Report No: CCC 040714

AGGREGATES

DEMANDS AND RESOURCES

Christchurch City Council District Plan Review – Background Data.

TWELFTH KNIGHT CONSULTING

Report prepared by Twelfth Knight Consulting for Christchurch City Council – October 2014

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SUMMARY.

S 1. Introduction.

The Christchurch City Council (the Council) is currently reviewing both its Banks Peninsula District and Christchurch City Plans with the intention of amalgamating them into a single District Plan document. The Council notes that, given the impacts of the changed circumstances post 2009, when an assessment was previously made of the area's demands and aggregate resources[(a)], it is opportune to undertake a re-assessment of those previous investigations in order to inform planning decisions with respect to the medium and longer term supply of aggregates to the Council area.

The project objectives are therefore to provide:

(1) An assessment of current and projected demand for aggregates in the Christchurch District for the planning periods to 2028 and 2041.

(2) Updated, cumulative data on existing, local aggregate resources to reflect changes to the quantum's of suitable, available materials within existing quarry zones and those newly consented quarries outside these zones.

(3) An assessment of the overall need for additional aggregate resources (zoned and/or consented) in the District to 2028 and 2041.

S2 . Demands.

S2.1 Past and Present Aggregate Production and Demands.

S2.1.1 Study Area.

The study area, which is bounded by the Canterbury foothills, the Pacific Ocean and the Ashley and Rakaia Rivers, is effectively self-contained from an aggregate production and demand perspective. Hence production equates to demand. There is however evidence to show that there is a transfer of materials out of the Christchurch City Council (CCC) area into the Selwyn District Council (SDC) and Waimakariri District Council (WDC) areas. Prior to the earthquakes this transfer amounted to approximately 10 - 15% of Council area production.

Annual aggregate production from all sources (i.e. rivers and local authority and privately owned quarries) from within the area encompassed by CCC, WDC, and SDC has increased approximately from 1. 8 million tonnes in 1992/3 to 7.2 million tonnes in 2013/14

(a) UDSMG Regional Gravel Resource Management Study report: "*Demands and Resources*" - UDS011209

S2.1.2 Christchurch City.

Eight, land based, alluvial quarries produce aggregates from both within the present Rural Quarry and Open Space 3D Zones and, relatively recently, consented sites outside these Zones. Significant quantities of materials are also sourced from the Waimakariri River.

Annual production, including that from the Waimakariri River, has increased from 1.5 million tonnes in 1992/3 to 5.8 million tonnes in 2013/4

S2.1.3 Selwyn District.

Selwyn District Council owns a number of relatively small lots, set aside for aggregate production. These properties are scattered across the District. Overall production is small in the context of this report.

There are presently six privately owned pits / quarries in the district. Three of these quarries are small, two are of a moderate size and one, opened recently at Burnham, has the potential to become large.

Annual production in the district, including local rivers, has increased approximately from 200,000 tonnes in 1992/3 to 900,000 tonnes in 2013/4

S2.1.4 Waimakariri District.

Waimakariri District Council owns three operational pits and there is one privately owned quarry in the area. Their combined production volume is understood to be relatively small.

Annual production in the district, including local rivers, has increased approximately from 100,000 tonnes in 1992/3 to 500,000 tonnes in 2013/4

S2.1.5 Rivers within the Study Area.

The Ashley, Eyre, Waimakariri, and Selwyn Rivers provide the majority of the river sourced materials for use in the study area. The percentage of river production as a proportion of the study area total increased steadily until 2008 although the proportion has fallen subsequently to currently less than 20%.

AREA	ANNUAL PRODUCTION @ 2013 / 14 (TONNES)		
	LAND BASED QUARRIES	RIVERS	TOTALS
Waimakariri District	190,000	300,000	490,000
Christchurch City Council	4,950,000	880,000	5,830,000
Selwyn District	810,000	85,000	895,000
TOTALS	**5,950,000**	**1,265,000**	**7,215,000**

S2.2 Future Demand to 2041.

S2.2.1 Background.

Long run increases in demand have approximately correlated with the increases in population and real Gross Domestic Product (GDP) over that period. This has been despite a range of influences relating to economic cycles and changes in methods of aggregate use. It has therefore been assumed for the purposes of predictions in this report that these underlying overall trends will continue.

It appears that underlying economic activity (i.e. excluding the impetus provided by the earthquake rebuild phase) will remain generally slightly below the more recent long term average through to 2016. The later sections of this report encompass these factors using a methodology adapted for the peculiar local circumstances in the post earthquake re-build period.

S2.2.2 Study Area.

Given the numbers of varying factors influencing future demand, and therefore the difficulty in making accurate predictions, a number of scenarios were tested during preparation of the 2009 reports to provide potential upper and lower bounds for demand.

The upper bound, which used the then greatest recently recorded annual increase in production rates as a predictor, was considered to be unlikely to continue in the longer term. The lower bound, which assumed population increase to be the sole driver in increases in demand, was considered to be too conservative for planning purposes.

The previous population projections used in the 2009 report have been adjusted in order to take account of the impacts of the earthquakes. In summary the differences between the 2009 and current projections for the increase in population for the period 2014 – 2041 within the study area are relatively small in the context of this report, even though the total, overall population numbers are slightly lower.

The 2009 report identified a number of specific one-off projects which, although delayed in some cases, are understood to generally still be proceeding as previously detailed. Accordingly the earlier list of potential one-off projects has been up-dated. This list indicates an average “one-off” project demand, for at least the next seven years, approaching 1 million tonnes annually. Accordingly ten million tonnes of demand from one-off projects (i.e. 7 million tonnes identified in the period 2014 to 2021 and an additional allowance of 3 million tonnes for the remainder of the period to 2028) have been included into predictions where noted.

The impacts of the earthquakes on demand are discussed in more detail in later sections however, in summary, the impacts are likely to be only short to medium term in nature.

It should be noted that the following scenarios do not purport to provide detail of demands at an annual level but rather to portray general trends based on predicted population and economic data.

S2.2.3 Study Area – Overall Demand.

Recent population projections indicate that the study area population may increase, on average, at approximately 0.8% per annum to 2041. This rate of population increase is less than long term national trends to date.(i.e. approximately 1.0% per annum) Accordingly an estimate has been based on the long term national demand increase plus an allowance for potential one-off projects less an allowance for the locally lower population increases – i.e. a base of approximately 3% per annum.

However the most likely underlying short to medium term scenario (i.e. to 2028) is considered to be for above average growth for the next 1 to 2 years, (i.e. before inclusion of the impacts of the rebuild on demand) followed by growth approximately in line with longer term national trends, with due allowance for one-off projects and a locally reduced rate of population growth. (i.e. an overall demand best described by an initial average equivalent growth rate of approximately 4.5% per annum.)

Leading up to the end of the period to 2028 and beyond, the rate of demand increase is likely to decrease as a result of the predicted reduction in the rate of population increase, the reduction in major roading projects, the escalating cost of aggregates, and a move to more efficient use of materials which in combination will reduce or even cap increases in demand per head in the longer term.

Accordingly the projected rate of increase in demand has been tapered over the period, resulting in, as noted above, an equivalent overall increase rate in demand between 2014 and 2041 of approximately 3% p.a.

S2.2.4 Christchurch City Council Area.

The City Council area population is projected to increase from a present approximate 365,000 to 400,000 by 2028; equivalent to an increase of approximately 0.6% per annum over the period. The population growth rate is predicted to fall further over the period 2028 to 2041 (i.e. 0.5% p.a.) resulting in an area projected population of approximately 425,000 by 2041. These projected population increase rates are less than both the long term national trends to date and the projections for the overall study area over the same timescales.

Although as a consequence of the earthquakes both the actual and predicted populations are less than those projected in the UDSIMG report[(a)] the majority of the larger infrastructural projects over the period will be constructed within, or very close to the city's boundaries. Accordingly the "best estimate" is based on both the study area "best estimate" and the long term national demand increase plus an allowance for infrastructural projects but less an allowance for the locally lower population increases – i.e. an initial base of approximately 4% per annum tapering to provide an average of approximately 2.5% overall between 2014 and 2041. (Refer S2.6 for details of the Christchurch area, earthquake adjusted, demand total for the period.)

S2.2.5 Selwyn District Council Area.

Partially consequent on the earthquakes, both the actual and predicted populations are greater than those projected in the UDSIMG report. The projected rate of population increase is greater than both long term national trends to date and that predicted for the overall study area

However tonnage per head figures are generally higher in rural than in urban areas. Therefore as the district becomes increasingly urbanised (in a relative sense) so will the average consumption per head decrease.

Identified larger infrastructural projects within the district are limited to the second Southern Motorway extension in the vicinity of Templeton, some four laning of State Highway 1 and building platforms for the IZone at Rolleston.

The combined impact of these effects, result in a "best estimate" demand average increase rate between 2014 and 2041 of approximately 3.5% p.a. and a total area demand over the period of approximately **25 million tonnes**

S2.2.6 Waimakariri District Council Area.

As with the Selwyn district, partially consequent on the earthquakes, the area's population is projected to increase to approximately 75,000 by 2041 (i.e. approximately 1.4% per annum over the study period.) Also as with the Selwyn area this rate of population increase is greater than long term national trends to date.

However as noted previously, as the district's population density increases so will the average consumption per head decrease although this impact will be less marked than in the SDC area.

No specific, large, future infrastructural projects have been identified in the area.

Accordingly this report's "best estimate" has been based on the long term national demand increase plus an allowance for the locally greater population increases but less an allowance for the impacts of urbanisation on demand. (i.e. an overall equivalent demand increase rate for the period 2014 to 2041 of approximately 3% p.a.) This results in a total area demand over the period 2014 - 2041 of approximately **25 million tonnes.**

S2.3 The Canterbury Earthquakes.

Demand predictions have been further complicated by the series of damaging earthquakes that began in September 2010. The consequent, short term impact on the demand for aggregates was evaluated in a report commissioned by the Canterbury Aggregate Producers Group (CAPG) and compiled in August 2012.

S2.3.1 The Horizontal Rebuild.

The earthquakes caused significant damage to the "horizontal" infrastructure in the Christchurch city area in particular. (i.e. roading, piping and cabling infrastructure.) The estimate of the remaining quantum of aggregates required to complete the requisite repair work currently stands at approximately **3 million tonnes**, although there remains a degree of uncertainty associated with this figure. This work is currently scheduled to be completed by the end of 2016

S2.3.2 The Vertical Rebuild.

S2.3.2.1 Commercial and Industrial.

The total numbers of buildings to be demolished has increased since the original CAPG report was published and although the original report assumed a time-scale of 10 years to completion of the re-build process, the initial pace of development has been relatively slow. Accordingly it is recommended that the 10 year time-scale remain. (i.e. completion of the majority of the commercial re-build is not anticipated until 2024.)

Taking these and others factors, outlined in the CAPG report, into account the remaining demand for the commercial and industrial rebuild is estimated to be of the order of **1.5 million tonnes.**

S2.3.2.2 Residential.

Unfortunately it appears that there is currently no definitive figure available for either the number of houses still requiring a complete rebuild or for the numbers of houses yet to be built to satisfy 'Red Zone' demand. However after informal discussions with Canterbury Earthquake Recovery Authority (CERA) staff and the use of local authority consenting data, it has been concluded that directly driven earthquake demand for new sections has now been satisfied. However it has also been assumed, potentially conservatively, that the numbers of houses requiring to be constructed either as replacements for those lost in the Red Zones and those requiring a full rebuild remain as a relatively high proportion of the initial CERA estimate.

Accordingly combining the latest floor slab demand, sub-divisional infrastructural demands and those for driveway repair/reconstruction, the remaining residential rebuild demand is likely to be of the order of **1 million tonnes.** The time scale for this demand has been taken as approximately 3 years. (i.e. completion approximately by the end of 2016 or early 2017.)

S2.3.3 Remaining Rebuild Demand.

The apparent, remaining, total rebuild demand for the horizontal, commercial and residential sectors is therefore **5.5 million tonnes.** However care has to be taken, from an overall planning perspective, to ensure that double counting of demand does not occur. The following sub-section presents a discussion on this issue.

S2.4 Adjustments to Overall Predicted Demand.

S2.4.1 Horizontal Rebuild.

The disruption to the horizontal infrastructure has been such that the original short and medium term programmes for maintenance and construction activities within Christchurch city continue to be significantly impacted. This disruption is so severe that it remains likely that effectively little or none of the CCC pre-earthquake forward programme will be undertaken during the next approximately two to three years. It is important therefore that this change in circumstance is accounted for and that due allowance is made for the reduction in demand created by the effective abandonment of the shorter term aspects of the CCC infrastructural programme.

Taking these factors into account the adjusted long term impact of the remaining earthquake demand on horizontal infrastructure demand is therefore estimated to be an overall increase of **1 million tonnes** during the period 2014 to 2018.

S2.4.2 Commercial and Industrial Rebuild.

Given current uncertainties with respect to a number of major projects it remains difficult to be precise about the timing of demand. However for the purposes of this report only, it is recommended that it be assumed that the bulk of the commercial and industrial rebuilds will be completed by approximately 2024.

Under normal circumstances new construction would have been taking place during this period, albeit at a lesser rate than presently anticipated. It is recommended however that this demand be retained as a contingency to cover the uncertainty inherent in the earthquake driven construction demand estimates. The adjusted remaining long term impact of the earthquakes on commercial and industrial demand is therefore estimated as **1.5 million tonnes.**

S2.4.3 Residential Rebuild.

The demand for aggregates for sub-division construction to replace “Red Zoned” and other uninhabitable houses began from a point from where underlying demand was lower than average. Beyond the initial boost in demand it is probable that activity in Christchurch will return to average pre-earthquake levels as the permanent population numbers begins to recover from the impacts of the earthquakes by approximately 2015. However despite these factors it is recommended for planning purposes that the additional long term demand, created by the residential rebuild, be taken as approximately **1 million tonnes.**

S2.5 Earthquake Demand Summary.

Taking all these factors into account the adjusted predicted remaining additional demand generated by the earthquakes for the study area is **3.5 million tonnes**

S2.6 Overall Demand Summary.

The data indicates that the medium to long term impact of the earthquakes on demand, whilst being large in numeric terms, are unlikely to be significant when considering overall demand in the longer term. In fact the changes in demand intimated in this report fall within the margin of error for the overall forecasts to 2041.

The adjusted total study area demands for the period to 2028 is **90 million tonnes** and for the period 2014 to 2041 is **180 million tonnes**. The corresponding figures for the Christchurch City Council area are **70** and **130 million tonnes** respectively.

S3. Resources.

S3.1 Background.

The 2009 report indicates that geologically there are many areas suitable for gravel extraction. However for the purposes of this report only those sites presently within the areas specifically zoned for quarrying and / or currently consented for gravel extraction have been included in the resource totals.

S3.2 Christchurch City - Land Based.

Consented, land based resources lie generally within the Christchurch City Council Rural Quarry (RuQ) and Open Space 3D Zones. A small, but increasing number of consented sites lie outside these Zones.

The total currently available resource (i.e. the sum of the remaining resource within the quarry zones and those in the consented areas outside the zones) is approximately **65 million tonnes** with an additional **8 million tonnes** anticipated to become available within the next twelve to twenty four months.

S3.3 Selwyn District - Land Based.

The Selwyn District Council owned, land based, resource presently totals approximately **0.5 million tonnes**. The resource is however not distributed uniformly over the district and very few, if any, of these sites are likely to be suitable to supply materials to satisfy demand from either private or larger infrastructural projects.

There are presently six privately owned pits / quarries in the district. Three of these quarries are small, two are of a moderate size and one, opened recently at Burnham, has the potential to become large.

The currently consented resource within the three medium to large quarries is approximately **45 million tonnes**.

S3.4 Waimakariri District - Land Based.

There is a resource within consented gravel reserves of approximately **0.5 million tonnes**. There are no land based pits in the District capable of supplying materials for either larger infrastructure or private projects.

S3.5 Rivers within Study Area.

This report has reduced the consented quantities to those which are actually available. Only a small allowance for those resources potentially available from the Rakaia River has been included in the totals as the extraction sites are generally too remote from the majority of the demand to be an economically viable source of materials.

Under these circumstances it is estimated that there is total one-off extractable quantity of **17 million tonnes** available together with a supply of approximately **500,000 tonnes** carried annually downstream by the rivers in the area, also available for extraction.

S3.6 Recycled Materials.

The quantities of materials presently in storage, and suitable for recycling into aggregate products, is estimated to be of the order of 0.25 million tonnes. It is difficult to know when, or indeed if these materials will eventually become available however their long term impact on reducing overall demand for virgin aggregates will be limited. They have therefore, conservatively, been disregarded in terms of existing resource estimates.

S3.7 Central Plains Water Enhancement Scheme.

The Central Plains Water Enhancement Scheme is predicted to raise groundwater levels above those previously recorded. As a consequence existing and potential sites located in the areas where groundwater levels are already relatively high could be adversely impacted and in the worst cases rendered uneconomic.

The eventual size, timing and impact of these increases are uncertain and dependant on the timing of the implementation of the full scheme, the time for the mounding effect to fully occur and the underlying groundwater levels at the time. Whilst these impacts have not been directly included in the current resource size assessment, under certain scenarios the reduction in available resource could be of the order of 10%.

S3.8 Additional Excavation.

At the time of compilation of this report the Canterbury Aggregate Producers Group was applying to Environment Canterbury for permission to excavate below currently consented maximum depths. However, given the current uncertainty of the success of the proposal, these potential additional resources have not been included in the resource data outlined in this report.

S3.9 Resource Summary.

AREA	RESOURCE (TONNES)	NOTES
Christchurch City	70 million + 0.45 million annually ex river	Includes Waimakariri River resource. Land based resource 65 million tonnes
Selwyn District	50 million + 0.05 million annually ex rivers	Includes Selwyn and (part) Rakaia Rivers resource. Land based resource 45 million tonnes
Waimakariri District	< 10 million	Includes Ashley and Eyre Rivers resource. Land based resource 0.5 million tonnes
TOTAL	+/- 130 million + 0.5 million annually ex rivers	Potentially additional 8 million tonnes available in CCC area in next twelve to twenty four months.

S4 . Demand / Resource Balance.

S4.1 "Life" of Existing Available Resource.

S4.1.1 Study Area

In summary, the overall quantity of material currently available within the study area is theoretically capable (i.e. without regard to location) of satisfying demand until approximately **2035**. An additional **40 million tonnes** will be required to satisfy the remainder of demand to 2041.

S4.1.2 Christchurch City – Land Based.

In theory the presently zoned and consented areas for quarrying will be exhausted by approximately **2031**. However, given that a significant proportion of the materials supplied to the Waimakariri District originate from with the Christchurch City area, it is possible that this date may be brought forward. To an extent this may encourage the importation of greater quantities of materials into the Christchurch area from the newly established quarries in the Selwyn District. It is recommended however that the resource exhaustion date of 2031 remain for planning purposes.

S4.1.3 Christchurch City – The Waimakariri River.

All rivers, and particularly the Waimakariri, are coming under increasing pressure as operators seek to eek out their existing land based reserves. It is difficult therefore to place a definite "life" on the present resource in the Waimakariri River. Very tentatively, it is possible that overall demand will outstrip total supply within the next 10 - 15 years.

S4.2 Efficiency of Use and Recycling.

Given that transport is a major component of aggregate pricing, and that it is likely that many of the new extraction sites will ultimately be further from the demand than is presently the case, it is almost inevitable that aggregate prices will rise at a rate greater than general inflation. It is possible that this may drive an increase in efficiency of use. Allowance however has not been made at this stage for this factor other than where specifically stated in the future demand scenarios.

Neither has allowance been made for the general recycling of materials. Pre-earthquake volumes of locally recycled materials were probably in the 2 to 5% range of overall production. Anticipated volumes of potentially recyclable materials are of the order of 10% of production.

S4.3 Location of Demand.

The general locations and quantums of demand were described in the 2009 report. Although the earthquakes have altered the shorter term patterns of demand the medium to longer term locations of demand remain similar to those predicted in 2009. That is, whilst overall the urban areas of Christchurch will continue to dominate demand, demands from the south western and northern sectors of the city and their immediate environs will be significant.

Quarries located at McLeans and Coutts Islands are well placed to serve the western and northern sectors of the city and the demand emanating from the Waimakariri District. Those quarries in the vicinity of Pound Road and locale are well located to serve the western, south western and southern sectors of the city. Unfortunately the Pound Road area is almost exhausted however recently established quarries in Selwyn District are potentially capable of effectively replacing this resource in at least the short term to medium term.

S5. Conclusions.

Once the majority of the earthquake rebuild process is completed, increases in demand will be driven predominantly by the expanding populations in those areas identified for growth. Whilst demands in these areas will continue to grow at rates greater than those for the remaining parts of the study area, overall, Christchurch city's demands will still dominate the local aggregate scene.

Demand for aggregates from within the Waimakariri district currently outstrips local supply. This shortfall is presently generally sourced from quarries within the Christchurch City Council area. Whilst demand from within Selwyn district is increasingly being satisfied from sources within the locale it is likely that transfers between (i.e. both to and from) the Selwyn District and Christchurch City Council areas will continue for the foreseeable future.

River resources are presently supplying approximately one quarter of the study area's underlying total demand. However, even at present rates, these resources are being utilised faster than is sustainable on a long term basis. This situation will only be alleviated if additional suitable land based areas are made available for quarrying purposes in a timely fashion. Demands generated by large infrastructural projects will place significant additional demands upon local gravel resources.

Although the remaining overall earthquake demand is large in numeric terms it remains within the margin of error for forecasts to the end of the study period and as such does not effectively impact on the overall estimates of total demand. The impact of the earthquakes may however bring forward the need for additional resources in the longer term.

Within the wider study area the theoretical "best estimate", without regard to location, is for the existing resources to be exhausted by approximately 2035. It is projected that the existing zoned and / or consented land based quarries within the CCC area will effectively be exhausted by approximately 2031.

The volumes of materials required to fill the gap to the end of the current planning horizon (i.e. 2041) remain relatively large and will require careful planning to ensure a continuing, cost-efficient supply of aggregates to the local market during the period under study. Whilst some of this gap may be filled by materials sourced from within the Selwyn District it is thought prudent that the Christchurch City Council should plan to satisfy the city's own demands from within its own borders if at all possible. This strategy is likely to minimise transport distances and hence overall costs.

S6. Cautionary Notes.

Whilst care has been taken in compiling this report it should be noted that the time frames of the projections are quite extended and as a consequence the potential variance in demand is correspondingly wide. It is felt however that the quantities derived are sufficiently accurate for the purposes specific to this report.

It should be emphasised that this report is not directly suitable for commercial use as it takes a conservative approach to the assessment of demand (i.e. errs on the upper side of projections) and is accordingly intended for District Plan review purposes only.

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AGGREGATES - DEMANDS AND RESOURCES

Report prepared by Twelfth Knight Consulting for the Christchurch City Council - October 2014

Section 1. Introduction.

1.1 Project Background.

The Christchurch City Council (the Council) is currently reviewing both its Christchurch City and Banks Peninsula District Plans with the intention of amalgamating them into a single District Plan document. The review of the provisions of the existing Rural Quarry Ru(Q) and Open Space 3D (Isaac Conservation Park/Quarry) Zones is understood to be providing an opportunity to resolve matters relating to these Zones and the provisions around aggregate resources(1) within the District generally.

In 2009 the Urban Development Strategy Partnership (UDS), in conjunction with Twelfth Knight Consulting, undertook an in-depth assessment of the future demand for aggregates and the resources available in the area to meet these demands.

However a series of large earthquakes, beginning in September 2010, have significantly impacted on both the built environment and the local economy. The consequent, short term impact on the demand for aggregates was evaluated in a report commissioned by the Canterbury Aggregate Producers Group and compiled in August 2012 by Twelfth Knight Consulting.

The Council notes that, given the impacts of the changed circumstances post 2009 and the current review of its District Plan, it is opportune to undertake a re-assessment of previous investigations of demand and supply in order to inform planning decisions with respect to the medium and longer term supply of aggregates to the Council area.

1.2 Project Objectives.

To provide:

(1) An assessment of current and projected demand for aggregates in the Christchurch District for the planning periods to 2028 and 2041.

(2) Updated, cumulative data on existing, local aggregate resources to reflect changes to the quantums of suitable, available materials within existing quarry zones and those newly consented quarries outside these zones.

(3) An assessment of the overall need for additional aggregate resources (zoned and/or consented) in the District to 2028 and 2041.

(1) Materials produced for rip-rap, agricultural or industrial purposes are not included in this report.

SECTION 2. DEMANDS.

2.1 Past and Present Aggregate Production.

2.1.1 Data Sources.

Past and present production and demand rates have been compiled from:

- Local land based quarry production data assembled in 1992, 2002 and 2007 - 2014.
- Extracted volumes from rivers within the study area (data supplied by ECan)
- National and regional aggregate production returns as reported by the Crown Minerals section of the Ministry of Business Innovation and Employment;
- Population data from Statistics New Zealand, Christchurch City Council, Selwyn and Waimakariri District Councils and the Urban Development Strategy team.
- Christchurch City Council Cleanfill Bylaw returns.
- "Planning for Growth? The Determinants of Aggregates Demand in New Zealand" by J. O'Brien published in IPENZ *engineering TreNz*. Dec 06
- ECan / MWH "Regional Gravel Management Report" (Report No. R06/1 January 2006)

It should be noted that “tonnages” have been quoted throughout this report in order to avoid confusion between "Solid" and "Loose" (or "Bulk") measured volumes.

2.1.2 Total Production and Demand within the Study Area(2).

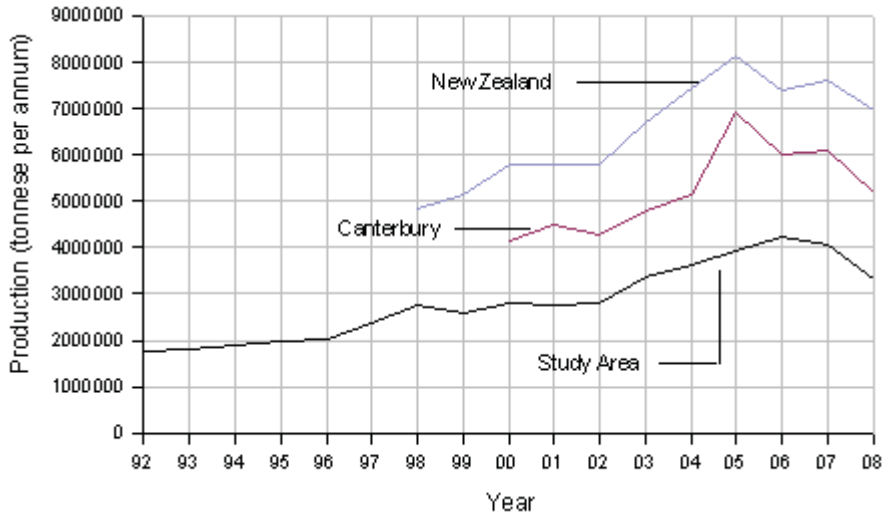
Data from the above sources was used to compile time sequences which enabled comparisons to be made between national and local trends in both total production and consumption on a tonnage per head basis. A base line of 1992 was chosen as this is the earliest point for which potentially reliable local data is available. (Detailed local information on extraction rates prior to 1992 is difficult, if not impossible, to obtain.)

Aggregate production from all sources (i.e. rivers and local authority and privately owned quarries) from within the area encompassed by CCC, WDC, and SDC has increased approximately as follows (July to June year):

Production 1992/3:	1,800,000 tonnes
2002/3:	2,800,000 tonnes
2006/7:	4,200,000 tonnes
2008/9:	3,400,000 tonnes
2010/11:	4,300,000 tonnes
2012/13:	6,200,000 tonnes
2013/14:	7,200,000 tonnes

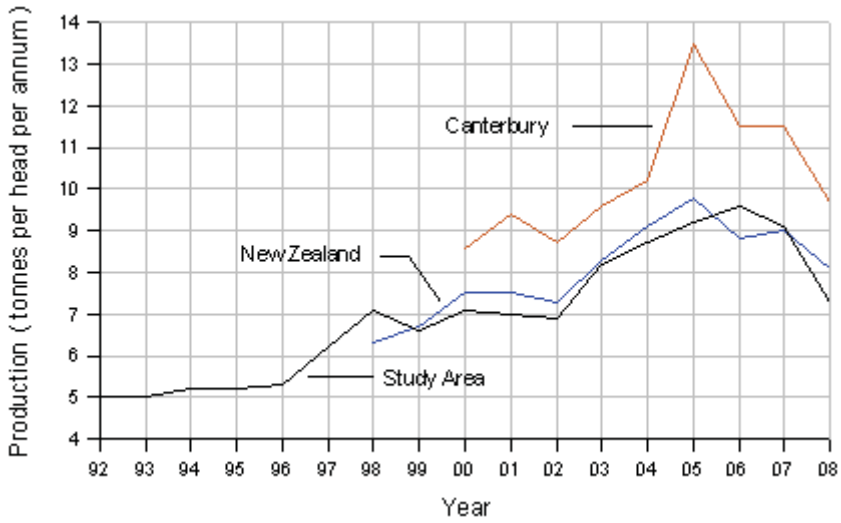
(2) The study area is bounded by the Canterbury foothills, the Pacific Ocean and the Ashley and Rakaia Rivers.

The following charts illustrate the increases in production over the study period and compares local data with data, where available, for the wider Canterbury area and nationally on both a total tonnage and tonnes per head basis. (National and Canterbury data post 2008 is considered unreliable and has therefore been omitted.)



Graph 1: Aggregate Production (tonnes per annum)

(New Zealand data scaled to 20% of actual for comparison purposes.)

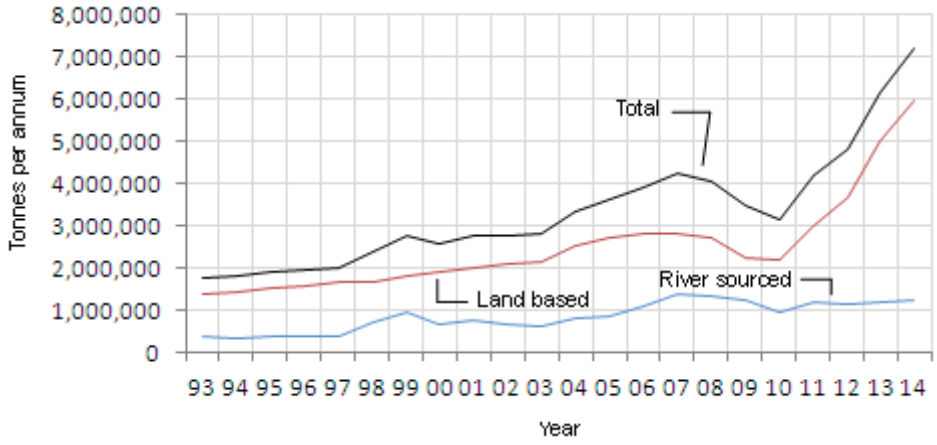


Graph 2: Aggregate Production (tonnes per head per annum)

The demand for aggregates within New Zealand is dominated by construction and maintenance activities in the roading and building sectors, with the former being the significantly larger of the two. (Approximately split 65% roading, 25% building, 10% filling.) As a consequence the average demand per head of population varies between rural areas, where building activity is low but road construction and maintenance expenditure may be relatively high on a per head basis, and urban areas where demands generated by roading and building activities are more evenly split.

Not unexpectedly therefore the per head demand / production figures reported for the wider Canterbury area are higher than those for the area under study in this report, where demand is largely determined by activity in the urban areas of Christchurch and its immediate environs.

The following chart illustrates the total and components of the study area's historical production.



Graph 3: Study Area Land Based, River Sourced and Total Aggregate Production.

The Ashley, Eyre, Waimakariri, and Selwyn Rivers provide the majority of the river sourced materials for use in the study area. The percentage of river production as a proportion of the study area total increased steadily until 2008. (i.e. from 20% in 1992 to 35+% in 2008) although the proportion has fallen subsequently to be currently less than 20%. The quantities of materials being sourced from the Waimakariri River constitute approximately two thirds of the river sourced aggregates in the study area.

It should be noted that not all of the materials from the rivers are considered satisfactory for some types of roading aggregates.

2.1.3 Land Based Quarrying within Christchurch City Council Area.

Eight, land based, alluvial quarries produce aggregates from both within the present Rural Quarry Ru(Q) and Open Space 3D (Isaac Conservation Park/Quarry) (OS4D/ICP/Q) Zones and, relatively recently, consented sites outside these Zones. Two hard rock quarries operate on Banks Peninsula although their total output is relatively small. These two quarries do however provide specialist products that cannot readily be sourced from elsewhere in the area.

Production totals have increased as follows since 1992.

Production 1992/3:	1,200,000 tonnes
2002/3:	1.900,000 tonnes
2006/7:	2,600,000 tonnes
2010/11:	2,700,000 tonnes
2012/13:	4,400,000 tonnes
2013/14:	4,950,000 tonnes

In order to preserve their land based resources, there has been an increasing trend for the quarries to import river sourced materials for processing through their existing plants. In order to avoid “double counting” the figures quoted above therefore do not include materials imported from river sources.

Pre earthquakes, land based quarries within the CCC area, (i.e. excluding production using materials sourced from the Waimakariri River) provided approximately 60% of the total study area production and 90% of the total of materials from land based quarries in the study area. (Post earthquakes these figures are currently approximately 70% and 85% respectively.)

2.1.4 Extractions from Rivers within Christchurch City Council Area.

Whilst the local authority boundary between WDC and CCC falls approximately along the physical centre line of the Waimakariri River (i.e. the production from the river could theoretically be distributed equally to the production profiles of the CCC and WDC areas) for the purposes of this study all production has been assumed to occur on the river’s south bank (i.e. within the CCC area.) The very small scale extractions from rivers on Banks Peninsula have been ignored for the purposes of this report.

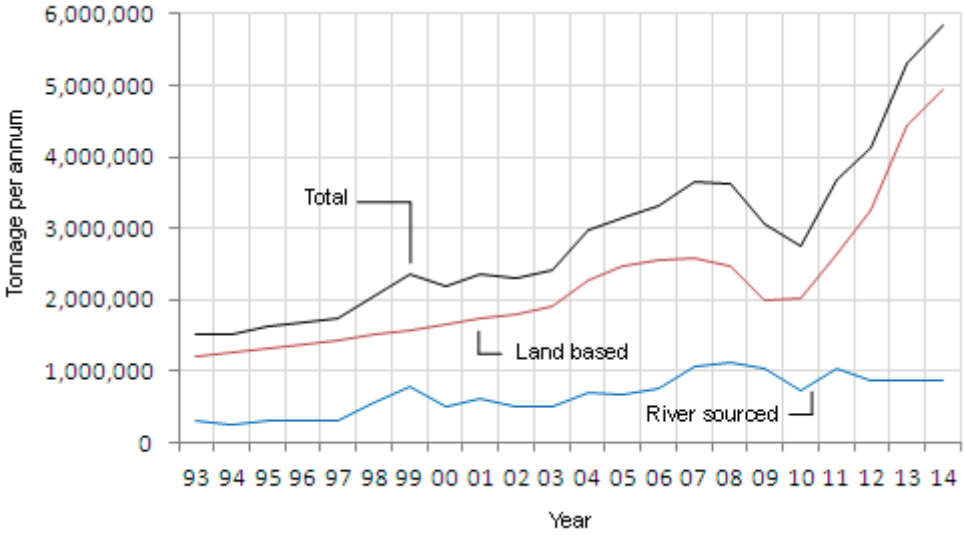
Materials are generally extracted from the lower sections of the Waimakariri River. Some of these materials are utilised for bulk filling (e.g. establishment of building platforms) whilst others are used for the production of concrete and crushed aggregates. Data as to the ultimate destination of these materials is limited.

Total extraction quantities have varied from a low of 250,000 tonnes in 1993/94 to a peak of 1,1550,000 tonnes in 2007/08. (880,000 tonnes for 2013/14.)

The presently consented extraction volumes are in excess of the long term sustainable supply of materials available. (Refer Section 3.5 for additional comments)

2.1.5 Total Production within Christchurch City Council Area.

The following graph illustrates the individual component and total tonnages of aggregate production in the Christchurch City Council area.



Graph 4: Aggregate Production within Christchurch City.

2.1.6 Land based Quarrying within Selwyn District.

Selwyn District Council owns a number of relatively small lots, set aside for aggregate production. These properties are scattered across the District in order to minimise haul distances. Approximately thirty of these areas are currently or were recently operational. Many are however worked out or are close to the end of their life.

SICON Ferguson Ltd manage the pits on behalf of the Council. On site crushing is undertaken by sub-contract using mobile plant. The materials produced are predominantly used for roading construction and maintenance purposes within the district. The pits are also accessed by other private companies on a royalty permit system, generally, but not exclusively for the production of materials also used for SDC roading contracts. Overall production is small in the context of this report.

There are presently six privately owned pits / quarries in the district. Three of these quarries are small, two are of a moderate size and one, opened recently at Burnham, has the potential to become quite large. The two moderate sized quarries are reasonably well placed to service both the commercial / industrial and urban areas of the western and south western sectors of Christchurch city. The quarry at Burnham is considered in practice to be relatively remote from all but the south western sectors of urban Christchurch as a result of potentially increased transport costs over its competitors.

Production totals have increased as follows since 1992:

Production	1992/3:	140,000 tonnes
	2002/3:	200,000 tonnes
	2006/7:	220,000 tonnes
	2010/11:	270,000 tonnes
	2012/13:	510,000 tonnes
	2013/14:	810,000 tonnes

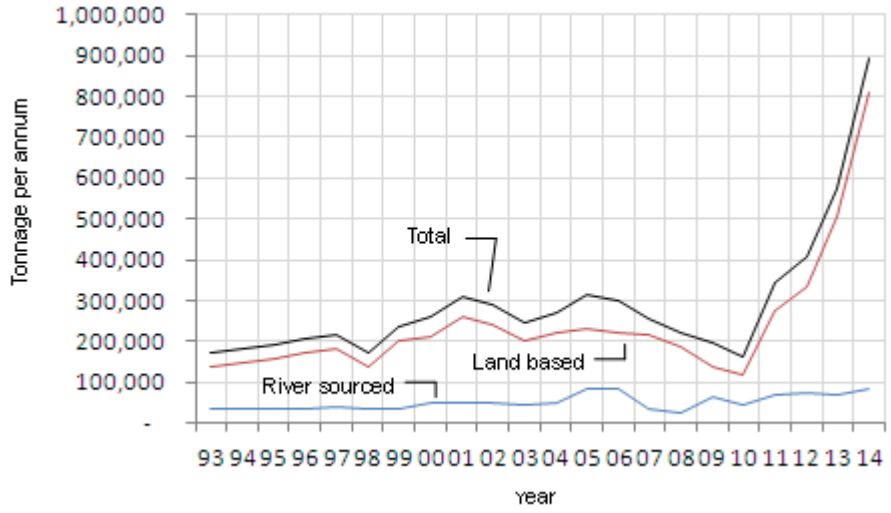
2.1.7 Extractions from Rivers within Selwyn District.

In addition to the land based quarries, materials are extracted primarily from the Waimakariri and Selwyn Rivers with lesser quantities being taken from the Cass, Kowai No's 1 & 2 and Hawkins and Rakaia Rivers. Total extractions from these rivers, pre-earthquakes, equated to approximately 15% of total aggregate output in the district.

Total extraction quantities have varied from a low of 25,000 tonnes in 1993/94 to a current peak of 85,000 tonnes in 2013/14.

2.1.8 Total Aggregate Production within Selwyn District.

The following graph illustrates the individual component and total tonnages of aggregate production in the Selwyn District area.



Graph 5: Aggregate Production within Selwyn District.

2.1.9 Land based Quarrying within Waimakariri District.

Waimakariri District Council owns three operational pits. These pits, which are also operated on the Council's behalf by SICON Ferguson Ltd, produce aggregates which are used solely for Council purposes – i.e. mainly for the supply of roading maintenance metal.

As with SDC, on site crushing is undertaken by sub-contract using mobile plant.

Production totals have increased as follows since 1992, the date from which there is reliable data

Production	1992/3:	30,000 tonnes
	2002/3:	30,000 tonnes
	2006/7:	50,000 tonnes
	2010/11:	50,000 tonnes
	2012/13:	70,000 tonnes
	2013/14:	190,000 tonnes

One small privately owned pit operates at North End, Kaiapoi supplying materials predominantly to Christchurch Ready Mix Concrete Ltd. It is understood that the majority of aggregates sold are produced from materials imported from the Ashley River. The reserves within the quarry itself are thought to be small

Materials currently being excavated during the formation of irrigation water storage lakes in the vicinity of Eyrewell Forest, consequent on the conversion of the area to dairying, are being utilised as bulk fill for some of the new sub-divisions being created mainly in the northern sector of Christchurch.

2.1.10 Extractions from Rivers within Waimakariri District.

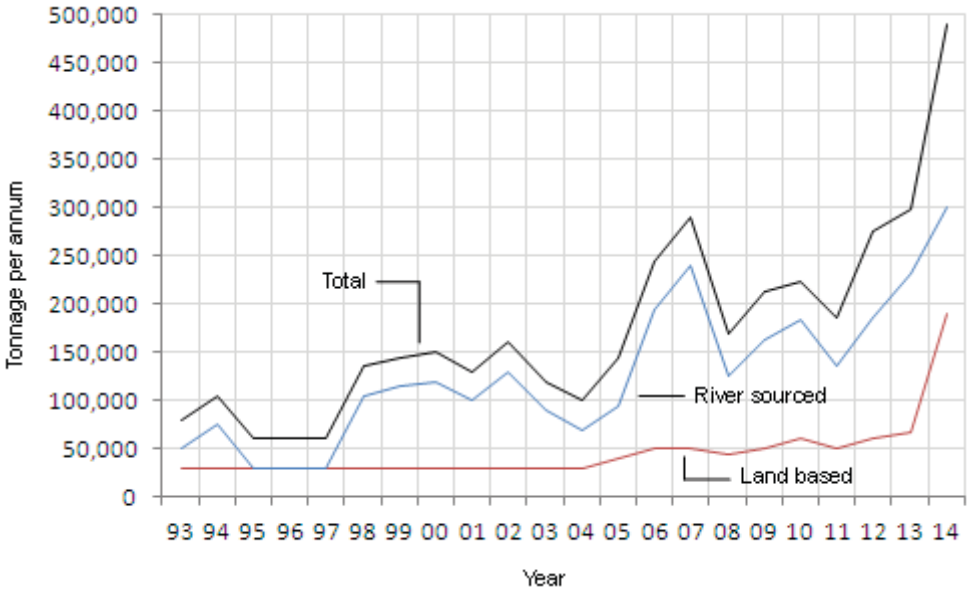
In addition to the land based quarries, the Ashley, Eyre, and Waimakariri Rivers are also used as sources for aggregates. In recent years extractions from the Ashley and Eyre Rivers have equated, on occasions, to greater than 75% of total aggregate output in the District. (refer also note under 2.1.4)

Total extraction quantities have varied from a low of 25,000 tonnes in 1994/95 to a current peak of 300,000 tonnes in 2013/14.

The consented extraction volumes may presently be in excess of the long term sustainable quantities of materials available. (Refer Section 3.5 for additional comments)

2.1.11 Total Aggregate Production within Waimakariri District.

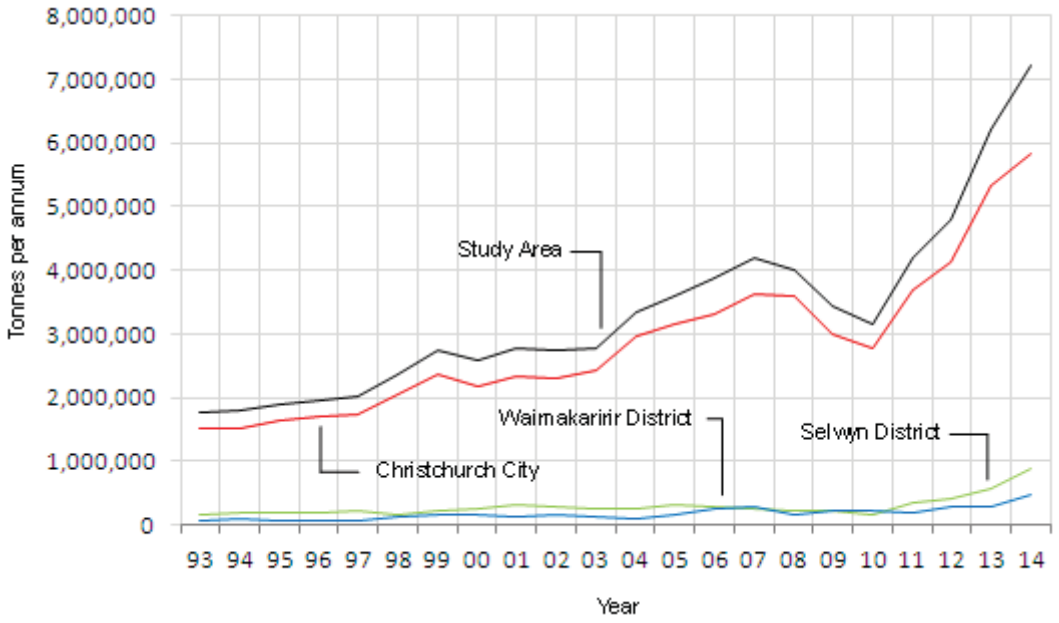
The following graph illustrates the individual component and total tonnages of aggregate production in the area.



Graph 6: Aggregate Production within Waimakariri District.

2.1.12 Study Area Aggregate Production Summary.

The following charts and table illustrate and summarise the production statistics outlined in the sub-sections above.



Graph 7: Aggregate Production within Christchurch City, Selwyn & Waimakariri Districts.

AREA	ANNUAL PRODUCTION @ 2013 / 14 (TONNES)		
	LAND BASED QUARRIES	RIVERS	TOTALS
Waimakariri District	190,000	300,000	490,000
Christchurch City Council	4,950,000	880,000	5,830,000
Selwyn District	810,000	85,000	895,000
TOTALS	**5,950,000**	**1,265,000**	**7,215,000**

Table 1: Study Area Aggregate Production (2013 / 14) Summary.

2.2.13 Data Uncertainty.

The following table lists the potential levels of uncertainty associated with each data set.

UNCERTAINTY	VALUE	NOTES
Past	-10% / +10%	A base-line of 1992 has been used. Detailed information on extraction rates prior to 1992 are difficult, if not impossible, to collect.
Present	< -10% / +10%	Quantities extracted in 2002 and 2007 - 2013 are known with a reasonable degree of accuracy. (I.E. better than +/- 10%) Where detailed data is not available land based volumes for 2003, 4, 5, and 6 have been estimated from 2002 and 2006 / 7 data (with an allowance for increased production in line with national trends) and production data from one of the larger Christchurch quarries.
Conversion of 'Loose' volume to Weight	- 10% / + 10%	Local industry accepts an average general density of 1.5 tonnes per cubic metre for excavated / loose material.
Population	< - 5% / +5%	Population data has been extracted from national census's in 1996, 2001, 2006 and 2013. Populations in the intervening years have been estimated from these figures. Local data has been supplied by the Christchurch City Council / UDS teams.
Combined	- 10% / +10%	(I.E. Probable range.)

Table 2: Data Uncertainty - Study Area Aggregate Production.

2.2 Past and Present Demand.

2.2.1 Introduction.

As noted earlier, the demand for aggregates within New Zealand is dominated by construction and maintenance activities in the roading and building sectors, with the former being the larger of the two. At a national level the size of these demands is, in the main, determined by population growth, general economic activity and central government patterns of expenditure on infrastructure. At a regional and sub-regional level demands are also influenced by local government expenditure and larger "one-off" projects.

The study area is effectively self-contained from an aggregate production and demand perspective. (i.e. There is little or no export out of, nor import of aggregates into the area.) Hence production equates to demand.

2.2.2 Christchurch City (including Banks Peninsula).

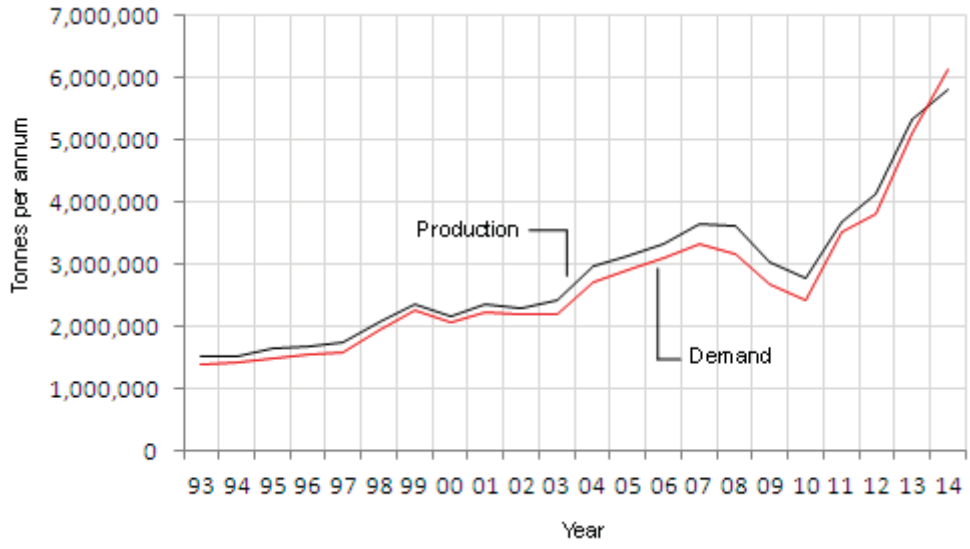
Anecdotally there are 'cross border' transfers of products between the local authority areas. Overall demand within the CCC area has therefore been determined by undertaking estimates for each sub-area (i.e. SDC, WDC and CCC) on a tonnage demand per head basis, with due allowance for the varying natures of these areas (i.e. the "urban" nature of the city versus the "rural" nature of much of the SDC, WDC and Banks Peninsula areas) and one-off projects, where known.

Balances between these sub-area demands and, sub-area and total production have then been used to estimate the size of the cross border transfers and hence the demand within the CCC area.

Whilst the derived demand data should be treated as indicative only, it can be seen that until the disruption created by the earthquakes there was an increasing disparity between demand and production in the CCC area. This disparity represented the "export" element of production from within the CCC boundaries to the WDC and SDC areas and was, pre-earthquakes, equivalent to approximately 10 - 15% of total production from within Christchurch City.

Complicating analysis further, three new quarries have begun operating in the Selwyn district over the last four years. Although their combined output is now capable of supplying the Selwyn district's total demand it is likely that competitive forces between the quarries within the Selwyn district and those within the city boundaries result in materials transferring in both directions. However, without a significantly more in depth analysis it is not possible to quantify the post earthquakes size of the current overall net transfer, if any, between local authority areas.

Significant quantities of materials are also sourced from the Waimakariri River. Whilst data does not exist as to the exact destination of these river sourced materials it is known that the majority of this material is processed or, on most occasions, used directly within the Christchurch city area. The following historical production figures therefore, for simplicity, include all materials sourced from the Waimakariri River.



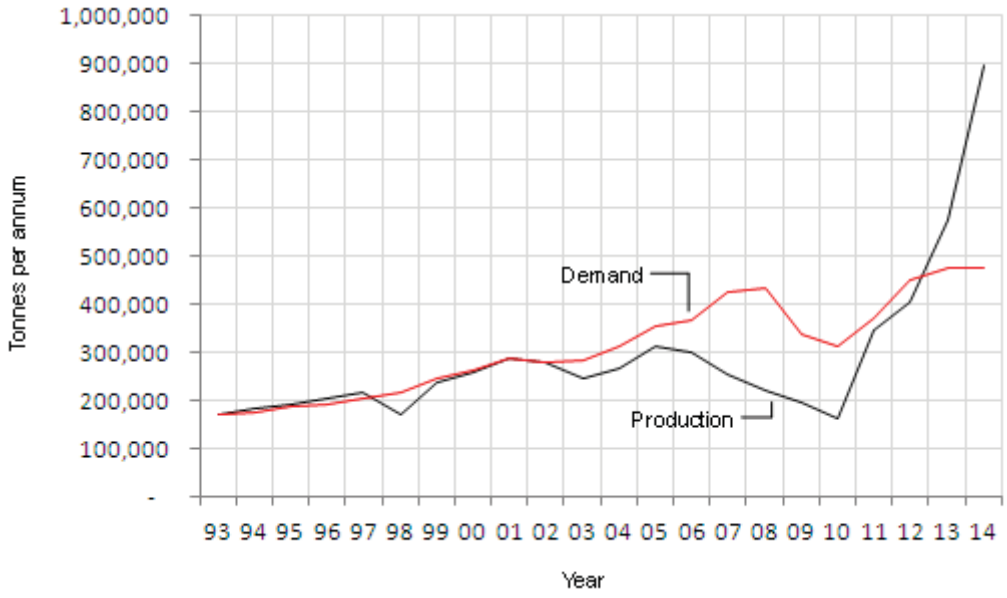
Graph 8: Aggregate Demand and Production within Christchurch City Council Area (tonnes per annum).

* **Note:** (Production CCC area - Demand CCC area) = Total Export Quantity to SDC and WDC areas

2.2.3 Selwyn District.

Although detailed data is not readily available, it is clear that pre the earthquakes and the establishment of three new quarries in the district post 2010, a significant proportion of the aggregates used within the District originated from outside its borders (As noted above, specifically from the quarries within the CCC area.) The only method to determine overall demand within the District is therefore to undertake estimates on a tonnage per head basis with due allowance for the "rural" nature of much of the District. (refer Section 2.1.8 for production details)

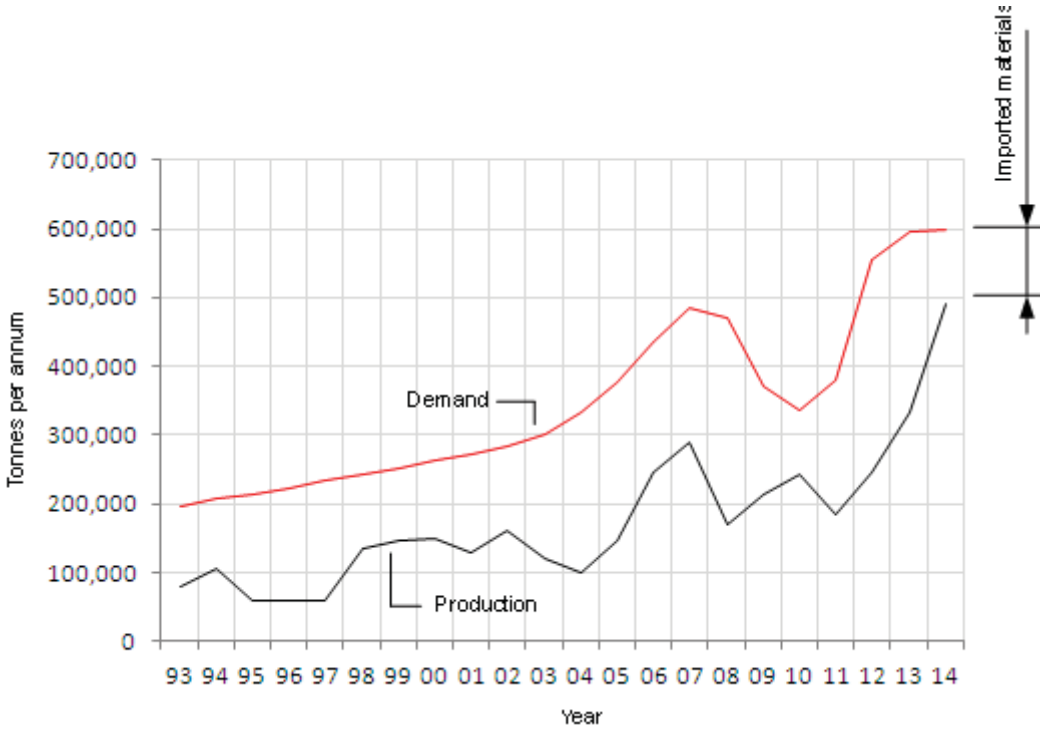
The following graph illustrates the earlier disparity between demand and production. This trend accelerated, particularly post 2001, until 2010 when the opening of new private quarries in the district and the impacts of the earthquakes reversed the trend.



Graph 9: Aggregate Demand and Production within Selwyn District.

2.2.4 Waimakariri District.

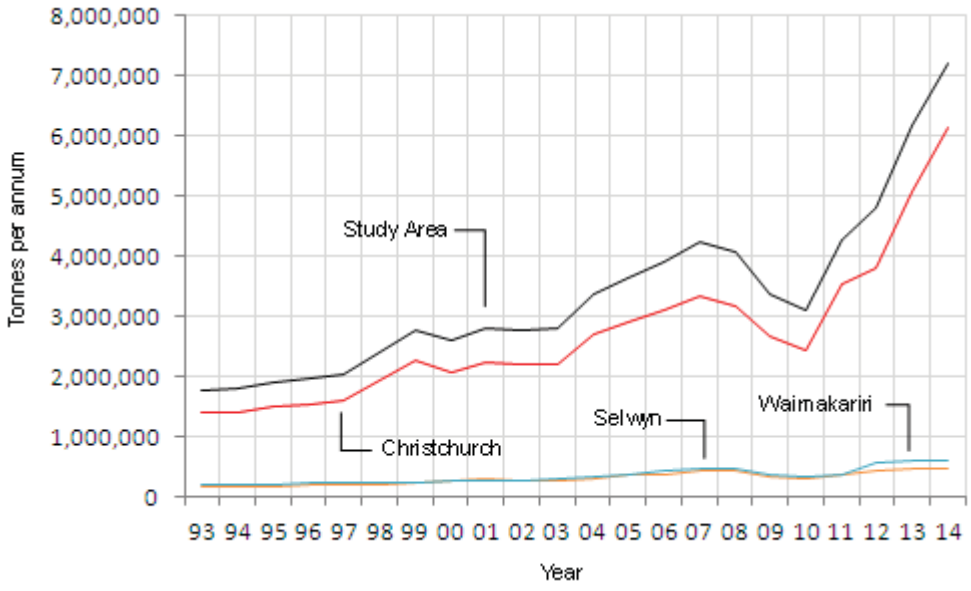
As with the demands generated from within the Selwyn District, detailed data is not readily available. However also as with Selwyn, it is clear that a significant proportion of the aggregates used within the District originates from outside its borders; specifically from the quarries within the CCC area and the lower Waimakariri River. Demand estimates on a tonnage per head basis have therefore been made with due allowance for the mix of urban and rural areas of the District. (refer Section 2.1.11 for production details.)



Graph 10: Aggregate Demand and Production within Waimakariri District.

2.2.5 Study Area.

The following graph illustrates the total study area demand and it's component parts. It can be seen that demand generated from within the CCC boundaries is the largest by a very significant margin.



Graph 11: CCC, SDC, WDC & Study Area Demands.

2.3 Future Demand to 2041.

2.3.1 Background.

This report provides an assessment of the quantum of demands for aggregates both within the study(2), Christchurch City, Waimakariri and Selwyn District Council areas for the periods to 2028 and 2041, and the resources that will be required to fulfil those demands. Notes and data pertaining to the impacts on demand consequent on the Canterbury earthquakes are also provided.

As noted in Section 2.2, the demand for aggregates within New Zealand is dominated by construction and maintenance activities in the roading and building sectors. As a consequence the average demand per head of population varies between rural areas, where building activity is low but road construction and maintenance expenditure may be relatively high on a per head basis, and urban areas, such as Christchurch city, where demands generated by roading and building activities are more evenly split.

Long run increases in demand - for the period 1947 to 2009 for example – have approximately correlated with the increases in population and real Gross Domestic Product (GDP) over that period(3 & 4). This has been despite a range of influences relating to economic cycles and changes in methods of aggregate use. It has therefore been assumed for the purposes of predictions in this report that these overall trends will continue in the short to medium term. (i.e. demand will continue in general to correlate with population and GDP increases(3).)

Demand data in the earlier UDSIMG report(5) was predicated on economic activity being at subdued levels until 2012 before returning to more average levels beyond that point. Whilst this has proved to be generally correct, the Reserve Bank of New Zealand's June 2014 "*Monetary Policy Statement*"(6) notes that "*The New Zealand economy is projected to grow 3.3 per cent in the year to the December quarter 2014, before moderating further ahead*" as illustrated in the following figure.

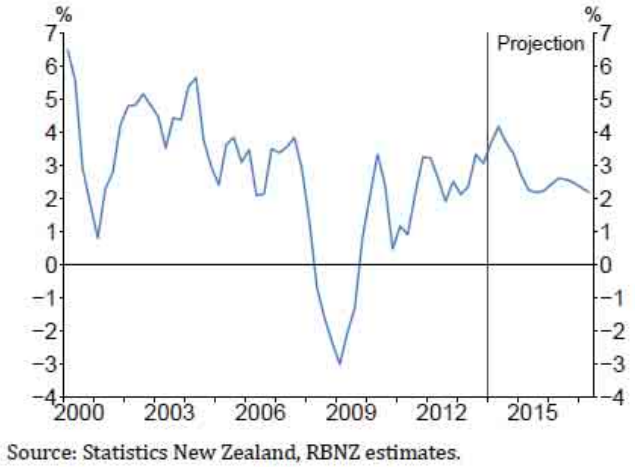


Fig 1. Annual change in GDP

(3) "*Planning for Growth. The Determinants of Aggregates Demand in New Zealand*" - J. O.Brien.
(4) "*A Quarterly Post-World War II Real GDP Series for New Zealand*" - V Hall and C. McDermott – 2009
(5) UDSMG Regional Gravel Resource Management Study report: "*Demands and Resources*" - UDS011209
(6) For the purposes of this report underlying economic activity within the study area has been assumed to follow national trends.

It appears that underlying economic activity (i.e. excluding the impetus provided by the rebuild phase) will remain generally slightly below the more recent long term average through to 2016. However in its June 2014 Policy Statement the Reserve Bank also notes that *"(T)ypically the timing of construction cycles has been in sync* (sic) *with cycles in GDP. However, over coming years construction is expected to remain elevated as a share of GDP…*" Although the latter would potentially lead to a global increase in the earlier forecast demand for the period 2014 to 2016, the later sections of this report encompass these factors using a methodology adapted for the peculiar local circumstances in the post earthquake re-build period.

Prediction of future demand for aggregates is difficult to complete accurately as demand is also often subject to wide swings. Accurate predictions at a regional and sub-regional level are further hindered by the potentially significant impacts of larger individual projects.

For example, over the years immediately prior to the earthquakes there were at least three projects which placed significant "one–off" demands on aggregate production locally. The demand from two of these projects alone, over one twelve month period, amounted to approximately 10% of the total underlying local demand at that time.

It is probable that economic factors, relating in particular to the escalating cost of aggregates, and the recently rapidly growing public awareness of sustainability issues will reduce or even cap increases in demand per head in the longer term.

Whilst effort has been made to provide a realistic estimate of future demand it is important to note that these and the following figures are very tentative given the long term nature of the projections.

The following sub-sections provide a description of and projections for the underlying demand over the specified time periods. These projections are modified for the specific short to medium term impacts of the earthquakes in later sections.

It should be noted that these scenarios do not purport to provide detail of demands at an annual level but rather to portray general trends based on predicted population and economic data. The total demand over the period, which is the key figure for this study, will be the same as if the demands for the individual years were modeled separately were sufficient data available to do so.

2.3.2 Study Area - General.

Given the numbers of varying factors influencing future demand, and therefore the difficulty in making accurate predictions, a number of scenarios were tested during preparation of the UDSIMG reports[5] in 2009 to provide potential upper and lower bounds for demand.

The upper bound (i.e. 8% per year increase), used the then greatest recently recorded annual increase in production rates as a predictor. This was considered to be unlikely to continue in the longer term as it would quickly lead to fanciful per head consumption figures. The lower bound, which assumed population increase to be the sole driver in increases in demand (i.e. approximately 1% per year), was considered to be too low for planning purposes.

Accordingly the "best estimate" for the period to 2026 was based on an annual increase of 5% per annum being a combination of long term national demand growth with allowances for differences in local population growth, impacts of urbanisation and one-off projects. This figure was debated with and agreed to by both the industry and the UDS team in early 2010. Accordingly this report has adopted this figure as a base on which to overlie pertinent changes subsequent to production of the 2009 report.

2.3.3 Study Area - Population.

The Council and the UDS team have re-visited the previous population projections used in the 2009 report in order to take account of the impacts of the earthquakes[7].

In summary the differences between the 2009 and current projections for the increase in population for the period 2014 – 2028 within the study area are relatively small in the context of this report, even though the total numbers are lower on average by approximately 2 - 3% in the later projections. (In the case of the patterns of demand for aggregates, it is the form of the increase in population that is generally of most importance rather than the total quantum of the population.)

The updated population projections indicate that the study area population may increase from the present approximate 465,000 to a total of 575,000 by 2041. (i.e. average 0.8% per annum) This rate of population increase is less than long term national trends to date. (i.e. approximately 1.0% p.a. Refer Appendix A.1.2 for details.)

Population increases have been used previously as a surrogate for the increase in the numbers of new dwellings required. This holds true where average numbers per household are constant, or at least relatively so. It is understood that, post earthquakes, the UDS team are projecting a slight increase in numbers per household for the short to medium term. This change is likely however to have only a small impact on the overall long term demand for aggregates.

2.3.4 Study Area – "One-Off" Demand.

The earlier UDSIMG report[5] identified a number of specific one-off projects which, although delayed in some cases, are understood to generally still be proceeding as previously detailed.

Accordingly the earlier list of potential one-off projects has been up-dated. This list indicates an average "one-off" project demand, for at least the next seven years, approaching 1 million tonnes annually.[8] (c.f. Present underlying study area total demand of approximately 4 - 5 million tonnes per annum.) However it is important to acknowledge that pre-earthquake demands already included a "one-off" element of approximately 350,000 tonnes per annum. Care therefore needs to be taken to ensure that "double counting" does not occur when making predictions concerning future demand.

Up-dated details of these "one-off" projects are provided on the following page.

It is not possible however to predict the occurrence of all significant projects over such relatively long time frames. At a regional and sub-regional level this can impact noticeably on total demand. The UDSIMG report therefore included a contingency for, as then, unspecified one-off projects totaling approximately 10 million tonnes over the earlier UDS forecast period of 2009 to 2026.

It is recommended that the original contingency be maintained to cover as yet unidentified earthquake related construction activity as well as unspecified non-earthquake activity to 2028.

Accordingly ten million tonnes of demand from one-off projects (i.e. 7 million tonnes identified in the period 2014 to 2021 and an additional allowance of 3 million tonnes for the remainder of the period to 2028) have been included in predictions where noted.

PROJECT	DEMAND (TONNES)	NOTES
Southern Motorway Extension (Springs Rd -Templeton) (NZTA)	1,500,000	Possibly 2016 / 2020
SH 1 Upgrade Rolleston to Christchurch (NZTA)	300,000	Possibly 2016 / 2020
Wigram – Magdala Link and Wigram Rd (CCC)	100,000	Possibly 2016 / 18
Christchurch Northern Arterial. (NZTA)	1,500,000	Possibly in period 2017 / 21
Western Belfast Bypass. (NZTA)	1,500,000	Possibly in period 2015 / 18
Miscellaneous 4 Laning Projects (NZTA & TA's)	300,000	Allowance for various projects in period 2014 / 2021
Lower Waimakariri River Stopbanks (ECan)	500,000	Period 2014 / 16 (Further 500,000 required between 2017 and 2021?)
Residential Building platforms.	500,000	Platforms required for housing throughout study period to 2028. Fill for large sub-divisions assumed drawn from non-quarry sources.
Building Platforms for I Zone at Rolleston	200,000	Indicative only. Assumed. Period 2014 / 2028
Central Plains Water Scheme.	100,000	Materials will be won from project sites. Demand quoted for concrete aggregates only. Period 2014 / 2020?
Lyttelton Port Reclamation	Assumed materials sourced from LPC quarry, dredged materials and other non-quarry fill. Period 2014 - 2041	
TOTAL	7 million tonnes (Figure rounded)	(i.e. Approx 1 million tonnes per year in period 2014 to 2021)

Table 3: Study area One–Off Projects Demands.

(7) UDS Population Projections - Adjusted SNZ Medium Growth Scenario. Source: Market Economics Growth Model - 6th May 2014. Prepared: David Price, CCC Monitoring and Research Team.

(8) It has been assumed that sub-divisions requiring large amounts of basic fill material will continue to source these materials from non-quarry sites, as has been practice in the past.

Provision of additional major roading infrastructure, which, as can be seen above, creates significant “one-off” demands, appears to be cyclic in nature. The period of these cycles is likely to be driven, as is demands for aggregates in general, by a combination of population growth and economic activity. Historical information suggests that periods between major road construction activity are currently of the order of thirty years. The period through to approximately 2021 has been identified as being a period of high activity. (refer Table 3) It is unlikely therefore that these high levels of roading construction activity will be repeated locally within the time frames under study in this report (i.e. 2041)

2.3.5 Study Area – Overall Demand.

Recent population projections indicate that the study area population may increase from the present approximate 465,000 to a total of 575,000 by 2041. (i.e. 0.8% per annum) This rate of population increase is less than long term national trends to date.(i.e. approximately 1.0% per annum) Accordingly an estimate has been based on the long term national demand increase plus an allowance for potential one-off projects of 20 million tonnes less an allowance for the locally lower population increases – i.e. a base of approximately 3% per annum.

However the most likely underlying short to medium term scenario (i.e. to 2028) is considered to be for above average growth for the next 1 to 2 years, (i.e. before inclusion of the impacts of the rebuild on demand) followed by growth approximately in line with longer term national trends, with due allowance for one-off projects and a locally reduced rate of population growth. (i.e. an overall demand best described by an initial average equivalent growth rate of approximately 4.5% per annum.)

Leading up to the end of the period to 2028 and beyond, the rate of demand increase is likely to decrease as a result of the predicted reduction in the rate of population increase (i.e. 0.7% p.a.), the reduction in major roading projects, the escalating cost of aggregates, and a move to more efficient use of materials which in combination will reduce or even cap increases in demand per head in the longer term.

Accordingly the projected rate of increase in demand has been tapered over the period, resulting in, as noted above, an equivalent overall increase rate in demand between 2014 and 2041 of approximately 3% p.a.

2.3.6 Local Authority Area Demands - General.

The following scenarios for the individual local authority areas have been based on the study area’s “best estimate” growth scenarios as discussed above, adjusted for each area’s predicted population growth rates, urbanisation and one-off projects as appropriate.

2.3.7 Christchurch City Council Area.

The City Council area population is projected to increase from a present approximate 365,000 to 400,000 by 2028; equivalent to an increase of approximately 0.6% per annum over the period. (c.f. Population numbers and growth rates used in the UDSIMG report[5] of 382,500, 422,000 and 0.7% respectively.) The population growth rate is predicted to fall further over the period 2028 to 2041 (i.e. 0.5% p.a.) resulting in an area projected population of approximately 425,000 by 2041. These projected population increase rates are less than both the long term national trends to date and the projections for the study area over the same timescales.

Although as a consequence of the earthquakes both the actual and predicted populations are less than those projected in the UDSIMG report[5] (i.e. approximately 5% lower) the majority of the larger infrastructural projects over the period will be constructed within, or very close to the city's boundaries. Accordingly the "best estimate" is based on both the study area "best estimate" and the long term national demand increase plus an allowance for infrastructural projects but less an allowance for the locally lower population increases – i.e. an initial base of approximately 4% per annum tapering to provide an average of approximately 2.5% overall between 2014 and 2041. (For earthquake impact adjusted, overall total demand refer Section 2.7)

2.3.8 Selwyn District Council Area.

The district's population is projected to increase from a present approximate 45,000 to 60,000 by 2028 (i.e. approximately 2.0% per annum over the study period.) Partially consequent on the earthquakes, both the actual and predicted populations are greater than those projected in the UDSIMG report[5] (i.e. 8% higher). This rate of population increase is greater than both long term national trends to date and that predicted for the overall study area. (i.e. 0.9% which remains as per that in the UDSIMG report[5].)

Tonnage per head demand figures are generally higher in rural than in urban areas. Accordingly as the district becomes increasingly urbanised (in a relative sense) so will the average consumption per head decrease.

Identified larger infrastructural projects within the district are limited to the second Southern Motorway extension in the vicinity of Templeton, some four laning of State Highway 1 and building platforms for the IZone at Rolleston. (Demands created by the Central Plains Water Enhancement Scheme will, it is understood, generally be satisfied by materials generated internally by the project itself.)

The combined impact of these effects, together with an allowance for one-off projects are a best estimate equivalent to an initial overall increase rate of 4.5% p.a.

The area's population is projected to further increase to approximately 70,000 by 2041 (i.e. approximately 1.7% per annum over the complete study period.) This rate of population increase is greater than long term national trends to date. Accordingly this report's "best estimate" has been based on the long term national demand increase plus an allowance for the locally greater population increases.

However, as noted above, the ongoing urbanisation of parts of the district will tend to lead to a reduction in the district's overall average consumption per head.

The combined impact of these effects, result in a "best estimate" demand average increase rate between 2014 and 2041 of approximately 3.5% p.a. and a total area demand over the period of approximately **25 million tonnes**

2.3.9 Waimakariri District Council Area.

The area's population is projected to increase from a present approximate 50,000 to 65,000 by 2028 (i.e. approximately 1.7% per annum over the study period.) This rate of population increase is greater than that for the overall study area and long term national trends to date.

As with the Selwyn district, partially consequent on the earthquakes, the predicted populations are greater than those projected in the UDSIMG report[5] (i.e. approximately 8% higher).

As noted previously, tonnage per head figures are generally higher in rural than in urban areas. Accordingly as the district's population density increases so will the average consumption per head decrease although this impact will be less marked than in the SDC area.

No specific, large, future infrastructural projects have been identified in the area.

The combined impact of these effects result in a best estimate equivalent initial overall area increase rate of 4% p.a. in the period to 2028 with a total demand over the period of approximately **10 million tonnes**

The area's population is projected to increase further to approximately 75,000 by 2041 (i.e. approximately 1.4% per annum over the study period.) As with the Selwyn area this rate of population increase is greater than long term national trends to date. Accordingly this report's "best estimate" has been based on the long term national demand increase plus an allowance for the locally greater population increases but less an allowance for the impacts of urbanisation on demand. (i.e. an overall equivalent demand increase rate for the period 2014 to 2041 of approximately 3% p.a.) This results in a total area demand over the period 2014 - 2041 of approximately **25 million tonnes.**

2.4 The Canterbury Earthquakes.

Demand predictions have been further complicated by the series of damaging earthquakes that began in September 2010. The consequent, short term impact on the demand for aggregates was evaluated in a report commissioned by the Canterbury Aggregate Producers Group (CAPG) and compiled in August 2012 by Twelfth Knight Consulting.[9] The following sections update the data in the CAPG report.

2.4.1 The Horizontal Rebuild.

The earthquakes caused significant damage to the "horizontal" infrastructure (i.e. roading, piping and cabling infrastructure.) in the Christchurch city area in particular. Damage to the horizontal infrastructure in Selwyn district was limited however the Waimakariri district suffered damage mainly in the Kaiapoi and adjoining coastal areas.

(9) "*Earthquakes Demands and Resources – The Impacts of the 2010 and 2011 Earthquakes on the Demand for Aggregates*" - Twelfth Knight Consulting for Canterbury Aggregate Producers Group - August 2012

The Stronger Christchurch Infrastructure Rebuild Team (SCIRT) provided data for the earlier CAPG report. This data has been updated using SCIRT and WDC web-based data[10, 11] in order to provide an estimate of the remaining quantum of aggregates required to complete the requisite repair work. This estimate currently stands at approximately **3 million tonnes**, although there remains a degree of uncertainty associated with this figure. (It should be noted that no attempt has been made by this report to independently verify the base SCIRT figures used in compiling this estimate.)

2.4.2 The Vertical Rebuild.

2.4.2.1 Commercial and Industrial.

The total numbers of buildings to be demolished has increased since the original CAPG report was published which was, at that time, based on Canterbury Earthquake Recovery Authority (CERA) supplied data. (Up-dated CERA web based data[12] has been used in this report.) The original report assumed a time-scale of 10 years to completion of the re-build process, however whilst some construction has taken place since the earlier report's publication, the initial pace of development has been relatively slow. Accordingly it is recommended that the 10 year time-scale remain. (i.e. completion of the majority of the commercial re-build is not anticipated until 2024)

Demand generated by any remaining subsequent demolitions of "earthquake prone" older buildings, which may ultimately be required, is anticipated to be relatively small and has therefore been assumed to be subsumed into the wider estimates of earthquake related demand.

Additional housing continues to be mooted to accommodate a potential influx of construction workers. Should they eventuate, it is anticipated that these buildings will be mainly temporary in nature and will be of predominantly timber construction. Demand for aggregate based materials will therefore be restricted to those required to form accessways and parking areas. In the context of this report this demand is considered to be small.

Taking these and others factors outlined in the CAPG report, into account the remaining demand from this sector will be of the order of **1.5 million tonnes.**

2.4.2.2 Residential.

CERA originally noted in March 2012 that approximately 12,000 houses, including those in the "red zones" required to be completely rebuilt or extensively refurbished. CERA estimated that the quantity of aggregates required to fulfil this demand, predominantly for floor slab construction, was of the order of 1 million tonnes**.** Whilst the CQOG report did not independently verify these quantities in detail they appeared to be a reasonable estimate of aggregate demand, at least for planning purposes.

For the purposes of the CAPG report it was assumed, conservatively, that all the then remaining replacement "Red Zoned" houses (approximately 7,500 houses) would be sited in new sub-divisions, Also conservatively, no allowance was made from a demand standpoint for sections that may have already been available for occupation pre-earthquake. The quantity of aggregates required for the sub-division and associated accessway construction for these houses was estimated by the CAPG report to amount to approximately 1.25 million tonnes.

(10) www.strongerchristchurch.govt.nz/more-progress dated 12 June 2014
(11) "*Earthquake Infrastructure Recovery Programme – Feb 14 Update*": Waimakariri District Council.
(12) www.cera.govt.nz/demolitions/list at 1 July 2014

Unfortunately it appears that there is currently no definitive figure available for either the number of houses still requiring a complete rebuild or for the numbers of houses yet to be built to satisfy 'Red Zone' demand. However after informal discussions with CERA and the use of local authority consenting data it has been concluded that directly driven earthquake demand for new sections has now been satisfied. However it has also been assumed, potentially conservatively, that the numbers of houses requiring to be constructed either as replacements for those lost in the Red Zones and those requiring a full rebuild remain as a relatively high proportion of the initial CERA estimate.

Some driveway and footpath reconstruction will be required for those houses that remain to be repaired. Without a detailed investigation it is not possible to place a precise figure on this demand. Consequently a 'guesstimated' allowance of **0.1 million tonnes** has been assumed to account for this demand.

Accordingly combining the latest floor slab demand, sub-divisional infrastructural demands and driveway repair/reconstruction the remaining residential rebuild demand is likely to be of the order of **1 million tonnes.** The time scale for this demand has been taken as approximately 3 years. (i.e. completion approximately by the end of 2016 or early 2017.)

2.4.3 Remaining Rebuild Demand.

The apparent, remaining, total rebuild demand for the horizontal, commercial and residential sectors is therefore **5.5 million tonnes.** However care has to be taken, from an overall planning perspective, to ensure that double counting of demand does not occur. The following sub-section presents a discussion on this issue.

2.5 Adjustments to Overall Predicted Demand.

2.5.1 Horizontal Rebuild.

The disruption to the horizontal infrastructure has been such that the original short and medium term programmes for maintenance and construction activities within Christchurch city continue to be significantly impacted. This disruption is so severe that it remains likely that effectively little or none of Christchurch City Council's (CCC) pre-earthquake forward programme will be undertaken during the next approximately two to three years. (Waimakariri District Council's programme was also disrupted however the remaining impact on overall demand is relatively small. Selwyn District Council's programme was largely unaffected.) It is important therefore that this change in circumstance is accounted for and that due allowance is made for the reduction in demand created by the effective abandonment of the shorter term aspects of the CCC infrastructural programme.

Some infrastructure that was originally already planned for re-construction or maintenance will fortuitously be completed during the earthquake repair phase. On the other hand some roads are becoming degraded earlier than had been expected as a result of traffic patterns having changed post-earthquakes.

It is understood however that CCC horizontal infrastructure programmes beyond the earthquake repair phase are yet to be determined. It is possible that funding constraints may restrict activity well beyond 2016 to levels lower than those forecast in the UDSIMG report in 2009, which was itself based on the then proposed CCC forward programme. It is recommended however that it be assumed, possibly conservatively from a demand standpoint, that the CCC demand will return to its pre-earthquake levels after say 2017.

The original pre-earthquakes programmed demand for CCC roading and piping was of the order of 1 million tonnes per annum. Hence an equivalent 'reduction' in demand of the order of 4 million tonnes was assumed in the CAPG report which was offset against the demand created by the earthquakes. Taking these factors into account the adjusted long term impact of the remaining earthquake demand on horizontal infrastructure demand is therefore estimated to be an overall increase of **1 million tonnes** during the period 2014 to 2016.

2.5.2 Commercial and Industrial Rebuild.

Whilst the initial phases of the commercial rebuild have been slower to gain pace than was originally anticipated by many, the CAPG report did in fact, as noted earlier, envisage that the commercial and industrial rebuild would be spread over a ten year time span. Given current uncertainties with respect to a number of major projects it remains difficult to be more precise about the timing of demand. However for the purposes of this report only, it is recommended that it be assumed that the bulk of the commercial and industrial rebuilds will be completed by approximately 2024.

Under normal circumstances new construction would have been taking place during this period, albeit at a lesser rate than presently anticipated. Whilst the earlier UDSIMG report contained an allowance for “business as usual” commercial and industrial construction activity it is recommended that this demand be retained as a contingency to cover the uncertainty inherent in the earthquake driven construction demand estimates. The adjusted, remaining long term impact of the earthquakes on commercial and industrial demand is therefore estimated as **1.5 million tonnes.**

It should be noted that once the reconstruction of the CBD has been completed it is likely that demand from this sector will fall below that predicted in 2009 as those building renewals previously forecast will have already taken place. Conservatively, however, these projections have not been reduced to account for the consequent impact on demand.

2.5.3 Residential Rebuild.

Sub divisional construction activity is generally cyclical in nature. At times of high housing construction activity the demand for aggregates is commensurately high. Such periods are frequently followed by periods of equally low activity. For example during the period 2002 to 2007 sub-divisional activity was high whereas activity then progressively fell to relatively low levels immediately prior to the September 2010 earthquake.

However in the long run sub-divisional demand is normally determined by population growth. Given the relatively short term cyclical nature of the demand from this sector, in comparison to the longer term nature of the overall forecasts, the UDSIMG report was therefore based on long run population trends. (As noted previously, the forecasts accordingly did not and do not purport to show demand on an annual basis.)

It should be noted that the demand for aggregates for sub-division construction to replace “Red Zoned” and other uninhabitable houses began from a point from where underlying demand was lower than average. Beyond the initial boost in demand it is probable that activity in Christchurch will return to average pre-earthquake levels as the permanent population (i.e. excluding temporary construction workers) begins to recover from the impacts of the earthquakes by approximately 2015.(7) (Population growth rates in Christchurch are not expected to return completely to pre-earthquake predicted levels until at least the end of the study period.)

However despite these factors it is recommended for planning purposes that the additional long term demand, created by the residential rebuild, be taken as approximately **1 million tonnes.**

2.6 Earthquake Demand Summary.

Taking all these factors into account the adjusted predicted remaining additional demand generated by the earthquakes for the study area is summarised in the following Table.

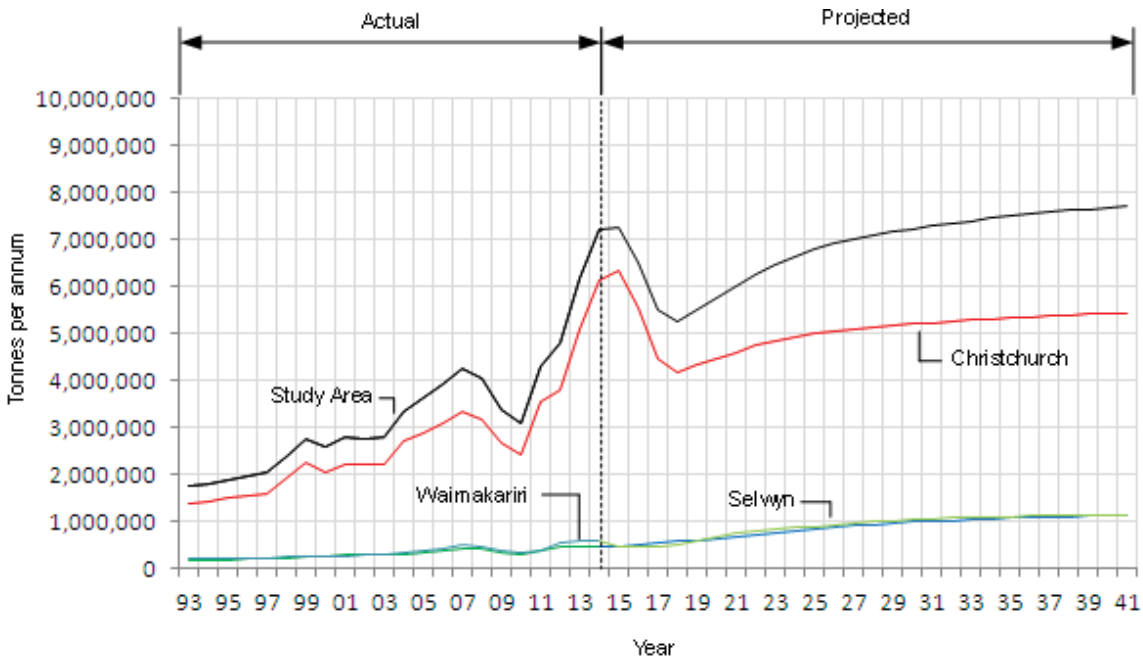
DEMAND	ADJUSTED QUANTITIES (TONNES)	PERIOD
Horizontal Infrastructure	1 million	2014 - 2016
Commercial / Industrial	1.5 million	2014 - 2024
Residential	1 million	2014 - 2016
TOTAL	3.5 million	

Table 4. Adjusted Remaining Earthquake Generated Demands. (All figures rounded.)

2.7 Overall Demand Summary.

The following table and chart illustrate the overall, revised predicted pattern of demands for the study, Christchurch City Council and Selwyn and Waimakariri District Council areas for the period to 2041.

(7) *“UDS Population Projections - Adjusted SNZ Medium Growth Scenario”*. Source: Market Economics Growth Model - 6th May 2014. Prepared: David Price, CCC Monitoring and Research Team.



Graph 12: Study, CCC, SDC and WDC Area Demands.

AREA	TOTAL DEMAND (TONNES)	
	2014 - 2028	2014 - 2041
Christchurch City Council	70,000,000	130,000,000
Selwyn District Council	10,000,000	25,000,000
Waimakariri District Council	10,000,000	25,000,000
STUDY AREA	90,000,000	180,000,000

(All figures rounded)

Table 5. Demand Summary (2014 – 2041)

A conservative approach has been taken throughout in evaluating these demands (i.e. the higher of any demand estimates have been used.) This is likely to lead to an overestimate of demand however this approach is considered to be prudent given the continuing level of uncertainty at this stage of the recovery process. The data indicates that the medium to long term impact of the earthquakes on demand, whilst being large in numeric terms, are unlikely to be significant when considering overall demand in the longer term. In fact the changes in demand intimated in this report fall within the margin of error for the overall forecasts to 2041.

2.8 Data Uncertainty.

The following table lists the potential levels of uncertainty associated with each data set.

UNCERTAINTY	VALUE	NOTES
Population	-10% / +10%	Local population increases are based on data provided by Christchurch City Council and the Urban Development Strategy team.
Production per Head	-25% / +25% (to 2028) -25% / + 10% (to 2041)	Whilst production per head has been generally in line with national trends, localised activity has the potential to markedly alter the relationship. A range of scenarios were therefore studied in the earlier UDSIMG report using the pre-earthquake t.p.h. rate as a base for calculations.
Long run Economic Activity (General)	-25% / +25%	Production is related to the general levels of economic activity both nationally and regionally.
Economic Activity (Construction)	Not directly used in calculations	Construction activity is related to general economic activity. However in the case of roading construction and maintenance, which constitutes a significant proportion of demand for local quarry products, demand is determined by central and local government policies which are sometimes out of phase with general economic activity.
TOTAL	-25% / + 10%	Potential variance in predicted demands

Table 6: Data Uncertainty - Study Area Future Demand (2014 – 2041).

Section 3. Resources.

3.1 Background.

The UDSIMG report *"Geological Investigation of Potential Aggregate Resources"*(8) indicates that geologically there are many areas suitable for gravel extraction. However for the purposes of this report only those sites presently within the areas specifically zoned for quarrying and / or currently consented for gravel extraction have been included in the resource totals.

3.2 Christchurch City - Land Based.

Consented, land based resources lie generally within the Christchurch City Council Rural Quarry (RuQ) and Open Space 3D (Isaac Conservation Park/Quarry) Zones. A small, but increasing number of consented sites lie outside these Zones.

Subsequent to the UDS report in 2009, resources within the zoned areas have been depleted at a faster rate than was originally anticipated as a result of the earthquake related demands. However several relatively large additional resources have become available as a result of a number of companies obtaining resource consents for new quarries generally located at Mcleans Island, but outside the previously zoned areas.

The total currently available resource (i.e. the sum of the remaining resource within the quarry zones and those in the consented areas outside the zones) is approximately **65 million tonnes** with an additional **8 million tonnes** anticipated to become available within the next twelve to twenty four months.

3.3 Selwyn District - Land Based.

A recent investigation concluded that the SDC owned, land based, resource presently totals approximately **0.5 million tonnes**. It should be noted however that this total is made up from a number of quite small lots. The resource is not distributed uniformly over the district and very few, if any, of these sites are likely to be suitable to supply materials to satisfy demand from either larger infrastructural or private projects.

There are presently six privately owned pits / quarries in the district. Three of these quarries are small, two are of a moderate size and one, opened recently at Burnham, has the potential to become large.

The currently consented resource within the three medium to large quarries is approximately **45 million tonnes**.

(8)*"Geological Investigation of Potential Aggregate Resources"* – Report No:.010809 – UDS: August 2009

3.4 Waimakariri District - Land Based.

There is a resource within consented gravel reserves of approximately **0.5 million tonnes**. (The remaining resource within the privately owned quarry is thought to be small.) There are no land based pits in the District capable of supplying materials for either larger infrastructure or private projects.

3.5 Rivers within Study Area.

The consented river extraction quantities are, in some instances, in excess of the material available. "Minimum Bed Level" conditions attached to the majority of resource consents limit the actual volume that can be extracted. This report has therefore reduced the consented quantities to those which are actually available. Only a small allowance for those resources potentially available from the Rakaia River has been included in the totals as the extraction sites are too remote from the majority of the demand to be an economically viable source of materials.

RIVER	TONNES ABOVE MIN BED LEVEL *	ANNUAL SUPPLY RATE (TONNES) * *
Ashley	3,500,000	25,000
Eyre	2,500,000	<1,000?
Waimakariri	7,500,000	425,000
Selwyn	2,000,000	25,000
Rakaia	1,500,000**	25,000**
Kowai, Cass, Lower Farm Stream, Hawkins River.	n / a	Quantities small in context of study
TOTALS	17,000,000	500,000

* Estimated volume above minimum bed levels (No allowance for areas of deficit)
** Estimated volume supplied annually by rivers. 25% of annual Rakaia supply allocated to study area.

Table 7: River Resources in Study Area.

Under these circumstances it is estimated that there is total one-off extractable quantity of **17 million tonnes**(9) available together with a supply of approximately **500,000 tonnes**(9), carried annually downstream by the rivers in the area, also available for extraction.

(9) Derived from pers comm: M. Surman, Asset Management Engineer, Environment Canterbury – July 14

3.6 Recycled Materials.

The quantities of materials presently in storage, and suitable for recycling into aggregate products, is estimated to be of the order of 0.25 million tonnes. It is difficult to know when, or indeed if these materials will eventually become available however their long term impact on reducing overall demand for virgin aggregates will be limited. They have therefore, conservatively, been disregarded in terms of existing resource estimates. (Refer to Section 4.3 for additional comments.)

3.7 Central Plains Water Enhancement Scheme.

The Central Plains Water Enhancement Scheme is predicted to raise groundwater levels. As a consequence existing and potential sites located in the areas where groundwater levels are already relatively high could, under some circumstances be adversely impacted and in the worst cases rendered uneconomic. An indication of the possible magnitude of the increase in groundwater levels (or "mounding") can be gained from the following figure.(10)

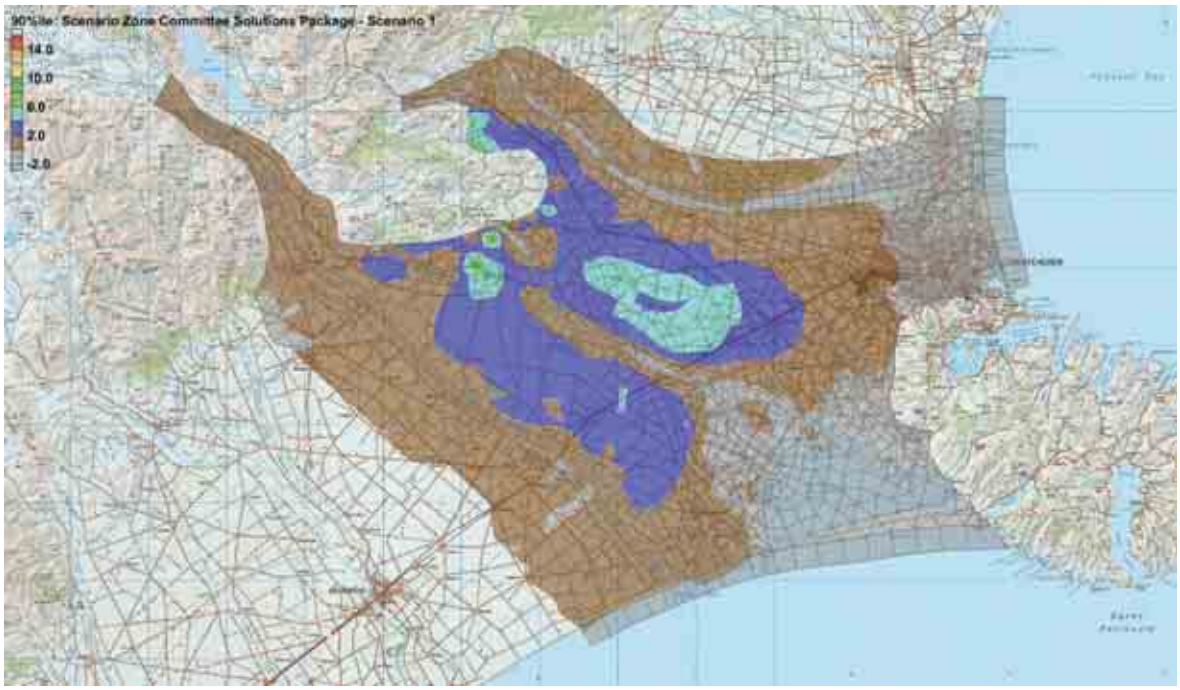


Fig 2: Possible Mounding Impacts of CPWES

In summary it would appear that groundwater level increases in both the current and potential future excavation sites in the Christchurch City council area may be of the order of 0 to 1.5m whilst in some sectors of the Selwyn district increases of 4m or more may occur.

(10) Fig 17 - "*Technical Report to support water quality and water quantity limit setting process in Selwyn Waihora Catchment. Predicting consequences of future scenarios: Groundwater Quantity*" Report No. R14/16 - Environment Canterbury: February 2014.

The eventual size, timing and impact of these increases are uncertain and dependant on the timing of the implementation of the full scheme, the time for the mounding effect to fully occur and the underlying groundwater levels at the time. It is understood that the full scheme may become operational in late 2018[11] and that the full extent of the mounding may eventuate 3 to 5 years later, although both these timings are subject to the level and timing of the uptake of the scheme by irrigators.

Whilst these impacts have not been directly included in the current resource size assessment, under certain scenarios the reduction in available resource could be of the order of 10%.

3.8 Additional Excavation.

At the time of compilation of this report the Canterbury Aggregate Producers Group (CAPG) was applying to Environment Canterbury for permission to excavate below currently consented maximum depths. Should the members of CAPG receive the requisite permissions this may, over time, release may be of the order of an additional 10 - 15% of consented land based resources. However, given the current uncertainty of the success of the CAPG proposal, these potential additional resources have not been included in the resource data outlined in this report.

3.9 Resource Summary.

AREA	RESOURCE (TONNES)	NOTES
Christchurch City	70 million + 0.45 million annually ex river	Includes Waimakariri River resource. Land based resource 65 million tonnes
Selwyn District	50 million + 0.05 million annually ex rivers	Includes Selwyn and (part) Rakaia Rivers resource. Land based resource 45 million tonnes
Waimakariri District	< 10 million	Includes Ashley and Eyre Rivers resource. Land based resource 0.5 million tonnes
TOTAL	+/- 130 million + 0.5 million annually ex rivers	Potentially additional 8 million tonnes available in CCC area in next twelve to twenty four months.

(All figures rounded)

Table 8: Study Area Resource Summary.

(11) http://www.cpwl.co.nz/scheme-development/construction-stages

3.10 Data Uncertainty.

The following table lists the potential levels of uncertainty associated with each data set.

UNCERTAINTY	VALUE	NOTES
Conversion of 'Solid' to 'Loose' Measure	- 10% / + 10%	Little technical data exists on the "in-situ" (or 'Solid') density of local alluvial, land based quarry deposits. A density of 2.1 tonnes per cubic metre (for 'solid' or 'unexcavated') land based material has been used in the calculations. (Note: Production figures are generally reported on a "loose" volume basis.)
Conversion of 'Loose' volume to Weight	- 10% / + 10%	Local industry accepts a general density of 1.5 tonnes per cubic metre of excavated /" loose material".
Excavation Depths	- 5% / + 0%	A conservative approach has been taken. It has been assumed that all disturbed areas have been excavated to full depth.
Access	< - 5% / +0%	All material presently assumed physically accessible however obstructions (e.g. power pylons) may exist which prevent excavation. (Potential land ownership access issues have not been addressed in this report.)
Quality	<- 5% / +0%	All material assumed usable. Occasional pockets of unusable material have been encountered in the past. Minor allowance made at Pound Road Block for known clay pan.
Permissible Excavation Depth	< - 5% / + 5%	A conservative approach has been taken. Some uncertainty exists over depths at Mcleans Island block
Area	< - 5% / + 5%	Derived from ECan and web based documents.
River Extraction volumes	-20% / +20%	Data ex ECan
SDC and WDC Quantities	-20% / +20%	Volumes not formally measured.
TOTAL	-10% / +10%	Subject to accuracy of SDC, WDC and ECan data.

Table 9: Data Uncertainty - Resources.

Section 4 . Demand / Resource Balance.

4.1 Resource Requirements to Fulfil Demand.

The following Table summarises the data from Sections 2 and 3 and notes the additional resources that will be required, if any, to be consented within both the study, Christchurch City Council, Selwyn and Waimakariri District Council areas to fulfil demands to 2028 and 2041.

AREA	EXISTING RESOURCE	DEMAND		ADDITIONAL RESERVES REQUIRED	
		2014 - 2028	2014 - 2041	2014 - 2028	2014 - 2041
Christchurch	70 million + 0.45 million annually ex river	70,000,000	130,000,000	0	50,000,000
Selwyn	50 million + 0.05 million annually ex rivers	10,000,000	25,000,000	0	(25,000,000) (surplus)
Waimakariri	< 10 million	10,000,000	25,000,000	+/- 0	+/- 15,000,000
Rivers	Included above	N/A	N/A	N / A	N / A
TOTAL	+/- 130 million + 0.5 million annually ex rivers	90,000,000	180,000,000	+/- 0	40,000,000

(All figures tonnes & rounded.)

Table10. Demands, Consented Resources, and Additional Resource Requirements.

4.2 "Life" of Existing Available Resource.

4.2.1 Study Area

In summary, the overall quantity of material currently available within the study area is theoretically capable (i.e. without regard to location) of satisfying demand until approximately **2035**. An additional **40 million tonnes** will be required to satisfy the remainder of demand to 2041.

4.2.2 Christchurch City – Land Based.

In theory the presently zoned and consented areas for quarrying will be exhausted by approximately **2031.** However given that the majority of materials supplied to the Waimakariri District originate from within the Christchurch City area it is possible that this date may be brought forward. To an extent this may encourage the importation of greater quantities of materials into the Christchurch area from the newly established quarries in the Selwyn District. It is recommended however that the exhaustion date of 2031 remain for planning purposes.

It should be noted that 8 million tonnes of the theoretical shortfall of 50 million tonnes to satisfy demand to 2041 is may become available within the next twelve to twenty four months theoretically extending the postulated exhaustion date by 1 to 2 years. As noted above a proportion of the remaining shortfall, dependent on the location of demand at the time, could be sourced from the quarries in Selwyn District. (Refer also sub-section 4.4 below)

4.2.3 Selwyn District – Land Based.

On the assumption that the extraction of materials from the SDC owned pits will be restricted in the future for use on SDC roading maintenance and construction projects only, it is likely that the existing pits will be exhausted in the near future. Three of the pits are likely to be empty within the next two years, whilst the life of the remainder will be dependant on their location and demand within the immediately adjacent areas.

However the recent establishment of three moderate to large quarries within the district will, in theory, be able to supply demand created by private and larger infrastructural projects within the district to 2041 and beyond, subject to the quantum of the transfer of materials to satisfy the Christchurch city and environs demand.

4.2.4 Waimakariri District – Land Based.

Provided WDC continue with their existing policy of restricting extraction from their pits to their own use then their resource has been estimated to last until 2026. The life of the privately owned quarry is unknown but is unlikely to extend beyond 2020.

However no quarries exist within the district capable of supplying private demand or demand generated by larger infrastructural projects. Increasing quantities of materials are likely therefore to be drawn from resources from within the Christchurch City area unless new quarries are established in the district.

4.2.5 Rivers within Study Area.

All rivers, and particularly the Waimakariri, are coming under increasing pressure as operators seek to eek out their existing land based reserves. It is difficult therefore to place a definite “life” on the present resource in the Waimakariri River. Very tentatively, it is possible that overall demand will outstrip total supply within the next 10 - 15 years at which point supply will reduce significantly to that equivalent to the natural replacement rate.

Other than for minor quantities, additional gravel that may be physically available from the Rakaia has, for the purposes of this report, been discounted as a source of aggregates given its distance from Christchurch - from where the majority of demand originates.

4.3 Efficiency of Use and Recycling.

A component of local aggregate demand may be driven by the relative cheapness of materials in the area. Given that transport is a major component of aggregate pricing, and that it is likely that many of the new extraction sites will ultimately be further from the demand than is presently the case, it is almost inevitable that aggregate prices will rise at a rate greater than general inflation. It is possible that this may drive an increase in efficiency of use. Allowance however has not been made at this stage for this factor other than where specifically stated in the future demand scenarios.

Neither has allowance been made for the general recycling of materials. Pre-earthquake volumes of locally recycled materials were probably in the 2 to 5% range of overall production. Anticipated volumes of potentially, ultimately recyclable materials are of the order of 10% of production.

4.4 Location of Demand.

The general locations and quantums of demand were described in the 2009 UDSIMG report[(5)]. Clearly the earthquakes have altered the shorter term patterns of demand. For example greater quantities of materials are currently destined for the Christchurch CBD than were envisaged in 2009. However the medium to longer term locations of demand remain similar to those predicted in 2009. That is, the urban areas of Christchurch in general will continue to dominate demand, with demands from the south western and northern sectors of the city and their immediate environs being significant.

Production facilities located at McLeans and Coutts Islands are well placed to serve the western and northern sectors of the city and the demand emanating from the Waimakariri District. Those quarries in the vicinity of Pound Road and locale are well located to serve the western, south western and southern sectors of the city. Unfortunately the Pound Road area is almost exhausted however recently established quarries in Selwyn District are potentially capable of effectively replacing this resource in at least the short term to medium term.

5. Conclusions.

Once the majority of the earthquake rebuild process is completed, increases in demand will be driven predominantly by the expanding populations in those areas identified for growth. (i.e. in general, the south western and northern sectors of Christchurch city and their immediate environs, Rolleston, Lincoln, Kaiapoi and Rangiora.) Whilst demands in these areas will continue to grow at rates greater than those for the remaining parts of the study area, overall, Christchurch city's demands will still dominate the local aggregate scene.

Demand for aggregates from within the Waimakariri district currently outstrips local supply. This shortfall is presently generally sourced from quarries within the Christchurch City Council area, there being no quarries in the Waimakariri District capable of effectively supplying materials for either private or larger infrastructure projects. Increasing quantities of materials are likely therefore to be drawn from resources from within the Christchurch City area unless new quarries are established in the district.

Whilst demand from within Selwyn district is increasingly being satisfied from sources within the locale it is likely that transfers between (i.e. both to and from) the Selwyn District and Christchurch City Council areas will continue for the foreseeable future.

River resources are presently supplying approximately one quarter of the study area's underlying total demand. However, even at present rates, these resources are being utilised faster than is sustainable on a long term basis. This situation will only be alleviated if additional suitable land based areas are made available for quarrying purposes in a timely fashion.

Demands generated by large infrastructural projects (e.g. the NZTA "Roads of National Significance") will place significant additional demands upon local gravel resources. It is possible that a proportion of the identified one-off demand will seek to utilise materials sourced predominantly from the Waimakariri River. This will inevitably place further pressure on that resource.

Although the remaining overall earthquake demand is large in numeric terms it remains within the margin of error for forecasts to the end of the study period (i.e. 2041) and as such does not effectively impact on the overall estimates of total demand. The impact of the earthquakes may however bring forward the need for additional resources in the longer term.

Within the wider study area the theoretical "best estimate", without regard to location, is for the existing resources to be exhausted by approximately 2035. It is projected that the existing zoned and / or consented land based quarries within the CCC area will effectively be exhausted by approximately 2031.Given these variables, the 2031 date should be treated with some caution.

The volumes of materials required to fill this gap to the end of the current planning horizon (i.e. 2041) remain relatively large and will require careful planning to ensure a continuing, cost-efficient supply of aggregates to the local market during the period under study. Whilst some of this gap may be filled by materials sourced within the Selwyn District it is thought prudent that the Council should plan to satisfy the city's own demands from within its own borders if at all possible. This strategy is likely to minimise transport distances and hence overall costs.

Section 6. Cautionary Notes.

Whilst care has been taken in compiling this report it should be noted that the time frames of the projections are quite extended and as a consequence the potential variance in demand is correspondingly wide. It is felt however that the quantities derived are sufficiently accurate for the purposes specific to this report. (i.e. the provision of an assessment of projected demand for, and existing and additional aggregate resources required for the supply of aggregates in the Christchurch area for the planning periods to 2028 and 2041.)

It should be emphasised that this report is not directly suitable for commercial use as it takes a conservative approach to the assessment of demand (i.e. errs on the upper side of projections) and is intended for District Plan review purposes only.

APPENDICES.

Appendix 1: Population Statistics and Projections.

Appendix 2: Demand Projection Statistics.

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Appendix 1: POPULATION STATISTICS AND PROJECTIONS

A.1.1 Study Area Populations.

City/District Summary Table **FINAL POPULATION PROJECTIONS : SNZ - Adj Medium**

LOCATION	2006	2011 Pre-Quake	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2028	2041
Inside UDS														
Christchurch City	358,778	364,592	362,631	363,936	366,030	368,233	370,240	372,361	374,481	376,689	379,096	381,701	396,550	423,660
Waimakariri in UDS	34,445	37,127	38,138	40,676	41,763	43,013	44,199	45,265	46,353	47,253	48,058	48,668	52,312	60,764
Selwyn in UDS	22,022	27,457	29,475	31,576	32,840	33,995	35,195	36,442	37,473	38,538	39,459	40,261	45,341	57,391
TOTAL UDS	415,245	429,176	430,244	436,188	440,633	445,241	449,634	454,068	458,307	462,480	466,613	470,630	494,203	541,815
Outside UDS														
Christchurch City	3,052	3,248	3,369	2,957	2,967	2,965	2,954	2,935	2,916	2,905	2,896	2,888	3,044	3,347
Waimakariri District	9,625	11,413	12,562	11,625	11,932	12,088	12,099	12,136	12,145	12,342	12,539	12,731	13,884	16,041
Selwyn District	12,948	13,663	14,725	14,018	14,251	14,505	14,502	14,453	14,625	14,660	14,740	14,840	15,160	15,070
OUTSIDE UDS	25,625	28,324	30,656	28,600	29,150	29,558	29,555	29,524	29,686	29,907	30,175	30,459	32,088	34,458
CH'CH, WDC & SDC	**440,870**	**457,500**	**460,900**	**464,788**	**469,783**	**474,799**	**479,189**	**483,592**	**487,993**	**492,387**	**496,788**	**501,089**	**526,291**	**576,273**

UDS Population Projections - Adjusted SNZ Medium
Source: Market Economics Growth Model - 6th May 2014
Prepared: David Price, CCC Monitoring and research team

A.1.2 Predicted Populations and Increases.

Area	Population*			Average Annual Per - Cent Increase		
	2014	2028	2041	2014 - 2028	2028 - 2041	2014 - 2041
Overall Study Area.	465,000	525,000	575000	0.9	0.7	0.8
Christchurch City (inc Banks Peninsula)	365,000	400,000	425,000	0.6	0.5	0.6
Selwyn District.	45,000	60,000	70,000	2.0	1.4	1.7
Waimakariri District.	50,000	65,000	75,000	1.7	1.1	1.4
New Zealand	4,500,000	5,000,000	5,500,000	0.9	0.6	0.8

*Figures Rounded

Appendix 2: **DEMAND PROJECTION STATISTICS.**

A.2.1 Past Demand and Population Patterns - Some Basic Statistics.

Statistic	Annual Per - Cent Increase			Notes
	1953 – 2008	1992 - 2008	2001 - 2005	1992 – 2008 represents the longest period for which relatively reliable statistics are available for national production. 2001 – 2005 represents the maximum annual rate of increase in the recent past. (i.e. Pre earthquakes.)
Average national increase in total production.	3.3	4.2	8.8	Average 2001 to 2008 = 2.6%
Average national increase in population.	1.3	1.2	1.5	Increase 1953 to 2014 = 1.3% Increase 1992 to 2014 = 1.1%
Variance in national consumption per head. (t.p.h.)	11.6 (max) 1966 4.4 (min) 1991	10.2 (max) 2005 5.5 (min) 1992	10.2 (max) 2005 7.8 (min) 2001	(t.p.h. = tonnes per head)
Average study area increase in total production	Data not available	4.0	9.0	Local data not available for period prior to 1992 Average less one-off projects 1992 – 2006 = 5.4% Average 2001 to 2008 = 2.6%
Average study area increase in population	N / A	1.6	2.2	Increase 1992 to 2014 = 1.1%projections
Study area consumption per head (tph)	Data not available	9.6 (max) 2006 5.0 (min) 1992	9.6 (max) 2006 6.9 (min) 2002	Local data not available for period prior to 1992