Pollution time bombs – Managing landfill at our dynamic shorelines

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Across New Zealand, low-lying coastal lands, river banks and estuaries have been used for landfill, industrial and other waste sites for decades. In some instances, waste has even been used to reclaim land. Over time, the effects of coastal erosion and inundation as well as catchment flooding have resulted in waste becoming exposed, littering our shorelines and marine environment to untold detriment.

In March this year the closed landfill of Fox Glacier Township in South Westland was uncovered as heavy rainfall caused the banks of the Fox River to breach. Hazardous waste has since been transported throughout the estuary and surrounding shoreline. In February last year, the shoreline fronting the old Cobden rubbish tip in Greymouth was eroded by a large storm resulting in thousands of plastic bags and other waste littering the coast. Another example is from 2014 when asbestos was released from the Kaiaua landfill on the Firth of Thames due to storm erosion. The clean-up process from events like this are costly and lengthy, and are made worse by coastal processes moving waste material along and offshore widening the affected area.

In the future this problem is likely to be exacerbated as the effects of climate change cause sea levels to rise and storms to intensify, resulting in greater areas of our shorelines becoming susceptible to erosion. This will ultimately increase the number of sites at risk as illustrated by Figure 1. There is therefore a need to take action to prevent other sites releasing waste to the dynamic and sensitive environment of our coast.

A recent publication by Local Government New Zealand revealed some preliminary statistics for landfill exposure to varying increments of sea level rise across the country. The data, provided by the local councils, identified that nationally there are around 110 closed landfills and two active landfills at only 0.5 m above MHWS leaving them potentially at risk from storm surge inundation and future increases in sea level. Of those 112 sites, Auckland dominates the numbers with responsibility for 88 of them. It is noted that these statistics represent

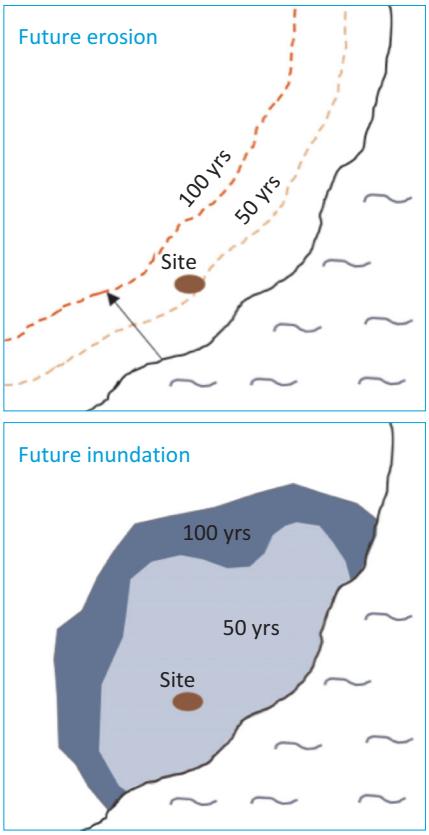

Figure 1: Future vulnerability from erosion and inundation (adapted from CIRIA, 2012).

potential for inundation only and have not investigated erosion, which is likely to have much more severe consequences to the release of waste from inadequately protected sites. They are also likely to have not captured the vast number of unknown historic sites that were created pre-environmental regulation. These sites are the real challenge for the future as their location, boundaries, volumes and types of waste are often undocumented meaning the first time we hear of their existence is when they become a problem.

So what can be done? Well, this is not a problem just faced by New Zealand. In the UK it has been approximated that 1,200 historic landfill sites are at risk from coastal flooding or erosion over the next 100 years. Given the scale of the problem, guidance documents were prepared in 2012 by CIRIA (Construction Industry Research and Information Association) that bring together the complexities of managing landfill sites and land contamination on eroding or low-lying coastlines. The guidelines recognise the importance of the broad expertise required from coastal scientists, geomorphologists, engineers, contaminated land specialists and planning experts to work with the local councils and communities to find appropriate solutions.

Tonkin + Taylor (T+T) has been involved in supporting government agencies and local councils to solve these complex problems for a number of years. In 2005, with the closure of the Brady Road Landfill in Auckland, T+T rehabilitated the coastal area to create Seaside Park, which later received awards from IPENZ and NZPI. In 2010, T+T supported Dunedin City Council to determine the existing and future risks an historic landfill at Ocean Beach posed. This included developing a range of potential management options over the short, medium and long term. In 2015, three landfills in South Tarawa, Kiribati, located at the coast protected by grouted sandbags were damaged. T+T assessed each of the sites to provide a range of options for closure, land rehabilitation and upgrades to provide sufficient coastal protection. Most recently, in 2018, T+T has helped Moyne Shire Council with two historic landfills located in the eroding sand dunes of East Beach at Port Fairy, Victoria, Australia (see Figure 2).

In the case of East Beach we defined the landfill boundaries, volume and type of waste through site inspections, geophysical surveys, test pits, and interviewing the old landfill operators, as well as reviewing historic aerials and archive records held at council. Using this information the pollutant pathways (i.e.

Figure 2: Daylighting rubbish from the sand dunes at East Beach, Port Fairy (source: www.abc.net.au).

how the waste could be released) were defined to establish the receptors (i.e. public, fauna and flora) at risk. An assessment of the coastal processes and erosion hazard over a range of timeframes and sea level rise scenarios provided the potential present and future risk of exposure. Combining these two datasets (see Figure 3) we were able to determine volumes of waste at risk over a range of timeframes over the next 100 years.

With greater knowledge of the site we were then able to identify and appraise a range of management options. These included:

- status quo 'do nothing', i.e. allowing the coastline to erode with waste material cleaned up on a case-by-case basis;
- removing the waste incrementally up to the different erosion hazard lines (see Figure 4); and,
- breaking the pollutant pathway by creating a barrier to provide erosion protection, e.g. dune stabilisation, beach nourishment, rock revetment, offshore breakwater and groynes (see Figure 5).

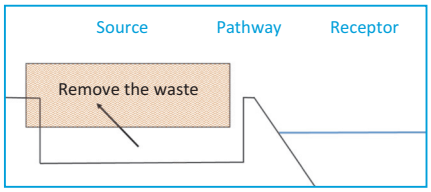

Figure 4: Removing the waste (adapted from CIRIA, 2012).

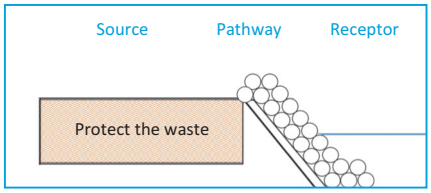

Figure 5: Breaking the pathway by protecting the waste (adapted from CIRIA, 2012).

Each of these options were technically, economically, environmentally and socially appraised with the findings presented to the local council.

To aid decision making, the dynamic adaptive policy pathway (DAPP) tool developed by Deltares (and contained within MfE's Coastal Guidance Manual) was used in conjunction with the option evaluation described above, to provide a number of pathways that could provide the long-term management plan required. This approach recognises that options can be used in combination or concurrently through time to achieve the protection over the long term without over-committing in the short term. Figure 6 illustrates the possible combinations considered for East Beach where the discontinuation of a line represents a tipping point where the preceding option is no longer feasible. At this point a decision has to be made to move to another available option shown as the circle icons. The dashed lines represent uncertainty in the viability of the option over the given timeframe.

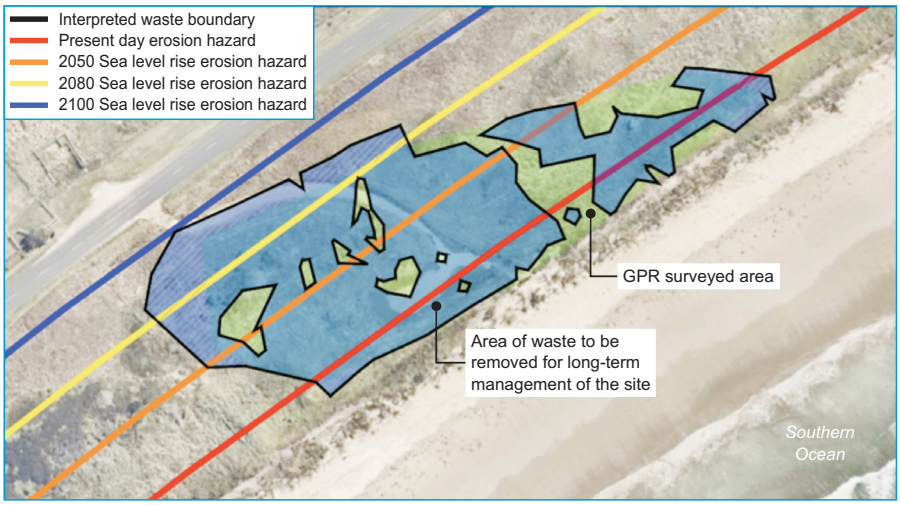

Figure 3: East Beach landfill at risk due to erosion over the next 100 years.

Using this approach, and based on available funding, a number of options were recommended to the local council that included:

- removing a portion of the waste in a trial cell to more accurately determine waste removal and disposal costs;
- extending an existing revetment as a short-term measure to protect the most high risk area; and,
- undertaking and monitoring a beach replenishment campaign to calibrate longshore drift models.

In summary, this article has highlighted the existing and future problem we face with managing landfills at eroding shorelines. Regional erosion and inundation assessments will help to better define the extent of the problem across New Zealand for those landfill sites that are known. However, more information is needed on the historic (pre-regulation) sites that are largely undocumented and litter our shorelines. Once the extent of the problem is known and sites at risk have been identified, site specific assessments can be undertaken to find the most appropriate solution considering the range of options available. In some instances removing the waste will be possible, but in others protecting the shoreline from erosion may be necessary. In all instances, taking a long-term view and using an adaptive management approach will allow for the uncertainties with climate change effects to be accounted for. By doing this, the most appropriate solutions may be found to remove short-term risk and properly plan for future protection.

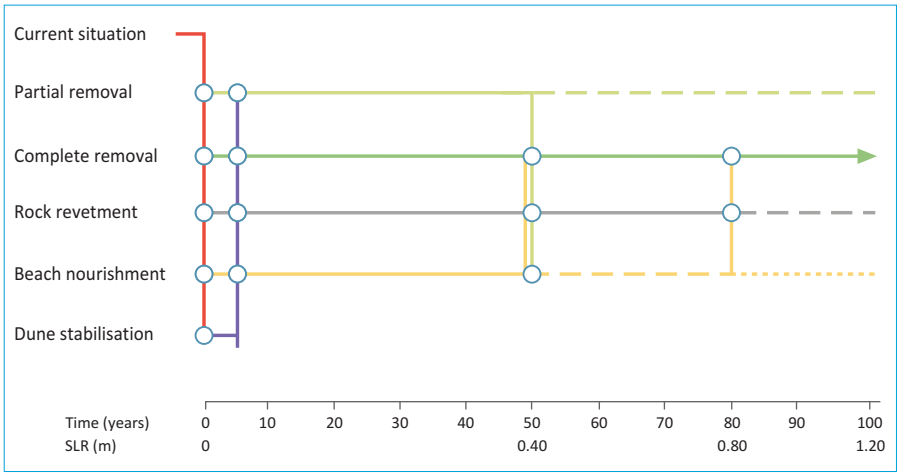

Figure 6: Example of a Dynamic Adaptive Policy Pathway (DAPP) map for East Beach.