Is Victoria Sewage Contaminating Southern Resident Killer Whales?

A Technical Submission to the SETAC Victoria Sewage Scientific and Technical Review Panel

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Abstract

This technical submission to the SETAC panel reviewing Victoria sewage is a review of the literature and the public record. It focuses on the possible relationship between contaminants in Victoria sewage and contaminants in southern resident killer whales. Specifically, it looks for possible indicators that Victoria sewage may be harming orcas. Finally, it assesses whether sewage treatment would help the orcas' plight.

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Introduction

Southern resident killer whales are on the endangered species list in both Canada[1] and the United States[2]. Experts say they are subject to a number of threats, some of which are environmental in nature[3].

This submission seeks to answer two questions:

1. Could Victoria's untreated sewage disposal be harming the resident orcas?, and
2. If so, would sewage treatment aid in their recovery?

Environmental Threats to the Orcas

The following categories of threats to the resident orcas of the Georgia Basin/Puget Sound area, which consists of three pods – J, K and L, numbering approximately ninety individuals, have been identified:

- Environmental contaminants
- Reduced prey availability
- Disturbance, and
- Noise pollution[4].

This submission concentrates on the threat posed by environmental contaminants, and specifically those associated with raw, untreated sewage.

Southern residents are considered to be amongst the most contaminated animals on the planet[5]. Numerous environmental threats from urban and non-urban activities have been identified in connection with southern resident orcas; sources include leachate from landfills and effluent from wastewater treatment plants[6]. Threats to the orcas include both biological and chemical pollutants.

Killer whales whose immune systems are compromised by chemical contaminants may be especially vulnerable to biological pollutants[7]. Biological pollutants either directly or indirectly impacting resident killer whales include antibiotic resistant bacteria and

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[1] They were listed as endangered by COSEWIC in November, 2001. When the Species at Risk Act (SARA) entered into force in June, 2003, they were listed on Schedule 3.
[2] They were listed under the Endangered Species Act on November 15, 2005.
[3] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, esp. pp. 17-22.
[4] Ibid., p. 17.
[5] Ibid., p. 17.
[6] National Marine Fisheries Service. 2005. Proposed Conservation Plan for Southern Resident Killer Whales (*Orcinus orca)*. National Marine Fisheries Service, Northwest Region, Seattle, Washington. (NMFS), p. 81.
[7] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, p. 20.

pathogens[8]. Experts also call for monitoring and minimizing the risk of infectious diseases in southern resident whales, since the southern resident community is vulnerable to a serious disease outbreak of this type[9].

Chemical pollutants threatening the southern residents include persistent organic pollutants (POPs) such as PCBs and DDT, which, although no longer widely used in countries such as Canada and the United States, persist in the environment[10]. High levels of PCBs have been found in the bodies of killer whales[11]. Although banned more than thirty years ago, they remain the pre-eminent toxic of concern to killer whales at present. The PCBs, which bioaccumulate in orcas, pose a risk of reproductive impairment, skeletal abnormalities, immunotoxicity and endocrine disruption[12].

While traditional POPs are said to pose the biggest threat to orcas, a number of lightly regulated, so-called emerging chemicals may have similar effects. They include:

- Polychlorinated paraffins
- Brominated flame retardants
- Fluorinated organic surfactants (PFOs)
- Polychlorinated napthalenes
- Polychlorinated terphenyls, and
- Alkyl phenol ethoxylates[13]

Recent evidence suggests that one type of these emerging chemicals, brominated flame retardants, which fall into a group called polybrominated diphenyl ethers, or PBDEs, are turning up in Chinook salmon, the principal prey of the resident orcas[14]. Of particular concern is the fact that, in contrast to the banned PCBs and DDT, the use of PBDEs is likely doubling in the environment every 3.5 to five years.

The PBDEs and other POPs are a type of endocrine disrupting chemical (EDC). EDCs from numerous sources are considered to be a threat to orcas[15]. Wong divides EDCs into

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[8] National Marine Fisheries Service. 2005. Proposed Conservation Plan for Southern Resident Killer Whales (*Orcinus orca)*. National Marine Fisheries Service, Northwest Region, Seattle, Washington. (NMFS), p. 72,

[9] National Marine Fisheries Service. 2005. Proposed Conservation Plan for Southern Resident Killer Whales (*Orcinus orca)*. National Marine Fisheries Service, Northwest Region, Seattle, Washington. (NMFS), p. 109.

[10] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, esp. p. 17.

[11] Ibid., p. 18.

[12] Ibid., Table 1, p.19.

[13] A Comparative Review of the CRD's Environmental Monitoring Programs for the Clover Point and Macaulay Point Wastewater Outfalls, Prepared by 2WE Associates Consulting Ltd. For Environment Canada, Pacific and Yukon Region, January 2002 (revised), p. 22.

[14] Hites, Ronald A., et al, "Global Assessment of Polybrominated Diphenyl Ethers in Farmed and Wild Salmon", Environmental Science & Technology, Vol. 38, No. 19, August 10, 2004, pp. 4945-4949.

[15]The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, Table 1, p. 19.

six classes of chemicals, and provides examples of the compounds within each of those classes as well as their potential sources. These are, as follows:

1. Steroids and sterols, including naturally occurring hormones and synthetic hormones
2. Organohalides such as DDT, dioxins and PCBs
3. Metals and organometals such as cadmium, tributyl tin, mercury and lead
4. Alkylphenols
5. Polynuclear aromatic hydrocarbons (PAHs) and crude oil
6. Plasticizers[16].

Catastrophic events such as oil spills also pose a "serious threat" to both killer whales and their prey[17]. There is no evidence that killer whales avoid oil, the best example of this being the 1989 *Exxon Valdez* spill in Prince William Sound, after which many members of the local pod of killer whales died[18]. Locally, oil spills pose a particular threat to the killer whales because of the heavy volumes of tanker (and other commercial) traffic in and out of Puget Sound and the Strait of Georgia[19].

Trace metals are also of concern to killer whales, principally via their prey. Cadmium, mercury, copper and lead, for example, may have toxic effects even at relatively low concentrations, and could impact killer whales. However, effects on their prey and/or habitat are more likely, since their livers seem to adapt to these toxic substances[20].

Contaminants in Victoria Sewage of Potential Damage to Resident Orcas

Approximately 150 kgs of PCBs are thought to be buried in sediments in the Strait of Georgia each year; comparable data for Juan de Fuca Strait do not exist[21]. Of this overall figure for the Strait of Georgia, approximately 2 kgs per year is believed to come from Victoria sewage[22]. Thus, a link between PCBs in the Strait of Georgia and Victoria sewage has been established[23].

From Wong's classes of EDCs listed in the previous section of this submission, there are five potential sources to sewer water:

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[16] Victoria Sewage: Separating Myth from Fact, Public Forum Transcript, September 26, 2005, Victoria, British Columbia, p. 16.
[17] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, p. 45.
[18] Ibid.
[19] Ibid., p. 32.
[20] Ibid., p. 21.
[21] Response to Petition 112 Filed by Sierra Legal Defence Fund Under the *Auditor General Act* Concerning: *Persistent Organic Pollutants in Wastewater*, Minister of the Environment (Canada), August 2004, p. 5.
[22] Ibid.
[23] It bears mentioning, however, that the CRD's own figures for 2004 at least show no PCBs whatsoever entering either outfall pipe. See Macaulay and Clover Point Wastewater and Marine Environment Program, 2004 Annual Report, Appendices D1 and D2.

- Human excretion
- Storm water runoff
- Areas treated with certain pesticides
- Personal care products
- Household fungicides[24].

Wong claims that every class of EDC listed above is present in municipal wastewater[25].

Large volumes of oil and grease are also being discharged from the two outfall pipes, although it is not possible to say how much of this is oil and how much is grease. Also, the term 'oil' is not broken down into types, such as cooking oil or engine oil[26].

In terms of metals, taking the example of mercury, an estimated 5.2 kgs was discharged from the Clover Point and Macaulay Point outfalls in 2004; Clover Point accounted for 3.8 kgs of this amount[27].

In researching this report, no data could be found on the amount of pathogens entering the waters of Juan de Fuca Strait from either of the two CRD outfall pipes.

Is Sewage Harming the Orcas?

PCBs are thought to get ingested into killer whales via the food chain - principally the Chinook salmon that they eat[28]. Chinook account for approximately 65% of killer whale diet[29].

Could at least some of these PCBs that end up in the Chinook and the whales be coming from Victoria sewage? Significantly, in the Marine Monitoring Advisory Group (MMAG)'s 2004 Annual Report to the Capital Regional District, one member of the Group called for effluent tracer studies to determine the fate of contaminants, particularly from the Clover Point outfall pipe. This member's concern was said to be that contaminants from this outfall pipe may end up as far east as Haro Strait, where they could "…enter the food web at all water depths,…"[30]. The same report indicates that this and other suggestions for additional investigation would be discussed by the MMAG in

[24] Victoria Sewage: Separating Myth from Fact, Public Forum Transcript, September 26, 2005, p. 16.
[25] Ibid.
[26] Macaulay and Clover Point Wastewater and Marine Environment Program, 2004 Annual Report, Appendices D1 and D2.
[27] Ibid.
[28] National Marine Fisheries Service. 2005. Proposed Conservation Plan for Southern Resident Killer Whales (*Orcinus orca)*. National Marine Fisheries Service, Northwest Region, Seattle, Washington. (NMFS), p. 79.
[29] Ibid., p. 10.
[30] Marine Monitoring Advisory Group Comments, 2004, p. 3. According to Davenne and Masson in "Water Properties in the Straits of Georgia and Juan de Fuca", August 2001 p. 9, the circulation produced by residual currents is as follows in Juan de Fuca Strait: surface water flows towards the west, while deep water flows eastward. A residual current is defined as the observed current minus the astronomical tidal current.

2005, with a view to determining "…whether they should be pursued…"[31]. There is, however, no mention of this item in the 2005 MMAG Annual Report.

A current meter located approximately ten metres above the Clover point outfall pipe is said to reveal that "…the strongest and most frequent currents" there move in the direction of the east 54% of the time[32]. Additionally, the results from some modelling undertaken in the early nineties reveal that an "…estimated 22 percent of dissolved sewage effluent from Vancouver and Victoria theoretically enters Puget Sound"[33].

Thus, Victoria sewage is being dumped, screened but untreated, into Juan de Fuca Strait, part of the core area for the local orcas. That core area includes parts of Georgia Strait, Puget Sound and the Strait of Juan de Fuca. The core area "is utilized regularly by all three southern resident pods during June through October in most years"[34], and J pod through much of the remainder of the year. For this reason, parts of the core area are being proposed as southern orca critical habitat[35]. And although during the summer months the whales spend much of their time swimming and feeding in Haro Strait (whence the concentration of whale watching activity in that area), from time to time the orcas swim right through the sewage, over the outfall pipes off of Clover Point and Macaulay Point (personal observation, Summer, 2005).

Evidence that at least some of the waters of the Strait of Juan de Fuca are contaminated is provided by the shellfish closure zone which at least partially overlaps the area of the orca's critical habitat. This shellfish exclusion zone, which owes its existence in part to sewage discharges, has been growing over the years; at the time of writing it encompasses an area of 60 square kms[36].

For its part, the U. S. Proposed Recovery Plan for southern residents expressly mentions sewage treatment plants as a potentially significant source of contamination[37]. With respect to flame retardants, for example, it states that they "…probably enter the marine environment via manufacturing processes and wastewater effluents"[38]. Canada's Draft National Recovery Strategy also lists "municipal effluent outfalls", "sewer overflows",

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[31] Marine Monitoring Advisory Group Comments, 2004, p. 3.
[32] Markovic, Untreated Municipal Sewage Discharge in Victoria Bight, British Columbia: An Investigation of Sediment Metal Contamination and Implications for Sustainable Development, Masters Thesis, Royal Roads University, April, 2003, p. 25.
[33] Response to Petition 112 Filed by Sierra Legal Defence Fund Under the *Auditor General Act* Concerning: *Persistent Organic Pollutants in Wastewater*, Minister of the Environment (Canada), August 2004, p.8.
[34] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, p. 4.
[35] Ibid., p. 34.
[36] Wong, quoted in Victoria Sewage: Separating Myth from Fact, Public Forum Transcript, September 26, 2005, Victoria, British Columbia, p. 15.
[37] National Marine Fisheries Service. 2005. Proposed Conservation Plan for Southern Resident Killer Whales (*Orcinus orca)*. National Marine Fisheries Service, Northwest Region, Seattle, Washington. (NMFS), p. 104.
[38] Ibid., p. 78.

and "urban runoff and storm-water drainage" as sources of contaminants potentially affecting killer whales[39].

As Environment Canada is quoted as saying, "there are many scientific uncertainties and unknowns regarding potential impacts of sewage effluents upon receiving environments"[40]. Obviously, then, further research is required, including on the possible link between Victoria sewage and killer whales. On balance, though, it would seem entirely possible that the contaminants in Victoria sewage could be contributing to the precarious status of the southern resident orca community, particularly if there is, as is suggested in the 2004 MMAG comment, a pathway for these contaminants to travel from the Clover Point outfall pipe to Haro Strait.

Would Sewage Treatment Help the Orcas?

Because the predominant process controlling the concentration of PCBs in local surface waters is thought to be air-sea exchange, the Auditor General believes that discontinuing the practice of discharging wastewater effluent "…would result in no measurable change in the net flux of PCBs into the Strait of Georgia"[41].
She reaches this conclusion because Victoria's contribution to the 150 kg per year Georgia Strait PCB burden is only around 2 kg. However, the Auditor General does not include amounts for Victoria sewage's contribution to the PCB burden in Juan de Fuca Strait, on the grounds that such figures are unavailable. One would have thought that this contribution would be a multiple of the 2 kg figure for Georgia Strait, since the effluent is discharged into the Strait, and only a fraction of it is thought to migrate to Georgia Strait. In any case, since PCBs are no longer being produced, their importance as a source of contaminants is likely to wane as time goes by, with the bigger concern coming from other endocrine disruptors and emerging chemicals, including the flame retardants.

Also on the subject of PCBs, while the Auditor General seems to admit the claim that secondary treatment removes up to 99% of them in wastewater, she also counterclaims that PCBs and many other constituents in wastewater are not destroyed by treatment; instead, they either pass through the process or end up in sludge, requiring either land application, incineration or landfill[42].

As for the impact of secondary treatment on EDCs, Wong claims that secondary treatment, coupled with disinfection, can remove >90% of many of most common compounds known or suspected to be EDCs that enter a treatment plant[43].

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[39] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, p. 22.
[40] Victoria Sewage: Separating Myth from Fact, Public Forum Transcript, September 26, 2005, Victoria, British Columbia, p. 27.
[41] Ibid., p. 1.
[42] Ibid., p.7.
[43] Victoria Sewage: Separating Myth from Fact, Public Forum Transcript, September 26, 2005, Victoria, British Columbia, p. 16.

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Critics of sewage treatment argue that it unnecessarily gets rid of substances that the ocean naturally takes care of, such as pathogens. Ishiguru, however, is not convinced that pathogens in Victoria's raw sewage are destroyed in the cold waters off our shores.[44]. He also points to the fact that in the absence of sewage treatment, the sludge that treatment would otherwise produce is, in effect, being dumped into the ocean off Victoria on a daily basis[45].

The American draft orca recovery plan specifically mentions improvements in managing sewage outflows as one possible way to "prevent the introduction of such pathogens into southern resident habitats"[46].

On the Canadian side of the border, the draft recovery plan lists "Continue to upgrade water treatment plants" as one of the "Recommended Additional Measures" to be taken against the threat of "Chemical & Biological Contaminants in Canadian Waters"[47].

Summary and Conclusion

A review of the literature and public record indicates a high degree of uncertainty as to whether Victoria sewage is harming the endangered southern resident killer whales. On the other hand, a number of chemical, biological and oceanographic indicators raise the possibility that this is indeed occurring. And, the fact that these same whales have recently achieved endangered status on both sides of the border should lead one to think twice before fouling prime orca habitat.

Admittedly, recovery plans for the southern residents in both Canada and the United States recognise numerous environmental threats to the orcas, municipal effluent being just one of them. Still, a number of the contaminants that threaten the orcas also appear to be present in Victoria sewage; these include PCBs, pathogens, oil and PBDEs.

This is not to say that the presence of these contaminants in the orcas has been traced to Victoria sewage; in short, there is no 'smoking gun'. But, at least one Marine Monitoring Advisory Group scientist has shown concern about possible migration of sewage contaminants from Clover Point into Haro Strait, and from there into the food chain. Oceanographers have ascertained that deep bottom currents around Clover Point move inland, towards Haro Strait.

That same Haro Strait, where contaminants from an unknown portion of Victoria sewage are suspected to end up, is home turf to endangered southern resident killer whales, particularly during the summer months, and year-round in the case of J pod. At all times of the year orcas swim these waters in search of Chinook salmon, their principal source of food. Occasionally the orcas will also come into the Strait of Juan de Fuca, in the

[44] Ibid., p. 7.
[45] Ibid.
[46] Ibid., p. 109.
[47] The Draft (Canadian) National Recovery Strategy for Northern and Southern Resident Killer Whales (*Orcinus orca*), March 2005, p. 40.

vicinity of both Victoria outfall pipes. The Chinook are contaminated, and through the process of bioaccumulation it is thought that the contaminants in them are being passed on to animals higher in the food chain – notably the killer whales.

The conclusion, then, would seem to be that PCBs, emerging chemicals and pathogens from Victoria sewage could, in combination, weaken or impact southern resident whales. For, as mentioned in the body of the paper, killer whales whose immune systems are compromised by chemical contaminants might be particularly vulnerable to biological pollutants. In other words, this might be a case of double jeopardy. Scientists have identified many other stressors on the orcas, though, and for this reason, sewage treatment is not a magic bullet. For example, there would still be the very real possibility of the southern resident community being wiped out by a catastrophic oil spill.

The local killer whales are a valued ecosystem component if ever there was one, as witnessed by the significant contribution of whale watching adventures to the local economy. Seen in this light, sewage treatment is just one tool in an arsenal of southern resident killer whale recovery options that also includes increasing the availability of their prey and reducing disturbances such as noise. But it is significant that both the Canadians and the Americans, in their efforts to reduce the potential stressors on the killer whales, and generally improve the marine environmental quality in their core area, do include sewage treatment components in the overall draft recovery plans for the species.

Undoubtedly, more research is called for. For instance, we need to know what happens to Victoria's sewage when it gets into the water column, and where it ends up. Such research could eventually determine that the contaminated effluent is, contrary to expectation, harmless to killer whales. But do we, as a society, have the luxury of waiting until such studies are complete?

A key issue may be whether we want to take a chance with the future of the southern resident killer whales, for whom time may be running out, judging by their endangered status. By incessantly disposing of raw sewage into Victoria Bight, are we not gambling with the survival of these icons of the Pacific northwest?

In brief, how insistent are we on continuing this live and potentially dangerous experiment with nature, without, for instance, even knowing where the sewage goes and what becomes of it? Will we ever know for sure? These are some of the questions the SETAC panel may wish to consider as it goes about its deliberations. To some they may seem to be ethical rather than scientific questions, but they are actually a bit of both. For, in the end, the science should inform the ethics, and ethics should inform the science.

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