Analysis of the GSI Technical Memorandum Dated April 19, 2019

To: Eric Casares from Dave O'Rourke & Tim Thompson

The latest modeling report from GSI discloses important details of the WRF water recycling strategy. They propose to recycle 800 acre-feet of reclaimed wastewater each year by pumping it into the ground in the lower Morro Valley. Two months later the water will be recovered downstream at the Morro Bay well field west of the narrows. A number of consequential facts from the GSI memorandum and its earlier full report in 2017 are the topic of this analysis, which is broken into four major areas topics below:

1. The basic limitations from the 2017 GSI study[2] have not been addressed in the latest 2019 report so they are still valid. Thus the modeling has not been strengthened, only extended. The expanded report discloses what is hoped to be done via using the Lower Morro Valley's small, unconfined aquifer. For a summary of these significant limitations see page 24 of the 2017 GSI report[2] regarding groundwater levels, aquifer properties, streambed percolation rates, nature of the aquifer geometry and ocean interface, aquifer geometry, and underflow issues. Unfortunately all these limitations needed to be overcome to get good predictions from the modeling studies. The study is not proof that water can be injected and recovered without significant losses and changes in the water quality. It is only suggestive. The reports validity is dependent on the accuracy of the underlying assumptions used in the model.

2. The sea water levels used in the study are historical using the average mean sea level numbers from the past 38 years, not current seawater levels. The study indicates 25% of the injected tertiary-treated water will be necessary to stop saltwater intrusion into the aquifer. This study does not take into account that 31 years hence, by year 2050, sea level is conservatively estimated to be 1-2 feet higher than in 2017[3]. This is well within the 50-year lifespan of the proposed "forever" plant. The consequences of this are completely ignored and yet that *is* the environment that *needs* to be modeled by GSI, not what would be relevant for a plant built in the year 2000!

   Does this mean, that in the "real world", to protect the lower Morro Valley aquifer for fresh water recovery, it will be necessary for the City to utilize more than 25% of their expensive, tertiary treated water, possibly 35-50%, to have a viable recycling process? What is the ultimate cost of this recovered fresh water? At what sea level rise will it become economically impractical to utilize the wells? The economics for a viable recycling process and the justification for an expensive WRF is heavily dependent on *amount* and *cost* of the potable water recovered from the ground. This is necessary to determine the merits of the proposed approach for providing for the future of Morro Bay. Specifically, the recycling plan would waste between 250 and 400 acre-feet of the 800 acre-feet of reclaimed water. If losses like this are tolerable, a more efficient method to recycle this lower amount of water would only require a WRF that is 35-50% smaller. Such a WRF facility would still be larger than the current sewage treatment plant, which handles both Cayucos and Morro Bay, and would provide significant construction savings.

3. The 2012 DUDEK report[4] on Recycled Water Feasibility, prepared for the Morro Bay and Cayucos Sanitary Districts, reports recycled water is in the range of 60% more expensive than desalination. This cost differential will be further exasperbated by the need to utilize 35-50% of the initially reclaimed water to prevent saltwater intrusion into the well field. The City's touted purpose of recovering wastewater is to provide a buffer for Morro Bay during times of drought.

If so, a truly independent cost analysis of the recycled water from the proposed WRF versus desalination water needs to be done before breaking ground on the facility. This analysis needs to include the capital costs of building the tertiary treatment facility, the infra structure to pump it into the Lower Morro Valley and its operating costs compared to the costs of refurbishing the current desalination plant and its routine operating costs. Which *is* the more economical solution? After all, the Pacific Ocean is a non-depletable source of potable water while the Lower Morro Valley wells have a limited time before salt-water intrusion destroys their value and the value of the WRF.

Furthermore, in wet years the small, unconfined aquifer in the Lower Morro Valley will have little, if any, capacity to hold the additional 800-acre feet of recovered water. What will be done with the very expensive recycled water other than pump it into the ocean? If there is an alternative use for this "excess" water, what is the additional capital costs of implementing it? There is no such thing as an 800 acre-foot water tank and what if the area gets back-to-back wet years? The only solution for this amount of water is a reservoir and if used, it would be the option of choice rather than pumping any water into the Lower Morro Valley Aquifer! Unfortunately, no reservoir currently exists in Morro Bay and the costs of creating one is unknown, but likely high.

It should be noted State water costs Morro Bay about 0.5 cents a gallon going down to about 0.2 cents a gallon in 2022 when the aqueduct costs are fully paid off. Recycled water will cost between 1 and 3 dollars a gallon depending on the number of RO treatments required, ground water losses and infrastructure necessary to reach potable requirements. The state water is pristine with regards to purity as received[7].

4. The Lower Morro Valley wells are contaminated with unacceptable levels of nitrates[5,6]. The GSI report[2] rationalizes their presence due to farming in the Lower Morro Valley basin, but the nitrate source claims fall far short of proof. Their speculation would be a reasonable possibility if it were not for the analysis of nitrates in the well water using a nitrogen and oxygen isotope analysis technique. This is a significant study since the methodology used is a well-established forensic method to distinguish human waste contamination from manufactured nitrate sources. The difference between the isotope ratios for the two potential sources is heavily on the side of human waste. Also another analysis from the wells has found Sucralose in the water. This sweetener could only come from human waste! It is not a result of farming since it has no value for raising crops or animals. The nitrate source is very important for a variety of reasons.

   So what is the concern about nitrates, a mild carcinogen that is present in all sausages (technically a mix of nitrates and nitrites) as a preservative? Basically, nitrates are a manageable waste-stream impurity. They can be easily removed by ion exchange chromatography and possibly other affordable methods. However, in this case the nitrates are the proverbial "canary in the mine". The concern is that if they are from human waste, as suggested above, the well *water also contains everything else* that is in human waste, including Sucralose. For the waste to get into the Morro wells, it has to come from the sewage lines approaching the narrows from Cayucos and North Morro Bay. Those lines have not been properly maintained for at least a decade or two and the leakage from them must have heavily contaminated the soil that drains into the well field. The GSI modeling study is compatible with a nitrate sewage source, possibly

contaminated with a small amount of nitrates from farming, to achieve the isotopic ratios observed in the tests. It is not primarily from fertilizer since the isotopic analysis does not support such a conclusion[2]. However, the GSI modeling study does not recognize a flow path from North Morro Bay that would enable sewage to enter the well field indicating an important flaw in their model.

What no one to date has analyzed for is the many other materials in the water that are present in human waste. Of primary concern are drugs, both ethical drugs and their metabolites, as well as unethical drugs and their metabolites. These are difficult, biologically active substances to remove from water. Chlorination does not generally remove them. In fact it might modify some of them to make so-called "designer" drugs of unknown properties.

So, what spectrums of substances are likely to be contaminating the water supply? They will be drug types such as painkillers including oxycodone, Lyrica and fentanyl, anti-inflammatories such as steroids, CBD2 and ibuprofen, anti-depressants such as Paxil and Cymbalta, anti-anxiety drugs such as Valium, Midazolam and Librium, birth control substances, erectile dysfunction drugs, etc., etc. Basically any drug available from your neighborhood pharmacy is likely there. Also included would be psychoactive drugs such as marijuana (THC), cocaine, heroin, methamphetamine and a number of "designer" drugs, all of which are not available in the drug store.

The body tries to detoxify itself using the liver and kidneys to excrete metabolites and unmodified drugs. These substances are biologically active materials that should not be in the body unless it has a condition that warrants a prescription for treatment. No one knows what routinely taking a cocktail of such substances at low concentrations does to individuals, particularly vulnerable infants and the elderly, but it is a main reason recycled wastewater is not considered to be potable. It should be emphasized that chlorination does not remove these substances.

It is clear, if the source of nitrates is human waste, as the analytical data strongly indicates, the Morro wells should be considered contaminated and require full tertiary purification to approach potability. Dilution is not the solution as proposed in the GSI report. It is internationally recognized as unethical (and possibly illegal in many nations) to use dilution to reduce the concentration of contaminants because ultimately dilution does not eliminate dosing of the *entire quantity of contaminant* to the public. Purification to eliminate the contaminant is the *only* ethical solution. Likewise, using contaminated wells for the recycle of purified wastewater is not likely a goal of the Federal and State governments. To meet WIFIA requirements, a different process *needs* to be implemented. Using a contaminated aquifer does not solve any problems and would likely require a second, full RO treatment at the WRF. This would likely be prohibitively expensive compared to other options not seriously considered yet.

CONCLUSIONS:

- The latest GSI modeling study contains the same limitations as the 2017 report. No significant improvements have been implemented, particularly with regards to pathways for sub-surface flows to enter the Morro Bay well field ground water.

- The modeling utilized mean sea level from the last 38 years. Today's sea level and most importantly the expected sea level in 2050 and beyond need to be studied to validate the robustness of the water reclamation strategy over the life span of the WRF which will likely greater than 50 years, since the City calls it their "forever" plant.

- The 2012 DUDEK Recycled Water Feasibility Study done for Cayucos and Morro Bay Sanitary Districts estimates that desalination of seawater is at least 60% less expensive than treated, and recycled wastewater. Disposing of 35-50% of the water nearly doubles the cost of the remaining recycled water. Since there have been no breakthroughs in water purification since 2012, an independent comparative cost analysis of the proposed WRF water recycling approach, taking into account correctly done modeling by GSI and projected capital costs and operating costs, compared to refurbishing the existing desalination plant is warranted before contracts are let and groundbreaking begins! That is the only financially responsible path to take.

- Alternative plans are needed to address recycling the treated water for potable use. The inherent cost of the recycled water far exceeds agricultural use economics. The high percentage of the expensive recycled water required to retard saltwater intrusion into the Morro Bay well field should kill this approach. It just makes the finally recovered water even more prohibitively expensive.

- Since the wells are contaminated with human sewage, the treatment of the recovered ground water is needed to remove all pharmaceutical residues before human consumption regardless of what quantity of water is pumped into the Lower Morro Valley unconstrained aquifer. In fact, any water taken from the Morro Bay well field needs to be similarly treated before distribution to the public. It is unethical to expose the citizens to the contaminants in the water, even after heavy chlorination.

Authored by Larry K. Truesdale Ph. D Chemistry
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