

# Notice

## *Environmental Protection Act 1994*

### Environmental Evaluation

#### **Notice to conduct or commission an environmental evaluation**

*This notice to conduct or commission an environmental evaluation is issued by the administering authority pursuant to section 326B and section 521 (5) (c) (ii) of the Environmental Protection Act 1994.*

Northern SEQ Distributor – Retailer Authority trading As Unitywater

33 King Street

CABOOLTURE QLD 4510

Attention: Mr George Theo, Chief Executive Officer

Your reference: EPPR00869113

Our reference: 101/0005498/ C-CPLRC-100084354/ E-100113006

~~Tuesday, 14 December 2021~~

Wednesday, 29 June 2022

**Take notice:** that under the *Environmental Protection Act 1994* (the Act) a notice to conduct or commission an environmental investigation is issued to Northern SEQ Distributor- Retailer Authority T/A Unitywater (Unitywater) (you) by the administering authority. The administering authority is the Chief Executive of the Department of Environment and Science (the department).

The notice to conduct or commission an environmental investigation is issued with respect to the activities of Kawana Sewage Treatment Plant (the STP), Main Drive, Bokarina, QLD 4575, on land described as Lot 101 on Plan SP295012 (the premises). Unitywater is authorised to undertake Environmentally Relevant Activity (ERA) 63-(1)(g) Sewage treatment >100,000 Equivalent Persons (EP) at the premises under the conditions of EPPR00869113 (the EA).

#### **A. Grounds**

The notice to conduct or commission an environmental investigation is issued on the following grounds:

1. Section 326B of the Act prescribes the following-  
When environmental investigation required—environmental harm (1) This section applies if the administering authority is satisfied on reasonable grounds that— (a) an event has happened causing environmental harm while an activity was being carried out; or **(b) an activity or proposed activity is causing, or is likely to cause environmental harm.**

Section 14 of the Act defines **Environmental Harm** as-

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*“any adverse effect, or potential adverse effect (whether temporary or permanent and of whatever magnitude, duration or frequency) on an environmental value, and includes environmental nuisance”.*

*Environmental harm may be caused by an activity— (a) whether the harm is a direct or indirect result of the activity; or (b) whether the harm results from the activity alone or from the combined effects of the activity and other activities or factors.*

Section 9 of the Act defines **Environmental Value** as-

*(a) “a quality or physical characteristic of the environment that is conducive to ecological health or public amenity or safety; or*

*(b) another quality of the environment identified and declared to be an environmental value under an environmental protection policy or regulation”.*

The facts and circumstances forming the basis for these grounds are:

- 1) The STP has undergone a \$73 million upgrade to increase the capacity of the plant from 100,000 EP to 200,000 EP. The increase in intensity of use and risks of environmental harm presented by the augmentation, specifically the introduction of the new secondary treatment technology known as a Moving Bed Biofilm Reactor (MBBR) has not been assessed by the administering authority. Unitywater had obtained advice indicating that amendment of the EA was not expected to be required.
- 2) One of the risks associated with MBBR technology is loss of reactor containment of MBBR plastic media.
- 3) Unitywater contracted Monadelphous (MEPL) to construct the MBBR system whereby a biofilm of microorganisms grow on MBBR plastic media carriers to break down organic matter in wastewater. MEPL were acting under Unitywater’s EA while the upgrade of the STP was underway.
- 4) Unitywater has advised the department that its contract with MEPL stipulated that the augmented plant must comply with Unitywater’s environmental authority conditions.
- 5) On 22 June 2021 Unitywater advised departmental authorised officers that the MBBR contains in excess of 3 billion individual pieces of MBBR plastic media.
- 6) The EA authorises the release of contaminants to the environment from the STP in a way which mitigates environmental harm. The EA does not authorise the release of any plastic to the environment.
- 7) On 16 January 2020, while MEPL was operating the Kawana STP, departmental officers undertook a reactive compliance inspection to investigate notifications by Unitywater of non compliances with effluent quality releases due to the commissioning of the augmented STP.
- 8) During the inspection, departmental officers discussed the risks of the MBBR technology, including the loss of reactor containment and the potential that MBBR plastic media carriers could be released to the environment in breach of Unitywater’s EA. Officers from the department stated during the inspection that the department would consider such releases to be unlawful environmental harm as the releases were not authorised by the EA.
- 9) At the time the issue was raised by the department, Unitywater staff were unsure if the mitigation measures installed by MEPL were sufficient to maintain reactor containment of MBBR plastic media.
- 10) As a result of the discussion, Unitywater conducted inspections of the beaches adjacent to the release point W1, identified as the outfall pipe located in waters described as the Pacific Ocean off Warana Beach, Caloundra, approximately 1km offshore, (condition K LW1 of the current EA).
- 11) Release point W1 is located 1 km offshore of Warana at approximately 20m depth and is comprised of a number of diffusers that are specifically designed to diffuse and disperse contaminant releases authorised by the EA from the STP into tidal waters.

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- 12) On 22 January 2020 the department received email notification from Unitywater stating that Unitywater had inspected the beaches adjacent to the release point W1.
- 13) Unitywater confirmed MBBR plastic media (the approximate volume of a golf ball) was found on the beach, despite the fact that release point W1 is located 1 km offshore.
- 14) Furthermore, Unitywater advised the department that temporary screens had been installed on the outlet of the chlorine contact tanks (CCT) to limit the potential release of the MBBR plastic media to the environment.
- 15) Compliance and technical officers from the department attended the premises on 18 February 2020 to discuss the loss of reactor containment and release of MBBR plastic media, with Unitywater.
- 16) During the inspection, departmental officers observed glass jars containing complete and broken up pieces of MBBR plastic media released from the STP which had been collected from the beach by Unitywater adjacent to the location of the release point W1.
- 17) The MBBR plastic media had been collected by Unitywater from the beach between 21 January 2020 and 10 February 2020. Whilst the volumes collected appeared to be between 10 and 50mL in each jar, it is reasonable to consider that this represents a small fraction of the volume released due to the efficacy of the outfall diffuser, the distance of the outfall offshore of Warana Beach and the dispersive influence of tide, winds and currents.
- 18) On 10 March 2020, the department issued MEPL with a warning for contravention of section 430 (3) of the Act for breach of condition WT1 of the EA for release of MBBR plastic media from release point W1 in January 2020. Condition WT1 of the EA prescribes “*Other than as permitted within this environmental authority, contaminants must not be released from any site to any waters or the bed and banks of any waters*”.
- 19) On 10 March 2020, the department issued Unitywater with a warning for contravention of section 431(1) of the Act for not ensuring MEPL complied with condition WT1 of the EA. Unitywater has advised the department that it is entitled to rely on the defence provided by s431(4) of the Act as it issued appropriate instructions and used all reasonable precautions to ensure MEPL complied with the EA; the alleged offence by MEPL was committed without the knowledge or approval of Unitywater; and Unitywater exercised all reasonable diligence to stop the commission of the offence.
- 20) On 24 September 2020 the department received notification from Unitywater which identified MBBR plastic media had again been released from the STP via WT1 ocean outfall, due to a mass sponge unknowingly growing in the clarifier pipes.
- 21) Unitywater advised that its investigation indicated that the sponge had disintegrated and flowed through chlorine contact tank 1 (CCT 1) and chlorine contact tank 2 (CCT 2) and blocked the temporary screening basket at the outlet of CCT 2.
- 22) The notification notice submitted by Unitywater stated that the temporary screening baskets had been retrofitted by Unitywater to allow effluent to flow through the CCTs and capture any broken MBBR plastic media that may have escaped from the MBBR.
- 23) Unitywater advised in the notification that it estimated the accumulation rate of MBBR plastic media in the basket is approximately 125 mL per day. Over the 5 days of the release Unitywater estimated that 625mL of media was discharged from the premises via WT1.
- 24) In the notification received on 24 September 2020, Unitywater acknowledged that the release of MBBR plastic from the premises was to the marine environment. Unitywater did not elaborate on how the release of MBBR plastic media had affected the marine environment.
- 25) As a result of the release of MBBR plastic media, Unitywater also conducted a clean-up sweep of the beach on 21 September 2020 adjacent to the release point W1. Unitywater found approximately 250mL of MBBR plastic media washed up on the adjacent beach. During subsequent inspections undertaken

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- by Unitywater on 22 and 23 September 2020 approximately 50mL of MBBR plastic media was collected from the beach. Unitywater did not undertake any inspections of the marine environment in the vicinity of the outfall location.
- 26) On 14 October 2020, MEPL submitted a notification to the department which stated approximately 500mL of MBBR plastic media was released via release point W1 as a result of the temporary screening baskets being blocked and overflowing. This notification related to the same release on 21 September 2020 that Unitywater had submitted to the department, however the volumes notified by MEPL were greater.
- 27) On Friday 6 November 2020, the department received an email notification from Unitywater stating that *“...during a shutdown activity overnight, a small warp in the CCT screen may have resulted in the potential release of MBBR plastic media from the plant”*.
- 28) As a result of the release of MBBR plastic media from the STP on 6 November 2020, a notification was received from Unitywater on 12 November 2020. In the notice, Unitywater acknowledged the release of plastic MBBR media from the STP was to the marine environment.
- 29) Additional email correspondence received by the department on 12 November 2020 confirmed that approximately 13 grams of MBBR plastic media had been collected from beaches adjacent to release point W1 as a result of the warp in the CCT from the 6 November 2020 release.
- 30) On 26 February 2021, Unitywater met with the department and reassured the department that it would work collaboratively with the department to make the STP compliant.
- 31) MEPL were operating the STP when the MBBR plastic media was released between 20 September 2020 and 6 November 2020.
- 32) The department issued MEPL with one Penalty Infringement Notice on 26 March 2021 for non-compliance with section 430 of the Act for breach of condition WT1 of the EA for releases of MBBR plastic media via release point W1 between 20 September 2020 and 21 September 2020.
- 33) The department also issued Unitywater with a warning notice on 26 March 2021 for non-compliance with section 431(1) of the Act for breach of condition WT1 of the EA whilst MEPL were operating the STP and the releases of MBBR plastic media occurred. Paragraph 19 of this notice describes Unitywater’s subsequent defence.
- 34) The department considered Unitywater’s response to the section 430 pre-enforcement letter which included commitments by Unitywater to implement a range of mitigation measures and retrofitted screens to prevent the release of MBBR plastic media from the augmented STP.
- 35) On 22 March 2021, the department received an email notification from Unitywater identifying a release of MBBR plastic media occurred from the premises as a result of hydraulic overload caused by heavy rainfall in the catchment.
- 36) A notification of the event was received on 26 March 2021 from Unitywater which stated that as a result of hydraulic overload at the discharge chamber of CCT 2, a permanently deployed floating boom twisted and failed resulting in the release of approximately 1 to 5 litres of MBBR plastic media from the STP at release point W3, the outfall pipe located in the Mooloolah River at a location described as opposite Portion 360, Parish of Mooloolah, County of Canning. According to the notification no media escaped into the ocean outfall via release point W1 and only released via W3 release point.
- 37) In the notification, Unitywater acknowledged that the release of MBBR plastic media from the premises to the Mooloolah River on 22 March 2021, was to the marine environment.
- 38) The department received a notification from Unitywater on 9 April 2021, which stated that on 5 April 2021, wet weather flows had caused the water level to rise and overtop the CCT 2 MBBR plastic media collection screen, resulting in broken MBBR plastic media that had been captured in the preceding 7 days to escape the retrofitted temporary screen and be discharged to chlorine contact tank three (CCT

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- 3). Inspection of release point W3 confirmed MBBR plastic media fragments had been discharged into the Mooloolah River.
- 39) In the notice, Unitywater acknowledge that release of MBBR plastic media from the site on 5 April 2021 was to the marine environment.
- 40) The department confirmed that Unitywater were operating the STP when the releases of MBBR plastic media occurred on 22 March 2021 and 5 April 2021.
- 41) Unitywater has provided advice that its interpretation of the technical schedule for the MBBR plastic media, is that the maximum anticipated loss of plastic media from the MBBR over a 12-month period due to plastic media degradation is 140m<sup>3</sup>.
- 42) Unitywater has provided advice that the observed loss of plastic media >2mm is around 1.5m<sup>3</sup> over a 12-month period with this media captured and not released.
- 43) Unitywater has provided advice that known releases of plastic media >2mm to the marine environment from the STP are estimated between 5 and 10 litres.
- 44) The department raised concerns with Unitywater during the inspection of the STP on 22 June 2021 that MBBR media microplastics <2mm are generated from the circulation and mechanical movement of MBBR plastic media in the aerobic and anerobic chambers of the MBBR.
- 45) Unitywater also confirmed during the 22 June 2021 inspection that <2mm MBBR media microplastics are not captured in the retrofitted Chlorine Contact Tank screens because they are smaller than the 2 mm screen aperture. Unitywater and the department agreed at the time of the inspection that the MBBR media microplastics smaller than 2 mm would continue to be released to the environment via W1 (ocean outfall) during business as usual flow scenarios and to W3 (Mooloolah River outfall) during wet weather flows.
- 46) Unitywater has advised that they currently do not have an estimate of the volume of degraded plastic media of a size <2mm released through the screens to the receiving environment.
- 47) It is the departments assessment that degradation of the MBBR plastic media as reported and observed by department officers is likely to include the generation of plastic particles <2mm.
- 48) MBBR plastic media and its degraded microplastics are considered a pollutant to the aquatic ecosystems of the Pacific Ocean and the Mooloolah River.
- 49) The *Environmental Protection (Water and Wetland Biodiversity) Policy 2019* (EPWWB) via the document titled Mooloolah River environmental values and water quality objectives, dated July 2010 ([https://environment.des.qld.gov.au/data/assets/pdf\\_file/0027/87273/mooloolah-ev-2010.pdf](https://environment.des.qld.gov.au/data/assets/pdf_file/0027/87273/mooloolah-ev-2010.pdf)) lists environmental values and water quality objectives (Basin No 141 (part), as:
- Lower Mooloolah River Estuary- Aquatic ecosystems, seagrass, human consumer, oystering, primary recreation, secondary recreation, visual recreation, industrial use and cultural and spiritual values.
- Open coastal waters - Aquatic ecosystems, seagrass, human consumer, primary recreation, secondary recreation, visual recreation, and cultural and spiritual values.
- 50) Plastic media and its degraded microplastics released from the STP are reasonably considered to contribute to or are likely to contribute to the effects that plastics in the marine environment have on the quality and/or physical characteristic of the environment that is conducive to ecological health.
- 51) This includes for example wildlife health. Microplastics have the potential to and do cause adverse effects to wildlife. Wildlife is reported throughout literature to consume and suffer adverse effects from microplastics, noting that the extent of harm is a continuing field of research. Healthy wildlife is a quality characteristic of the environment being part of an ecosystem that is conducive to ecological health.

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- 52) The department has a number of subject matter experts in the fields of endangered species protection for birds, turtles and benthic organisms who have confirmed that the release of microplastics to the environment can lead to ingestion by these organisms and can cause death of the individuals.
- 53) Furthermore, scientific studies on the impacts of macro and micro plastic on aquatic ecosystems have been undertaken over a long period of time, and have demonstrated that plastic ingestion causes a large range of impacts to marine organisms including death. (A copy of a summary of some of these studies is attached as **Appendix A.**)
- 54) The department considers it reasonable to conclude that the MBBR plastic media released to the Mooloolah River on 22 March 2021 and 5 April 2021 and ongoing to the Pacific Ocean via release point W1, is likely causing environmental harm.

### B. Requirements

The report on the environmental investigation must address the following relevant matters:

1. By **5 January 2022** you must engage independent **Appropriately Qualified Persons** (AQP) to carry out the requirements of the notice and confirm the engagement to the department in writing to [sunshinecoast.esr@des.qld.gov.au](mailto:sunshinecoast.esr@des.qld.gov.au). The written confirmation of the engagement must include each persons' academic qualification and suitable experience relevant to the scope of work of the investigation each AQP will undertake.
2. At least once per calendar month you must submit a progress report describing progress towards the completion of the requirements of this notice.
3. By **28 February 2022** the AQP engaged in requirement 1 must design and commence implementing, a Sampling and Analysis Quality Plan (SAQP) that is representative for all reasonably foreseeable hydraulic operational scenarios expected to occur during the operation of the MBBR and that:
  - a. Proposes a size of MBBR plastic media which can be accurately collected, distinguished from other plastic sources in the influent and measured, and define why this size of MBBR plastic media to be sampled is proposed.
  - b. Assesses the breakdown rate of the MBBR plastic media in the MBBR due to existing mechanical forces as currently configured (such as collision with infrastructure, other media and abrasion with sediment in influent) and chemical breakdown processes (including that caused by ultraviolet UV degradation of the plastic and exposure to chemicals in the sewage influent); and
  - c. Determines the percentage of broken MBBR plastic media within the MBBR in a way which determines if the percent rate of breaking media is increasing or decreasing over time.
  - d. Determines the size distribution of the resultant breakdown plastic media with specific reference to current containment controls (i.e. 2 mm screen aperture); and
  - e. Determines the current volume of plastic media being released from the STP via release points W1 and W3, as referenced in the EA;

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4. The AQP must implement the SAQP and undertake analysis and interpretation of the data obtained to estimate the volume and size distribution of MBBR plastic media released over a range of hydraulic scenarios, and over the proposed lifespan of existing MBBR plastic media.
5. By ~~30 June 2022~~ 11 July 2022, the AQP must submit an environmental report to the department on the outcomes of the investigation.
6. The environmental report must be presented in a manner and contain sufficient information to allow for an independent technical review and substantiation of the material. The environmental report must at a minimum include:
  - a. Details of the methodology applied in conducting the investigation, including any assumptions relied upon and the justification for those assumptions.
  - b. The results of the sampling, analysis and assessments carried out during the investigation.
  - c. The outcomes and findings of the investigation including discussion on the significance of the results and justification for any conclusions and/ or recommendations.
  - d. A copy of the SAQP
  - e. A copy of all of the raw data collected during the investigation in an excel spreadsheet.
  - f. A copy of all laboratory certificates
  - g. A copy of quality assurance and quality control procedures applied

### Definitions:

**Appropriately qualified person(s)** means a person or persons who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis to performance relative to the subject matter using the relevant protocols, standards, methods or literature.

The environmental report must be submitted to the department on or before: **Thursday, 30 June 2022**

The suitably qualified person who prepares the environmental report must also provide a statutory declaration in the form attached to the environmental report submitted to the department.

Copies of the template statutory declarations can also be accessed from the Queensland Government website at [www.qld.gov.au](http://www.qld.gov.au), using the publication number as a search term:

Statutory declaration for suitably qualified person ([ESR/2016/2266](#))

### Take notice:

1. The requirements of the notice to conduct or commission an environmental investigation take effect immediately upon service of this notice;
2. This notice remains in force until further notice from the department; and
3. You are responsible for meeting the costs of conducting or commissioning the environmental evaluation, preparing the environmental report and providing any further information as requested by the department.

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### C. Reviews and appeals

The provisions regarding reviews of decisions and appeals are found in sections 519 to 539 of the Act.

A person who is dissatisfied with certain decisions of the department, may be able to apply to have the department review that original decision.

Generally, a request to have a decision reviewed must:

2. be made within 10 business days of the decision being notified to the person;
3. be supported by enough information to enable the department to decide the application for review; and
4. be made using the application form, Application for review of original decision ([ESR/2015/1573](#)) available on the Queensland Government website at [www.qld.gov.au](http://www.qld.gov.au), using the publication number (ESR/2015/1573) as a search term.

Where an application has been made for a decision to be reviewed, the applicant may also apply to the relevant court for a stay of the decision to secure the effectiveness of the review.

Once the original decision has been reviewed, a person who is dissatisfied with the review decision may be able to appeal against that decision to the relevant court within 22 business days after receiving notice of the review decision.

A person whose interests are or would be adversely affected by a decision of the department may also be able to request a statement of reasons for a decision or a statutory order review under the *Judicial Review Act 1991*.

For further information about reviews and appeals see the information sheet, Internal review and appeals ([ESR/2015/1742](#)) available on the Queensland Government website at [www.qld.gov.au](http://www.qld.gov.au), using the publication number (ESR/2015/1742) as a search term.

The information sheets are available on the Queensland Government website at [www.qld.gov.au](http://www.qld.gov.au), using the publication number as a search term.

You may have other legal rights or obligations and should seek your own legal advice.

### D. Penalty

Failure to comply with a notice to conduct or commission an environmental evaluation is an offence.

1. The maximum penalty for an individual is 300 penalty units, totalling \$ 41,355.
2. The maximum penalty for a corporation is 1500 penalty units, totalling \$ 206,775.
- 3.

Should you have any queries in relation to this notice, please contact Ben Grant of the department on telephone number 07 5459 6170.

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Signature



Tim Brain

~~Quo Conzo~~

Delegate of the Chief Executive

Department of Environment and Science

*Environmental Protection Act 1994*

~~11 December 2021~~  
29 June 2022

Date

**Enquiries:**

Sunshine Coast Compliance Centre

Ph: (07) 5459 6132

Email: [sunshinecoast.esr@des.qld.gov.au](mailto:sunshinecoast.esr@des.qld.gov.au)

**Appendix A- Literature review.**

Plastic waste throughout the environment is known to be ubiquitous. Bergmann, Gutow & Klages (2009) suggest that the scale of plastic pollution by anthropogenic litter has been recognised as a serious global environmental concern. The authors note that marine litter is defined as any “*persistent manufactured or processed solid material discarded, disposed of or abandoned in the marine coastal environment*”. In June 2021, the Queensland Government released the Keeping Queensland Clean: the Litter and Illegal Dumping Plan (QLD 2021) which identifies that approximately 75% of waste found on the Australian beach is plastic, confirming that the ingestion of plastic waste is a significant issue leading to increased mortality of seabirds, turtles and other wildlife.

Plastic in the marine environment impacts marine species in a variety of ways. Ribero et. al (2018) suggest that the potential for microplastics to cause injury to marine organisms has been widely encountered and leads to the reduction of feeding rates and predatory performance, physical damage, oxidative stress, impacts of reproduction, decreased neurofunctional activity, development of pathologies and mortality. Fish are a known consumer of both macro and micro plastics. Menezes et al. (2019) identified that Dolphinfinh ingested plastic by confusing it with a food source and/or being attracted to the floating debris and can bioaccumulate by eating smaller prey containing plastic. The authors also state that plastic causes physical harm (e.g decreased food intake, gut injuries and gastrointestinal obstruction) and chemical harm (e.g liver toxicity, pathology and bioaccumulation through the food web) which often is lethal.

Turtles are also well known to consume a range of plastic matter in the marine environment. Duncan et al. 2019 suggested that synthetic particles including microplastics were present in every turtle across all species and ocean samples even though not all individuals had ingested plastics. Limpus (2021) states that the Department of Environment and Science had observed an unusually large number of flatback turtles washed up dead in the Keppel Bay. Limpus states that fragments of floating hard plastics and soft plastics have been found in post hatchling turtles and is concerned that the turtles have been compromised because they have been swallowing plastic debris. Research undertaken by David Steward (Senior Conservation Officer- Threatened Species Coordination) confirmed that 50% of the worlds seabird species have been reported to be affected by marine debris ingestion. In some species more than 90% of the individuals examined have ingested plastic, which are those that have a zoo plankton diet or are surface feeders, including short tailed shearwaters and storm-petrels (at least eight species of storm petrels are known to occur off the Queensland Coast including one species that breeds near Lord Howe Island and listed as vulnerable under the *Environmental Protection and Biodiversity Act 1999* (EPBC Act)). Plastic ingestion has been linked to a variety of negative health effects in seabirds, including nutritional deprivation- starvation and reduced body mass and growth rates.

Crump et. al (2020) confirmed that hermit crabs exposed to plastic impairs information gathering, resource assessments and decision making whilst Alexiadou, Foskolos & Frantzis (2019) identified that stomach content analysis of cetacean species in the Greek Seas confirmed that at least half of those tested contained plastic. Duncan et al. (2019) states that microplastic ingestion in crabs can affect food consumption and energy balance and ingestion of microscopic uplasticised polyvinylchloride reduces growth and energy reserves in marine worms. Bangun, Wahyuningsih & Muhtadi (2018) undertook a study of the impacts of plastic on macrozoobenthos in the tidal zone which concluded that an increase in the number of microplastic densities has lead to a decrease in macrozoobenthos density. Cole & Galloway (2015) report that Pacific Oysters are susceptible to ingesting microplastics and report that the plastic affects the feeding quality and gamete quality. It was reported by Smith et al (2018) that shellfish and other marine organisms with intact gastrointestinal tract pose particular concern because they bioaccumulate and retain microplastics.

Human are also impacted by consuming marine organisms such as crabs as confirmed by Ribeiro et al. 2020 who states that as crabs are omnivores, feeding on algae, molluscs, worms, crustaceans and detritus, and as crabs foregut is used in many seafood dishes, one blue crab per person assuming that both the flesh of the claws/ legs and abdomen are eaten, a consumer can potentially be exposed to 3mg of plastic.

Plastic in the marine environment also has the ability to absorb other contaminants. Brennecke et al. (2016) research suggests that microplastics can absorb heavy metals often encountered in the marine environment and polyaromatic hydrocarbons and polychlorinated biphenyls are capable of sorbing to the plastic surface and becoming bioavailable to animals upon ingestion causing additional potential for toxicity.

## References

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- Bangun, A, Wahyuningsih & Muhtadi, A 2018, 'Impacts of macro- and microplastic on macrozoobenthos abundance in tidal zone', *International Conference on Agriculture, Environment and Food Security*, vol 122, pp. 1-7
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- Ribeiro, F, O'Brien, J, Galloway, T & Thomas, K, 2018, 'Accumulation and fate of nano- and microplastics and associated contaminants in organisms', *Trends in Analytical Chemistry*, vol. 111, pp.139-147.
- Smith, M, Love, D, Rochman, C & Neff, R, 2018, 'Microplastics in seafood and the implications for human health', *Current Environmental Health Reports*, Vol. 5, 375-386
- Wilson, K & Semmler, E, 2021, Dead, sick baby turtles wash up on central Queensland beaches after eating plastic, ABC News, 17 February 2021, <https://www.abc.net.au/news/2021-02-17/baby-turtles-washing-up-on-qld-beach-eat-plastic-debris/13162720>