Herman, Jason, NMENV

From:	JEROME HANSEN <jha2570@comcast.net>
Sent:	Tuesday, June 11, 2019 12:26 PM
To:	Herman, Jason, NMENV
Cc:	John Durham; Thompson, Terry
Subject:	[EXT] Jerome Hansen's letter of protest
Attachments:	J. Herman letter 5-23-2019.pdf

Jason,

Attached please find my letter to you of 5-23-2019.

I understand that you are bound by department policy and precedents, but in this case, I believe that the sewage cells have completely outlived their useful life and design capacity and are much more than a nuisance. It appears to me (and NMED must decide if my observations are correct) that the effluent has been seeping into the adjacent property for some time and is essentially percolating down from there. Is it fair for the adjacent landowner to take the brunt of the discharged effluent to be disposed of on his property? Or do S&R's grandfathered rights to discharge take precedent? NMED has to make the call to terminate the operation at some point. How much worse does it have to get?

I recommend that discharge be ceased or terminated and that a civil engineer / hydrologist be retained to determine their integrity and efficacy, and to assess the threat of this pollution to the Shallow Aquifer.

Thank you for your time.

Jerome Hansen

hard copy of J. Herman letter 5-23-2019.pdf to follow by mail

Jason G. Herman April 19, 2019

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Dear Mr. Herman, Re: Renewal of DP-465 S&R Septic Service Discharge Permit

I am a retired petroleum geologist and resident of the Stagecoach Hills Neighborhood, a community on "The Mesa" west of Taos. My career and graduate studies were focused on the Tertiary sedimentary basin fill sequences in the Great Basin (in Nevada and Arizona) which are highly analogous to the basin fill in the Taos region of the Rio Grande Rift. These are the sediments into which the sewage is being discharged. While I want to stress that I am not a hydrologist or a civil engineer, I have deep concerns about the integrity and efficacy of these sewage cells, particularly with regard to contamination of the ground water. My concerns are detailed below.

The permit allows S&R Septic Service to discharge partially-treated sewage to <u>unlined</u> cells on the surface. Apparently, one reason for initial approval in 1987 and continued approval since then is because the aquifer that the surrounding community relies on is greater than 500' deep. The underlying assumption seems to be that the sediments into which the waste water is discharged are relatively impermeable, and therefore the chances of the wastewater and the aquifer coming into contact are low. However, since 1987, with more well data and analysis by UNM and Glorieta Geoscience, researchers [1 and 2], the subsurface geology and hydrology of the wastewater site and surrounding area have been defined better. The presence of thick permeable formations beneath the site, such as members of the Servilleta Basalt calls this assumption into question and suggests that the risk of contamination from discharge into these pits is higher than has been perceived. Furthermore, as more wells in the communities of Hondo Mesa, Stagecoach Hills and Lower Las Colonias access this aquifer, there is a greater risk for contaminated wells and disease now than when the permit was first issued. (Figures 1 and 2, images from 1991 compared to 2016).

<u>Aquifers and Infiltration</u>

There are two aquifers beneath the waste water site: the Servilleta Basalt, and associated fine grained sediments, described below, and Quaternary alluvium, which lies above the basalts. These formations are part of the Shallow Aquifer System [2].

The Servilleta is black basalt, of Pliocene age, which is highly fractured with columnar cooling joints, as seen in outcrops in the Rio Grande Gorge. The tops of individual flow units are vesicular (contain gas bubbles, i.e. they are porous). The Upper and Middle members of the Servilleta are aquifers in the vicinity, a result of the fractured and jointed nature of these volcanic rocks. In this area, water wells have also been completed in channel gravels in associated with the basalt.

Basalts are often highly permeable rocks. I was on a well in Railroad Valley Nevada, where a similar

Pliocene basalt was flow tested at a rate of 292 gal/min. This flow was from a 9.625" borehole in a 70' zone, which yielded many darcies of permeability. Although this is a remarkable flow rate, a quick review of water well logs within 2000 m of the site showed that one well was completed in fractured basalt at 50 gal/ min also from a 70' zone. If the basalt can yield water at this rate, it will also accept water at this rate if the formation is dry. To put this in perspective, if this kind of flow rate (or injection rate) could be sustained, the amount of sewage discharged into the septic system for the last 32 years (500,000 gallons per year for 32 years = 16,000,000 gallons) would be filled in 222 days! If a plume of sewage-contaminated water reaches a zone like this in the Servilleta, it will likely move quickly downward to the water table. Although the section below the sewage pits is ~550' thick, 300' of that section is fractured and jointed (i.e. permeable) basalt (Figure 3, log of a nearby well ~1140 feet from the site). So, rather than insulating the water table from the effluent above, the open joints and fractures in the basalts would more likely allow a "fast-track" of the effluent to the water table.

The ~100' of alluvium above the basalt contains clay derived from the volcanics which is somewhat impermeable, but the deposit has been highly channeled by arroyos (Figure 1). The gravel in these arroyos is very permeable, and if the water table extended higher into the alluvium, these channels would be aquifers. These channels may have formed during the present interglacial period, and they eroded into alluvium deposited during a previous glacial period. Or they may have resulted from tectonic cycles. Either way, the cycles have created a complex series of stacked channel systems. The channels are permeable and vertical downward movement of water is possible. The sewage cells were built across one of the arroyos (see Figures 1, 2 and 8-15) and this may facilitate movement of the sewage discharge into the alluvium. It seems unlikely that the alluvium is much of an impediment to the downward movement of effluent toward the water table.

Based on tritium decay studies of the surface water and groundwater, Drakos and others [2, p.413] determined that "recharge of the shallow aquifer occurs on a time scale of less than 5-10 years." This indicates that the gross permeability of the Shallow Aquifer is relatively large, and like the groundwater, effluent from the cells can also move quickly through the Shallow Aquifer.

In 1987, when these sewage cells were constructed in a remote area of the county, the central question to be answered was, "What is the depth to the water table?" Now, after 32 years of discharge, the appropriate question is, "Are there sufficient aquitards in the alluvium to effectively isolate the surface effluent and pathogens from the water table?" Obviously the discharge cannot be continued indefinitely, or the aquifer will become infected. In 32 years, how much effluent has been discharged into this 4.83-acre area and how deeply has this plume penetrated? These are critical questions that need to be answered before renewal of the permit. Based on a rough analysis of the volume of pore space in the alluvium (Appendix), I believe that 32 years of discharge of effluent into this small area of 4.83 acres has created a plume of pollution that may have entered into the basalt, where it may percolate downward to the water table via open fractures, faults and joints.

The depth of the effluent plume was measured in 2000 by Duke Engineering and Services in a report to NMED Groundwater Quality Bureau [3]. Duke measured the concentration of nitrate (a proxy for the effluent) at various depths at this waste water site and developed mathematic models of the depth and concentration that could be used to predict depth of penetration of the effluent with time. For the sewage cells (the "Taos Impoundment Site") they ran a number of two-part models: a fine-grained layer overlying silt loam, a fine-grained layer overlying loamy sand, a fine-grained layer overlying medium sand, a fine-grained layer overlying coarse sand. Duke used these models to predict the downward percolation of nitrate over time. I have extracted Figure 17 from this report (Fine grained layer over coarse sand) and have interpolated the 32 year timeline onto this figure (my Figure 4). At 32 years, this model predicts the depth of effluent (i.e. zero nitrates) to be ~84 feet. However, Duke describes the upper 30 feet at the Taos site as "gravelly sand", which is likely to be substantially more permeable than their coarse sand model. Thus it is likely that effluent has penetrated to depths of more than 100, the depth of the Upper Basalt.

Both Duke's sophisticated modeling and my crude pore volume analysis (Appendix) suggest that the effluent may be close to or within the Upper Basalt, where it can move downward quickly to the water table. Thus, I believe that the 500' depth rule used by NMED is arbitrary and does not take into account the permeability of the rock formations below the cells, nor the length of time that the cells have been operational.

<u>Communication Between the Sewage Cells and the Water Table</u>

There are faults in the area that have not been mapped or published (A. L. Benson, oral communication, 2018). These north-trending normal faults can be seen on high resolution aeromagnetic surveys conducted recently by the U.S. Geological Survey. These north-trending faults run through the area approximately 0.75 miles east and west of the sewage cells. Open fractures associated with this fault extend through the Servilleta Basalt and would enable effluent from the cells to move rapidly down to the water table. The trace of the western fault can be seen on Google Earth images (Figure 5). The fault zone is permeable: note the darker color of the fault trace (a result of denser vegetation) and increased amount of purple flowers along the trace near the northern red arrow. The water table dips to the west from the cells, and if contamination reaches the water table and hits this fault, it would spread along the plane of the fault, and expand and complicate the plume.

Contamination of the groundwater below the water table may result from nearby water wells. One well, RG-78139, is 1140' from the cells. RG-78139 was drilled with an 8" bit and cased with 5" SCH 40 PVC pipe. The casing was not cemented to the borehole, leaving a 1.5" ring of void space between the borehole wall and the casing. This "annulus" extends vertically from the surface casing to the water table and to the bottom of the well. The annulus was packed with gravel during the well completion, but this gravel pack is not sufficient to isolate the water table from effluent from above. If effluent reaches this borehole, via the alluvium or the basalt, it has essentially an open conduit to the water table below (Figure 6). The only thing that may keep it from entering the annulus is a thin amount of drilling mud cake in the borehole wall. There are no records of either packers or cement in the well. The well should be monitored closely for signs of communication with the lagoons. Although it is 1140' from the south edge of the cells, an effluent plume only needs to move at a rate of 37 feet year to reach this borehole. Thus it is critical to know where the effluent is in the subsurface, and to know where it is moving. If it is moving toward this well, it should be properly plugged by drilling out the PVC casing and gravel pack, setting 5" steel casing, cementing the annulus to the surface and setting cement plugs in the casing.

Communication between the effluent and the water table through water wells near the sewage cells may be the single biggest threat to the Shallow Aquifer. Plugging and redrilling are expensive operations and it seems logical to stop the discharge and gather the data necessary to evaluate this threat.

<u>History of the Sewage Cells</u>

All of the information about the aquifers would be of little interest if the sewage cells were operating correctly. As you are aware, in a properly operating lagoon, the solids, effluent and pathogens are broken down by microbial action, and the water is clear and free of vegetation. This water is clean and does not pollute the aquifers. In contrast, these cells are choked with verdant, green weeds that indicate that the waste is being converted into fertilizer instead of being consumed by aquatic bacteria (Figure 7). In addition to the odor and flies, the problem is that the pathogens in the waste have not been consumed and are free to leach downward toward the water table.

A history of the cells can be seen on Google Earth images spanning the interval from 1991 to2016 (Figures 8-16). **The following observations are based on an examination of these images, and I have not verified or contradicted these observations by an onsite examination**. The onsite examination should be the responsibility of NMED.

Initially, from 1987-1997, it looks like the sewage cells were designed to be functional sewage lagoons with sloping bases in each of the cells to cut down on wave action (Figures 8 and 9). Note the shallow arroyo over which the system was built in Figure 9. By 2005, however the cells were subdivided, and vegetation choked the cells (Figures 10 and 11). A dark spot appears in the 2009 image (Figure 12, arrow), on the central northeast side of the cells, which persists through all of the subsequent images. **During their inspection of the site, NMED personnel should determine whether or not near-surface seepage out of the permit area has occurred and is responsible for this dark spot.** If so, is this a violation of Condition 23 of the permit and is this non-containment a public health hazard? In the 2009 image (Figure 12), note how the cars in the adjoining auto salvage yard are parked to avoid this area. The cells are vegetated. The dark spot persists in the 2010 and 2011 images (Figures 13 and 14). Note the lush green weeds on the 2013 image (Figure 15). Clearly, by 2016, nearly all of the cells were non-functional because of the intense vegetation, and the dark spot persists on the adjacent property (Figure 16). In addition, the hummocky surface of the ground in this area of the dark spot suggests that the ground may have subsided. **During their inspection of the waste water site, NMED personnel should determine whether or not ground subsidence has occurred.** If so, how and why did this subsidence occur, and is it a hazard, and what are the consequences if the subsidence spreads laterally into the sewage cells? If both the seepage and subsidence are determined to have taken place, how are the seepage and subsidence related, what does this mean for the integrity of the cells, and importantly, what does this mean for a connection between the cells and the aquifer? If NMED concludes that leakage and ground subsidence have occurred offsite, either the structural integrity of the cells is gone or they have been used well beyond their original design capacity.

Conclusions

Rather than continue the discharge by renewing this permit, it is time to commence the cleanup operation in accordance with the terms of the permit. At the very least, a moratorium on discharge should be declared and the site studied by a civil engineer and/or hydrologist to ascertain that the structural integrity of the site is intact and that the site is not contaminating the aquifer. Certain critical parameters, such as the depth to the top of the Servilleta, and the location, depth, velocity and direction of movement of the effluent in the subsurface need to be determined, especially with regard to nearby existing water wells and to avoid drilling any future water wells into the path of the plume. I believe that this information could be gathered by geophysical techniques, such as IP (Induced Polarization), CSAMT (Controlled Source Audio Magneto Tellurics) and refraction seismic, which are commonly used in the mining industry. (See http://zonge.com/solve-underground-problems/geotechnical-environmental/ Alternatively, this data could be acquired much less expensively through grants from NMED to UNM Taos and the NM School of Mines for graduate studies to properly characterize the geophysical, geological, hydrologic and environmental aspects of the site.

Because of the distinct possibility that any leftover solid matter in these pits contains pathogens, merely burying the pits would not be sufficient. This effluent will continue to leach downward into the alluvium and volcanics, and eventually reach the water table. Instead, this nitrogen-rich matter needs to be sterilized before burial. One way to do this might be to mix it with sawdust (i.e. carbon) from nearby lumberyards and compost the mixture to temperatures greater than 160 degrees F, and then bury this compost onsite. Another suggestion would be to truck the sludge to a waste water plant where it could be properly disposed. Then, remediate the site and adjoining property with compactible, impermeable clay to prevent further infiltration of the effluent plume, and restore the area to its original contours. Again, recommendations for the environmental mitigation for this site and adjacent property could stem from grants awarded for theses and dissertations to in-state universities.

Many people and businesses on the mesa depend on this aquifer, and this area is likely to be a locus of future growth in the region. Presently, the water quality is good, and with additional droughts forecast by climate models, this groundwater will become many orders of magnitude more valuable than the few dollars saved by not transporting the sewage to the municipal facility. Contrary to assumptions about the impermeability of the basin fill sediments, the alluvium and volcanics are permeable, and the transit time between the surface and the aquifer may be substantially shorter than NMED has assumed. A continuance of the permit increases the chances of contamination of the aquifer. It seems to me that NMED has a window of opportunity to avoid a catastrophic contamination of the Shallow Aquifer in this area. Why compound an already bad problem with continued discharge when the Taos Waste Water Plant can process 1.5 million gallons per day? The discharge is clearly not in the public interest, and if any nearby water wells show evidence of contamination, it's too late. Do the right thing: deny the permit and commence the cleanup. Time is of the essence.

Sincerely

Jerome B. Hansen

References

1. Benson, A.L. , 2004, Groundwater Geology of Taos County, in New Mexico Geological Society Guidebook, Geology of the Taos Region, Brister, B.S., Bauer, P.W, Read, A.S. and Lueth, V.W., eds. P.420-432.

2. Drakos, P., Lazarus, J., White, B., Banet, C.,Hodkins, M., Riester, J, and Sandoval, J., 2004 Geologic Characteristics of Basin-fill Aquifers in the Southern San Luis Basin, New Mexico, in New Mexico Geological Society Guidebook, Geology of the Taos Region, Brister, B.S., Bauer, P.W, Read, A.S. and Lueth, V.W., eds. P.391-404.

3. Duke Engineering & Services, 2000, Evaluation of the Migration of Nitrogen Compounds from Septage / Sludge Land Disposal Facilities: Vadose Zone Predictive Computer Modeling, Summitry Report prepared for New Mexico Environment Department, Groundwater Quality Bureau, 81

Appendix
A rough estimate of the depth of the effluent plume in the alluvium, based on pore volume analysis

Given: Area of site = 4.83 acres (planimetered including potential seepage)
43560 sq ft per acre
7.8 gal per cubic foot

Assumptions: The site has been filled at a rate of 500,000 gal/ year for 32 years =16,000,000 gal
30% porosity in the alluvium
25% of the alluvium section is effectively permeable
80% of the effluent has moved downward
Evaporation = Precipitation

So, 16,000,000 = (Area x 43560) x D x 7.8 x 0.30 x 0.25 x 0.80

D = 16,000,000 / (4.83 x 43560 x 7.8 x 0.30 x 0.20 x 0.80)

D = 162 feet

162 feet represents a uniform downward movement of the effluent over the 4.83 acres.
If the effluent "fingers" downward, or if the discharge is greater than the permitted capacity, the depth of the effluent plume is even deeper

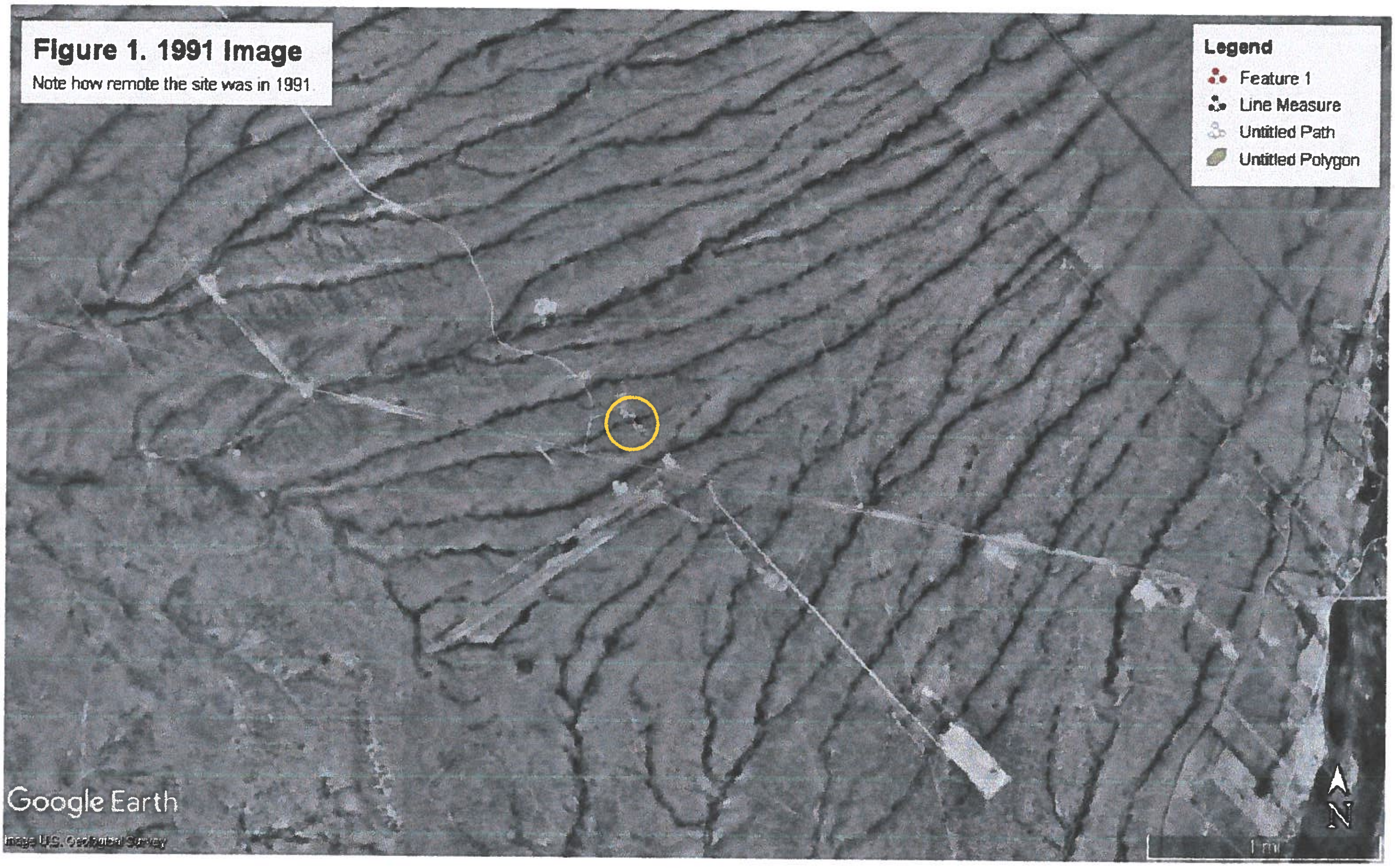


Figure 1. 1991 Image

Note how remote the site was in 1991.

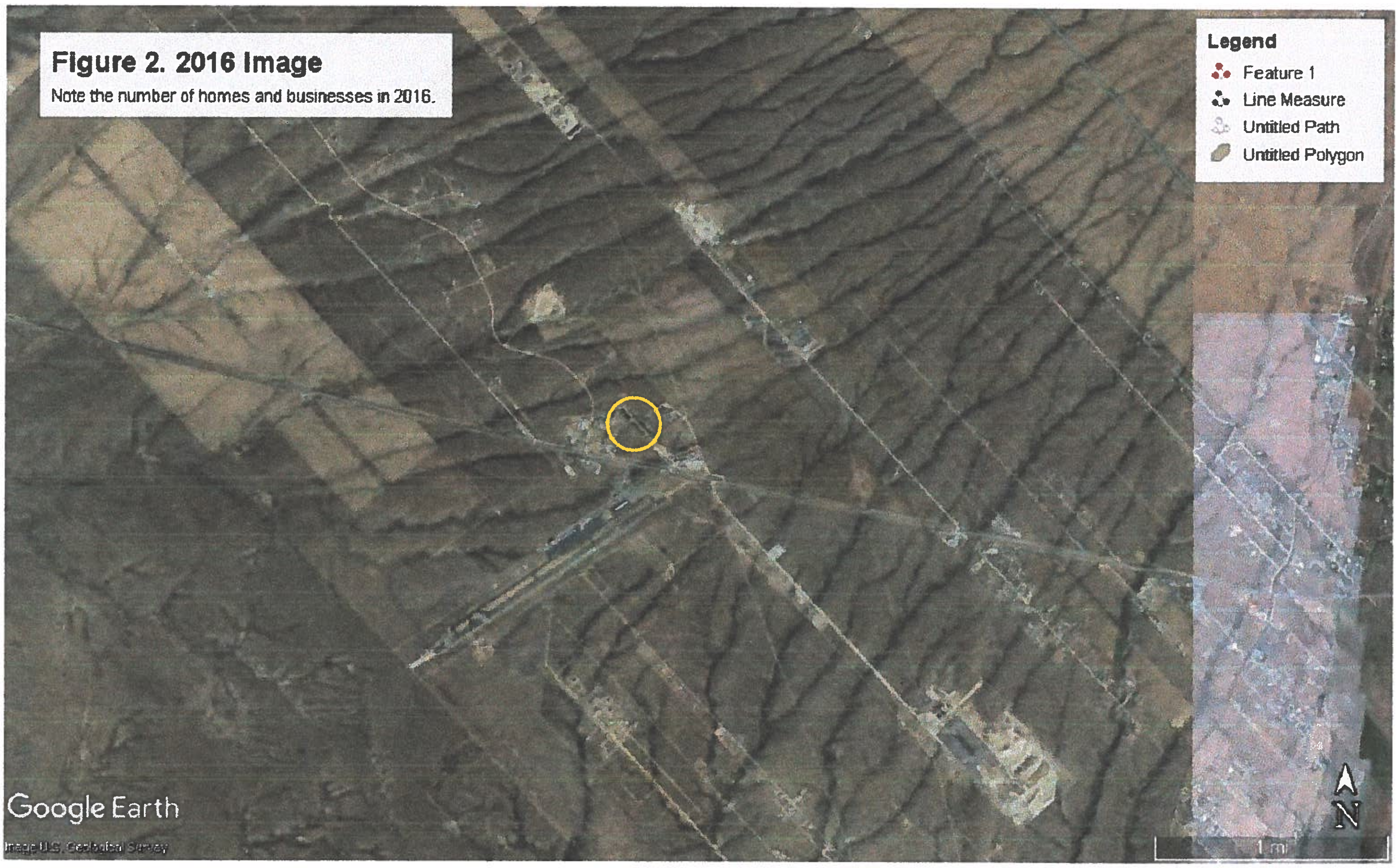


Figure 2. 2016 Image
Note the number of homes and businesses in 2016.
Legend
Feature 1
Line Measure
Untitled Path
Untitled Polygon
Google Earth
1 mi
N

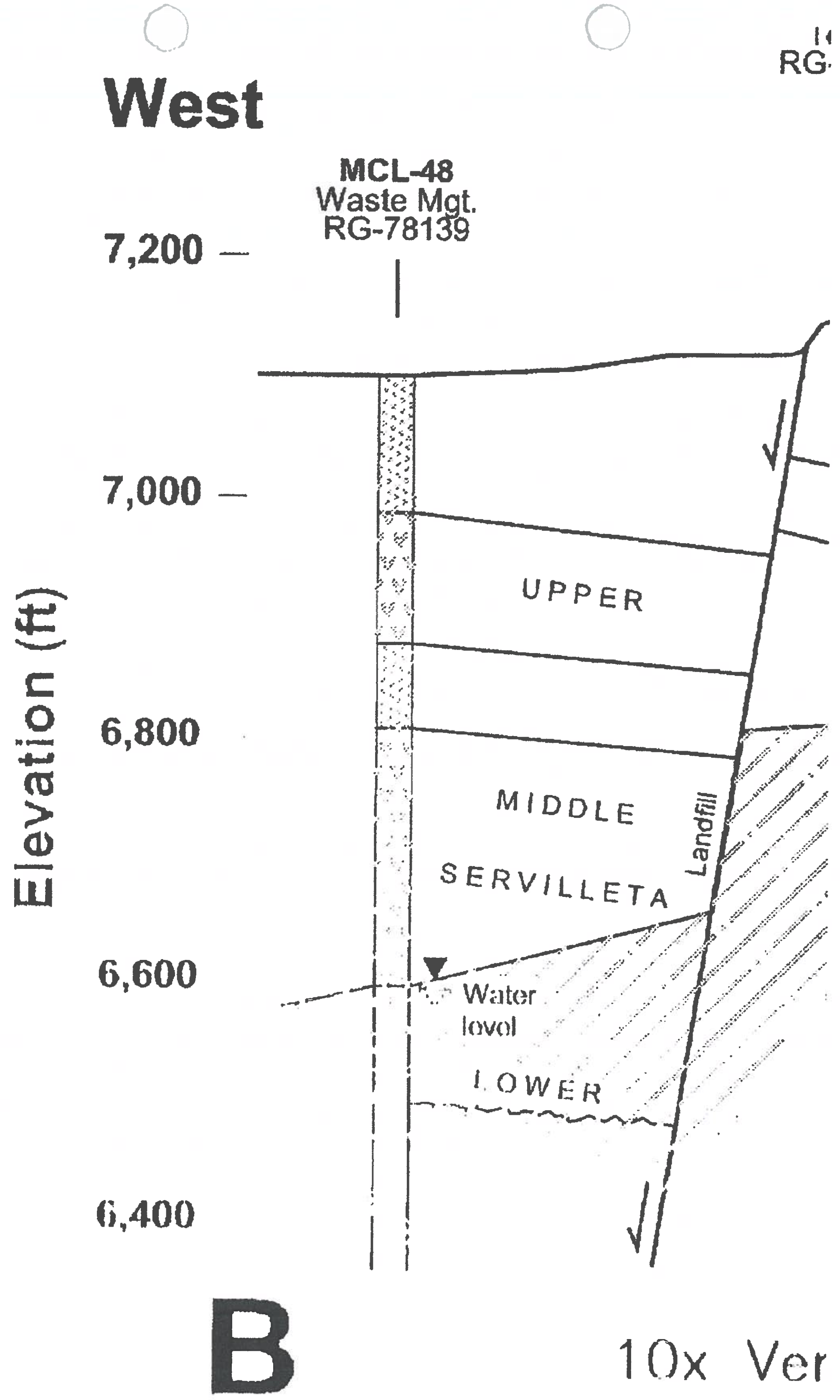
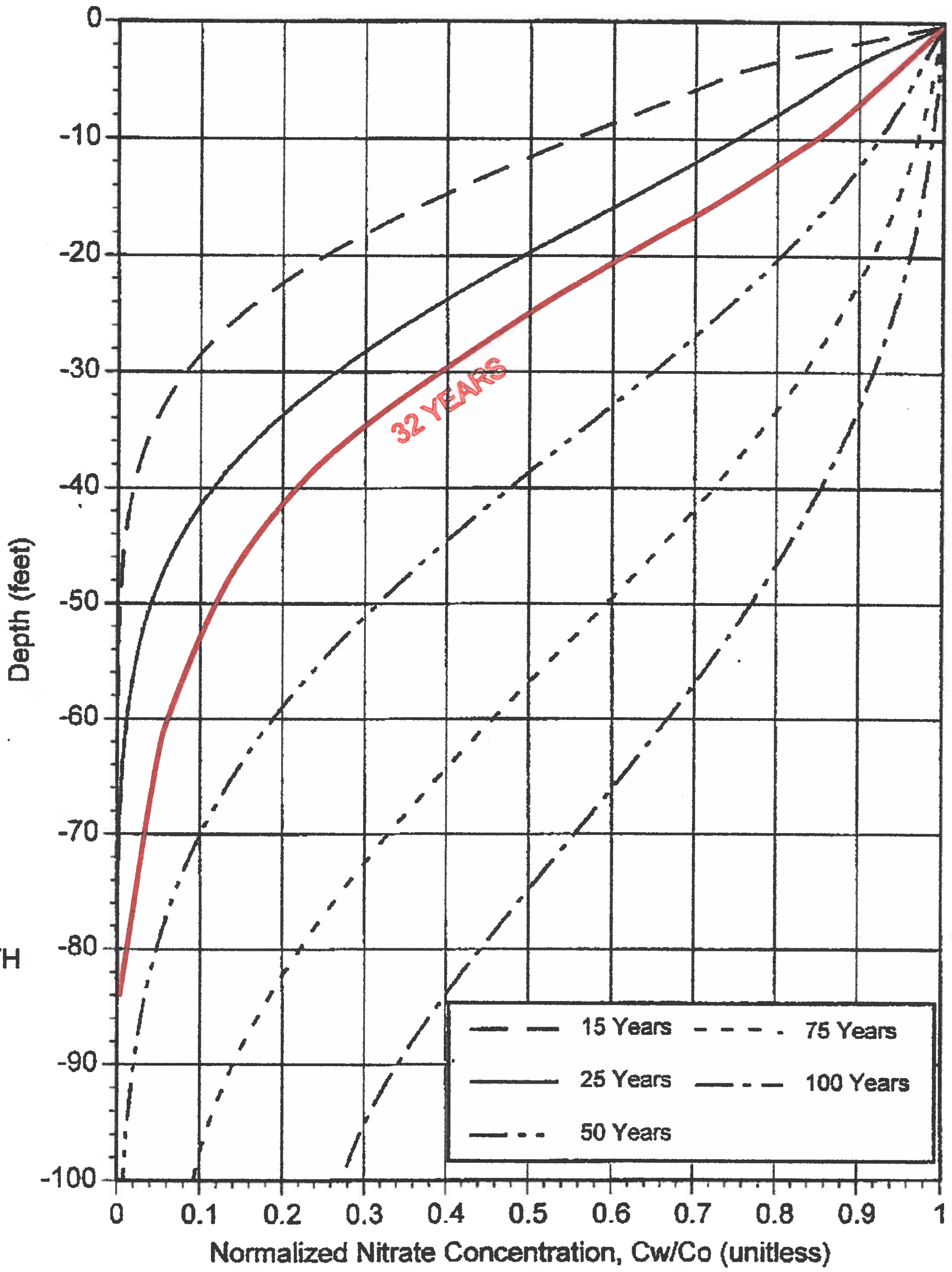


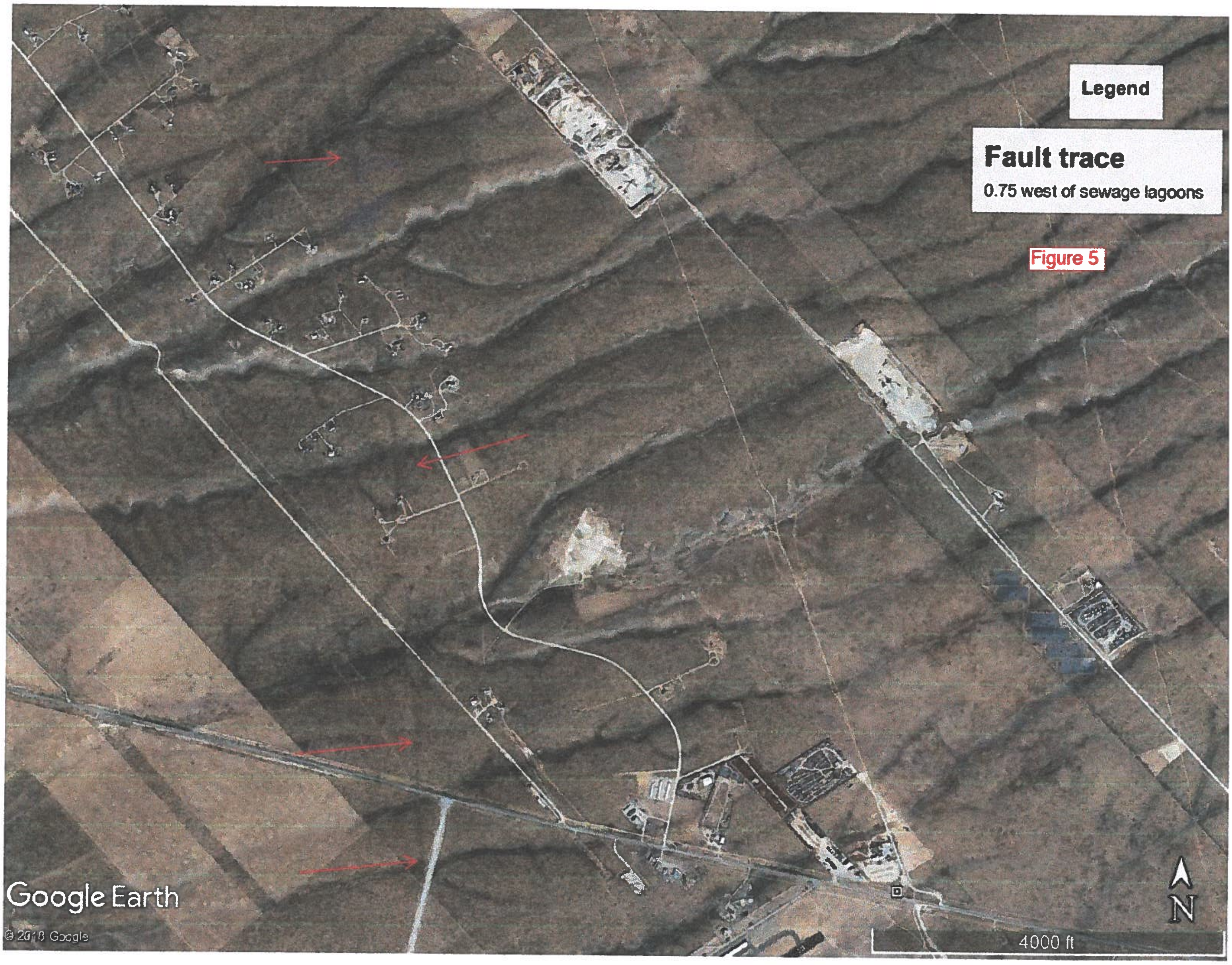
Figure 3. The Waste Mgmt well near the site.
(From Benson, 2004)



DEPTH

Figure 17. Predicted Normalized Concentration of Nitrate, for Septage Impoundment on a Fine-Grained Surface Layer Overlying Coarse Sand Sediments.

Figure 4. The 32 year line has been interpolated onto the "fine sediment above coarse sand" chart. Effluent depth is ~ 84'. Fine sediment over gravelly sand would be deeper, maybe 100-110'.



Legend
Fault trace
0.75 west of sewage lagoons
Figure 5
Google Earth
© 2018 Google
4000 ft
N

Figure 6 A POSSIBLE CONNECTION BETWEEN THE SEPTIC LAGOONS AND THE WATER TABLE

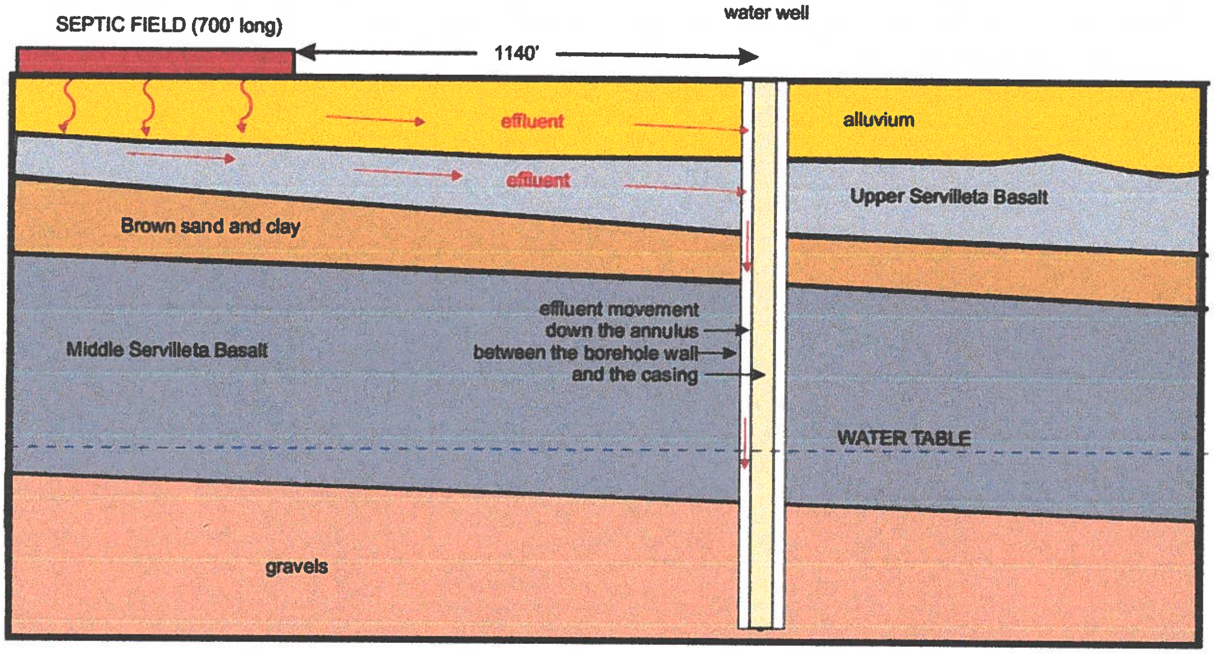


Figure 7. The septic system 7/2018.


S&D Septic
9/1991
Figure 8
sloping base
Google Earth
U.S. Geological Survey


S&R SEPTIC
10-1997
Figure 9
sloping base
Google Earth
ge U.S. Geological Survey


S&R SEPTIC
7-2005
Figure 10
Google Earth
ge NMRGIS


S&R SEPTIC
11-2006
Figure 11
Google Earth
ge © 2018 DigitalGlobe


S&R SEPTIC
8-2009
Figure 12
Google Earth
USDA Farm Service Agency


S&R SEPTIC
9-2010
Figure 13
Google Earth
Image © 2018 DigitalGlobe

S&R SEPTIC
8-2011
Figure 14
Google Earth
ge USDA Farm Service Agency


S& Septic
9/2013
Figure 15
Google Earth


S&R SEPTIC
2016
Figure 16
oogle Earth