

Tables

TABLE 2.1: Major Projects – Gold Coast Region

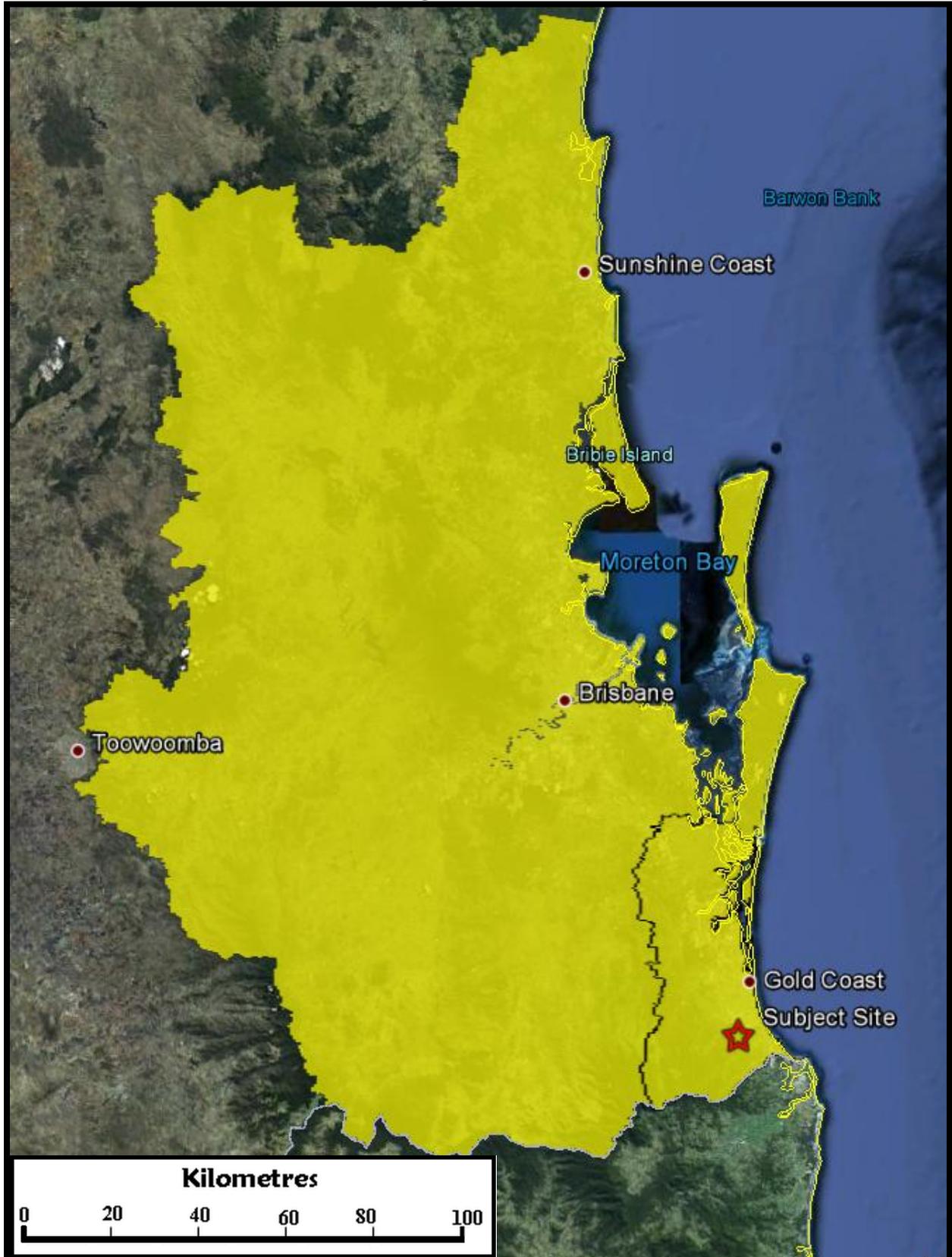
PROJECT	PROJECT DESCRIPTION
Transport	
Stage 4 Hope Island Road Upgrade	Stage four is currently in planning which involves the duplication of the Jabiru Island Bridges across Jaiburu Island and is the final stage of the state governments commitment to the \$166 million upgrade of upgrade Hope Island Road.
John Muntz Causeway	Tamborine-Oxenford Road. Initial plans to permanently repair the causeway, however, due to substantial damage suffered by flood waters in January 2012, the Department of Transport and Main Roads is seeking a long term solution through the replace the John Muntz Causeway with a bridge. Tender has recently been called for the building and construction of the bridge.
Smith Street Motorway Upgrade	Upgrade of the Smith Street Motorway to 3 lanes eastbound between the Smith Street on-ramp and Olsen Avenue interchange. Project is estimated at \$120 million with preliminary construction works including vegetation clearing and relocation of public utility services currently underway. Construction is expected to commence in 2013.
Gold Coast Light Rail	Stage one involves the development of the light rail system from the Gold Coast University Hospital (Parklands Drive, Southport) to Broadbeach extending 13 kilometres and includes the development of 16 stations. Construction of stage one commenced in January 2012, with passenger services scheduled to begin 2014. The ultimate route for the Gold Coast light rail extends 40 kilometres extending Helensvale to Coolangatta with planning within the early stages.
Nerang-Broadbeach Road (Future Transport Improvements)	Continued road improvements of Nerang Broadbeach Road through increasing opportunities for cycling, walking and public transport. Total spending is estimated at \$18 million with \$10 million allocated towards road improvements beyond 2015.
Worongary Exit 77 to Mudgeeraba Exit 79 (Pacific Motorway)	Widening of the motorway between Worongary (Exit 77) and Mudgeeraba (Exit 79) from four to six lanes with construction expected to commence late 2012/early 2013 with \$95.5 million allocated to the project. Completion is scheduled for early 2015.
Southport-Nerang Road Upgrade	Proposed two kilometre upgrade of Southport-Nerang Road between Queens Street and Minnie Street, including new road pavement, upgraded intersections and footpath improvements. Planning is continuing with construction anticipated to occur in 2014/15 subject to funding with \$54.4 million allocated up to 2014/15 under the Queensland Transport and Roads Investment Program (QTRIP) 2011/12 to 2014/15.
Old Coach Road Connector Corridor	Planning underway to investigate the provision of a new connection linking the Pacific Motorway and Old Coast Road to assist in the management of traffic growth on the western side of the motorway. The connection would provide a more direct route from Tallebudgera Valley along Old Coach Road.
Residential	
Maddison Estate, Pimpama	Approved 118ha masterplanned residential estate comprising approximately 2,500 dwellings, 2,500m ² retail space and childcare centre, parkland and recreational facilities.
Coomera Town Centre	Designated Principal Regional Activity Centre under the South East Queensland Regional Plan 2009 – 2031 intended to function as a higher order centre for the northern Gold Coast community including a mix of retail, commercial and community development with a dwelling target of 25,000.
Pacific View Estate,	Proposed residential estate located on along Hinkler Drive, Worongary. The Pacific View Estate is estimated to comprise 3,500

Worongary	dwellings and has been declared a Major Project.
Jewel Surfers Paradise	Approved in September 2012 the \$1 billion Jewel Surfers Paradise development is to comprise 215 luxury apartments over 41 levels in the northern tower, the central tower comprising a six star hotel with 300 suites and apartments over 45 levels; and the beachfront tower will have 108 premium residences over 35 levels. Commercial office and retail space would also be provided.
Tourism, Sport and Recreation	
Gold Coast International Marine Precinct	Featuring 28.9 hectares for a marine industrial zone, a stacked dry boat storage facility for about 290 vessels, 4.5 hectares internal marina with about 110 berths, external marina within the Coomera River with 280 multiple-sized berths, 9.3 hectares mixed-use precinct—sales showroom, office space, small-scale light industry, yacht club, restaurants and retail outlets, and a TAFE college including a 3,000 m ² Centre of Excellence and a workshop devoted to marine-industry training. Currently being assessed by the Coordinator Genera
Broadwater Marine Project	Expressions of Interest was released in November 2012 for the Broadwater Marine Project seeking the delivery of a cruise ship terminal as part of an integrated tourism development on state government owned land on the Spit or on Wavebreak Island. The integrated development could include a hotel, casino, marina, super yacht facilities, retail, entertainment, hospitality, community open space and recreation facilities and a mix of residential development.
Gold Coast Aquatic Centre Upgrade	Upgrading of the existing centre to international standards in light of the 2018 Commonwealth Games and the opportunity to host other major national/international competitions. It will include a 10 lane 50-metre competition pool, new change room, gym and toilet facilities, meeting rooms, event facilities, permanent seating for 1,000 people and refurbishment of the existing pool. Construction is likely to commence in March 2013 and expected to take about 16 months to complete.
Commonwealth Games 2018	Numerous infrastructure and development to be undertaken in preparation of the 2018 Commonwealth Games to be hosted on the Gold Coast.

Source: Gold Coast City Council Draft Transport Strategy, Gold Coast City Council pdonline, Department of Transport and Main Roads, State Government, Norling Consulting's Research

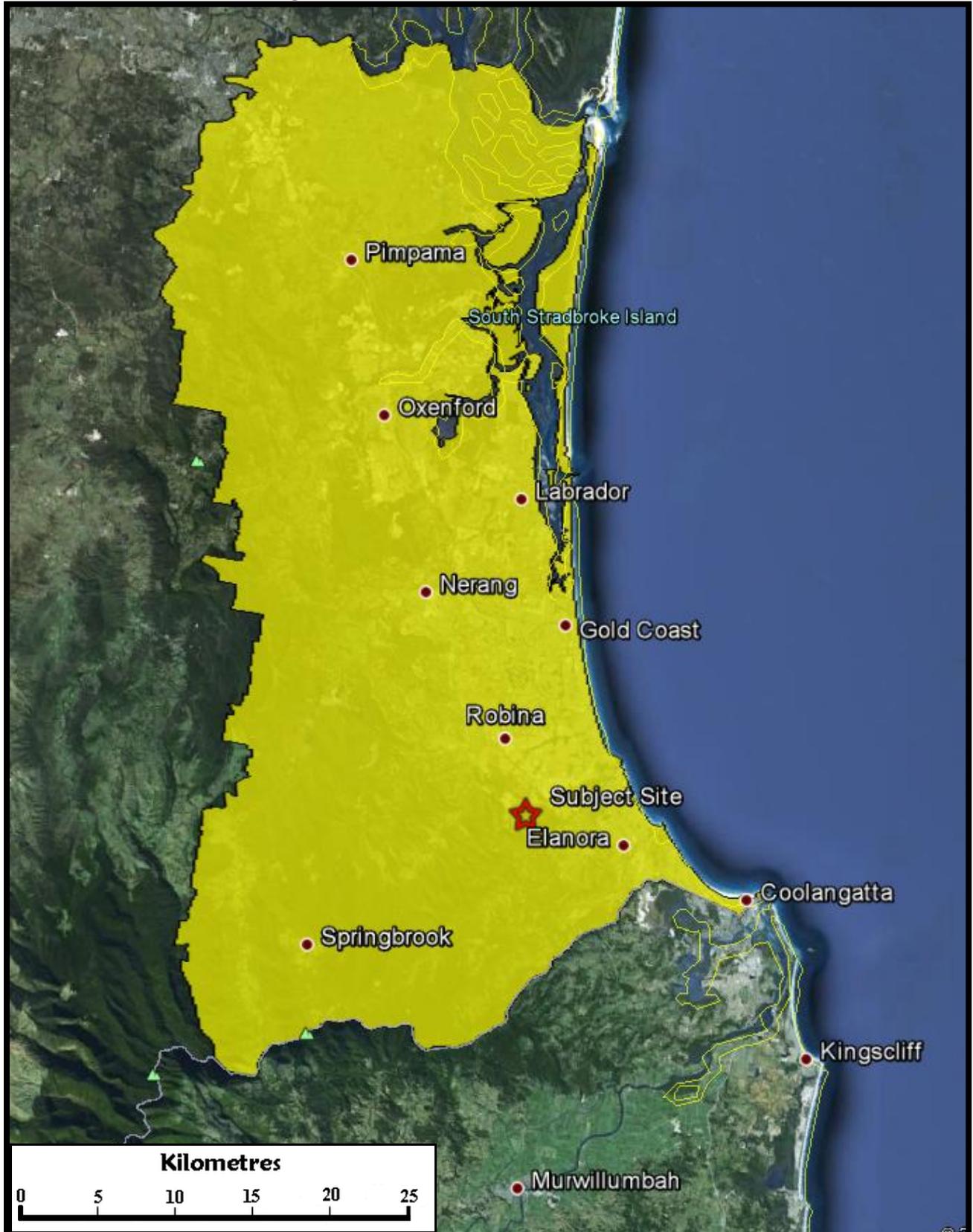
Figures

FIGURE 2.1: South East Queensland Region



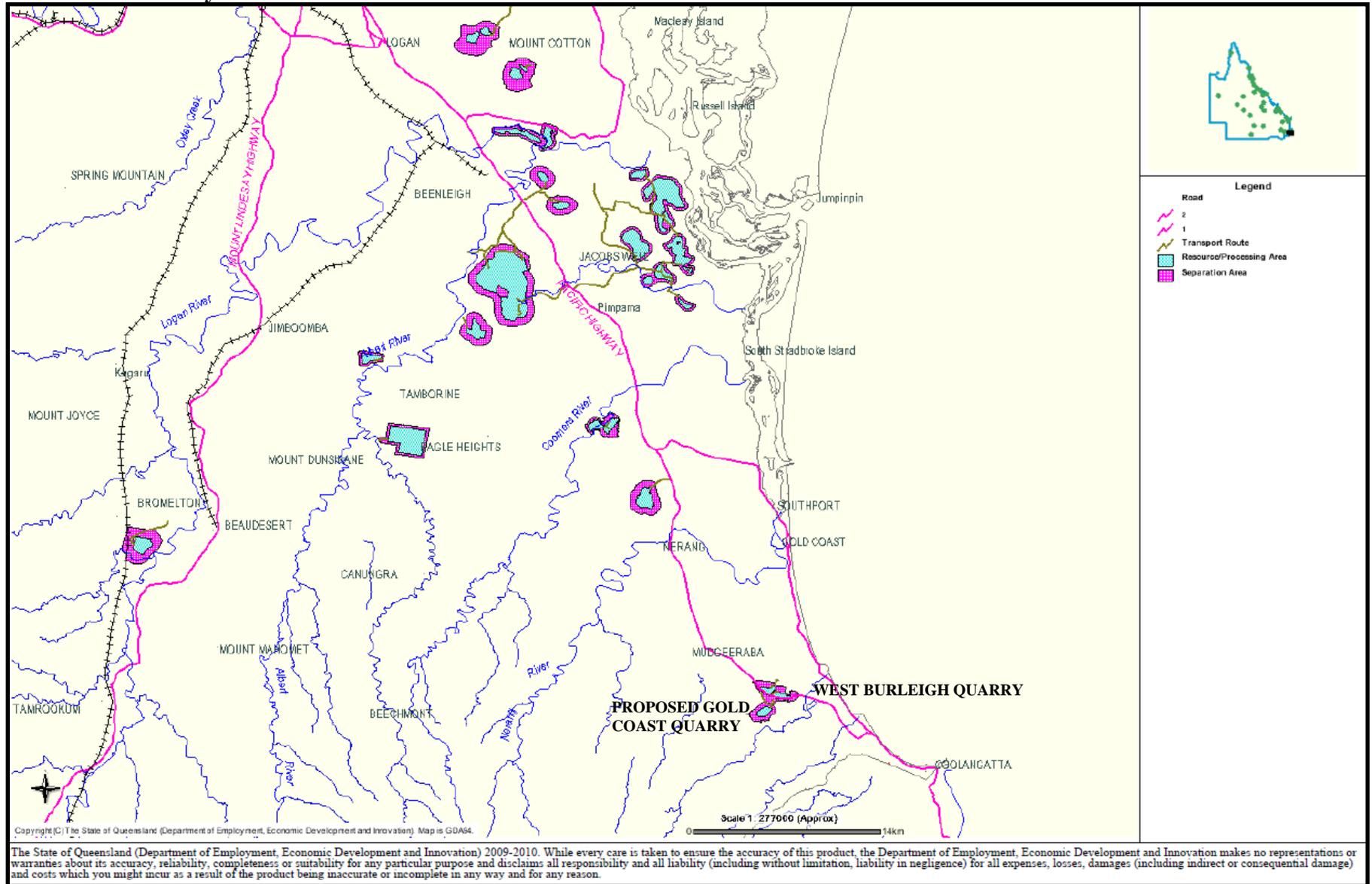
Source: Google Earth

FIGURE 2.2: Gold Coast Region



Source: Google Earth

FIGURE 2.3: Key Resource Areas

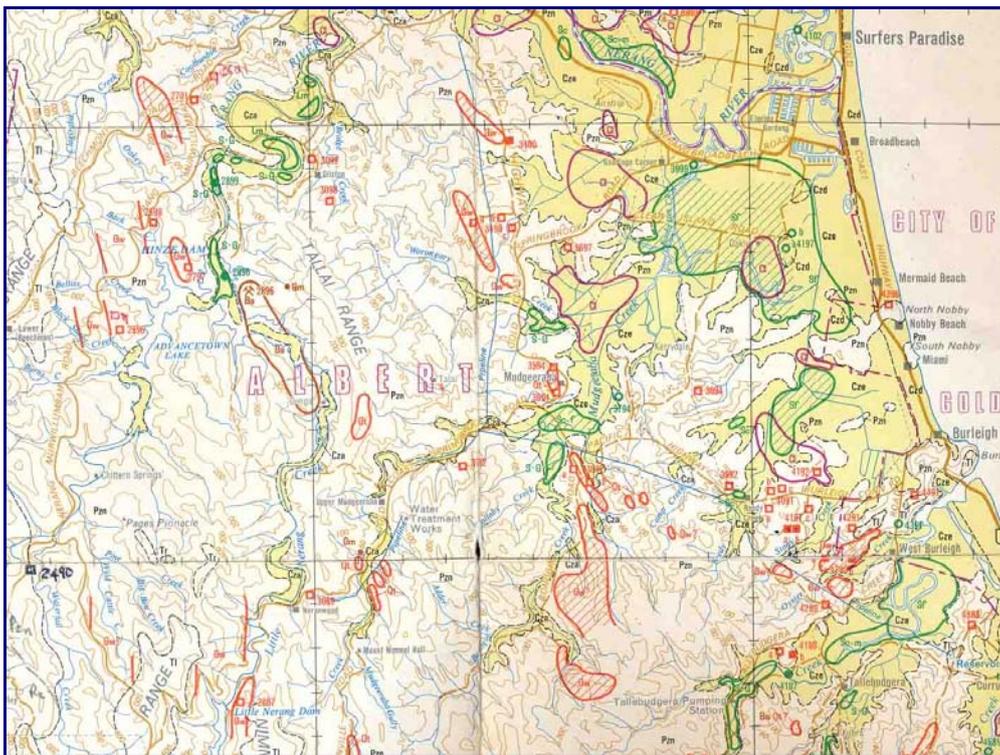


Appendix A

ALTERNATIVE QUARRY ROCK RESOURCES

SOUTHERN GOLD COAST

OVERVIEW OF OLD GOVERNMENT RECONNAISSANCE SURVEYS 1974-1992



ALTERNATIVE RESOURCES OF QUARRY ROCK - SOUTHERN GOLD COAST

Overview of old Government reconnaissance surveys 1974-1992

Introduction

In 1974 I undertook a reconnaissance survey of operating quarries and potential resources of quarry rock in the then Albert Shire and City of Gold Coast, whilst with the Geological Survey of Queensland in the Department of Mines (Willmott & Cooper, 1975). The aim was to outline resources of significant potential for consideration in land use planning by the two local governments, and to provide guidance for the industry. This information was later published in a broader report on the Beenleigh and Murwillumbah 1:100 000 map sheet areas (Willmott & others, 1978) and summarised in a report on the whole eastern Moreton Region (Willmott, 1979).

The information was reviewed in 1980 at the request of the Albert Shire Council which was compiling its Strategic Plan at the time (Willmott & Cooper, 1980). Major deposits throughout the Moreton Region, including some on the Gold Coast, were again reviewed in 1992 (O'Flynn, 1992).

I have been asked by the Boral Property Group to summarise this early reconnaissance work to assist with an identification of possible future rock resources on the southern Gold Coast that may be alternatives to the company's proposed quarry at Reedy Creek, West Burleigh. This has been requested as there have been no further broad-scale assessments of resources published since the early work. Here the southern Gold Coast district is taken to lie between the Coomera River and the New South Wales border. A similar reconnaissance of rock resources in Tweed Shire in New South Wales, some of which might have the potential to contribute to the Gold Coast market, was undertaken in 1975 (Chesnut, 1975) but this is not included in the present summary.

Geological background to the rock resources

Virtually all the rock resources of significance to the southern Gold Coast market occur within the geological unit termed the Neranleigh-Fernvale Beds. This underlies most of the district between the coast and the high plateaus to the west. As the nature of the rock deposits and the ease of locating them have been strongly influenced by the history of these rocks, it is worth summarising this history here.

The rocks were originally sediments eroded from a volcanic mountain chain, deposited initially on a continental shelf, and then re-deposited in a deep ocean trench off the edge of the continent by major slumping down submarine canyons in 'turbidity currents'. This occurred about 360 to 310 million years ago in the Devonian and Carboniferous periods when an oceanic crustal plate to the east was colliding with and being 'subducted' (dragged) beneath a continental plate to the west. The trench was the expression of the subduction zone. The sediments from the turbidity currents settled on the sea floor as fans of dirty, coarse sands and finer silts and muds. The coarser sands were deposited first near the foot of the slope, and the finer materials were carried farther to the east. Basalt lavas were also erupted onto the deep ocean floor, possibly from sea-mounts, and in places patches of silica-rich ooze built up from the accumulation of innumerable siliceous skeletons of microscopic animals called radiolaria.

At about 310 to 300 million years ago, the subduction process stopped, and the crustal plates were squeezed together. The sediments in the trench were compressed, deformed, and pushed up

above sea level to form mountainous terrain. The strata became steeply inclined and sliced by numerous faults, and the sediments became hardened and partially recrystallised ('metamorphosed') to new minerals. The coarse dirty sands became meta-greywacke, commonly called simply **greywacke**, the finer material became **argillite** (or meta-siltstone), the basalt lavas became **greenstone**, and the siliceous ooze became chert or **quartzite**. Most of the unit is composed of interbedded greywacke and argillite, with the greenstone and quartzite occurring only in isolated bands.

Greywacke is of most significance for the quarrying industry, as it is a hard competent rock that crushes to stable, reasonably equi-dimensional particles. Bands of quartzite have also been quarried, but they produce a more dusty product limited mostly to road pavement gravels, as potential for alkali reactivity limits their use for concrete or bitumen aggregates. Bands of greenstone are only known in the mountainous country to the west, and only one is quarried in the Albert River valley to the north (the Blue Rock quarry). Argillite is unsuitable for quarrying as it produces flaky particles on crushing.

Location of deposits of greywacke that can be usefully quarried requires the identification of sufficiently thick greywacke bands in an otherwise closely interbedded sequence of greywacke and argillite, as only small amounts of argillite can be tolerated in the crushed products. This is not simple, as the limited extent of the original tongues of coarser material on the sub-sea fans, the subsequent deformation to steeply inclined strata and the slicing up into numerous fault blocks means that individual beds of greywacke can rarely be traced any distance. They usually do not outcrop prominently, and give signs of their presence only by blocky rubble at the surface of the soil profile. Delineation of a deposit that looks promising at the surface requires careful drilling to determine its continuity and the proportion of argillite that may be present, as greywacke outcrops more readily than argillite. Bands of quartzite are more easily recognised as they resist erosion to give prominent ridges, commonly with red soils, but they are usually limited in width and extent.

Other rocks units with theoretical potential for quarry rock in the district include rhyolite lavas of the Chillingham Volcanics (Triassic in age, 220 million years old), and basalt lavas from the Tweed Volcano from 23 million years ago. However, there are significant if not insuperable problems of delineating any deposits within these units, as described below.

Methods of the reconnaissance surveys

It was clearly impossible to inspect every hill and ridge throughout an area as large as the Albert Shire for any promising greywacke and quartzite outcrops, and even if this had been possible drilling would have been necessary to confirm the presence of actual deposits. Instead the approach was to drive all roads and tracks to examine the rocks exposed in cuttings, to scan hillsides and aerial photographs for outcrops, and to traverse some more promising hillsides on foot. Existing quarries and their surrounds had been inspected previously and the knowledge of operators, Shire Council personnel and some landowners was utilised. No drilling was undertaken.

Exposures that seemed to have potential were described and shown on accompanying maps in two categories, namely Significant Sources (cross-hatched in red) and Possible or Minor Sources (outlined in red). Quite a number of Minor Sources were delineated originally, as at the time the Shire Council was working several small pits and there were more small operators in the industry who may have been interested in such small deposits. In the latter report (O'Flynn, 1992) most of these smaller deposits were not discussed further.

It was not claimed that all possible deposits had been located, but it was hoped that the most significant in the most important areas were included. This has been borne out by subsequent experience, in which some additional deposits have been located by industry groups, but close to deposits that had been outlined (eg, the Hymix Quarry north of Nerang, on an extension of an outlined band, and the proposed Reedy Creek Quarry of Boral on a westward extension of deposits outlined in Oyster Creek). Only the Coomera Quarry of the Neumann Group has been established on an unidentified band.

Overview of the findings of the reconnaissance surveys

In addition to the delineation of the specific Significant Sources and Possible and Minor Sources in the reconnaissance reports as described above, certain generalisations were made about the distribution of rock types in the Neranleigh-Fernvale Beds, which are pertinent to the present situation.

Greywacke

Enormous volumes of greywacke, in thick bands virtually without any interbedded argillite, exist along the foothills of the Springbook Plateau, along the western side of the Hinze Dam reservoir below Beechmont Plateau, in the Canungra Land Warfare Centre, and in the eastern foothills of Tamborine Mountain. The greywacke bands currently being quarried in less steep terrain to the north at Ormeau and Wolffdene appear to be on a continuation of this trend. (The prominence of such thick bands of the coarser material in the west may be a reflection of original proximity to the edge of the old continent). Whilst the reconnaissance surveys noted the presence of this material, with one exception they stated that workable deposits would be difficult to locate because of steepness of terrain, potential scarring of hillsides, existence of parks and reserves, and difficult transport to markets along narrow rural roads. As such they were considered only of very long term interest. The exception was an area south of Nerang adjacent to the Numinbah Valley road, and although this has been investigated, closer settlement has apparently made extraction not viable.

To the east of Nerang, east of the Pacific Highway and further north in Redland Shire, argillite appears to dominate the sequence, possibly reflecting deposition of finer material away from the continent. Only sporadic bands of greywacke seem to be present, and the depth of weathering is greater than to the west.

Between the thick greywacke bands on the west and the area where argillite predominates to the east, there is a more mixed sequence of interbedded argillite and greywacke. Within this sequence, a zone where greywacke bands are more prominent was identified. This so-called '*zone of bands*' of greywacke extends in a north-northwesterly direction from near West Burleigh to Nerang and Coombabah. At the time greywacke bands were being worked in this zone at West Burleigh (Readymix and Pioneer Quarries), at Gilston (General Quarries) and in quarries near Molendinar, and quarrying had ceased at quarries west of Merrimac and north of Nerang (Main Roads Quarry). The Hymix Quarry north of Nerang was established in another band of this zone in 1980.

A number of Significant Sources and Possible Sources were delineated along this zone, but even in 1975 and certainly by 1980 it was noted that increasing urban and rural residential development was beginning to preclude quarry establishment, and many sources were deleted from the revised 1980 report. Still considered of prime importance in 1980 were large greywacke deposits in the hills south of Bonogin Creek south of Mudgeeraba, although it was recognised that an access road other than the rural Bonogin Road would be required. Deposits at Oyster Creek at West Burleigh, and a southern extension of the Hymix band in the Nerang State Forest were also still considered of potential in 1980. However, O'Flynn (1992) noted in 1992 that the

planning policy of the Albert Shire Council was to direct future quarry development to the northern section of the Shire on the Darlington Range and in the Stapylton areas, and no provision was made for protection of deposits at the southern end. As a result rural residential development was allowed over the Bonogin Creek deposits, and later urban development occurred over the Oyster Creek deposit. (The Nerang State Forest containing the southern extension of the Hymix deposit has subsequently been converted to Conservation Park and has been crossed by major powerlines).

It is unfortunate that this West Burleigh-Coombah *'zone of bands'* of greywacke was in the path of the western expansion of the Gold Coast urban area, and that no provision for protection of deposits other than those of existing quarries was made. It contained appreciable resources, was close to areas of demand, and was conveniently placed adjacent to major transport routes and. No deposits shown on the original reconnaissance surveys would appear to remain available in this *'zone of bands'*.

The surveys did not delineate any significant greywacke sources west of this zone, until the greywacke in the problematical steep terrain below the western plateaus mentioned above was encountered. Some bands of greywacke undoubtedly exist there, but they are likely to be interbedded with much argillite. Moreover, the topography is more hilly than further east, access is along rural roads, and rural residential development has spread through the hills. Thus the finding of additional greywacke resources does not simply involve moving further west from existing quarries.

Quartzite

At the time of the reconnaissance surveys a major band of quartzite was being worked at West Burleigh by M and M Quarries and the Gold Coast City Council, primarily for road pavement gravels. Another smaller quartzite quarry was being worked beside the Tallebudgera Creek Road. It is understood that reserves at these operations have since been exhausted, and other small quartzite pits have closed. The reconnaissance surveys did not locate any further sizeable accessible bands of quartzite that would be of interest for a modern quarrying operation. Thick bands of quartzite form the summits of Mount Nathan and the Tallai Range, but steep terrain and increasing rural residential development precluded any interest for quarrying.

Greenstone

Bands of greenstone are only known in the steep terrain to the west of the Hinze Dam reservoir and in the eastern foothills of Tamborine Mountain. The difficulty of extracting the greywacke deposits in these areas would also apply to the greenstone occurrences.

Other rock types

There may be hard bands of *rhyolite* of the Chillingham Volcanics within the Canungra Land Warfare Centre west of Nerang, but steep terrain and operational needs of the Army are likely to preclude any extraction. In any case much of the rhyolite may be sufficiently weathered to disallow a satisfactory aggregate product.

Basalt lavas from the Tweed Volcano cap the Springbrook, Beechmont and Tamborine Plateaus, but are only accessible by narrow winding mountain roads. In addition, the basalt is usually deeply weathered, and even where thicker, harder layers outcrop, they are likely to be interlayered horizontally with softer, unsuitable flows, making establishment of a quarry face difficult. No deposits were outlined. At the time of the reconnaissance surveys a quarry was operated by Tweed Blue Metals in basalt at Terranora in NSW, where the basalt extends to somewhat lower elevations, but it is understood that this quarry ceased operations some time ago.

Conclusions

Within the southern Gold Coast area the reconnaissance surveys delineated an important 'zone of bands' of greywacke quarry rock extending north-northwest from West Burleigh to north of Coombabah. This contained several quarries and areas of future potential. However no planning protection was provided for the additional resources in the zone and it would appear that the zone has now been overwhelmed by closer settlement.

No significant deposits of greywacke were delineated immediately to the west of this zone. Some bands of greywacke undoubtedly exist but are likely to be interbedded with unsuitable argillite. Moreover the area is more hilly than that to the east, is serviced only by rural roads, and rural residential settlement was gradually spreading even in 1980.

Very large volumes of greywacke were identified in the foothills of the Springbrook, Beechmont and Tamborine plateaus, but steep and scenic terrain, the existence of parks and reserves, and poor access along narrow rural roads means that they cannot be considered available resources for the foreseeable future.

No bands of quartzite of sufficient size for a modern quarrying operation were identified, and other rock types offered little potential.

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