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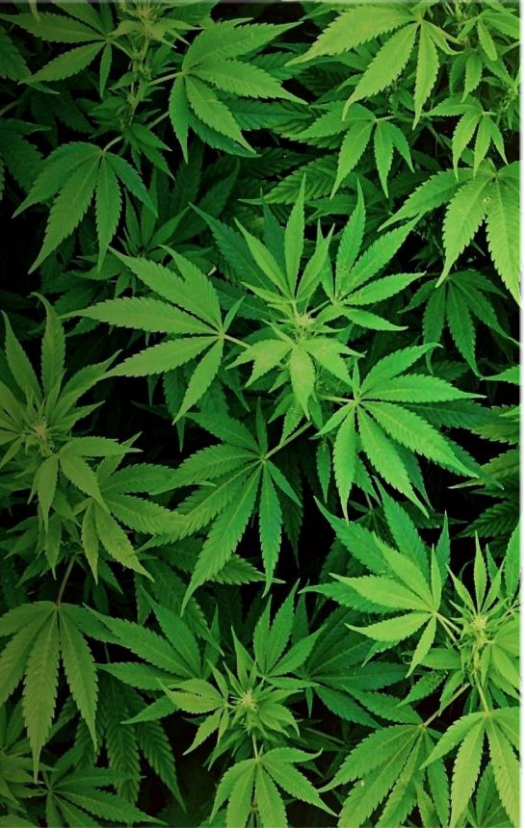
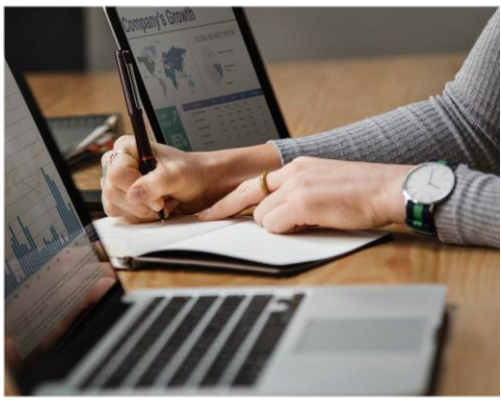
1. This report was prepared by Business and Economic Research Limited (BERL), under commission from the Ministry of Justice.

2. The views, opinions, recommendations, and advice expressed in this report belong solely to the authors of the report. The views do not necessarily reflect the views of the Ministry of Justice or the New Zealand Government.

3. The report was one of a number of inputs considered by the Ministry in the development of the draft Cannabis Legalisation and Control Bill. The overarching objective of the regulatory framework, which is set out in the draft Cannabis Legalisation and Control Bill, is to reduce the harms associated with cannabis use experienced by individuals, families, whānau, and communities in New Zealand. In developing the model, harm reduction was preferred over other considerations, including economic ones.

4. The report is not part of the Ministry of Justice's public information campaign for the referendums.





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Evidence to inform a regulated cannabis market

Here-turi-kōkā 2019 berl.co.nz

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 Reference No: #6009 Here-turi-kōkā 2019

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Glossary

Assumption – a value imposed on a model, or in a calculation, in the absence of precise data or information

Baseline model – a set of calculations to measure the existing illegal market for cannabis in New Zealand and harms associated with the production and consumption of cannabis and related products

Benchmark model – a set of calculations to measure the post-legalisation market for cannabis in New Zealand and harms associated with the production and consumption of cannabis and related products

Cannabis – is the psychoactive dried flower buds, leaves, or preparations (such as hashish) or chemicals (such as THC) that are derived from the cannabis plant. While most international research refers to marijuana, we have used the term cannabis for consistency with current policy direction. The term marijuana also has historical racist overtones, and cannabis is the correct scientific name.

Cannabis equivalents – are products that are manufactured to incorporate THC into the product, and therefore can be treated as equivalent products to dried cannabis buds

Cannabis growers/producers – are businesses that are licenced to grow and harvest cannabis plants in New Zealand. Cannabis growers must sell their cannabis plants to a licenced cannabis processors

Cannabis processors – are businesses that are licenced to process cannabis buds and other plant material in New Zealand. Cannabis processors must buy their cannabis from a licenced cannabis grower, and sell to a licenced cannabis retailer

Cannabis retailers – are businesses that are licenced to sell cannabis and cannabis related products to the general public aged over 20 in New Zealand. Cannabis retailers must buy their cannabis products from a licenced cannabis processor

Capital cost – initial or one-off costs incurred in the setting up a business or enterprise

Combined store – is a store that has been licenced to sell only cannabis (to be consumed on premises or taken away) and cannabis related accessories (such as vaporisers, bongs, pipes, infusers, storage containers, grinders, and other accessories) to the general public aged 20 or older. In addition this store can sell limited amounts of non-alcohol beverages and food to customers consuming cannabis on-site

Depreciation – is the loss of value from equipment and capital assets as they age

Demographics - information relating to the population and particular groups within it

Dried cannabis – refers to cannabis flower buds which have undergone a drying and curing process

Elasticity - the amount by which cannabis demand goes up (or down) in response to a decrease (or increase) in its price

Excise tax (duty) – tax placed on a product based on the amount of a particular component in that product (e.g. tax on cannabis products based on THC content of product)

Fiscal cost – the cost to government

Harm – a bad outcome, this can be for an individual (e.g. poor health), community (e.g. lower employment rates), or an additional cost to the government

Hospitalisation – when a person is admitted to hospital, or spends longer than four hours in the emergency department

Hydroponics – refers to the process of growing plants in sand, gravel, or liquid, with added nutrients but without soil

Kilowatt hours (kWH) – is a measure of electrical energy equivalent to a power consumption of one thousand watts for one hour

Labour force status – describes whether a person is employed (casually, part time, or full time), unemployed, studying, retired, or otherwise not in market employment. For those that are employed, this can further describe whether a person is an employer, an employee, or is self-employed

Licenced premise – is a store that has been licenced to sell only cannabis to the general public aged 20 or older for consumption on site. In addition this store can sell limited amounts of non-alcohol beverages and food to customers consuming cannabis on-site

Mark-up percentage or retail mark-up – is the percentage difference in the retail price compared to the price the store paid for the item (often this is referred to as the wholesale price of the item)

Medicinal – when cannabis is used as a treatment for a medical condition or to relieve pain

Mid-range estimate – the middle value for a particular measure where there are a range of estimates (perhaps resulting from the need to adopt assumptions to generate such estimates, or due to lack of precise data)

Operating cost – regular or recurring (e.g. weekly, monthly, annual) costs incurred in the operation of a business or enterprise

Parameter – an input to the model which may be changed to approximate a different circumstance

Prevalence – number of people (or rate per 1000 people) affected by a condition or disease at a given time

Recreational – when cannabis is used with the intention to get 'high'

Retail store – is a store that has been licenced to sell cannabis and cannabis related accessories (such as vaporisers, bongs, pipes, infusers, storage containers, grinders, and other accessories) to the general public aged 20 or older. Retail stores are prohibited from selling any other good or service

Scenarios – hypothetical experiments that use a model to compare and assess the impacts (on wellbeing, for example) of suggested interventions or price changes

Secondary processors – are businesses that are licenced to purchase processed cannabis from cannabis processors for the purpose of making other cannabis products, such as cannabis edibles

Tetrahydrocannabinol (THC) – is the chemical responsible for most of cannabis's psychological effects. It acts much like the cannabinoid chemicals made naturally by the body. Cannabinoid receptors are concentrated in certain areas of the brain associated with thinking, memory, pleasure, coordination and time perception. THC attaches to these receptors and activates them and affects a person's memory, pleasure, movements, thinking, concentration, coordination, and sensory and time perception. THC is one of many compounds found in the resin secreted by glands of the cannabis plant. More of these glands are found around the reproductive organs of the plant than on any other area of the plant.

Abbreviations

ACC – Accident Compensation Corporation

ADOM – Alcohol and Drug Outcome Measure

CURF – Confidentialised Unit Record File

DAWN – Drug Abuse Warning Network

FTE – full-time equivalent

GBD – Global Burden of Disease

GDP – gross domestic product

HLFS – Household Labour Force Survey

ICD – International Classification of Diseases

IDI – Integrated Data Infrastructure

IPV – intimate partner violence

LSF – Living Standards Framework

MCL – medicinal cannabis legislation

MoJ – Ministry of Justice

MoH – Ministry of Health

MSD – Ministry of Social Development

NDIB – National Drug Intelligence Bureau

NIAAA – National Institute of Alcohol Abuse and Alcoholism

NPC – National Poisons Centre

NSDUH – National Survey on Drug Use and Health (United States)

NZADUS – New Zealand Alcohol and Drug Use Survey

NZCASS – New Zealand Crime and Safety Survey

NZGSS – General Social Survey

NZHS – New Zealand Health Survey

RPC – Regional Poisons Centre

SAMHSA – Substance Abuse and Mental Health Services Administration

SHORE – Social and Health Outcomes Research and Evaluation (Massey University)

THC – Tetrahydrocannabinol

WHO – World Health Organisation

1 Summary overview

1.1 Tīmatanga kōrero

This document collates a suite of information provided to the Ministry of Justice relating to a regulated cannabis market.

Our work has involved constructing a baseline model reflecting cannabis users, their consumption, and associated harms and indicators of wellbeing. The harms and wellbeing indicators incorporated in the model are restricted to those that have quantitative data. Qualitative and other impacts of the legalisation of cannabis on the wellbeing of users and their communities have been assessed and summarised in a separate narrative. This includes research findings and information from overseas studies.

Additionally, we have constructed a model of business operations across the cannabis value chain to investigate the financial viability of these concerns. This analysis explores how the number of licences at each stage of the value chain (grower/producer, processor, retailer) will affect their likely scale of operations and so impact on financial viability. We incorporate the impact of excise tax and licence fees (at varying levels) on these operations, as well as restrictions at the retail level on the sale of non-cannabis related products.

We explore the cost to government, and the organisational design options, for a regulatory body to manage and enforce the licencing and other restrictions to be imposed on this market.

This section summarises the various inter-related aspects of such a regulated market. Further details are provided in each of the following sections, as follows:

- Wellbeing scenarios – section 2
- Baseline model method and assumptions – section 3
- International research analysis – section 4
- Financial viability of establishments in a legal cannabis industry – section 5
- Organisation design – section 6.

References are provided in section 7, along with data sources in sub-section 7.1.

1.2 The shape of the current illegal cannabis market

The current (2018) illegal cannabis market was estimated based on total consumption of cannabis, frequency of use and demographics. A summary table of the current market is provided in Table 7.1 in Appendix A.

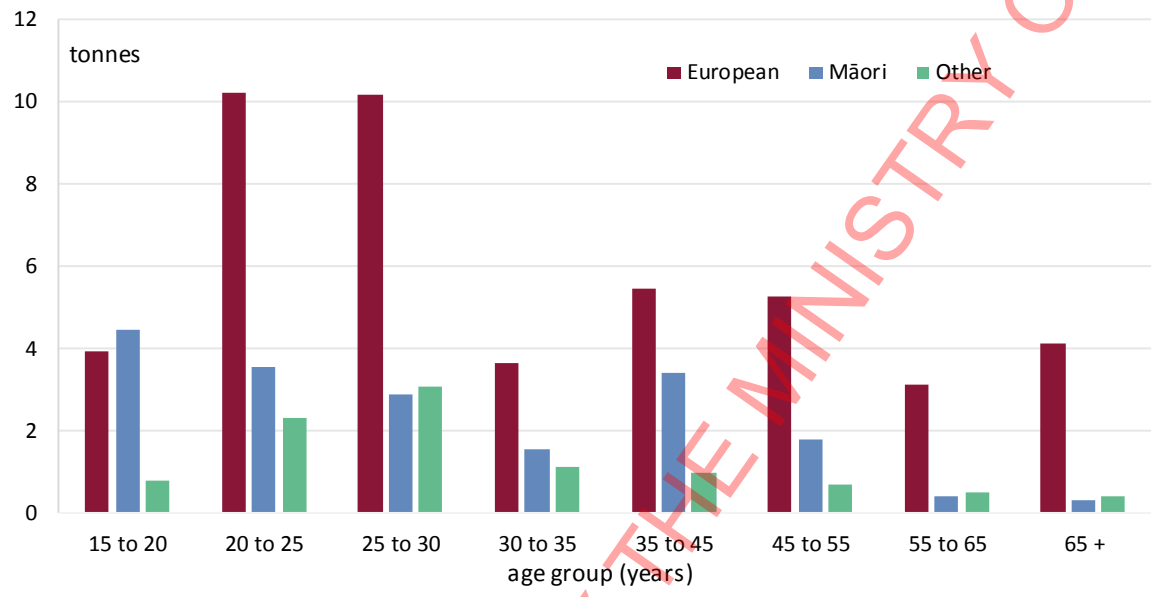
1.2.1 Baseline consumption

We estimate the current size of the cannabis market at a total 74 tonnes consumed per year across a total of over 557,000 users aged 15 years and above. As cannabis is currently prohibited in New Zealand, the entire market is illegal.

An assumed price of $20 per gram suggests this market has a retail value of $1.5 billion. However, there are suggestions that regular and frequent users access cannabis at a noticeably lower per gram price. If so, then this retail value figure is likely to be an over-estimate.

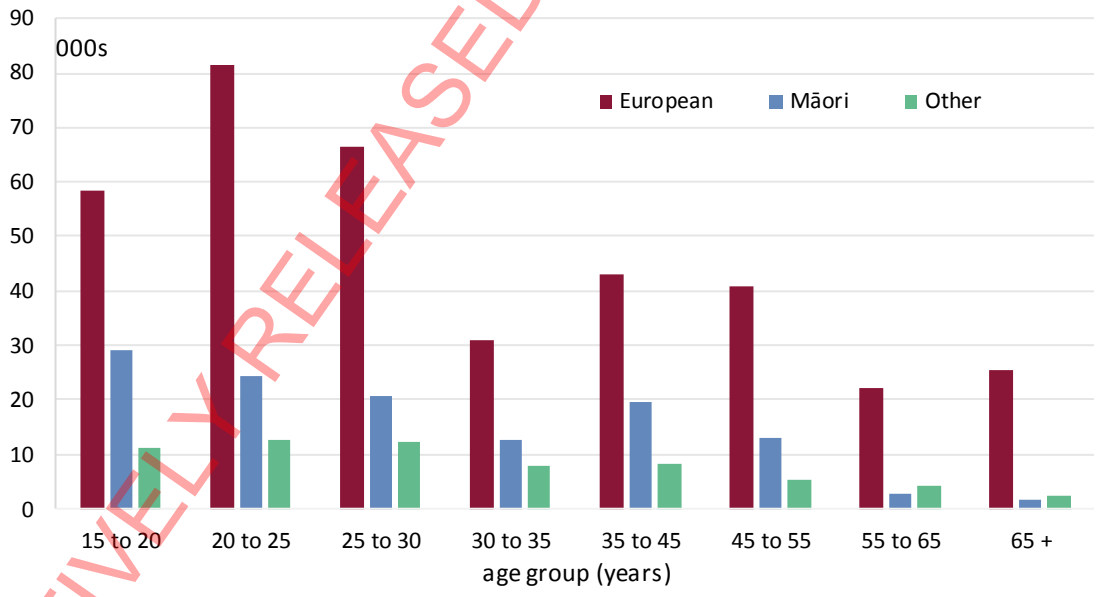
Consumption is heavily dominated by daily users, with this group accounting for 62 tonnes of the total annual figure. The distribution of consumption is skewed towards those aged from 20 to 30 years old, especially for those of European ethnicity (Figure 1.1). There is also significantly large consumption by Māori 15 to 20 year olds.

Figure 1.1 Baseline annual cannabis consumption by ethnicity and age group



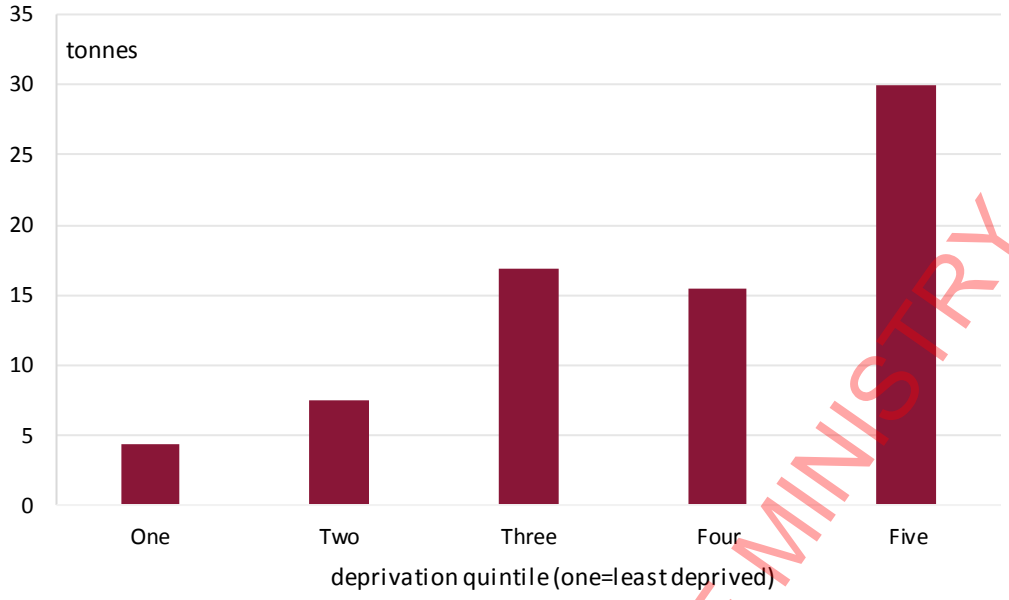
The distribution of cannabis users is similar, although the number of 15 to 20 year olds of European ethnicity shows through in this picture (Figure 1.2).

Figure 1.2 Number of cannabis users by ethnicity and age group



It is also clear that the bulk of cannabis is consumed by those residing in the most deprived areas of New Zealand (Figure 1.3). In particular, at close to 30 tonnes, consumption by those in the most deprived quintile accounts for 40 percent of the total.

Figure 1.3 Baseline annual cannabis consumption by deprivation quintile



1.2.2 Wellbeing measures

Health

Under current baseline levels of consumption there are annually 1,115 hospitalisations related to cannabis consumption. These hospitalisations incur an annual fiscal cost of $14.7 million.

These are mid-range estimates, based on the hospital identifying cannabis as a factor in the primary or the secondary diagnoses. A more conservative estimate based on the primary diagnosis alone, puts cannabis related hospitalisations at 56 annually, incurring a fiscal cost of $3.3 million. In contrast, a high figure based on any cannabis presence results in an estimated 354 hospitalisations per year at a fiscal cost of $25.7 million.

In terms of other health indicators, the higher incidence of long-term health conditions (Figure 1.4) and mental health conditions (Figure 1.5) among cannabis users is clear. As illustrated, these higher incidences occur across all age groups.

Figure 1.4 Incidence of those with long-term health conditions per 100,000 of population

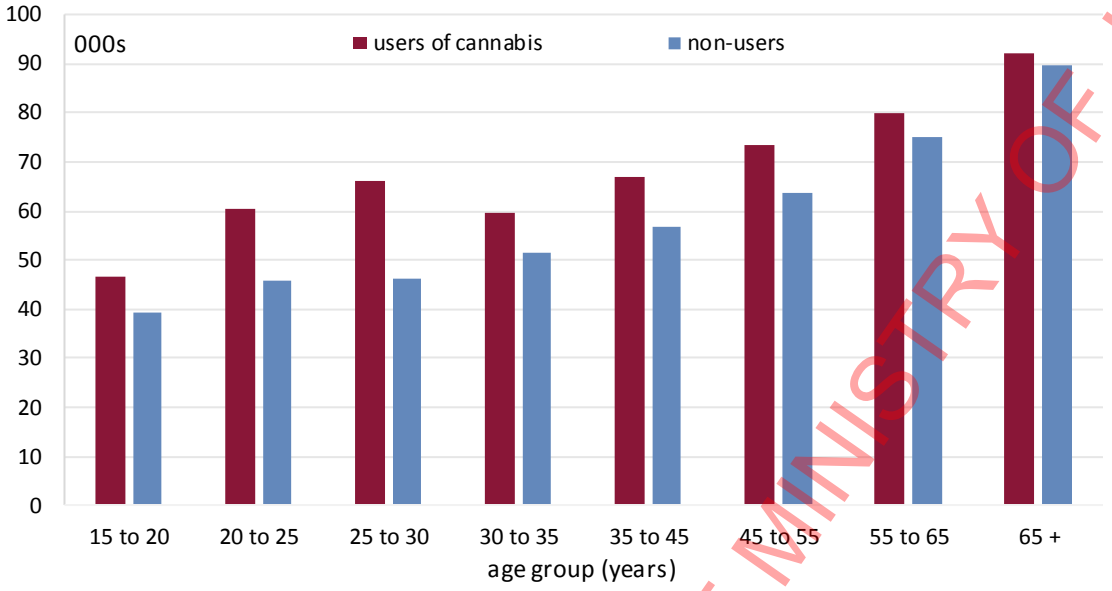
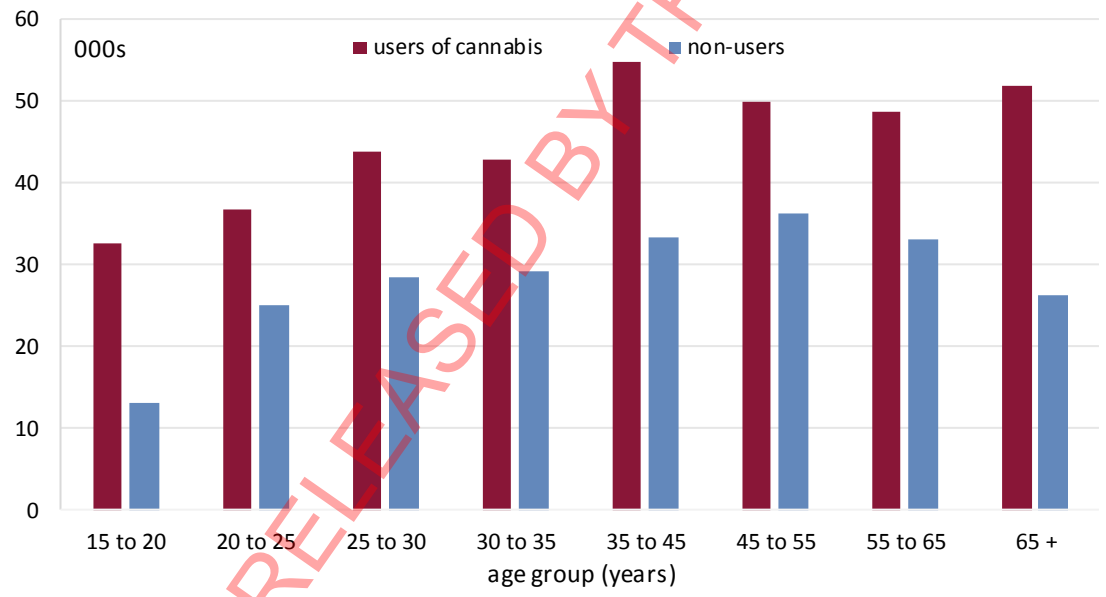


Figure 1.5 Incidence of those with mental health conditions per 100,000 of population



Education

Education indicators also show a higher incidence of those with no qualifications among cannabis users across almost all age groups (Figure 1.6). Conversely, there is a lower incidence of those with degree qualifications among cannabis users (Figure 1.7).

Figure 1.6 Number with no qualifications per 100,000 of population

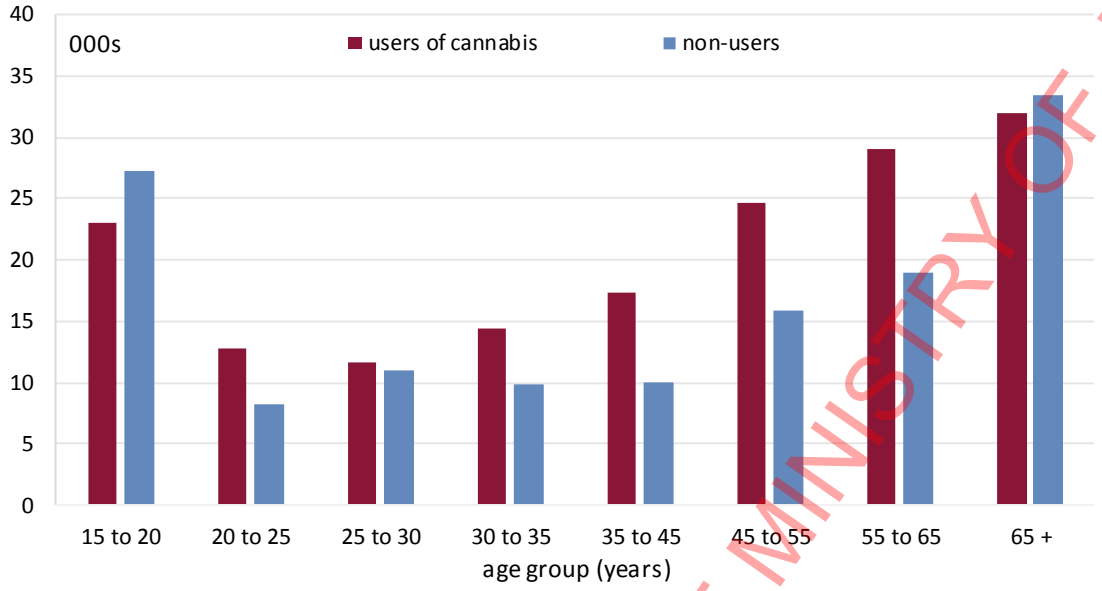
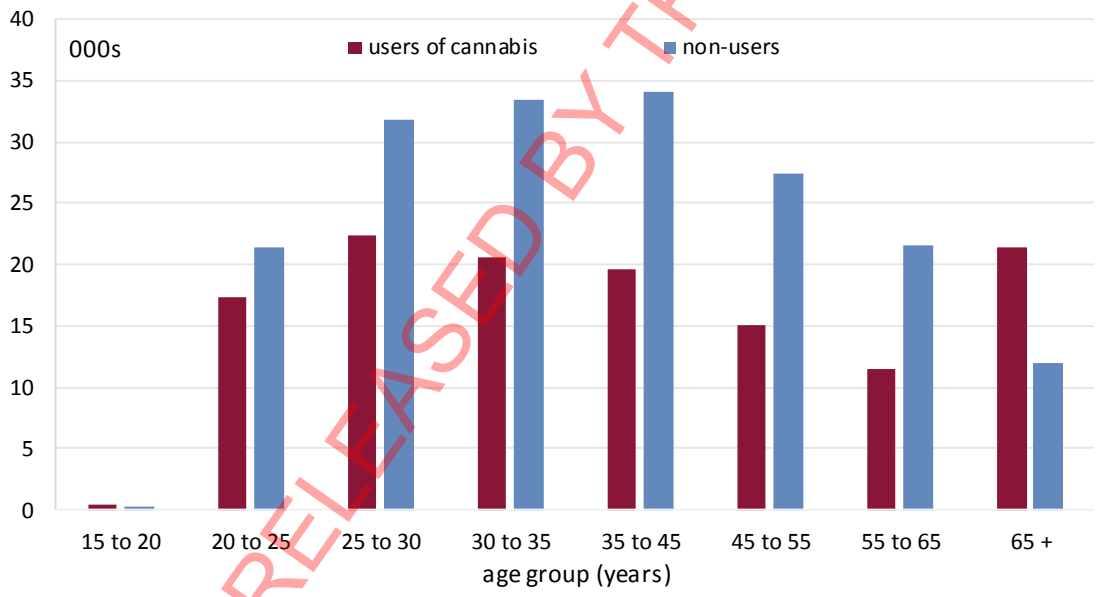


Figure 1.7 Number with degree qualifications per 100,000 of population



Justice and corrections

Under current baseline levels of consumption, there were 3,245 warnings issued by the police for cannabis related offences in 2018. These resulted in 1,650 charges and 1,250 convictions annually. These incurred annual fiscal costs for justice and corrections of, respectively, $2.6 million and $11.3 million.

These are mid-range estimates, based on cannabis being the most serious charge. A more conservative estimate based on cannabis being the only charge, puts cannabis offences at 1,352 charges and 883 convictions annually. This leads to an estimated fiscal cost of $1.5 million and $3.5 million justice and corrections, respectively. In contrast, a high figure based on all cannabis

offences results in an estimated 3,969 charges and 3,099 convictions, at a fiscal cost of $4.4 million and $30.2 million for justice and corrections annually.

Recorded cannabis charges and convictions are skewed towards Māori, with a notably higher rate of convictions (Figure 1.8). Additionally, the higher corrections costs (compared to justice costs) illustrated in Figure 1.9 indicate relatively more (or longer) custodial sentences being imposed on Māori.

Figure 1.8 Number of cannabis charges and convictions by ethnicity

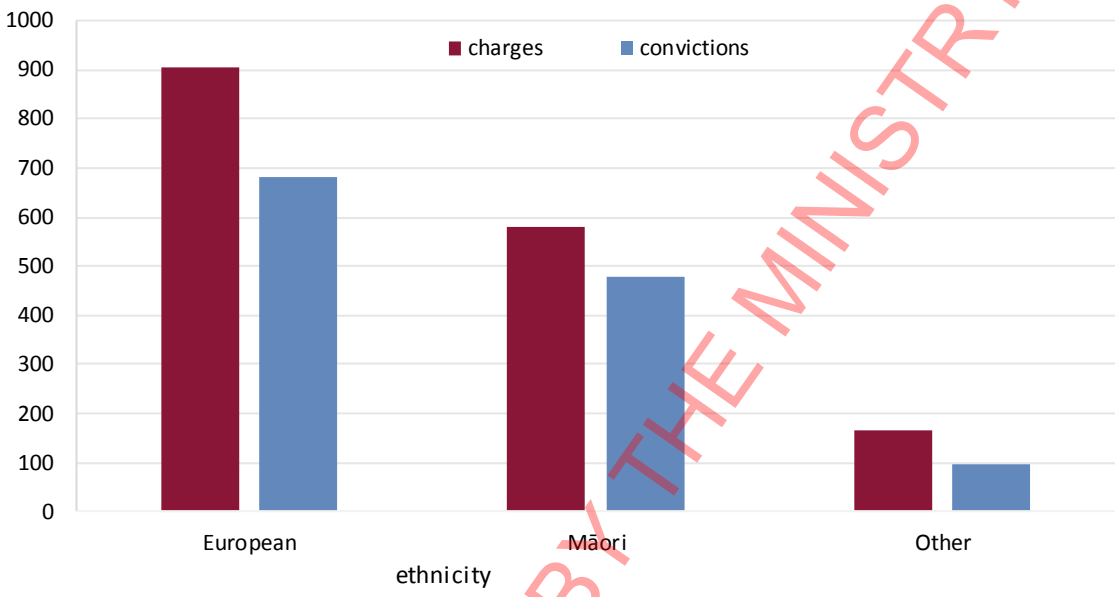
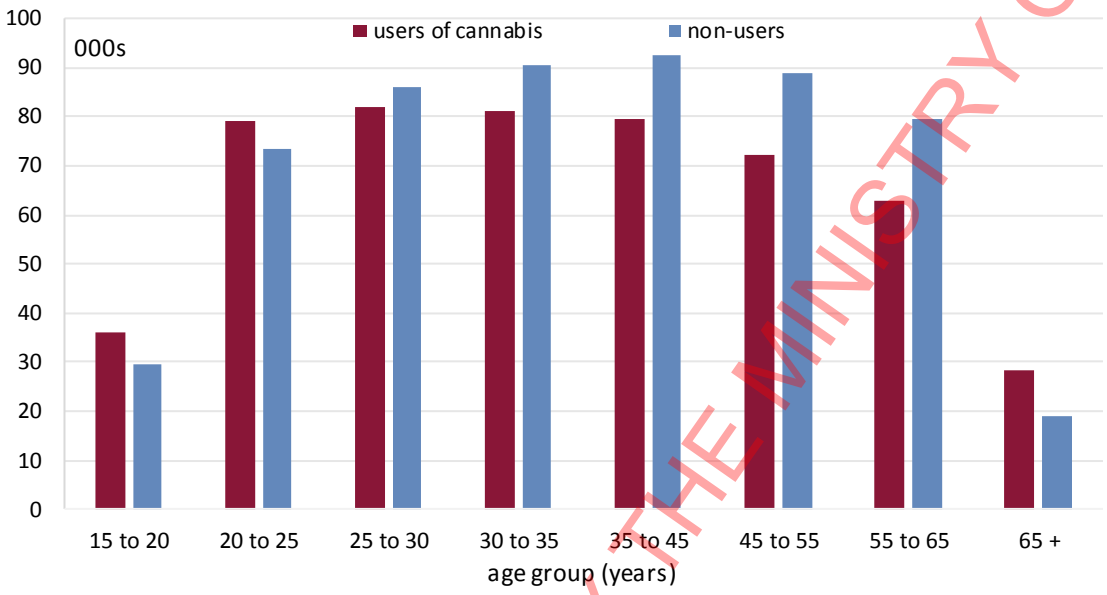


Figure 1.9 Cannabis related justice and corrections costs by ethnicity

Employment and income

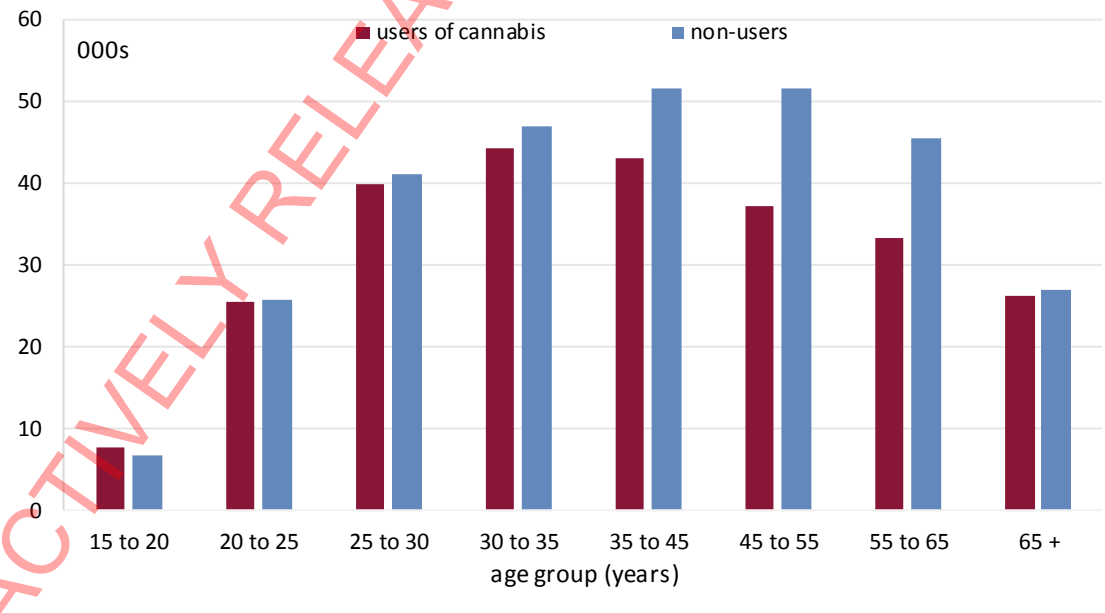
Labour market measures show a noticeable difference in employment outcomes. At the headline level, cannabis users have lower employment rates across most age groups (Figure 1.10). The exceptions are among youth (aged 15 to 25 years old) and those aged 65 years and older.

Figure 1.10 Incidence of employment per 100,000 of population by age group



The combination of education and employment outcomes is also reflected in the average income of cannabis users compared to non-users (Figure 1.11). For youth (those 15 to 25 years old) the difference in incomes is marginal as other factors (e.g. skills, experience, and training) are the levelling influences. However, the difference in incomes becomes apparent for those in the 25 to 30 years old age group, and grows thereafter as non-users report higher average incomes.

Figure 1.11 Average Income by age group



1.3 Post legalisation – the changes

We begin with the assumption that regulated prices in the legal market are similar to those in the illegal market – i.e. $20 per gram.

Legalisation will change the nature, levels, and composition of consumption.

This will result in changes in wellbeing indicators. Changes in wellbeing outcomes are effectively driven by changes in consumption levels (kilograms consumed), the number of users, and the distribution of such use across population groups. Note that post legalisation we assume that all consumption of cannabis by those under 20 years old will be sourced from the illegal market.

Numbers stated in this section as to changes in wellbeing indicators are mid-range estimates.

1.3.1 Immediate impact (ST0)

On legalisation, we expect a short-term spike in levels of consumption. Based on evidence from the states of Colorado, Massachusetts, Washington and the District of Columbia, we model the short-term spike in demand as an approximately 30 percent increase in kilograms consumed across a 25 percent increase in the number of users. Data from Colorado and Washington, indicate a substantial decline in use rates since legalisation suggesting that this initial effect may tail off over a period of three to five years.

The short-term spike in cannabis use is modelled, with summary indicators (in terms of change from baseline) listed in Table 1.1 under the column heading ST0. This scenario sees:

- An increase of 300 in the annual number of hospitalisations related to cannabis consumption, with a $4.0 million increase in the annual fiscal cost
- Annually, 1,930 fewer warnings, 1,200 fewer charges, and 940 fewer convictions for cannabis related offences, with a reduction in justice and corrections costs of, respectively, $2 million and $8.7 million. These costs assume no change in the intensity of enforcement of the illegal cannabis market.

1.3.2 Medium-term legalised scenario (LT0)

After the short-term spike recedes we assess the situation and outcome where demand reverts to current baseline levels of consumption. This scenario is modelled, with summary indicators listed in Table 1.1 under the column heading LT0.

As there is no change on the baseline in the overall number of users and kilograms being used, health outcomes in this scenario revert back to those recorded in the baseline.

However, justice outcomes see **a reduction** in cannabis related offences by (annually):

- 1,990 warnings, 1,280 charges, and 1,000 convictions for cannabis related offences, with a reduction in justice and corrections costs of, respectively, $2.1 million and $9.3 million. These costs assume no change in the level of enforcement of the illegal cannabis market.

Due to the shift from the market being illegal to a majority legal market, the justice outcomes are significantly improved. As the whole supply chain will have both legal and illegal elements (unlicensed manufacture or retailing, and possession of over 15 grams) there will remain some justice outcomes proportional to the reduction in size from the current illegal market. The outcomes of charges for these offences will be highly dependent on any changes in the legislated penalties for each type of offence.

Legalisation will be unable to completely eliminate cannabis related justice outcomes as while legalised, the market will be tightly regulated. Those breaching the new regulations will be processed in the justice system. Secondly, prohibition will continue for individuals under the age of 20 years old, therefore all cannabis procured by this group will be illegal.

Table 1.1 Summary indicators of modelled scenarios

	Baseline	ST0	LT0	LT1	LT2
Legal price ($)	na	20.00	20.00	20.00	20.00
Illegal price ($)	20.00	20.00	20.00	20.00	20.00
Market share legal (%)	0	85	85	85	85
Use	**Base**	**Change on base**			
Total use (Kg)	74,083	22,467	0	-6,733	-6,926
Total users (number)	557,244	138,685	0	0	-27,684
Share of population (%)	14	3.5	0.0	0.0	-0.7
Value of legal consumption* ($m)	0	1,438	1,104	-100	-103
Value of illegal consumption ($m)	1,482	-989	-1,104	-34	-35
Total value of consumption ($m)	1,482	449	0	-135	-139
Economic outcomes					
No qualification	93,993	na	0	-1,169	-1,531
Employed	346,229	na	0	1,179	1,718
Income ($)	30,636	na	0	282	380
Health outcomes					
Long term health condition	326,325	na	0	-4,623	-5,936
Mental health diagnosis	219,531	na	0	-6,573	-7,840
Hospitalisations (first 2 diagnoses)	1,115	306	0	-101	-104
Hosp costs (first 2 diagnoses) ($000s)	14,690	4,042	0	-1,335	-1,372
Justice outcomes					
Warnings	3,251	-1,932	-1,989	-2,104	-2,106
Charges	1,650	-1,208	-1,284	-1,317	-1,318
Convictions	1,262	-944	-1,009	-1,031	-1,032
Justice cost ($000s)	2,606	-1,969	-2,106	-2,151	-2,153
Corrections cost ($000s)	11,311	-8,689	-9,314	-9,495	-9,500

Baseline: The market as it currently exists in New Zealand
ST0: Short term expected spike in demand
LT0: Long term market with both legal and illegal production and retail
LT1: Long term market with reduction in use rates
LT2: Long term market with reduction in number of users
* including the value of homegrown cannabis

1.3.3 Alternative intervention scenarios (LT1 and LT2)

We have also modelled scenarios where interventions successfully reduce use and numbers of users by between 5 percent and 10 percent (listed as LT1 and LT2 in Table 1.1). Note, the model is not designed to assess which interventions may or may not be successful. Nor can it assess the investments required to make such interventions successful. Rather, these scenarios illustrate the potential gains of a hypothetical exercise aimed at reducing use and usage rates.

If successful, such interventions could potentially see:

- A reduction of between 4,600 and 5,900 in the number of cannabis users with long-term health conditions
- A reduction of between 6,500 and 7,800 in the number of cannabis users with mental health diagnoses
- A reduction of 100 in the number of hospitalisations related to cannabis consumption, with a $1.3 million reduction in the fiscal cost
- 2,100 fewer warnings, 1,310 fewer charges, and 1,020 fewer convictions for cannabis related offences, with a reduction in justice and corrections costs of, respectively, $2.1 million and $9.5 million. These are reductions on current baseline levels. As previously, these costs assume no change in the intensity of enforcement of the illegal cannabis market.

Over the longer term, should these reduced levels of use endure (i.e. by between five and 10 percent on baseline), we model:

- A reduction of between 1,200 and 1,400 in the number leaving school without a qualification
- An increase of between 1,200 and 1,700 in the number employed
- An increase of between $280 and $380 in average annual incomes.

It is noticeable that intervening to reduce the usage of cannabis (i.e. the kilograms consumed) results in similar wellbeing gains to that focussed on reducing both usage and the number of users. Alternatively, there do not appear to be large gains in terms of reduced harms by intervening to reduce the number of users. The larger gains in terms of reduced harms arise from interventions that successfully reduce the usage (kilograms consumed) of cannabis.

These scenario results are driven by parameter and intensity of use model settings. They cannot assess the success or otherwise of an intervention. There is a lack of data or research to determine the extent of the success that may arise from any particular interventions. Excise duty revenues of the order of $640 million per annum (refer sub-section 1.4.1), would potentially be available to fund intervention efforts to minimise harms.

Available international literature and data on cannabis use and outcomes post-legalisation has been assessed and is detailed in section 4. A summary is provided in Table 7.2 in Appendix B.

In summary, data in this area and research on the impact of legalisation remains limited. Data relevant and usable for the New Zealand context is further limited. Consequently, the modelled outcomes are contingent on a range of model assumptions.

1.3.4 Alternative price scenarios

Table 1.2 summarises the model results under alternative assumptions as to the price of cannabis.

Higher price in legal market (LTa)

A higher price in the legal market results in a reduction in the quantity used in the legal market. However, as the illegal market remains at $20, the number of cannabis users does not reduce as individuals shift consumption towards the illegal market.

The reduction in the overall quantity used has a positive influence on the health harms through reducing the overall level of use.

The price increase in the legal market causes some users to switch to an illegal supply as it is cheaper. This results in the illegal market being slightly larger than in the LT0 scenario, with an associated higher level of justice sector harms.

Table 1.2 Summary indicators for alternative price scenarios

	LT0	LTa	LTc
Legal price ($)	20.00	25.00	20.00
Illegal price ($)	20.00	20.00	18.00
Market share legal (%)	85	85	85
Participation elasticity	na	na	Yes
Use	**LT0**	**Change**	
Total use (Kg)	74,083	-7,435	67
Total users (number)	557,244	0	21,624
Share of population (%)	14	0.0	0.5
Value of legal consumption* ($m)	1,104	58	-42
Value of illegal consumption ($m)	378	26	1
Total value of consumption ($m)	1,482	84	-41
Economic outcomes			
No qualification	93,993	-3,031	-1,554
Employed	346,229	3,280	2,179
Income ($)	30,636	603	145
Health outcomes			
Long term health condition	326,325	-7,990	304
Mental health diagnosis	219,531	-10,362	2,839
Hospitalisations (first 2 diagnoses)	1,115	-109	6
Hosp costs (first 2 diagnoses) ($000s)	14,690	-1,421	95
Justice outcomes			
Warnings	1,262	47	168
Charges	366	30	39
Convictions	247	24	25
Justice cost ($000s)	500	50	49
Corrections cost ($000s)	1,997	220	187

LT0: Long term market with both legal and illegal production and retail
LTa: Long term market with increase in legal price to $25
LTc Long term market with decrease in illegal price to $18
* Includes an assumed 10 percent of home grown cannabis

Lower price in illegal market (LTc)

The new legal cannabis market will present a substantial threat to the current illegal market. This scenario models a possible future where the illegal market responds to this threat by selling product at a lower price.

As this scenario makes cannabis more affordable for users in the illegal market, the level of use, and the number of users will be expected to increase as seen in Scenario LTc.

As users under 20 years old can only purchase cannabis from the illegal market, this group is expected to grow. Overall, this results in a small change in the quantity of cannabis consumed despite a substantial increase in the number of users.

The harms in this scenario are varied. The reduction in overall use levels will result in better health outcomes for individuals over 20 years old, though the increase in use of under 20 year olds will result in substantially worse health outcomes for this group.

The increase in the level of use of cannabis in the illegal market will also result in increased costs of policing and then the subsequent costs to the justice system.

1.4 Post legalisation – controlling the market

1.4.1 Excise tax

We model the use of a progressive excise tax that is applied:

- To dried, cured cannabis based on weight (or the equivalent in 'fresh' cannabis)
- On a progressive basis, according to potency levels.

The point of production or manufacture of cannabis for the purposes of levying an excise tax is defined as when the cannabis has been dried and cured. Basing the tax on the weight of the product at this point is similar to the way that excise tax is currently applied to tobacco products. Applying a tax at this point of the production supply process, rather than at the point of retail sale, also enables strong controls to be in place around the manufacturing and storage processes to ensure no goods are released to the market without excise being paid.

The proposed excise tax to be set is modelled at:

- $8.90 per gram for low-strength THC potency cannabis
- $17.60 per gram for medium-strength THC potency cannabis
- $26.30 per gram for high-strength THC potency cannabis.

These rates of excise tax are consistent with average retail prices for cannabis including GST being:

- $20 per gram for low-strength THC potency cannabis
- $30 per gram for medium-strength THC potency cannabis
- $40 per gram for high-strength THC potency cannabis.

This structure of excise tax ensures the average retail profit per gram is similar across potency levels. In turn this ensures no incentive for retailers to concentrate sales on higher potency products. Higher levels of excise tax risks increasing retail prices (assuming there was no regulated maximum price), which increases the risk of a larger illegal market continuing.

Modelling estimates project these levels of excise tax to raise $640 million per year. This is based on the current baseline consumption of 74,000 kilograms per annum, with 49,700 kilograms subject to the excise tax on the commercial market. This is also based on sales in the commercial market comprising 72 percent of low-strength THC potency, 23 percent of medium-strength THC potency, and 5 percent high-strength THC potency.

The revenue from licensing (see section 1.5) and excise tax can be used to address the costs of the regime to government and the objectives for harm reduction and reducing overall usage over time.

By comparison, the 2018 fiscal year (the latest complete year available) saw revenue from excise tax total $1.8 billion from tobacco products and $1.0 billion from alcohol products.

Goods and Services Tax (GST) would also be charged on the excise-inclusive price of cannabis products. At the above retail excise-inclusive prices and sales shares of different potency products, it is estimated that the revenue generated from GST would be $180 million.

1.4.2 Price and potency controls

Another mechanism that could be used to control the price of cannabis are direct price controls (e.g. government fixing the price at which products must be sold or setting a minimum/maximum price, like the approach used in Scotland to the sale of alcohol).

Cannabis usage in New Zealand is currently the highest amongst low-income groups and Māori. Given that low-income groups are more price-sensitive than high-income groups, price and the potency of products will be an important consideration of the regime.

These users may also be more prone to industry pricing strategies that promote cheaper and higher potency products that may increase usage and therefore impact government efforts to reduce usage.

Appropriately graduated (or progressive) excise tax settings based on potency levels, such as those noted above, would be the primary tool to ensure prices are neither too high nor too low. Too low retail prices will hinder efforts to reduce usage and minimise harm, while too high retail prices risks higher sales in the illegal market.

The imposition of levels of excise tax, together with quantity restrictions through licence requirements (see below), should effectively set a minimum price for retail sale. These measures can be further reinforced through advertising and sales restrictions.

Nevertheless, consideration could be given to imposing a minimum price should these measures prove insufficient. Similarly, the number of licences and the separation of retail from wholesale operations should effectively set a maximum price by limiting the risk of monopolistic behaviour. However, consideration could be given to imposing a maximum price should these measures prove insufficient.

These controls also take into consideration the price of cannabis and the illicit trade. Research remains sketchy as to the linkage between demand across the two markets. For modelling purposes, we have assumed the two products (legal cannabis and illegal cannabis) are perfect substitutes. However, theory suggests that the price of legal cannabis could remain higher for some (higher income, older-age) population groups without causing a shift to the illegal market. For some in these groups, the reassurance of accessing (regulated) quality products, along with the stigma associated with illegal behaviour, is important.

In order to continually monitor the impact of pricing mechanisms and the potency of products, it is also recommended that the cannabis industry be required to provide data on its sales and profitability by product, and marketing activities in New Zealand.

1.5 Post legalisation – viability of market participants

The cannabis sector will be a strongly regulated market with only licenced entities able to participate in either growing, processing, and/or retailing activities.

Licensing fees would help the government carry out functions such as managing licence applications and monitoring licensees for compliance.

An annual license based on the number of grams produced/sold will better serve the target of minimising harm. A flat licence fee could be a barrier to entry for smaller operators and skew the sector towards larger producers and/or retailers. Given the uneven consumption of cannabis throughout New Zealand, a variable fee would be a fairer way of distributing licensing costs across the country. In addition a variable fee would mean retailers are more likely to remain financially viable if cannabis sales are lower than envisaged.

The yearly licencing fee, based on a $1.20 per gram (40c for growers, 40c for processors and 40c for retailers) could generate approximately $56 million in revenue. This is based on our medium-term scenario (LT0) where the commercial cannabis market totals 49.7 tonnes, with the remainder being homegrown (5.5 tonnes) or sourced from illegal market (18.9 tonnes).

1.5.1 Model

We have explored the financial viability of enterprises across the growing, processing, and retailing components of the value chain. Running scenarios through the financial viability model, including sensitivity analysis, suggests the following:

- While labour costs are the largest fixed operating cost faced by each of the retail options, they are only a small percentage of total annual operating costs
- The largest costs facing retailers are the variable costs of purchasing cannabis, cannabis accessories, and food and non-alcoholic beverages. These variable costs account for around two-thirds of the total operating costs for each of the retail options
- The sensitivity analysis reveals that the key parameters in the model are the volume of cannabis sales, and the purchase cost of cannabis products. These two parameters directly affect total revenue generated by the retailers, and the largest variable cost faced by the retailer, the purchase of cannabis
- The proposed rates of excise duty are consistent with retail prices at $20 per gram for low-potency products. Most operators retain financial viability at these levels of consumption
- The exception to our financial viability finding is licenced premises in smaller minor urban areas and rural townships. These may not be financially viable due to their need for substantial numbers of customers to use their premises. It is likely that in these areas combined stores would be needed, to provide a viable business model for the sale and consumption of cannabis.

1.5.2 How many shops and where

To supply the estimated 49.7 tonnes of cannabis products to be consumed each year in the legal retail market, 134 retail stores, 59 licenced premises, and 227 combined stores are estimated to be needed:

- In total 207 retail businesses will be needed for the six major urban areas, while a further 94 retail businesses will be needed for the 14 minor urban areas, and 119 retail businesses will be needed for the rural townships and settlements
- In total 112 grower licences will be needed to grow the 42.2 tonnes of dried and cured cannabis bud, as well as the 7.5 tonnes of cannabis equivalent edibles and other products. These will be

spread across the three types of growers, with 81 indoor licences, 17 greenhouse licences, and 14 outdoor licences

- In total 35 processor licences will be needed to process this quantum.

In order to create equitable access for businesses looking to enter the cannabis market, a mandatory separation of retail and other licenses would be appropriate. That is, an enterprise or organisation may be able to hold both a grower and a processor licence, but if so would not be able to hold a retail licence. In other words, any organisation with a retail licence, would not be able to have interests in growing or processing the product. This would help enable a balance between larger established commercial regimes and smaller businesses looking for opportunities to enter the market.

Given the commercial market price, revenue, and consumption settings above, the number of licences that enable a scale of operations to ensure appropriate profitability (as well as an appropriate geographic distribution of activities) totals 567 as listed in Table 1.3.

Table 1.3 Number of licences by type of activity

Cannabis licences types	Count of licences
Indoor growers	81
Greenhouse growers	17
Outdoor growers	14
Primary processers	35
Retail stores	134
Licenced premises	59
Combined stores	227
Total number of licences	**567**

1.5.3 Managing the short-term spike

The short-term spike (as modelled above – sub-section 1.3.1) will require production higher than the 49.7 tonnes that are the basis for the above licence estimates. This extra production would be best treated through the quantity restrictions placed on each licence. We note that the availability of sufficient legal product is critical to achieving a reduction in illegal activity and associated harm.

However, issuing additional licences for the short-term would encourage more organisations to enter the market than would be consistent with the longer-term objective of reducing consumption.

Clearly, industry participants will need to be made aware that quantity restrictions on each licence will be tightened over time consistent with the overall objective of harm reduction.

1.6 Government costs and revenue

From our industry production model, we estimate employment of approximately 5,000 full-time equivalent positions across these sectors, with overall wages and salaries of $210 million per year. This suggests a direct addition to measured annual Gross Domestic Product (GDP) of the order of $440 million.

At a conservative average income tax rate of 15 percent[1], this would yield additional income tax revenue of the order of $30 million per annum. Taxable profit numbers are even more difficult to estimate, but our base assumptions would suggest an order of magnitude of another $10 million in corporate tax revenue.

Our summary of government revenues, based on the medium-term production and consumption scenario (LT0) is listed in Table 1.4.

We estimate the annual running costs of a regulatory agency at $27 million. This comprises approximately 60 enforcement officers/inspectors, with 25 licencing, management and support staff.

As noted above, estimating the costs of harm reduction and other intervention programs are outside scope of our modelling.

Table 1.4 Government revenue from cannabis market

Government revenue	$m
Excise tax	646
GST	181
Licence fees	56
Income and company tax	40

[1] Allowing for low wage rates and part-time nature of those in retail sector.

2 Wellbeing Scenarios

2.1 Summary

This section outlines scenarios applied to the cannabis regulatory model developed for the Ministry of Justice. The scenarios are designed to demonstrate the model and how changes in the parameters affect the calculation of the resulting cannabis markets and the associated harms.

Section 2.3 presents a set of base cases to provide a benchmark for assessing the effects of changes in the cannabis market across three time periods. These base cases are the market as it exists now, the market as it is expected to be immediately post legalisation, and the long term situation the market will reach once fully established. The wellbeing outcomes are summarised to enable comparison to later scenarios.

Section 2.4 looks at scenario outcomes resulting from government intervention to reduce cannabis use in New Zealand. The first focusses on moderating use, while the second seeks to reduce the number of users.

Each model reduces cannabis by approximately seven tonnes

- Model 1 – moderating use
  - Use declines by 6.7 tonnes while the number of users remains constant, health and justice outcomes improve.
- Model 2 – reducing number of users
  - Use declines by 6.9 tonnes as a result of 27,000 fewer users
  - Justice outcomes fall proportionately, though health and economic harms fall more significantly than in the previous model
- The associated wellbeing outcomes demonstrate that the amount of cannabis used is the key driver of the wellbeing outcomes, though reducing the number of users has a greater effect on health.

Section 2.5 examines the effects of changes in the legal and illegal cannabis prices.

- Scenario A – legal price set at $25 per gram, illegal price $20
  - Improved health outcomes but poorer justice outcomes
- Scenario B – legal price set at $18 per gram, illegal price $20
  - Reduced health outcomes but improved justice outcomes
- Scenario C – legal price set at $20 per gram, illegal market undercuts with $18
  - Youth use increases substantially, adult use decreases.

Each case includes a mix of positive and negative results, with health impacts often being offset with justice impacts, or effects on youth offsetting effects on older users.

Section 2.6 highlights the sensitivity of key assumptions in the model.

- Assumption of 85 percent legal market reduced to 75 percent

  - This assumption has no effect on the base health harm, though justice harms increase substantially

- Price elasticities increase
  - Increasing the price elasticities results in a more significant change in use following price increases, resulting in more substantial reductions in harms following price increases
- Size of the initial spike reduced to a more moderate level
  - Health harms are reduced proportionately, though justice harms are comparable as a result of the market being predominantly legal
- Assume bulk cannabis purchases have lower prices per gram
  - This assumption change has no effect on the harms, but substantially reduces the total financial size of the cannabis market. Having bulk discounts, including an ounce for $350 would result in the market reducing from $1.5 billion to $1 billion.

2.2 Assumptions, limitations, and caveats

A number of the parameters and assumptions of this model have substantial effects to the overall wellbeing effects of the proposed legislation.

2.2.1 Illegal share of the market

The experience of international markets in controlling the illegal market have had varied success based on their regulatory setting.

In California, while cannabis is legal to consume, some local authorities have prevented retail outlets from opening. This has resulted in widespread illegal retailing across the state. At the other end of the scale, Colorado allowed individuals with access to medical cannabis to grow 99 plants at home, leading to legally grown cannabis flooding the illicit market from cannabis in Colorado and neighbouring states.

2.2.2 Initial demand spike

The effects of the initial demand spike are driven by increase in cannabis use following legalisation.

It is also likely that individuals are more likely to report using cannabis following legalisation. This effect has not been included in the cost of hospitalisations. If an individual would otherwise have not informed hospital staff of their cannabis use, the hospitalisation would still occur though not measured as a cannabis related hospitalisation. Consequently, our measured impacts on hospitalisation and costs for this initial demand spike may be understated.

2.3 Base cases

Initially a set of base cases are established that the following scenarios are compared against. These base cases are the market as it exists now, the market as it is expected to be immediately post legalisation, and the projected long term state the market will reach once fully established.

The model measures the cannabis market and wellbeing at three points in time, prior to legalisation (baseline), immediately post legalisation (Short Term - ST) and once the market is property

established (Long Term - LT). Each of these scenarios forms a basis for comparison of future scenarios.

The demand in each stage is divided into the component in the legal and illegal markets. The legal market is assumed to secure 85 percent of the total demand from users over 20 years old. As the purchase age is 20, all users under 20 years old are assumed to buy from the remaining illegal market. The legal price in the new market is assumed to be equal to the illegal price of $20 per gram.

2.3.1 Current market baseline

This is the market baseline estimate of the current demand for cannabis, in terms of kilograms and retail value, and the resulting effects on wellbeing under prohibition. Cannabis consumed is estimated at 74 tonnes, with a retail value of $1.5 billion. As cannabis is currently prohibited in New Zealand, the entire market is illegal.

Table 2.1 Use and price parameters for baseline calculation

Use Group	Amount per use (g)	Price per gram ($)
Daily	1.60	20.00
Frequent	0.67	20.00
Periodic	0.67	20.00
Rarely	0.67	20.00

2.3.2 Post regulation demand spike (ST0)

International evidence suggests that immediately post legalisation, there will occur an initial spike in cannabis use. The magnitude of this increase varies widely between jurisdictions and will be driven by a wide range of factors including the regulatory settings and social acceptance of cannabis use. The magnitude of the spike in this model is based on evidence from the states of Colorado, Massachusetts, Washington and the District of Columbia, all of which legalised recreational cannabis between 2012 and 2016[2]. The two states with the earliest legalisation dates; Colorado and Washington, have had a substantial decline in use rates since legalisations suggesting that this initial effect may tail off over a period of three to five years.

On average across these jurisdictions the cannabis use rates for young people fell following legalisation, while there was an increase in participation rates in older age groups. These parameters are approximate as the use and age groups available in the data are not accurately aligned to those in the model. Further, there are variations in the markets and regulations of these jurisdictions both between the examples and to the New Zealand proposal.

Table 2.2 Parameters to model post legalisation demand spike (percent change in users)

Use Group	15 to 20	20 to 25	Over 25
Daily	-6	10	44
Frequent	-6	10	44
Periodic	-9	7	37
Rarely	-9	7	37

[2] NSDUH 30 day and 12 month use rates.

2.3.3 Long term (LT0)

Following the initial spike, it is assumed that the demand for recreational cannabis will return to the same level as pre regulation. The resulting outcomes will be different to the extent that they are affected by the legalisation. This case serves as a comparison for many of the following scenarios.

2.3.4 Wellbeing outcomes of base cases

Table 2.3 outlines the associated outcomes of each of the three base scenarios.

Baseline wellbeing

These are expressed in natural numbers to allow for comparison with the change in harm from future policy changes. Under the baseline of cannabis users in New Zealand, 94,000 users have no qualification and 346,000 are in employment. The burden on the health system as a result of cannabis use is estimated to be an annual $15 million.

Each year the police issue 3,250 warnings to individuals for cannabis offences while 1,250 individuals are convicted for offending. These figures are reflective of the actual numbers of people in the justice system where their most serious charge is for a cannabis related offense.

Immediate post regulation (ST0) wellbeing outcomes

From the projected base of 74 tonnes of cannabis consumed, the initial spike is projected to be 22.5 tones, resulting in a total consumption of 96.5 tonnes.

In the short term, the effects of cannabis are not expected to have any effect on many of the harm areas reported in this model such as employment, qualifications and mental health as these are long term effects. The main short term harms will include the hospitalisation as a result of cannabis use and the associated costs, costing an additional $4 million in the first year. This finding is consistent with the overseas evidence where an increase in cannabis related hospitalisations has been observed in the short term following legalisation.

Long term (LT0) wellbeing outcomes

As this scenario contains no change in the frequency or level of use and there is no change to the number of individuals using cannabis, there are no changes to health harms compared to the baseline.

Due to the shift from the market being illegal to a majority legal market, the justice outcomes are significantly reduced. As the whole supply chain will have both legal and illegal elements (unlicensed manufacture or retailing, and possession of over 15 grams) there will remain some justice outcomes proportional to the reduction in size from the current illegal market. The outcomes of charges for these offences will be highly dependent on any changes in the legislated penalties for each type of offence[3].

Legalisation will be unable to completely eliminate cannabis related justice outcomes as while legalised, the market will be tightly regulated. Those breaching the new regulations will be processed in the justice system. Secondly, prohibition will continue for individuals under the age of 20 years old, therefore all cannabis procured by this group will be illegal.

[3] The new system of penalties and offenses is yet to be confirmed at the time of writing. As such they are not modelled.

Table 2.3 Outcomes of the base case scenarios

	Baseline	ST0	LT0
Legal price ($)	na	20.00	20.00
Illegal price ($)	20.00	20.00	20.00
Market share legal (%)	0	85	85
Use	**Base**	**Change**	
Total use (Kg)	74,083	22,467	0
Total users (number)	557,244	138,685	0
Share of population (%)	14	3.5	0.0
Value of legal consumption* ($m)	0	1,438	1,104
Value of illegal consumption ($m)	1,482	-989	-1,104
Total value of consumption ($m)	1,482	449	0
Economic outcomes			
No qualification	93,993	na	na
Employed	346,229	na	na
Income ($)	30,636	na	na
Health outcomes			
Long term health condition	326,325	na	na
Mental health diagnosis	219,531	na	na
Hospitalisations (first 2 diagnoses)	1,115	306	0
Hosp costs (first 2 diagnoses) ($000s)	14,690	4,042	0
Justice outcomes			
Warnings	3,245	-1,932	-1,989
Charges	1,650	-1,208	-1,284
Convictions	1,256	-944	-1,009
Justice cost ($000s)	2,606	-1,969	-2,106
Corrections cost ($000s)	11,311	-8,689	-9,314

Baseline: The market as it currently exists in New Zealand
ST0: Short term expected spike in demand
LT0: Long term market with both legal and illegal production and retail
* Includes an assumed 10 percent of home grown cannabis

2.4 Successful interventions to reduce demand

This set of scenarios (results summarised in Table 2.6) examines the possible outcomes of interventions to influence the social acceptability and level of cannabis use. This intervention could take the form of education programmes, public messaging or other intervention. In the first example, the intervention is focused on reducing the level of use, in a similar way to the current responsible drinking campaign for alcohol. In the second scenario, the intervention is focused on reducing the number of people choosing to use cannabis. The parameters chosen produce approximately the same reduction in the total amount of cannabis consumed to allow for a comparison of the resulting outcomes.

In both scenarios, the intervention is targeted more heavily towards the highest use groups.

Table 2.6 shows the outcomes of each scenario, as compared to the base case LT0.

2.4.1 Reduction in amount per use (LT1)

In this scenario, the amount of grams used per use is reduced following the successful intervention. This intervention has no effect on the number of users but reduces the total amount of cannabis consumed by 6.7 tonnes.

Table 2.4 Parameters used to model demand shock in level of use

Use Group	Initial use (g)	Following intervention (g)
Daily	1.60	1.45
Frequent	0.67	0.62
Periodic	0.67	0.62
Rarely	0.67	0.62

2.4.2 Reduction in people using (LT2)

In this scenario, people across the use groups reduce how often they are using, shifting the group they fall into. The total number of people using cannabis falls by five percent as some people in the "rarely" group stop altogether. The amount of cannabis consumed reduces to the extent that people reduce their usage. The parameters used to model this shift are shown in Table 2.5.

The use parameters for this scenario are the same as for the base case LT0.

Table 2.5 Parameters used to model demand shock in number of users

Use Group	Demand Shock (%)
Daily	-10
Frequent	-6
Periodic	-4
Rarely	-1

Wellbeing outcomes following successful interventions

These scenarios result in a comparable reduction in the total quantity of cannabis consumed in both the legal and illegal markets. This results in comparable reductions in the justice sector outcomes as in both cases the illegal market will be a comparable size.

Table 2.6 Wellbeing outcomes for intervention scenarios

	LT0	LT1	LT2
Legal price ($)	20.00	20.00	20.00
Illegal price ($)	20.00	20.00	20.00
Market share legal (%)	85	85	85
Use	**LT0**	**Change**	
Total use (Kg)	74,083	-6,733	-6,926
Total users (number)	557,244	0	-27,684
Share of population (%)	14	0.0	-0.7
Value of legal consumption* ($m)	1,104	-100	-103
Value of illegal consumption ($m)	378	-34	-35
Total value of consumption ($m)	1,482	-135	-139
Economic outcomes			
No qualification	93,993	-1,169	-1,531
Employed	346,229	1,179	1,718
Average income ($)	30,636	282	380
Health outcomes			
Long term health condition	326,325	-4,623	-5,936
Mental health diagnosis	219,531	-6,573	-7,840
Hospitalisations (first 2 diagnoses)	1,115	-101	-104
Hosp costs (first 2 diagnoses) ($000s)	14,690	-1,335	-1,372
Justice outcomes			
Warnings	1,262	-115	-117
Charges	366	-33	-34
Convictions	247	-22	-23
Justice cost ($000s)	500	-45	-46
Corrections cost ($000s)	1,997	-181	-186

LT0: Long term market with both legal and illegal production and retail
LT1: Long term market with reduction in use rates
LT2: Long term market with reduction in number of users
* Includes an assumed 10 percent of home grown cannabis

These scenarios differ substantially in terms of the total harms in the employment and health areas. From the total 94,000 users with no qualifications in the base case LT0, the scenario LT1 and LT2 interventions reduce this by 1,170 and 1,530 people respectively. People in employment increase by 1,180 and 1,720, respectively.

The reductions in health harms in both scenarios are substantial, though the LT1 scenario results in a greater reduction in harms. From the 326,000 individuals that have a long-term health condition, LT1 results in a reduction of 4,600, while LT2 results in a reduction of 5,900 people. In both scenarios, the largest improvements in health outcomes are distributed across similar population groups, with the reduction in harms most concentrated in the population of users under 30 years old.

Overall, the reduction in harms is driven relatively more by the kilograms used, rather than the number of users. This suggests a responsible use programme, rather than targeting a reduction in the number of users, may be a relatively more appropriate policy aiming for harm reduction.

2.5 Pricing differences

In this section, the scenarios modelled explore the reaction of the market to changes in price in both the legal and illegal markets. The three scenarios consider the outcomes of three independent price change scenarios from the long term base case (LT0). In the first scenario the legal price is $5 higher than the illegal market (LTa). The second (LTb) and third (LTc) scenarios show the outcomes where the legal and illegal markets under-cut the other market in an attempt to increase their market share.

Table 2.7 Price ($/g) in each scenario

Scenario	Legal	Illegal
LTa	25	20
LTb	18	20
LTc	20	18

The extent of these reactions are based on the parameters for two types of elasticities. Parameters for the price elasticity of demand have been chosen based on international research. Participation elasticity also comes into play where there are changes in the minimum price. The participation elasticities used in these scenarios are shown in Table 2.8 and Table 2.9.

Table 2.8 Participation elasticity in the legal market used in Scenario LTb

Use Group	15-20	Over 20
Daily	0.0	0.2
Frequent	0.0	0.2
Periodic	0.0	0.3
Rarely	0.0	0.4

Elasticities for those aged under 20 are zero because the legal purchase age is to be 20 years old.

As the illegal status of cannabis will influence use decisions of some individuals above the change in the price, the participation elasticity of this group will not be symmetrical to the reduction in the legal price.

Table 2.9 Participation elasticity in the illegal market used in Scenario LTc

Use group	15 to 20	Over 20
Daily	0.5	0.1
Frequent	0.8	0.1
Periodic	1.0	0.2
Rarely	1.2	0.2

Elasticities for those aged over 20 years old are smaller than for the legal market in recognition that there are many people who may choose to use cannabis in a legal context, but would not participate in an illegal market.

All other parameters are held constant including the 85 percent legal market share.

2.5.1 Wellbeing outcomes given pricing differences

Table 2.10 summarises the results of modelling scenarios with different price assumptions.

Wellbeing outcomes with higher legal price (LTa)

In the first scenario, the higher legal price results in a reduction in the quantity used in the legal market from the LT0 scenario. As the illegal market remains at $20, the number of cannabis users does not reduce as individuals shift towards the illegal market.

The reduction in overall use quantity has a positive influence on the health harms through reducing the overall level of use.

The price increase in the legal market causes users to switch to an illegal supply as it is cheaper. This results in the illegal market being slightly larger than in the LT0 scenario, with an associated increase in the justice sector harms. This increase in harms affects all age groups other than the under 20 year old users who have equal outcomes with the LT0 scenario.

Wellbeing outcomes under lower legal price (LTb)

The new legal market will enter the wider cannabis market and be in immediate competition with the existing illegal market. This scenario models a possible future where the new legal market uses low pricing to build the initial market share.

As this scenario makes cannabis more affordable for users, the level of use, and the number of users will be expected to increase while this pricing strategy is in place. The expected increase in users is expected to be approximately 25,000 users, increasing total cannabis use by five tonnes. Under this scenario, the reduction in the illegal price results in no increase in use of underage users who are still required to purchase from the illegal market.

While this will increase total level of use, the wellbeing outcomes need to be viewed with respect to limiting the extent of the illegal market, and in particular reducing youth access to cannabis. The amount of cannabis demanded, and the associated wellbeing outcomes are compared against the long term scenario LT0.

The reduction in the legal price results in no increases in associated harms for individuals under 20 years old. The increase in the long term health, education and employment harms as a result of this price change include 9,000 additional individuals with long term health conditions, and 3,700 fewer individuals in employment.

The primary benefits of this policy includes further reductions in the illegal cannabis market, and reductions in the associated contact with the justice sector.

Wellbeing outcomes with lower illegal price (LTc)

The new legal cannabis market will present a substantial threat to the current illegal market. This scenario models a possible future where the illegal market responds to this threat by selling product at a lower price.

As this scenario makes cannabis more affordable for users in the illegal market, the level of use, and the number of users will be expected to increase as seen in Scenario LTc.

Table 2.10 Wellbeing outcomes under different pricing scenarios

	LT0	LTa	LTb	LTc
Legal price ($)	20.00	25.00	18.00	20.00
Illegal price ($)	20.00	20.00	20.00	18.00
Market share legal (%)	85	85	85	85
Participation elasticity	na	na	Yes	Yes
Use	**LT0**		**Change**	
Total use (Kg)	74,083	-7,435	5,145	67
Total users (number)	557,244	0	24,359	21,624
Share of population (%)	14	0.0	0.6	0.5
Value of legal consumption* ($m)	1,104	58	-14	-42
Value of illegal consumption ($m)	378	26	-4	1
Total value of consumption ($m)	1,482	84	-18	-41
Economic outcomes				
No qualification	93,993	-3,031	3,445	-1,462
Employed	346,229	3,280	-3,715	2,288
Income ($)	30,636	603	-650	65
Health outcomes				
Long term health condition	326,325	-7,990	9,033	2,294
Mental health diagnosis	219,531	-10,362	11,838	6,413
Hospitalisations (first 2 diagnoses)	1,115	-109	75	6
Hosp costs (first 2 diagnoses) ($000s)	14,690	-1,421	984	95
Justice outcomes				
Warnings	1,262	47	-8	168
Charges	366	30	-5	39
Convictions	247	24	-4	25
Justice cost ($000s)	500	50	-9	49
Corrections cost ($000s)	1,997	220	-38	187

LT0: Long term market with both legal and illegal production and retail
LTa: Long term market with increase in legal price to $25
LTb: Long term market with decrease in legal price to $18
LTc Long term market with decrease in illegal price to $18
* Includes an assumed 10 percent of home grown cannabis

As users under 20 years old can only purchase cannabis from the illegal market, this group is expected to grow by 9,500 users while the use increases by 1,300Kg. The use rates of individuals over 20 years old is expected to increase following the minimum price of cannabis reducing, though the level of use is expected to be lower than in the LT0 scenario by 1,300Kg. Overall, this results in a very small change in the quantity of cannabis consumed despite a substantial increase in the number of users.

The harms in this scenario are varied. The reduction in overall use levels will result in better health outcomes for individuals over 20 years old, though the increase in use of under 20 year olds will result in substantially worse health outcomes for this group.

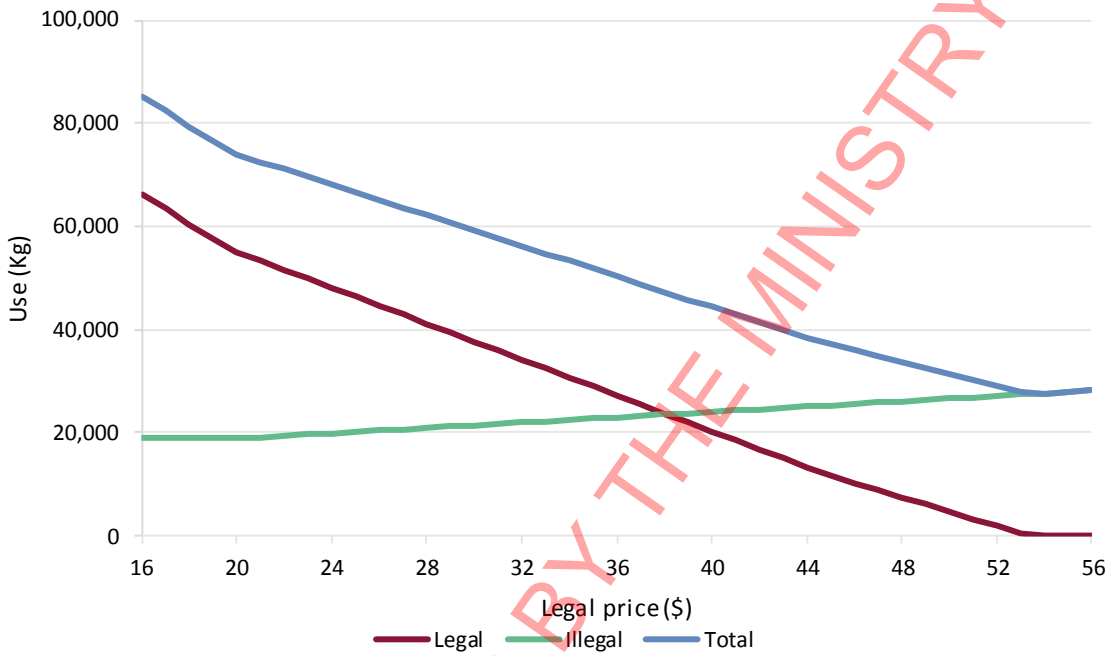
The increase in the level of use of cannabis in the illegal market will also result in increased costs of policing and then the subsequent costs to the justice system.

2.5.2 Hypothetical market size with different legal price

At each level of legal price, the quantities consumed under the initial model parameters are displayed in Figure 2.1.

Once the market is established, the substantial legal market share will allow changes in price to reduce the total quantity of cannabis consumed.

Figure 2.1 Effect of legal price changes on cannabis consumed – 85 percent legal base assumption



This analysis has some limitations as these elasticities are based on findings in international markets, where pricing legal cannabis at substantially higher levels than the illegal market has not been adopted by other jurisdictions. With the base assumption of the market being 85 percent in the legal market, this model shows the effect of small changes in price. For substantial increases in prices, it is likely that the market share of legal cannabis would reduce substantially in favour of the illegal market.

Similarly, the cross-price elasticities are assumed to be constant. If the prices increase significantly, these elasticities may also increase resulting in a faster growth in the illegal cannabis market.

The extent of this shift will be highly dependent on the level of policing of the production of illegal cannabis. There is a risk that high pricing with strict policing will result in a continuation of the present prohibition outcomes.

2.6 Sensitivity testing

Scenarios in this section use examples of changes to certain parameters to illustrate the sensitivity of the model to such changes. This section considers the share of the market that remains illegal, the price elasticities, the size of the initial demand spike, and the assumption that cannabis is purchased at $20 per gram.

2.6.1 Legal market share (LTm)

This scenario changes the assumption of the legal market occupying 85 percent of the market. In this example, the legal market share is reduced to 75 percent. The changes in the resulting associated outcomes give an example of the model sensitivity to this assumption.

Wellbeing outcomes for change in market share

Table 2.11 summarises the modelled results for a scenario with a different legal market share assumption.

Table 2.11 Wellbeing outcomes for change in market share scenario

	LT0	LTm
Legal price ($)	20.00	20.00
Illegal price ($)	20.00	20.00
Market share (%)	85	75
Use	**LT0**	**Change**
Total use (Kg)	74,083	0
Total users (number)	557,244	0
Share of population (%)	14.1	0.0
Value of legal consumption* ($m)	1,104	-130
Value of illegal consumption ($m)	378	130
Total value of consumption ($m)	1,482	0
Economic outcomes		
No qualification	93,993	0
Employed	346,229	0
Income ($)	30,636	0
Health outcomes		
Long term health condition	326,325	0
Mental health diagnosis	219,531	0
Hospitalisations (first 2 diagnoses)	1,115	0
Hosp costs (first 2 diagnoses) ($000s)	14,690	0
Justice outcomes		
Warnings	1,256	234
Charges	366	151
Convictions	247	119
Justice cost ($000s)	500	248
Corrections cost ($000s)	1,997	1,096

LT0: Long term market with both legal and illegal production and retail
LTm: Long term market with decrease in the market share parameter to 75 percent
* Includes an assumed 10 percent of home grown cannabis

The levels of justice sector harms is directly related to the size of the illegal market. The higher the share of the illegal market, the higher presence of cannabis related offending in the justice system.

In this scenario, the 10 percentage point difference in the size of the illegal market results in the projected justice sector harms increasing by approximately 40 percent. The harm with the smallest

increases in this scenario is police warnings as these are most likely to be issued to under 20 year old individuals that are entirely in the illegal market in both scenarios.

The result of a larger illegal market base will also result in a higher sensitivity to changes in legal market price.

2.6.2 Price elasticity (LTp)

Table 2.13 lists model results exploring an increased responsiveness (price elasticity) to a change in the price of cannabis.

We compare the outcome in the price change scenario LTa to an assumed higher responsiveness to that same price change. The elasticities in this new scenario (LTp) are only with respect to price changes in the legal market so there is no effect on use of individuals under 20 years old. Increasing the price elasticity increases the sensitivity of the demand and consumption of cannabis to changes in price. The price elasticities used in this scenario are presented in Table 2.12.

Table 2.12 Price elasticities for modified scenario for individuals over 20 years old

Use group	LTa	LTp
Daily	0.6	0.7
Frequent	0.8	0.9
Periodic	0.9	1.2
Rarely	1.2	1.6

Wellbeing outcomes for changes in price elasticity

In this scenario, the higher price elasticities result in a larger reduction in cannabis use, for individuals over 20 years old, than occurred in Scenario LTa. The additional decrease of 1.4 tonnes results in a further reduction in harms for the population using cannabis in the legal market. This reduction in use results in an additional reduction in harms by 20 to 30 percent from the LTa scenario. As this scenario does not modify the cross-price elasticity with the illegal market, there is no difference in justice outcomes from LTa.

Table 2.13 Wellbeing outcomes for change in price elasticity scenario

	LT0	LTa	LTp
Legal price ($)	20.00	25.00	25.00
Illegal price ($)	20.00	20.00	20.00
Market share legal (%)	85	85	85
Use	**LT0**	**Change**	
Total use (Kg)	74,083	-7,435	-8,871
Total users (number)	557,244	0	0
Share of population (%)	14	0.0	0.0
Value of legal consumption* ($m)	0	58	22
Value of illegal consumption ($m)	1,482	26	26
Total value of consumption ($m)	1,482	84	48
Economic outcomes			
No qualification	93,993	-3,031	-3,960
Employed	346,229	3,280	4,278
Income ($)	30,636	603	791
Health outcomes			
Long term health condition	326,325	-7,990	-10,403
Mental health diagnosis	219,531	-10,362	-13,604
Hospitalisations (first 2 diagnoses)	1,115	-109	-130
Hosp costs (first 2 diagnoses) ($000s)	14,690	-1,421	-1,696
Justice outcomes			
Warnings	1,256	47	47
Charges	366	30	30
Convictions	247	24	24
Justice cost ($000s)	500	50	50
Corrections cost ($000s)	1,997	220	220

LT0: Long term market with both legal and illegal production and retail
LTa: Long term market with increase in legal price to $25
LTp: Scenario LTa with adjusted price elasticities as presented in Table 2.12
* Includes an assumed 10 percent of home grown cannabis

2.6.3 Smaller initial demand spike (ST1)

In Section 2.3.2, the initial demand spike forms a substantial increase in the amount of use and users, particularly for increases in the high user groups. Similarly, the initial spike suggested a substantial immediate reduction in short-term use rates of users under 20 years old.

This section shows a more moderate spike in demand for cannabis immediately post legalisation. This scenario models a slightly smaller demand spike than the previous example, with casual users being the group more likely to increase consumption. For users under 20 years old, the reduction in use is modelled as a smaller reduction in the level of demand.

Table 2.14 Use parameters to model reduced initial demand spike (percent change in users)

Use Group	15 to 20	20 to 25	Over 25
Daily	-3	6	15
Frequent	-3	6	15
Periodic	-6	9	25
Rarely	-6	9	25

Wellbeing outcomes during reduced initial demand spike

In this scenario, the share of the population using cannabis increases by 1.9 percentage points, as compared with 2.6 in scenario ST0. This also results in a much smaller increase in the amount and value of the cannabis consumed during this initial period. Under this scenario, the spike in use increases the consumption by 8.1 tonnes, worth $162 million.

The only short term harms included in the model are as a result of hospitalisations. In this scenario, the quantum of the health harms are reduced by approximately one third from the initial spike scenario.

Table 2.15 Wellbeing outcomes during initial demand spike scenarios

	Baseline	ST0	ST1
Legal price ($)	na	20.00	20.00
Illegal price ($)	20.00	20.00	20.00
Market share (%)	0	85	85
Use	**Base**	**Change**	
Total use (Kg)	74,083	22,467	8,105
Total users (number)	557,244	138,685	73,233
Share of population (%)	14	3.5	1.9
Value of legal consumption* ($m)	0	1,438	1,224
Value of illegal consumption ($m)	1,482	-989	-1,062
Total value of consumption ($m)	1,482	449	162
Economic outcomes			
No qualification	93,993	na	na
Employed	346,229	na	na
Income ($)	30,636	na	na
Health outcomes			
Long term health condition	326,325	na	na
Mental health diagnosis	219,531	na	na
Hospitalisations (first 2 diagnoses)	1,115	306	112
Hosp costs (first 2 diagnoses) ($000s)	14,690	4,042	1,474
Justice outcomes			
Warnings	3,245	-1,932	-1,975
Charges	1,650	-1,208	-1,258
Convictions	1,256	-944	-986
Justice cost ($000s)	2,606	-1,969	-2,058
Corrections cost ($000s)	11,311	-8,689	-9,095

Baseline: The market as it currently exists in New Zealand
ST0: Short term expected spike in demand
ST1: Short term, smaller than expected spike in demand
* Includes an assumed 10 percent of home grown cannabis

2.6.4 Purchasing patterns (BKP)

To demonstrate the sensitivity in the expenditure outcomes of the model, this scenario assumes that people in the different use groups have different purchasing patterns, particularly when using regularly. A daily user is assumed to purchase an ounce (28g) for $350, saving $210 over buying the same amount in one-gram 'tinnies'. Similarly, frequent users are likely to purchase a '$50 bag' which contains three grams.

Table 2.16 Prices for bulk purchasing pattern

Use Group	Unit	Size (g)	Price per gram
Daily	ounce	28	12.50
Frequent	50 bag	3	16.67
Periodic	tinny	1	20.00
Rarely	tinny	1	20.00

Wellbeing outcomes for change in purchasing patterns

Changing the total cost of cannabis from the $20 prices to the bulk price model reduces the financial size of the market substantially. If all users purchase at these prices, the market will be a total value of $978 million, as compared with 1.48 billion under the $20 price in the model.

Table 2.17 Summary of use for pricing pattern scenario

	Baseline	BKP
Legal price ($)	na	na
Illegal price ($)	20.00	Pattern
Market share (%)	All illegal	
Use	**Base**	**Change**
Total use (Kg)	74,083	74,083
Total users (number)	557,244	557,244
Share of population (%)	14	14
Value of legal consumption* ($m)	0	0
Value of illegal consumption ($m)	1,482	978
Total value of consumption ($m)	1,482	978

This scenario also has a substantial difference on the proportion of income spent on cannabis by each level of deprivation. With bulk discounts, the amount of income the most deprived group spend on cannabis reduces from 17 to 11 percent on average.

As a share of income, this pricing assumption makes a substantial change to the total share of income spent by daily users. With the $20 price assumption, the annual spend is $11,000, 50 percent of income. Under this scenario, spending on cannabis would equal $7,000, or 22 percent of the total income.

Table 2.18 Expenditure on cannabis across deprivation quintiles

			Expenditure LTO		Expenditure BKP		Change
Deprivation	Users	Avg income	$	% income	$	% income	% income
1	57,359	36,165	1,525	4	1,034	3	-1
2	72,378	42,329	2,062	5	1,391	3	-2
3	123,823	37,969	2,716	7	1,804	5	-2
4	136,715	26,402	2,263	9	1,502	6	-3
5	166,969	21,697	3,589	17	2,332	11	-6
Total	**557,244**	**30,636**	**2,659**	**9**	**1,755**	**6**	**-3**

3 Baseline model method and assumptions

3.1 Summary

This section outlines the data sources and methods used in the development of the cannabis market models. Development of the input-output multipliers used to assess the impact a new cannabis market would have on the New Zealand economy is also described.

The baseline model is a set of calculations which produce an estimate of the size of the existing illegal market for cannabis. The model can also estimate the proportions of users by frequency of use, age, sex, deprivation quintile, and ethnicity. The model is then extended to benchmark the extent of existing harms from cannabis use in New Zealand. From this point parameters are added to enable estimates of harms under alternative future scenarios.

The main source of information on cannabis use is the New Zealand Alcohol and Drug Survey (NZADUS), last completed in 2008. This survey asked respondents several questions about their cannabis use giving comprehensive information on use patterns. This is supplemented by information from the New Zealand Health Survey 2016-17 (NZHS) which askes one cannabis related question, and gives wide ranging information on the respondents' health.

Given the time elapsed since the NZADUS, findings were compared to those from the NZHS back to 2013 to check for consistency between the studies. It was found that the results of each were comparable for most groups, but the NZHS consistently reported lower use rates for people aged under 20. This may be due to the differences in the questions and general subject matter of the survey.

Using the NZHS, and information from a range of government sources, prevalence rates of a range of health, justice and education outcomes were assessed for their associations with cannabis use. This data forms the benchmark of existing costs and harms, as well as estimates of future harms and benefits of influencing the numbers of cannabis users and the amount they consume.

The base assumptions have been chosen according to the available research. There are areas where little research is available and so the evidence for these assumptions is limited. For this reason the assumptions in the model are created as parameters, this enables the user to vary these and produce alternative scenarios.

3.2 Assumptions, limitations, and caveats

For detailed descriptions of the international research accessed see section 4.

3.2.1 Quantity of cannabis consumed per use

International research was relied on to address the question of the quantity of cannabis consumed per use. The base assumption is that daily users use 1.6 grams a day, while all other use groups use 0.67 grams on each occasion. Changes to this assumption have an impact on the market estimate, and estimated harms associated with cannabis use. This effect is explored in the Wellbeing Scenarios in section 2. For sales revenue calculations we took the total volume of cannabis consumed and multiplied it by the price. In the absence of other information, we assumed this was the total sales value of the cannabis consumed.

3.2.2 Tetrahydrocannabinol (THC) content

The NZADUS and the NZHS do not have any reference to the THC content of cannabis used. As these surveys have presented health outcomes based on cannabis used with unknown THC content, it is assumed that all cannabis consumed has an equal share of THC.

Data sourced from the National Drug Intelligence Bureau (NDIB) suggests that the level of THC potency varies significantly across users in New Zealand. Outdoor grown cannabis had an average THC of one percent, compared with indoor grown cannabis with 13 percent THC.

Within the model all cannabis is assumed to have a consistent THC level, as there is no information available on the average or specific THC levels of cannabis consumed in New Zealand.

3.2.3 Wellbeing outcome calculations

The model predicts the wellbeing outcomes based on changes in the number of users and quantity of cannabis consumed. The harm per kilogram consumed is held constant with changes in use having a corresponding change in the wellbeing outcomes. Outcomes of non-users remain constant. The formula used to calculate the wellbeing outcomes is shown in Appendix A.

3.2.4 Age ranges of survey respondents

The NZADUS surveys people aged 16-64 years. The NZHS respondents are aged 15 and over (respondents aged over 90 are coded as 90). The NZHS Child questionnaire does not ask about cannabis use. No large survey data was able to be accessed which gave information on the cannabis use of people under 15 years old. Use data for people aged over 65 was imputed from the NZHS and from the 55-65 age group.

Due to these limitations the model does not include children under the age of 15. As there was some data available on cannabis users aged over 65 years, these have been included, but findings for this group should be used with caution.

3.2.5 Ethnic groupings

The ethnic groups used in the model are European, Māori, and other. While the NZADUS survey does include 817 people of Pacific descent, rates of cannabis use are much lower in this group than for the other major ethnicities. Other ethnic groups had low use rates and small samples in the survey. For this reason the three ethnic groupings were chosen to protect the anonymity of survey participants and give sufficiently sized groups for analysis.

3.2.6 Minimum use rate

As there are very few individuals of 'other' ethnicity sampled in the NZADUS, and the relatively low cannabis rates for this group, many user groups do not have a sufficient number of individuals to identify cannabis use. For these groups, we have assumed a minimum cannabis use rate of one percent of the total population. When divided further into deprivation, for each deprivation quintile the minimum use is one tenth of a percent.

3.3 Baseline market estimates

The aim of the baseline market estimates is to establish the total consumption of cannabis, based on frequency of use and demographics.

3.3.1 New Zealand Alcohol and Drug Use Survey 2007/8

The NZADUS is the most recent large survey available which asked questions about the magnitude and pattern of drug use of people in New Zealand. Conducted by the Ministry of Health (MoH), the survey collected information on 6,784 New Zealanders aged 15–64 years, including 1,825 Māori and 817 Pacific respondents. For this research, MoH provided the survey responses in the format of a Confidentialised Unit Record File (CURF).

The survey oversamples Māori and females as compared to the total New Zealand population, and this is accounted for when making inferences about the total population. The results of this analysis are used to calculate the total amount of cannabis used in New Zealand, a direct input into the calculation of the total market for cannabis.

Group classifications

The model estimates the total cannabis market in New Zealand by analysing user groups in the NZADUs and multiplying them with the size of that population group in New Zealand. The user groups are classified by age, sex, ethnicity (European, Māori, other), deprivation and frequency of cannabis use.

The level of cannabis use is determined by the three primary questions about cannabis use in the NZADUS.

- "Have you ever tried cannabis?"
- Have you used cannabis in the last 12 months?
- In the last 12 months, how many times have you used cannabis?

From the population of people who reported they have tried cannabis in the last 12 months, groups were formed according to the reported frequency of use over this period.

These groups are defined as follows:

- **Daily** – response of: "Daily", or "5-6 times a week"
- **Frequent** – response of: "About 3 – 4 times a week", "Twice a week", or "Once a week"
- **Periodic** – response of: "2 - 3 times a month", "Once a month", "Once every 6 weeks in the last 12 months", or "3 – 6 times in the last 12 months"
- **Rarely** – response of: "1 or 2 times in the last 12 months", "Never in the last 12 months[4]".

Those who answered "Don't know", or "I don't want to answer" were excluded, along with those who reported that they have not used cannabis in the past 12 months.

Data assumptions

The NZADUS has relatively low number of observations of ethnicity other than Māori or European. These other ethnic groups also have lower cannabis use rates than Māori and Europeans. Due to both of these factors, for some groups, no respondents indicated that they had used cannabis in their lifetime. As there are very few individuals of 'other' ethnicity sampled in the NZADUS, and the relatively low cannabis rates for this group, many user groups do not have a sufficient number of individuals to identify cannabis use. For these groups, we have assumed a minimum cannabis use

[4] This is a very small group of individuals who have answered inconsistently with the previous question.

rate of one percent of the total population. When divided further into deprivation, for each deprivation quintile the minimum use is one tenth of a percent.

3.3.2 Quantity of cannabis used

To estimate the quantity of cannabis used by each use group, use amounts have been obtained from Cooper, et al., (2016). This study uses data from the United States National Survey on Drug Use and Health (NSDUH) 2010-2013 to estimate the total use in grams for each group. Daily users use 1.6 grams each day they consume cannabis, while all other use groups use 0.67 grams on each occasion.

3.3.3 New Zealand Health Survey 2016-17

The NZHS provides information about the health and wellbeing of New Zealanders. The NZHS became a continuous survey in 2011, enabling the publication of annual updates. For this research the data accessed was in the format of a CURF.

In analysing the responses to the adult survey, the following question was used to identify those who use cannabis: "In the last 12 months, have you used any of the following drugs for recreational or non-medical purposes, or to get high?" Further analysis used only on those individual records where the answer to this question was "Yes" to cannabis (marijuana, hash, hash oil). As there is no information in the NZHS regarding amount or frequency of use, the outcomes were only able to be measured for individuals that use cannabis at any level.

Comparison to NZADUS

This data has been used as a comparator to the NZADUS to check for consistency between the findings. Survey results from 2013-14, 2014-15 and 2015-16 were examined to look for consistency of patterns over time, as well as the 2006-07 results, being the same time period the NZADUS was conducted. However, no questions on cannabis were included in the survey that year..

It was found that the results of each were comparable for most groups, but that the NZHS reported lower use rates for people aged under 20 consistently from 2013 to 2017. The reason for this difference is unknown but may be due to under reporting as a result of the differences in the questions and general subject matter of the survey, or other unknown factors.

In Table 3.1 the results of the NZHS have been averaged across 2014 to 2018 as all years have similar results. This is then presented against the results from the NZADUS. All results are presented as a percentage of the survey sample population who reported some cannabis use.

Table 3.1 Reported cannabis use by age group (percent of respective survey sample)

	15-19	20-24	25-29	30-34	35-44	45-54	55-64	65+
NZHS	19	29	21	15	14	11	6	1
NZADUS	31	31	25	16	12	9	3	N/A

3.3.4 Cannabis use of people over 65 years old

The NZADUS does not include any data for individuals aged over 65. The rates of use for the over 65 years old group have been scaled based on the difference in use rates for each group in the NZHS.

As the NZHS does not present any information regarding the frequency of use, the distribution of these users have been applied to the four use categories following the proportion of users of 55 to 64 years old.

3.3.5 New Zealand population information

As the NZADUS is from 2007, establishing a 2018 baseline requires scaling the results to the current New Zealand population. To establish the current scale of cannabis use in New Zealand, population counts and breakdowns of age, sex, ethnicity and deprivation, the following projections from Statistics New Zealand were used:

- New Zealand national ethnic population projections by age, 2013-2018
- New Zealand national population estimates by age and sex, 2013-2018
- New Zealand national population estimates by age, sex and territorial authority
- New Zealand 2013 Census ethnic group by age and sex

The University of Otago New Zealand Socioeconomic Deprivation Index (2006 & 2013) was used to allocate deprivation quintiles to match the methodology used in the NZHS

The use rates for each group of age, sex, ethnicity and deprivation from the NZADUS and NZHS have been scaled according to the respective population changes. This forms the 2018 estimate of cannabis use in New Zealand for the total population.

3.4 Benchmark of existing costs and wellbeing outcomes

The outcomes associated with cannabis use have been presented in broad categories, and each have been aligned to the four capitals of the Treasury's Living Standards Framework (LSF).

3.4.1 New Zealand Health Survey 2017

The NZHS 2017 presents a wide range of information for a range of outcomes for individuals that use cannabis. This information is used to analyse the extent of long-term physical or mental health conditions of cannabis users. As cannabis is often associated with use of other drugs, this information is also used to inform rates of use of other drugs for recreational use, and regular use of alcohol and cigarettes.

As the NZHS also asks for a wide range of demographic information, this information is used for identifying some outcomes of cannabis users. As well as health outcomes, educational attainment and labour force status for each user group was used as part of the benchmark of existing costs and wellbeing outcomes, as well as estimates of future harms and benefits.

3.4.2 Ministry of Health

Hospitalisations and emergency department visits

Data was sourced directly from the Ministry of Health (MoH) on publicly funded hospital discharges from July 2013 to June 2018 with reported diagnosis codes (ICD-10-AM-VI) of:

- F12 Mental and behavioural disorders due to use of cannabinoids
- T407 Cannabis (derivatives) (Poisoning by, adverse effect of and underdosing of cannabis (derivatives))".

As this information presents the number of cases where cannabis was present, cannabis cannot be attributed as causative in each instance. To present these figures, we have employed three filters for presenting this information to show the direct harm of cannabis, and the full extent of cannabis in hospitalisation records. The three filters are as follows:

1) Where cannabis is the primary reason reported for the visit

2) Where cannabis is the primary or secondary reason reported for the visit

3) Where cannabis was reported as any one of the reasons for the reported visit.

These three filters set a range where filter one is the minimum harm and filter three is the maximum harm.[5]

For each hospitalisation event, a cost weight is recorded that can be converted to a financial cost for each event, using annual hospital cost rates for each of the three filters. The results in the benchmark are for the year 1 July 2017 to 30 June 2018.

Avoidable mortality

Sourced from the MoH, this dataset included all death registrations from 2011 to 2015 with cannabis involved flag = Y or any clinical code from this table:

- F12 Mental and behavioural disorders due to use of cannabinoids
- T407 Cannabis (derivatives) (Poisoning by, adverse effect of and underdosing of cannabis (derivatives))".

This information is used to identify counts of deceased people through suicide or vehicle accidents where cannabis was a factor.[6] As the counts are small across some demographics, figures are averaged across the five-year sample period. Some counts may need to be suppressed for public release.

3.4.3 Ministry of Justice

The Ministry of Justice (MoJ) data counts of offences, charges, and charge outcome, sourced directly from the MoJ database for the calendar years 2009 – 2018. As with the health data, the extent that cannabis contributes to offending is not specified. The information is presented for the following three overlapping groups:

1) Proceedings which included a cannabis related charge; the outcome information for these relates to the most serious of the cannabis charges

2) Proceedings in which the most serious charge is a cannabis charge, but may include other less serious charges in the proceeding

3) Proceedings in which all charges are cannabis related.

This information is tabulated against age group, sex, ethnicity, offence type, convictions, and most serious sentence.

The sentence and sentence magnitude are used to estimate the financial costs of the sentences. For prison sentences of shorter than two years, one half of the sentence is served in prison, and

[5] It is possible that due to cannabis being illegal, individuals will avoid reporting any cannabis use or any cannabis related factors.

[6] It is unknown if the deceased was driving the vehicle or was a passenger at the time of the vehicle accident, therefore cannabis cannot be assumed to be causative.

the remainder on release conditions. The costs for imprisonment are calculated as being half served in prison and half on release conditions for all individuals. Analysis in the benchmark is presented for the calendar year 2018.

3.4.4 Cannabis enforcement and intelligence

The National Drug Intelligence Bureau (NDIB) provided a report to the Ministry of Justice for the purpose of informing their work on developing the Cannabis Regulatory Framework. This report includes information on cannabis production and the seizures of crop and seeds, and informs pricing in the existing illegal market.

3.4.5 Information on outcomes for children

Children aged under 15 years old – hospitalisation, ED, and mortality data was accessed from MoH. As counts are small, confidentiality and validity of results may be compromised. For these reasons this information has not been included in the model.

There is no New Zealand information on cannabis use by under 15 year olds as the NZADUS does not include this group. The NZHS Child questionnaire does not ask about cannabis use.

3.4.6 Other information sources approached

The following agencies/organisations were approached or relevant datasets in the Statistics New Zealand Integrated Data Infrastructure (IDI) were investigated for usefulness. They either could not provide relevant information, or did provide some information but this has not been relied on for analysis.

MSD Welfare – asked for information regarding work drug testing and the extent to which work readiness is affected by cannabis use of job seekers. Unable to provide any information.

ACC – very small amount of information. Relevant counts would have to have been supressed to meet confidentiality rules and thus cannot be extracted from the IDI.

Christchurch Health and Development Study – some information provided, has not been used for analysis.

Te Pou o te Whakaaro Nui - some information provided, has not been used for analysis.

3.5 Post legalisation scenario modelling

The model is constructed to allow a user to determine certain parameters creating a post legalisation scenario. The resulting market and associated wellbeing outcomes can then be compared with the current situation, or an alternate set of parameters. This section explains the parameters provided and their interaction, as well as the calculations of associated wellbeing outcomes. See Appendix A for the formulas used to apply these parameters.

A range of example scenarios which demonstrate the model and how it responds to changes in the parameters are described in section 2.

3.5.1 Elasticity of demand

Price elasticity of demand for cannabis

Drug demand responsiveness to price changes is studied fairly extensively for a range of drugs. However, no clear consensus exists on the direction and magnitude of effects for cannabis specifically. A number of New Zealand and international studies were assessed, from which some broad themes emerged:

- Participation elasticity: Young people (under 20) are price sensitive in choosing to initiate cannabis use. A higher price delays the age of initial use
    - This initiation delay does not appear to hold for those aged over 20
- Heavy users do have a degree of price sensitivity despite the need to continue consumption to satisfy a dependency
- People who consume less cannabis have a larger price sensitivity than heavy users.

Separate to price effects, it is possible that legalisation itself has a positive effect on both the amount people use, and the initiation of use. Other non-price effects include societal approval and enforcement levels.

A literature review by Pacula and Lundberg (2014) identifies several studies which attempt to quantify the price elasticity of cannabis. The studies examined were conducted in jurisdictions where recreational cannabis was illegal at the time, although some had legal medical cannabis markets. Contributing non-price factors were controlled for in some studies, though methods varied. The elasticities arrived at in these studies ranged from -0.002 to -0.69.

A later study by Hansen, Miller and Weber (2017) conducted in Washington State, which has legalised recreational cannabis, found that the price elasticity in a legal market is higher than in an illegal market. The estimate arrived at was -0.85. The sensitivity of high frequency users is likely to be less elastic than for less frequent users.

Within the model the elasticity is input as a parameter meaning it can be adjusted by the user to observe the effect on the market of a higher or lower elasticity. Refer to Appendix C for the formula used to apply the elasticity parameters.

A parameter is provided to enable scenarios where an illegal market persists. The user can nominate the proportion of total sales which will occur in the legal and illegal markets and observe the resulting impacts on the wellbeing outcomes.

Cross price elasticity

The rate of substitution to the illegal market with respect to price is based on the cross price elasticity of illegal cannabis with legal cannabis. For each percentage increase in the legal price, the level of cannabis consumed from the legal market will increase by the cross price elasticity coefficient.

Extent of the illicit market

In no jurisdiction where cannabis has been legalised has the illegal market been completely removed. It can be expected that a black market will continue to some extent within New Zealand. A base level parameter is provided to allow the user to influence the share of the legal market. The

actual outcome will be determined by a variety of influences including policy settings, social factors and the accessibility of the new legal market.

3.5.2 Changes in indicators

Health, education and labour force status outcomes

The changes in these indicator outcomes are based on the total level of cannabis use. The wellbeing outcomes in each category are based on the total harm per kilogram consumed and the change in the level of use over time. The change in the level of use in the regulated scenario is a combination of change in the number of users, and the change in the amount used per user.

Justice outcomes

The magnitude of the justice outcomes are based on two characteristics, the size of the illicit market, and the penalties for breaching the new legislation. The overall level of offending is based on the size of the illicit market, as compared with the 2018 benchmark levels of production and consumption. The level of each type of offending is scaled based on this ratio. The formulas used to calculate the justice outcomes are presented in Appendix C.

3.6 Input-output analysis

In order to calculate the input-output multipliers for the impact of cannabis legalisation on the New Zealand economy the linkages of the newly legalised cannabis market have been constructed using the Statistics New Zealand National Accounts input-output tables: Year ended March 2013 (the most recent available).

Input-output tables are an analytical tool for describing the structure of New Zealand's economy. They show the relationships between industries, the goods and services they produce, and who uses them.

Because cannabis is currently illegal, the input-output tables do not capture data for the cultivation, manufacture or retailing of cannabis. To bring legalised cannabis cultivation, manufacturing and retail into the economy we created three new industries in the input output tables, *Cannabis Cultivation*, *Cannabis Manufacturing* and *Cannabis Retail*. This approach is consistent with studies for other jurisdictions.

To create the new industries for cannabis production, cannabis processing, and cannabis retail we identified existing New Zealand industries that require similar inputs to the three new cannabis industries.

Table 3.2 Industries used to create cannabis industry inputs

Production	Processing	Retail
Horticulture and fruit growing	Fruit, oil, cereal and other food product manufacturing	Specialised food retailing
Agriculture, forestry and fishing support services	Beverage and tobacco product manufacturing	Other store based retailing; non-store and commission based retailing

3.6.1 Data on cannabis outputs

Limited data is available on the value of volume of cannabis produced and consumed. We have made assumptions that the total volume of cannabis consumed and the price of cannabis is consistent with the data provided by the New Zealand Police. To create the total required by the new cannabis industries we took the total volume of cannabis consumed and multiplied it by the price. In the absence of other information, we assumed this was the total value of the outputs from retail sales.

To estimate the total output from cannabis processing and production in New Zealand we applied the cannabis production and cannabis processing outputs as a proportion of total value of retail sales as identified by RCG Economics for Nevada.[7]

Table 3.3 Nevada cannabis industry outputs

Sector	Value (US$ million)	% retail sales
Retail	457.3	100
Manufacturing	219.5	48
Cultivation	140.1	31

3.6.2 Method

The first step was to estimate the proportion of inputs for each new cannabis industry that would come from each of the other industry groups. This required the assumption that the proportion of inputs for the new cannabis industries would be consistent with the existing industries that require similar inputs as cannabis identified above.

The next step was to estimate the inputs used by the new cannabis industries that come from each of the industries in the economy. To do this, we calculated the combined inputs from the two industries that we used as the basis for each new cannabis industry as a proportion of total combined output for the two industries.

For the new cannabis industries, we assumed that all cannabis produced in the growing phase would be used for growing or would be used for processing. We then assumed that all cannabis processed would be used for further manufacturing or will be sold through a retail store. Finally, we assumed that all retail sales were to the final consumer, who would make no further use of the cannabis except consumption.

The proportions of inputs from each industry were then estimated. These proportions were applied to the estimated outputs from each of the three new cannabis industries. Once the total inputs into the three new cannabis industries were estimated, a series of calculations were then run to balance the input-output tables to account for the three new industries. Finally, multipliers were calculated using the data generated from the input-output tables.

[7] RCG Economics (unknown). Nevada initiative to regulate and tax marijuana: Economic and Fiscal benefits study.

4 International research analysis

4.1 Summary

This section explores international research related to the baseline and benchmark described in sections 2 and 3. This section is laid out using the existing Treasury Living Standards Framework (LSF) and using the same terminology, such as domains, indicators, and capitals.[8] This is to support alignment of current government-wide policy development and direction, whereby the LSF indicators are being used to inform policy and budget decisions. It also allows wider use of population level data that is already being captured, although for many of the indicators cannabis use is unknown. An overview of further data gaps related to the indicators is noted in sub-section 4.5 of this section.

Research has been selected where it discusses the direction of indicators in jurisdictions that have implemented cannabis regulations. The term "jurisdiction" is used as often the research is based on data from a region or state rather than a country, and jurisdiction describes a distinct area with its own set of laws. While most international research refers to marijuana, we have used the term cannabis for consistency with current policy direction. The term marijuana also has historical racist overtones, and cannabis is the correct scientific name.[9]

An important note is that the obtainable research predominantly looked at changes in particular outcomes after cannabis regulation was passed. Such associations do not prove that cannabis use or cannabis regulation caused the changes. There is a shortage of research that focuses on causality (the relationship between cause and effect). Researchers try to account for outside influences, but other factors related to causality may not always be identified. At best, the research can prepare policy makers for what may be reasonably expected to occur if such regulation was passed in New Zealand.

The human capital section is by far the largest section, understandable given these indicators relate to things which enable people to participate fully in work, study, recreational activities and society more broadly. In addition, any discussion on moving the economic and societal costs of cannabis use from the justice system to the health system must consider the current situation in the health system and the impacts of moving these costs. Therefore, the indicators in the human capital section look at people's physical and mental wellbeing, including substance use and disorders, acute medical outcomes, and avoidable deaths. This section also covers people's skills, knowledge, employment, and subjective wellbeing. Section 4.2.8 gives particular attention to the impacts on children and youth.

The section on social capital explores safety and security indicators, with considerable focus on the consequences of cannabis regulation on justice systems in overseas jurisdictions. It is important to note the ongoing presence of racial disparities in these statistics.

Finally, while not present in the baseline due to the challenge in estimating the current use of resources in cannabis production, international evidence on post-regulation impacts on the environment are noted in the natural capital section.

[8] https://treasury.govt.nz/information-and-services/nz-economy/living-standards/our-living-standards-framework
[9] https://www.theguardian.com/society/2018/jan/29/marijuana-name-cannabis-racism

A summary of indicators may also be found in Appendix B, giving an overview of the direction of change after cannabis regulation in overseas jurisdictions as detailed in the bulk of this section. The summary describes the effect of legalisation rather than the effect of cannabis use.

4.2 Assumptions, limitations, and caveats

The largest body of research on cannabis use and regulation is from the United States of America (USA), where cannabis was illegal in all states prior to 1996, and recreational use is still illegal in many states. Consequently, any research relying on self-reporting in such environments will likely underreport and underestimate both use and effects. The illegality of use also means research funding has often focused on identifying adverse effects from cannabis use, which presents bias in funding and publication inherent in research and literature out of the USA. Limited European research can be applied to a New Zealand regulatory context for a similar reason. The legal landscape is too recent in Canada for any retrospective studies on the impacts of legalisation on social systems to have emerged.

Another limitation of international research is the lack of investigation into the dynamics of cannabis use. Patterns and trajectories of cannabis use are not static, and within population groups, there will be those who have never used, those who use experimentally, and those who use frequently. Within the population of frequent users, the intensity and quantity of use may change over time depending on influencing factors. These factors may include supply conditions, such as price elasticity, social network and work experiences, cultural norms, familial circumstances, or other socio-economic determinants. Largely, information on these factors and how they influence dynamics of use are not explored in-depth.

The lack of information on how people use cannabis before legalisation cannot be underestimated when interpreting research undertaken after legalisation. The outcomes of legalisation in overseas jurisdictions where regulations on legal cannabis are in effect may not be understood for some time. In some USA states, regulations have incrementally evolved from medical cannabis use to legal recreational use, which adds many variables into assessing longer term trends and outcomes. At this time, the best data on the cannabis regulation outcomes comes out of Colorado and Washington, as they adopted both medical and recreational cannabis legislation early.

4.3 Human capital

4.3.1 Health domain

Within the health domain, the following indicators are explored:

- Health status, including health life expectancy, and physical wellbeing
- Mental health, including estimated prevalence of use/abuse of other substances, estimated prevalence of mental health disorders, estimated prevalence of cannabis abuse disorders, and rates of attendance at cannabis treatment programmes. Prevalence refers to the number of people affected by a condition or disease at a given time
- Avoidable deaths, such as rates of death by suicide and rates of fatal transport accidents
- Acute health status, including rates of hospitalisation, rates of emergency department (ED) visits, and calls to the National Poisons Centre (NPC)
- Neonatal outcomes.

Self-report measures cannot be costed as there is no indication of health service use based on these measures. Therefore, the baseline and benchmark estimates do not have costing data attached to the health figures, aside from hospitalisations and emergency department visits where cost data was supplied.

4.3.2 Health status

Healthy life expectancy

Healthy life expectancy at birth is an indicator from the LSF, and is defined as the *Number of years that a person under 1-year-old can expect to live in good health, taking into account mortality and disability*. On the LSF, this data is derived from the Global Burden of Disease (GBD) study by the Institute for Health Metrics and Evaluation.[10] New Zealand life expectancy data is also reported by Statistics New Zealand bi-annually with the most recent data being for the 2016-18 period.[11] Estimates from the GBD study differ from Statistics New Zealand figures due to differences in data sources and methodology.

Cannabis use is unknown for regions, and we were unable to evidence whether cannabis use currently impacts life expectancy in New Zealand. Research by the United States (US) Burden of Disease Collaborators (2018) showed states with cannabis regulations did not have lower life expectancy overall, and all of the 10 states with the lowest probability of premature death had legalised or decriminalised cannabis, or had medical cannabis legislation (MCL). Furthermore, research by National Academies of Sciences, Engineering, and Medicine [NASEM] (2017) looking at multiple studies showed insufficient evidence to support an association between cannabis use and any cause of death.

Physical wellbeing

The LSF indicator for health status is a subjective self-report measure generated from responses to the SF-12v2™ (SF-12) Health Survey section of the New Zealand Health Survey (NZHS). The indicator is expressed in the percentage of adults reporting good or very good health. The SF-12 is also the indicator on physical health in the New Zealand General Social Survey (NZGSS) (Statistics New Zealand, 2016). Both indicators are insufficient in understanding the differential impact of cannabis use on physical wellbeing, in particular to the largest contributors to disability and/or premature death in New Zealand.

Therefore, we have used variables from the first section of the NZHS on long-term health conditions, which asks about conditions diagnosed by a doctor. Physical long-term health conditions in the 1 July 2016 – 30 June 2017 NZHS include heart disease, angina, heart failure, other heart disease, stroke, diabetes, asthma, arthritis, and chronic pain (Ministry of Health [MoH], 2017).

International literature largely focuses on changes in specific disease prevalence in post-regulation environments. Research is complicated by some of the conditions in the NZHS being treated by medical cannabis in overseas jurisdictions.

Heart disease

There is some limited evidence that cannabis use may increase risk for heart attack (Retail Marijuana Public Health Advisory Committee, 2017). Kalla, et al. (2018) found cannabis use

[10] http://www.healthdata.org/gbd
[11] https://www.stats.govt.nz/information-releases/new-zealand-abridged-period-life-table-201618-final

independently predicted the risks of heart failure and strokes in individuals 18-55 years old, with a 16.7 percent increase in rates of heart failure in users compared to non-users. Research on hospitalisation of recreational cannabis users in the USA showed the following increases in heart disease prevalence over the time many states were legalising cannabis use (2010-14):

- 70 percent increase in non-specific chest pain
- 28.6 percent increase in acute myocardial infarction
- 64.7 percent increase in congestive heart failure
- 32.8 percent increase in arrhythmia (Desai, et al., 2018).

Stroke

There is moderate evidence that cannabis use increases risk of ischemic stroke in individuals younger than age 55 years (Retail Marijuana Public Health Advisory Committee, 2017). Accompanying risk factors include tobacco and alcohol consumption (Hackam, 2015). Desai, et al., (2018) showed a 15.4 percent increase in stroke prevalence, from 1.3 percent to 1.5 percent in hospitalisations after regulation. The researchers did not find a corresponding trend in the general population over that time.

Diabetes

Cannabis users have less diabetes mellitus diagnoses than non-cannabis users, with 10 percent lower rates (Kalla, et al., 2018; Rajavashisth, et al., 2012; Sidney, 2016). As a result, there are no changes to incidence rates in the benchmarking projections. However, it is worth noting that there is a greater risk of prediabetes (HR=1.39) in individuals who report a lifetime use of cannabis of 100 times or more (Bancks, et al., 2015). This situation should be monitored in a New Zealand context given the high population prevalence of diabetes of 5.3 percent, and the extent of the bed occupancy by those with diabetes.[12] International research has not yet investigated whether legalisation impacts the prevalence of diabetes.

Asthma

Due to high rates of tobacco co-use in cannabis users, international researchers have found it difficult to show a causal relationship between asthma and cannabis use (Chatkin, et al., 2017; Tashkin, 2014). There are small increases (OR=1.1) in incidences of sputum, cough, wheezing/breathlessness, and bronchitis in cannabis users compared to non-cannabis users, although this increases (OR=2.1) if a long-term user (20+ years) (Ribeiro & Ind, 2016). Past-month use of cannabis is associated with self-reported increases in coughing and wheezing, but no clinically significant changes in measures of lung function as measured by spirometry (Kempker, Honig & Martin, 2015). International research has not yet investigated whether legalisation impacts the prevalence of asthma.

Arthritis and chronic pain

While different conditions, arthritis and chronic pain are considered together here as neither condition is associated with cannabis use. In many overseas jurisdictions, medical cannabis is used as a treatment or people self-medicate for these conditions (Blake, et al., 2006; Fitzcharles, et al., 2017; NASEM, 2017; Notcutt, et al., 2006; Russo, Guy & Robson, 2007; Swift, Gates & Dillon, 2005).

[12] https://www.hqsc.govt.nz/our-programmes/health-quality-evaluation/projects/atlas-of-healthcare-variation/diabetes/

Therefore, research tends to focus on whether cannabis use reduces symptoms rather than whether prevalence changes after legalisation.

Moore and Davies (2018) found that one in five people experiences chronic pain, which has negative implications on relationships, employment, and wellbeing. The same research found higher rates of chronic pain in quintiles 4 and 5, in Māori and European populations, and in those 55 years and older. With an aging population and the high probability of arthritis and chronic pain increasing in occurrence, the use of cannabis for pain relief is more likely to also increase.

4.3.3 Mental health

Prevalence of mental health diagnoses

There are two indicators for mental health in the LSF, both of which are self-report measures. One indicator is based on responses to the SF-12 health screening questions in the NZGSS. The SF-12 was included in 2014 and 2016 NZGSS survey years, but was not included in the 2018 NZGSS survey making long term trends difficult to measure (McLeod, 2018). The SF-12 is a multipurpose short form survey with 12 questions selected from the longer SF-36 Health Survey (Ware, Kosinski, and Keller, 1996). As a generic measure, the SF-12 does not target a specific age or identify disease groups. It is not a measure of population level mental health diagnoses. The questions focus on energy, social functioning, peace or calm, nervousness, and happiness.

The second indicator uses responses to the first section of the NZHS on long-term mental health conditions that have lasted, or are expected to last, for more than 6 months, and have been diagnosed by a doctor. These conditions have been used for establishing the mental health baseline. Mental health conditions in the 1 July 2016 – 30 June 2017 NZHS are depression, bipolar disorder, and anxiety disorder, including panic attacks, phobia, post-traumatic stress disorder, and obsessive compulsive disorder (MoH, 2017a). Psychosis and schizophrenia are not included in the questions. There is no indication of currency or intensity of symptoms.

The NZHS also included a mental health and substance use module, the SF-12, as well as the Kessler Psychological Distress Scale (K10), a measure of psychological distress (Kessler, et al., 2003). The K10 scale can be used as a brief screen to identify levels of distress, and may indicate the likelihood of having a mental disorder. It does not indicate levels of diagnosis for the purposes of establishing the baseline described in section 2.

No LSF mental health indicators are currently based on quantitative statistical data from medical professionals. Mental health diagnoses, including substance abuse diagnoses, are generally coded using ICD-10 and DSM-IV diagnosis codes (World Health Organization [WHO], 1992; American Psychiatric Association [APA], 2013). These codes are utilised by MoH in coding health interactions against NHI numbers, and have been used in sections 4.2.4 on Acute medical outcomes and 4.2.5 on Avoidable deaths. However, they were not retrievable for use in establishing a baseline prevalence of mental health diagnoses in cannabis users, nor prevalence of cannabis dependency or abuse disorders. In 2015, ICD-10 was implemented in place of ICD-9, taking the coding from around 13,000 to over 69,000 codes. Consequently, it is difficult to compare pre-2015 and post-2015 data and only pre-2015 data has been included in these sections.

All self-report data sources will underestimate the prevalence of mental health conditions and cannabis abuse disorders, as conditions that have not been diagnosed or for which help has not been sought will not be identified. An additional data limitation to consider post-regulation is that

increased honesty regarding cannabis use may skew responses due to decreased stigma and increased social acceptability.

In a summing up of available research, WHO (2016) found many studies investigating cannabis use and mental health disorders occurring at the same time, had not adequately controlled for confounding variables or ruled out reverse causation (mental health disorder contributing to cannabis use). In some studies any associations lessen with controlling for other factors or influences. The WHO report stated that while there was frequent co-occurrence of regular cannabis use or cannabis-use disorders and many mental health disorders, it has not been established which one came first or how to account for shared risk factors.

International research on the prevalence of co-occurring mental health diagnoses and cannabis-related disorders is mixed. In the United States, the National Survey on Drug Use and Health (NSDUH) by the Substance Abuse and Mental Health Services Administration (SAMHSA) underwent methodological changes on estimating cannabis-related disorders in 2015, around the same time as the ICD-10 changes. Estimates of co-occurrence from the 2017 survey are not comparable with any estimates from prior to 2015, which is generally when many regulatory changes around cannabis use occurred in the USA. Therefore, it is not possible to identify the impact of regulation on co-occurrence. Non-pathological, or recreational cannabis use without any form of diagnosis, is not addressed in the NSDUH data.

Pre-2015 NSDUH data was evaluated by Dutra, et al. (2018), comparing states with and without MCL. The researchers found between 2008 and 2015, states with liberal MCL had a higher prevalence of serious mental illness than states without MCL. Adjusting for current cannabis use accounted for 66 percent of the relationship between MCL and serious mental illness, but the prevalence still remained on average two percent higher. In contrast, there was no significant difference between states with restrictive MCL (i.e., use for chronic or life-threatening conditions only), and states without MCL. The lead author stated, “While this study doesn’t establish a causal relationship between liberal medical marijuana laws and mental illness, it does demonstrate that different types of marijuana laws likely have different effects on public health. We should explore what is driving the relationship we found”.

The extent to which cannabis use can be said to specifically cause psychotic disorders is low, with an inconsistent degree of association (WHO, 2016). Most longitudinal studies show a dose-response relationship and an increased risk of around 40 percent for a psychosis outcome in heavy cannabis-users (Marconi, et al., 2016; Radhakrishnan, Wilkinson & D’Souza, 2014). Radhakrishnan, et al. (2014) reported that cannabis use could account for between 8-14 percent of schizophrenia diagnoses, but that the prevalence of schizophrenia has not increased with increased prevalence of cannabis use in jurisdictions with cannabis regulation, likely due to schizophrenia having a variety of causative or contributory factors.

Substance co-use

This indicator defines rates of recreational substance co-use, and co-use with tobacco or alcohol by those who have used cannabis in the past 12 months. Responses from the NZHS are used for all substances. Substance co-use patterns are important to consider in monitoring cannabis-related public health statistics. Changes in patterns of cannabis use may lead to changes in complementary use (i.e., smoking cannabis with tobacco), substitution effects (i.e., using cannabis rather than drinking alcohol), or gateway effects (i.e., using other recreational substances). Fergusson, Boden and Horwood (2015) identified that cannabis users differed from non-users in

risk-taking, impulsivity, cognitive ability and other ways that increase their risk of adverse health outcomes, including using other illicit drugs.

Recreational or non-medical substance co-use

For recreational substance co-use, the NZHS question asks if any of the following substances have been used for recreational or non-medical purposes, or to get high - ecstasy, amphetamines, stimulants, prescription opioids, sedatives, hallucinogens, cocaine, heroin. Synthetic cannabis is not included in the question. An additional data limitation is that the survey asks around use in the past 12 months, with no indication of currency, frequency or volume of use.

There is a theory that cannabis, like alcohol and tobacco, is a gateway drug as it primes the brain's reward regions (Volkow, et al., 2014). Volkow also suggested that people who are more susceptible to drug-taking behaviour may be more likely to start with cannabis due to convenience, and interactions with peers who use other drugs just increases the probability that they would try those drugs.

It is challenging to obtain useful data for a New Zealand context around recreational substance co-use - the "opioid crisis" in the USA, where most reliable post-regulation cannabis data exists, means the majority of substance co-use from the USA focuses on opioids. The availability of opioids in the USA is more widespread than in New Zealand and every day more than 90 people in the USA die from an opioid overdose. Opioid and heroin deaths in Alaska, Oregon, Colorado, and Washington, where recreational cannabis use is legal, remained below the national USA average in 2017, while trending in the middle in 1999.[13] Recent research indicated prescriptions for opioids decreased when MCLs went into effect (Hill and Saxon, 2018).

Tobacco co-use

For tobacco co-use, responses are taken to a series of questions on tobacco use in the NZHS. The first question asks if cigarettes or tobacco have ever been used, and an additional question asks about current frequency (daily, weekly, monthly, less often). For the purposes of the baseline, responses of at least daily and at least weekly were used as there is limited research on public health implications of monthly or less frequent tobacco smoking. Light and intermittent smoking is defined as anywhere from 1-39 cigarettes a week to less than 10 cigarettes a day (Husten, 2009).

There are no longitudinal studies on tobacco and cannabis co-use post-regulation. The studies that do exist either compare trends over two years in a specific location, or investigate the impact of MCL on tobacco consumption. Tobacco consumption has been trending downwards in the USA for many years – from 2011 to 2016 among those aged 18-25, tobacco use decreased from 40 percent to 31 percent, and remained stable at around 25 percent among those aged 26 and older (SAMHSA, 2017).

In Oregon, 46 percent of current cannabis users also reported cigarette smoking every day or on some days in 2015, decreasing to 20 percent of 18-29 year olds and 16 percent of those aged 30 and over (Oregon Public Health Division, 2016). While the figure for those aged 30 and over was the same in 2014, the year Oregon legalised non-medical cultivation and uses of cannabis, the figure was 18 percent for 18-29 year olds. The same research asked about self-reported use of cannabis, alcohol and tobacco after recreational cannabis legislation – 27 percent of adults who co-used

[13] CDC/NCHS, National Vital Statistics System, Mortality. CDC WONDER, Atlanta, GA: US Department of Health and Human Services, CDC; 2018. Data obtained from https://wonder.cdc.gov/controller/datarequest/D76

cannabis and tobacco reported using tobacco less often after legalisation and 11 percent reported using it more often.

Wang, et al. (2016) analysed data from the 2013 NSDUH comparing cannabis and tobacco co-use and found 5.1 percent reported past 30-day cigarette and cannabis co-use, with a higher proportion of co-users residing in states with MCL (5.8 percent compared to 4.8 percent in non-MCL states). The researchers found co-use was associated with greater odds of having nicotine dependence compared to cigarette-only use across age categories, particularly in adults aged 50-64 years (OR=3.08) and adolescents (see section 4.2.8 Youth).

Choi, Dave, and Sabia (2018) undertook similar research examining the impact of MCLs on tobacco cigarette consumption. They found MCL enactment was associated with a one to 1.5 percentage-point reduction in adult tobacco consumption across all age groups (18-25, 26-54, 55+), and a reduction in the number of cigarettes consumed for those above 26 years. The researchers estimated healthcare cost savings of US$4.6 to US$6.9 billion per year from the reduction in tobacco consumption.

Alcohol co-use

For alcohol co-use, responses are taken to a series of questions on alcohol use from the NZHS. The first question asks if a drink containing alcohol had been drunk in the past year, and an additional question asks about current frequency (monthly or less, up to 4 times a month, up to 3 times a week, 4 or more times a week). For the purposes of the baseline, responses of up to 3 times a week, 4 or more times a week were used to identify regular alcohol consumption among those who had smoked cannabis in the previous 12 months.

SAMHSA (2017) identifies cannabis as the second most commonly used substance by those who drink alcohol, the first being tobacco. When comparing four states with legal cannabis to binge alcohol use with the other states, the four states had rates close to the national average (SAMHSA, 2017).

Among cannabis users aged 18 years and older, 40 percent reported binge drinking in the previous 30 days in a 2016 study by the Oregon Public Health Division. Of the adults who used both cannabis and alcohol, 26 percent reported drinking alcohol less often after recreational cannabis legislation, and a very small number reported that they would drink alcohol more often.

Understanding substitution (increased use of one substance when decreasing the use of the other) and complementary/simultaneous (increased use of one substance if use of the other substance is also increased) effects is important in understanding how cannabis users consume alcohol (Subbaraman & Kerr, 2015). There are no studies of these effects post-regulation.

One study that compared simultaneous use across states that with legal and non-legal cannabis, found cannabis users do not commonly use it with alcohol, regardless of recreational or medical cannabis use (Pacula, Jacobson & Maksabedian, 2016). The study found only 12 percent of recreational cannabis users reported simultaneous use of alcohol and cannabis most or all of the time. A limitation on the study is that the cohort was largely female, and males and young users were underrepresented.

Estimated prevalence of cannabis-related disorders

Prevalence rates of cannabis abuse or dependence disorder could not be determined for this indicator. Cannabis use disorders (also known as dependence or abuse) are defined as meeting

criteria in the DSM-IV for either dependence or abuse (APA, 2013). DSM-IV and ICD-10 codes are present on individual's health records that could lead to identification through the Integrated Data Infrastructure (IDI). However, microdata is not useful for population level monitoring and reporting, and currency of diagnosis is unclear if looking at year-on-year trends.

Internationally, NSDUH data shows prevalence of past-month cannabis use has been trending upwards since the mid-2000s in those aged 12 and older, from six percent to eight percent in 2013-14 (SAMHSA, 2017). SAMSHA data also found that this increase in past-month use is driven by adults with use by those aged 18-25 years increasing 2.3 percentage points from 2015-7 and use by those aged 26 or older increasing 1.4 percentage points. At the same time, use by those aged 12-17 years decreased 0.5 percentage points. Daily use by 18-25 year olds also increased 1.2 percentage points. Females in this age group have seen the largest increase, with a three percentage point increase compared to males with a 1.6 percentage point increase. Daily use by those aged 26 and older increased by 0.6 percentage points.

However, while daily and past-month cannabis use has been trending upwards, the NSDUH research does not show a corresponding increase in the prevalence of cannabis dependence disorders. For those aged 18-25, and 26 and older, rates have remained static (SAMHSA, 2017). On the other hand, National Institute on Alcohol Abuse and Alcoholism (NIAAA) research found past-year prevalence of cannabis dependence disorders was 1.5 percent in 2001–2002 and 2.9 percent in 2012–2013, after cannabis regulation in many USA jurisdictions (Hasin, et al., 2015). The NSDUH and NIAAA studies have different methodologies that would need to be explored in more detail for greater clarity on the variation in their findings.

The Department of Corrections (Corrections) has provided data on cannabis abuse and dependence rates in prisoners, from research undertaken in 2015. This data has been used in the baseline and would be valuable to monitor in a post-regulation environment. There is no reliable international data on pre-/post-regulation cannabis use disorders in prison populations.

Rates of attendance at cannabis treatment programmes

This indicator aims to measure rates of attendance at treatment programmes for cannabis abuse or dependency disorders. We are unable to provide population level data for this indicator due to the difficulty in accessing the Programme for the Integration of Mental Health Data (PRIMHD) database. PRIMHD is the national MoH mental health and addiction information database, with service activity and outcomes data collected from district health boards (DHBs) and non-governmental organisations (NGOs) (MoH, 2015). Also PRIMHD activity codes for substance abuse treatment do not specify the substance of abuse, and currently can only be accessed through the IDI.

Data from Te Pou Alcohol and Drug Outcome Measure (ADOM) was provided but not used. This data has major limitations - the dataset is small, and from a total of 23,746 alcohol and drug episodes of care opened in mandated ADOM services, the latest ADOM report only covers 1,036 "matched pairs" (Te Pou o te Whakaaro Nui, 2019). That is, episodes with both treatment start and treatment end dates in the ADOM system. Thus, these figures are likely to understate the rates of treatment.

Internationally, there is no USA data on changes to treatment programme attendance in jurisdictions with cannabis regulation as yet. The Netherlands has the highest rates of treatment for cannabis dependence in Europe, but Portugal has considerably lower rates and all drugs are decriminalised there (MacCoun, 2011). Australian research suggests it may take as long as 10 years before those who initiate cannabis use in their adolescence to present to addiction treatment

services in their late 20s and early 30s (Roxburgh, et al., 2010). The UNODC report indicated there had been a decline in treatments of cannabis use disorders in the USA since 2009, but that this decline may be linked to changes in the referral process used by the criminal justice system rather than cannabis legislation itself (UNODC, 2016).

4.3.4 Acute medical outcomes

In reviewing international research on acute medical outcomes related to cannabis use, it is important to place the data in context. Alongside the concerns around bias in pre-regulation research in the USA previously mentioned, individuals using cannabis may have been deterred from seeking medical advice or services when they experienced adverse reactions from cannabis use, due to the threat of criminal penalties or stigma. Furthermore, increased public health education campaigns have focused on the harm reduction and the risks of consuming cannabis.

It is therefore unclear whether incident rates have increased or whether the number of people seeking assistance has increased, due to less risk of prosecution or public disgrace. Observing acute health data over time will be needed to ascertain contributing factors.

Hospital bed nights

Hospital bed night data was extracted from a MoH dataset on publicly funded hospital discharges with ICD-10 diagnosis codes of either F12 (mental and behavioural disorders due to use of cannabinoids) or T407 (poisoning from cannabis or derivatives). The indicator looks at rates of hospital admissions where cannabis is attributable or present. Consideration should be given to changes in screening or toxicology methodologies, and increases in potency for future trend analysis.

In Colorado, hospitalisations with cannabis-related billing codes had a two-fold increase from 274 incidences per 100,000 hospitalisations in 2000 to 593 in 2015 (Wang, et al., 2017). This time period covers both medical and recreational cannabis legislations.

Emergency department visits

The MoH dataset for hospitalisations was also used for emergency department (ED) visits, using the same diagnosis codes. An additional filter was applied to the health speciality column using only M05 (Emergency medicine) health speciality.

Wang, et al. (2017) also found a considerable increase in ED visits, from 313 incidences per 100,000 hospitalisations in 2011 to 478 in 2015 for those with cannabis-related billing codes in the first three diagnoses. The highest rates occurred in 2014 (554 ED visits) but decreased by 12.5 percent in 2014. However, to keep these increases in context, they identified that less than one tenth of one percent (0.04 percent) of the state's 2.3 million ED visits in 2014 were for cannabis-related exposure.

Calls to National Poison Centre

This indicator was identified through international research, whereby calls to poison control centres in the USA experienced an increase on cannabis exposure or intoxication post-regulation, particularly in regard to children and youth. The National Poison Centre (NPC) advised they had no data on calls regarding cannabis exposure in New Zealand.

However, insufficient data is not surprising – even post-regulation, in Oregon less than one percent of calls to the state's poison centres in 2016 were related to cannabis exposure, and in Washington DC, the figure was closer to 0.5 percent (Oregon Poison Centre, 2018; Washington Poison Center,

2016). Nonetheless, in Oregon calls increased from 103 cases in 2014 to 254 cases in 2017, with 247 calls three-quarters through 2018 (Oregon Poison Centre, 2018). These increases were largely in under five year olds, and over 21 year olds. In Washington, cases increased from 146 in 2011 to 286 in 2016, of which 17 percent were 0-5 year olds, and 18. Five percent were 13-19 year olds (Washington Poison Center, 2016). In both areas, those aged 6-12 years had the lowest case rates.

4.3.5 Avoidable deaths

Unnatural or avoidable deaths are deaths caused by external factors (intentional injury, such as homicide or suicide), and death caused by unintentional injury in an accidental manner, such as traffic accidents (Lukaschek, et al., 2012). The term "avoidable mortality" was defined as "deaths that should not occur in the presence of effective and timely health care" by Rutstein, et al. (1976) as an indicator of the quality of health care, and this term is used in some research. Lukaschek, et al. (2012) argued that avoidable mortality was an appropriate term to classify contributors to the three main causes of unnatural death: suicide, fatal transport accidents, and homicide. Suicide and fatal transport accidents are discussed here, while homicide is discussed in the section on safety.

Rates of death by suicide

The rates of deaths by suicide is a LSF indicator, defined as *Deaths caused by intentional self-harm, age-standardised rate per 100,000 population*, as obtained from the Mortality Collection of the MoH. Data for this indicator was extracted from this data. The primary filter was cause of death coded as intentional self-harm (X60-X84) using ICD-10 diagnosis codes, with the additional presence of any F12 (mental and behavioural disorders due to use of cannabinoids) or T407 (poisoning from cannabis or derivatives) diagnosis codes.

It is difficult to conclude that the presence of cannabis in an autopsy, or a previous diagnosis of a cannabis use disorder, is a causative factor in intentional self-harm. As shown in the section on mental health, there are high rates of co-morbidity between mental health diagnoses and substance abuse. Death by suicide also has many contributing variables, which are impossible to control for.

In the USA, the Drug Abuse Warning Network (DAWN), sponsored by SAMHSA, monitors drug-related ED visits, including those for drug-related suicide attempts. DAWN defines drug-related as drug overdoses and suicide attempts by other means while under the influence of a drug. Some jurisdictions do not conduct toxicology tests for the presence of cannabis and do not report cannabis to DAWN. Therefore, the full extent of cannabis underreporting in ED data from the USA is unknown. From 2004-10, drug-related suicide attempts where cannabis was present increased 42.6 percent, from 12,074 to 17,219, with annual figures ranging from 11,995 to 17,285. Overall drug-related suicide attempts increased 31.7 percent over that time, with over 90 percent of suicide attempts involving pharmaceuticals, and cannabis-related suicide attempts were 7.5-8 percent of the total.

A study of suicides across 27 USA states found 22.4 percent of those who died by suicide in 2015 tested positive for cannabis, with 22.7 percent having a known mental health issue and 22.1 percent not having any previously identified mental health issue (Stone, et al., 2018). This compares to 40.8 percent testing positive for antidepressants, 40.6 percent testing positive for alcohol, 30.3 percent for benzodiazepines, and 26.6 percent for opioids in the same research. In total, the research found 74.4 percent of deaths by suicide tested positive for any substance in a toxicology screening.

USA research into the association of medical cannabis regulation and deaths by suicide from 1990–2007, found regulation was associated with the following reductions in rates of death by suicide:

- 10.8 percent in males aged 20-29 years
- 10.4 percent in females aged 30-39 years
- 9.4 percent reduction in males aged 30-39 years.

The decrease in rates of death by suicide of women over 60 years was also statistically significant (Anderson, Rees & Sabia, 2014). Overall, rates of death by suicide in states with MCL trended downwards after legalisation, while rates in those without MCL remained roughly constant. The researchers hypothesised that these age groups may have used cannabis to cope with stressful life events, particularly if cannabis is used rather than alcohol, as MCL has shown to be associated with a decline in alcohol participation and binge drinking.

Fatal transport accidents

Data for this indicator was extracted from Ministry of Health (MoH) mortality data. The primary filter was individuals whom had a "Cannabis involved" value of 'Y' (Yes), with secondary filters being cause of death coded as a transport accident (V01-V99) using ICD-10 diagnosis. The Y value is selected if the death was referred to the coroner and the coroner, police, post-mortem report or toxicology report indicate that the deceased had taken/used cannabis before their death; or the police/coroner's report details evidence of cannabis use or poisoning prior to death (MoH, 2017b). There is no data for passengers who died where the driver was under influence but the deceased was not. Therefore, the full impact of cannabis use on fatal transport accidents is not able to be determined.

International research post-regulation is mixed. Data from the USA indicates the increase of cannabis for recreational use has increased the number of users driving while under the influence post-regulation, although increased law enforcement scrutiny must also be considered (UNODC, 2016). In Colorado, the trend became positive in the proportion of drivers in a fatal transport accident who tested positive for cannabis (change in trend, 2.16 (0.45), $p<0.0001$) compared to non-cannabis states (Salomonsen-Sautel, et al., 2014). However, in a review looking at 16 states with cannabis legislation, Anderson, Hansen & Rees (2011) found states with MCL showed an 8-11 percent decrease in fatal transport accidents the first full year after legalisation. They attributed this to substitution effect with alcohol, which has a much higher risk profile. The same study found the arrest rate for driving under the influence of alcohol and other drugs had decreased in Washington and Colorado following legislation.

Cannabis is suggested to have a lower driving impairment risk profile than alcohol, but the risk profile increases dramatically when used in combination (Hartman, et al., 2015). In the mortality data set, which covers the period from 2011-5, acute alcohol intoxication was present in 53 out of 217 (24 percent) of deaths. This was determined by searching for the ICD-10 diagnosis code F100, which indicates acute alcohol intoxication.

Non-fatal transport accidents

Data on non-fatal transport accidents attributed to cannabis use in New Zealand was not available. A review of a number of research studies by Rogeberg and Elvik (2016) showed acute cannabis intoxication is associated with a statistically significant risk increase of low-to-moderate magnitude (OR 1.22-36), strongly suggesting driving while impaired increases the risk of transport accidents.

Issues regarding roadside screening complicate matters with no clear correlation between tetrahydrocannabinol (THC) levels in blood serum and cognitive impairment (Compton, 2017; Logan, Kacinko, & Beirness, 2016; Nordstrom & Hart, 2006; Ramaekers, et al., 2009).

4.3.6 Productivity

Jobs and earnings domain

Within the jobs and earnings domain, the following indicators are explored:

- Employment rates (labour force participation)
- Average income
- Workplace absenteeism.

Employment rates

There are two related indicators in the LSF; employment rate (percentage of adults (aged 15+) who are employed), and unemployment rate (percentage of labour force who are unemployed). Both indicators are measured through the Household Labour Force Survey (HLFS), which does not ask about cannabis use. Therefore, NZHS data has been used to measure labour force participation.

The legal cannabis industry itself is a contributor to employment, making up 0.7 percent of total employment in Colorado at February 2018. Light, et al., (2016) found 18,000 jobs were caused by the cannabis industry, including direct and indirect employment. Indirect employment included security guards; construction and heating, ventilation, and air conditioning specialists; transportation; consulting, legal and advisory services; and other business services.

Around 5.5 percent of the total change in Colorado employment in the first half of 2017 could be attributed to the cannabis industry. By comparison, the mining and logging sector contributed almost seven percent, and the leisure and hospitality sector contributed 23 percent. At that time, Colorado's unemployment rate was 2.3 percent, nearly half that of the USA rate of 4.3 percent.[14]

However, Washington State and Oregon, who passed legislation at a similar time, did not experience a similar employment boom, with Washington sitting at 4.8 percent unemployment and Oregon at 4.1 percent in mid-2018. Seattle, the Washington State capital, did not experience an employment spike after legalisation, despite having the bulk of cannabis retail and tourism.

A complicating factor is that the USA Bureau of Labor Statistics refuses to count or report job gains in the cannabis industry because it remains illegal at federal level. There are also no specific job codes related to cannabis employment in the national labour statistics system. Economists have been able to attribute specific job numbers to cannabis sales, often by cross referencing with company registrations (Light, et al., 2016; Barcott & Whitney, 2019). Estimated job gains for 2018 are listed in Table 4.1.

Barcott and Whitney (2019) estimated there were more than 211,000 full-time jobs in the legal American cannabis industry (296,000 if counting direct, indirect, and induced employment), up from around 120,000 in early 2017. Overall, there is no conclusive evidence that cannabis legalisation has an impact on employment or unemployment rates.

[14] https://www.colorado.gov/cdle

It is worth noting that MCL is associated with 5-10 percent increases in labour supply of adults over 51 years due to improvement in reported pain measures, with researchers stating it is difficult to separately examine the effects of medical and recreational cannabis use (Nicholas & Maclean, 2016).

Table 4.1 Cannabis job gains in the USA (2018)

State	Jobs Added in 2018	% Gain in Jobs	Jobs, Jan. 2018	Jobs, Jan. 2019
Florida	9,068	703%	1,290	10,358
Nevada	7,573	181%	4,193	11,766
Washington	7,035	26%	26,556	33,591
Arizona	5,120	82%	6,250	11,370
Colorado	4,595	17%	26,891	31,486
Pennsylvania	3,788	4208%	90	3,878
New York	3,726	278%	1,341	5,067
Maryland	2,624	469%	559	3,183
Alaska	2,268	418%	542	2,810
Oklahoma	2,107	-	0	2,107
New Jersey	1,834	355%	516	2,350
Illinois	1,668	123%	1,352	3,020

Source: Barcott & Whitney (2019)

Average income

The median hourly earnings for wage and salary employees aged 15 and over is measured by HLFS data. This data is not able to be connected to cannabis use. For the benchmark, responses to the NZHS on income was used, with average income across quintiles being calculated. Due to the way the survey is administered, with income from all sources considered, and allocated to income bands, comparing hourly earnings between cannabis-users and non-users was not possible.

Van Ours and Williams (2015) reported most economic studies from 1998-2007 found that infrequent or non-problematic cannabis use had no impact on wages, whereas problematic use had negative wage effects. Sabia and Nguyen (2018) found MCL enactment was associated with reductions of 2-3 percent in hourly earnings of young adult males (20-29 years) but no changes in earnings for females or older males.

Cannabis regulation was also found to produce a 1.3 percent decline (approximately US$1,300 per employee) in labour productivity in the year following policy changes (Albino, 2017). A one year lag saw the decline at one percent in the second year following regulation. The residual effects tailed off in the third year and the research did not test assumptions past the fourth year. The researcher found the decline was not spread evenly across the sectors being studied (construction, mining, arts/entertainment/recreation, accommodation/food service). Construction showed large and significant effects (3.2-4 percent) in the two years respectively following policy changes, but there were no changes in the other sectors.

Workplace absenteeism

A Treasury study of the cost of ill health in 2004-2005 estimated working fewer hours or not working at all affected 1.3m people and cost between NZ$5.4-12.9bn dollars, 3.6-8.5 percent of GDP (Holt, 2010). A more recent study found around 6.6 million working days were lost to absence in 2017 at a cost of NZ$1.5bn (Summers, 2017).

There is limited international research on workplace absenteeism post-regulation, and any that does exist is largely related to MCL rather than recreational use. Ullman (2017) found that absenteeism from work due to health issues decreased by 13 percent after MCL was introduced in USA states with more liberal legislation. Some age groups were less likely to report sickness absence post-regulation, including:

- 30-39 years – 16 percent
- 40-49 years – 11 percent
- 50-59 years – 13 percent.

The study hypothesised that the decline was due to an overall decline in alcohol consumption after legislation, alcohol being a major driver of workplace absenteeism. This may be considered a positive substitution effect.

Knowledge and skills domain

Within the LSF, the knowledge and skills domain is measured by rates of educational attainment, or qualifications, of adults between 25 and 64. Data is obtained both from NZGSS self-reported responses and Treasury analysis of the HLFS. Neither of these indicators ask about cannabis use so are not useful for comparisons. For the benchmark, NZHS data was used to identify highest qualification. There is no international data on differences in educational attainment between cannabis-users and non-users, or between jurisdictions with differing cannabis regulations. It is likely not enough time has passed to collect enough data and to be able to effectively evaluate any impacts.

4.3.7 Subjective wellbeing domain

While many of the indicators in the LSF are self-reported and by definition subjective measures of wellbeing, this domain concerns itself with subjective wellbeing as assessments of some aspect of a person's life. Indicators here include life satisfaction and perceptions of harm risk.

Life satisfaction

Overall life satisfaction is an indicator of subjective wellbeing in the LSF, and is measured through scaled NZGSS responses to a question, "How do you feel about your life as a whole?" This is a general 0-10 scale question rather than a validated multi-item scale, such as the Satisfaction with Life Scale (SWLS) designed by Diener, et al. (1985), which may be used more widely in international research. There is also no data on cannabis use to compare whether there is a difference in current life satisfaction between cannabis users and non-users in New Zealand.

Data provided (but not used) by the Christchurch Health and Development Study (CHDS) had a custom-written life satisfaction measure that asked broadly about satisfaction with work, education, leisure, intimate, familial and social relationships, and financial situation, as well as life as a whole. These are not concepts that are present in the SWLS and similar instruments. The

NZGSS and CHDS measures may be measuring different things and thus not have convergent validity (two measures being related) with tools such as SWLS.

There is conflicting research on the relationship between life satisfaction and cannabis use (Barnwell, Earleywine & Wilcox, 2006; Deligianni, et al., 2019; Fergusson & Boden, 2008). There is no research on differences in life satisfaction between jurisdictions with differing cannabis regulation for comparison. Nor is there research on the difference in life satisfaction between cannabis users and non-users in a regulated environment, bar a market research study that found cannabis users had higher life satisfaction than non-users.[15] One study compared life satisfaction of returned veterans who used cannabis medicinally with those who used cannabis recreationally, and found recreational users had high life satisfaction, as well as better measures in physical and mental health (Metrik, et al., 2018). There was no comparison with non-users in this research.

Perceptions of harm risk

This indicator measures the perceptions of harm risk of cannabis use in order to understand the impact of social acceptability on cannabis use. Perceptions of harm risk is considered a public health indicator that, as part of a range of social and environmental measures, increases understanding of the relationship between perceptions and attitudes, and cannabis use behaviour (Azofeifa, Mattson, & Grant, 2016). There is no current data on perceptions and attitudes to inform the baseline.

Research from NSDUH from 2002-2014 showed that among people aged over 18 years, the perception of great risk from smoking cannabis once or twice a week and once a month decreased, and the perception of no risk increased (Azofeifa, et al., 2016). The same study found decreases in the perception of great risk combined with increases in the perception of availability and fewer punitive legal penalties for the possession of cannabis for personal use might play a role in increased use among adults. Overall, there was a significant decrease in the perceived risk associated with occasional and regular cannabis use, with younger age, male gender, and past month use associated with decreased perceived risk. Perception of risk of harm follows in Table 4.2.

Table 4.2 Changes in perceived harm risk 18+ year olds, 2002-2014

	2002 (%)		2014 (%)	
	18-25 yrs.	26+ yrs.	18-25 yrs.	26+ yrs.
Perceived great risk from smoking cannabis once a month	23. 5	41. 7	13. 5	29. 2
Perceived great risk from smoking cannabis once or twice a week	35. 5	54. 1	18. 3	36. 6
Perceived no risk from smoking cannabis once a month	18. 6	8. 7	36. 6	17. 4
Perceived no risk from smoking cannabis once or twice a week	11. 1	4. 7	25. 5	13

Source: Azofeifa, et al. (2016)

[15] https://bdsanalytics.com/cannabis-consumers-happy-campers/

Dills, Goffard, and Miron (2017) found cannabis regulation had decreased perceived riskiness of cannabis consumption in general. However, it has also increased perceived riskiness of heavy alcohol consumption with higher rates of disapproval also reported.

4.3.8 Children and youth

There is no specific domain in the LSF related to child and youth wellbeing. Therefore, all indicators described here have been drawn from available international research exploring changes in child and youth wellbeing as a result of cannabis regulation. For the purposes of this section, youth refers to those aged 12-17 years, and child/children refers to those aged 0-11 years.

Indicators described here include:

- Youth cannabis use, including rates of use, age of initiation, and dependency
- Rates of school-based drug prevention programmes
- Youth engagement with education
- Perceptions of harm risk
- Acute medical outcomes
- Cannabis-related crime rates.

One of the challenges when comparing New Zealand data to international research, is that most USA research has age groupings of 12-17 years, 18-25 years, and 26 years or older. Given the suggested legal purchase age is 20 years, the research presented in this report regarding those 18-19 years will be found in the general sections reflecting adult use.

Youth cannabis use

This topic includes all measures related to rates of cannabis use, age of initiation, and prevalence of cannabis-related disorders for those aged under 18yrs.

Rates of cannabis use

Youth'12 cannabis prevalence data indicates youth cannabis use has been trending downwards in New Zealand, dropping from 20 percent of respondents in 2001 reporting at least monthly cannabis use, to 8 percent in 2012 (Fleming, et al, 2014).

Research looking at cannabis use among 8th (NZ=Year 9), 10th (NZ=Year 11), and 12th graders (NZ=Year 13) in Washington State and Colorado, found mixed results in post-regulation environments (Cerdá, et al., 2017). In Washington State, cannabis use increased two percent from 2010-2012 to 2013-2015 among 8th graders, and 4.1 percent among 10th graders, while no significant differences in cannabis use were found with 12th graders there or in any grade in Colorado. The authors considered the previous medical cannabis system already present in Colorado may have already exposed youth to cannabis commercialisation and advertising, and this influence cannot be discounted in assessing the results.

Across the USA, NSDUH data shows prevalence of past-month cannabis use decreased among those aged 12-17, from seven percent (1.8m) in 2015 to 6.5 percent (1.6m) in 2017 (SAMHSA, 2017). Earlier data indicated past month cannabis use in this age group had increased from 6.7 percent in 2006 to 7.1 percent in 2013, so these statistics show a reversal of this trend despite increasing liberalisation (Azofeifa, et al., 2016).

The national Monitoring The Future (MTF) study found that in 2018, the prevalence of cannabis use among 8th graders was 5.6 percent; among 10th graders, 16.7 percent; and among 12th graders, 22.2 percent (Johnston, et al., 2019). It is worth noting that these rates are nearly half the rates of those in the mid-1990s when there was no cannabis regulation, and the prevalence of use in the 12th grade was 51 percent when the study started in 1977. Over this time, there has also been a decline in the perceived availability of cannabis. MTF showed that in 2018, historical gender gaps among the grades had all but disappeared due to sharp declines in use rates by males and slight increases in use rates by females.

Age of initiation

The data from the CHDS did not indicate age of initiation as a rate of the overall cohort. Rather, the information provided indicated the rates of specific outcomes based on age ranges of initiation. Therefore, the data was unable to be utilised solely for identifying age of initiation, or for establishing mean age of past year initiates of cannabis use, and was not used in the baseline.

The USA NSDUH data showed the estimated national prevalence of past year initiation among youth aged 12 years or older was 1.7 percent in 2014, increasing by 13.0 percent from 1.5 percent in 2002 (Azofeifa, et al., 2016). Among those 18-25 years, the prevalence of past year initiation increased from 4.9 percent in 2002 to 6.2 percent in 2014. The authors estimate the mean age at first use of cannabis had increased for all age groups during 2002–2014. In 2014, the mean age at first use estimate among everyone aged 12 years or older as 19.4 years, whereas in 2002 it was 17.0 years. Over that time, among youth aged 12–17 years, the estimated mean age at first use of cannabis among past year initiates has remained stable at around 14.9 years. The difference between these statistics indicates any increases in the first use of cannabis are largely in those over 18 years of age, and while there has been an increase in the prevalence of past year initiation among 12-17 year olds, there has not been a reduction in the mean age at first use.

This is supported by a review of cannabis use across the USA that found those who used cannabis for medical purposes tended to have a higher age of initiation (Hasin, 2018). This group of cannabis users will be included in the NSDUH data.

Prevalence of cannabis-related disorders

As with the section on estimated prevalence rates of cannabis abuse or dependence disorders for adults, youth prevalence in New Zealand could not be determined for this measure. International research indicates that along with an overall decline in cannabis use by youth aged 12-17 years, there has been a corresponding decline in the prevalence of cannabis-related disorders.

Azofeifa, et al. (2016) found that the general population prevalence of cannabis-related disorders among youth aged 12-17 was 4.3 percent in 2002, decreasing to 2.7 percent in 2014, after many jurisdictions had cannabis legislation. Among cannabis users (of any frequency), prevalence also decreased from 27 percent in 2002 to 20.4 percent in 2014. The more recent SAMHSA data shows population prevalence in this age group at 2.2 percent, continuing the overall decline.

Rates of school-based drug prevention programmes

The Ministries of Education (MoE), Youth Development (MYD), or Health (MoH) were unable to provide data on the number of school-based drug prevention programmes per annum or rates of attendance at such programmes. Therefore, we do not have a current understanding of the magnitude of such programmes currently.

Massey University's Centre for Social and Health Outcomes Research and Evaluation (SHORE) undertook a review of school-based education on alcohol, drugs, and mental health in 2014. SHORE reported that most of the evaluations of the New Zealand programmes focused on learning outcomes, and there was a tendency to assume behavioural change would follow. However, the bulk of international literature indicated there was little to no effect on longer term substance abuse from classroom-based drug and alcohol education programmes.

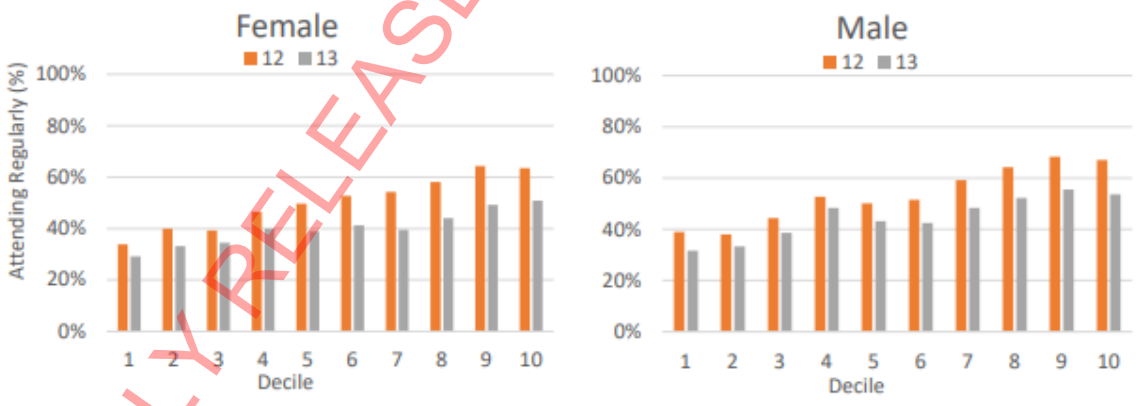
In jurisdictions with cannabis regulation in the USA, the focus has been on changing curriculum content and in increasing the number of healthcare workers in schools, such as social workers and counsellors.[16] Post-regulation, the Drug Policy Alliance recognises that abstinence-only drug education has not been shown to be effective, and the movement in the USA is towards harm minimisation.[17] Legalisation has also shifted the focus to discussions on potency, edibles, brain chemistry, and delaying use.[18] As yet, there is no evidence that there has been an increase in numbers of programmes or rates of attendance in states with cannabis regulation.

Youth engagement with education

For this measure, rates of school absenteeism and rates of school completion are considered. In particular, the rates of school absenteeism in secondary schools. The MoE reports school attendance data annually with breakdowns by multiple demographic and school type features.[19] Highlights from 2018 data include:

- Regular attendance stabilised at 63.8 percent of students, following declines seen in 2016 and 2017; 67.2 percent and 63.0 percent respectively
- In Years 12 (Y12) and 13 (Y13), female students continued to have regular attendance than male students, being most pronounced those in Y13 students at 5.5 percentage points below; when broken down by the deciles of the schools they attend, the proportional decline between the years is most notable in the higher deciles (see Figure 4.1).

Figure 4.1 Regular attendance of students across Years 12-13 by school decile (2018)



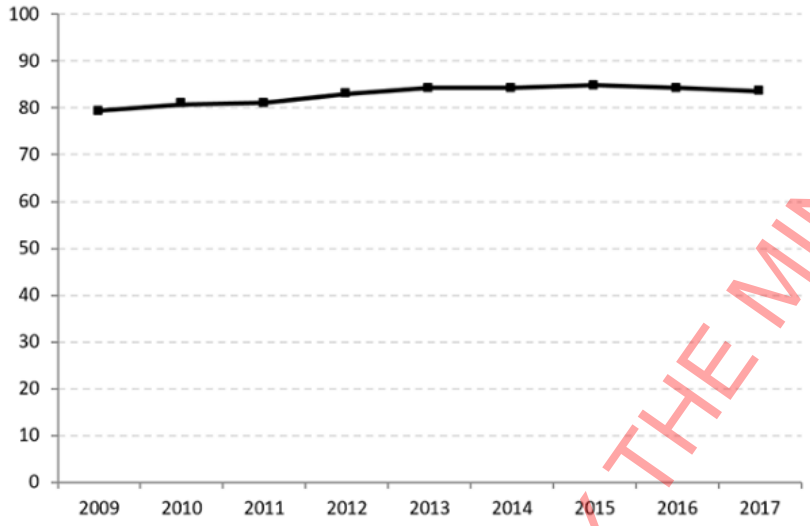
Source: Education Data and Knowledge, Ministry of Education

International evidence that cannabis regulation impacts school absenteeism could not be located. Monitoring any trends in school absenteeism in a post-regulatory environment is recommended.

[16] https://www.npr.org/sections/health-shots/2015/02/22/388156660/when-pot-goes-from-illegal-to-recreational-schools-face-a-dilemma
[17] http://www.drugpolicy.org/issues/real-drug-education
[18] https://khn.org/news/with-the-rise-of-legal-weed-drug-education-moves-from-dont-to-delay/
[19] https://www.educationcounts.govt.nz/publications/series/2503

Rates of school completion in New Zealand remained within a band in the high-70 to low-80 percentage range from 2009 to 2017 (Figure 4.2). In 2017, 83.5 percent of students stayed at school to the age of 17. There was a 4.1 percentage point increase from 2009 (79.4 percent), and a 0.8 percentage point decrease from 2016 (84.3 percent). Female students (86.1 percent) were more likely to remain at school until age 17 than their male counterparts (80.9 percent) despite the lower attendance rates noted above. Asian students had a considerably higher rate of retention to 17 years old than other groups. Conversely, Māori students had a considerably lower rate of retention.

Figure 4.2 Percentage of school leavers retained until age 17 (2009 to 2017)



Source: Education Data and Knowledge, Ministry of Education

In Colorado, school completion rates increased after legalisation (Colorado Department of Public Safety, 2018). The graduation rate rose steadily from a 10-year low point of 72 percent in the 2009-2010 school year to 79 percent in the 2016-2017 school year. Over that same time period, the drop-out rate decreased from 3.1 percent to 2.3 percent. However, another study looking at the impact of MCL found regulation was associated with a 0.40 percentage point increase (from 3.99 percent to 4.39 percent) in the probability of not earning a high school diploma after completing the 12th grade (Plunk, et al., 2016).

Perceptions of harm risk for those aged under 18 years old

This indicator measures the perceptions of harm risk of cannabis use in youth aged 12-17 years, similar to the adult measure in section 4.2.7.

Table 4.3 Changes in perceived harm risk 12-17 year olds, 2002-2014

	2002 (%)	2014 (%)
Perceived great risk from smoking cannabis once a month	32. 4	22. 9
Perceived great risk from smoking cannabis once or twice a week	51. 5	37. 4
Perceived no risk from smoking cannabis once a month	8. 6	17. 6
Perceived no risk from smoking cannabis once or twice a week	5. 0	13. 0

Source: Azofeifa, et al. (2016)

Table 4.3 shows the changes in perceived harm risk for youth. The perception of risk is inversely associated with the prevalence of use, in that youth see smoking cannabis as less risky but are also smoking cannabis less. It may be that changes in legislation may need more time to be reflected in measurable changes in cannabis use among youth. In addition, despite increased perceptions of no risk from cannabis use, perceived availability (i.e., fairly easy or very easy to obtain cannabis) among 12–17 year olds has decreased in states with legislation (Johnston, et al., 2019). This could explain the lower prevalence of cannabis use and the static age of initiation.

Acute medical outcomes for those aged under 18 years old

Hospital bed night and ED visit data is available from MoH datasets. However, the numbers are so small as to risk identifying individuals so this data has been left out of the baseline and benchmark models. As with calls regarding adults to the NPC, there was insufficient data on calls regarding youth and children.

Although the literature does not show evidence of fatal cannabis exposures (in children, youth or adults), acute symptoms in children can include lethargy, ataxia, dizziness, and respiratory depression (NASEM, 2017). A retrospective study in Colorado found hospital and Regional Poison Center (RPC) visits for paediatric (children aged 0-9 years) cannabis increased significantly and at a higher rate than the rest of the USA after legalisation. During 2009 through 2015, 81 children (median age, 2.4 years) were evaluated for cannabis exposure at the hospital, with the rate of cannabis-related visits increasing significantly from 1.2 per 100,000 people in the two years before legalisation to 2.3 in the two years after. Among 62 children for whom cannabis exposure was the primary diagnosis, 22 (35 percent) were admitted overnight (hospital bed night vs ED), with two requiring respiratory support. Known cannabis products involved in the exposure included 30 infused edibles (48 percent).

Findings were similar at the RPC, which received 163 cases during the study period. Most children (74 percent) had no or minor effects. Annual RPC paediatric cannabis cases increased more than five-fold from 2009 (9) to 2015 (47). For 10 exposure cases (nine percent), the product was not in a child-resistant container; for an additional 40 cases (34 percent), poor child supervision or product storage was reported. Edible products were responsible for 51 cases (52 percent).

Over this time, the mean number of cases received by poison control centres increased at a significantly higher rate in Colorado than in the rest of the USA (34 percent versus 19 percent per year). Although the number of paediatric exposures to cannabis reported to the National Poison Data System was low, the call rate related to cannabis exposure increased from 2005 to 2011 in states that had passed cannabis legislation (Wang, et al., 2014). There were 985 unintentional cannabis exposures reported from 2005 through 2011 in children aged nine years and younger: 496 in non-legal states, 93 in transitional states, and 396 in decriminalised states. The authors found the call rate in decriminalised states increased by 30.3 percent, while transitional states increased by 11.5 percent. They did not report any increases in non-legal states.

More recent research in Colorado indicated there was a spike in the number of cannabis exposures reported to poison control immediately after the recreational cannabis was legalised with 110 calls in 2012 and 223 in 2014. Total increases across all ages stabilised during 2014-2017. However, in the eight year-old and younger age group, the increase persisted with 16 calls in 2012 and 64 in 2017. For those aged 9-17 years, calls numbered 30 and 47 respectively.[20]

[20] https://www.colorado.gov/pacific/cdphe/marijuana-health-effects-poison-center-calls

Cannabis-related crime rates for those aged under 18yrs

The baseline and benchmark models include justice-related data for those aged 17-20 years of age, including warnings, charges, convictions, and related costs. Youth offenders under the age of 17 are not subject to the same penalties as adults. Youth justice data for those 10-16 years is so small to be identifiable and is not present in the model. Overall illicit drug offences in any court numbered 54 in 2009, decreasing to 15 in 2018.[21] Illicit drug offences remained at one percent of total offences during this time.

Post-legalisation research from Colorado showed the total number of youth (10-17 years old) cannabis arrests decreased from 3,168 in 2012 to 2,655 in 2017, with a corresponding arrest rate decrease from 583 per 100,000 people 10–17 years old in 2012 to 453 in 2017 (Figure 4.3). There were differences in trends based on gender and ethnicity. The arrest rate for Black youths (642 per 100,000) was above that of Whites (517 per 100,000) and Hispanics (369 per 100,000). The most common type of youth cannabis arrest was possession, with 90 percent of these arrests in 2017. This is a similar rate to the adult population post-legalisation.

Figure 4.3 Youth cannabis arrests in Colorado, by demographics and crime type, 2012–2017

	Number of marijuana arrests					
	2012	2013	2014	2015	2016	2017
10 to 17 years old						
Total	3,168	3,030	3,325	2,956	2,615	2,655
Race						
White non-Hispanic	2,146	1,961	1,984	1,803	1,613	1,703
Hispanic	767	773	972	858	741	733
Black non-Hispanic	202	258	318	263	221	172
Other	53	38	51	32	40	47
Gender						
Male	2,478	2,318	2,451	2,185	1,882	1,904
Female	690	712	874	771	733	751
Drug crime type						
Sales	41	44	52	23	35	40
Smuggling	2	1				
Possession	2,859	2,731	3,127	2,335	2,321	2,171
Production	5	4	3		5	3
Unspecified	328	345	218	123	140	190

Source: Colorado Bureau of Investigation, National Incident-Based Reporting System

In California, arrests for cannabis related possession for youths fell from 14,991 in 2010 to 5,831 in 2011 after legislation was enacted, a 61 percent difference (Males, 2012). The author noted cannabis felonies (supply, distribution, etc) fell from 2,206 to 1,952, a 12 percent reduction. California's 2010 law did not legalise cannabis, rather reduced "simple" possession of less than one ounce from a misdemeanour to an infraction (an instant fine of US$100). The law does not have an age limit so it also applies to youths. It is still a misdemeanour for anyone to possess any amount of cannabis on school grounds, regardless of age.

[21] https://www.justice.govt.nz/justice-sector-policy/research-data/justice-statistics/data-tables/#cyp Retrieved 21 June 2019

Child safety

Oranga Tamariki were unable to provide data on the number of children being supported by the agency due to either parental cannabis use, or cannabis use by the child/youth. Youth'12 data indicated those with very high levels of substance use (including cannabis, alcohol, and tobacco) were more likely to have witnessed or directly experienced violence or sexual abuse (Fleming, et al., 2014). Dubowitz, et al., (2016) supports this data in a USA context, showing that extensive maltreatment was associated with cannabis use by youths.

USA research examining the relationship between MCL use by parents and child maltreatment found legislation was associated with an increase in the reporting of child maltreatment initially, with decreases over time (Vijay, 2016). The author found that while reported abuse increased in states with mandatory arrest laws, the true incidence of maltreatment fell. In particular, physical abuse rates declined with 0.55 fewer children (per 1,000 children) experiencing physical abuse relative to states without MCLs, a decrease of 21.4 percent against the sample mean of 2.56 per 1,000. Child fatality rates as a result of abuse or neglect decreased in states with MCL, with 0.85 fewer child fatalities compared to the mean child fatality rate of 1.84 per 100,000 children. However, the neglect rate increased with 0.75 more children per 1,000 in states with MCL, compared to the mean of 6.94 children per 1,000.

Vijay noted that the estimated effect of increased reporting and arrest rates may not just reflect changes in reports of maltreatment, but also changes in arrests conditional on police receiving a report. For example, parents who use medical cannabis are more likely to be subject to a child neglect inquiry since social workers may determine that cannabis use would substantially impair a parent's judgement and ability to care for their children's basic needs. If Child Protection Services and courts instruct that parental usage of medical cannabis consistently places the child at a substantial risk of harm, officers are more likely to arrest these parents. Therefore, the positive effect came largely from the increase in the reporting and investigation of cases of child neglect. The systemic impacts of cannabis policy in a New Zealand context would need to be considered, particularly in relation to the operations of Oranga Tamariki.

Adverse neonatal outcomes

This indicator was also identified through international research, alongside concerns expressed in the regulatory paper on adverse outcomes for babies whose mothers use cannabis while pregnant. We were unable to access New Zealand data on any differences between babies whose mothers smoked cannabis during pregnancy (compared to those whose mothers did not smoke cannabis) in mean birth weight, admission to a neonatal intensive care unit (NICU), and Apgar scores. In order to effectively measure this indicator, actual cannabis use by pregnant women must be measured.

Agrawal, et al. (2019) found self-reported rates of pre-regulation cannabis use during pregnancy are typically low (3-6 percent). However, urinalyses suggest considerable under-reporting (Ryan, Ammerman & O'Connor, 2018). Recent SAMHSA research indicates an increase in cannabis use overall, from 3.4 percent of pregnant women aged 15-44 years old in 2015, to 7.1 percent in 2017 (SAMHSA, 2017). Daily or near daily use has increased from 1.2 percent to 3.1 percent of pregnant women over that time.

Cannabis is increasingly being used by pregnant women for nausea and vomiting. Nausea is a medically approved indication for medicinal cannabis use in some USA states with MCL, and none of the states with MCL list pregnancy as a contraindication (Volkow, Compton & Wargo, 2017). Young-Wolff, et al. (2018) found women were two to four times more likely to use cannabis while

pregnant if they experienced nausea and vomiting, than women who did not experience nausea and vomiting.

International research does identify some data limitations to consider should data become available. There is insufficient research on pregnant women in this space due to ethical concerns, and increased honesty may skew any post-regulation results. In addition, women who use cannabis more frequently are also more likely to use higher amounts of tobacco and other drugs. It is also difficult to adjust for other confounders, i.e., age, emotional stressors, employment status, etc. Some of these variables have adverse neonatal outcomes as defined by the indicator, particularly tobacco use in relation to lower birth weight (Agrawal, 2019; Ryan, Ammerman & O'Connor, 2018).

4.4 Social capital

4.4.1 Safety and security domain

Indicators within the Living Standards Framework (LSF) safety and security wellbeing domain include:

- Safety and security, such as feeling safe or unsafe, victims of crime, neighbourhood problems
- Intentional homicide rate
- Domestic violence rate
- Workplace accident rate
- Cannabis-related crimes, including systemic costs.

Safety and security

Safety and security self-report measures from the New Zealand General Social Survey (NZGSS) include:

- Feeling unsafe/safe at home alone at night, walking home after dark, using public transport or doing online transactions
- Whether or not a victim of crime in the past year
- Level of problems with vandalism, burglaries, assaults, harassment or drugs in neighbourhood.

There is no connection to the NZGSS indicators of safety and security, and cannabis use; there is no indication of the relationship between cannabis and these measures, and the term used in the showcard on neighbourhood safety ("people using or dealing drugs") is too broad to be attributable to cannabis use or sale/supply (Statistics New Zealand, 2016). However, research suggests a relationship between neighbourhood characteristics, such as social cohesion, safety, residential stability, and unemployment rate, with cannabis initiation and use (Lin, et al., 2012; Tucker, et al., 2013).

Intentional homicide

The intentional homicide indicator in the LSF is defined as *Deaths caused by assault, age-standardised rate per 100,000 people* and is obtained from the MoH Mortality Collection. Intentional homicide is a leading cause of avoidable mortality or unnatural death, alongside suicide and fatal traffic accidents, discussed earlier. The Mortality Collection data records cause of death,

and will identify those who with F12 or T407 ICD-10 diagnosis codes or a "Cannabis involved" value. However, it does not identify whether the perpetrator has a cannabis dependency diagnosis or had used cannabis prior to the event. A New Zealand Police (2018) report on homicide data provides descriptive statistics on:

- Who has been killed
- The relationship between the victim and offender
- What type of location people were killed in
- What type of weapon (if any) was used.

The report does not provide descriptions of offenders, nor does the official statistics website.[22] As a result it is difficult to ascertain what proportion of homicides were committed under the influence of cannabis. There is no international research showing any changes in homicide rates post-regulation.

Domestic violence

The domestic violence indicator is sourced from the New Zealand Crime and Safety Survey (NZCASS) conducted by the Ministry of Justice (MoJ). The indicator is described as *Percentage of adults who were victims of family violence.* The NZCASS excludes types of crimes that have no direct victim, e.g., illicit drug offences, and does not identify where cannabis use may have contributed (MoJ, 2015). As with the intentional homicide rate, there is no gauge of what proportion of domestic violence incidences were committed under the influence of cannabis. Therefore, the NZCASS was not suitable for assessing levels of cannabis-related crimes that are not possession, supply, or manufacturing, where cannabis use may be a factor. This indicator does not include child victims of family violence, which is a gap in the measure.

There has been no international research specifically on domestic violence rates post-regulation or between regions with differing regulation models. Research on intimate partner violence (IPV) conducted over the time legislation has been enacted in the US, does not control for the legal status of cannabis. The body of research over this time is conflicting, with Smith, et al. (2014) finding cannabis use was inversely associated with IPV among married couples, while Shorey, et al. (2018) observing cannabis use was positively associated with all forms of IPV among men who were arrested for domestic violence. An earlier study supports this finding, with consistent cannabis use at adolescence being predictive of IPV (OR=2.08) or increasing the risk of IPV (OR=1.85) (Reingle, et al., 2012). However, these studies all had data or methodological limitations that impact the generalisability of their findings.

Workplace accident rates

This indicator is the sourced from Accident Compensation Corporation (ACC) claims data and reported by Statistics New Zealand as the *Number of work-related injury claims per 1,000 full-time equivalent employees (FTEs).* To make this specific to cannabis use, data was requested from ACC on the number of work-related claims where cannabis is attributable. ACC advised this dataset was so small as to risk identifying individuals. Therefore, this indicator is not included in the baseline or benchmark.

[22] www.policedata.nz

International research indicates that testing positive for tetrahydrocannabinol (THC) does not indicate someone was impaired at time of accident as it remains in the system for some time, and there is no indicator for acute impairment. No consensus currently exists around the length of time someone should wait between consuming cannabis and engaging in safety-sensitive work. There is also no research with control groups either between United States of America (USA) states with differing legislation or between cannabis users and non-users in similar sectors or environments. Research looking at multiple studies found insufficient evidence between cannabis use and workplace accidents or injuries (NASEM, 2017). Goldsmith, et al. (2015) stated that, "Correlating impairment with urine levels of parent or metabolite, as is often used in workplace testing, is entirely unreliable".

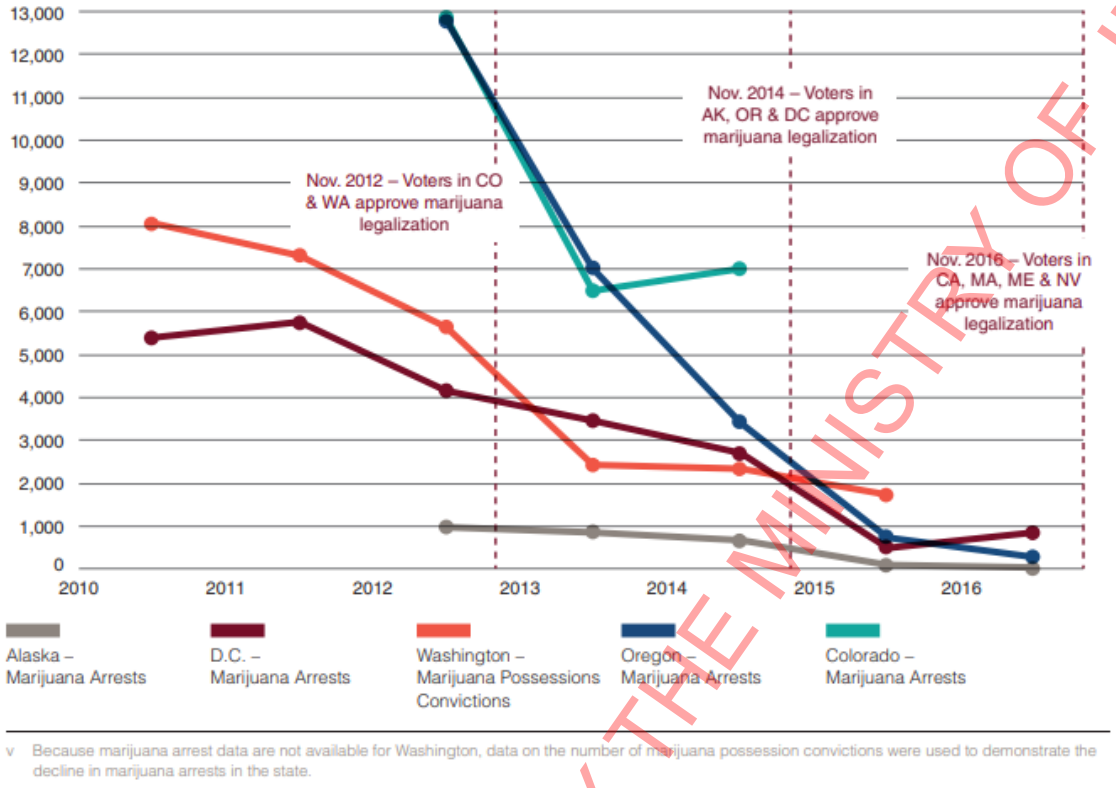
Research on workplace fatalities in USA states with medical cannabis legislation (MCL) found that the change in regulation was associated with a 19.5 percent reduction in the expected number of workplace fatalities among workers aged 25-44 (incident rate ratio (IRR)=0.81), with a negative, but not statistically significant association for those aged 16-24 (Anderson, Rees & Tekin, 2018). The negative association for 25-44 year olds persisted and increased over time with a 33.7 percent reduction in the expected number of workplace fatalities (IRR=0.66). There were larger reductions in states where pain was a qualifying condition for accessing medical cannabis. The researchers noted further research was required as to whether substitution effect (with alcohol or other substances) was a factor in the reductions.

Cannabis-related crime rates

This range of indicators measures the incidence of crimes related to cannabis importation, manufacture, sale or possession. These figures were easily obtainable from relevant government agencies and are likely to be considerably easier to track than health data due to this ease of access. Cost figures are available from New Zealand Police, MoJ, and the Department of Corrections, and these have been included in the baseline and benchmark models.

The widest range of international evidence to support post-regulation trends is for crime indicators. In the USA, the number of arrests and court cases associated with cannabis-related offences have declined substantially in states that have legalised or decriminalised cannabis. Figure 4.4 shows the decline in the number of arrests or convictions across several jurisdictions. Each jurisdiction has a different regulatory structure, but largely, legalisation has focused on personal possession and use of cannabis. The decline in arrests or convictions for distribution, manufacturing and cultivation has occurred as a result of retail availability. A report by the Drug Policy Alliance (2018) suggested that by no longer arresting and prosecuting possession of small quantities and other low-level offences, such as home cultivation, states were saving hundreds of millions of dollars in cannabis enforcement. In addition, there is a significant social impact on individuals who are no longer being stopped, arrested, charged or convicted.

Figure 4.4 Annual cannabis arrests or convictions by USA state (2010 to 2016)



v Because marijuana arrest data are not available for Washington, data on the number of marijuana possession convictions were used to demonstrate the decline in marijuana arrests in the state.

Source: Drug Policy Alliance (2018).

Table 4.4 illustrates the year-on-year conviction changes in Colorado, where cannabis was legalised in 2012. There is an immediate decline the following year, with the trend continuing in 2014. This trend reflects the number of charges recorded in the justice system, and may not reflect cannabis-related offences that did not lead to prosecution or sentencing. Data on warnings for possession is not easily available. Possession charges were 85 percent of all charges in 2010, and 94.4 percent in 2014.

Table 4.4 Cannabis charges in Colorado courts* (2010 to 2014)

Year	Possession	Distribution	Cultivation	Total
2010	8,736	1,077	423	10,236
2011	8,501	987	415	9,903
2012	8,978	930	419	10,327
2013	2,739	553	144	3,436
2014**	1,922	23	91	2,036
Change '10-'14	-78. 0%	-97. 8%	-78. 4%	-80. 1%

**Does not include all possession data for Denver because of differences between local ordinances and State Criminal Code*
***pro-rated based on data for 49 weeks*
Source: Colorado Judicial Branch

Data from the Colorado Bureau of Investigation's National Incident-Based Reporting System[23] reveals that the arrest rate per 100,000 for 10-17 year olds has remained constant from 2012, while the arrest rate for those 18-20 has declined by around a third, and by over 80 percent for those 21 years or older.

Table 4.5 Cannabis incidents in Washington State by crime type (2012 to 2015)

Year	Possession or consumption	Distribution or selling	Cultivation or Manufacturing	Total
2012	5786	327	127	6336
2013	2373	194	84	2689
2014	2103	126	62	2326
2015	1999	198	47	2313
Change '12-'15	-65. 5%	-39. 4%	-63. 0%	-63. 5%

Source: Forecasting and Research Division, Washington State Office of Financial Management. Monitoring Impacts of Recreational Marijuana Legalization: 2016 Update Report. Olympia; 2017.

A similar situation exists in Washington State where cannabis legislation was also enacted in late 2012. At that time, possession or consumption incidents made up 91.3 percent of all incidents, decreasing to 84.4 percent in 2015 (Table 4.5). The first non-medical cannabis retail stores opened in 2014, seeing an uptick in distribution or selling incidents that year as a retail structure was established.

In Washington State, it is a misdemeanour for those under 21 to possess cannabis. Despite this, among this age group, possession convictions declined 28.9 percent from 1,015 convictions in the first three months of 2012, to 722 in the first quarter of 2013, the first quarter following the legislation (Darnell & Bitney, 2017). For those over 21, possession of more than one ounce is a misdemeanour, and these changes declined to zero over the same time period. Misdemeanour charges for "paraphernalia" also dropped substantially after legislation.

Racial inequalities endure after regulation overseas

Within the justice system, Māori are more likely to be apprehended, charged and given a prison sentence for cannabis related offences, with police contact rates for Māori three times that of non-Māori on the basis of equivalent usage (Department of Corrections, 2007). The same report indicates ethnicity in and of itself had an influence on drug policing, with Māori offenders twice as likely to be subject to police attention.

The report also stated that the over-representation of Māori in criminal justice statistics relates to increased and cumulative early-life disadvantages, and this is cyclic and systemic in nature. An additional issue for Māori regarding the inequality of justice outcomes, is that they are less likely to benefit from the Clean Slate scheme due to being more likely to receive prison terms for the same cannabis offences as non-Maori, hence the consequence and social stigma may be life-long.

[23] https://coloradocrimestats.state.co.us/tops/

Therefore, the higher rates of low-level cannabis convictions within Māori communities has a disproportionate effect on employment and income rates, as well as whānau cohesion.[24] Areas with high Māori population rates, such as the East Coast and Northland, experience the negative impacts of the resulting economic and social disenfranchisement profoundly.

Consequently, it is relevant to consider whether racial inequalities have endured after cannabis legislation was enacted in overseas jurisdictions. Overall, USA research suggests a decrease of cannabis-related arrests and convictions in general but not a decrease of racial inequalities (Drug Policy Alliance, 2018). Pre-legalisation data shows that African-Americans/Blacks were 2.8-3.9 times more likely to be arrested for cannabis possession despite similar use patterns across ethnic groups (Edwards, Bunting & Garcia, 2013). The same research reported that racial disparities in arrests and convictions for cannabis-related crimes have grown significantly worse post-regulation. In counties with the worst disparities, African-Americans/Blacks were as much as 30 times more likely to be arrested. These inequalities existed across regions, income areas, and populations.

The research suggested that the persistence, or sometimes worsening, of racial inequality indicated inequitable policing practices, such as over-policing low-income neighbourhoods, racial profiling, etc., and this minimised positive potential of regulatory changes for some population groups. Gettman (2015) supported this suggestion, stating that in Oregon, "These data indicate that while the number of marijuana possession arrests has dropped, the law enforcement practices that produce racial disparities in such arrests have not changed since the passage [of Amendment 64]".

Data on specific areas includes:

- Washington, D.C. – arrest rates for possession per 100,000:[25]
  - 2010 – Black 1,109.8; White 151.6; Other 27.0 (41.1:5.6:1)
  - 2015 (year legislation went into effect) – Black 16.6; White 2, Other 1.6 (10. 4:1.25:1)
  - 2016 – Black 8; White 2; Other 3.2 (4:1:1.6)
- Colorado - arrest rates among African Americans/Blacks compared to Caucasians in 2015:
  - Possession – 2:1
  - Cultivation – 2.5:1
  - Distribution – 5.4:1 (Gettman, 2015)
- Oregon - age-adjusted rates of cannabis-related arrests for African Americans/Blacks 2-3 times the rate of Caucasians over 2010–2014; 2015 arrest rate for African Americans/Blacks 77 percent higher (Oregon Public Health Division, 2016)
- Washington State – cannabis court filings per 100,000 people aged 21 years and older:
  - 2012 – White 106; Black 286 (1:2.7)
  - 2013 (year legislation went into effect) – White 2; Black 5.6 (1:2.8).[26]

Statistics indicate the situation is much the same across the USA (Drug Policy Alliance, 2018). Some jurisdictions in the USA are expunging cannabis-related convictions incurred prior to

[24] Noting that this implies not only social capital implications, but also impacts on the human as well as the financial capital dimensions of the Living Standards Framework.
[25] Source: Census Quick Facts; Metropolitan Police Department.
[26] https://www.aclu-wa.org/news/court-filings-adult-marijuana-possession-plummet

legalisation, given the impact those convictions have on job and education opportunities for ethnic/racial minorities (Edwards, Bunting & Garcia, 2013).

4.4.2 Trust

Similarly to the safety and security domain, generalised trust is an important factor in social cohesion and a key indicator of social capital (Paxton, 1999). A relevant indicator for generalised trust in people can be found in the LSF within the *Civic and governance* domain. This indicator is sourced from NZGSS responses to the generalised trust showcard that asks, "...in general how much do you trust most people in New Zealand?" (Statistics New Zealand, 2016). As with the safety and security indicators, there is no connection between the NZGSS indicator of trust and cannabis use. Therefore, there is no data to indicate levels of generalised trust in cannabis users. However, research suggests a relationship between low generalised trust and cannabis use (Lindström, 2004).

Lindström found that low generalised trust was significantly and positively associated with cannabis use among both genders. For women with low social capital (low generalised trust and low social participation) also had a significantly higher proportion of cannabis use (OR=1.6). And for men aged 18-34 years, cannabis was positively associated with low generalised trust and high social participation (OR=1.8), the combination of which is described as the "miniaturisation of community". High social participation or high trust by themselves are not associated with cannabis use.

Miniaturisation of community can be considered "an indirect measure of the ideologically and culturally increasingly narrow forms of social participation that excludes generalised trust to other people" (Lindström, 2003). Lindström also identified this feature among intermittent smokers (2003) and high alcohol drinkers (2005), indicating those with these personality traits are more likely to indulge in substances with health-related harms.

4.5 Natural capital

The environmental impact of commercial-scale cannabis cultivation has not been studied widely. Initial studies out of California, where by some estimates 60 to 70 percent of cannabis consumed in the USA is grown, indicate cannabis production causes environmental damage.

One study found that planting cannabis for commercial production in remote locations increased forest fragmentation, stream modification, soil erosion and landslides (Wang, Brenner, & Butsic, 2017). Brenner noted, "Cannabis leaves a small spatial footprint but has potentially significant environmental impacts. To mitigate these impacts, policymakers and planners need to enact specific environmental and land-use regulations to control cannabis crop expansion during this early stage in its development". The research used a per-unit-area analysis of landscape change comparing the effects of cannabis growing to those of timber harvest from 2000 to 2013. On a per-unit-area basis, the areas with cannabis resulted in 1.5 times more forest loss and 2.5 times greater fragmentation of the landscape, breaking up large, contiguous forest into smaller patches and reducing wildlife habitat.

Under current law in California, the size of outdoor cannabis production is capped to one acre per parcel, in order to prohibit the development of industrial-scale cannabis operations outdoors. Wang, Brenner and Butsic (2017) noted an unintended consequence of this may be small dispersed cannabis plots that edge out wildlife, and create fragmented landscapes from the inside out, as cannabis plantations are often placed away from roads and other human infrastructure.

An earlier study observed that the majority of cannabis in California is grown outdoors, and was a water- and nutrient-intensive crop that was associated with land clearing, road building, habitat conversion, diversion of surface water, and agrochemical pollution (Carah, et al., 2015). The study identified that cannabis was twice as water reliant than wine grapes, a major irrigated crop in the north coast region, estimated to use a mean of 271m litres of water per square kilometre (km2) of vines per growing season. In comparison, cannabis is estimated to use 3b litres per km2 of greenhouse-grown cannabis per growing season, and 430m litres per km2 of outdoor-grown cannabis per growing season. These estimates were based on documented planting densities in greenhouses (900,000 plants per km2) and outdoors (130,000 plants per km2).

Cannabis crops are tested for pesticide levels in the USA, with one testing company saying that as recently as last year (2018), nearly 25 percent of the cannabis it tested had too much pesticide in it; in 2019 the fail rate for excessive pesticides has dropped to less than three percent.[27]

Mills (2012) reported that legalised indoor cannabis-growing operations accounted for one percent of total electricity use in the USA, at a cost of US$6bn per year. Annually, such consumption produces 15m tons of greenhouse gas emissions (CO2), equal to that of three million average cars. The author noted cannabis production is energy intensive in places like Colorado, with 24-hour indoor lighting rigs, heating, ventilation and air-conditioning systems at grow sites. Mills said a single cannabis cigarette represented two pounds of CO2 emissions, an amount equal to running a 100-watt light bulb for 17 hours. One indoor grower stated their power bill was around US$4,000 monthly.[28]

Boulder Colorado County has a “Marijuana Energy Impact Offset Fund”, which is used to educate and finance sustainable cannabis growing in the County, such as installing energy monitors at grow facilities.[29] Commercial cannabis growers are required to either offset their electricity use with renewable energy, or pay a 2.16c charge per kilowatt-hours (kWh). The County noted that the average electricity consumption of a local 5,000 square foot indoor grow facility is about 41,808 kWh monthly, while the average consumption for non-cannabis commercial use of that space is 5,750 kWh monthly. For comparison, the average electrical consumption of a local household in Boulder County is about 630 kWh monthly. The County reports that electricity consumption increased 71 percent from 5.8 Million kWh in 2015 to more than 10 Million kWh in 2016. In that same time period, the regulated cannabis growing and processing area increased from 114,197 square foot (sq. ft.) to 170,341 sq. ft., a 49 percent increase. Of that, two thirds was indoor growing and one third was in greenhouses.

4.6 Data gaps

The following data gaps and issues have been identified as a result of the international research analysis:

- Better quality measures of recent cannabis use, such as blood THC levels or urinary metabolites instead of self-reported cannabis use, are needed
- Improved measures to determine cumulative cannabis exposure, frequency of use, volume of use, method of consumption are required

[27] https://csalabs.com/blog/press/
[28] https://www.theguardian.com/society/2017/jun/20/cannabis-climate-change-fossil-fuels
[29] https://www.bouldercounty.org/environment/sustainability/marijuana-offset-fund/

- Many Statistics New Zealand data sources cannot be connected to cannabis use (NZGSS etc)
- Access to insightful and accurate health data is inadequate for current use. NZHS self-report measure of past-12mth use is an ineffective proxy for population level prevalence if looking to transfer justice costs (which are well recorded and easily accessible for monitoring, reporting and evaluation) to health costs – unable to give current diagnosis rates, service usage (primary, secondary or tertiary) or healthcare costs of harmful cannabis use, so estimating future impact is based on many assumptions. The general overreliance on NZHS for baseline data, due to it being one of the only social statistics measures to ask about cannabis use, is a risk factor
- No New Zealand health data on schizophrenia or psychosis prevalence
- No New Zealand health data on cannabis abuse or dependency disorders; NZADUS is 12yrs old, and harmful use of cannabis is used as proxy for diagnosis
- No New Zealand data on cannabis treatment programme attendance – PRIMHD data can only be accessed through the IDI, which is not a suitable approach for population level monitoring and reporting; data from ADOM is small and high level
- NPC has no New Zealand data on calls regarding cannabis exposure
- No New Zealand data on babies whose mothers have smoked cannabis during pregnancy (compared to those whose mothers did not smoke cannabis) in mean birth weight, admission to a neonatal intensive care unit (NICU), and Apgar scores
- No New Zealand data for passengers who died where driver was under the influence of cannabis but the deceased was not, where a person is deceased through intentional homicide and the perpetrator was under the influence, or whether a perpetrator had used cannabis in relation to domestic violence
- No New Zealand transport data on non-fatal transport accidents
- No New Zealand data on labour productivity, hourly earnings or workplace absenteeism
- No data on life satisfaction and cannabis use in NZGSS; CHDS data uses custom-written measure that may not compare to validated measures such as SWLS
- No New Zealand data on either perceived risk of harmfulness or the social acceptability of cannabis use
- There are minimal child or youth data on any indicators, and what is available is either not current (Youth'12 data is 7 years old) or too small a dataset to be useable due to risk of identification
- No New Zealand data on feeling safe/unsafe and cannabis use
- NZCASS is not suitable for assessing levels of cannabis-related crimes that are not possession, supply, or manufacturing, where cannabis use may be a factor; it is unclear whether its replacement, the New Zealand Crime and Victims Survey will fill this gap
- The ACC dataset on the number of work-related claims where cannabis is attributable is so small as to be identifiable
- No New Zealand data on generalised trust and cannabis use.

5 Financial viability of cannabis industry enterprises

5.1 Summary

- While labour costs are the largest fixed operating cost faced by retailers in the cannabis sector, they are only a small percentage of total annual operating costs
- The largest costs facing retailers are the variable costs of purchasing cannabis, cannabis accessories, and food and non-alcoholic beverages. These variable costs account for around two-thirds of the total operating costs for each of the retail options
- The sensitivity analysis reveals that the key parameters in the model are volume of cannabis sales, and the cannabis price paid to processors. These two parameters directly affect total revenue generated by the retailers, and the largest variable cost faced by the retailer, the purchase of cannabis products
- Licenced premises may not be financially viable in smaller minor urban areas and rural townships, due to their need for substantial numbers of customers to use their premises. It is likely that in these areas combined stores would be needed, to provide a viable business model for the sale and consumption of cannabis
- Annual per gram licensing fees would raise more revenue, than flat annual licensing fees. Large flat fees could be a barrier to entry. Given the uneven consumption of cannabis throughout New Zealand, a variable fee could be a fairer way of distributing licensing costs across the country. In addition a variable fee would mean businesses are more likely to remain financially viable if cannabis sales are lower than envisaged
- To supply the estimated 49,668,000 grams of cannabis products to be consumed each year in the legal retail market, 134 retail stores, 59 licenced premises, and 227 combined stores are estimated to be needed
- In total 207 retail businesses will be needed for the six major urban areas, while a further 94 retail businesses will be needed for the 14 minor urban areas, and 119 retail businesses will be needed for the rural townships and settlements
- In total 112 grower licences will be needed to grow the 42,217,600 grams of dried and cured cannabis bud, as well as the 7,453,000 grams of cannabis equivalent edibles and other products. These will be spread across the three types of growers, with 81 indoor licences, 17 greenhouse licences, and 14 outdoor licences
- In total 35 processor licences will be needed to process the 42,217,600 grams of dried and cured cannabis bud, as well as oil and resin required to create the 7,453,000 grams of cannabis equivalent edibles and other products.

5.2 Assumptions, limitations, and caveats

Outlined below are the major data limitations and caveats for this section of the report, these are those limitations and caveats which have the greatest impact of the findings from this research.

- It has been assumed that the percentage share of the cannabis growers market allocated to indoor, greenhouse and outdoor growing will be:
    - 50 percent indoor

  - 10 percent greenhouse
  - 40 percent outdoor
- It has been assumed that the average size of cannabis growing operations will be:
  - 1,000 square meters for indoor
  - 2,000 square meters for greenhouse
  - 10 hectares for outdoor
- It has been assumed that the licence fee per gram of dried cannabis or its equivalent will be:
  - $0.40 for cannabis growers
  - $0.40 for cannabis processors
  - $0.40 for cannabis retailers
- It has been assumed that five grams of fresh cannabis buds is required to get one gram of dried and cured cannabis
- It has been assumed that the profit margin per gram of dried cannabis or its equivalent will be:
  - $1.00 for cannabis growers
  - $0.50 for cannabis processors
  - $0.75 for cannabis retailers
- It has been assumed that the per gram retail price of dried cannabis and its equivalents will be:
  - Low THC products will have a retail price of $20 per gram (including GST)
  - Medium THC products will have a retail price of $30 per gram (including GST)
  - High THC products will have a retail price of $40 per gram (including GST)
- It has been assumed that cannabis edibles will constituent 15 percent of equivalent cannabis consumption within the legal retail market
- It is therefore assumed that the excise duty per gram of dried cannabis and its equivalents will be:
  - Low THC products will have an excise duty of $8.90 per gram
  - Medium THC products will have an excise duty of $17.60 per gram
  - High THC products will have an excise duty of $26.30 per gram
- Cannabis retail businesses will make a reasonable level of profit, given the estimated costs of operating such a business, if they are able to the sell the following cannabis amounts each year:
  - Major urban areas
    - Retail store and Combined store = 150,000 grams
    - Licenced premise = 100,000 grams
  - Minor urban areas
    - Retail store and Combined store = 110,000 grams

        - Licenced premise = 75,000 grams
    - Rural townships
        - Combined store = 100,000 grams
- It has been assumed that the market share for retail businesses will be split as follows:
    - Retail stores will sell 45 percent of the legal retail cannabis market
    - Licenced premises will sell 20 percent of the legal retail cannabis market
    - Combined stores will sell 35 percent of the legal retail cannabis market.

Minor data limitations and caveats are noted in the relevant sub-sections of this section.

5.3 Introduction

The proposed cannabis regulatory framework would see the New Zealand Government establish a legal recreational cannabis industry, through licencing of cannabis growers, processers, and retailers.

This section examines the financial viability of a legalised recreational cannabis industry. To do so this section examines:

- The cost of setting up and growing cannabis through one of three different production options (sub-section Growing (or production) 5.4)
    - Indoor growing
    - Greenhouse growing
    - Outdoor growing
- The cost of setting up and running a cannabis processor (sub-section 5.5)
- The cost of setting up and running one of three different retailing options (sub-sections 5.6 to 5.9)
    - Retail store
    - Licenced premise
    - Combined store

To enable the exploration of different circumstances, along with the uncertain operating costs and revenue that may face the cannabis growers, processors, and retailers, BERL have built a financial viability model. This model allows the user to run scenarios of the circumstances facing the three different parts of the legal cannabis market, and determine the financial viability of each part, including their sub-parts.

As it is envisaged that all sub-sectors cannabis industry (i.e. production, processing, and retailing) would comprise privately run businesses operating under licence agreements and industry regulations, it is important to understand the circumstances under which these cannabis businesses will be financially viable. This enables the regulations and restrictions to be crafted to ensure the financial viability of each part of the industry, and therefore ensure private businesses will want to be involved.

As the legal cannabis industry would be a new industry in New Zealand, there are a number of uncertainties around the full operating costs and revenue of retailers, processors, and growers. These uncertainties include the retail prices able to be charged to customers, the volume of cannabis able to be sold, capital costs in setting up a cannabis business, the price paid to cannabis processors, labour requirements, and fit out requirements.

Within the growers section of the proposed new cannabis industry, three different growing approaches are available. These are indoor using hydroponics and artificial lights, in greenhouses using hydroponics, and outdoors. While within the processors section of the proposed new cannabis industry there is only a single approach to drying and curing the cannabis buds. This only leaves the question of the size and volume the processor can process each year.

Within the retail section of the proposed new cannabis industry, three different retail options have been mooted. These options are a retail store where cannabis can be purchased, a licenced premise where cannabis can be purchased in order to be consumed on site, and a combined store, which includes a retail store and a licenced premise. Before specific regulations for these outlets can be determined, a simple question needs to be answered, under what circumstances would enterprises operating in the cannabis industry be financial viable?

5.4 Growing (or production) sector

In New Zealand, cannabis will be able to be grown using one of three production options, indoor using hydroponics and artificial lights, in greenhouses using hydroponics, and outdoors. Each of these three options have their own strengths and weaknesses for growing cannabis, as are detailed below in as much detail as is available at this point of the policy development. Information on production volumes and production costs of legalised cannabis across each of the three production options has been sourced from Caulkins (2010)[30], and the American website Cannabis Business Plans[31]. All cost information from these sources has been updated to reflect current New Zealand production costs.

5.4.1 Indoor growing

Commercial indoor growing typically will take place in a large warehouse (around 1,000 square meters in size), and makes use of artificial light and targeted irrigation using hydroponics to grow cannabis plants. These cannabis plants tend to be smaller than outdoor grown plants, as the focus is on maturing the plant as soon as possible and maximising its yield of cannabis buds. For indoor growing of cannabis the following conditions and assumptions are noted:

- Indoor grown cannabis can be harvested four times a year
- Cannabis grown indoors will tend to have a higher Tetrahydrocannabinol (THC) level than outdoor grown cannabis, though THC levels will also be dependent on the cannabis cultivar grown
- Set-up costs average around $830 a square meter, this includes building improvements, growing and lighting equipment, and security systems
- Annual operating costs average around $845 a square meter
- Electricity demand will be around 530 Kilowatt Hours (kWH) per square meter each year

[30] Caulkins, J.P. (2010) *Estimated cost of production for legalized cannabis.* Drug Policy Research Center.
[31] https://cannabusinessplans.com/much-cost-grow-cannabis-indoor/

- On average 20 percent of the indoor space is required for walkways and equipment
- An average of 262 grams of dried cannabis can be produced each year per square meter
- Each cannabis plant will need around 3,000 litres of water during its lifecycle.

5.4.2 Greenhouse growing

Commercial greenhouse growing typically will take place in a large greenhouse (around 2,000 square meters in size), and makes use of natural light, plus some additional artificial light, and targeted irrigation using hydroponics to grow cannabis plants. These cannabis plants tend to be smaller than outdoor grown plants, as the focus is on maturing the plant as soon as possible and maximising its yield of cannabis buds. For greenhouse growing of cannabis the following conditions and assumptions are noted:

- Greenhouse grown cannabis can be harvested three times a year
- Cannabis grown in greenhouses will tend to have a higher THC level than outdoor grown cannabis, but lower than indoor grown cannabis, though THC levels will also be dependent on the cannabis cultivar grown
- Set-up costs average around $850 a square meter, this includes construction of the greenhouse, growing and lighting equipment, and security systems
- Annual operating costs average around $375 a square meter
- Electricity demand will be around 88 KWH per square meter each year
- On average 20 percent of the greenhouse space is required for walkways and equipment
- An average of 131 grams of dried cannabis can be produced each year per square meter
- Each cannabis plant will need around 3,000 litres of water during its lifecycle.

5.4.3 Outdoor growing

Commercial outdoor growing typically will take place in a field (around 10 hectares in size), and makes use of natural light, and irrigation to grow cannabis plants. These cannabis plants tend to be larger than indoor grown plants, as the focus is on allowing the plant to fully mature and maximise its yield of cannabis buds, and other THC laden plant material in the one harvest per year. For outdoor growing of cannabis the following conditions and assumptions are noted:

- Outdoor grown cannabis can be harvested once a year
- 11,960 cannabis plants will be planted in each hectare, with 9 square feet per plant
- Cannabis grown outdoors will tend to have a lower THC level than indoor grown cannabis, though THC levels will also be dependent on the cannabis cultivar grown
- Annual operating costs average around $137,000 a hectare
- An average of 128,900 grams of dried cannabis can be produced each year per hectare
- Other THC laden plant material gathered during harvest will be sent to processors to turn into cannabis oil and resin
- Each cannabis plant will need around 3,000 litres of water during its lifecycle.

5.4.4 Grower parameters in model

Within the financial viability model for the cannabis market, the following are adjustable parameters for the growers market:

- Percentage share of the growers market allocated to indoor, greenhouse and outdoor growing
- Average size of growing operations
- Licence fees for growers per gram of dried cannabis in dollar terms
- Excise duty per gram of dried cannabis in dollar terms
- Conversion factor between fresh cannabis and dried and cured cannabis
- Profit per gram of dried cannabis in dollar terms.

5.5 Processing sector

In New Zealand, cannabis will need to be processed independently of growers and retailers. Therefore licenced processors will be required to dry and cure the cannabis buds for retailers to sell, and extract cannabis oil and resin from the cannabis plants for sale to retailers and secondary processors. In this section cannabis processors are detailed in as much detail as is available at this point of the policy development.

While in theory a single very large processor could process the entire New Zealand cannabis crop, to ensure geographic spread of processors and to ensure competitiveness in the market, it is best to assume that each licenced processor will be a mid-sized processor. For these mid-sized processors the following conditions and assumptions are noted:

- It will cost around $1.3 million to set-up a processor, this includes building improvements, security, and processing equipment
- Operating costs to dry, cure and process cannabis will cost around $0.83 per gram of dried cannabis, this includes drying, curing, sorting, packaging, and labelling the cannabis products
- For each gram of dried and cured cannabis, five grams of fresh cannabis buds is required
- Each processor will on average turn 5.9 million grams of fresh cannabis buds into 1.18 million grams of dried and cured cannabis ready for retail sale or to be turned into pre-rolled joints for retail sale
- Each processor will extract cannabis oil and resin from cannabis plants, which can then be supplied to either licenced secondary processors to produce edibles and vaporiser oil, or straight to retail stores for consumer purchasing.

5.5.1 Processor parameters in model

Within the financial viability model for the cannabis market, the following are adjustable parameters for the processor market:

- Average size of processor operations in square meters
- Average capacity level for processor dryers
- Licence fees for processors per gram of dried cannabis in dollar terms
- Profit per gram of dried cannabis in dollar terms

- Number of days to fully harvest a cannabis crop
- Licence fees for edible processors
- Retail price of 10 servings of edibles
- Non-cannabis costs of production for edibles
- Share of profit on edibles between manufacturer and retail, in dollar terms.

5.6 Retail sector

We examine the financial viability of three different retail options that could operate under the proposed cannabis regulations. These three retail options are detailed below in as much detail as is available at this point of the policy development.

5.6.1 Retail store

Under this option the retail store will be licenced to sell cannabis and cannabis related accessories (such as vaporisers, bongs, pipes, infusers, storage containers, grinders, and other accessories) only. These retail stores would be prohibited from selling any other good or service. In addition these stores would have the following conditions:

- Minimum and maximum operating hours set by the licensor
- Operating site to be approved by the licensor
- Secure storage area
- Secure display cabinets
- Security and alarm systems
- Purchase all cannabis product from a licenced processor
- 14 grams of dried cannabis or its equivalent per person per day purchasing limit
- Provide information on safe consumption behaviours
- A ban on all advertising
- Prohibiting the sale of cannabis in a promotional fashion (discounts, bulk purchase offers, special offers, etc)
- A minimum age of 20 to work in a retail store or hold a licence to operate a retail store
- Licence operator would need to pass a 'fit and proper person' test.

5.6.2 Licenced premises

Under this option the licenced premises will be licenced to sell only cannabis for consumption on site, and only limited sales of non-alcohol beverages and food will be permitted. In addition these licenced premises would have the following conditions:

- Minimum and maximum operating hours set by the licensor
- Operating site to be approved by the licensor
- Secure storage area

- Secure display cabinets
- Security and alarm systems
- Purchase all cannabis product from a licenced processor
- 14 grams of dried cannabis or its equivalent per person per day purchasing limit
- Provide information on safe consumption behaviours
- A ban on all advertising
- Prohibiting the sale of cannabis in a promotional fashion (discounts, bulk purchase offers, special offers, etc)
- A minimum age of 20 to work in a retail store or hold a licence to operate a licenced premise
- Responsibility to both monitor and respond appropriately to unsafe and excessive use
- Licence operator would need to pass a 'fit and proper person' test.

5.6.3 Combined store

Under this option the combined retail store and licence premises will be licenced to sell only cannabis (to be consumed on premises or taken away), cannabis accessories, and limited sales of non-alcohol beverages and food. In addition these licenced premises would have the following conditions:

- Minimum and maximum operating hours set by the licensor
- Operating site to be approved by the licensor
- Secure storage area
- Secure display cabinets
- Security and alarm systems
- Purchase all cannabis product from a licenced processor
- 14 grams of dried cannabis or its equivalent per person per day purchasing limit
- Provide information on safe consumption behaviours
- A ban on all advertising
- Prohibiting the sale of cannabis in a promotional fashion (discounts, bulk purchase offers, special offers, etc)
- A minimum age of 20 to work in a retail store or hold a licence to operate a licenced premise
- Responsibility to both monitor and respond appropriately to unsafe and excessive use
- Licence operator would need to pass a 'fit and proper person' test.

5.7 Modelled retail costs

To be financially viable each of the retail options needs to be able to cover their annual operating costs through their permitted activities. At this stage there is little known about the likely amount of sales per retail option, and the retail price of cannabis products. Examining similar retail outlets provides information on the likely operating costs.

Set out below are the main operating cost categories that all of the retail options face, though actual operating costs will depend on the retail type, their location and other market factors.

5.7.1 Labour costs

Labour costs for each of the options is dependent on a number of factors, such as the opening hours, the size, and regulations the store operates under. A retail store open for 70 hours a week, 150 square metres in size, and requiring a security guard and store manager to be on duty during open hours, will most likely have around three to five staff on duty during opening hours. At the same time a retail store open for 30 hours a week, 50 square metres in size, and with no requirement for security and management to be on duty during open hours, will most likely have around one to two staff on duty during opening hours.

Given that each store will be a different size, the model needs to be able to be adjusted for the different sizes of retail stores. Parameters are provided for the opening hours of the store, and number of staff for weekly operation, as these regulations are still unknown.

For each option modelled in this report, BERL has used international research from Canada and the United States of America (USA) on retail operation setups, together with information sourced locally on the size of available retail stores[32]. This has enabled us to make assumptions around the likely size of the retail stores, their opening hours and staffing numbers. Data from Payscale New Zealand[33] provides maximum, median and average hourly pay rates for different occupations throughout New Zealand. This has been used to inform hourly costs of staff.

Examining the three retail options using as an example a store located in a regional centre within Auckland, such as North Shore, we can assume the following setups and costs:

Retail store:

- Size = 80 square metres
- Opening hours = 9am to 8pm, seven days a week
- Employs nine staff at an annual cost of $386,000, including:
    - One manager
    - One assistant manager
    - Five sales staff, with two on duty during store opening hours
    - Two security staff, with one on duty during store opening hours

Licenced premises:

- Size = 140 square metres
- Opening hours = noon to midnight, seven days a week
- Employs 11 staff at an annual cost of $410,000, including:
    - One manager
    - One assistant manager
    - Seven sales staff, with two on duty during store opening hours

[32] Colliers New Zealand
[33] https://www.payscale.com/research/NZ/Country=New_Zealand/Salary

- Two security staff, with one on duty during store opening hours

Combined store:

- Size = 160 square metres
- Opening hours = 9am to midnight, seven days a week
- Employs 15 staff at an annual cost of $559,000, including:
  - One manager
  - One assistant manager
  - 10 sales staff, with three on duty during store opening hours
  - Three security staff, with one on duty during store opening hours.

5.7.2 Rental costs

Rental costs for each of the options is dependent on the size and location of the store. Information from Colliers New Zealand shows that currently a retail store in Auckland Central Business District (CBD) would cost between $1,250 and $4,300 per square metre annually, while a retail store in an Auckland regional centre would cost between $650 and $1,850 per square metre annually. In Wellington CBD the cost would between $1,114 and $1,527 per square metre annually, while a Wellington regional centre would cost between $700 and $1,450 per square metre annually for a retail store. This shows the large difference in rents faced by stores in Auckland compared to Wellington and other locations.

As discussed in the labour costs section, given the differing sizes of locations available for lease, we have used parameters in the model to allow for different store size. Examining the three retail options using as an example a store located in the North Shore, we can assume the following setups and costs:

Retail store:

- Size = 80 square metres
- Charged $1,850 per square metre, for being located in a prime spot
- Annual rental cost = $148,000.

Licenced premises:

- Size = 140 square metres
- Charged $1,100 per square metre, for being located in an average spot
- Annual rental cost = $155,000.

Combined store:

- Size = 160 square metres
- Charged $1,480 per square metre, for being located in a good spot
- Annual rental cost = $236,800.

5.7.3 Insurance

For insurance costings in this model, we have assumed that each retail option is a single entity operating on its own. BERL reviewed existing information from insurance companies online around the cost of small business insurance. Most insurance companies provide a bundle option for small businesses covering material damage to business assets, liability cover, employer's liability cover, and statutory liability cover. For this model BERL have used small business insurance costings from AMI[34], at $98 a month, and have added business interruption insurance, theft cover, and natural disaster cover. This takes the total monthly cost to $200 a month or $2,400 a year for insurance.

Given the nature of the three retail options, we have assumed that this insurance cost would be the same for all three options and would be the same or similar regardless of location throughout the country.

5.7.4 Electricity and internet

To estimate the likely average electricity costings for the three retail options, BERL have used information from power compare[35] to determine the average annual costings. For internet costings BERL have used information from Spark[36] on the cost of unlimited fibre internet as the basis of our costings for internet for the three retail options.

Given the information available, BERL estimates that the annual average electricity costs for each of the three retail options would be around $4,500 per year, while the annual average internet cost would be around $1,320 per year for three retail options.

5.7.5 Professional services

Professional services cover legal, accounting, human resources, and banking costs to the business. Again to determine these costs, BERL have assumed that each retail option operates as a separate store, rather than part of a larger business that will most likely be able to access these services at a lower cost per store, or may have these services in-house.

In total we have assumed that on average per year legal fees would be $5,000, accounting fees (including day-to-day accounts plus GST returns and annual reporting) would be $8,220 a year. Human resources costs would be $800 a year, and banking costs would be $600 a year. These costs are assumed to be similar across all three retail options and all locations.

5.7.6 Depreciation

Depreciation is the loss of value from equipment and capital assets as they age. In New Zealand the Inland Revenue Department (IRD) allows businesses to claim depreciation on capital goods (assets and equipment) that it owns, leases or hires. To claim depreciation the capital assets cannot be land, trading stock, franchise fees, assets that cost less than $500, and intangible assets like goodwill. Depreciation of assets can be calculated using two different methods, the diminishing value method, and the straight-line method.

For this model, we have used the straight-line method that sees capital assets depreciate by the same amount over their working life. For each retail option capital assets will include store fittings (such as display cabinets), and the security system (includes CCTV, sensors, alarms, and anti-theft

[34] https://www.ami.co.nz/business/small-retailers
[35] https://www.powercompare.co.nz/n/average-power-bill-in-new-zealand
[36] https://www.spark.co.nz/business/shop/internet/

equipment). For the licenced premises and the combined option, a ventilation system is included in the capital assets. All the capital assets have a straight-line depreciation rate of between 10.5 percent and 13.5 percent. This means that the assets will be fully depreciated in eight years, therefore we have assumed an eight year life cycle.

Given the potential differences in size and layout of each retail store, and the different ways an owner may wish to set up, it is likely that the fit out costs for a retail store will be varied. An average fit out cost of $75,000 is assumed. In addition, for licenced premises and the combined option a ventilation system to remove cannabis smoke from the outdoor smoking area of the premises will be required to comply with existing smoke-free legislation. This cost is estimated at $200,000. Fit out cost is a parameter within the model that can be changed to reflect different fit out requirements. In addition we have assumed that a security system including CCTV, sensors, alarms, anti-theft measures, and measures to decrease the risk of break-ins will cost around $100,000. Again this cost is a parameter in the model for each of the three options.

Examining the three retail options using as an example a store located in the North Shore, we can assume the following fit out, security systems and depreciation costs:

Retail store:

- Fit out = $75,000
- Security system = $100,000
- Total capital assets = $175,000
- Annual depreciation cost of capital assets = $21,875.

Licenced premises:

- Fit out = $275,000
- Security system = $100,000
- Total capital assets = $375,000
- Annual depreciation cost of capital assets = $45,875.

Combined store:

- Fit out = $300,000
- Security system = $100,000
- Total capital assets = $400,000
- Annual depreciation cost of capital assets = $50,000.

5.7.7 Product costs

Product costs for each of the three different retails options covers a slightly different range of goods. While for each option the main product cost is dried cannabis or its equivalent, each of the three different options has differing additional product costs. For a retail store this is the cost of cannabis accessories (bongs, pipes, containers, grinders, infusers, vaporisers, and other accessories). For a licenced premise this is the cost of non-alcohol beverages and food, while for combined store it is the cost of both cannabis accessories, and the cost of non-alcohol beverages and food.

Non-cannabis products

To determine non-cannabis product costs for each of the three retail options, BERL have used mark-up percentages. Mark-up percentage is the percentage difference in the retail price compared to the price the store paid for the item (often this is referred to as the wholesale price of the item).

Additional parameters are included in the model for the mark-up percentages for both non-alcohol beverages and food, and cannabis accessories. Initially we have set these at 100 percent for non-alcohol beverages and food, and 150 percent for cannabis accessories. These have been initially set at these levels because these retail options have effectively a captured market. Customers consuming cannabis at a licenced premise wanting food or drinks, will need to purchase them from the premises. This allows the retailer to increase their mark-up of these items, as customers are at these premises for the primary purpose of consuming cannabis not consuming food and drinks. For cannabis accessories a high mark-up has been used, as these retail stores will be the only places legally allowed to sell cannabis accessories. With these restrictions in place, this allows for these retail stores to charge a higher mark-up.

Cannabis

For dried and cured cannabis, BERL has estimated the cost per gram to grow, process and deliver the dried and cured cannabis or its equivalent to retail stores. These costs include profit for both growers and processors, licence fees for both growers and processors, and finally excise duties on the three different levels of THC potency products being sold in retail stores.

Overall it is estimated that excluding GST it would cost retail businesses on average:

- $13.81 for low THC products
- $22.51 for medium THC products
- $31.21 for high THC products.

Cannabis edibles

Researching what cannabis edibles are available in legal Canadian and American markets, it was noted that most edible products were sold on the basis of 10 servings, which contained 100mg of THC across the 10 servings, or 10mg of THC per serve. This was regardless of whether they were chocolate bars, candies, gummies, or other edible products.

To estimate the cost of cannabis edibles to retail businesses, BERL has made the following assumptions:

- 4ml of cannabis oil would be required per 10 servings of edibles, with 1ml of cannabis oil containing on average 25mg of THC
- It will cost $6 per 10 servings to manufacture the edibles, outside the cost of obtaining the cannabis oil
- The cannabis oil will be made from cannabis plant trim (the non-bud THC containing parts of the cannabis plant, such as leaves)
- It will cost $2,000 to turn 100 kilograms of cannabis trim into 1 litre of cannabis oil
- It will cost in total $8.80 per 10 servings for the 4ml of cannabis oil required.

Given these assumptions the initial cost of cannabis edibles will be around $14.80 per 10 servings. On top of this initial cost of producing the cannabis edibles, the secondary processor will need to generate a profit. This profit per 10 servings of edibles is a parameter of the model. It has been initially set at $7.50.

Given that the secondary processor of cannabis edibles may need to also be licenced under the proposed regulations, a licence fee of $3.5 per 10 servings has been assumed, though this licence fee is once again a parameter of the model. Altogether this makes the cost of 10 servings of cannabis edibles to the retail business $25.80.

5.7.8 Licencing costs

The exact nature of licencing costs is currently unknown, but research on licencing costs in the United States of America (USA) and Canada reveals that there are two possible approaches. The first approach is to charge a fixed annual licensing fee. This approach is used in Alberta, British Columbia, and Ontario in Canada, and the states of Washington, Colorado, Oregon, Alaska, and Nevada in the USA. Within this approach is a range of different fixed fees, with Alberta charging C$700 per year and Nevada charging US$20,000 per year for a retail licence.

The second approach is to charge a variable licencing fee, where the retail operation is charged per gram of cannabis sold or by total annual revenue of the store. This approach is used by the states of California and Michigan in the USA, where the licensing fee is based on the annual revenue of the store.

In addition to the annual licencing fee, each of the Canadian and American states charge a one-off fee of between $1,000 and $7,500 to apply for a retail licence. In New Zealand it has been stated that the barriers to entry into this new industry should not be high, so therefore it is assumed that the one-off fee for applying for retail licence will be negligible and therefore it has not been included in the model.

In terms of the annual licensing fee, both a fixed and variable option are included in the model. For the variable option this is set up to charge a fixed amount per gram of dried cannabis or its equivalent sold at the store, while the fixed option is a fixed charge per year. For both options the licensing fee is included as a changeable parameter in the model.

5.7.9 Accident Compensation Corporation (ACC) levies

The Accident Compensation Corporation (ACC) funds injury claims for all New Zealanders, to fund these injury claims ACC charges levies. Businesses pay an ACC work levy that funds ACC, and a Working Safer levy that goes to the Ministry of Business, Innovation and Employment (MBIE) to support WorkSafe's activities. The levy amount is based on the industry the business operates in, according to a risk profile.

Given that cannabis retail is not included in the industry classification used by ACC, the closest substitute industry for each of the three retail options has been used.

The substitute industries and relevant rates are the liquor retailing industry ACC levy ($0.65 per $100 of wages) and Working Safer levy ($0.08 per $100 of wages) for retail stores; the pubs, taverns and bars industry ACC levy ($0.60 per $100 of wages) and Working Safe levy ($0.08 per $100 of wages) for licenced premises and the combined store. Using this industry classification the total annual cost of ACC levies is calculated for the three retail options based on the total wage and salary bill for the retail option.

5.7.10 Goods and Service Tax (GST)

The New Zealand Government charges a goods and services tax (GST) of 15 percent on the value of goods and services sold in New Zealand. Businesses who purchase goods and services as inputs into their business can claim back the GST paid. These businesses would still need to pay the GST charged on goods and services sold.

Overall the retail businesses GST bill will be smaller than 15 percent of its total revenue, as it will claim back on the GST it has paid to suppliers. Eventually the New Zealand Government would get the full 15 percent of total revenue from cannabis retailers, but to do so it will need to gather the relevant GST from all of the businesses supplying the goods and services to the cannabis retail businesses.

To simplify this process GST payments on the operating costs of the business have been ignored, while GST has been included in the operating revenue of the business. This allows us to determine the overall GST amount going to the New Zealand Government generated by the retail businesses sales. Of course in reality this amount would not be supplied directly by the retail business, but would rather come from a large array of businesses.

5.7.11 Other costs

Other costs include all other sundry costs of a retail business. This includes remote monitoring of the alarm system, point of sale system, banking fees, staff training, and other costs. Given the minor nature of these costs, rather than determine each item, $8,000 is allocated to cover these expenses for each of the three retail options across the country.

5.8 Modelled retail revenue

While retail operation costs can be sourced from similar retail industries, it is more difficult to gather revenue information on the likely sale of cannabis, cannabis accessories and food and non-alcoholic beverages at licenced cannabis retailers. Therefore, the model includes parameters for the total annual amount of cannabis sold, the retail price of low, medium and high Tetrahydrocannabinol (THC) products, and the number of cannabis accessories sold for retail stores. For licenced premises a parameter determines the number of customers who will buy one gram of cannabis to consume within the premises each year.

Set out below are our assumptions of the amount of cannabis being sold, by THC level and its price, the amount of cannabis accessories being sold, and the amount of food and non-alcoholic beverages being consumed each year.

5.8.1 Cannabis sales

It has been suggested that to encourage cannabis growers to grow lower potency cannabis the proposed excise tax would increase in line with the level of THC. This would mean that higher THC cannabis would also have a higher retail price.

Accordingly it is assumed:

- Low THC would have a retail price of $20 per gram (including GST)
- Medium THC would have a retail price of $30 per gram (including GST)
- High THC would have a retail price of $40 per gram (including GST)

- Edibles will have a retail price of $33.50 for 10 servings (including GST)[37]
- Edibles will constituent 15 percent of equivalent cannabis consumption
- The relative changes in price between the three potency of cannabis products will alter the share of the market each will command. As part of this it is assumed that higher potency cannabis will never sell for less than lower potency cannabis
- That regardless of the price changes that there will be a minimum of five percent of the market that will purchase medium and high THC cannabis.

Overseas cannabis retailers sell pre-rolled cannabis joints as well as dried cannabis. It is assumed that between 15 and 25 percent of the dried cannabis sold at the retail store will be in pre-rolled joints. If these pre-rolled joints are sold at 150 percent mark-up on the dried cannabis, low THC pre-rolled would be sold at $25 a gram.

From information provided, it is likely the government will seek to limit the number of retail stores per urban area, to avoid a proliferation of such stores. A substantial number of retail stores, licenced premises and combined stores will be permitted across the country to ensure access to everyone. It is assumed the following volumes of cannabis will be sold per each retail option, in each of the three broad areas of New Zealand:

- Major urban areas
  - Retail store and Combined store = 150,000 grams
  - Licenced premise = 100,000 grams
- Minor urban areas
  - Retail store and Combined store = 110,000 grams
  - Licenced premise = 75,000 grams
- Rural townships
  - Retail store and Combined store = 100,000 grams
  - Licenced premise = 75,000 grams.

At these volumes Auckland could have 38 combined stores, 49 retail stores, and 32 licenced premises to cater for the estimated 16,220,000 grams (see Table 5.9) consumed by people over 20 each year in the city. While smaller urban areas such as Taupō or Nelson would only be able to sustain a small number of combined and retail stores.

5.8.2 Accessory sales

It is expected that retail stores and combined stores would be able to legally sell cannabis accessories as well as dried cannabis and its equivalents. Accessories available through the Ontario online cannabis store[38], the state government's official store, demonstrates the wide array of accessories potentially available. These include a wide array of bongs, pipes, humidity controlled storage containers, cleaning supplies, vaporisers, grinders, and infusers. Retail prices of these items from the website, minus Canadian sales tax provides a guide on the average price of these cannabis accessory items.

[37] This is based on current average retail prices for edibles in Canada and the United States of America, converted into New Zealand dollars.
[38] https://ocs.ca/

Retail stores and combined stores would be the only places in New Zealand to legally purchase many of these accessory items. This means the stores would be able to charge a high mark-up for the items. We have assumed a 150 percent mark-up on these items. Given a lack of information on the likely amount of these items to be sold and the wide range of prices within each category, the following assumptions are relied on:

- 15 bongs per 1000 grams each year will be sold at an average price of $79.50 (including GST)
- 15 pipes per 1000 grams each year will be sold at an average price of $48.40 (including GST)
- 20 storage containers per 1000 grams each year will be sold at an average price of $57.10 (including GST)
- 12 vaporisers per 1000 grams each year will be sold at an average price of $157.80 (including GST)
- 5 infusers per 1000 grams each year will be sold at an average price of $265.80 (including GST)
- 30 grinders, cleaners and other accessories per 1000 grams each year will be sold at an average price of $23 (including GST).

All of these assumptions can be altered in the model as they have been setup as parameters within the model.

5.8.3 Food and non-alcoholic beverage sales

It has been suggested that licenced premises and combined stores would be able to legally sell food and non-alcoholic beverages as well as dried cannabis or its equivalents for consumption on the premises. The sale of food and non-alcoholic beverages would be limited for these premises, as the primary focus would be on responsible consumption of cannabis. Limiting the sale of food and non-alcoholic beverage would prohibit cafes that exist to primarily sell food and beverages from being permitted to allow the consumption of cannabis onsite.

It is envisaged that the non-alcoholic beverages available for purchase within these premises would include items such as tea, coffee, soft drinks, juices, and other non-alcoholic beverages. While the food available would consist of pre-packaged food items, rather than food items that are cooked or prepared onsite.

Given the lack of information on the likely consumptive patterns of cannabis consumers on these licenced premises, we have made the following assumptions:

- 60 percent of all customers will purchase a coffee at an average price of $5 (including GST)
- 35 percent of all customers will purchase another non-alcoholic beverage item at an average price of $4 (including GST)
- 60 percent of all customers will purchase food items such as potato chips, biscuits, and chocolate, at an average price of $3 (including GST)
- 30 percent of all customers will purchase food items such as meat pies, sandwiches, and muffins, at an average price of $6 (including GST).

All of these assumptions can be altered in the model as they have been setup as parameters within the model.

5.9 Model results for retailing options across three locations

Given the costs and revenues for each of the retail options laid out in the previous two sub-sections, it is important to show how these modelled costs and revenues work in specific locations. To showcase the financial viability model we have assessed the costs and revenues for retailers in three different locations. Location one is in a major urban area, location two is in a minor urban area, and location three is in a rural township.

For each location the sensitivity around three of the major assumptions within the model is demonstrated. Results for location one are sensitive labour costs; for location two sensitivity to the total volume of cannabis sold is tested; and for location three it is the retail mark-up (difference in the price paid to processors and the retail price) that is critical.

5.9.1 Location one – major urban area (e.g. Auckland)

Location one focuses on the financial viability of the three retail options in a major urban area. Auckland has been chosen as the location for this scenario, as it has the highest population in the country and likely the highest total volume of consumption in the country.

Location assumptions

The main parameters for this location are as follows:

- Retail price
  - $20 retail price for low THC products
  - $30 retail price for medium THC products
  - $40 retail price for high THC products
- Licencing fees
  - $0.40 licence fee per gram of dried cannabis and its equivalents sold
- Volume of cannabis sold or consumed
  - 150,000 grams sold annually in a Retail store and a Combined store
  - 100,000 grams consumed annually in a Licenced premise and a Combined store
  - 15 percent of cannabis sold as edibles
- Size of retail option
  - The Retail store is 80 square metres in size
  - The Licenced premise is 140 square metres in size
  - The Combined store is 160 square metres in size
- Employment and opening hours
  - Retail store is open for 77 hours a week, employs one manager, one assistant manager, two sales staff, and one security staff present during opening hours
  - Licenced premises is open for 84 hours a week, and employs one manager, one assistant manager, two sales staff, and one security staff present during opening hours

  - The Combined store is open for 98 hours a week, and employs one manager, one assistant manager, has three sales staff, and one security staff present during opening hours
- Non-cannabis sales
  - Cannabis accessories have a 150 percent retail mark-up
  - Food and non-alcoholic beverages have a 100 percent retail mark-up
  - Non-cannabis revenue has a maximum share of revenue of 30 percent
- Capital costs
  - $100,000 security systems for all three retail options
  - $75,000 fit-out of the Retail store
  - $275,000 fit-out of the Licenced premises
  - $300,000 fit-out of the Combined store.

Retail store

Under these location parameters, the Retail store would have total annual revenue of $4,973,200 (including GST), broken down into the following categories:

- Cannabis revenue = $3,927,200
- Cannabis accessory revenue = $1,046,000

The Retail store has total annual costs of $4,301,300 (excluding GST), broken down into the following categories:

- Labour costs = $386,400
- Rent = $148,000
- Licence fees = $60,000
- GST = $684,700
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $2,179,600
- Purchase of cannabis edibles = $504,800
- Purchases of delivered cannabis accessories = $418,400
- ACC levies = $2,800
- Professional service costs = $14,600
- Other costs = $29,900.

Given these parameters the Retail store would make an annual profit of $571,800.

Licenced premises

Under the above location parameters, the Licenced premise has total annual revenue of $3,519,600 (including GST), broken down into the following categories:

- Cannabis revenue = $2,719,600
- Food and non-alcoholic beverages revenue = $800,000.

The Licenced premise would have total annual costs of $3,334,700 (excluding GST), broken down into the following categories:

- Labour costs = $410,100
- Rent = $155,400
- Licence fees = $40,000
- GST = $459,100
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $1,453,000
- Purchase of cannabis edibles = $336,500
- Purchases of delivered food and non-alcoholic beverages = $400,000
- ACC levies = $2,800
- Professional service costs = $14,600
- Other costs = $54,900.

This means the Licenced premise would make an annual profit of $184,900.

Combined store

Under the above location parameters, the Combined store would have total annual revenue of $5,849,300 (including GST), broken down into the following categories:

- Cannabis revenue = $4,003,300
- Cannabis accessory revenue = $1,046,000
- Food and non-alcoholic beverages revenue = $800,000.

The Combined store would have total annual costs of $5,244,300 (excluding GST), broken down into the following categories:

- Labour costs = $559,500
- Rent = $236,800
- Licence fees = $60,000
- GST = $763,000
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $2,179,600
- Purchase of cannabis edibles = $504,800
- Purchases of delivered cannabis accessories = $418,400

- Purchases of delivered food and non-alcoholic beverages = $400,000
- ACC levies = $3,800
- Professional service costs = $14,600
- Other costs = $58,000.

Under these parameters the Combined store would make an annual profit of $605,000.

Scenario one – summary

The table below summarises the total revenue, cost and profit for each of the three retail options in location one.

Table 5.1 Summary of location one, revenue, cost and profit

Retail options	Total revenue	Total costs	Profit
Retail store	4,973,200	4,401,400	571,800
Licenced premises	3,519,600	3,334,700	184,900
Combined store	5,849,300	5,244,300	605,000

As the table shows, at this location each of the three retail options is able to generate a profit. Both the Combined store and Retail store make a profit equivalent to around 10 to 12 percent of revenue, while the Licenced premise has a profit of around five percent of revenue.

As already mentioned, labour costs are the largest fixed operating cost facing each of the retail options. If the number of staff employed each week was increased for each of the retail options, the costs of each retail option will increase. At the same time revenue will remain the same. Overall this analysis shows how sensitive each of the three retail options are to labour cost changes and staffing requirements.

The table below shows the change in labour costs, total costs, and profit for each of the three retail options. For Retail stores and Licenced premises the number of staff has been increased to four sales staff and two security staff. While for Combined stores the number of staff has been increased to five sales staff and three security staff.

Table 5.2 Summary of location one with labour cost changes

Retail options	New labour costs	Total costs	Profit
Retail store	647,400	4,664,300	308,900
Licenced premises	694,900	3,621,400	-101,800
Combined store	1,020,200	5,708,100	141,200

The table shows, with the higher staffing requirements, the profit level of each of the three retail options has declined. In particular the Licenced premise is now making a loss, while the Retail store and Combined options profits have decreased to around two to six percent.

5.9.2 Location two – minor urban area

Location two focuses on the financial viability of the three retail options in a minor urban area. Minor urban areas includes places such as Whangarei, New Plymouth, Palmerston North, Nelson, and Invercargill.

Location assumptions

The main parameters for this location are as follows:

- Retail price
  - $20 retail price for low THC products
  - $30 retail price for medium THC products
  - $40 retail price for high THC products
- Licencing fees
  - $0.40 licence fee per gram of dried cannabis and its equivalents sold
- Volume of cannabis sold or consumed
  - 110,000 grams sold annually in a Retail store and a Combined store
  - 75,000 grams consumed annually in a Licenced premise and a Combined store
  - 15 percent of cannabis sold as edibles
- Size of retail option
  - The Retail store is 80 square metres in size
  - The Licenced premise is 140 square metres in size
  - The Combined store is 160 square metres in size
- Employment and opening hours
  - Retail store is open for 77 hours a week, and employs one manager, one assistant manager, two sales staff, and one security staff present during opening hours
  - Licenced premises is open for 84 hours a week, and employs one manager, one assistant manager, two sales staff, and one security staff present during opening hours
  - The combined store is open for 98 hours a week, and employs one manager, one assistant manager, three sales staff, and one security staff present during opening hours
- Non-cannabis sales
  - Cannabis accessories have a 150 percent retail mark-up
  - Food and non-alcoholic beverages have a 100 percent retail mark-up
  - Non-cannabis revenue has a maximum share of revenue of 30 percent
- Capital costs
  - $70,000 was spent on security systems for all three retail options
  - $50,000 was spent on fitting out the Retail store
  - $200,000 was spent fitting out the Licenced premises

- $250,000 was spent fitting out the Combined store.

Retail store

Under the above location parameters, the Retail store has total annual revenue of $3,647,000 (including GST), broken down into the following categories:

- Cannabis revenue = $2,879,900
- Cannabis accessory revenue = $767,100.

The Retail store has total annual costs of $3,251,200 (excluding GST), broken down into the following categories:

- Labour costs = $367,700
- Rent = $40,000
- Licence fees = $44,000
- GST = $475,700
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $1,598,300
- Purchase of cannabis edibles = $370,200
- Purchases of delivered cannabis accessories = $306,800
- ACC levies = $2,700
- Professional service costs = $14,600
- Other costs = $23,000.

This means the Retail store makes an annual profit of $395,800.

5.9.3 Licenced premises

Under the above location parameters, the Licenced premise would have total annual revenue of $2,639,700 (including GST), broken down into the following categories:

- Cannabis revenue = $2,639,700
- Food and non-alcoholic beverages revenue = $600,000.

The Licenced premise has total annual costs of $2,517,100 (excluding GST), broken down into the following categories:

- Labour costs = $391,400
- Rent = $42,000
- Licence fees = $30,000
- GST = $344,300
- Insurance = $2,400
- Electricity and internet = $5,800

- Purchases of delivered cannabis = $1,089,800
- Purchase of cannabis edibles = $252,400
- Purchases of delivered food and non-alcoholic beverages = $300,000
- ACC levies = $2,700
- Professional service costs = $14,600
- Other costs = $41,800.

The Licenced premise makes an annual profit of $122,600.

Combined store

Under the above location parameters, the Combined store has total annual revenue of $4,302,800 (including GST), broken down into the following categories:

- Cannabis revenue = $2,935,700
- Cannabis accessory revenue = $767,100
- Food and non-alcoholic beverages revenue = $600,000.

The Combined store has total annual costs of $3,859,300 (excluding GST), broken down into the following categories:

- Labour costs = $540,800
- Rent = $32,000
- Licence fees = $44,000
- GST = $561,200
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $1,597,300
- Purchase of cannabis edibles = $370,200
- Purchases of delivered cannabis accessories = $306,800
- Purchases of delivered food and non-alcoholic beverages = $300,000
- ACC levies = $3,700
- Professional service costs = $14,600
- Other costs = $48,000.

The Combined store makes an annual profit of $443,500.

Location two – summary

The table below summarises the total revenue, cost and profit for each of the three retail options at location two.

Table 5.3 Summary of location two, revenue, cost and profit

Retail options	Total revenue	Total costs	Profit
Retail store	3,647,000	3,251,200	395,800
Licenced premises	2,639,700	2,517,100	122,600
Combined store	4,302,800	3,859,300	443,500

As the table shows, at this location each of the three retail options is able to generate a profit. Both the Combined store and Retail store make a profit of around 10 to 11 percent of sales revenue, while the Licenced premises has a profit of around five percent.

As already mentioned, cannabis costs are the largest operating cost facing each of the retail options. If the volume of cannabis sold each year was changed for each of the retail options, the revenue and costs of each retail option would change. Overall this analysis shows how sensitive each of the three retail options are to changes in the volume of cannabis sold.

The table below shows the new total revenue, total costs, and profit for each of the three retail options, based on the altered volume of cannabis. For Retail stores and Combined stores the volume of cannabis sold has been halved to 55,000 grams. For Licenced premises the volume of cannabis sold has been doubled to 150,000.

Table 5.4 Summary of location two with cannabis sales volumes changes

Retail options	Total revenue	Total costs	Profit
Retail store	1,823,500	1,853,700	-30,200
Licenced premises	5,279,300	4,533,600	745,700
Combined store	3,051,400	3,080,600	-29,200

The table shows that decreasing the volume of cannabis sold through retail options will decrease their revenue, costs and profit. Increasing the volume of cannabis sold through retail options will increase their revenue, costs and profit. In particular the Licenced premise is now making a 14 percent profit after having its volume of cannabis doubled, while the Retail store and Combined options profits have become losses of around one to two percent.

5.9.4 Location three – rural township

Location three focuses on the financial viability of the three retail options in a rural township. Rural townships include places such as Gore, Masterton, Levin, Taumarunui, Westport, and Kerikeri.

Scenario parameters

The main parameters for this location are as follows:

- Retail price
  - $20 retail price for low THC products
  - $30 retail price for medium THC products
  - $40 retail price for high THC products

- Licencing fees
  - $0.40 licence fee per gram of dried cannabis and its equivalents sold
- Volume of cannabis sold or consumed
  - 100,000 grams sold annually in a Retail store and a Combined store
  - 75,000 grams consumed annually in a Licenced premise and a Combined store
  - 15 percent of cannabis sold as edibles
- Size of retail option
  - The Retail store is 80 square metres in size
  - The Licenced premise is 140 square metres in size
  - The Combined store is 160 square metres in size
- Employment and opening hours
  - Retail store is open for 77 hours a week, and employs one manager, one assistant manager, two sales staff, and one security staff present during opening hours
  - Licenced premises is open for 84 hours a week, and employs one manager, one assistant manager, two sales staff, and one security staff present during opening hours
  - The combined store is open for 98 hours a week, and employs one manager, one assistant manager, three sales staff, and one security staff present during opening hours
- Non-cannabis sales
  - Cannabis accessories have a 150 percent retail mark-up
  - Food and non-alcoholic beverages have a 100 percent retail mark-up
  - Non-cannabis revenue has a maximum share of revenue of 30 percent
- Capital costs
  - $70,000 security systems for all three retail options
  - $50,000 fitting out the Retail store
  - $150,000 fit-out of the Licenced premises
  - $200,000 fit-out of the Combined store.

Retail store

Under the above location parameters, the Retail store would have total annual revenue of $3,315,500 (including GST), broken down into the following categories:

- Cannabis revenue = $2,618,100
- Cannabis accessory revenue = $697,300.

The Retail store has total annual costs of $2,981,100 (excluding GST), broken down into the following categories:

- Labour costs = $367,700
- Rent = $24,000

- Licence fees = $40,000
- GST = $432,500
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $1,453,000
- Purchase of cannabis edibles = $336,500
- Purchases of delivered cannabis accessories = $278,900
- ACC levies = $2,700
- Professional service costs = $14,600
- Other costs = $23,000.

This means the Retail store makes an annual profit of $334,300.

Licenced premises

Under the above location parameters, the Licenced premise has total annual revenue of $2,639,700 (including GST), broken down into the following categories:

- Cannabis revenue = $2,039,700
- Food and non-alcoholic beverages revenue = $600,000.

The Licenced premise has total annual costs of $2,494,100 (excluding GST), broken down into the following categories:

- Labour costs = $391,400
- Rent = $25,200
- Licence fees = $30,000
- GST = $344,300
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $1,089,800
- Purchase of cannabis edibles = $252,400
- Purchases of delivered food and non-alcoholic beverages = $300,000
- ACC levies = $2,700
- Professional service costs = $14,620
- Other costs = $35,500.

This means the Licenced premise makes an annual loss of $145,600.

Combined store

Under the above location parameters, the Combined store would have total annual revenue of $3,966,200 (including GST), broken down into the following categories:

- Cannabis revenue = $2,668,800
- Cannabis accessory revenue = $697,300
- Food and non-alcoholic beverages revenue = $600,000.

The Combined store would have total annual costs of $3,598,400 (excluding GST), broken down into the following categories:

- Labour costs = $540,800
- Rent = $19,200
- Licence fees = $40,000
- GST = $517,300
- Insurance = $2,400
- Electricity and internet = $5,800
- Purchases of delivered cannabis = $1,453,000
- Purchase of cannabis edibles = $336,500
- Purchases of delivered cannabis accessories = $278,900
- Purchases of delivered food and non-alcoholic beverages = $300,000
- ACC levies = $3,700
- Professional service costs = $14,620
- Other costs = $41,800.

This means the Combined store makes an annual profit of $367,800.

Location three – summary

The table below summarises the total revenue, cost and profit for each of the three retail options at location three.

Table 5.5 Summary of location three, revenue, cost and profit

Retail options	Total revenue	Total costs	Profit
Retail store	3,315,500	2,981,100	334,300
Licenced premises	2,639,700	2,494,100	145,600
Combined store	3,966,200	3,598,400	367,800

As the table shows, at this location all three retail options is able to generate a profit, though the Licenced premise needs to sell as much as a Licenced premise in minor urban area in order to make a profit. This level of activity for a licenced premise in a rural location we believe to be highly unlikely. The profit for the Combined store and the Retail store would be around nine to 10 percent.

As already mentioned, cannabis costs are the largest operating cost facing each of the retail options. If the retail mark-up (the difference between the retail price and the price paid to processors) was to change for each of the retail options, the costs of each retail option would

change. At the same time the revenue of each option would remain the same with the retail price unchanged. Overall this analysis shows how sensitive each of the three retail options are to changes in the retail mark-up of cannabis sold.

The table below shows the new revenue, costs, and profit for each of the three retail options, based on the altered retail mark-up of cannabis. For Retail stores and Combined stores the price paid to processors of cannabis has been changed to $14.81 for low, $23.51 for medium, and $32.21 for high THC products. For Licenced premises the price paid to processors of cannabis has decreased to $12.81 for low, $21.51 for medium, and $30.21 for high THC products.

Table 5.6 Summary of location three with cannabis retail mark-up changes

Retail options	Total revenue	Total costs	Profit
Retail store	3,315,500	3,068,100	247,400
Licenced premises	2,639,700	2,428,900	210,800
Combined store	3,966,200	3,685,400	280,800

The table shows that increasing the retail mark-up on cannabis sold through retail options will increase their revenue and profit, while decreasing their costs. Decreasing the retail mark-up on cannabis sold through retail options will decrease their revenue and profit, while increasing their costs. In particular the Licenced premise is now making a larger profit after having its retail mark-up on cannabis increased. The Retail store and Combined option profits have decreased to around seven percent, with the decrease in their retail mark-up.

5.10 Cannabis market size

In this section, the number of growers, the number of processors, and the number of retail businesses required to adequately service the New Zealand cannabis industry is considered. Firstly, the total size of the New Zealand retail market needs to be established. Once this is established the number of growers and processors needed to supply this retail market can be determined. Lastly, if cannabis is made legal recreationally there will be a short-term spike in the number of users and consumption of cannabis. While consumption will drop back down to a long-term average, the legal cannabis market will need to be able to supply this short-term spike, or risk allowing the illegal cannabis market to maintain a sizable share of the market.

5.10.1 Summary - number of licences

Across a legal cannabis market, growers, processors, and retailers will all need licences to operate. The table below provides a summary of the estimated number of licences needed under the long-term average consumption of legal cannabis of 49,668,000 grams. For each of the three sectors of the cannabis market industry the number of licences is based on available information, and the already detailed assumptions and parameters in the financial viability model.

Table 5.7 summary count of licenses

Cannabis licences types	Count of licences
Indoor growers	81
Greenhouse growers	17
Outdoor growers	14
Primary processers	35
Retail stores	134
Licenced premises	59
Combined stores	227
Total number of licences	**567**

As the tables notes an estimated total of 567 licences will be needed across the three sectors of the market. In total 112 grower licences, 35 processor licences, and 420 retail licences will be needed to grow, process, and sell the estimated 49,668,000 grams of dried and cured cannabis buds and other cannabis products.

5.10.2 Retail market

BERL used the financial viability model combined with cannabis consumption by area to estimate the size of the potential retail market in that area. Using the assumptions and parameters underpinning the financial viability model enables an estimate to be made of the number of retail stores, combined premises, and combined stores needed for a specific area to meet current demand. These estimates can also highlight the difficulties that may face some cannabis retail businesses in smaller urban areas, or rural areas, as noted in our summary of the model findings.

Overall BERL has estimated that there are 557,200 cannabis users over 15 years of age, currently in New Zealand consuming around 74,083,100 grams of cannabis each year.[39] This consumption level is forecast to be our long-term annual consumption level. In addition BERL has been able to model the number of users and their consumption across New Zealand, based on the University of Otago's deprivation index, as shown in the Table 5.8.

Table 5.8 Estimated number of cannabis users aged over 15 and consumption by quintile, 2018

Quintiles	Cannabis users	Cannabis consumed (grams)
One	57,360	4,373,870
Two	72,380	7,463,220
Three	123,820	16,814,680
Four	136,720	15,472,680
Five	166,970	29,958,670
Total	557,200	74,083,100

[39] As per section 2

In the above table, the 10 deprivation index categories have been combined into five quintiles. Quintile one includes people living in deprivation index one and two categories (these are the least deprived areas), while Quintile five includes people living in deprivation index nine and ten categories (these are the most deprived areas). Taking the 2018 population over 15 years of age within each local authority in New Zealand, we are able to determine the share of population within each local authority, within each of the quintiles. With these estimates we have been able to separate the local authorities into three market tiers, major urban areas, minor urban areas, and rural towns and settlements.

As outlined earlier in this report, we are using the following assumptions around the amount of cannabis purchased from each of the three retail options across the three different markets tiers:

- Retail and combined stores will sell 150,000 grams in major urban areas, 110,000 grams in minor urban areas, and 100,000 grams in rural townships and settlements. These volumes can also be expressed in the number of people needed each day to purchase a gram of dried cannabis or its equivalents. For major urban areas this is 411 people per day, for minor urban areas 301 people per day, and for rural townships and settlements this is 274 people per day
- Licenced premises will sell 100,000 grams in major urban areas, 75,000 grams in minor urban areas and rural townships and settlements. These volumes can also be expressed in the number of people needed each day to purchase and consume a gram of dried cannabis or its equivalents. For major urban areas this is 274 people per day, for minor urban areas and for rural townships and settlements this is 205 people per day.

Under the proposed regulations individuals will be able to grow a small number of their own cannabis plants for personal consumption. In addition the illegal market will undoubtedly remain an option for those unable to purchase cannabis from a licenced retail store. The presence of these two options will mean the amount of cannabis purchased from licenced retail stores will be smaller than the estimated total consumption for New Zealand.

Using international literature on the amount grown by individuals for personal consumption[40], combined with the estimated cannabis consumption of those under 20 (for whom it will remain illegal to purchase cannabis), and the estimated illegal cannabis market for those over 20, we made the following assumptions on the size of personal and illegal markets:

- 9,158,000 grams will be consumed from the illegal market by those under 20
- 9,739,000 grams will be consumed from the illegal market by those over 20
- 5,519,000 grams will be legally home grown and consumed
- 49,668,000 grams will be consumed from the legal market.[41]

Under these assumptions only 67 percent of total current consumption will occur through a licenced retail store. This means that an estimated 49,668,000 grams of current consumption will be available for sale through retail stores. So lastly we need to make a few assumptions about the distribution of cannabis sales through each of the three retail options available, which are detailed here:

- Retail stores will sell 45 percent
- Licenced premises will sell 20 percent

[40] As per section 4
[41] As per section 2

- Combined stores will sell the remaining 35 percent
- In rural townships only combined stores will be present, as demand in any one rural township is likely to be too low to support a retail store and a licenced premise.

From the outlined assumptions and estimates, and using the financial viability model information, we can estimate the following numbers of store will be needed to meet the cannabis consumption in New Zealand. Table 5.9 outlines the estimated amount of cannabis to be sold through licenced retailers and the number of stores of each option needed.

The table shows that Auckland is estimated to need 119 retail businesses to supply the legal cannabis market. The table also shows that most minor urban areas will only need around seven retail businesses to supply the legal market, and that in six of these 14 areas, licenced premises will not be needed, as a small number of retail stores and combined stores can supply the legal market. Lastly, at least 119 combined stores will be needed across the entire remainder of the country, if each combined store sells 100,000 grams each year.

Table 5.9 Estimated number of retail business per cannabis retail market

Cannabis retail markets	Total cannabis consumed (kgs)	Total cannabis sold by retailers (kgs)	Number of retail stores	Number of licenced premises	Number of combined stores
Auckland	24,190	16,220	49	32	38
Wellington	5,750	3,850	12	8	9
Christchurch	5,120	3,430	11	5	9
Hamilton	2,770	1,860	6	3	5
Dunedin	2,110	1,420	5	1	4
Tauranga	2,020	1,360	5	1	4
Major Urban Centres	**41,960**	**28,140**	**88**	**50**	**69**
Whangarei	1,610	1,080	5	1	4
New Plymouth	1,320	890	4	2	3
Whanganui	980	650	3	0	3
Taupō	700	470	2	1	2
Rotorua	1,430	960	4	1	4
Whakatane	820	550	3	0	2
Gisborne	1,080	720	3	1	3
Napier	1,110	750	4	0	3
Hastings	1,450	970	4	1	4
Palmerston North	1,530	1,030	5	1	4
Nelson	730	490	3	0	2
Ashburton	1,000	670	3	1	3
Queenstown	390	260	2	0	1
Invercargill	230	150	1	0	1
Minor Urban Centres	**14,380**	**9,640**	**46**	**9**	**39**
Rural townships	**17,740**	**11,890**	**0**	**0**	**119**
Total New Zealand	**74,080**	**49,670**	**134**	**59**	**227**

Short-term spike in consumption

If cannabis is legalised for recreational use, it is expected there will be a short-term spike in user numbers and consumption. In total it is expected that during this short-term spike annual consumption will increase from 74,083,100 grams to 96,550,000 grams.[42] Given the assumptions on the percentage of the market that will be home-grown and illegal, this means that around 67,285,000 grams of cannabis will be legally consumed via retail purchases.

To cater for this increase in consumption, one of three approaches can be used. The first approach is to keep the number of retail licences the same, but increase the expected volume of cannabis to be sold through each store. The second approach is to keep the volume of cannabis sold at each store the same and provide more retail licences to enable the industry to cope with the additional demand. The third and final approach is a mix of the first and second approaches.

5.10.3 Grower market

With 49,668,000 grams of dried and cured cannabis required to supply the long-term legalised retail market each year, the number of growers required to grow this volume of cannabis can be determined. Given the following initial assumptions:

- 50 percent of the market will be grown indoors
- 10 percent will be grown in greenhouses
- 40 percent will be grown outdoors
- 15 percent of market (7,453,000 grams of cannabis equivalent edibles) will be cannabis edibles made with cannabis oil derived from cannabis plant material other than the bud.

Overall these assumptions mean that only 42,217,600 grams of dried cannabis bud needs to be grown each year. Given this the following amounts of cannabis will be grown each year:

- 21,108,800 grams of dried cannabis buds grown indoors, across four harvests
- 4,221,800 grams of dried cannabis buds grown in greenhouses, across three harvests
- 16,887,000 grams of dried cannabis buds grown outdoors, across one harvest.

With each indoor operation using 1000 square meters, a greenhouse operation using 2000 square meters, and an outdoor operation using 10 hectares on average, the following totals will be needed:

- 81 licences for indoor growers
- 17 licences for greenhouse growers
- 14 licences for outdoor growers.

Short-term spike in consumption

In total it is expected that during this short-term spike annual consumption will increase from 74,083,100 grams to 96,550,000 grams. Given the assumptions on the percentage of the market that will be home-grown, illegal, and edible, this means that around 57,192,100 grams of cannabis bud will need to be grown to supply the legal market.

[42] As per section 2

In total to provide this supply, an increase in the number of licences will be needed. Given the assumptions around average size of growing operators the following licence numbers will be needed:

- 110 licences for indoor growers
- 22 licences for greenhouse growers
- 18 licences for outdoor growers.

5.10.4 Processor market

With 42,217,600 grams of dried and cured cannabis required to supply the long-term legalised retail market each year, the number of processors required to dry and cure this volume of cannabis can be determined. Given the following initial assumptions:

- 12 days to fully process a harvest
- The cannabis dryers will run at on average 80 percent capacity
- On average a processor will occupy a 750 square meter premise
- On average 1,180 kilograms of dried and cured cannabis will be processed by each processor.

As noted above indoor growers complete four harvests a year, greenhouse growers complete three harvests a year, and outdoor growers harvest once a year. To fully process a single harvest from outdoor growers, greenhouse growers and indoor growers at the same time would require 35 processors. If indoor and greenhouse growers can avoid harvesting at the same time as outdoor growers then the maximum number of processers required will be reduced to 25. This is because under our current assumptions outdoor growers will have the single largest harvest of any of the grower groups.

Short-term spike in consumption

In total it is expected that during this short-term spike annual consumption will increase from 74,083,100 grams to 96,550,000 grams. Given the assumptions on the percentage of the market that will be home-grown and illegal, this means that around 57,192,100 grams of cannabis bud will need to be processed to supply the legal market.

In total to provide this supply, the volume of cannabis being processed at each processor will need to increase, rather than setting up more processors. In essence this would mean that on average each processor would need to process 1,634 kilograms of dried and cured cannabis each year.

6 Organisational design

6.1 Summary

This section examines the best option for the organisational design to support the operational functions to regulate the recreational cannabis sector.

- Due to the complexity of developing and executing a totally new regulatory model that will span across various government departments, it might not be efficient to have it housed within an existing government department.
- Therefore, the options examined were setting up a Crown agency or Departmental agency.
- The cannabis regulatory functions might fit better within a Crown agency than a Departmental agency due to the regulation taking some time to be ring fenced and for the initial period, it will not have stable policy settings.
- We estimated that the yearly running cost for the Crown Agency would be about $27 million.
- Based on our calculations for the licencing fees and excise duties, the running costs for the Crown Agency will be less than four percent of the revenue collected for cannabis.

6.2 Data limitations and caveats

The following limitations with regards to the calculation in this section:

- Calculations for the running costs for the Agency was based on Annual reports from Worksafe and Civil Aviation Authority (CAA).
- The licencing fees and excise duties data limitations and caveats have been discussed in earlier sections.

6.3 Organisational design for cannabis regulation

The organisational design to support the operational functions to regulate the recreational cannabis sector will depend on the level of compliance and enforcement, policy and legislative oversight, as well as monitoring. Taking into consideration the level of integration to implement the policy and supporting functions, having it positioned within an existing government department might not be suitable. A Crown agency or Departmental agency could be a more efficient model to support this function and deliver on the government obligations.

6.4 Options for the organisational design for cannabis regulation

Is there a role for government?

Yes, it is a priority for government, with the Cannabis Referendum 2020. If the Referendum outcome is that cannabis should be legalised, then there is a definite rationale for the establishment of separate entity based on the introduction of new policy and regulations.

Does this need to be at arm's length from the Minister?

It would be prudent to have at arm's length from the Minister for ensuring a relationship with the sector and to mitigate the strategic risk to the Crown.

Does this need to be a stand-alone entity?

Due to the complexity of developing and executing a totally new regulatory model that will span across various government departments, it might not be efficient to have it housed within an existing government department. Focussing on effectiveness and efficiency, a separate entity that reports directly to the Minister might be more suitable. There are two options for an organisational design that could deliver and execute the regulatory model, either a crown or a departmental agency.

Although the two types of agencies fulfil relatively similar roles, there are differences.

Table 6.1 Characteristics of different organization structure

Crown agency	Departmental agency
Is a statutory entity that must give effect to government policy directions, as distinct from having regard to government policy directions or being generally independent of government policy. Crown agencies are those entities most closely subject to ministerial control.	Is a new organisational form involving a specific operational delivery or regulatory function or functions placed within a host department. A Departmental agency has a chief executive appointed by the State Services Commissioner. The Departmental agency's chief executive reports directly to the Minister responsible for the agency, who may or may not be the same as the Minister responsible for the host department.

What are the advantages of the two agency models?

Departmental agencies was introduced as an alternative to establishing wholly separate departments or new Crown entities. In this way, the Departmental agency model could be useful for cannabis regulation as it will consolidate regulatory functions from different agencies to serve the cannabis objectives and priorities, especially if doing so would shore up capabilities and produce back office efficiencies.

It will also transfer functions from Crown entities into the legal Crown (ie, into a department) in a manner that retains their separate identity and accountability and will provide greater autonomy and transparency for existing functions that might otherwise lose 'visibility' or focus as part of a large multifunctional department[43]. However, it will be part of a specific government department, whereas a Crown entity will be one step removed and could provide a stronger platform for ensuring that Crown entities and departments work together to achieve the goals for especially harm reduction as part of the cannabis policy objectives.

The Departmental agency model can serve to improve system coherence and consolidation, provide benefits of scale and leverage from Crown investments, and reduce fragmentation and costs. Although the yearly running costs between a Departmental agency and a Crown agency might not be that significant overall.

Regulating the cannabis sector – a Crown or Departmental agency model?

The activities best suited to the Departmental agency model would tend to be regulatory, service delivery or other ring-fenced operations that do not need to be carried out by an entity separate from the Crown, and that can be accountable directly to a Minister (rather than come under the

[43] Retrieved from https://www.ssc.govt.nz/sites/all/files/mog-guidance-2017-departmental-agency.pdf

authority of a governance board). Whereas the activities best suited to a Crown agency would tend to be a step removed from the government, creating some level of autonomy.

The cannabis regulatory functions might fit better within a Crown agency than a Departmental agency due to two specific reasons:

- Cannabis regulation will take some time to be ring fenced and might benefit from being one step removed from government
- Also, for the initial period, it will not have stable policy settings. Policy settings will need to be refocussed as more information becomes available, and policies redirected.

6.5 Fees, licencing and taxes

While legalised cannabis promises to establish a sizable legitimate industry, it comes with heavy administrative costs. To execute this effectively we need seed-to-sale tracking systems, production facilities have to be inspected and held to standards. There has to be a licensing system to process and register who can produce and who can sell. All of these come at a cost. On top of administration costs, the burdens placed on health care and social services will have to be factored in with increased funding for support services for people through health, social and education.

This mix of fees, excise duties, and GST taxes will ensure the government and taxpayers, aren't unduly burdened by the regulation of the cannabis industry. For the first two years (at least) it will be difficult to accurately forecast the operational costs of overseeing the industry. Moreover further policy, tax and legal issues may arise that may have to be addressed.

6.5.1 International models

Within the current legal markets, there is not a compatible government structure to New Zealand. International models showed that the oversight of the cannabis regulations and taxes are normally positioned within various existing government departments. There is also a significant amount of cross agency work implemented to deal with the various touch points of the regulatory obligations for the various parts of the industry.

USA experience on fees, licensing and tax:

With laws fully implemented, adult-use marijuana programs have generated large annual surpluses from taxes and fees after accounting for the costs to administer the program. States have implemented adult-use regulatory programs for as little as US$1.8 million (in Alaska). Adult-use states generated as much as US$369 million (Washington) and US$250 million (Colorado) in tax revenues in a single year.

Application fees vary by state, ranging from US$250 to US$5,000. Licensing fees vary by state and business type (i.e., cultivator, product manufacturer, producer, transporter, testing). These fees range from US$1,000 (for a limited cultivation license in Colorado) to US$200,000 (for a distributor license with greater than US$120 million in operation in California). The revenues generated from application and licensing fees alone are upwards of US$12.9 million (in Colorado which has a population of 5.6 million) and US$250 million in sales tax revenue[44].

[44] Retrieved from https://www.mpp.org/issues/legalization/financial-information-on-states-with-adult-use-legalization/

It appears from international experience that the taxes, licencing and fees that will be collected from the cannabis industry would be far greater than the cost to operate the program. Also, a significant proportion of the money collected is redirected into health and social programmes as well as educational support.

6.6 Set up and running costs

There will be additional costs if cannabis regulations are positioned outside a government department in either a Crown agency or Departmental agency. There is no cost structure model (that we could find) prescribed for the respective agencies by State Services Commission or The Treasury.

However, Te Arawhiti is a Departmental agency that was established recently. The establishment cost was about $42 million (see table below).

Table 6.2 Set up and running costs of Te Arawhiti

Initial cost	Yearly running cost
On 1 January 2019, the Office for Māori Crown Relations – Te Arawhiti was established, bringing together the Māori Crown Relations Unit, the Office of Treaty Settlements, the Settlements Commitments Unit and the Marine and Coastal Area Unit. Vote Justice (in relation to the Māori Crown Relations: Te Arawhiti portfolio) and Vote Treaty were appropriated $4.228 million and $37.548 million respectively in departmental funding for 2018/2019.	The costs of running the Office for Māori Crown Relations – Te Arawhiti in 2018/19 is funded from within existing baselines from Vote Treaty Negotiations and Vote Justice[45].

The main cost difference between the two agencies will be in the yearly running costs. For a Departmental agency it is absorbed into the baseline of the existing department, whereas a Crown agency will have a separate expenditure (costs) line. The majority of the expenditure will be in salaries. Another Departmental agency, the Social Investment Agency reported $45 million in expenditure in 2018, and it was mostly salaries.

Table 6.3 Running costs of Worksafe and CAA

Crown Entity	Yearly running cost
Worksafe	2017/18 Annual Report[46] yearly expenditure was $96 million, of which personnel costs was $63 million
CAA	With expenditure of $137 million (2017)[47], the majority of expenditure in salaries.

Establishment cost and running cost of cannabis regulation

We assume that the establishment cost for a Crown agency will be similar than for a Departmental agency. Therefore, we would estimate the establishment cost to be about $40 million

[45] Written question: https://www.parliament.nz/en/pb/order-paper-questions/written-questions/document/WQ_00643_2019/643-2019-hon-paula-bennett-to-the-m%C4%81ori-crown-relations
[46] Retrieved from https://worksafe.govt.nz/about-us/corporate-publications/annual-reports/
[47] http://reportingnz.org/wp-content/uploads/2018/07/11-Civil-Aviation-Authority.pdf

The yearly running cost (structure) for implementing cannabis regulations, focussed on the proposed regulations, would be closer to a Crown agency such as Worksafe, although not to the same scale and magnitude.

We would consider the fixed and running cost for the first year to be about $67 million. From there onwards, the yearly running cost would be about $27 million. As the market settles, these costs might reduce as less control and regulation are needed.

Conservative estimation of licencing fees, tax and excise duties for New Zealand market

The yearly licencing fees, based on a $1.20 per gram (40c for growers, 40c for processors and 40c for retailers) could generate approximately $56 million in revenue, on the basis that about 35 percent of the current market will not be included in these fees, as this proportion will either be personally grown or accessed through the illegal market. The excise duties could generate an additional $646 million, based on the following assumptions.

- Retail stores charging $20 per gram for low THC products, $30 for medium THC products and $40 for high THC products.
- Low THC products will provide $8.90 per gram excise duties. Medium THC products will provide $17.60 per gram excise duties and high THC products will provide $26.30 per gram excise duties.

If these assumptions hold, it will cost about $27 million to administer cannabis regulations per year, meaning that about $675 million[48] could be available for harm reduction per year. Meaning that less than four percent of revenue will cover the administration costs and the rest could be allocated to harm reduction.

Table 6.4 Yearly running cost estimates

Activity	Roles	Total FTEs	Cost
Board and committees	Six board members and four committees		$500,000
Management	CE, DCE, EA	3	$600,000
Application and licence fees	Manager, Senior administration, Administrators, Solicitor, Senior accountant, Accountants, EA	15	$1,900,000
Regulation enforcement	Manager – production, processing Regional team leaders, Senior inspectors, Inspectors, Administrators, EA Manager – retail, Regional team leaders, Urban Inspectors, Rural inspectors, Administrators, EA	60	$8,000,000
Administration and ICT	Manager, Administrators, ICT specialists	10	$1,000,000

[48] That is, $646 million + 56 million = $702 million. Less $27 million for administration and regulatory costs.

Other costs	Travel, rental, leasing, audit fees, ICT, consultancy fees		$15,000,000
TOTAL		**88**	**$27,000,000**

These government revenue estimates do not include additional income tax that may arise from the profits of growers, processors and retailers. Nor do they include additional income tax on the wages and salaries of those newly employed in these sectors of the legal cannabis market.

From our industry production model, we estimate employment of approximately 5,000 people (FTE equivalents) across these sectors, with overall wages and salaries of $210 million per year. At a conservative average income tax rate of 15 percent[49], this would yield additional income tax revenue of around $30 million. Taxable profit numbers are even more difficult to estimate, but our base assumptions would suggest an order of magnitude of another $10 million in corporate tax revenue.

[49] Allowing for low wage rates and part-time nature of those in retail sector.

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Appendix A Baseline consumption summary

Table 7.1 Baseline consumption summary

		Users	Share of population	Total annual consumption	User average annual consumption	Total value of consumption	User average expenditure	Average income
		number	%	kilograms	grams	$ million pa	$pa	$pa
Use	Daily	113,033	3	62,963	557	1,259	11,141	31,117
	Frequent	122,360	3	9,426	77	189	1,541	33,996
	Periodic	194,004	5	1,569	8	31	162	28,681
	Rarely	127,846	3	125	1	2	20	29,962
	Total	**557,244**	**14**	**74,083**	**133**	**1,482**	**2,659**	**30,636**
Deprivation	1=least deprived							
	One	57,359	8	4,374	76	87	1,525	36,165
	Two	72,378	10	7,463	103	149	2,062	42,329
	Three	123,823	15	16,815	136	336	2,716	37,969
	Four	136,715	16	15,473	113	309	2,263	26,402
	Five	166,969	22	29,959	179	599	3,589	21,697
	Total	**557,244**	**14**	**74,083**	**133**	**1,482**	**2,659**	**30,636**
Age	15 to 20	98,412	31	9,158	93	183	1,861	7,752
	20 to 25	118,580	33	16,072	136	321	2,711	25,418
	25 to 30	99,426	26	16,146	162	323	3,248	40,036
	30 to 35	51,622	16	6,302	122	126	2,442	44,397
	35 to 45	70,721	12	9,817	139	196	2,776	43,059
	45 to 55	59,151	9	7,790	132	156	2,634	37,302
	55 to 65	29,450	5	4,014	136	80	2,726	33,418
	65 +	29,880	4	4,783	160	96	3,202	26,325
	Total	**557,244**	**14**	**74,083**	**133**	**1,482**	**2,659**	**30,636**
Sex	Male	341,622	18	49,076	144	982	2,873	35,970
	Female	215,622	11	25,007	116	500	2,320	22,186
	Total	**557,244**	**14**	**74,083**	**133**	**1,482**	**2,659**	**30,636**
Ethnicity	European	369,284	14	45,884	124	918	2,485	34,152
	Māori	123,870	25	18,309	148	366	2,956	21,343
	Other	64,089	8	9,890	154	198	3,086	28,338
	Total	**557,244**	**14**	**74,083**	**133**	**1,482**	**2,659**	**30,636**

Appendix B International literature summary findings

Table 7.2 Selected wellbeing measures and international literature on effect of cannabis legalisation

Domain	Indicator		Effect	Notes
Human Capital				
Health	Healthy life expectancy		○	
	Heart disease		↑	18-55 yrs
	Stroke		↗	18-55 yrs
	Diabetes		○	
	Asthma		○	
	Arthritis/Chronic Pain		○	
	Mental Health		↗	
	Substance co-use	Recreational	↘	
		Tobacco	↘	
		Alcohol	↘	
	Cannabis-related disorders		○	
	Treatment programme attendance		○	
Acute medical outcomes	Hospital / ED visits		↑	
	Calls to poison centre		↑	
Avoidable mortality	Suicide rate		↘	Decrease for all 30-39 yrs, and 20-29 yrs males
	Fatal transport accidents		↘	Attributed to substitution effect with alcohol
Productivity	Employment rates		○	Medical cannabis - increase in labour supply of 51yrs+
	Average income		↘	Mixed - decrease in construction and young males, no change other sectors/gender/age, tails off 3yrs after legalisation
	Workplace absenteeism		↘	30-59 yrs; attributed to substitution effect with alcohol
	Educational attainment		○	
Subjective wellbeing	Life satisfaction		○	
	Perception of harm risk		↓	
Children and youth	Use		↘	Slight increase for female, large decrease for male
	Age of initiation		○	
	Cannabis related-disorders		↘	
	School-based drug education programmes		○	
	School absenteeism		○	
	School completion		↗	
	Perception of harm risk		↓	
	Perception of availability of cannabis		↘	
	Acute medical outcomes		↑	Largely in those under 9yrs
	Cannabis-related crime rates		↘	
	Child safety		○	Physical abuse and child fatality rates decreased, neglect rate increased
	Adverse neonatal outcomes		○	
Social capital				
Safety and security	Safety and security		○	
	Intentional homicide		○	
	Domestic violence		○	Mixed results
	Work accident		↘	Reduction in workplace fatalities for 25-44 yrs, less so for 16-24 yrs; substitution effect?
	Cannabis-related crime rates		↓	Substantial declines, however racial disparities persisted post-legalisation
Trust	Generalised trust		○	
Natural capital				
	Environment		↓	High water usage; associated with land clearing, road building, habitat conversion, and agrochemical pollution
	Energy use		↑	Indoor operations high consumers of electricity

↑ Significant increase
↗ Some increase
○ No change or not enough data
↘ Some decrease
↓ Significant decrease

Appendix C Formulas used

The following formulas have been used in the calculations of the benchmark and scenario modelling for each group of cannabis users and scenario (0, a).

Total harm of all users $\boldsymbol{TH_u^0}$

Total kilograms used $\boldsymbol{TK_u^0}$

Total number of users $\boldsymbol{U^0}$

Price elasticity $\boldsymbol{E_u^A}$

Cross price elasticity $\boldsymbol{X_u^A}$

Price $\boldsymbol{P}$

Grams per users $\boldsymbol{k}$

Harm per kilogram $\boldsymbol{h}$

Illicit proportion of the cannabis market $\boldsymbol{I}$

Harm calculation

Assume $h_u^0 = \frac{TH_u^0}{TK_u^0} = h_u^A$

$$Harm_u^A = \frac{TH_u^0}{TK_u^0}(TK_u^A - TK_u^0)$$

Participation elasticity calculation

$$U^A = U^0((1 - E_u^A) * \%\Delta P)$$

Price elasticity calculation

$$TK_u^A = k_u^0 U^A (1 - E_u^A) * \%\Delta P$$

Cross price elasticity of legal cannabis on illegal consumption

$$TK_{iu}^A = k_u^0 U^A((1 - X_u^A) * \%\Delta P_l)$$

$$TK_{lu}^A = k_u^0 U^A((1 - EX_u^A) * \%\Delta P_i)$$

Illegal demand

$$TK_{iu}^A = Ik_u^0 U^A((1 - E_u^A) * \%\Delta P_i + ((1 - X_u^A) * \%\Delta P_l))$$

Legal demand

$$TK_{lu}^A = (1 - I) * k_u^0 U^A((1 - E_u^A) * \%\Delta P_l + ((1 - X_u^A) * \%\Delta P_i))$$

Total cannabis demand

$$TK_u^A = TK_{lu}^A + TK_{iu}^A$$