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*Final report*

# Northland's mineral resources

## Potential economic impacts

**Report commissioned by:**

**Crown Minerals**
**Northland Regional Council**
**Far North District Council**
**Whangarei District Council**

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## Preface

NZIER is a specialist consulting firm that uses applied economic research and analysis to provide a wide range of strategic advice to clients in the public and private sectors, throughout New Zealand and Australia, and further afield.

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## Authorship

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# Executive Summary

This brief report summarises the potential economic impact of the mineral resources of the Northland region: for the region as a whole, and for each of its districts (Far North, Whangarei and Kaipara). The purpose of the analysis is to determine what additional economic benefits accrue, in terms of value added, output and employment, from a scenario of increased mineral production. This scenario, developed by Christie and Barker (2007), is based on an assessment of the region's mineral deposits and the potential for new discoveries, and is shown in Table 1.

***Table 1 Mining production scenario***

| | Far North | Kaipara | Whangarei | Northland |
|---|---|---|---|---|
| Total future mining production | $201,300,215 | $25,766,096 | $125,304,811 | $352,371,122 |
| 2005 | $19,984,119 | $13,530,085 | $22,090,134 | $55,604,339 |
| % increase from 2005 | 907% | 90% | 467% | 534% |
| $ Increase from 2005 | $181,316,096 | $12,236,011 | $103,214,677 | $296,766,783 |

Source: Christie and Barker (2007)

The economic impact analysis presented in this report effectively compares two future economies (for each district):

- A 'business as usual' economy in which the status quo prevails with respect to all sectors i.e. the future economy is assumed to be unchanged from its existing level and structure.
- A 'counterfactual' economy which incorporates the mining production scenario presented above. The only changes from the BAU economy arise from the additional mining activity, thus all changes, regardless of where in the economy they occur, are attributable to the increase in mining production.

Changes in economic activity resulting from the production scenario are measured in terms of:

- Output – that is, the value of production.
- Value added – that is, the difference between the value of production (i.e. output) and the value of goods and services that are needed in the production process. The sum of value added across all the sectors of an economy is equal to GDP.
- Employment in full-time equivalent terms.

The estimated economic impacts of the production scenario (shown above) are presented in Table 2. It is estimated that the projected mining scenario will lift Northland's GDP by nearly $279 million, or about 6% higher than it would otherwise be, with around $142 million of this increase occurring in sectors other than mining.

***Table 2 Mining scenario: economy-wide impacts***

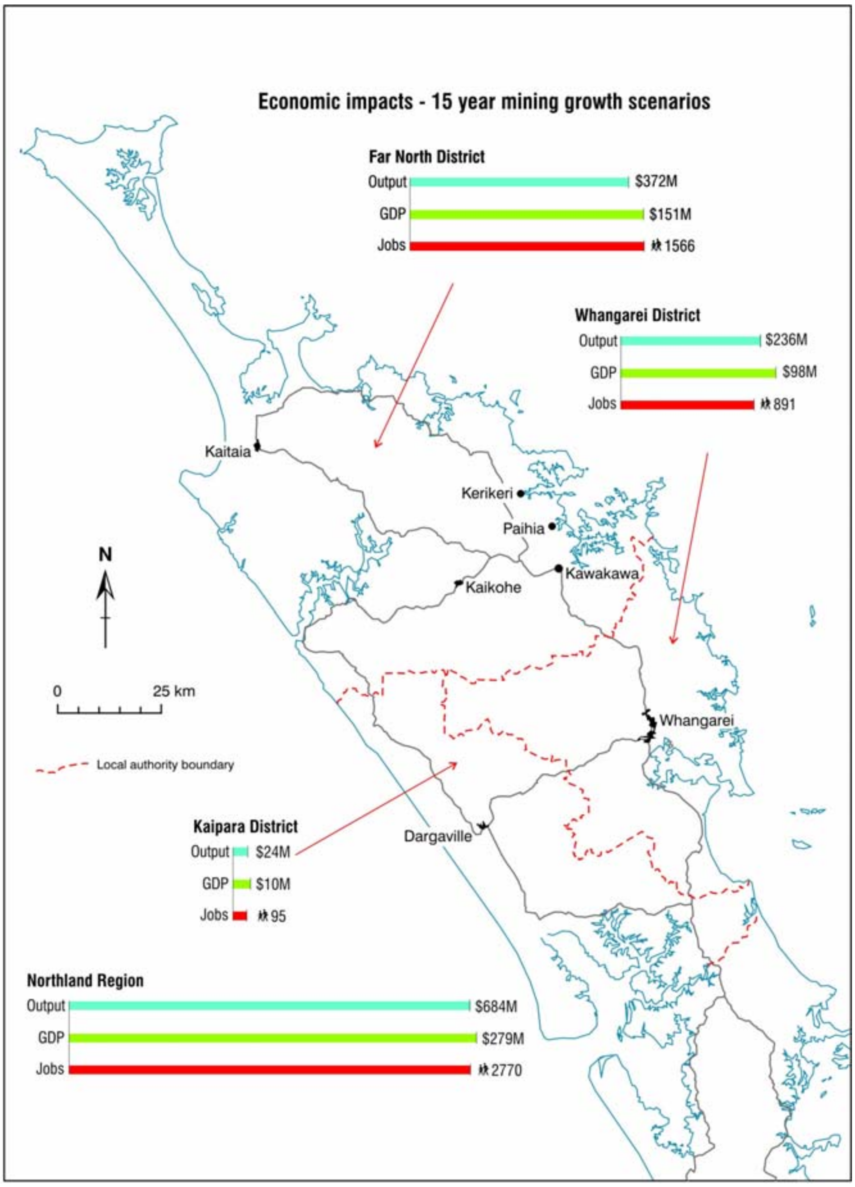
| Area | Economy-wide increase in output ($m) | Economy-wide increase in GDP ($m) | Economy-wide increase in employment |
|---|---|---|---|
| Far North | 372,151,287 | 150,577,550 | 1,566 |
| Kaipara | 23,976,464 | 9,619,340 | 95 |
| Whangarei | 235,236,570 | 97,830,000 | 891 |
| Northland | 682,919,721 | 278,602,281 | 2,720 |

Note that the district impacts may not sum to the regional impact due to the methodology used to derive the underlying input-output tables.

Source: Christie and Barker (2007), NZIER

The regional and district impacts are also presented in Figure 1 (page iii).

*Figure 1 Mining growth scenario economic impacts*




Source: NZIER, GNS

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# 1. Introduction

This report estimates the potential economic impact of the mineral resources of the Northland region: the region as a whole, and for each of its districts (Far North, Whangarei and Kaipara). The purpose of the analysis is to determine what additional economic benefits accrue, in terms of value added, output and employment, from a scenario of increased mineral production. This scenario, developed by Christie and Barker (2007), is based on an assessment of the region's mineral deposits and the potential for new discoveries.

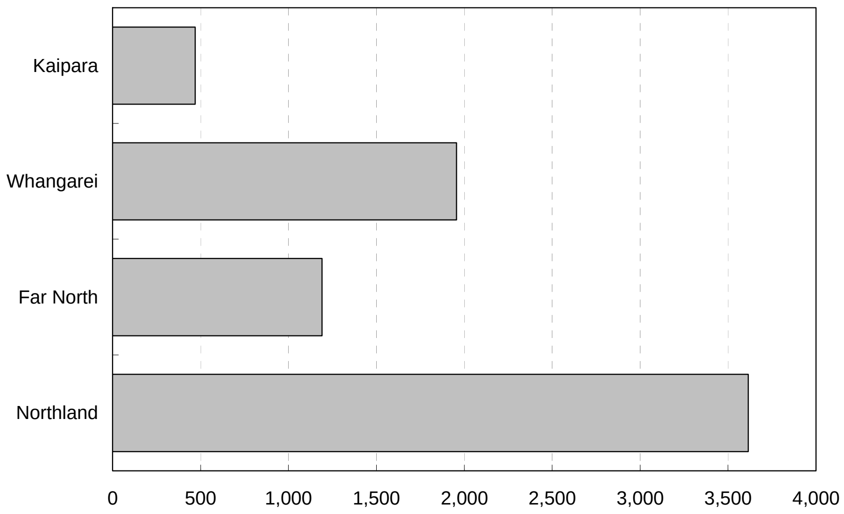
This report is laid out as follows: to provide some context to the economic impact analysis, a brief statistical overview of the Northland economies is presented. The report then briefly reviews the mining production scenario before presenting a summary of the economic impact analysis results.

# 2. Economic background

For the year ending March 2003, GDP for the Northland region is estimated to be slightly more than $3.6 billion. This represents around 2.8% of national GDP for that year.

In GDP terms, the Whangarei district is the largest of the region, being larger than the Far North and Kaipara districts combined (see Figure 2)

***Figure 2 Northland and districts GDP***
Year ending March 2003, $ million

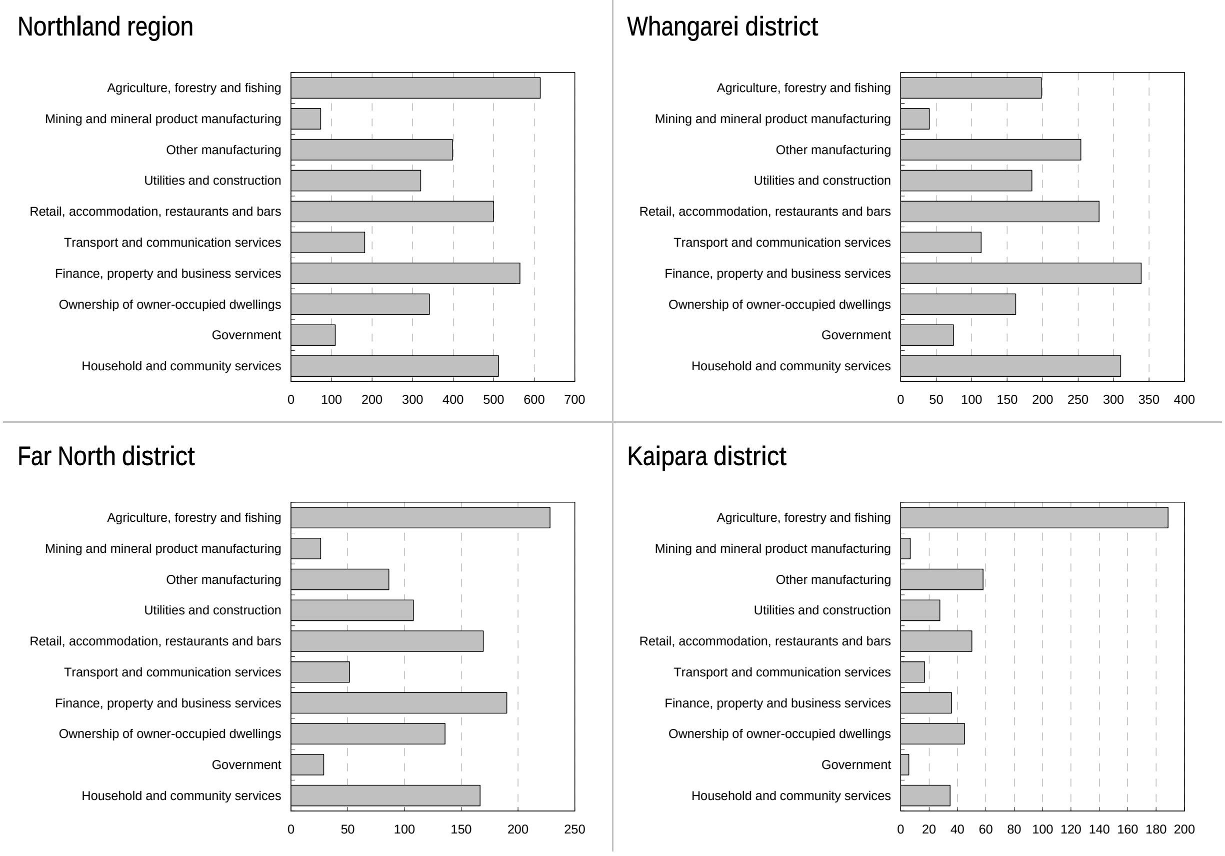



Source: NZIER, Statistics New Zealand

The Northland regional economy is relatively well-diversified across the 9 sectors used in this study. The combined agriculture, forestry and fishing sector makes the largest contribution to regional GDP, but 7 other sectors also make significant contributions to the total. The two remaining, relatively small sectors are government and mining (see Figure 3).

***Figure 3 Northland and districts sectoral GDP***

Year ending March 2003, $ millions




Source: NZIER, Statistics New Zealand

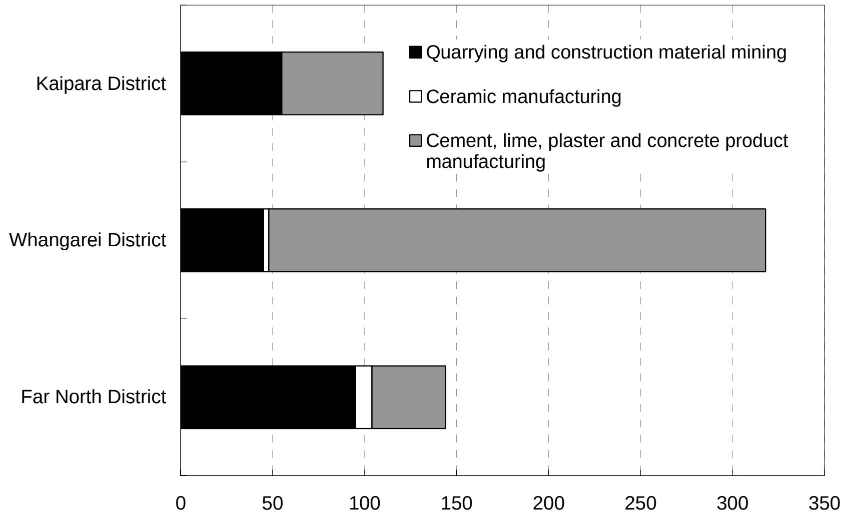
Sectoral composition varies a little across the districts. The relative contribution of agriculture, forestry and fishing, for instance, is much greater for Kaipara than it is for Whangarei and the Far North. Notably mining (including mineral product manufacturing) is not a significant contributor to GDP for any of the three districts.[1] Mining's relative contribution is greatest for the Far North district, where mining GDP contributes 2.2% of the district's total GDP.

While its contribution to regional GDP may be relatively low, the mining sector is nonetheless an important source of employment for residents. As at February 2006, the sector employed nearly 600 people. The largest concentration is in the cement, lime, plaster and concrete product manufacturing industry (see Figure 4)

[1] Throughout this report, the "mining" sector includes the mineral product manufacturing industries, including cement and ceramics production.

*Figure 4 Northland districts' mining employment 2006*

Numbers employed




Source: Statistics New Zealand

# 3. Production scenario recap

Table 3 presents the future production scenario estimated by Christie and Barker (2007). Future production levels for the region and districts are compared to the current (i.e. 2005) levels of production. The posited production scenario clearly represents a significant increase over existing levels for all districts, although as noted above, existing mining production levels are relatively modest.

*Table 3 Mining production scenario*

| | Far North | Kaipara | Whangarei | Northland |
|---|---|---|---|---|
| Total future mining production | $201,300,215 | $25,766,096 | $125,304,811 | $352,371,122 |
| 2005 | $19,984,119 | $13,530,085 | $22,090,134 | $55,604,339 |
| % increase from 2005 | 907% | 90% | 467% | 534% |
| $ Increase from 2005 | $181,316,096 | $12,236,011 | $103,214,677 | $296,766,783 |

Source: Christie and Barker (2007)

# 4. Economic impact analysis

The purpose of the economic impact analysis is to determine the magnitude of the impact of increasing mining production levels in line with the scenario presented in Table 3 above. The analysis effectively compares two future economies (for each district):

- A ‘business as usual’ economy in which the status quo prevails with respect to all sectors i.e. the future economy is assumed to be unchanged from its existing level and structure.
- A ‘counterfactual’ economy which incorporates the mining production scenario presented above. The only changes from the BAU economy arise from the additional mining activity, thus all changes, regardless of where in the economy they occur, are attributable to the increase in mining production.

Changes resulting from the production scenario can be measured in terms of a range of economic indicators. We use output, value added and employment because they are the standard measures of economic growth. Each is explained in turn:

**Output** is the value of production. At the firm level, this closely corresponds to sales revenue earned for the supply of goods or services. Sectoral output is simply the aggregation of the output of all firms within a particular sector; similarly, economy-wide output is the aggregate output of all firms in the economy.

**Value added** represents the difference between the value of production (i.e. output) and the total value of any intermediate input goods or services used. Intermediate inputs are those goods and services that are purchased from other firms and which are required as part of the production process. Firms can be thought of as purchasing a selection of goods and services which they combine and transform into another good (or goods) for on-selling. This transformation process adds value to the input goods and services – hence the label value added. The two major elements of this transformation process are labour and profit margins; value added thus also has the important distinction of representing the incomes that are generated from the production process and earned by employees and business owners. GDP is simply the sum of the values added for all firms in an economy.

**Employment** is measured in full-time equivalent terms. One full-time equivalent employee is equal to one full-time employee or 2 part-time employees.

## 4.1 Impact analysis methodology

The analysis undertaken here uses multipliers derived from district level input-output tables.

**Multipliers** are sets of numbers that, for each sector, measure the economy-wide change resulting from a change in that sector. An output multiplier of 1.8 for the mining industry, for instance, says that if output of the mining industry were to increase by $1 million, the output of the other sectors of the economy would need to increase by $0.8 million in order to support the additional needs of the mining sector. The magnitude of a multiplier for a particular sector relates to the inter-connectedness between that sector and other sectors in the local economy; in general, the more that a particular sector relies on inputs from local businesses in other sectors, the greater will be its multipliers. Multipliers can be derived for a number of economic variables; for this project we focus on output, value added and employment (as noted above).[2]

Note that multipliers for a particular sector may vary across regions (or districts) due to differences in the level of interconnectedness between that sector and others in the local economy. If a sector is relatively dependent on local suppliers then its multiplier will be relatively high; on the other hand, if the sector sources a large share of its inputs from outside the region (including from overseas), then its multiplier will be relatively low. Variances in multiplier values shown below thus reflect the differing degrees of interconnectedness that the mining sector has in each local economy.

**Input-output tables** are, in simple terms, matrices that present the flow of goods and services between the sectors that make up an economy. By manipulating these tables we can derive measures of the extent to which each sector is dependent on the other sectors of the economy; multipliers are one of these measures. The input-output tables used in this project represent each district's economy for the year ending March 2003.

## 4.2 Impact analysis results

***Table 4 Mining scenario: mining impacts***

| Area | Increase in mining production ($) | Increase in mining value added ($) | Increase in mining employment |
|---|---|---|---|
| Far North | 181,316,096 | 83,187,421 | 688 |
| Kaipara | 12,236,011 | 5,613,855 | 46 |
| Whangarei | 103,214,677 | 47,354,664 | 391 |
| Northland | 296,766,783 | 136,155,938 | 1,125 |

Note that the district impacts may not sum to the regional impact due to the methodology used to derive the underlying input-output tables.

Source: Christie and Barker (2007), NZIER

Table 4 presents the impact of the mining scenario on the mining sector only. The "Increase in mining production" column is simply a transposition of the production values presented in Table 3 above. The following two columns represent the additional value added and employment generated within the mining sector in line with this production scenario.

Table 5 shows the economy-wide impact on output of the mining production scenario. Using the Northland numbers as an example, the interpretation is that if mining output increases in line with the production scenario presented in Table 3, the total value of output of the Northland economy will increase by nearly $683

2 Details on the derivation of the multipliers is provided in Appendix B .

million. This total impact includes the initial impact within the mining sector; thus, a scenario in which mining output is increased by $297 million will lead to increases in the output of the other sectors of the Northland economy of about $386 million. As noted earlier, these increases are with respect to the BAU case in which the economy remains static, so we can say that if the mining production scenario were to eventuate (and with the economy otherwise behaving in a business-as-usual manner), the output of the Northland economy would be nearly $683 million higher than it would otherwise have been.

***Table 5 Mining scenario: change in economy-wide output***

| Area | Increase in mining production ($) | Output multiplier | Economy-wide increase in output ($) |
|---|---|---|---|
| Far North | 181,316,096 | 2.053 | 372,151,287 |
| Kaipara | 12,236,011 | 1.960 | 23,976,464 |
| Whangarei | 103,214,677 | 2.279 | 235,236,570 |
| Northland | 296,766,783 | 2.301 | 682,919,721 |

Source: Christie and Barker (2007), NZIER

Table 6 shows the economy wide impact on value added of the mining production scenario of Table 3.

***Table 6 Mining scenario: change in economy-wide value added***

| Area | Increase in mining value added ($) | Value added multiplier | Economy-wide increase in value added ($) |
|---|---|---|---|
| Far North | 83,187,421 | 1.810 | 150,577,550 |
| Kaipara | 5,613,855 | 1.714 | 9,619,340 |
| Whangarei | 47,354,664 | 2.066 | 97,830,000 |
| Northland | 136,155,938 | 2.046 | 278,602,281 |

Source: Christie and Barker (2007), NZIER

Again using Northland as an example, the analysis shows that if mining production increases by $297 million, mining value added will increase by around $136 million, and the value added of the other sectors will increase by around $142 million (above what it would otherwise be in the BAU case).

Finally, Table 7 shows the impact of the increased mining activity on local employment levels. The additional mining production shown in Table 3 will generate an additional 1,125 full-time equivalent jobs in Northland’s mining sector, and the employment of other sectors in Northland will increase by a further 1,595 jobs.

*Table 7 Mining scenario: change in economy-wide employment*

| Area | Increase in mining employment | Employment multiplier | Economy-wide increase in employment |
|---|---|---|---|
| Far North | 688 | 2.278 | 1,566 |
| Kaipara | 46 | 2.049 | 95 |
| Whangarei | 391 | 2.278 | 891 |
| Northland | 1,125 | 2.417 | 2,720 |

Source: Christie and Barker (2007), NZIER

## 4.3 Context for the results

The results above can – and probably do – appear to be very abstract in the absence of any context to which they can be compared. To provide that context, Table 8 compares the economy-wide impacts of the mining production for Northland with our forecast BAU case for the Northland economy in 2020. The table shows that if the mining production scenario presented in Table 3 is achieved by 2020, it has the potential to lift Northland's GDP by 5.98% above what it will otherwise be.

*Table 8 Northland mining impacts vs forecast BAU*

| | Output ($m) | Value added ($m) | Employment |
|---|---|---|---|
| Forecast BAU | 11,259,707,009 | 4,656,942,974 | 64,991 |
| Mining scenario economy wide impact | 682,919,721 | 278,602,281 | 2,720 |
| % impact of mining above BAU | 6.07 | 5.98 | 4.18 |

Source: NZIER

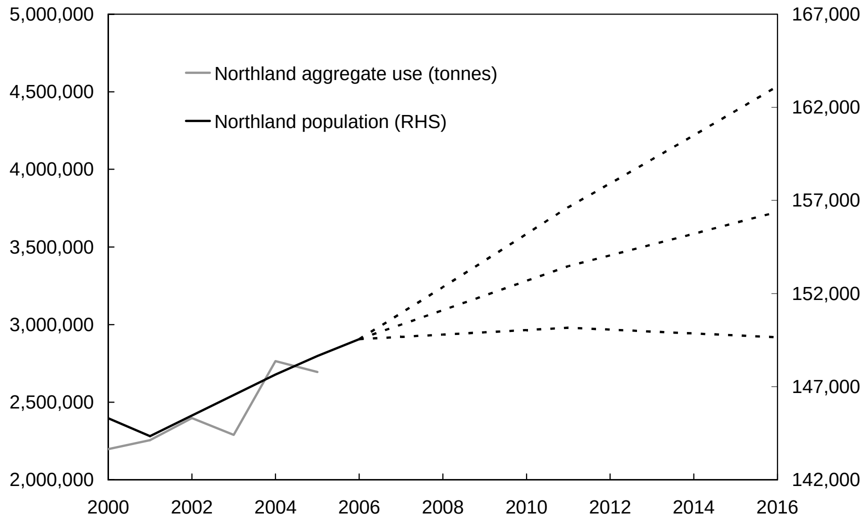
### 4.3.1 Northland demand for aggregate

During the past 5-6 years, the demand for aggregate in Northland has correlated remarkably well with the growth in the regional population. This accords with the simple hypothesis that an expanding population requires additional housing and infrastructural assets, which in turn creates increased demand for building materials, including aggregate. Figure 5 plots the historical relationship between Northland aggregate demand and population growth together with Statistics New Zealand's projections of future population growth. The three dashed lines represent high, medium and low scenarios of population growth. Should the historical relationship between aggregate demand and population growth be maintained in the future, then the outlook for aggregate suppliers appears to be relatively robust under both the high and medium population growth scenarios.

The low population growth scenario paints a weaker picture, with aggregate demand consolidating at around current levels.[3]

***Figure 5 Northland aggregate use and population growth***

Tonnes, population count (RHS)




Source: Crown Minerals, Statistics New Zealand

Population changes and projections evaluated at the regional level can mask pockets of significant positive growth (or decline) at the township level. For instance, while the population of the Far North District grew roughly in line with Northland population growth between 2001 and 2006 (at around 2.3%), a number of relatively large communities grew at between 15-20% over the same period (including Kerikeri, Haruru Falls, Kapiro and Waihou Valley – Hupara). This suggests that even if regional population growth follows the low growth scenario portrayed in Figure 5, local pockets of growth are likely to support significant demand for construction materials in specific locations.

3 Data from the 2006 Census shows that the Northland population increased by 4,120 people (or 2.9%) between 2001 and 2006. This growth mostly closely aligns with Statistics New Zealand's low growth projection for that period.

# 5. References

Christie, A.B. and Barker, R.G. (2007): Mineral resource assessment of the Northland region. GNS Science science report 2007/06.

# Appendix A Multiplier analysis: caveats

For a host of reasons, multipliers must be interpreted with caution. In particular, three key points should be noted:

(i) Multipliers assume that sectors combine inputs, and produce outputs, in fixed proportions.

(ii) Multipliers take no account of induced changes in relative prices.

(iii) Multipliers assume that labour and capital are available in unlimited quantities.

These assumptions are, to some degree, abstractions from reality. Businesses will, to an extent, be able to substitute between purchased goods, and thus alter their input mix. Changes in the supply and demand of goods and services will affect the price of those products. And the factors of production, particularly labour in the New Zealand context, are only available in limited quantities, certainly in the short run.

Further, these assumptions become increasingly unrealistic, the greater the size of the economic change being modelled. Clearly then, multipliers are at their best when being used to examine relatively small economic shocks. It is with these provisos in mind that the multiplier analysis contained in this report is presented.

# Appendix B Input-output methodology

## B.1 Introduction

This appendix aims to provide detail regarding the techniques employed in this report. The appendix covers the input-output table, derivation of multipliers, and extraction and linkage techniques.

## B.2 The Input-output model

An input-output (IO) table is a matrix representation of the flows related to the production and consumption of goods and services for a particular economy. A stylised picture of an input-output table is presented in Figure 6.

***Figure 6 The input-output table***

| | Industry inputs | | | | Final demands (f) | | | | Total sales (x) |
|---|---|---|---|---|---|---|---|---|---|
| Industry sales | $z_{11}$ | $z_{12}$ | … | $z_{1n}$ | $c_1$ | $i_1$ | $g_1$ | $e_1$ | $x_1$ |
| | $z_{21}$ | $z_{22}$ | … | $z_{2n}$ | $c_2$ | $i_2$ | $g_2$ | $e_2$ | $x_2$ |
| | ⋮ | ⋮ (I) | | ⋮ | ⋮ | ⋮ (II) | ⋮ | ⋮ | ⋮ |
| | $z_{n1}$ | $z_{n2}$ | … | $z_{nn}$ | $c_n$ | $i_n$ | $g_n$ | $e_n$ | $x_n$ |
| Value added | $l_1$ | $l_2$ (III) | … | $l_n$ | | (IV) | | | $l$ |
| | $k_1$ | $k_2$ | … | $k_n$ | | | | | $k$ |
| Imports | $m_1$ | $m_2$ | … | $m_n$ | | $m_f$ | | | $m$ |
| Total outlays (x) | $x_1$ | $x_2$ | … | $x_n$ | $c$ | $i$ | $g$ | $e$ | |

The first $n$ rows of Figure 6 record the distribution of a sector's output; the first $n$ columns record the distribution of a sector's inputs. The cells in the intersection of the first $n$ rows and columns represent the interindustry transactions; this square array of transactions is known as the transactions matrix, or quadrant I of the input-output table, and is denoted **Z**.

Purchases by final consumers from each sector $i$ are recorded in the array to the right of the transactions matrix (i.e. quadrant II). These purchases can be broken down into:

$c_i$ = personal consumption expenditure on goods from sector *i*

$i_i$ = purchases of fixed assets for investment on goods from sector *i*

$g_i$ = government purchases on goods from sector *i*, and

$e_i$ = exports of goods from sector *i*.

Sector j's payments to the factors of production are recorded in quadrant III (i.e. the array below the transactions matrix). In Figure 6 these are:

$L_j$ = payments made to labour

$K_j$ = payment made to owners of capital, including the depreciation allowance.

Also included within quadrant III are imports of intermediate inputs by sector *j*, $m_j$. Imports purchased by final consumers, $m_f$, are recorded in quadrant IV.

Using the observed inter-relationships portrayed in an IO table, we can measure the impact of a change in one industry on the remainder of the economy, and these measures are known as multipliers.

### B.2.1 Type I and Type II multipliers

Type I and Type II multipliers differ in the extent to which they fully capture economy-wide impacts of a sectoral change. Type II multipliers provide a more comprehensive measure of economic change. The derivation of Type II multipliers is essentially an extension of the Type I algebra; hence both Type I and Type II derivations are presented here.

The distinction between Type I and Type II multipliers is as follows:

- *Type I multipliers* measure the direct and indirect effects of a change. In the instance of an output multiplier, the direct effect is the initial rise in output in the industry which is experiencing higher demand. The indirect effects result from the need to produce more inputs for that industry.
- *Type II multipliers* include the direct and indirect effects, as well as the income-induced effect of a change. The initial direct and indirect effects result in higher employment, which in turn boosts household income, which increases demand, which lifts output, which then lifts employment further, and so on.

### B.2.2 Derivation of Type I multipliers

Given an *n*-sector economy, the transactions matrix and the vectors of final demands and outputs can be represented as:[4]

[4] In the Inter-industry Study 1996, which forms the basis of the multiplier analysis contained in this report, *n* = 126.

$$\mathbf{Z} = \left(\begin{array}{cccc|c} z_{11} & z_{12} & \cdots & z_{1n} & z_{1c} \\ z_{21} & z_{22} & \cdots & z_{2n} & z_{2c} \\ \vdots & \vdots & & \vdots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nn} & z_{nc} \\ \hline z_{c1} & z_{c2} & \cdots & z_{cn} & \end{array}\right) \qquad \mathbf{f} = \begin{pmatrix} f_1 \\ f_2 \\ \vdots \\ f_n \end{pmatrix} \qquad \mathbf{x} = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix}$$

where:

$z_{ij}$ = sector $i$ sales to sector $j$

$f_j$ = sector $j$ sales to final demand

$x_j$ = total sector $j$ sales

The $c$-th row represents compensation of employees (i.e. payments for labour), and the $c$-th column is household consumption.

The relationship between the elements of these matrices is:

$$x_i = z_{i1} + z_{i2} + \ldots + z_{in} + f_i \qquad (1)$$

The technical coefficients (or direct input coefficients) of sector $j$ are written:

$$a_{ij} = z_{ij} / x_j \qquad (2)$$

which in matrix form is:

$$\mathbf{A} = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{in} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix}$$

Thus $a_{ij}$ is the proportion of sector $j$'s total output (the value of which is equivalent to the value of sector $j$'s total input) and is made up of inputs from other sectors.

Given equation (1), sector $i$'s sales can be rewritten and expressed in terms of technical coefficients as:

$$x_i = a_{i1}x_1 + a_{i2}x_2 + \ldots + a_{in}x_n + f_i \qquad (3)$$

Equations (1) and (3) respectively can be written in matrix form as:

$$\mathbf{x} = \mathbf{Zi} + \mathbf{f} \qquad (4)$$

$$\mathbf{x} = \mathbf{Ax} + \mathbf{f} \qquad (5)$$

where **i** is an *n*-element column vector of 1s.

Recall that equations (1) and (3), and hence (4) and (5), are equivalent.

Using an *nxn* identity matrix, **I**, and rearranging equation (5) yields:

$$\mathbf{Ix - Ax = f}$$

$$\Rightarrow \quad \mathbf{(I - A)x = f} \qquad (6)$$

From this we can derive the change in output, $\mathbf{x}^*$, arising from a change in final demand, $\mathbf{f}^*$:

$$\mathbf{x}^* = \mathbf{(I - A)}^{-1}\mathbf{f}^* \qquad (7)$$

$\mathbf{(I - A)}^{-1}$ is the Leontief Inverse, or the total (initial, direct and indirect) requirements matrix. This can be represented by **B** so that:

$$\mathbf{x}^* = \mathbf{Bf}^* \qquad (8)$$

#### B.2.2.1 Output multipliers

Re-expressing equation (8) in expanded format gives:

$$\mathbf{x}^* = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix} \begin{pmatrix} f_1^* \\ f_2^* \\ \vdots \\ f_n^* \end{pmatrix}$$

From this it can be seen that the economy-wide impact of $f_j^*$ is:

$$x_j^* = \sum_{i=1}^{n} b_{ij} f_j^* \qquad (9)$$

For $f_j^* = 1$, $x_j^*$ reduces to:

$$x_j^* = \sum_{i=1}^{n} b_{ij} \qquad (10)$$

$x_j^*$ is the (Type I) *output multiplier*: that is, how much does economy-wide output have to increase to meet a $1 increase in final demand for the output of sector *j*.

#### B.2.2.2 Value added multipliers

In principle these are calculated in the same way as for output multipliers; the distinction is that changes in sectoral output arising from a change in final demand are scaled by each sector's value added input coefficient (i.e. the ratio of value added to total inputs).

The value added input coefficients are calculated using the sum of the compensation of employees, the operating surplus and net indirect tax rows of the input-output table. We shall denote this sum as $z_{vaj}$. In a manner similar to that used to derive the direct input coefficients in equation (2), the value added input coefficients are:

$$a_{vaj} = z_{vaj} / x_j \qquad (11)$$

By using this to scale the impact of changes in output we have:

$$v_j^* = \sum_{i=1}^{n} a_{vai} b_{ij} / a_{vaj} \qquad (12)$$

This is the (Type I) *value added multiplier*. Its interpretation is: how much will economy-wide value added increase, above the initial increase in sector *j*'s value added payments, given an increase in final demand of sector *j*'s output of $1.

#### B.2.2.3 Income multipliers

These are calculated as for the value added multipliers, with scaling of sectoral output done by compensation of employees (i.e. household income). Recalling that compensation of employees is recorded in *c*-th row of the input-output table, the compensation of employees coefficient is:

$$a_{cj} = z_{cj} / x_j \qquad (13)$$

By using this to scale the impact of changes in output we have:

$$h_j^* = \sum_{i=1}^{n} a_{ci} b_{ij} / a_{cj} \qquad (14)$$

This is the (Type I) *income multiplier*. Its interpretation is: how much will economy-wide income increase, above the initial increase in sector *j*'s income (i.e. compensation of employees) payments, given an increase in final demand of sector *j*'s output of $1.

#### B.2.2.4 Employment multipliers

These are calculated as for the income multipliers, but rather than use compensation of employees to scale the output effects we have used the ratio of full-time equivalent (FTE) jobs to output by sector. This employment ratio is:

$$e_j = FTE_j / x_j \qquad (15)$$

Using this in our multiplier calculation gives:

$$e_j^* = \sum_{i=1}^{n} e_i b_{ij} / e_j \qquad (16)$$

### B.2.3 Derivation of Type II multipliers

In the calculations above, the matrix elements are restricted to those within the *n*x*n* confines of the transactions matrix of the inter-industry table. However, this effectively excludes the impact of changes in household income arising from additional final demand, since household income and consumption is outside of the *n*x*n* matrix. Type II multipliers address this issue by expanding the *n*x*n* matrix to include household consumption and compensation of employees. Households are effectively treated as another production sector in Type II multiplier analysis, producing labour services and demanding consumption goods and services.

The technical coefficients for the household row and column are:

$$a_{cj} = z_{cj} / x_j \qquad (17)$$

$$a_{ic} = z_{ic} / x_c \qquad (18)$$

where:

$a_{cj}$ = the labour coefficient for sector *j*

$a_{ic}$ = the 'household consumption' coefficient.

In equation (18), $x_C$ represents household disposable income. For the analysis contained in this report we calculated household disposable income as the sum of:

- compensation of employees (from the input-output tables)
- self-employed earnings (derived from SNZ's *Institutional Sector Accounts*)
- dividend earnings (derived from SNZ's *Institutional Sector Accounts*)

and then subtracted tax from that sum using an average personal income tax rate derived from the *Institutional Sector Accounts*. Note that both self-employed earnings and dividend earnings are reflected in the operating surplus row of the input-output table.

# Appendix C Chart data

***Table 9 Figure 2 data: Northland and districts sectoral GDP***

Year ending March 2003, $ millions

| | Northland | Far North | Whangarei | Kaipara |
|---|---|---|---|---|
| Agriculture, forestry and fishing | 614.8 | 228.2 | 198.2 | 188.5 |
| Mining and mineral product manufacturing | 73.4 | 26.3 | 40.3 | 6.8 |
| Other manufacturing | 398.2 | 86.3 | 253.9 | 58.0 |
| Utilities and construction | 320.3 | 107.8 | 184.8 | 27.7 |
| Retail, accommodation, restaurants and bars | 499.1 | 169.4 | 279.6 | 50.1 |
| Transport and communication services | 181.9 | 51.6 | 113.5 | 16.9 |
| Finance, property and business services | 564.8 | 190.1 | 338.9 | 35.8 |
| Ownership of owner-occupied dwellings | 341.5 | 135.7 | 162.2 | 45.0 |
| Government | 109.0 | 28.9 | 74.4 | 5.7 |
| Household and community services | 511.6 | 166.6 | 310.1 | 34.9 |
| Total | 3614.6 | 1191.0 | 1955.8 | 469.2 |

Source: NZIER

***Table 10 Figure 3 data: Northland districts' mining employment 2006***

Numbers employed

| | Far North | Whangarei | Kaipara |
|---|---|---|---|
| Quarrying and construction material mining | 95 | 45 | 55 |
| Ceramic manufacturing | 9 | 3 | 0 |
| Cement, lime, plaster and concrete product manufacturing | 40 | 270 | 55 |
| Total | 144 | 318 | 110 |

Source: Statistics New Zealand

## *Table 11 Figure 4 data: Northland aggregate use and population growth*

| Year | Northland population | Northland aggregate use (tonnes) | Population projection - high | Population projection - medium | Population projection - low |
|---|---|---|---|---|---|
| 2000 | 145,300 | 2,197,220 | | | |
| 2001 | 144,350 | 2,255,500 | | | |
| 2002 | 145,450 | 2,396,850 | | | |
| 2003 | 146,550 | 2,289,980 | | | |
| 2004 | 147,650 | 2,764,820 | | | |
| 2005 | 148,650 | 2,693,980 | | | |
| 2006 | 149,550 | | 149,550 | 149,550 | 149,550 |
| 2007 | | | 150,941 | 150,325 | 149,673 |
| 2008 | | | 152,344 | 151,105 | 149,796 |
| 2009 | | | 153,761 | 151,888 | 149,919 |
| 2010 | | | 155,191 | 152,675 | 150,042 |
| 2011 | | | 156,634 | 153,467 | 150,165 |
| 2012 | | | 157,912 | 154,045 | 150,063 |
| 2013 | | | 159,200 | 154,626 | 149,960 |
| 2014 | | | 160,498 | 155,208 | 149,858 |
| 2015 | | | 161,808 | 155,793 | 149,755 |
| 2016 | | | 163,128 | 156,380 | 149,653 |

Source: Crown Minerals, Statistics New Zealand