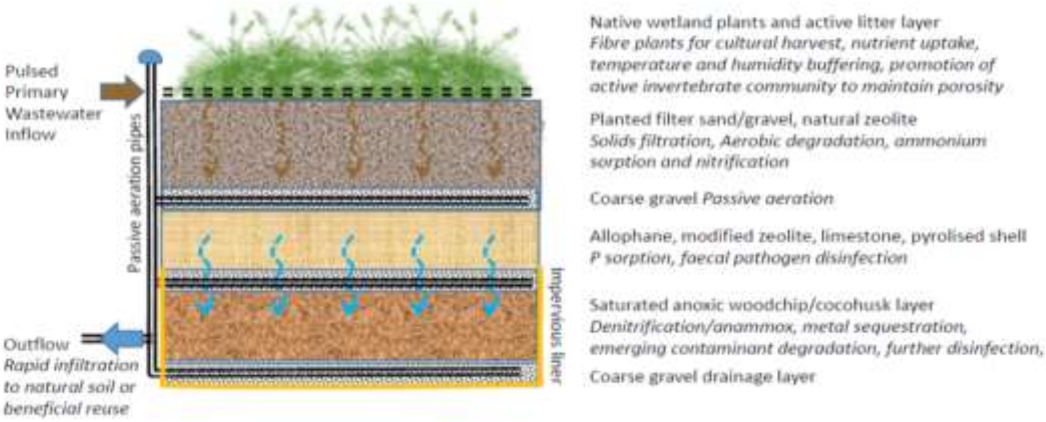
- Digester tank

Intensified Multi-Layered Wetland Filters (IMWF)

- Designed for enhanced treatment performance in terms of nutrient and faecal indicator bacteria removal and resilience to fluctuations in flow by:
  - Operates with vertical downward-flow
  - Incorporates novel active filter media layers with different treatment roles
    - Native wetland plants
    - Soils
    - Biomedia
  - Using pulsed wastewater dosing to cycle aerobic/anoxic conditions.
- Aligns with the mātauranga Māori understanding that passage through Papatūānuku (mother earth) will revitalise the mauri of water.
- Requires less land application area than horizontal and vertical-flow wetlands

- Potential resource recovery co-benefits.

Intensified Multi-Layered Wetland Filters (IMWF)



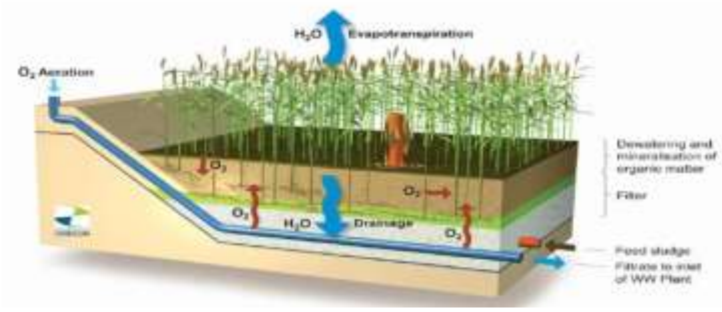
Te Kopua Whanau Campground

- Intensified wetland filter with woodchip addition

Te Kopua Whanau Campground

Sludge treatment wetlands (STW)

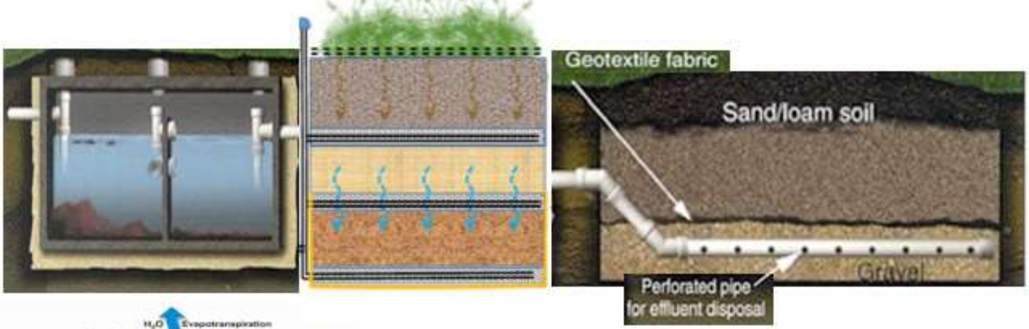
- To remediate wastewater sludge onsite to avoid costs of septage transport and further treatment.
- Established designs from our European industry partner (Orbicon Ltd)
- Combined with mātauranga Māori of native plants and soils
  - Alternative to Phragmites (invasive reed in NZ)
- Scaled down for onsite treatment

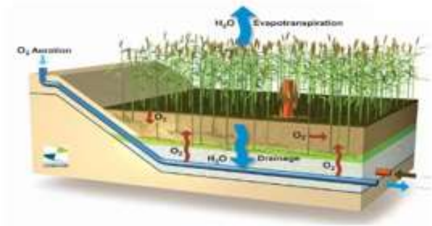


Summary: Please help us to answer these questions

- Can Matauranga Māori be incorporated into OSWM design to address cultural concerns with wastewater management?
- Can Septic Tank design be improved to more fully digest wastewater sludge and capture GHG emissions?
- Can Wetland design be improved to reliably provide nutrient removal and handle fluctuating loading?
- Can a novel Sludge Treatment Wetlands be designed to turn onsite sludge into soil?
- Can performance, regulatory and policy barriers be addressed to enable widespread implementation?

Thank you!





Contact
rupert.craggs@niwa.co.nz
0276811926

A MICROBIAL RISK ASSESSMENT TOOL TO MANAGE THE DISCHARGE OF FAECAL PATHOGENS TO LAND NEAR DRINKING WATER WELLS

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ABSTRACT

In 2010 ESR released *Guidelines for separation distances based on virus transport between on-site domestic wastewater systems and wells*. These guidelines calculate the separation distance between a single drinking water well and a single domestic on-site wastewater management systems (OWMS) based on virus fate and transport in the subsurface environment. The 2010 guidelines have some limitations, such as only considering a single OWMS and only providing the 95% confidence limits.

The proposed Microbial Risk Assessment tool will address a range of land use activities that might occur within a source protection zone of a drinking water well, including multiple OWMS and drinking water wells that are pumped. Users will be able to vary the level of uncertainty from the expected value (50%) to a 90% confidence level or an even more conservative level such as 99% confidence, so that the entire spectrum from risk averse to risk tolerant solutions can be considered. An Envirolink Tools proposal has passed the stage 1 approval process and the full proposal is currently under consideration. This tool will assist staff in councils, consultancies and landowners in preparing and assessing resource consents for land activities near drinking wells.

Keywords: Risk assessment, faecal pathogens, drinking water wells, land use

Outline

E/S/R
Science for Communities

- Background
- Need for a Microbial Risk Assessment tool
- Overview of the MRA tool
- Land-uses that are included
- Modelling approaches
- Next steps

Background

- Need for assessment of activities within drinking water protection zones – now known as Source Water Risk Management Areas
  - Signalled in the Essential Freshwater reforms and the NES for drinking water – proposed amendments

- In 2018 Environment Canterbury approached ESR and GNS to develop a Microbial Risk Assessment tool

- Also gained support from the Groundwater Forum in May 2018 – this was fleshed out using a survey of all councils in June 2018

- Didn't get funded in 2018/19 but ended up having a LAG to collate & derive microbial loading rates; a LAG to specify the model scenarios & get feedback from councils; and the EnviroLink Tools project was funded in 2019/20 – started Nov 2020

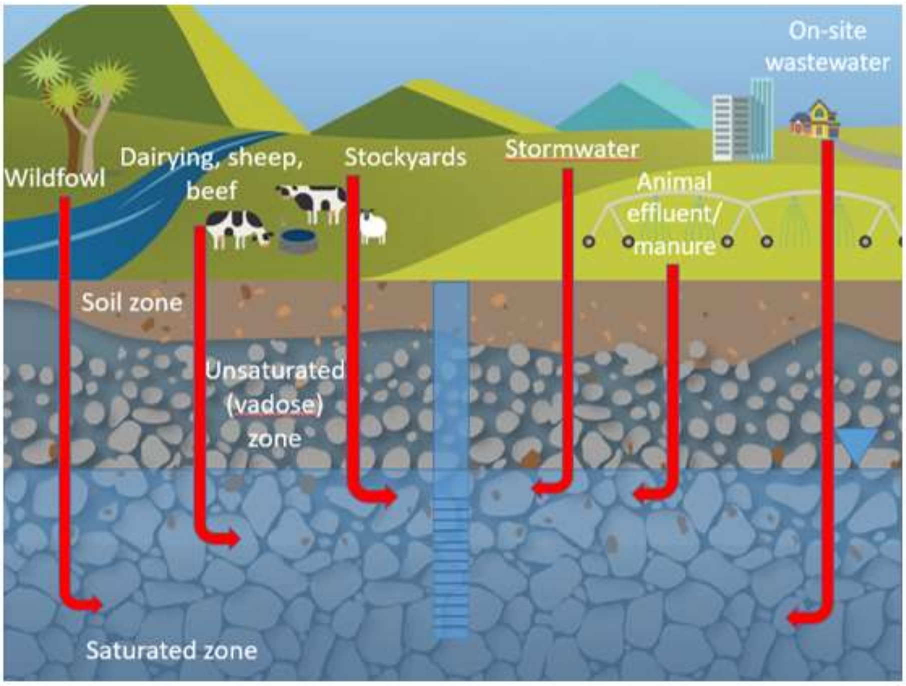
Need for a MRA tool

- New regulations require risk management areas around drinking water sources

- Three Source Water Risk Management Areas
  - SWRMA1 – area around the well or surface water intake
  - SWRMA2 – area focussed on reduction of microbial risk (1 yr TOT for groundwater)
  - SWRMA3 – entire contributing catchment

- Areas within SWRMA2 need to be assessed for microbial risk to drinking water

- This risk assessment is the purpose of the MRA tool



Land-uses that are included

E/S/R
Science for Communities

- Multiple Onsite Wastewater Management Systems (OWMS)
- Community size OWMS
- Dairy farming
- Sheep and beef farming
- Wildfowl
- Stormwater systems
- Stockyards
- Animal effluent/manure application.

Microbes used for each land use

- Human sources – OWMS;
  - Norovirus; *E. coli*
- Animal sources – Dairy, Sheep & Beef, wildfowl, stockyards, animal effluent
  - *Campylobacter, E. coli*
- Mixed sources – Stormwater
  - Norovirus, *Campylobacter, E. coli*

Modelling approaches: Zones

- Estimated microbial loadings for sources
  - Removals for sources such as OWMS
- Microbial transport & removal in the soil (13 types)
- Microbial transport & removal in the unsaturated zone (10 types)
- Microbial transport & removal in the groundwater systems (6 types)
  - Only unconfined groundwater systems
- Estimate the microbial removal for each zone to get the total risk

Modelling approaches: Soil zone

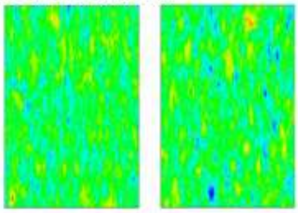
- Vast majority of microbial transport occurs under near-saturated conditions
- Approach is to simulate transport under saturated conditions
- Then simulate the frequency of those conditions for each land use, soil type and climate region to estimate the risk
  - Irrigated and non-irrigated depending on the land use
- Using a daily water balance model usually with 40 years data
- Using 10 climate regions modified from the 1983 NZ Met Service report
  - Not using mountainous areas & combining other regions
- The 13 soil types can be simulated with 5 microbial removal rates

Modelling approaches: Unsaturated zone

- Using a simple 1-D mixing cell, analytical model described by Bidwell (2000)
- There are more complex models available but usually there are insufficient data to parameterise them adequately for all situations
- The analytical model is run with @RISK to generate multiple realisations based on the likely range & distribution of parameter values and provide an estimate of uncertainty

Modelling approaches: Groundwater

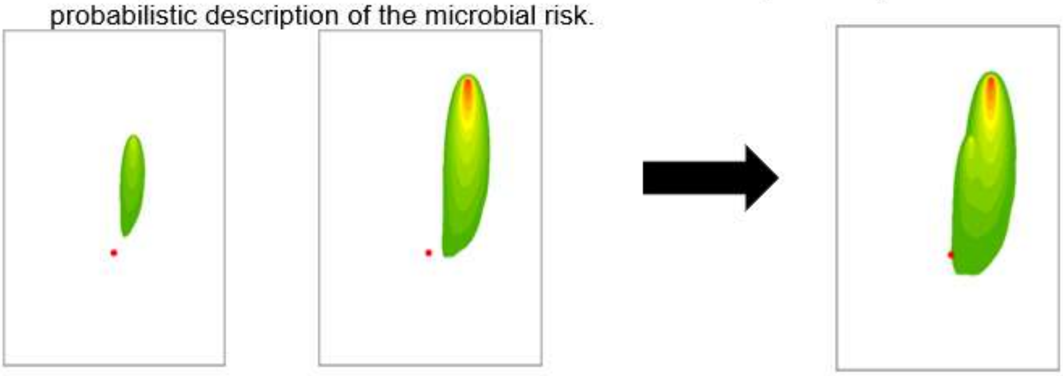
- Contaminant transport & microbial removal will be addressed in a stochastic framework.
- Multiple realisations will be generated for each aquifer type
- Steady state flow fields will be generated for each realisation using MODFLOW for each pumping rate



- Microbial log-removal will calculated using the inverse transport solution using MT3DMS with the removal simulated as a first order irreversible reaction

Modelling approaches: Groundwater

- Our approach allows multiple sources and areal sources to be simulated using the superposition principle
- The outputs from all the MT3DMS simulations will be compiled and provide a probabilistic description of the microbial risk.



Uncertainty analysis

- The 2010 setback distance guidelines provided a conservative confidence level (95%) that was hard-wired into the guidelines
- Where there was significant uncertainty this resulted in very large setback distances
- The MRA tool will enable the user to set the confidence levels from risk tolerant to risk adverse
- This will enable users to explore how the different confidence levels impact the estimated microbial risk

Next steps

- Collated the loading rates for all the land uses
- Set out the assumptions for the model scenarios that we are planning and have sought and received feedback from a range of council staff and consultants
- Started the simulations
- Preparation of a prototype MRA tool for 2 of the land uses, together with draft documentation, for discussion with a selection of users to ensure that we are on the right track

LESSONS FROM TWO COMMUNITY ENGAGEMENT PROJECTS TO IMPROVE LAND TREATMENT OUTCOMES FOR ON-SITE WASTEWATER SYSTEMS

Craig Brown [AD], Kristin Busher [B], and Dr Dan Ducker [C]

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[A] Waiheke Resources Trust, Waiheke Sustainability Centre, Mako Street, Oneroa, Auckland 1081

[C] EcoMatters Environment Trust, 1 Olympic Place, New Lynn, Auckland 0600

[D] Corresponding author. Email: craig@cbcwastewater.co.nz

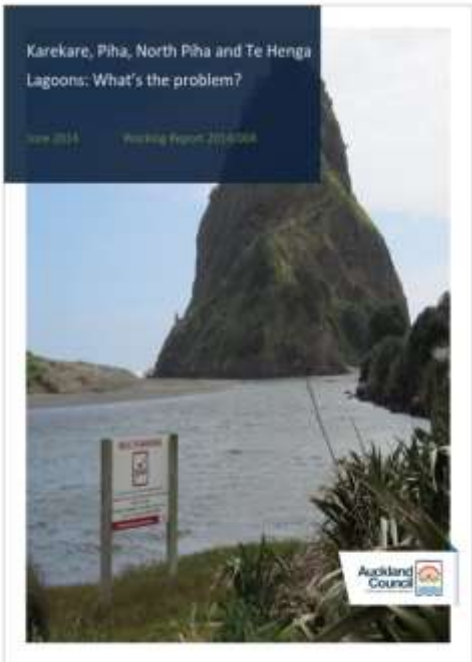
ABSTRACT

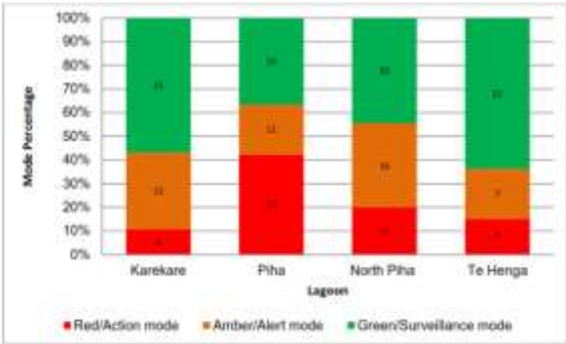
Two community engagement initiatives, one on Auckland's West Coast, and one on Waiheke Island, found that servicing and maintenance of on-site wastewater treatment systems was inadequate, whether privately organised, or managed by council. The majority of systems were not compliant, either technically (due to missed services, or inadequate records), or physically (where systems were causing, or likely to cause pollution). However, most systems could be repaired, and other improvements could be implemented, especially relating to water conservation, topsoil augmentation, planting, and stormwater diversion. There was substantial community interest in developing a greater understanding of wastewater treatment and discharge and in implementing the recommendations. It was observed that before the initiatives, system owners thought the treatment tanks were the entire wastewater system, meaning they had poor understanding of the importance of the discharge pipework, soils, vegetation, and separation distances. However, the engagement process drew attention to these aspects, which were quickly understood. Physical, economic and psychosocial barriers to improvements are discussed in this paper, and recommendations are made for best/better practice. A checklist for assessing existing systems is included in an appendix.

Keywords: Servicing; maintenance; compliance; on-site wastewater; community engagement; evaluation checklist


Piha


Figure 1. Sampling sites at South Piha, North Piha, Te Henga Bethells, and Karekare (clockwise from tip left)





6.0 Recommendations

To better manage the water quality of the West Coast lagoons at Karekare, Piha, North Piha and Te Henga a range of recommendations follow.

Recommendations

- Improve septic system management in all lagoon catchments
- Improve control of dogs and wildfowl adjacent all of the lagoons
- Exclude stock from waterways in Te Henga lagoon catchment
- Place permanent warning signage explaining the health risks of swimming in the lagoons
- Investigate whether opening the lagoon mouths would lower pollution levels in the lagoons
- Further investigation to identify the biological sources of faecal pollution of the lagoons


HEART

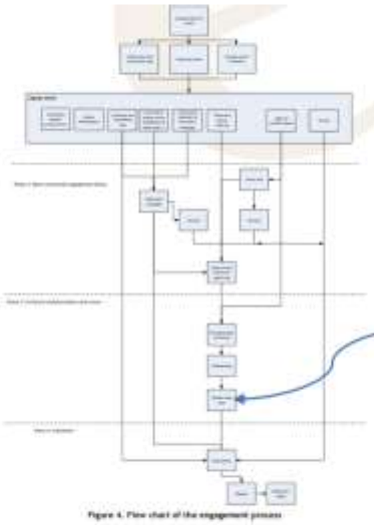

LOVE LAGOONS
LOVE YOUR LAGOONS


MADAL HUI - APRIL 29TH
STREAM CLEANUP
WITH DAN DUCKER OF ECOMATTERS
When: Saturday 29th of April (Wet day: Sunday 30th)
Time: 10am - 2pm
Where: EcoMatters 1 Olympic Pl, New Lynn, Auckland
What: Exciting opportunity to help clean up a local stream and do some water testing to study the stream's health! There will also be time for everyone to share their progress on projects and any future intentions.
FREE Pizza provided afterwards!
PLEASE REGISTER YOUR INTEREST HERE:
HTTPS://MADAL1.TYPEFORM.COM/TO/GRCIVM

Click to download

Appendix 4: Technical Check Sheet Included – but early draft.

*For final version contact **CBC Wastewater Limited** or **EcoMatters Environment Trust***



RED: Currently likely to be contributing to downstream pollution (i.e. not containing and treating pollutants on site). Urgent action is required: Reduce water consumption, avoid harsh chemical use and budget for an upgrade to the treatment and/or discharge systems.

AMBER: Currently not likely to be a major contributor to downstream pollution under current operational practice, but careful management is required and upgrades/improvements would be desirable to treatment and/or discharge systems. Under certain weather conditions or with an increased level of use, or lack of maintenance (not just pump out every three years), the wastewater system would likely contribute to downstream pollution..

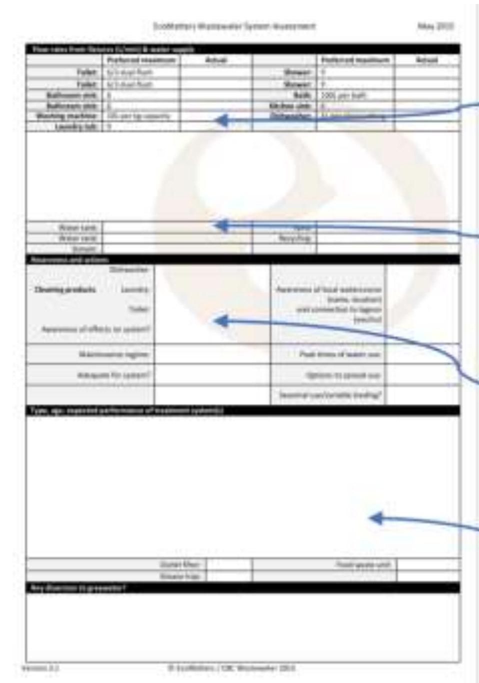
GREEN: Currently not likely to be contributing to downstream pollution, provided that there is ongoing careful management and maintenance (not just pump out every three years) of the wastewater system.

Owner's concerns noted

- Helps identify issues
- A sense of being listened to
- Owner can request specific information
- A way of judging level of knowledge

Stress test

- Run about a day's water through the system over the course of an hour
- Start at beginning then work through other questions
- *Only way to identify some issues?*



Flow rates measured & white goods inspected

- Finds inefficient fixtures and fittings
- Gives feedback on what is considered efficient
- Immediate feedback given where fixtures are not efficient

Water sources

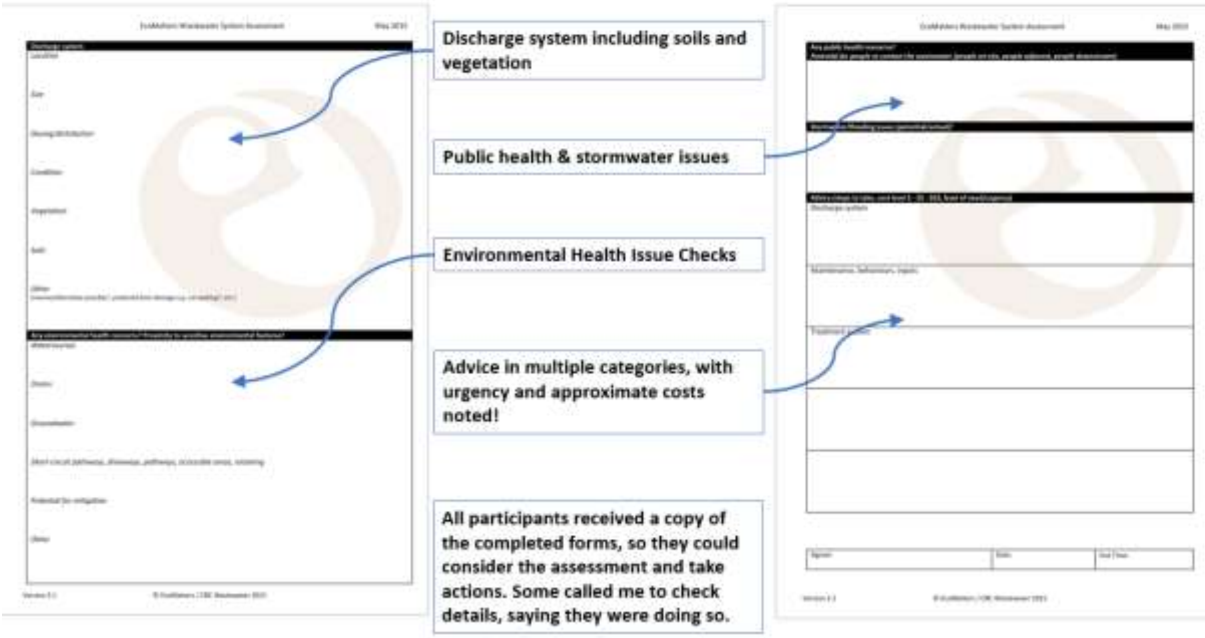
- Much less water storage in Piha than Waiheke
- Higher rainfall than Waiheke
- Participant discomfort and lack of concentration during stress test!

Chemical use, awareness, behaviours

- About 90% thought maintenance regime = council contractor pumps out every three years (only)
- Asking and discussing these questions was educational. So was looking in the laundry and kitchen for cleaning products used

The treatment system (in its place)

- A lot of participants wanted to show me their tank immediately
- They were surprised that many of these other factors were equally or more important…
- …But found that revelation empowering!



Technical check results

As of 31 July, 29 waste water systems have been checked in the three communities, including 3 long drops, 18 older style septic systems, 7 modern high tech systems, and one vermiculture system. Results are shown in Table 4. Of the 29 systems tested, 4 were assessed to be RED, 8 AMBER, and 17 GREEN. In other words 40% of systems checked had significant issues. Problems were found in systems in all 3 locations and in all major waste treatment types.

Due to the relatively small sample sizes, it is not possible to confirm assertions statistically, however, the results of the pilot provide some indication of the following:

1) Modern systems are just as likely to have problems as older systems;
2) Regular maintenance is very low (14%);
3) Systems with regular maintenance are ½ as likely to have significant problems (red or amber) detected.

	Piha	Karekare	Te Henga Bethells	Total	%
Waste water systems checked	17	6	6	29	
Long drop	2	0	1	3	10%
Old septic tank	10	4	4	18	62%
Modern hi tech septic tank	4	2	1	7	24%
Other	1	0	0	1	3%
Red	1	2	1	4	14%
Amber	5	1	2	8	28%
Green	11	3	3	17	59%
Long drop (with significant problems)	1	0	1	2	67%
Old septic tank (with significant problems)	2	2	2	6	33%
Modern septic tank (with significant problems)	3	1	0	4	57%
Other (with significant problems)	0	0	0	0	0%
Regular maintenance regime	3	1	0	4	14%
No regular maintenance regime (with significant problems discovered)	5	3	3	11	44%
Regular maintenance regime (with significant problems discovered)	1	0	0	1	25%

Reasons for Amber and Red Ratings:

- Dripline damaged by garden fork;
- Damaged dripfield;
- Pipe into tank near gully traps needs repair. Install indicator of pump failure;
- Water pressure very high and fittings not low flow, capacity for system overloading;
- Discharge blocked;
- Low level of treatment, could bypass soil treatment and go straight to groundwater;
- Solids not being retained in septic tank. Very old steel tank. No maintenance access;
- Pit - with possible contribution to groundwater contamination;
- Likelihood of groundwater intrusion;
- Evidence of water in long drop - may be seeping into groundwater;
- Soakholes clogged. Overflowed from top of soakaway and from septic tank;
- Drip lines have moved and cross over many times. One flush tap left open. One non-functioning tee. Air relief placed incorrectly. Field lines clogged;

Highlighted items found by 'stress testing'

Reasons for Amber and Red Ratings:

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- Pipe into tank near gully traps needs repair. Install indicator of pump failure;
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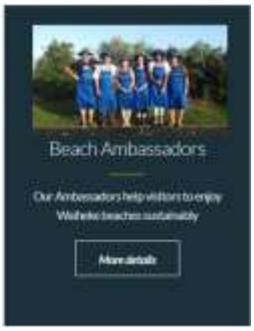
WRT

Waiheke Resources Trust



Testing the waters: Citizen science project

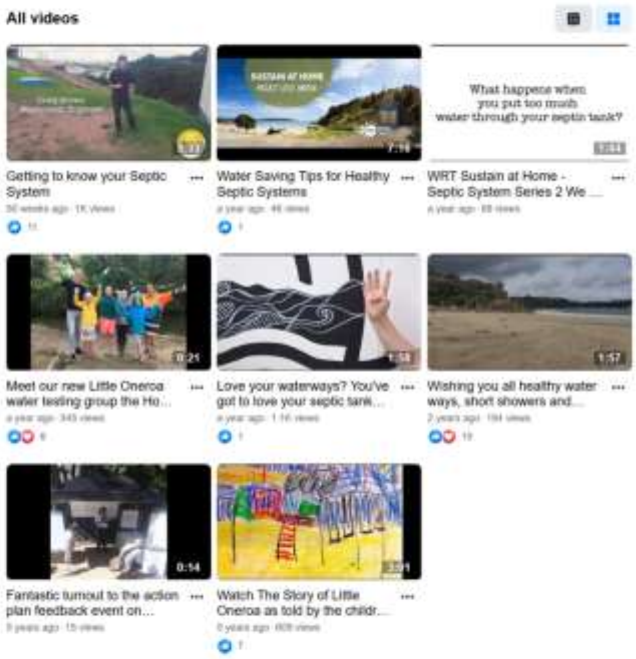
- Workshops → more engagement
- Septic safe products → happier microbes
- Citizen science → more data & more ownership of the problem

+ Videos
+ 'Ask a wastewater engineer' stand at events
+ …

Stickers and other printed materials

GOOD PLANETS ARE HARD TO FIND

HELP US KEEP OUR SEPTIC TANK AND WATERWAYS HEALTHY BY ONLY FLUSHING WHEN NECESSARY



Informational videos (including several made during lockdown)
https://www.facebook.com/watch/projectlittleoneroa/

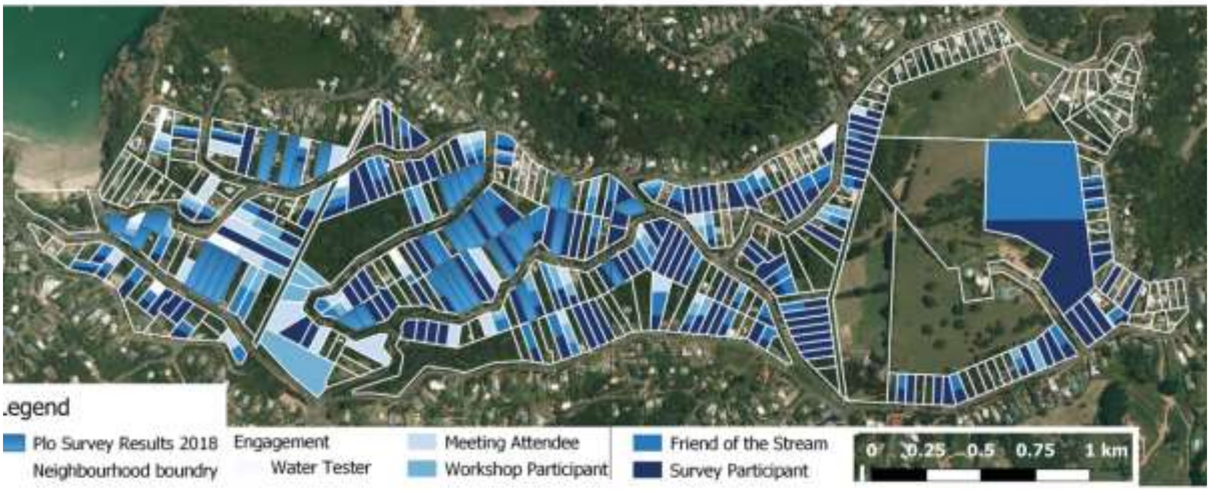
Septic tank workshops

This wordy stuff is mostly to read later as you'll get copies of the slides

- 1.5 to 2 hrs
- One every few months on average
- Different places, different days, different times
- 20-30 attendees generally
- Two facilitators from Waiheke Resources Trust (WRT) and one wastewater engineer
- Describes different levels of treatment that exist and why (different site requirements and when consented – i.e. rules have changed)
- Help identifying what system the participants have and understanding it better
- What their obligations are in terms of servicing, maintenance, performance (and why a stitch in time saves nine)
- What maintenance they could perform themselves and what requires professional input
- Assessing plumbing fixture flow rates and discussing 'septic safe' products (usually run by facilitator)
- If weather dry: Maybe stress test the system. If weather wet: Maybe track stormwater flows
- Scale model of a septic tank and a range of filters
- Take the lid off a real system (the one at the venue). Measure sludge and scum levels and discuss risers, outlet filters, how solids should build up and when to pump out. Disc filters, flush taps
- Discuss what's good and bad about the specific system at the venue and how to manage it (checks on learning and prompts again for inputs, consideration of discharge area including soils and planting, as well as the treatment system)
- Questions and discussion can be free-flowing throughout – relatively informal
- Free food
- Time for informal/private questions

- PS follow-up questions can be (and are) emailed; discounted inspections can be arranged (usually with a local service agent, only with CBC Wastewater if ongoing issues)

We know that we can get high levels of participation:



The programme has expanded beyond the Little Oneroa catchment to be island-wide (but may possibly focus on specific catchments where there is need)

Lessons

Community Engagement is Essential

1) Community engagement projects are really valuable. When council compliance checks in the Little Oneroa catchment were well-supported, this was because of the years of work by WRT leading up to it, running workshops to define the problem and agree a roadmap to a solution, getting people involved and up-skilling them along the way.
2) Council can't run the events and workshops and expect the same level of engagement. System owners won't share potentially compromising information with the regulatory body. A non-council partner needs to collect and anonymise the data before sharing it with council, and to 'own' the process, and this needs to be seen to be so. There are some really skilled organisations who can do an outstanding job. EcoMatters and the Waiheke Resources Trust would be happy to talk to other organisations who might want to run something similar in other communities. They have also documented their work and published reports. (NB they didn't do the same things – they adapted to the local situation. E.g. Spanish-speaking community on Waiheke).
3) The upcoming compliance work in Waitakere, Great Barrier Island and Franklin should also start with a community organisation
4) People are really genuinely interested and concerned to do the right thing! (To a $$$ point).
5) There's some significant knowledge within the communities about wastewater system management.
6) There's also some significant lack of knowledge and misunderstanding. E.g. around servicing and maintenance obligations. And that effective on-site wastewater system management doesn't start and end at the tank. This can and should be addressed.

This wordy stuff is mostly to read later as you'll get copies of the slides

Servicing and Checks Must be Improved

7) Council did checks in the Little Oneroa catchment. They checked that the systems were being professionally serviced and that records were being kept. Many (most?) weren't and now are. This is great! They will be doing this elsewhere.
8) Servicing and maintenance needs to be improved. There are many failing systems which could easily be identified and fixed and operated satisfactorily. Many of those have been getting tick-box maintenance for years. Someone has to check that they are doing a good-enough job.
9) And that requires water be run through the system – a **stress test**. I made this procedure up, having been unable to find a protocol, but I'm happy that it seems to distinguish between failing systems, dubious systems, and well-functioning systems more effectively than anything else. (NB it can be run through the whole system, which may be useful, but it's safer to just run it through the discharge system). I have found systems with servicing records going back years, where the water flows directly from the septic tank into the stream, or into the roadside drain.
10) NB don't confuse it with the stress testing outlined in AS 1546.3:2017. This is conceptually similar, but different. My nomenclature predates this and I can't think of a different name so I'm sticking with it unless and until it becomes a problem…but maybe think of it as a *discharge stress test* to distinguish it.
11) Council performed a couple of stress tests (elsewhere I believe) and found that "they broke the systems" and so stopped! *More likely they simply identified that the systems were failing.*

Servicing and Checks Must be Improved

12) Manufacturers servicing their own systems presents the risk of conflict of interest – concealing the failures.
13) Service people servicing multiple systems often lack knowledge of the specific systems and can fail to perform actions, or can perform incorrect actions. There's no qualification required and it's hard to get staff. To do it properly with skilled staff probably costs more than they charge. There are also charlatans. And people with a little bit of knowledge…that they stretch to fit the situation.
14) No service people ever seem to have time to review the design, specifications, as-built plans, etc. If they can't find flush taps, they'll keep writing 'couldn't find flush taps' on the forms, and then 'boggy field', and 'pump failed - replaced' etc., maybe for years; yet documentation often exists which could help locate it, and other actions would be more helpful. Property owners don't read the forms or don't understand what they say, or don't understand the implications or inaction or the value of action.
15) LPED or trench systems are often only dosing a percentage of the lines, because someone was rotating them once, but the knowledge wasn't passed on and wasn't identified by a service person. A failing system could perhaps be instantly fixed at no cost by closing the over-used line and opening the rested one…(but no-one noticed).
16) The emphasis is often on ticking the boxes, doing the minimum, responding to failures – not on understanding the specific site context and system, or undertaking proactive actions and improvements.

Repairs, Upgrades and Improvements

17) The **10 – 90 – 90 – 10 rule** (or the opposite of the law of diminishing returns):

    10% of the systems are causing 90% of the pollution…but that can be reduced by 90% per system, at about 10% of the cost of a new system. (*Approximately, I reckon*). This is where to focus for best results for any intervention in the catchment.

18) Example improvements:
    a) Reading the design and as-built plans, then locating the discharge field elements and checking that they are working (a stress test is helpful). Flushing them, rotating (resting/reinstating) them, replacing them, etc. If water flows overland during the stress test,
    b) Replacing plumbing fixtures and fittings to reduce water use. Changing behaviour to reduce water use, or to make discharges more even
    c) Observing stormwater flows – when it's actually been raining hard – and diverting where necessary. Whereas a stress test is best done when the soil is dry (to make it possible to see wastewater wetted areas), stormwater tracking is best done in the rain. We apparently often have to imagine what happens when it rains or when the wastewater system discharges. We need to test and observe more. It can be surprising (better *or* worse than expected).
    d) Augmenting topsoil & planting & adding ponga logs as 'detention sponges' to improve discharge areas and hold soil and mulch. (NB more guidance with plants would be welcome – not just ones which can survive and not damage the discharge pipework, but plants which can hold or build the topsoil, clean the wastewater, and transpire it).

19) It's hard to upgrade/replace a system if the works need consent. Council has raised standards and interprets rules more strictly, hence tends to require a discharge permit application much more often now than a few years ago, which will increase again when GD06 is introduced. This may be valid for new applications. But for upgrades it is counter-productive. People are not willing to spend $7000 or more on a consent which has much higher obligations, is ongoing, and needs renewal. It is a classic barrier to change and a perverse (dis)incentive. People would often be willing to spend $7000 on improving their system. **There needs to be a process which allows for improvements without such high costs and change in status, when the only proposed work is to improve the wastewater system.**

20) There are a lot of older systems. If we can fix the 1 in 10 that cause 90% of the pollution, isn't that close to 'problem solved'?

I'd be happy to discuss this further:
craig@cbcwastewater.co.nz

WRT
Waiheke Resources Trust

cbc wastewater

EcoMatters

LAND TREATMENT – MANAWATU DISTRICT COUNCIL

Hamish Waugh [A]

[A] Manawatu District Council

Land Treatment Resource Consent

- 2008 – more of the same, no land treatment
- 2009 – more of the same, some land treatment
- 2011 – change in direction, a lot of land treatment
- 2014 – continuation of 2011, more science and data
- 2016 – Environment Court decision – finally!

MANAWATU DISTRICT COUNCIL

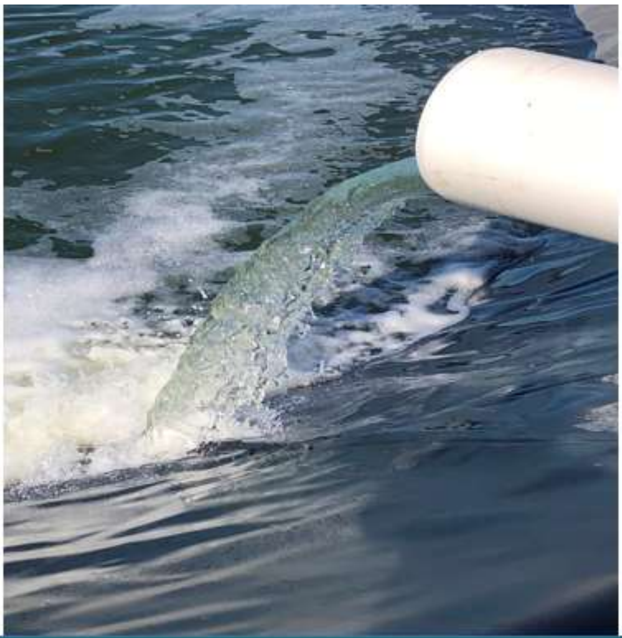
MANAWATU DISTRICT COUNCIL

Land Treatment Resource Consent

$3,700,000

CONSENT CONDITIONS – ABRIDGED

- No discharge to the Oroua River below the half median flow (3.49m^3/s)
- Irrigation commissioned prior to 24 November 2019
  - Buffer zones and separation distances
- Land Application Management Plan
  - Nutrient balance
  - Irrigation trial with fresh water
  - Wind speed cut off / spray drift
- Groundwater monitoring

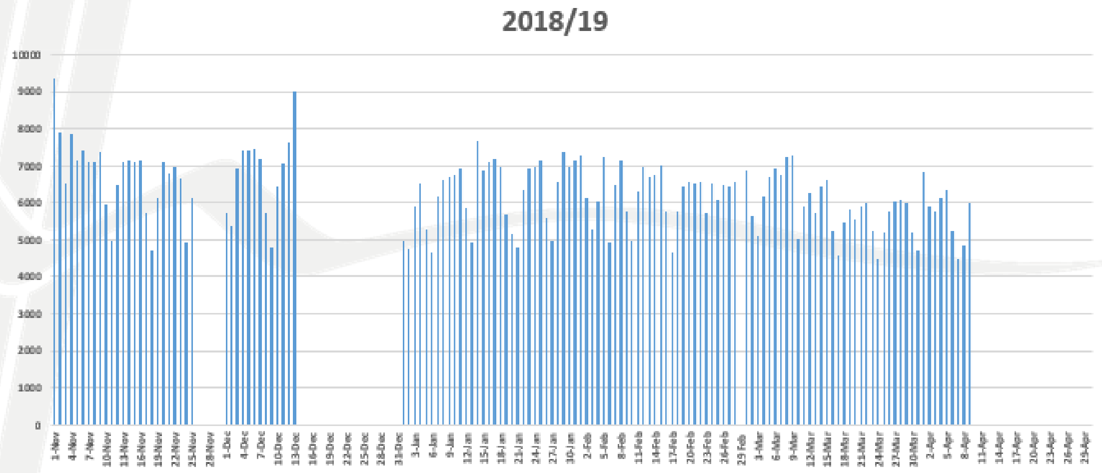


MANAWATU WWTP – HOW DID WE GO?

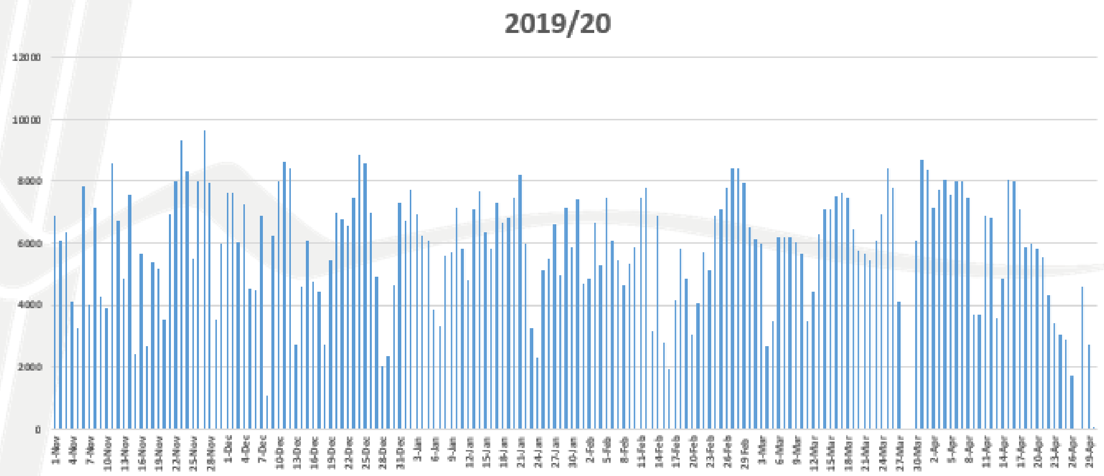
- Irrigation system commissioned 1 year early
- No discharge below the half median flow in the Oroua River
- No demonstrable environmental harm / effect
- 100% focused on environmental outcomes
- Mana whenua *"it's definitely better"*

- 2018/19 – 859,249 m3
- 2019/20 – 1,051,354 m3
- 2020/21 – 747,281 m3

MANAWATU WWTP IRRIGATION



MANAWATU WWTP IRRIGATION



MANAWATU WWTP IRRIGATION