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Contaminant Denialism in Water Governance

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Abstract Noting that contaminant denialism is an increasing problem in environmental governance globally, this study describes public communication strategies that inappropriately minimize the problem of contaminants in respect of sewage discharges in and around water-bodies in Cape Town, South Africa. The article describes four kinds of contaminant denialism encountered in official public communications: data foreclosure; misinformation; the weaponization of science, and the use of point data instead of flow models. Interpreting these with reference to the sociology of science known as agnogenesis, the study of the production of public ignorance, the study demonstrates that contaminant denialism is exacerbated in contexts where scientific findings are expected to support marketing of tourism or excellence in a political administration. This is further exacerbated where there is reluctance to recognize that public infrastructure designed prior to the increased influx of toxic, non-biodegradable compounds that bioaccumulate in the open environment, generates new hazards; a political culture has difficulty acknowledging human waste; point-based data is regarded as definitive empirical fact without regard to the hydrological reality of water flows, and science provision derives from a privatized and market-driven service sector. The study concludes with proposals to minimize contaminant denialism in the public sector, inter alia removing institutionalized conflicts of interest; using predictive modeling; re-assessment of inherited infrastructure design in light of the challenges presented by new toxins, and subjecting for-profit scientific consultancies and official public science communications to regular peer review and/or audits by statutory scientific bodies that are independent of regional governance.

Plain Language Summary The study identifies strategies that have been used by authorities in one city to dismiss or downplay contamination issues, including secrecy, withholding data, and attacking the credibility of independent scientists. The study of a decade-long battle over scientific data demonstrates the importance of accountability in how environmental data is collected, managed and communicated to the public, emphasizing the need for predictive flow models rather than past-tense point-data studies in open water management. It also calls for leadership that can confront and address their inherited legacies of outdated infrastructure in an era of new toxins. The research underscores the importance of ensuring a culture of science that values independent questions, in scientific communications. This is particularly important in an era of for-profit data provision, where there is a risk of misinformation linked to corporate science procurement and the use of brand management communication strategies in matters of governance. Addressing misinformation that sounds like science but may not stand up to scientific scrutiny is critical for the credibility of the institution of science; for public access to information, and for environmental justice.

Key Points:

- This study of contests over pollution science in one city describes communication strategies that deny the problem of contaminants
- Identified strategies include data foreclosure; misinformation; weaponizing science, and the use of point data instead of plume flows
- Solutions include reassessing conflicts of interest and infrastructure; using flow models and reviewing public science communications

Supporting Information:

Supporting Information may be found in the online version of this article.

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1. Introduction

United Nations High Commissioner for Human Rights Volker Türk commented in 2023 that although Article 27 of the Universal Declaration of Human Rights asserts that everyone has the right to share in scientific advancement and its benefits,

> never has that right been so crucial, or in such danger. Global action and inaction, fueled by failures of policymakers and businesses, and worsened by greed, ideology and indifference, are propelling us ever deeper into environmental catastrophe. Addressing the crisis is possible only through open debate, critical thinking and evidence-based analysis. Yet we still see heavy corporate influence on regulatory processes, direct attacks on scientific studies, smear campaigns against scientists, misleading literature and exploitation of scientific illiteracy. Too many governments,

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> policymakers and big-industry leaders are willfully shutting their eyes to science and deploying biased "experts" to sow doubt and undermine scientific facts. … [B]ig industries have also suffocated evidence, on the harms of everything from pesticide use to lead additives, at the expense of people's right to health (Türk 2023).

Research on the rise of obfuscation in "post-truth" and political cultures of misinformation have received increasing attention in the social studies of science for the past two decades via the emergent field known as "agnotology," which studies the manufacture of public ignorance (Barton & Davis, 2018; Frickel & Edwards, 2014; Goldberg & Vandenberg, 2019, 2021; Gross and McGoey, 2022; Oppenheimer et al., 2019; Oreskes, 2004, 2015, 2021; Proctor & Schiebinger, 2008). Agnotological studies have described strategies that use science to sow "unknowing," that is, ignorance and doubt, rather than knowledge, in issues that have ranged from greenhouse gas emissions to agrochemicals, COVID and tobacco use, among many others. This body of research underscores the need for new forms of scientific literacy that are necessary to interpret forms of public science communication that primarily serve not publics, but those who seek the institutional authority that comes with the claim to have produced unquestionable scientific data (Bergan et al., 2015). Agnotology demonstrates the potentially malign use of the authority of science to hide, obfuscate and distract public discussion (Galison, 2004). "Ignorance is a crucial means through which public acceptance of serious and sometimes mass harms is achieved," note Barton and Davis (2018). When public ignorance is the product of communication strategies, the institution of science is unable to play its rightful role in governance, which is to assist all to reach agreement on how best to proceed.

In the water sector, the production of public ignorance was the focus of the study by Martyn and Bosman (2019) on the obfuscations that attended the lead contamination scandal in the United States town of Flint in Michigan. "When obfuscation pays," they observe, "it becomes the preferred reality." Addressing the long period of inaction that amplified harms, they note that "the deliberate production of ignorance, or "agnogenesis," has been identified as one of the mechanisms by which neoliberal [i.e., market-driven] rationality secures governability." They explain:

> In the context of environmental injustices, the seemingly innocuous post-truth moment is better understood as an outgrowth of the deliberate production of targeted ignorance. As evidence of the requisite harm perpetuated by the alternate reality mounts, inertial forces resist via agnogenesis their replacement. Ever more layers are added to the onion, and ever more misrepresentations woven into the matrix of social relations. For these inertial forces … [n]ew knowledge is resisted as a challenge to the dominant paradigm, and evidence-based revelations are either rendered irrelevant or absorbed in parallel (Martyn & Bosman, 2019, p. 956).

Recent years in which an inland water quality crisis has headlined United Kingdom environmental news, similarly, exemplifies a global trend toward for-profit water management along with the defunding, obfuscation or undermining of independent science that could hold those responsible to account, with a consequent and dramatic increase in sewage spills to water bodies. This matters deeply as microbial contaminants in sewage carry significant risk of serious diseases and travel along multiple vectors, as do antibiotics, the distribution of which amplify the risks of antimicrobial resistance. Moreover, chemicals of emerging concern (CECs) derive from multiple sources including pharmaceuticals, plastics, fire retardants, water repellents, personal care products, pesticides and herbicides that mainly reach the open environment via municipal waste-water treatment systems. Several of these chemical compounds are listed in the Stockholm Convention designed to limit the release of CECs to the open environment. Once in the open environment, many of these compounds do not break down and may bioaccumulate along the food chain at orders of magnitude on each trophic level. As they pass through organisms, they may be misrecognized by cells and cause many harms including changes to metabolic processes, cancers, reproductive problems and genetic shifts (Geissen et al., 2015; Jiang et al., 2013; Li et al., 2012).

Poorly treated sewage carries multiple risks far afield, far into the future. Given the presence of new contaminants such as per- and polyfluoroalkyl substances (PFAS) and pharmaceutically active compounds (PhACs) which enter global circulation from local sources via long-range meteorological processes (Scheringer, 2009), the challenging conditions facing district-level contaminant research teams must be a global policy concern. Yet independent local research that can hold officials to account is often under-resourced and at-risk to powerful institutional actors whose access to legal services is via the public purse.

Contaminant denialism is the focus of this study of official communications on open water pollution in the city of Cape Town, South Africa. This article catalogs official responses to multidisciplinary research conducted by this team over the period 2014 to 2024.

It highlights the institutionalized conflict of interest that arises when those responsible for procuring scientific services and public science communication are also those responsible for cleaning up oceans and inland waters. In such situations, as the saying goes, the fox guards the hen-house—and the resulting contaminant denialism undermines scientific integrity, good governance, and public health. Those conditions are exacerbated, we argue, under conditions in which science is a product to be supplied by private companies, consultancies and semi-privatized state institutions that must secure long-term contracts with procuring agencies. The resulting contradiction is that the political authority of science becomes available for purchase. When procured science is linked to marketing—whether for tourism or political parties—the result may be the curation of misinformation. In the domain of human waste management, all of the above are exacerbated by polite ideals that encourage the erasure of human waste in public discourse. And where this prurience dominates, the risk is that cultural and political ideals invite a science that affirms good governance via the absence of contaminants. The kind of contaminant science presented by City officials specifically focuses on intermittent point data to prove good governance, rather than drawing on available flow data to question risks to the public, or the inheritance of infrastructures that under certain conditions demonstrably foul waterways and beaches. The evidence therefore focuses on past events (without accountability for the collection and handling of samples) rather than pro-active modeling that would provide public guidance on the safest beaches to use on a particular day on the city's 300 km of coast.

Point-based data obscures the thermodynamic, metabolic and kinetic realities of constantly moving bodies of water. Our analysis therefore also proposes a paradigmatic and methodological shift to flow modeling as pro-active management of urban oceans and water bodies in line with the precautionary principle, and we propose institutional amendments that may reduce the potential for conflicts of interest in contaminant governance.

Finally, since journalists, members of the public and scholars rarely have the tools to contest misinformation that is presented in scientific terms and on the basis of laboratory data, we share this study with the goal of strengthening public science literacy in a global context where the curation of misinformation may become a weaponization of science.

2. Methodology: How We Arrive at This Analysis

Given the unusual situation in which a team of scientists write about contests over science that bear on their own work, we bear a particular responsibility to design an approach that stands up to independent scrutiny. All source material, therefore, is provided as links in Supporting Information S1. Readers may independently assess the scholarly and public outputs of this transdisciplinary team of co-authors who have, over almost a decade, pursued environmental chemical studies (Petrik; Ojemaye); epidemiological research (Barnes); qualitative social science studies (Green, Solomon, Beukes, Zackon); social justice (Farr) and documentary film (Green, Farr) in efforts to bring to officials' attention the health concerns of those living alongside profoundly contaminated water bodies.

Our research interviews have collected accounts of community groups, households, ratepayer associations and water user groups that have described environmental changes and widespread health challenges that are consistent with pollution. Wherever possible we have tested these against laboratory findings in multiple disciplines, specifically environmental chemistry and epidemiology. Evidence in the latter ranges from microbial counts to public health statistics. It is noteworthy that very few members of the public or independent scientists external to this team, wished to be named for fear of reprisals that ranged from a fear of litigation (in the case of ratepayer association office holders); exclusion or reputational harm in the case of independent scientists from a range of disciplines, including meteorology, algal blooms, microbial ecology, infrastructure engineering, desalination companies and even a financial accountant who investigated, on our behalf, the payments made to a desalination company to evidence quantities of produced water from contaminated raw water.

The timeline of Supporting Information S1 includes scientific and public communications by ourselves, by City officials and their contractees, and other independent scientists and community organizations. In some instances, it includes published responses and correspondence from officials (whose names are redacted).

Qualitative research methods have included interviews with households and with representatives of these organizations, as well as detailed historical research in City archives (Overy, 2020). In the 11 years this team has

worked together, we have engaged closely with local civil society organizations, ratepayer associations, investigative journalists and a documentary filmmaker (Desai, 2024) to understand the dissonance between lived experience of contaminated landscapes and seascapes, and official claims that all is well. Our interpretations are therefore informed by a critical synthesis of the multiple data sources described above, cross-referenced with quantitative evidence collected over a decade.

Quantitative methods have included epidemiological studies of microbial contamination and water parameters, with environmental chemistry studies that have spanned heavy metals, pesticides, per- and poly-fluoroalkyl substances and, most importantly, a wide range of pharmaceuticals whose collective presence in organic tissues means they are unlikely to have any source other than sewage. The data on which all our arguments are based have been published in high impact and peer-reviewed journals, and successfully defended in doctoral and masters dissertations.

Between the published material and the correspondence surrounding it, we are confident that we have provided a robust and replicable analysis that serves the purpose of strengthening the institution of science in public life and environmental governance. In support of our claim that our studies are replicable even though contested by officials, we include instances when officials disclosed data months or years later, which substantively confirmed that our earlier findings had been correct, and matched by the City.

We are indebted to journalists who have followed evidence provided by ourselves and others, and investigated specific incidents. We are also indebted to institutional protections afforded by South Africa's Broadcasting Complaints Commission after television journalists were cleared of malpractice accusations brought to it by City officials, and we are indebted to senior figures in our universities, including various Deans and University executives; the Academy of Science of South Africa, and three offices at the University of Cape Town (the Academic Freedom Committee, the Office of Research Integrity, and the Communications and Marketing Department) for assisting us to respond to multiple reputational attacks on members of this team.

In Section 3 we offer a four-fold typology of strategies of contaminant denialism in the material: Section 3.1 addresses data foreclosure; Section 3.2 focuses on data obfuscation using techniques of science; Section 3.3 sets out the weaponization of scientific authority, and Section 3.4 argues that hydrological irrealism (representing moving bodies of water with fortnightly point data) is a paradigm due for replacement. Each item of analysis is demonstrated in several further itemized forms of denial, which we have clustered under those four headings. The analytical approach thus derives from the material, as is the standard for qualitative social science studies which seek to understand conceptual frameworks, and it builds on approaches offered in agnotological literature cited earlier that pertains to science wars in marketing and reputation management. In addition, the analysis draws on current scientific literature that highlights the weaponization of scientific authority.

Since the purpose of the analysis is not to attack individuals but offer institutional proposals that will bring to an end the ongoing arguments over water data in our City, we have not named officials. We interpret the data to be demonstrating that the social relations institutionalized by science-based governance structures have not responded to the rise of market-driven science communication and science procurement, both of which have been increasingly privatized or semi-privatized in the past decade. We note also that the socio-cultural impulse to deny the ubiquity of human waste is pronounced where tourism marketing is a prominent goal of city governance. Under such conditions, corporate marketing strategies, paradoxically, appropriate the political authority of science while claiming their communications to be apolitical.

3. Techniques of Contaminant Denialism

With approximately 300 km of coastline along two bays joined by a peninsula, Cape Town has a vital relationship with the Indian Ocean in the south and the Atlantic Ocean in the west. In this city, however, contention over the risks inherent in discharging wastewater to oceans is over a century old, as evidenced in the study of Council archives by historian Overy (2020). Overy focused on the contestation over the use of the ocean for sewage disposal at Green Point in Table Bay on the western Atlantic seaboard that dates back to the 1880s. At that time, public outcry was linked to an outbreak of typhoid as well as the presence of feces on the beach. Council decisions led to the extension of the main sewer outfall further out to sea, and later, the installation of maceration facilities that do not remove contaminants. Since that date, the Green Point outfall system on the Atlantic Ocean has not been upgraded to include secondary or tertiary treatment, even though the quantity and nature of pharmaceuticals

and other chemicals entering WWTW have changed dramatically as producing industries have brought new compounds onto the market.

In addition, Cape Town has added a further two marine sewer outfalls on the Atlantic seaboard in recent decades. Together these three outfalls daily deliver some 40 ML of raw, macerated sewage to the ocean. Effluent from the Potsdam Wastewater Treatment Works (WWTW) and local unserviced informal settlements also enters the Atlantic Ocean via the Milnerton water catchment and estuary. Studies by members of this team, published since 2017, have noted extensive contamination of sessile organisms by pharmaceuticals that could only have come from sewage (Petrik et al., 2017).

On the Indian Ocean to the east of Cape Town's peninsula, four rivers carry to False Bay significant quantities of partially treated effluent from WWTWs, along with pollutants that diffuse from informal stormwater ditches, poorly serviced shack settlements, and a major solid waste facility which is one of two servicing a city of almost 5 million residents. A recent UNEP study found that the Cape Flats aquifer, a sizable body of water on which the city will depend in future droughts, is heavily polluted (Riemann, 2021). The major contributors, the study found, are the Cape Flats Waste Water Treatment Works (CFWWTW) on the Zeekoe River and the Zandvliet WWTW on the Kuils River.

The Cape Flats WWTW settlement ponds on the dunes less than a kilometer from the shores of False Bay were built by the Apartheid state in the 1950s on lands designated for the use of people of color. These ponds are now only partially lined, even though they lie atop the major recharge zone of the Cape Flats Aquifer. In turn, this aquifer releases significant volumes of contaminated water into the ocean (Pfaff et al., 2019). The Zeekoe River that adjoins the Cape Flats WWTW receives millions of liters daily from these settlement ponds where the poor quality of the effluent has been noted in prior studies (Swartz et al., 2018) and is also evident in Google Earth images which show dark and murky waters flowing into the surf zone from its route between the treatment works and a major landfill. Studies by Ojemaye and Petrik reveal extensive contamination of sessile organisms and fish in False Bay (Ojemaye & Petrik, 2019; Ojemaye, Onwordi, Pampanin, et al., 2020; Ojemaye et al., 2021a, 2021b, 2022, 2024).

Given the historical water infrastructures of the city, it is unsurprising that repeated public outcry has aired regarding contamination of rivers and the oceans. These concerns were underscored when three emergency desalination plants built by the city on both the Indian and the Atlantic Oceans during Cape Town's drought of 2017–18 were inoperable for several months due to algal blooms aggravated by nutrient release, and by poor raw seawater quality. Significantly, the operator of the Atlantic Ocean desalination plant released contaminant figures showing pollution of raw intake water to be up to 400% higher than the contaminant figures released by the city in the tender documents (Gosling, 2019; QFS, 2018). The early settlement of the contracts for all three plants was subject to non-disclosure agreements.

The assessment of official texts and public communications on water contamination in the period 2013 to 2024 is organized below in four streams.

3.1. Data Foreclosure

3.1.1. Non-Disclosure Agreements

From 2013 to 2020, the City of Cape Town (henceforth, the City)—the official name of the municipality—released inland and coastal water quality results only to Ratepayer Associations (RA), subject to non-disclosure agreements that required signature of an individual RA member that precluded sharing that information with anyone outside of the area. RAs could therefore not seek verification of the supplied data from independent scientists without the risk of litigation in their personal capacities. This was confirmed in writing by several active citizens from sporting bodies; local environmental action groups and RA members, some of whom, on condition that they would not be named for fear of litigation, supplied official documents seen by members of this team, indicating *E.coli* counts in some inland water bodies that were at times in the order of 10,000 000 *E.coli*/100 mL, or, in the case of one recent sampling by Barnes, 8,000 000 *E.coli*/100 mL in the Disa River adjoining an informal settlement in Hout Bay (Petersen, 2024).

3.1.2. Statistical Obfuscation

When the City's Coastal Water Quality report was released in 2020 (City of Cape Town, 2020a), official contaminant data was released as a 52-week average. City officials responsible for water governance argued in a meeting that the public would be unable to interpret an *E. coli* count, resulting in a science communication strategy in place until October 2023, with a 52-week rolling average based on two tests per month. This produces not scientific knowledge but the illusion of science, as it smooths out data and makes details of microbial exceedances inaccessible. This strategy contravenes multiple guarantees of freedom of information in South Africa's Constitution. Nonetheless, when the "Know Your Coasts 2022" (City of Cape Town, 2022) released those 52-week averages, the indicators were so poor that a public outcry followed. Subsequently, "Know Your Coasts 2023" (City of Cape Town, 2023a, 2023b) only offered a narrative account that excluded contaminant findings.

More recently, reflecting a post-2021 Mayoral commitment to water data transparency, there has been significant improvement in ocean water data availability in the form of a website with the data reporting the rolling 12-month average, beginning October 2023, reporting on enterococci. Commendably, this sets out three sets of data: the Blue Flag data; the Coastal Monitoring division data, and tests conducted by the City's Scientific Services (See Blue Flag Weekly Enterococci Results).

However, long-term data series remain unavailable for comparison or trend analysis. The infrequency of the samples (fortnightly); the large number of data gaps on particularly problematic beaches such as Strand and Hout Bay, and the inconsistent limit of detection (e.g., ">150" or ">24,190," which could mean anything) calls into question the data underlying percentile averages.

3.1.3. Narrowing the Evidentiary

A published article based on qualitative social science research described local residents' experience of respiratory conditions, including asthma, from living next to the highly contaminated Kuils River that was regularly treated with chlorine to kill bacteria (Green, Petrik, Solomon et al., 2018). As a volatile element, chlorine may combine with molecules present in the water to produce unpredictable respiratory hazards. In response to the article, a City official wrote an email to the writers to demand further proof. Dated 18 December 2018, the text reads:

1. You allege that the Zandvliet WwTW discharged "millions of liters of raw, unfiltered sewage into the Kuils River" around the 27th of November: Would you please forward us the proof that you have of this, as well as the exact location of where this sewage spill supposedly occurred;
2. You further allege that "the treatment works regularly discharge sewage along the channel": Would you please forward us the proof that this is occurring on a regular basis, including dates, times and locations of such a regular raw sewage discharge from the Zandvliet WwTW; […]
3. You state that "*the poorly treated sewage discharge*" is a likely explanation for the … "[findings of] fish contamination in False Bay in 2018" and further on you state "the diverse contaminants … found in all parts of the sampled fish to different degrees, *can thus only have originated from sewage discharges into the marine environment of False Bay*". … [Y]ou are inferring that the City is not treating the wastewater to a standard that removes contaminants of emerging concern (CEC). … [Y]ou must have proof directly linking Zandvliet's treated effluent discharge to the contaminants found in the fish, since this article is about Zandvliet's supposed pollution. Would you please forward us the CEC analysis done on Zandvliet's treated effluent, the level of the same contaminants as measured in False Bay together with the results obtained from the fish tissue in question? Also, how do these levels in our wastewaters, in False Bay, and in the marine life compare to similar studies done in the rest of the world?
4. … Would you please send us a list of what local experience we have allegedly excluded, so that we can remedy the situation?

The demand for evidence of a particular kind functions here "in a mode that can be qualified as predatory, for [it lays] claim to the power to disqualify and silence others" in the words of philosopher of science Stengers (2023). When the statutory body known as Environmental Law Enforcement indicated an intent to action applicable laws relating to poor water quality in the area in a letter dated 22 November 2018, the then-Executive Director or Water and Sanitation dismissed the findings of the scientist whistleblower (not on this team) on the grounds that the sample had not been precisely geolocated (letter, 28 November 2018).

Environmental Law Enforcement had investigated a complaint from residents. It noted that "the effluent discharge standards are non-compliant with the chemical limits for the facility and has resulted in offensive odours and high levels of *E. coli* counts being found in the Kuils River downstream of the facility … which poses a serious health risk to the community living in close proximity to the facility." (Directorate: Environmental Law Enforcement, 2018).

The response from the then-Executive Director of Water and Sanitation in the City, dated 28 November 2018, acknowledged that the upgrade of the treatment works had been delayed by almost 9 years; that the plant was over capacity in terms of its nutrient load, and that the plant discharged approximately 90 million liters per day into the river. The letter averred that the WWTW was compliant with flow rates although non-compliant with its permit conditions for nutrient load. However, at the time, severe water restrictions were in place due to Cape Town's unprecedented drought (Joubert & Ziervogel, 2019), rendering the claim context-specific rather than generalizable.

When the investigative television series Carte Blanche picked up the Kuils River story in January 2019, the City filed a complaint against the producers with the Broadcasting Complaints Commission (BCC). The BCC found against the City (BCCSA, 2019).

Later, it became evident that *the City was at the time in possession of data that confirmed our findings*. After a change of leadership in the water sector led to the release of water quality data, the City's 2020 Inland Water Quality Report (henceforth CIWQR) noted that the Kuils River had been listed as a sub-catchment of concern for several prior years. The report notes that "median *E. coli* values lay well within the Unacceptable range for intermediate contact recreation, and the 75% percentile extended further into the Unacceptable range… in the 2015–2018 period" (City of Cape Town, 2020b, p. 117). It continues: "The data suggest that the Lower Salt and Kuils sub-catchments had by far the greatest frequency of reported sewage spills" (City of Cape Town, 2020b, p. 6). Moreover: "The Eerste and Kuils sub-catchments also showed a significant increase over time in the proportion of sites where water is in Poor or Unacceptable condition, suggesting increased nutrient enrichment, possibly associated with poor performance from WWTWs in the area …" (City of Cape Town, 2020b, p. 50). The report also recognizes an "apparent correlation between the proximity of WWTWs and poorly serviced informal settlements, and water in an Unacceptable condition with regards to orthophosphates, in all catchments where these land uses occur" in the Kuils among others (City of Cape Town, 2020b, p. 53).

It is commendable that a change of Water and Sanitation leadership led to the study being made public.

The official request for proof of pollution in December 2018 was answered in July 2024 with the publication of a further study authored by a team including City officials, indicating that in regard to some criteria the Macassar beach at the mouth of the Eerste/Kuils watershed was one of the worst polluted in the world and that WWTW discharges to rivers were a major cause. The study specifically notes: "At some coastal sites in Cape Town the concentrations of numerous PhACs were higher, or amongst the highest when compared to concentrations reported in estuarine, coastal, and marine waters in other parts of the world." (Newman et al., 2024, p. 7).

Again, while it is commendable that such a study was published with the co-authorship of officials, it remains noteworthy that no retraction of allegations against this team has been offered either privately or publicly, even though this was formally requested by Petrik in correspondence with the Executive Director of Water and Sanitation. The absence of a retraction suggests that where reputation management is the ascendant priority for officials, being known as always right may be more important than fidelity to scientific fact. Such a position constitutes an abuse of scientific authority, for science is the practice of being permanently open to question and refutation.

3.1.4. Restrictions on Independent Scientific Research

The City passed a by-law in February 2021 that restricted independent scientific research. It stated that "No person may in a nature reserve, without written authorization of the City, carry out scientific or general research or undertake monitoring projects" (City of Cape Town, 2021). Given that the majority of rivers and wetlands within the city limits have nature reserve protections, and much of the coast is a marine-protected area, the new by-law rendered almost all independent testing illegal unless the researcher applied for and received a City permit to conduct it (Kretzmann, 2020). Effectively, this prohibited independent research in emergencies when the public is at highest risk, such as in flood conditions.

After local elections in 2021, the bylaw was withdrawn by the incoming Mayor in response to objections. However, the research permissions system that takes its place is deeply problematic: at the time of completion of this paper, four graduate researchers on one of our teams had waited between 200 and 250 days for research approvals that had been lodged on the City's online research applications portal. It would appear that the research permissions strategy serves to extend scientific restrictions by other means.

3.2. Misinformation

3.2.1. The False Claim

To renew its marine outfall licenses at three sites on the Atlantic coast, the City commissioned a study by the Council for Scientific and Industrial Research (CSIR) in 2016. The study concluded: "It is … illogical and indeed irresponsible to imply that effluent discharged through the outfalls is not impacting on the marine receiving environments or posing a potential human health risk. Indeed, the notion of no impact to a marine receiving environment in the context of effluent discharge is unfounded" (CSIR, 2017, p. 224).

Cape Town's then-Mayoral Water and Sanitation Committee Chair, however, claimed in a press release accompanying the public release of the study, that "A study by the Center for Scientific and Industrial Research (CSIR) into the City's marine outfalls has confirmed that they pose no significant risk to human health and do not measurably affect inshore water quality or the wider environment" (City of Cape Town, 2017).

No comment on the discrepancy was noted by any other officials, participating scientists, or the media. The claim that the marine environment is not affected by marine outfalls remains regularly repeated by senior officials.

3.2.2. Reductive Use of Key Indicators

In a research interview in late 2018, the head of a Ratepayers Association recounted to Green his disbelief in a meeting with a coastal official at the edge of the foul and stinking Milnerton lagoon. The official, he said, had insisted that there was no problem with the water because the *E. coli* count was within legal parameters defined by the applicable KPI, the key performance indicator.

An *E. coli* count is an indicator of the likelihood of sewage pollution in environmental water and thus of the likely presence of other fecal pathogens. Elevated *E. coli* counts can, by inference, also indicate the presence of chemical compounds, pharmaceuticals and nitrates. Yet *E. coli* as an indicator of fecal pollution can be manipulated. It dies off more readily than some other contaminating organisms when excess chlorine had been added to the water. *E. coli* detection is sensitive to misapplication of sampling procedures and incorrect sample storage before analysis. Any transgressions of scientific procedure would reduce the count and thereby downplay the risks. For this reason, an *E. coli* analysis should be interpreted in relation to other indicators such as ammonia counts (from urine) and total available oxygen. If the evidence of sewage is reduced to a single decontextualized index, the agreed measure of good water governance—the key performance indicator—may be mobilized against reason and the public interest.

KPI reductionism also allows the scientific chain of accountability for samples and their handling to be obscured: that is, how and when the sample was collected, transported and stored at the laboratory prior to the *E. coli* analysis being performed. Used reductively as point data without regard to ecological processes, this key performance indicator of good environmental governance may mutate into what philosopher Stiegler (2018) describes as "absolute non-knowledge."

3.2.3. Self-Certification

The Blue Flag program is an eco-label for beaches that claims to offer independent assessment of recreational water bodies for the tourist industry. On its website it is described as "one of the world's most recognized voluntary eco-labels awarded to beaches, marinas, and sustainable boating tourism operators. In order to qualify for the Blue Flag, a series of stringent environmental, educational, safety, and accessibility criteria must be met and maintained." As a voluntary program, however, the Blue Flag requires *the applicant* to submit the bathing water test results of the microbiological and physical-chemical parameters as well as details of the laboratory carrying out the analysis (Blue Flag, 2024). While the Wildlife and Environment Society of South Africa (WESSA) currently holds the contract, there is no double-blind testing of those samples nor an audit of their collection and handling. Nor is there any guarantee that the contractor and contractee are free of potentially

Table 1
Date for Blue Flag Certified Beaches Extracted From City of Cape Town November 2023 Water Quality Results

Blue flag approved beach	City reporting	City "Previous 365-day rolling period outcome"	Enterococci 5-year rolling period calculated as at 08 November 2023	*E.coli* (Latest count per 100 mL at 25 October 2023). Blue flag criteria specify <250 to 100 mL
Bikini Beach	Bikini Beach	Excellent	Excellent	5
Camps Bay	Camps Bay North	Excellent	Excellent	29
	Camps Bay	Good	Good	330
	Camps Bay Tidal Pool A	Too Few Data	Poor	No data
	Camps Bay Tidal Pool B	Poor	Poor	7260
	Maidens Cove Tidal Pool 1	Good	Good	7260
	Maidens Cove Tidal Pool 2	Sufficient	Sufficient	7260
Clifton 4th Beach	Clifton Beach 1–4 (four beaches amalgamated)	Good	Good	157
Fish Hoek	Fish Hoek South	Good	Good	86
	Fish Hoek Beach	Poor	Poor	153
	Clovelly	Sufficient	Sufficient	179
Llandudno	Llandudno	Sufficient	Sufficient	28
Melkbossstrand	Melkbosstrand	Good	Good	4
Muizenberg Beach	Muizenberg Station	Sufficient	Sufficient	7260
	Muizenberg Central	Good	Good	921
	Muizenberg Pavilion	Poor	Poor	613
	Sunrise Beach	Poor	Poor	1,986
Silwerstroom	Silwerstroomstrand resort	Sufficient	Sufficient	116
	Silwerstroom	Good	Good	No data

Note. Note the apparent limit of detection at 7260. The data is no longer available on the City website but screenshots of it were published in the Daily Maverick, https://www.dailymaverick.co.za/article/2023-12-04-its-code-red-on-the-water-quality-of-beaches-around-cape-town-ahead-of-peak-holiday-season/.

conflicting interests that may influence choices of when and where a sample was taken, or whether negative results may affect the continuation of the Blue Flag contract with the City who is the contracting party.

3.2.4. Data-Smoothing

In October 2023, the Blue Flag was awarded to eight City of Cape Town sites, viz Bikini Beach, Camps Bay, Clifton Fourth Beach, Fish Hoek, Llandudno, Melkbosstrand, Muizenberg and Silwerstroom. However, several of those beaches have multiple sampling sites that demonstrate significant variation in contamination data (see Table 1). As noted in the City's then-most-recent published results (City of Cape Town, 2022, p. 7), Camps Bay was sampled in four locations with significantly varying results. However, the Blue Flag was awarded to Camp's Bay beach as if it is a single entity (City of Cape Town, 2022, p. 20). Joe Public, walking along the Blue Flag beach, has no idea where one City reporting section stops and the other starts, nor how to account for variation of the sewage plume under different wind and current conditions.

The flaws in this reporting system are evident when comparing the results. Of the eight Blue-Flag approved beaches, only one (Bikini Beach) had achieved "excellent" water quality in the official figures released in November 2023 for the 365-day rolling average (see Engel, 2024). Both Camps Bay and Fish Hoek had beach sections where the water quality was poor; Llandudno, Muizenberg and Silwerstroom achieved only "Sufficient" water quality, while only two beaches—Clifton 4th and Melbosstrand—were rated "good."

Of concern in the City figures released in November 2023 and published in the *Daily Maverick*, is that seven of the 61 beaches sampled show a "latest *E. coli* count per 100 mL" of exactly 7260, suggesting that this may have been the laboratory maximum. No higher figures appear in that data set. If this was the maximum detection limit, it implies that higher actual figures may have been excluded from the maximum entered into the 365-day rolling average.

The margin of error in providing figures to the public in 365 days rolling averages is evident in that three of the statistics marked "good" or "sufficient," within the Blue-Flag-approved beaches, also marked the most recent *E. coli* count at that maximum, that is, 7260 cfu/100 mL.

3.2.5. Irrelevant Objections

After the publication of a study which found high levels of diclofenac in fish caught in False Bay (Ojemaye & Petrik, 2019), the Mayoral Water Committee chair asserted in a radio interview that the presence of this pharmaceutical was both negligible and not alarming because it amounted to much less than an adult dose. From the radio station recording:

> Our testing to date and testing that's been done by other external scientific agencies like the CSIR has shown that the concentration of pollution in our marine environment is what we term at trace levels, meaning you would need to consume about 147,000 kg of snoek [a local fish] or 60,000 whole snoek at this single sitting in order to ingest the equivalent to one diclofenac tablet, as an example (transcribed from Friedman, 2019).

This assertion evidences a category mistake: confusing human medicinal dosages and environmental contaminant levels. Environmental contamination sciences are concerned with the effects of chronic long-term exposure to the tissue of all living species. For this reason, the presence of diclofenac in the open environment has been a scientific concern for two decades (Bonnefille et al., 2018). It has been demonstrated to be profoundly harmful to sessile organisms in marine environments (Joachim et al., 2020); to avian species both domestic and wild (Hussain et al., 2008; Van Dooren, 2010), and to plants (Pawłowska et al., 2021). These impacts bear no relation to an adult human medicinal dosage.

There are three further errors in the official's assessment. First: diclofenac was only one of multiple compounds found in the published study (Ojemaye & Petrik, 2019). The presence of multiple contaminants in organisms and in the open environment will yield unknown metabolites. Thus, what is at issue is not the presence of a single pharmaceutical but the risks of unknown interactions of thousands of chemical compounds and pharmaceuticals.

Second, the presence of pharmaceuticals in the open environment risks the development of pathogens with unknown levels of antibiotic resistance.

Finally, besides the conflation of disciplines, the figures given were based on flawed comparatives: wet and dry weights (see Section 3.2.6).

3.2.6. Flawed Comparatives

While the standard scientific measure of dry weight is used in mass spectrometry as a method for "normalizing," to "compare apples with apples," the City's CSIR report of 2017 relied on wet weight as a scientific measure to determine the concentration of pollution from pharmaceuticals. Wet weight requires the factoring in of a dilution scale of 100, and its use will result in a finding of contamination at two orders of magnitude (i.e., two decimal points) lower than concentrations detected in dry weight samples.

In the CLS study the eutrophic risk of the Green Point outfall is noted as low by way of comparison to the entire Southern Benguela current region. "There are approximately 19 upwelling events of varying intensities and durations per year in the Southern Benguela Current region which may therefore inject $2.0 \times 1{,}014$ mM N to the euphotic zone. This is 5-orders [sic] of magnitude greater than the estimated nitrogen supply from the Green Point outfall which is thus a very minor proportion of the overall nitrogen supply underpinning phytoplankton production in the region" (CLS, 2022a, p. 20). For sessile organisms in the local marine protected area, however, the quantity of nitrogen upwelling in an entire ocean current region is irrelevant to the in situ disruption of the nitrogen cycle from the daily discharge and settlement of 20–40 million liters of raw sewage. The scale of the comparatives is irrelevant. The claim obfuscates the effect of sewage contamination on a specific bay.

3.2.7. Levels of Detection

Simazine and atrazine are herbicides used extensively in industrial farming. Simazine is used mainly on citrus, grapes, nuts, maize and apples, while atrazine is used on maize and sugarcane (Tierney et al., 2008). Both are known endocrine disruptors (Machete & Shadung, 2019). A study published by Ojemaye, Onwordi, Pampanin,

et al. (2020) demonstrated the presence of atrazine and simazine in Camps Bay, a suburb on the Atlantic coast without any major rivers or industrial agriculture but with several dozen busy restaurants and supermarkets. The article suggested that the presence of these herbicides could be linked to the marine outfall, a claim strengthened by the presence of those herbicides in prior data published by the City (CSIR, 2017).

City employees published a rebuttal that did "not dispute the findings" of the presence of the five indicators for herbicides in the biota and sediment at Camps Bay but did challenge the assertion that the marine outfall is the primary source of the herbicides (Colenbrander et al., 2020). They argued that the herbicides and other contamination in Camps Bay's marine environment and biota were due to stormwater, urban runoff and gray water discharges. Ojemaye et al. (2021a) published a supplement by way of response, pointing out that since that year was a drought year, the compounds could not have come from surface runoff. In turn, officials sent a Certificate of Analysis from a laboratory in the Eurofins group of private laboratories, which stated that there was no evidence that these compounds had been found—even though they were evident in the prior CSIR study of marine outfalls (2017) commissioned by the City. The level of detection was not stated on the Eurofins Certificate. In subsequent correspondence the Eurofins laboratory manager confirmed that the detection was performed at the level of micrograms per liter which is 1,000 times less sensitive than the typical values measured in nanograms per liter. In a letter dated 16 March 2021, Eurofins clarified the meaning of the reporting limits: "If a chemical concentration is below the reporting limit there is no evidence from the analysis to indicate the chemical is present at a concentration below the reporting limit." Thus, in a final corrigendum concerning the Camps Bay study published in August 2021, Ojemaye et al. (2021b) simply stated that they had found sub-nanograms per liter.

Notwithstanding the resolution of the dispute as set out above, the City's 2023 Coastal Water Quality Report lists only their rebuttal of Ojemaye, Onwordi, Pampanin, et al. (2020) and Colenbrander et al. (2020), mentioning neither the further data published in the Corrigendum, nor the clarificatory correspondence with Eurofins (City of Cape Town, 2023b, p. 26).

3.2.8. Social Media: Unresolved Questions

The idea of "the green nudge" lay at the core of the City's water strategy during the 2017/18 drought (Joubert & Ziervogel, 2019). Nudge theory, as proposed by Sunstein (2014) as "libertarian paternalism," is based on behavioral economics and promises to shift the architecture of public choices for the better. Yet nudge theory has a dark side (Campione, 2020; Madi, 2020): it is inherently unaccountable to the public because it operates in secret.

During the drought years, City officials had drawn on the services of three private political communication companies to gain public compliance with water use regulations. While the City has denied employing anyone under the fake names used by avatars in social media communications at the time, two were of particular interest as they sought to change people's water-use practices and justify higher water pricing while repeatedly drawing on information that was not publicly available. Later, after the rains came and City water revenues were low from minimal water consumption, both avatars called for increased water usage on the same social media fora. Their names were "Mia Taylor" and "Willie Cuthgart."

The Taylor profile appears to have been an avatar available for global hire in influence campaigns (see Green, 2020, 2021). "Cuthgart" is a surname unrecognized in any database. "Willie Cuthgart" appears to have been a sleeper-influencer (sharing banal information like weather forecasts for a lengthy period) but became far more active when the Taylor avatar disappeared. The latter deleted "her" Facebook profile after a live online interview with Green (2020) during which "she" shared information from a closed-door, high-level City meeting about the contentious closure of the Granger Bay desalination plant near the Green Point marine outfall.

Taylor and Cuthgart played an obfuscatory role that is not dissimilar to that associated with the defunct political marketing company Cambridge Analytica (Campione, 2020; Barker, 2018; Goldhill, 2022). In response to a team-written article on the water-access difficulties experienced by Capetonian households (Scheba et al., 2021), in an argument borne out later by Savelli et al. (2023), Cuthgart attacked Green on Facebook as a "fascist liberal" and "bitter old woman," suggesting longstanding personal animosity. Given their similar emotional ranges, access to insider information, and their equivalent lexicon and keyboard habits, it is entirely possible that their posts were written by the same person or team (Green, 2020, 2021, 2022a, 2022b).

At an online meeting of water researchers and the City on 27 January 2021 in which Green raised a question about whether media trolls were operating in the city's water sector, a senior official undertook to follow up with an internal forensic investigation. The outcome was never communicated.

3.2.9. Deflecting Responsibility

The City's Coastal Water Quality Report (CWQR) of 2020 claimed that ocean pollution at Three Anchor Bay, next to the Green Point sewer outfall, was due to surface runoff. While it is the case that a pipeline discharges surface runoff into that bay, the statement is misleading given the proximity of this beach to the Green Point Outfall that discharges approximately 40 ML per day to sea. The Report notes that "the sources of these [surface] contaminants include the washing of refuse bins and the discharge of soiled water into the stormwater system, construction site waste washing into the stormwater system, blockages in the sewer system caused by the presence of foreign materials (and subsequent overflows of sewage into the stormwater system), as well as illegal connections to the stormwater system" (City of Cape Town, 2020a.)

Shifting the blame for poor water quality from infrastructure design to the public, this communication overlooks multiple sources of evidence including:

- Published science on pharmaceutical contaminants that could only have come from sewage (Petrik et al., 2017).
- The findings of the City's commissioned consultancy (CSIR, 2017) noting contaminants in the area that could only have come from sewage.
- Data from the emergency shore-based desalination plant at the adjoining Granger Bay (in Table Bay) designed for Cape Town's 2017–8 drought, which demonstrates sea water contamination was at times up to 400% higher than the official figures (Gosling, 2019; News24 Wire, 2019).
- City-commissioned studies showing that the sewage plume reaches the surface in north-westerly wind conditions (CLS 2022a, p. 5).

3.3. Weaponizing Science

3.3.1. Reputational Harm

After officials had refused to meet researchers and community members to discuss Solomon's data showing 1.2 million Enterococci per 100 mL on the Kuils River (Green et al., 2019, 2019b; Solomon, 2022) and a fortnight had passed with no responses to repeated requests, the team elected to publish the data in the press on the grounds that it was a matter of urgent public interest. In response to our article, five senior water officials attacked this team as setting off "unsubstantiated bombshells triggering panic free of accountability" (City of Cape Town, 2019). Multiple wholly false claims and misleading statements sought to discredit the researchers, who responded with a call to the City to commit to ethical, truthful and evidence-based governance. While the reputational mauling served a cautionary notice on water scientists not to dissent from City officials, it is noteworthy that undisclosed City data at that time supported our pollutant findings (see Section 3.1.4). Nonetheless, the contributing authors of the "bombshells" allegations included five of the then-top six water officials and political appointees in the City.

Among the problematic and misleading statements:

- When a junior journalist in a daily newspaper erred in reporting Green's telephonic comment on a beach *E.coli* count as a "cholera count" and the morning paper headlined with the story, Green worked with the University of Cape Town's media division to put out a press release to all print and broadcast sources that the report was the newspaper's error and should not be cited. Green alerted senior City water officials to the journalist's error and the correcting media release, among them, three of the co-authors of the attack article. However, the "unsubstantiated bombshells" article asserts that our team had falsely claimed there to be a cholera outbreak.
- A meeting with officials, to which we had invited a journalist and advised the Executive Director's office by requesting parking for her, was misrepresented. The City claimed we had not advised them of the invitation.
- Their claim that we had been alarmist in regard to a False Bay algal bloom referred to a private emailed query, not a public media allegation, sent to a city official to ask whether the dramatic algal bloom evident in the ocean at the time was a toxic species. Members of this team had received an alert from a local mid-career scientist who was concerned about what species his data was suggesting, but he did not wish to approach the City directly for fear of reprisals.

- Where we had described tramping along the stinking Kuils River with efflorescences of cyanobacteria and "a community struggling with chronic and acute respiratory ailments; chronic gastrointestinal complaints; [and] chronic skin infections" to such an extent that horses were dying, we were derided for using the descriptor "apocalyptic" in an interview. It is noteworthy that 5 years later, one of the authors of the "bombshells" allegations co-authored a study which found that specific contaminants on Macassar Beach at the mouth of the Kuils were among the highest documented (Newman et al., 2024; see Section 3.1.3 above).
- Our reporting of 1,275,000 Enterococcal cfu/100 mL was ignored while the 245 *E.coli* upstream in a pungently chlorinated stream was decried as our own data showing us wrong, even as chlorine is regularly used by the City to minimize microbial counts. It was the Kuils River contaminant data that was at issue, and as set out in Section 3.1.3 above, later-released City data demonstrated that undisclosed information was available to the writers at the time, which substantively matched our findings. Notably the Inland Water Quality Report (City of Cape Town, 2020b) found that the waste water treatment works bore significant responsibility for contamination downstream.

3.3.2. Laboratory Wars

During the summer holidays in late 2024, a civil society led organization known as Rethink The Stink, was commissioned by the activist group "Bays of Sewage" to test sea water quality on some Cape Town beaches. Petrik and Barnes, of this team, advised on the report called Project Blue which was sent to the City and subsequently to the media. Project Blue found "Exceedances were noted in 42% of the sample dates for the Table Bay side of the survey, while for the False Bay side the exceedances occurred for 38% of the sample dates." (Rethink The Stink, 2024).

In response the ruling political party in the province issued a statement demanding an apology and data handling information:

> "The Democratic Alliance in the Western Cape … [calls] on Project Blue to make public their testing samples, methodology, and additional key details to uphold transparency and ensure accurate, constructive dialog. These details should include the exact locations of sampling, the conditions under which samples were collected, the analysis methods and standards used, and the frequency of testing. Moreover, Project Blue should disclose whether their findings were peer-reviewed, provide any historical data comparisons, and clarify their funding sources to address potential conflicts of interest." (Democratic Alliance WCPP Newsroom, 2025a, 2025b).

By way of response, Project Blue issued a statement:

> "A L Abbott, the laboratory used for Table Bay analysis including Camps Bay and Clifton 4th Beach is SANAS accredited for both E Coli and Enterococci in saline water, see attached certificate. Vinlab, the laboratory used for False Bay analysis is SANAS accredited for E Coli, fecal coliforms and total coliforms in effluent, potable water and environmental samples as well as Enterobacteriaceae for environmental samples. …
>
> Project Blue was initiated after requests from concerned community members and water user groups and funding was community donation based with no single donor providing more than 20% of the project costs. As many donors are regular swimmers and kayakers it is surely evident that they would prefer that no evidence of pollution be found, there is thus no outside agenda." (Rethink The Stink, 2025).

The City responded to say it "the "Project Blue" report falsely claims to have used SANAS-accredited laboratories to analyze coastal water quality data. Neither of the two laboratories used are in fact SANAS accredited for analysis of either *E. coli* or enterococci in seawater." It adds, "This is at best a major oversight by the three academics named in the Project Blue report, or at worst, a major misrepresentation of the facts with the intent to mislead the public." (City of Cape Town, 2025)

A journalist responded with evidence of "valid South African National Accreditation System accreditation which is indeed possessed by the two labs used for the project. … One is certified for testing for *E. coli* in potable water, effluent and environmental samples. The other lab is certified for testing both *E. coli* and Enterococci in sea water." The journalist noted that after publication of the online article, the City had demanded a change of "sea water" to "saline water" (Engel, 2025).

The head of safety and security in the city, a political appointee, released a cartoon showing a car wreck with the caption "Imagine if "Project Blue" was also responsible for vehicle roadworthy clearance" and a picture of a derelict car with the verdict "Roadworthy status: Passed" (Davis, 2025). A fortnight later the Deputy Mayor published a further response again alleging that the laboratories were not accredited for testing sea water (notwithstanding their accreditation for saline water) and arguing that:

> At the heart of the activism behind Project Blue is a suspicion that sewage from these three outfalls —at Camps Bay, Hout Bay, and Green Point—does not disperse into a limited zone in deep waters at a safe distance from the shore as designed, without deleterious impact on the environment or human health, but instead that the pollution is carried by tides back to the beaches.
>
> Thankfully, to debunk this fear, the city has published 10 years of extensive monitoring, reporting and analyses from independent experts, all available online, including data from hundreds of water samples from around 18 stations at each of these outfalls, which also perform salinity tests at the bottom, mid-water, and surface.
>
> Detailed numerical dispersion modeling shows that South African Water Quality Guidelines are not exceeded anywhere along the shoreline due to the effluent from the marine outfalls (Andrews, 2025).

This argument is not borne out by the testing commissioned by the City which clearly demonstrated that under certain conditions the laws of thermodynamics result in warmer sewage rising to the surface and being blown back to the Atlantic shore when a north-west is wind blowing (see Section 3.4 below, and CLS 20221a, 2022b, 2022c). The argument is further invalidated by evidence of bioaccumulations of pharmacopeia in shoreline sessile organisms, as demonstrated by Petrik et al. (2017). Moreover, the City's 12-month rolling averages show unacceptable water conditions (see e.g., City of Cape Town, 2020a).

Details of two further examples demonstrate the weaponization of laboratory access and accreditation. Petrik's then-Dean advised her that City officials had approached him to request her laboratory activities be curtailed, but that he had refused on the grounds of academic freedom. And after publication of an article on pharmaceutical contaminants in fish caught in False Bay (Ojemaye, Onwordi, & Petrik, 2020), the authors received correspondence from the head of a laboratory that had been used, threatening to request a journal retraction on the grounds that the published research was hurting fishers' livelihoods (an identical claim to that made by officials in the same week), and asserting that laboratory protocols had not been followed. The claims were refuted. No further reply was received.

3.3.3. Claims of Laboratory Failure

Around the time of the local government elections in 2021 during which a major issue was the inland river water quality, all three recreational water bodies in Cape Town were closed due to unacceptable levels of sewage contamination.

Officials claimed that the City's Scientific Services had experienced a laboratory equipment failure in terms of which the water tests at Milnerton lagoon had serially "over-counted" its results and implying that the water quality had been acceptable during the pre-election period.

By contrast, all seven water tests conducted for 3 weeks running at Zeekoevlei, an inland lake, claimed to show exactly 10 *E. coli* cfu per 100 mL. Understanding this incongruous result is difficult for 21 tests in an urban wetland that abuts the Cape Flats Wastewater Treatment Works. It is possible that a scientist was releasing the Zeekoevlei results in a manner that would provoke questions about whether political pressure was being exerted on the laboratory. Tragically, this theory could not be confirmed as the head of Scientific Services, Mpharu Hloyi, was killed in an incidence of spousal abuse at her place of work in which Hloyi courageously intervened to prevent her colleague from being shot (Duval, 2024).

Notably, both sets of errant results arrived at the same conclusion: that the respective bodies of water were safe for recreational use. Officials did not explain to a journalist how the same laboratory failure could have overcounted microbial contamination in samples from one lake, while undercounting those from another (Ntseku, 2022).

3.4. A Flawed Paradigm: A Call for Hydrological Realism in Water Contaminant Governance

3.4.1. Flow Data

In recent years, laboratory data has been communicated more regularly in the summer season (November to February) on the city's "Coastal Summer Dashboard," however, this has a lag time of 4–14 days. This also leaves out 8 months of the year, typically when sea water is colder and the warmer sewage water tends to rise to the surface and be blown inshore on the prevailing north-west wind (CLS Southern Africa, 2022b, 2022a, 2022c). Summer south-east winds blow sewage offshore, although occasional rain winds from the north-west will blow surface water inshore. Subsequent higher microbial counts after rainfall events are however officially attributed only to the flushing of catchments, rather than the changed direction of currents around sewage. A newly introduced sampling regime may improve this (City of Cape Town, 2024) however the current data is patchy and not linked to prevailing winds. It is therefore unable to assist people to know which beaches are likely to be safest under specific conditions.

Predictive modeling is considered, in scientific literature, to be best practice in beach management because it uses available modeling techniques to address flows. With predictive modeling, it is possible to forewarn beach users of the risks when specific currents are likely to carry sewage plumes in a particular direction. In the absence of predictive modeling, data is only available a week later at the earliest—far too late for citizens to change their weekend beach plans.

Having argued the case for predictive modeling in City beach management in 2017 (Petrik et al., 2017), members of this team raised an international grant that, among other scientific goals, sought to design a smartphone app that would be available to the public to facilitate the choice of the safest beach on any given day. The app was to be based on the existing models of brine dispersal that had been designed for the desalination plants in Table Bay (which would have used the marine outfall) and False Bay (Laird et al., 2017). Given the existence of the brine models from the outfalls that had been designed for the desalination plants, it was possible to predict where sewage plumes would flow based on winds and currents. Accordingly, the team engaged scientific colleagues from an appropriate national government agency who would be in a position to disseminate the data without any conflicts of interest. However, when a representative of this agency approached City officials to request access to the daily data on temperature, viscosity and salinity of marine sewage outfalls to build the app, the response was negative. Without the data, the predictive modeling app was not able to function. Citizens therefore do not have access to real-time tools with which to assess which would be the safest beach to swim on, along the 300 km-long coastline.

Multiple routes to real time information on plume flow exist, including via the use of geospatial data (see Faria et al., 2023; Klemas, 2012; Mamidisetti & Vijay, 2023). In addition, the capacity to model sewage outfall flows was commissioned by the City prior to the approval of the desalination plants. Most astonishing is that the City had commissioned a plume modeling study at Hout Bay, Camps Bay and at Green Point *but required the consulting scientists not to disclose the findings*, contravening the South African Constitution which guarantees both public access to information, and freedom of scientific enquiry. Completed in 2022, these studies were marked for "limited distribution" and the conditions of the use of the report are noted as follows:

> "This report is the property of the client … CLS Southern Africa will not publish this report or the detailed results without the client's prior consent. CLS Southern Africa is, however, entitled to use technical information obtained from the investigation *but undertakes*, *in doing so*, *not to identify the sponsor or the subject of this investigation*" (CLS Southern Africa, 2022a, 2022b, 2022c; our emphasis).

At present, this modeling is presented to the public at the City's biannual Public Advisory Forum (PAF), but the models are based on an instant in time, thus misrepresenting the result of continuous daily flows. Moreover, although the models are used by the city, at PAF meetings, to argue that the outfall plumes hardly ever reach the shoreline, its data is not available in real time. Multiple calls have been made for this. A report in the online *Daily Maverick*, for example, recounts the hospitalization of three beachgoers between May and November 2023 had swum or surfed at Strand Beach along the False Bay coast near to rivers that receive discharges from sewage treatment plants including the Cape Flats Wastewater Treatment Works (to the Zeekoe River) and the Zandvliet Wastewater Treatment Works (to the Kuils and then the Eerste River). All reported serious infections that were

(variously) respiratory, abdominal and dermal, including a report of one surfer's struggle with antibiotic-resistant bacteria (Engel, 2024). Asked by the journalist whether a daily flag system could be used to warn people of water quality, a coastal management official rebuffed the proposal, saying they would need "lots of signs to explain the flags and colors, and what they mean to the people. We do this with our shark spotting flags and still people get confused after 16 years" (Engel, 2024). However, the Shark Spotters program has won at least three major awards for excellence, including one from the City of Cape Town in 2014; from a tourism authority in 2016, and from South African National Parks in 2024.

A change in the approach to the production of facts about water is urgent and necessary to address water data in the fullness of its materiality: its kinetics, thermodynamics, metabolism, ingestion and meteorological responsiveness. Without this "hydrological realism" in an approach to scientific data, a default position ineluctably becomes defensive protection of the empirically implausible.

3.4.2. Eliding Metabolic Processes

In an online meeting with water scientists in 2021, a senior water official screened an aerial image, then circulating on social media, of black water flowing out of the Milnerton estuary into Table Bay on the Atlantic Ocean. The official requested that scientists assist the City to educate the public that the black water was not sewage, but an algal bloom. Yet an algal bloom of that size in estuarine water would not have been present at that level if a sewage spill had not preceded it.

At around the same time, the City had failed to timeously renew a sludge collection contract from the Potsdam WWTW in Milnerton. The result was a terrible stench and a public outcry. The incumbent political head of water and waste in the city responded to public protest with the same denial, and declared on radio, "It's not sewage: it's sludge!" (Friedman, 2021). Claiming sewage as sludge, or as algal bloom, or in other contexts, "foam," becomes possible when evidence is reduced to the thing itself, independent of any metabolic processes. A conceptual sleight of hand, the argument reduces a phenomenon to an object as if it is "pure nature" devoid of the human, and therefore, independent of municipal responsibility.

Multiple City communiqués have claimed that algal blooms in the area, which have been demonstrated to be increasing, are "natural." While it is certainly the case that an ocean upwelling releases algal blooms, it is nonsensical to suggest that the chlorophylls in an algal bloom somehow distinguish between nitrates from human urine and nitrates from "nature." The argument exemplifies the central myth of modernist thought (Latour, 2004): that nature is independent of humans, as if human waste is somehow external to the Earth and independent of its flows.

4. Commentary

The material presented above highlights the multiple ways in which contaminant misinformation is made possible when the production and communication of scientific evidence is reduced to a product in service to a goal, whether that be the reputational goal of the city as a tourist destination; a political party vying for reputation as a good municipal manager, or the KPIs of a division whose responsibilities institutionalize a conflict of interest to both manage beaches and contract the science that proves them to be well managed.

Conflicts of interest must be addressed in institutional design. The use of scientific indicators to test good governance is laudable. However, when the responsibility for procuring scientific data and ensuring clean water bodies is included in the same municipal division's responsibility, the produced or contracted science risks a conflict of interest that could run contrary to established principles of scientific integrity. Those who are responsible for providing a clean environment should not be those procuring the science that proves it so.

Science procurement requires the revision of institutional safeguards if scientific integrity is to be guaranteed. Questions should be asked as to why a global for-profit scientific company was contracted to provide low resolution spectrometry that could easily be checked with higher resolution equipment available in South Africa (see Section 3.2.7). Eurofins, the international company in question, has some 800 global branches and provides scientific services on contract to corporates and governments. In the USA, "Good Jobs First," a policy resource center promoting corporate and government accountability in economic development, had by 2018 noted 11 adverse court judgments against Eurofins in that country, including penalties of over $26 million for "kickbacks

and bribery" and "false records" (Good Jobs First, n.d.). The Pennsylvania Department of Environmental Protection (DEP), for example, collected:

> … a $600 000 penalty from Eurofins, QC (EQC), for violations related to falsified and mishandled discharge water tests and results at their lab in Southampton, PA. … ***After*** being alerted to the questionable results, EQC hired a third-party auditor to review records from the facility. *That audit found hundreds of cases of manipulated or falsified data, as well as hundreds of missing records, and cases where samples were mishandled.* (Pennsylvania Pressroom, 2018; our emphasis)

These accounts underscore the importance of independently funded laboratories with tenured staff where scientific testing may be pursued in the public interest. For-profit science that depends on future contracts is not operating under the conditions of academic freedom that are the guarantors of the institution of science.

Corporate brand management and political reputation management strategies cannot guarantee reliable public science communication. When an official asked this team, for example, "How can you publish this at the start of the tourist season?," the question suggested that science-based governance was subsumed to the goals of brand management. Similarly, when journalists asking questions about contamination receive the reply that the city is "blessed" with a beautiful environment for tourism, the claim renders dissenting evidentiaries to the realm of unbelief—and science slips on to the spectrum between opinion marketing and quasi-religious dogma (Mavelli, 2020). For this reason, public science communications from officials who are reporting on matters involving constitutional rights, should be routinely subject to question and skepticism by science journalists and independent researchers including on the collection and handling of samples, and the independence of contracted scientific services. All public science and its communication by officials should be subject to audits by independent and authoritative scientific bodies such as a national academy of science.

Ad hominem attacks harm the institution of science as a whole. Scientific research requires funding, access to data, and a scientific community with which to work and be accountable. All three are necessary. When officials have engaged in reputational denunciations and "science wars," other water scientists in possession of contrary data have remained silent. Multiple accounts of adverse findings by scientists in this sector were shared by both scientists and dissenting officials with members of our team on the condition that they were to be assured total anonymity. The information that scientists, community and ratepayer associations shared off the record with us included research on algal blooms; microbial contaminants including Cyanobacteria; data on sewage to rivers, and the proceedings of meetings in which the City had required signature of non-disclosure agreements. Authoritarian uses of the institution of science run counter to the institution of science, and to the practice of democratic governance.

Non-disclosure agreements with contracted scientists are inappropriate and unlawful. In the South African Constitution, the Bill of Rights (BoR) forms Chapter 2. Within that, BoR Section 32 provides that "Everyone has the right of access to (a) any information held by the state; and (b) any information that is held by another person and that is required for the exercise or protection of any rights" (Republic of South Africa, 1996). Moreover, BoR Section 16 guarantees academic freedom and the freedom of scientific research, and BoR Section 24 provides that "Everyone has the right (a) to an environment that is not harmful to their health or well-being; and (b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that (i) prevent pollution and ecological degradation …". Taken together it is clear that South Africa's Constitution requires officials to provide access to all data that is in the public sphere and support its public discussion, expressions of dissent, and procedural scrutiny. Accordingly, the request for non-disclosure as formalized in the 2022 City studies of sewage plumes (see Section 3.4.2) in which the authors were required to agree not to disclose data on environmental pollution (CLS, 2022a, 2022b, 2022c), appears to be unlawful.

Excellence in governance is not defined by the absence of pollutants, but the will to acknowledge and deal with them. Contamination results from our collective inheritance of wrongful ideas whose flaws were evident a century ago (Overy, 2020). Those errors are compounded in an era of mass-consumption of pharmaceuticals and other environmental contaminants that are not biodegradable, and which bioaccumulate in living tissues all along the food chain. When courageous leadership is absent, a culture of blame and fear sets in, putting enormous pressure on middle-management who, as the saying goes, may be compelled to keep "rearranging the deck chairs on the Titanic." Then, instead of addressing the legacy of contaminants from inherited infrastructures designed with the fiction that all wastes are absorbed by oceans, rivers or wetlands, shifting blame becomes a political habit. At the end of the era that has generated the hockey-stick graphs defining multiple measures of environmental

degradation (Steffen et al., 2015), political leadership requires the insight necessary to acknowledge the flaws of inherited infrastructures. Blaming "human behavior" or incumbent political parties when infrastructure design is premised on flawed ideas (see e.g., Newman et al., 2024, p. 7), individualizes and renders partisan the responsibility for clean-ups.

When political leadership perceives mention of human waste to be socioculturally unacceptable, the conditions exist to conceal, deny and obscure its presence. When this is exacerbated by the fiction that a city's "pristine nature" exists separately from "society," a culture of contaminant denial predominates. In such a situation, officials situate themselves as the defenders of all that is blessed, rendering profane those whose empirical data brings this set of beliefs into question. The socio-cultural denial of bodily wastes becomes an ideological dogma to be defended rather than addressed with cooperative problem-solving. This is a particular problem in landscapes that were designed around racism; a factor noted by UN Special Rapporteur on the implications for human rights of the environmentally sound management and disposal of hazardous substances and wastes, Marcos Orellana, in a visit to South Africa in 2024 (Orrelana, 2024).

Predictive modeling changes an unhelpful reliance on point data. Basic work on predictive modeling has already been done by the City, paid for by ratepayers (CLS, 2022a, 2022b, 2022c; see Section 3.4.1 above). In addition, ocean and atmospheric data sets are readily available, and daily data of the movement of contaminated plumes should be placed in the public service. It makes no sense to continue to study ocean contaminants using point data collected fortnightly when public health is at risk and the tools are available to make those risks known on a daily basis. "Another science is possible" (Stengers, 2018). Water is a constantly moving medium. That hydrological reality should be the basis of water body management. Working with point data collected twice a month from a body that moves 24/7/365, and to which sewage is constantly dispersed via rivers and outfalls, is an inherently flawed methodology that can only lead to a situation of permanent contestation.

This study provides a conceptual framework for understanding contaminant denialism encountered in official public communications, namely data foreclosure; misinformation; the weaponization of science, and the use of point data instead of flow models. We assert that the findings and conclusions have a wider significance as the institutional and sociological conditions that we identify here, in respect of increasingly privatized science and the ubiquity of claims to scientific authority in political marketing, are not unique. Under these conditions, new risks to academic freedom and media freedom arise where misinformation is claimed as truth. These struggles over the institution of science and the role of the university in public life, warrant strategic responses from academies of science globally.

Our experiences as an independent team of contaminant researchers have been challenging when working alongside communities where health, ecology, livestock and recreation have been profoundly harmed by ongoing contamination that we have documented, only to hear this evidence denied (though later confirmed) by City data that had been previously undisclosed. We recognize and value the beginnings of new steps to data transparency in the Mayoral office, noting in particular the efforts made toward data availability for inland water bodies (City of Cape Town, 2020b), even as we observe with concern that this standard has not been matched by the Coastal Water Quality report (City of Cape Town, 2020a, 2022, 2023b). We would welcome generative dialog on resetting the scientific methods and paradigm that inform publics on environmental safety. As such, we share this study with the hope that it will contribute to the emergence of a strong and credible public science based on predictive modeling, and that reduces harmful contaminant loads.

Data Availability Statement

No new data were used or produced in this study. All data referred to are published and referenced in the paper. A chronological account with links to key reports is available in Supporting Information S1.

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