Ministry for the Environment
Manatū Mō Te Taiao

Proposed regulation of jettisoned material from space launch vehicles under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012

DISCUSSION DOCUMENT

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Contents

Message from the Minister

Space rocket launches are a new activity for New Zealand. The Government wishes to help develop a peaceful, safe, responsible, and secure space industry that meets New Zealand's international obligations.

A component of this is appropriate environmental regulation. This discussion document deals with the effects in New Zealand's Exclusive Economic Zone (EEZ) of the deposit of jettisoned material from space launch vehicles. Some of this material will burn up in the atmosphere but some material may reach the Earth's surface and settle on the seabed.

We are proposing to make this activity permitted subject to conditions. This is similar to the approach we take to regulating the environmental effects of seismic surveying, marine scientific research, and prospecting and exploration for petroleum (excluding exploration drilling).

The Government has commissioned an environmental risk assessment which assesses the cumulative effects of different levels of launch activity. Adverse effects are assessed to be minor or less than minor for the level of activity proposed by Rocket Lab, a ground-breaking business granted resource consents to build and launch space vehicles into space from the Mahia Peninsula. Although the effects may become more significant after 10,000 launches, this would take 200 years to reach at one launch per week. The regulatory regime would have been reviewed well before this number of launches.

This is a practical approach to the regulation of the environmental effects in the EEZ of this novel industry for the foreseeable future.

I welcome feedback on the proposals. Our 'Bluegreen' approach to this issue is about enabling new technologically advanced industries to locate and prosper in New Zealand while ensuring we maintain New Zealand's high environmental standards.

Hon Dr Nick Smith
Minister for the Environment

Section 1: Background

About this consultation

The Government is considering making regulations under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) to classify the deposit of jettisoned material on the seabed.

Space vehicle launches are a new activity in New Zealand and are expected to result in the deposit of some material on the seabed in the Exclusive Economic Zone (EEZ). This activity is not currently managed under the EEZ Act but could have an effect on the environment and existing interests in the EEZ and continental shelf. The Government is considering how to manage this new activity and is seeking feedback on which classification under the EEZ Act is most appropriate for managing the likely effects.

This consultation only considers how the EEZ Act can best promote the sustainable management of the natural resources of the EEZ and continental shelf. It does not address effects on land, the coastal marine area, or the high seas. Effects in these areas are managed under other legislation, including the Civil Aviation Act 1990, Maritime Transport Act 1994, and Resource Management Act 1991.

Submissions close at 5.00 pm on Friday 16 September. Information on how to make a submission, including questions to guide your feedback, is included in section 8.

How does New Zealand currently manage space vehicle launches?

A new regulatory regime for space

Space vehicle launches are a new activity in New Zealand. The Government has announced the development of a new regulatory regime for space and high altitude activities that will ensure the development of a peaceful, safe, responsible and secure space industry that meets New Zealand's international obligations. The space and high altitude regulatory regime will include:

- the Outer Space and High Altitude Activities Bill
- the Technology Safeguards Agreement (a bi-lateral treaty with the United States)
- accession to the United Nations Convention on Registration.

The Outer Space and High Altitude Activities Bill will create a regulatory framework and licensing regime for space vehicle launches, payloads, and high altitude vehicles. Rocket Lab is a company registered in the United States that is proposing to launch space vehicles from New Zealand. Rocket Lab is required to seek a licence from the United States Federal Aviation Authority (FAA), which is responsible for licensing launch activities for US registered companies even for launches from New Zealand.

Offshore effects on the environment and existing interests: the EEZ Act

The EEZ Act came into force on 28 June 2013 when the first set of regulations under the Act was made. The purpose of the EEZ Act is to:[1]

a. promote the sustainable management of natural resources of the EEZ and continental shelf, and

b. in relation to the EEZ, continental shelf and waters above the continental shelf beyond the outer limits of the EEZ, protect the environment from pollution by regulating or prohibiting the discharge of harmful substances and the dumping or incineration of waste or other matter.

Under the EEZ Act, sustainable management means managing the use, development, and protection of natural resources in a way, or at a rate, that enables people to provide for their economic well-being while:

a. sustaining the potential of natural resources (excluding minerals) to meet the reasonably foreseeable needs of future generations

b. safeguarding the life-supporting capacity of the environment

c. avoiding, remedying, or mitigating any adverse effects of activities on the environment.

The EEZ Act applies to the environmental effects of a specific list of activities that were not previously regulated in the EEZ or continental shelf.

In the Act, an 'effect' refers to any:[2]

- positive or adverse effect
- temporary or permanent effect
- past, present, or future effect
- cumulative effect that arises over time or in combination with other effects
- potential effect of high probability
- potential effect of low probability that has a high potential impact.

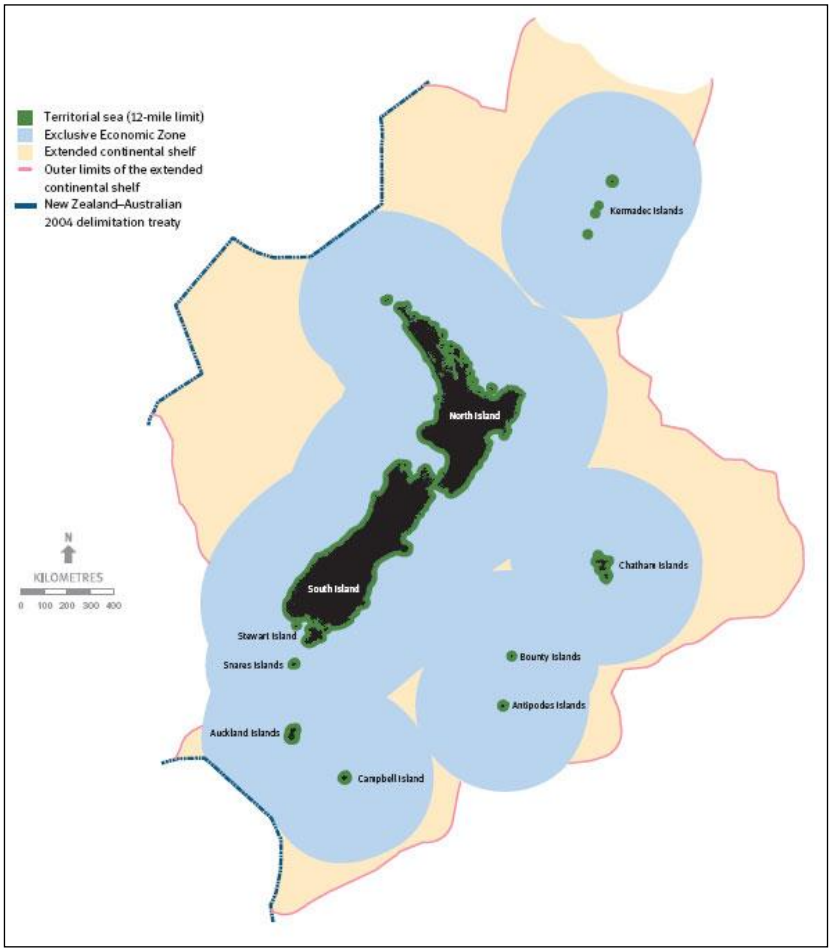
The EEZ Act regulates environmental effects by restricting certain activities from taking place in the waters and seabed of the EEZ and continental shelf. These include activities such as constructing or placing a structure on the seabed, disturbing the seabed in a manner likely to have effects, depositing anything or dumping material on the seabed, discharging hazardous substances, and creating noise that can have an adverse effect on marine life.

The activities that have been regulated by the EEZ Act so far are those associated with the oil and gas industry, seabed mining, and dumping of material on the seabed.

[1] Section 10(1) of the EEZ Act.

[2] Section 6(1) of the EEZ Act.

Figure 1: Extent of New Zealand's territorial sea, EEZ and continental shelf[3]



Iwi/Māori and the EEZ Act

Iwi/Māori interests in the ocean include safeguarding taonga and mahinga kai (food gathering locations and resources), spiritual practices, customary rights, and commercial and recreational fishing. Iwi/ Māori resource management ethos provides for sustainable use so marine biodiversity is enhanced and is not subject to unacceptable risks.

Section 12 of the EEZ Act explains how the EEZ Act recognises and respects the Crown's responsibility to give effect to the principles of the Treaty of Waitangi.

Existing interests under the EEZ Act

The EEZ Act also considers effects on existing interests. Existing interests are:[4]

a. any lawfully established existing activity, whether or not authorised by or under any Act or regulations, including rights of access, navigation, and fishing

b. any activity that may be undertaken under the authority of an existing marine consent granted under section 62

[3] Source: NIWA.

[4] Section 4 of the EEZ Act.

c. any activity that may be undertaken under the authority of an existing resource consent granted under the Resource Management Act 1991

d. the settlement of a historical claim under the Treaty of Waitangi Act 1975

e. the settlement of a contemporary claim under the Treaty of Waitangi as provided for in an Act, including the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992

f. a protected customary right or customary marine title recognised under the Marine and Coastal Area (Takutai Moana) Act 2011.

Other marine management regimes

The EEZ Act is one part of a regulatory system that manages activities in the territorial sea, EEZ and continental shelf. The EEZ Act forms part of this system by providing explicit consideration of environmental effects associated with activities. Other marine management regimes relevant to the effects of space launch activities include the:

- Fisheries Act 1996
- Marine Mammals Protection Act 1978
- Marine Reserves Act 1971
- Maritime Transport Act 1994
- Resource Management Act 1991
- Wildlife Act 1953.

The nature and effect of other marine management regimes is an important consideration under the EEZ Act. For example, the Maritime Transport Act manages the safety of ships travelling through the EEZ.

New Zealand's international obligations

Section 11 of the EEZ Act states that "the Act continues or enables the implementation of New Zealand's international obligations" including the United Nations Convention on the Law of the Sea 1982 (UNCLOS) and the Convention on Biological Diversity 1992. There are no international conventions that specifically and comprehensively regulate for the deposit of jettisoned material on the seabed. The general obligations that do apply include those under UNCLOS and the Convention on Biological Diversity. As well as the general obligations under these international agreements, New Zealand has general obligations under, for example, the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region 1986 (Noumea Convention).

UNCLOS: Under UNCLOS, States exercise sovereign rights over their EEZ and continental shelf for the purpose of exploring it and exploiting its natural resources. This right must be exercised with due regard to the rights of other States and in accordance with the duty to protect and preserve the marine environment, including taking necessary measures, as consistent with UNCLOS, to prevent, reduce and control marine pollution. This includes evaluating as far as practicable the risks and effects of pollution on the marine environment. Where there are reasonable grounds for believing that planned activities under a States' jurisdiction or control may cause substantial pollution of, or significant and harmful changes to, the marine environment, the State must assess the potential effects of such activities on the marine

environment and publish relevant reports or provide them to appropriate international organisations.

Convention on Biological Diversity: The Convention on Biological Diversity reiterates that States have the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction (Article 3). The Convention on Biological Diversity also requires that States provide environmental impact assessments of proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimising such effects and, where appropriate, allow for public participation in such procedures.

Noumea Convention: The Noumea Convention includes a requirement that parties shall endeavour to take all appropriate measures consistent with international law to prevent, reduce and control pollution of the Convention Area (which includes New Zealand's EEZ). Where it is within a party's capabilities, they must also assess potential effects of 'major projects' so appropriate measures can be taken to prevent or minimise harmful impacts on the Convention Area and, where appropriate, invite public comment on major projects. What constitutes a major project is not defined.

Section 2: Rocket Lab's proposed space launch vehicle

Overview

In September 2015, Wairoa District Council granted Rocket Lab resource consents to build and launch space vehicles from the Mahia Peninsula into space. Rocket Lab is planning to provide frequent, low cost launch services to a growing international small satellite industry.

Rocket Lab is planning to conduct test launches in late 2016. Its public schedule for launches indicates one commercial launch in 2016, nine in 2017 and 12 in 2018, with a longer-term plan to build towards a maximum of one launch per week.

After a space vehicle is launched but before reaching orbit, material from the vehicle is jettisoned and falls back to Earth. As they fall, friction with the atmosphere increases the temperature of the components and some or all of them will burn up in the atmosphere. Some proportion of the jettisoned components may reach Earth's surface. There is a possibility that jettisoned material from the vehicle will land in the waters of the EEZ, sink to the seafloor, and be deposited on the seabed off the east coast of New Zealand. No jettisoned material is likely to impact landmasses.

Launch vehicle structure and materials

Rocket Lab has developed a small, two-stage liquid-fuelled orbital launch vehicle (the Electron) capable of lifting a 150 kg payload to a 500 km sun-synchronous orbit.[5] An overview of the physical characteristics of the launch vehicle is shown in Table 1 below.[6]

Table 1: Physical characteristics of the Electron space launch vehicle

	Units	Stage 1	Stage 2	Faring	Total
Mass (dry)	kg	950	250	50	1,250
Mass (fuelled)	kg	10,200	2,300	50	12,550
Length	m	12.1	2.4	2.5	17
Diameter	m	1.2	1.2	1.2	1.2

The Electron space launch vehicle (the launch vehicle) carries no explosives, toxic materials, or radionuclides. The following sections detail the construction and behaviour of the primary components of the launch vehicle.

Carbon fibre composite

The primary structural material is carbon fibre reinforced polymer, which is an efficient, lightweight, high strength material. The carbon filaments are chemically inert and do not react to seawater.

[5] Technical terms used in this document are explained in the Glossary on page 34.

[6] Source: Rocket Lab.

Propellants

Liquid oxygen and kerosene (RP-1 analogue) propellants are used on both the first and second stages of the launch vehicle, both of which have proven safety and benign handling characteristics. Liquid oxygen, if released to the atmosphere, rapidly boils and returns to the atmosphere as gaseous oxygen. RP-1 kerosene is a highly refined grade of hydrocarbon with low density, a thin surface film and rapid evaporation.

Pneumatics

All inflight pneumatic systems use stored pressurised cold gases to provide tank pressurisation, cold-gas manoeuvring thrust in space, and for stage separation mechanisms. All gases are non-toxic.

Engines

The launch vehicle uses nine engines for stage 1 and a single engine for stage 2. The engines are constructed of inconel, an inert high performance, corrosion resistant nickel alloy. Each engine has a mass of approximately 20 kg and is mounted to the thrust section of the launch vehicle. At stage 1 separation, the thrust section is likely to separate from the stage, return to Earth's surface and land in the EEZ.

Batteries

The launch vehicle carries 13 high powered lithium batteries for stage 1, mounted at the rear of the launch vehicle with the engines. Stage 2 carries one battery to orbit, and jettisons a further two as each becomes exhausted during flight.

The first stage batteries are highly likely to burn-up before returning to Earth's surface. The stage 2 batteries will entirely burn-up downrange, with only the first battery potentially landing in the EEZ. The batteries are lithium-based, and contain no lead, acid, mercury, cadmium, or other toxic heavy metals.

Launch vehicle flight profile

Jettison and fragmentation

In the course of a launch, stage 1, an aerodynamic nose fairing, and two stage 2 batteries are jettisoned. Stage 1 is automatically jettisoned when empty of propellants and is expected to break up into multiple fragments as the result of a combination of temperature-induced reduced structural strength, inertia loads from rapid tumbling, and high aerodynamic loads applied to the sides of the first stage. Fragments are expected to range in size from <0.01 to 6.5 m^2 and weight from 0.03 to 360 kg. Some proportion of the jettisoned fragments will burn up in the atmosphere, but some of them may land in the waters of the EEZ. See Appendix A for a table detailing the expected fragmentation of stage 1.

The aerodynamic fairing is released from the launch vehicle shortly after stage 1. Stage 2 of the launch vehicle will continue to climb and accelerate, jettisoning two batteries before entering orbit and releasing its payload

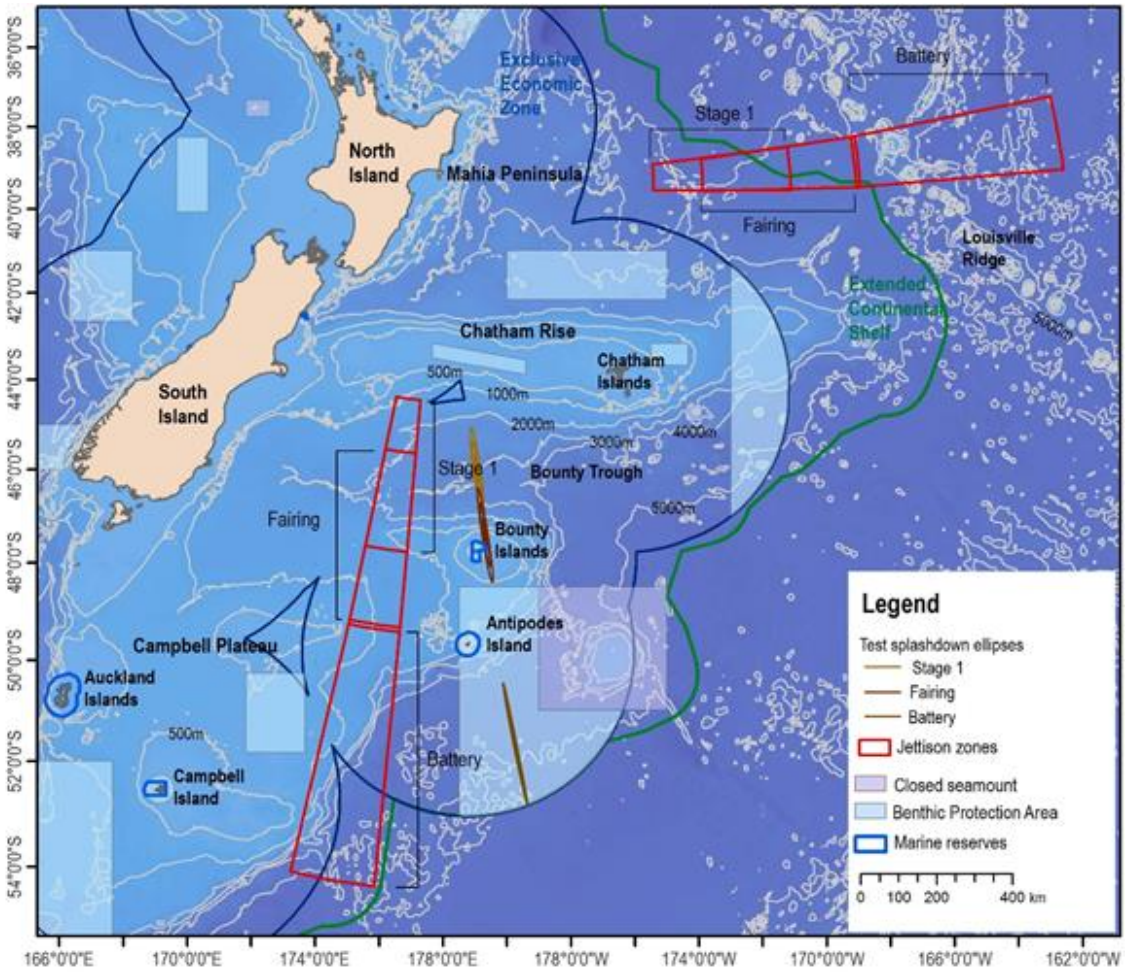
The batteries have a low auto-ignition temperature of 150˚C, which means they are highly likely to burn up in the atmosphere before reaching Earth's surface. Figure 2 below includes the jettison zone for any batteries that do survive re-entry and return to the Earth's surface.

Over the course of a number of months, the second stage will lose altitude, re-enter the atmosphere and completely burn up.

Jettison zones

There are three deep-water jettison zones corresponding to the trajectories used for test launches, commercial sun-synchronous and commercial eastern launches. Jettisoned material from test launches will fall along a path to the south of the Chatham Rise and east and south of the Bounty Islands. Debris from commercial launches will fall either to the south over the southern flank of the Chatham Rise, and across the Bounty Trough and the Campbell Plateau (sun-synchronous launch), or east of the North Island (eastern launch). A map of the jettison zones is shown below in Figure 2.

Figure 2: The jettison zones for jettisoned material from stage 1, the fairing, and stage 2 batteries originating from the test launches are shown as ellipses, while the jettison zones for sun-synchronous (to the south) and eastern (to the east) launches are shown as red boxes.



Source: NIWA. Data supplied by Rocket Lab.

Where will stage 1 and the fairings impact for test and sun-synchronous launches?

During the test launch and commercial sun-synchronous launches, the jettisoned material from stage 1 will fall into the Bounty Trough, an area of deep water (2000 – 3000 m) lying between the southern flank of the Chatham Rise and the northern slopes of the Campbell Plateau and the Bounty Platform.

For test launches, the fairings are predicted to fall across the northern flank and crest of the Bounty Plateau. The fairings are not expected to land on the Bounty Islands but will possibly splash down in the Bounty Islands/Moutere Hauriri Marine Reserve and the Bounty Heritage Benthic Protection Area. Any impacts on the marine reserve would be managed by the Department of Conservation under the Subantarctic Islands Marine Reserves Act 2014. Benthic protection areas are managed by the Ministry for Primary Industries.

During commercial sun-synchronous launches, the fairings will fall across the Bounty Trough and the eastern flank of the Campbell Plateau.

Where will stage 1 and the fairings impact for eastern launches?

The jettisoned material from stage 1 and the fairings of commercial eastern launches is expected to fall largely in very deep water (3000 – 5000 m) within the extended continental shelf.

Section 3: What is the Government considering?

As described in section 2 above, space vehicle launches will result in jettisoned material landing in the EEZ. This material is then likely to be deposited on the seabed. The deposit of jettisoned material on the seabed is a new activity that has not previously been classified under the EEZ Act. This means it is automatically treated as a discretionary activity under the EEZ Act and requires a fully notified marine consent.[7]

However, there are four ways to classify an activity under the EEZ:

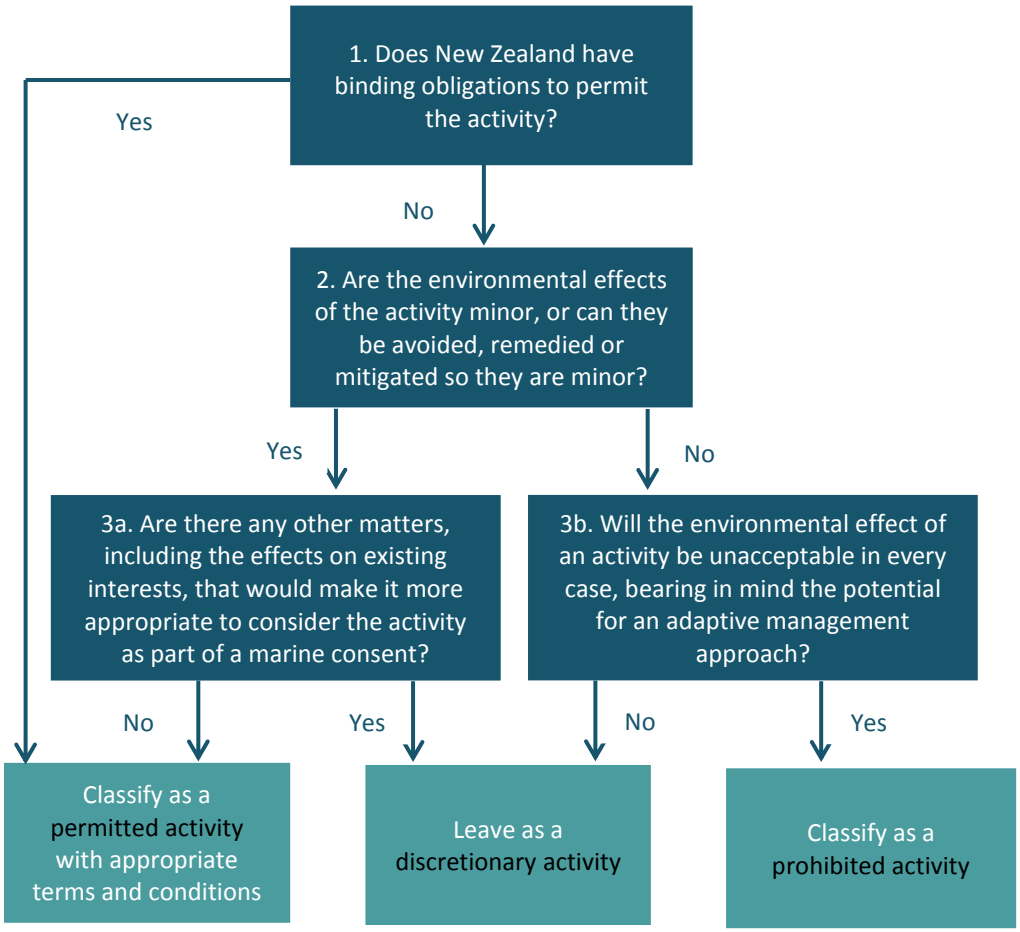
1. It can be **prohibited**, meaning that it cannot be undertaken in any circumstances.
2. It can be **permitted**, meaning the activity can occur and does not require a marine consent as long as the activity meets certain conditions set out in advance. For example, marine scientific research is a permitted activity provided it meets certain conditions including notifying the Environmental Protection Authority in advance, undertaking an initial impact assessment, and keeping a logbook.
3. It can be a **non-notified discretionary** activity, meaning a marine consent is required before the activity can begin. The applicant would be required to make an application that includes an impact assessment that identifies the effects of the activity on the environment and existing interests, but the application process does not require public notification.
4. It can be a **discretionary** activity, which also means that a marine consent is required. The applicant would be required to make an application that includes an impact assessment, and the application process would also provide an opportunity for public submissions on the application. For example, production drilling for oil and gas is a discretionary activity.

How an activity is classified depends on the potential for adverse effects on the environment and existing interests. See Figure 3 below for an explanation of the assessment criteria for classifying activities under the EEZ Act.

The Government has gathered information on the potential effects of the activity on the environment and existing interests, and is seeking feedback on which classification under the EEZ Act is most appropriate for managing the likely effects of the activity.

[7] Section 36 of the EEZ Act.

Figure 3: Assessment criteria for classifying activities



Section 4: What are the Government's objectives?

The Government is considering making regulations under the EEZ Act to classify the deposit of jettisoned material on the seabed. See Appendix B for the matters the Minister for the Environment must consider when making regulations.

If Rocket Lab was to launch a space vehicle today, the deposits resulting from the launch would require a fully notified discretionary marine consent. The Government is considering whether a fully notified discretionary classification is proportionate to the likely effects of the activity, or whether it is appropriate to classify the activity in a different way.

The process for a marine consent can be time consuming and costly, as it is designed to enable consideration of activities that have the potential for significant and ongoing adverse effects.

Through previous public consultation, a set of objectives have been developed for regulations made under the EEZ Act.[8] These objectives draw on the purpose of the EEZ Act and matters required to be considered by the Minister for the Environment when making regulations under the EEZ Act. These objectives are to:

- ensure New Zealand fulfils its obligations under relevant international conventions relating to the marine environment
- ensure the natural resources of the EEZ and continental shelf are sustainably managed
- ensure classifications and conditions are cost-effective, with the cost to Government and users proportional to the level of environmental effects addressed
- provide for the consideration of non-environmental impacts, including on existing interests, iwi and other matters set out in the EEZ Act, in a manner proportionate to the scale and effects of activities.

[8] Ministry for the Environment. 2012. *Managing our oceans: A discussion document on the regulations proposed under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Bill.* Wellington: Ministry for the Environment.

Section 5: Effects of the activity

Environmental effects

The Ministry for the Environment commissioned the National Institute of Water and Atmospheric Research (NIWA) to undertake a marine environmental risk assessment of the effects of Rocket Lab's activities.[9] The report assessed the ecological impact of jettisoned material from one and 10 weekly test launches, and from one to 10,000 weekly commercial launches. At one launch a week, it would take 200 years to reach 10,000 launches.

Rocket Lab is planning to conduct test launches in late 2016. Its public schedule for launches indicates one commercial launch in 2016, nine in 2017 and 12 in 2018, with a longer-term plan to build towards a maximum of one launch per week.

The report assesses the potential of environmental impacts of eight threats arising from the fall of jettisoned material on five components of the ecosystem in the jettison zones. It assumes a worst case scenario where none of the jettisoned material burns up, but returns to Earth's surface and lands in the EEZ.

The threats assessed were:

- toxic contaminants from the jettisoned material that falls in the EEZ
- ingestion of jettisoned material by animals
- displacement of fishing effort
- provision of new habitat for attachment
- provision of floating shelter for animals
- underwater noise and disturbance from the impact of the jettisoned material hitting the sea surface
- direct strike from jettisoned material with seabirds or marine animals at or near the sea surface
- smothering of animals living on the seabed.

The report looked at the consequence of each of these threats on different species and ecosystems and assessed the probability of occurrence to reach a conclusion about the risk.

Test launches

The jettisoned material from one and 10 test launches was found to have a low ecological risk for all ecosystem components. As in most cases the consequences of an effect would be negligible and the likelihood of it occurring remote, no further description is provided here. Further information can be found in the NIWA report *Marine ecological risk assessment of the cumulative impact of electron rocket launches*.

[9] National Institute of Water and Atmospheric Research. July 2016. *Marine ecological risk assessment of the cumulative impact of Electron Rocket launches.* Prepared for the Ministry for the Environment by the National Institute of Water and Atmospheric Research. Wellington: Ministry for the Environment.

Commercial sun-synchronous and eastern launches

For sun-synchronous and eastern jettison zones, the ecological risk was assessed to be low for all ecosystem components for up to 100 launches, and low for the pelagic community of phytoplankton, zooplankton, fish and larger invertebrates at all levels of launch activity from one to 10,000 launches. A summary of the risk for all of the threats assessed is presented below.

Risk of toxic effects

The toxic effects of the materials comprising stage 1, the fairings and the two stage 2 Lithium-Ion batteries were assessed as low at all levels of launch activity.

Risk of ingestion of materials and provision of floating shelter

Floating jettisoned materials as shelter for pelagic organisms and the ingestion of jettisoned materials were both evaluated as having low ecological risk at all levels of launch activity.

Environmental effect of the displacement of fishing activities

For the benthic invertebrate community, and sensitive benthic environments (as defined in the Exclusive Economic Zone and Continental Shelf (Environmental Effects – Permitted Activities) Regulations 2013) in the sun-synchronous jettison zone, there may be a moderate rebuilding of seafloor invertebrate communities resulting from the possible displacement of fishing activities from the jettison zone after 1000 and 10,000 weekly launches. For the demersal fish and mobile invertebrate community, marine mammals and seabirds, the effects of fishing displacement would be low because these populations could also be impacted in the areas to which fishing is displaced.

In the eastern jettison zone there is less fishing activity so the consequences of fishing displacement on the seabed community, demersal fish and mobile invertebrates, marine mammals and seabirds are negligible, reaching minor impacts after 1000 or more launches.

Effect of the provision of hard substrates

Another potential positive outcome for seafloor biota requiring hard substrates is that the jettisoned materials would provide further attachment sites. However, even after 10,000 launches this would provide only about 50 ha of additional attachment surface, leading to a moderate benefit at most.

Disturbance to marine fauna

Noise and disturbance to marine fauna above and below water is a potential consequence of the jettisoned materials falling into the jettison zone. The chance of repeated disturbance to the same individuals or groups of marine mammals or seabirds increases with the number of launches. This was assessed as a low risk for up to 100 launches over two years, a moderate risk for up to 1000 launches over almost 20 years, and a high risk for up to 10,000 launches over almost 200 years.

Risk of direct strikes causing mortality to components of the ecosystem

Direct strikes causing mortality are a low risk for all components of the ecosystem up to 1000 launches over an almost 20 year period. Direct strikes reach moderate levels of risk for the benthic invertebrate community, sensitive benthic environments, and a rare threatened species, the magenta petrel, after 10,000 launches over a period of almost 200 years.

Risk of smothering of sea floor organisms

Smothering the feeding or respiratory structures of sea floor organisms by jettisoned materials was assessed as a low risk for all levels of launches up to 1000 launches and a moderate risk by 10,000 launches. This is likely to be a factor principally in areas of hard substrate where the jettisoned materials are unlikely to become buried in sediment so will be important principally on the Bounty Platform.

Questions

1. Do you agree that the environmental effects described are the main environmental effects likely to occur as a result of the activity? If not, why not?
2. Do you agree with the scale of the described environmental effects? If not, why not?
3. Are there any other environmental effects that you are aware of that the Government should consider? If so, what are they?

Economic effects

Sapere Research Group (Sapere) undertook an independent economic impact analysis of the development of a space vehicle launch industry in New Zealand.[10] The analysis was based on a situation where the number of possible launches per year is between 52 (one a week) and 120 (the maximum number consented by Wairoa District Council).

Sapere identified the following types of economic benefits:

- additional employment by Rocket Lab to scale up to launch capacity
- additional activity and employment in supplying industries (industries that supply Rocket Lab with intermediate inputs (components) and other linked industries in the supply chain)
- space tourism – international visitors or New Zealanders watching space vehicle launches, and members of the satellite industry or their clients attending the launch of their satellites
- construction and launch activities – Rocket Lab building or upgrading facilities for space vehicle launches including satellite dishes, launch pads
- cluster effects – development of related clusters for example in the areas of satellite manufacture/technology, carbon composites or 3D printing
- aspiration effects – achievements in aerospace have been shown to have a significant impact in motivating prospective students and researchers into the field

[10] Sapere. June 2016. *Economic Impact Analysis of the Development of a Rocket Industry in New Zealand*.

- knowledge and technology spill-overs – the benefits from technology, information and knowledge that is generated by Rocket Lab (or its key suppliers) being applied in other companies or sectors of the economy
- prestige effects – enhancements to national prestige resulting from having a space industry
- human capital effects – benefits to New Zealand from an increased proportion of highly skilled personnel in the population.

Sapere found that the majority of immediate economic benefits are likely to be felt by a small number of related companies, namely company owners and investors, those employed in New Zealand by Rocket Lab, and key New Zealand based component suppliers.

Indirect benefits are likely to be in sectors with high import ratios, such as the import of titanium powder for 3D printing, whilst spill-over benefits may be limited given the commercially sensitive nature of the space industry.

Overall, Sapere estimated that the establishment of a space vehicle launch industry could directly contribute around $30 – $80 million per year in value-add to the New Zealand economy ($600 – $1,550 million over a 20 year period).

Table 2: Benefits to New Zealand from the development of a space vehicle launch industry[11]

Effect	Definition	Magnitude (millions)*
Direct effects	Activity and employment by Rocket Lab and its key suppliers. Key suppliers are those who directly supply parts of the launch vehicle.	$13.5 - $35 per year ($270 - $700 over 20 years)
Indirect effects	Activity and employment by industries who supply intermediate goods and services to Rocket Lab and its key suppliers. Intermediate goods are those produced by one first/industry that are used in the production process of another. Also include tourism and launch infrastructure build.	$49 - $149 per year ($80 - $280 over 20 years)
Induced effects	Activity and employment that is the result of spending by those employed directly or indirectly owing to Rocket Lab's activities.	$2.25 - $7.5 per year ($45 - $150 over 20 years)
Catalyst effects	Other benefits not counted about where Rocket Lab's activities have acted as a catalyst to benefits being realised, including: – aspirational effects – research and design spill-overs – easier access to satellites for New Zealand industry.	Catalyst effects (excluding satellite access): $1.5 - $5.5 per year ($30 - $110 over 20 years) Satellite access: $8 - $17 per year ($160 - $340 over 20 years)

* Direct, indirect and induced effects have been discounted at a rate of 8%. Catalyst effects, which are more speculative, have been discounted at a rate of 50%.

Questions

4. Do you agree that the economic effects described are the main economic effects likely to occur as a result of the activity? If not, why not?
5. Do you agree with the scale of the described economic effects? If not, why not?
6. Are there any other economic effects that you are aware of that the Government should consider? If so, what are they?

[11] Source: Sapere. June 2016. *Economic Impact Analysis of the Development of a Rocket Industry in New Zealand*.

Effects on existing interests

Existing interests are defined under section 4 of the EEZ Act, and include both existing activities that are authorised under an Act or regulation and those that are not. Commercial fishing is an example of the former, and shipping is an example of the latter. Also included in the definition of existing interests are:

- the settlement of a historical claim under the Treaty of Waitangi Act 1975
- the settlement of a contemporary claim under the Treaty of Waitangi as provided for in an Act, including the Treaty of Waitangi (Fisheries Claims) Settlement Act 1992
- a protected customary right or customary marine title recognised under the Marine and Coastal Area (Takutai Moana) Act 2011.

As space vehicle launches are a new activity in New Zealand, it is not yet clear what all the effects on existing interests will be. The Government encourages those with knowledge and evidence of possible effects to provide that information as part of this consultation. This will help the government better understand any potential effects, so that we can work with people with existing interests on ways to avoid, remedy or mitigate those effects.

The best available information suggests the routine effects of the activity on existing interests will most likely be limited to shipping and fishing in the jettison zone, including the risk of a direct impact from a fragment and fishing displacement.

The jettison zone for each space vehicle launch is long and very narrow. On the narrow axis, it will be no more than 30 nautical miles wide, although some of the jettison zones will be narrower than this.

For the first launch, Land Information New Zealand (LINZ) and Maritime New Zealand will issue maritime safety information (a combination of Notices to Mariners and radio navigation warnings) to warn mariners of hazards in the jettison zone. This process will continue for subsequent launches.

Rocket Lab has modelled the risk of a vessel in the jettison zone being directly impacted by a fragment as less than 1 in 100,000. Modelling of impacts in the jettison zone is based on NASA's Debris Assessment Software suite, which meets the requirements of the United States' Federal Aviation Authority and is based on NASA's experience over the past 50 years.

Confidence in the impact modelling is supported by the fact no one has ever been injured by space debris or jettisoned material, even though more than 5400 metric tons of it is believed to have reached Earth's surface over the past 40 years.

Even though the possibility of impact with a vessel is extremely remote, vessels may choose to move out of the jettison zone during the time that fragments are expected to reach Earth's surface. This may result in a relocation of fishing effort over time.

Questions

7. Do you agree that the existing interests described are the main existing interests? If not, why not? Please describe any other existing interests you are aware of that may be affected by the activity.
8. What do you think the main effects will be on existing interests? Please provide any information you have in relation to those effects.

Section 6: Proposed approach: classifying the deposit on the seabed of jettisoned material from space launch vehicles as a permitted activity

The Minister proposes a *permitted* classification for the deposit on the seabed of jettisoned material from space launch vehicles. This classification means:[12]

- a person may undertake the activity without a marine consent provided the activity complies with any terms and conditions specified for the activity in regulations
- a person intending to undertake a permitted activity must notify the Environmental Protection Authority (EPA) before undertaking the activity if required to do so by regulations.

Currently, seismic surveying, cable laying, marine scientific research, and the prospecting and exploration phases of oil and gas and minerals operations (except exploratory drilling) are all classified as permitted.[13]

Why is the Government proposing a permitted activity classification?

For an activity to be classified as permitted under the EEZ Act, the Minister must be satisfied that:

- the proposed classification meets the purpose of the EEZ Act (see section 1 above for the purpose of the EEZ Act)
- the activity meets the requirements to be classified as permitted under section 29(4) of the EEZ Act.

The Minister must take into account the matters set out in section 33(3),[14] and have regard to comments received under consultation (section 33(2)). Furthermore, decisions on regulations must be based on the best available information (section 34).

An assessment of whether the proposed classification meets these requirements is set out in the sections below.

[12] Section 35 of the EEZ Act.

[13] Exclusive Economic Zone and Continental Shelf (Environmental Effects - Permitted Activities) Regulations 2013.

[14] See Appendix B for the matters the Minister must take into account.

Purpose of the EEZ Act

The Minister's preliminary view is that classifying the deposit of jettisoned material from space launch vehicles as a permitted activity is consistent with the purpose of the EEZ Act because:

- the minor adverse effects of the activity will not impact the potential of natural resources to meet the needs of future generations, or affect the life-supporting capacity of the environment
- adverse effects can be mitigated by requirements set out in conditions
- a permitted classification provides for the protection of the environment, while enabling economic activity of benefit to the New Zealand economy and persons undertaking the activity
- regulations can be reviewed which means the cumulative effects can be assessed with regard to improved information and the reported effects of the activity
- the EEZ Act does not operate in isolation and other regulatory regimes reinforce requirements to operate safely and minimise the likelihood of adverse effects
- space vehicles cannot be launched until all the regulatory requirements have been met.

Section 29(4) – Requirements to be classified as a permitted activity

Section 29(4) of the EEZ Act specifies that regulations must not provide for an activity to be a permitted activity if, in the Minister's opinion:

- the activity has or is likely to have adverse effects on the environment or an existing interest that are significant in the circumstances, and
- it is more appropriate for the adverse effects to be considered in relation to an application for a marine consent.

As described in section 5, there are no significant adverse effects on the environment or existing interests from the deposit on the seabed of jettisoned material from space vehicle launches. Balancing this against the economic benefits to New Zealand, the Minister considers that it is more appropriate to classify the activity as permitted than to have the effects considered in relation to an application for a marine consent.

The Minister therefore considers that the deposit on the seabed of jettisoned material from space launch vehicles meets the requirements of section 29(4) of the EEZ Act in relation to adverse effects on the environment or existing interests.

Section 33 – Matters the Minister must consider when making regulations

As outlined above, under section 33(3) of the EEZ Act, the Minister must take into account a number of factors when considering the development of regulations (see Appendix B).

The available information relevant to this proposal is provided elsewhere in this document and in the NIWA report *Marine ecological risk assessment of the cumulative impact of electron rocket launches*. Any further relevant information provided through submissions will be taken into account by the Minister when making the decision about whether or not to recommend that regulations be made.

Section 34 – Best available information

When developing regulations to classify an activity as permitted, the Minister must:[15]

- make full use of the information and other resources available to him or her
- base decisions on the best available information
- take into account any uncertainty or inadequacy in the information available.

If, in relation to the making of a decision under this Act, the information available is uncertain or inadequate, the Minister must favour caution and environmental protection.

Given that space vehicle launches are a new activity in New Zealand, there is a degree of uncertainty in the information that can only be resolved by the activity taking place. The proposed permitted activity classification provides a precautionary approach by setting appropriate conditions on the activity. To manage the limitations on the current information used to inform the environmental risk assessment, the Government is also proposing that the regulations will expire after a certain number of years. This will ensure there is consideration of how the activity is managed once the effects are better understood.

The Minister's preliminary view is that, based on the information available, is that there will be no significant adverse effects on the environment or existing interests from the deposit on the seabed of jettisoned material from space vehicle launches. This discussion document provides an opportunity for the public to produce evidence, if they have it, supporting or countering this position.

Conclusion

Taking all of the factors into account, the Minister considers that the permitted activity classification provides an appropriate balance between the assessment and management of environmental effects on the one hand, and cost-effectiveness and certainty for users on the other. It improves the attractiveness of New Zealand as an investment opportunity for the global space industry while ensuring there is appropriate regulatory oversight of the effects of the industry in the EEZ and continental shelf.

The Minister therefore proposes that the deposit on the seabed of jettisoned material from space launch vehicles be classified by regulations as a permitted activity. In proposing this classification, the Minister is satisfied, on the basis of information currently available, that the objectives outlined in section 4 will be met. See Table 3 below for an assessment of the permitted activities classification against the Government's objectives.

Questions

9. Do you agree that the deposit on the seabed of jettisoned material from space launch vehicles should be classified as permitted? If not, how should the activity be classified or regulated?

[15] Section 34 of the EEZ Act.

Table 3: An assessment of the permitted classification for the deposit on the seabed of jettisoned material from space launch vehicles against the Government's objectives

Objectives	Assessment of preferred option
New Zealand fulfils its obligations under relevant international conventions relating to the marine environment	Meets relevant international obligations under UNCLOS, the Convention on Biological Diversity and the Noumea Convention: The permitted activity classification complies generally with these international obligations because: • the probability of significant adverse effects from the activity is low, and conditions can be set in regulations to avoid, remedy or mitigate effects on the environment, biodiversity and existing interest. • to satisfy the Noumea Convention requirements, the Minister needs to consider whether the activity is a 'major project' for the purpose of the Noumea Convention. Through consultation with experts, including NIWA, officials have assessed the routine environmental effects of the activity as not significant, and concluded that the activity is therefore unlikely to be considered a major project. • although public participation is low (consultation on regulations only), this is proportionate to the likely level of effects on the interests of the public and iwi/Māori
The natural resources of the EEZ and continental shelf are sustainably managed	Will provide certainty of environmental protection through conditions set in regulations Will provide certainty for users that they are able to comply with conditions Will ensure sustainable management by allowing for the use of marine resources while sustaining their future potential and the environmental integrity of the EEZ
Classifications and conditions are cost-effective, with the cost to Government and users proportional to the level of environmental effects addressed	Cost effective for the Government in terms of monitoring through conditions Imposes low compliance costs on users Conditions are proportionate to the likely effects of the activity
Provide for the consideration of non-environmental impacts, including on existing interests, iwi and other matters set out in the EEZ Act, in a manner proportionate to the scale and effects of activities	Effect on existing interests and iwi likely to be low Public participation is low (consultation on regulations only), but this is proportionate to the likely level of effects on the interests of the public and iwi

What conditions should be placed on the permitted activity?

Regulations can set conditions on permitted activities. These conditions will set the limits for the activities and any other matters that need to be considered to ensure the activity meets the test for being permitted.

The Minister is proposing the following specific conditions as a minimum for the deposit of jettisoned material on the seabed from space launch vehicles:

- pre-activity notification to the EPA
- post-activity reporting to the EPA.

Pre-activity notification

The person undertaking the activity will be required to notify the EPA of the date and time of the space vehicle launch (launch schedule), the predicted flight path and the areas in which jettisoned material are expected to fall into the EEZ. They will also be required to confirm that this material has been provided to LINZ and Maritime New Zealand for the purpose of release of a notification to mariners.

Pre-activity notification must occur no less than 15 working days before launch, with final confirmation of the launch schedule no less than 24 hours before launch. Failure to comply with the pre-activity notification requirement will constitute an offence under section 134G(1) of the EEZ Act.

Post-activity reporting

The person undertaking the activity will be required to provide a post-activity report to the EPA confirming that the vehicle launch occurred in accordance with the pre-activity notification. As far as is reasonably possible, the post-activity report should include the observed flight path of the space launch vehicle and the areas in which jettisoned material fell into the EEZ.

Twice yearly or after 10 consecutive launches (whichever comes earlier), the person undertaking the activity will be required to provide a report to the EPA describing any effects that have occurred that do not align with the information provided pre- or post-activity.

Pre-activity notification and post-activity reports to be made publicly available

The EPA will make all pre- and post-activity reports available on its website so they can be accessed by the public, iwi/Māori, and existing interests.

Other limitations: limiting the duration of the regulations

To manage the risks of cumulative effects and the limitations on the current information used to inform the environmental risk assessment, the Government is also proposing that the regulations will expire after a certain number of years.

Questions

10. Do you agree with the proposed conditions for the activity? If not, what changes would you propose and why?
11. Are there any other conditions that you think should be set on the activity?

Section 7: How will the classification be implemented?

Timeframe for implementation of the regulations

Following consultation, officials will analyse submissions and provide advice to the Minister, who will then decide whether to proceed with the proposed activity classification or revise the proposals. If it is decided to proceed, regulations would be made before the end of 2016.

What implementation of a permitted activity classification could cost

The EPA would incur administrative costs if the deposit on the seabed of jettisoned material from space launch vehicles is classified as a permitted activity. Costs would include evaluation of reports and notification of activities on the EPA website, and would partly be recovered from the person undertaking the activity. The costs to the person undertaking the activity of complying with conditions are unlikely to be significant given that the necessary information would be produced as part of normal business operations.

Monitoring and reporting costs would be in addition; however, given the newness of the activity it is not possible to estimate costs at this time.

Monitoring and evaluation of the regulations

As this is a new activity the Government considers it is important that the classification is reviewed in the near future, to ensure the permitting regime is proportionate to the effects of the activity. The Government proposes that the regulations would expire after a certain number of years. This will ensure there is consideration of how the activity is managed once the effects are better understood.

This consideration could include confirming the regulations are the appropriate tool for managing the activity, or choosing to regulate the activity in a different way, for example, through a different classification.

Section 8: Consultation process

How to make a submission

The Government welcomes your feedback on this discussion document. The questions posed throughout this document are summarised below. They are a guide only and all comments are welcome. You do not have to answer all the questions.

To ensure your point of view is clearly understood, you should explain your rationale and provide supporting evidence where appropriate.

You can make a submission in three ways:

- use our online submission tool, available at www.mfe.govt.nz/consultation/proposed-regulation-jettisoned-material-space-launch-vehicles-new-zealands
- download a copy of the submission form to complete and return to us. This is available at www.mfe.govt.nz/consultation/proposed-regulation-jettisoned-material-space-launch-vehicles-new-zealands. If you do not have access to a computer, a copy of the submission form can be posted to you
- write your own submission.

If you are posting your submission, send it to Regulation of jettisoned material from space launch vehicles, Ministry for the Environment, PO Box 10362, Wellington 6143 and include:

- the title of the consultation (Regulation of jettisoned material from space launch vehicles)
- your name or organisation
- postal address
- telephone number
- email address.

If you are emailing your submission, send it to slvconsultation@mfe.govt.nz as a:

- PDF
- Microsoft Word document (2003 or later version).

Submissions close at 5.00 pm on Friday 16 September.

Contact for queries

Please direct any queries to:

Phone: +64 4 439 7400
Email: slvconsultation@mfe.govt.nz
Postal: Regulation of jettisoned material from space launch vehicles, Ministry for the Environment, PO Box 10362, Wellington 6143

Publishing and releasing submissions

All or part of any written submission (including names of submitters) may be published on the Ministry for the Environment's website, www.mfe.govt.nz. Unless you clearly specify otherwise in your submission, the Ministry will consider that you have consented to website posting of both your submission and your name.

Contents of submissions may be released to the public under the Official Information Act 1982, following requests to the Ministry for the Environment (including via email). Please advise if you have any objection to the release of any information contained in a submission and, in particular, which part(s) you consider should be withheld, together with the reason(s) for withholding the information. We will take into account all such objections when responding to requests for copies of, and information on, submissions to this document under the Official Information Act.

The Privacy Act 1993 applies certain principles about the collection, use and disclosure of information about individuals by various agencies, including the Ministry for the Environment. It governs access by individuals to information about themselves held by agencies. Any personal information you supply to the Ministry in the course of making a submission will be used by the Ministry only in relation to the matters covered by this document. Please clearly indicate in your submission if you do not wish your name to be included in any summary of submissions that the Ministry may publish.

Questions to guide your feedback

Environmental effects

1. Do you agree that the environmental effects described are the main environmental effects likely to occur as a result of the activity? If not, why not?
2. Do you agree with the scale of the described environmental effects? If not, why not?
3. Are there any other environmental effects that you are aware of that the Government should consider? If so, what are they?

Economic effects

4. Do you agree that the economic effects described are the main economic effects likely to occur as a result of the activity? If not, why not?
5. Do you agree with the scale of the described economic effects? If not, why not?
6. Are there any other economic effects that you are aware of that the Government should consider? If so, what are they?

Effects on existing interests

7. Do you agree that the existing interests described are the main existing interests? If not, why not? Please describe any other existing interests you are aware of that may be affected by the activity.
8. What do you think the main effects will be on existing interests? Please provide any information you have in relation to those effects.

Classifying the deposit on the seabed of jettisoned material from space launch vehicles as a permitted activity

9. Do you agree that the deposit on the seabed of jettisoned material from space launch vehicles should be classified as permitted? If not, how should the activity be classified or regulated?

Proposed conditions for the activity

10. Do you agree with the proposed conditions for the activity? If not, what changes would you propose and why?

11. Are there any other conditions that you think should be set on the activity?

Other comments

12. Do you have any other comments you wish to make?

What happens next?

Once submissions have been considered, further work will be undertaken to refine proposals and draft regulations. The Government intends to progress this work into regulations before the end of 2016.

Appendix A: Expected fragmentation of stage 1 of the space launch vehicle[16]

Component	Fragment count	Fragment mass (kg)	Fragment area (m^2)
Connector	4	0.02 to 0.04	<0.01
Cables and mounts	103	0.02 to 0.04	<0.01
Structure	12	0.03 to 0.06	<0.01
Vent assembly	6	0.04 to 0.07	<0.01
Structure	14	0.06 to 0.10	<0.01
Controller assembly	6	0.10 to 0.16	<0.01
Valve	2	0.11 to 0.18	<0.01
Structure	1	0.11 to 0.19	<0.01
Valve assembly	1	0.17 to 0.28	<0.01
Structure	1	0.17 to 0.29	0.05
Connector	3	0.20 to 0.33	<0.01
Structure	6	0.22 to 0.36	<0.01
Miscellaneous small parts	31	0.24 to 0.40	0.01
Structure	3	0.33 to 0.56	<0.01
Controller assembly	3	0.38 to 0.63	<0.01
Structure	1	0.38 to 0.64	<0.01
Controller assembly	1	0.41 to 0.69	0.01
Structure	1	0.47 to 0.79	0.02
Sensor assembly	1	0.61 to 1.02	0.01
Valve assembly	1	0.76 to 1.27	0.02
Structure	1	0.92 to 1.54	0.03
Controller assembly	2	0.97 to 1.61	0.02
Valve assembly	1	1.01 to 1.68	0.02
Valve assembly	1	1.01 to 1.69	0.02
Structure	1	1.09 to 1.82	<0.01
Structure	15	1.10 to 1.83	0.23
Spring assembly	4	1.82 to 2.13	0.02
Actuator assembly	6	1.28 to 3.03	<0.01
Controller assembly	1	2.25 to 3.74	0.02
Battery component	15	2.85 to 4.75	0.02
Structure	1	3.35 to 5.59	0.3
Pump assembly	1	5.03 to 8.39	0.03

[16] Source: Rocket Lab.

Component	Fragment count	Fragment mass (kg)	Fragment area (m^2)
Gas cylinder	6	5.17 to 8.62	0.09
Structure	4	9.69 to 13.17	3.29
Structure	4	19.21 to 25.61	6.52
Battery	13	15.68 to 26.13	0.08
Cylinder	1	17.21 to 28.68	1.14
Stage 1 motor assembly	1	307.4 to 355.9	1.92

Appendix B: Section 33 of the EEZ Act: Matters to be considered for regulations

(1) This section and section 34 apply when the Minister is developing regulations for the purposes of section 27.

(2) The Minister must have regard to any comments made under section 32(2).29.

(3) The Minister must take into account—

(a) any effects on the environment or existing interests of allowing an activity with or without a marine consent, including—

(i) cumulative effects; and

(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

(b) the effects on the environment or existing interests of other activities undertaken in the exclusive economic zone or in or on the continental shelf, including—

(i) the effects of activities that are not regulated under this Act; and

(ii) effects that may occur in New Zealand or in the waters above or beyond the continental shelf beyond the outer limits of the exclusive economic zone; and

(c) the effects on human health that may arise from effects on the environment; and

(d) the importance of protecting the biological diversity and integrity of marine species, ecosystems, and processes; and

(e) the importance of protecting rare and vulnerable ecosystems and the habitats of threatened species; and

(f) New Zealand's international obligations; and

(g) the economic benefit to New Zealand of an activity; and

(h) the efficient use and development of natural resources; and

(i) the nature and effect of other marine management regimes; and

(j) best practice in relation to an industry or activity; and

(k) in relation to whether an activity is classified as permitted or discretionary, the desirability of allowing the public to be heard in relation to the activity or type of activity; and

(l) any other relevant matter.

Glossary

Auto-ignition	The lowest temperature at which a fuel spontaneously ignites in normal atmosphere without an external source of ignition.
Benthic	The flora and fauna found on the bottom, or in the bottom sediments, of a sea or lake.
Biota	The animal and plant life of a particular region, habitat, or geological period.
Cumulative effects	Effects that accumulate or arise over time or in combination with other effects.
Demersal	The zone of the water column that is closest to the seabed.
Dumping	The disposal into the sea of waste or other matter or ships, aircraft, or structures.
Deposit	The act of placing anything or organism in, on, or under the seabed.
Ecosystem	A biological community of interacting organisms and their physical environment.
Fairing	An external metal or plastic structure whose primary function is to produce a smooth outline and to reduce drag.
Fauna	The animals of a particular region, habitat, or geological period.
Invertebrates	An animal lacking a backbone.
Mahinga kai	Food-gathering practices and traditional Māori foods including indigenous shellfish, inland fish (tuna [eels], freshwater kōura [crayfish]) and plants (pūhā, kūmara etc).
Payload	An object that is placed in outer space by means of a launch vehicle, or, as the case may be, placed above the upper limit of controlled airspace by means of a high altitude vehicle.
Pelagic	Water that is not close to the shore or the bottom of the ocean (usually in the depth range 0 – 1000 m). Fish that live in the water column in the open ocean are often referred to as pelagic.
Phytoplankon	Microscopic organisms that inhabit the upper layer of the oceans and bodies of fresh water. These organisms obtain their energy from sunlight.
Pneumatics	The branch of physics or technology concerned with the mechanical properties of gases.

Propellants	A material that is used to move an object by applying a motive are dispersed.
Launch vehicle	A rocket used to carry a payload from Earth's surface into outer space.
Substrate	The surface or material on or from which an organism lives, grows, or obtains its nourishment.
Sun-synchronous orbit	A geocentric orbit that combines altitude and inclination in such a way that the satellite passes over any given point of the planet's surface at the same local solar time.
Zooplankton	Plankton consisting of small animals or the early life stages of some species (eg, juveniles of many fish species), some of which migrate through the water column on a daily basis down to depths > 300 m. Zooplankton obtain their food by eating other organisms, including phytoplankton.

References

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